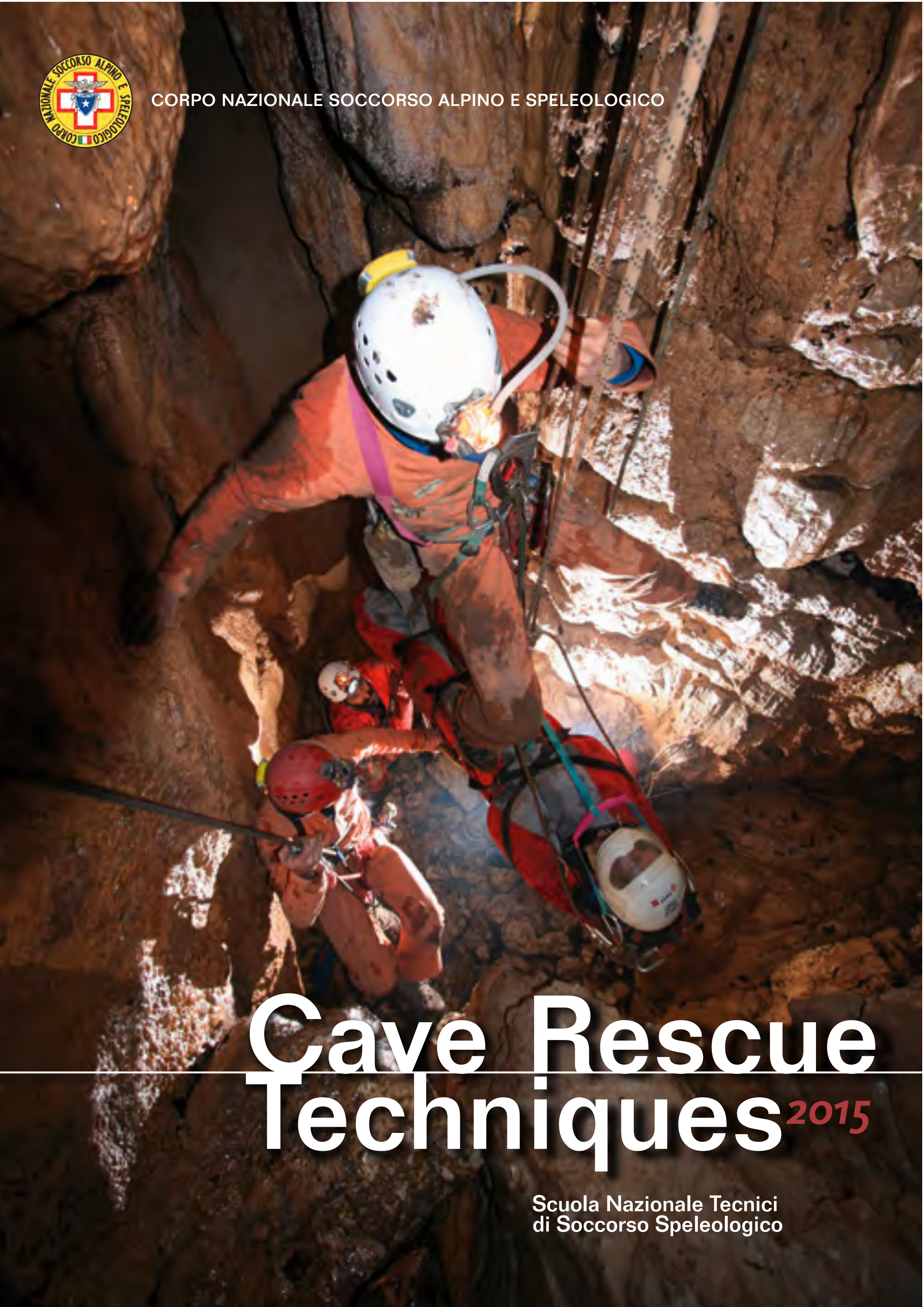


CORPO NAZIONALE SOCCORSO ALPINO E SPELEOLOGICO

Cave Rescue Techniques 2015

Scuola Nazionale Tecnici
di Soccorso Speleologico

Cave Rescue Techniques *2015*

Authors
Giuseppe Antonini, Matteo Baroni, Giacomo Berliocchi, Antonino Bileddo, Paolo Capelli, Federico Faggion, Francesco Fisichella, Angelo Iemmolo, Andrea Giura Longo, Ruben Luzzana, Paolo Manca, Sandro Mariani, Piergaetano Marchioro, Valerio Olivetti, Piero Palazzo, Michele Pazzini, Massimiliano Re, Andrea Sbisà, Gianpaolo Scrigna, Paolo Stenico, Cristiano Zoppello.

Former National trainers Liano Antonelli, Giovanni Becattini, Carlo Ferrari, Francesco Lo Mastro, Fabio Scabar, Stefano Scala, Marco Zurru deserve a special mention for creating the educational material from which this handbook is drawn.

Graphic design and Layout
Fortunato Della Guerra

Cover photo
Giuseppe Antonini, Paolo Manca

Translation
Federica Cuneo, Andrea Sbisà

Credits
Several Regional trainers, the Caving Technical Committee and many Cave Rescuers collaborated in the revision of this handbook. We would like to thank Giovanni Ferrarese and Elisabeth Gutiérrez Fregoso for their much appreciated help in the final editing and Angelo De Marzo for the photographs taken for vRigger®.

Technical drawings were performed with vRigger.
For more information, please visit www.vrigger.com

Foreword

Get into the habit, train yourself, to do whatever you are doing conscientiously, with elegance, with distinction, don't blur your work, don't do anything in bad taste, all anyhow. Remember that you can waste a whole lifetime on all anyhow, whereas in measured, rhythmic activity even things or tasks of secondary importance may help you to discover much that may later serve you, perhaps, as a most profound source of creative insights…

P. Florensky

Nomina sunt omnia

The Handbook on Cave rescue techniques illustrates the techniques adopted by the Italian Cave and Alpine Rescue Organization (CNSAS) to rescue injured cavers. These techniques are the result of decades of uninterrupted experiences, changes and improvements involving every level of the CNSAS. These techniques are characterized by the use of two ropes.

Two years after the Italian edition, we now present the English version - the translation of the handbook represented a stimulating challenge.

First of all, we aimed to assure clarity and ease-of-understanding, therefore we adopted a simplified linguistic structure. We then strived to search for well established terms which best conveyed our concepts. An example is the "back-up line", that in our opinion better indicated the role played by the second rope than "belay", a term that sometimes can be found. In fact, the second rope is used to improve the manoeuvres efficacy, and not their safety (as the Italian name sicura may erroneously suggest).

We also had to face another issue: how to translate the techniques that we have developped, and for which no equivalence existed. This forced us to consider the inner and deeper function of our techniques in order to name them appropriately - it is the case of the Releasable rope locking system.

Finally, we wanted to give an international breath to a handbook which was originally conceived within the CNSAS organizational structure. The CNSAS is formed by volunteers and it has a nationwide presence, it is therefore tightly connected to the various caving groups and societies. The CNSAS promotes the education and training of the rescuers at different levels through its national and regional schools. Purpose of the cave rescue training is to bring the technical skills of every rescuer to the highest level possible in order to minimize the need for teams' specialization or for specific roles within the teams involved in a rescue operation - each rescuer needs to be familiar with the different tasks carried out by a cave rescue team. This means that every rescuer should master the basic techniques as a minimum requirement.

The basic techniques, characterized by the use of a back-up line, are the key for spreading a safe and efficient rescue method. The use of a second rope may appear redundant, and sometimes it is. It nevertheless allows to a great number of rescuers to face complex or unforeseen situations. The back-up line can be seen as an always available spare wheel.

With that said, single rope techniques can be adopted in specific situations or based on the skills of the involved rescuers, as they allow for a more efficient use of the material, speeding up the teams work-flow.
From time to time the need arose to promote a transnational dialogue between the different national cave rescue organizations in order to increase the technical skills and lay the foundation for a more fruitful collaboration.
This handbook is intended to be used as a tool for future collaborations and it is a contribution to set up a common language.
We deliberately chose an open source of diffusion such as the electronic format. The handbook is released under a Creative Commons license imposing few limits to its use. We only ask you to acknowledge the CNSAS legitimate authorship of the document. Any suggestion is more than welcome and the e-format allows to easily amend the content than the paper format. We tried to give our contribute to promote the cave rescue to cavers from every part of the world.

November 2014
The Cave rescue national school

November 2014
The Cave rescue national school

Foreword to the 2013 Italian version

Cave rescue operations are luckily quite uncommon but, whenever they take place, they usually are so complex and long-lasting to involve rescuers coming from all the Country. This consideration resulted in the need to unify the techniques and training of the different rescuers. After many years, this standardization continues to be the real strong point of the Italian Cave Rescue Organization.

Back in the 80's, annual meetings were already held nationwide, where more expert volunteers from the different “CNSA cave groups” (as they were called at the times) showed the latest techniques and solutions adopted in their areas.

The Caving techniques committee was then born (preceded, to be honest, by the Cave rescue techniques working group or GLATSS) with the mission of collecting the diverse experiences and making a publication that the entire Cave rescue could refer to. The “Cave rescue exercise book”, an instalment collecting the result of this work, was born. We were in the 90's.

The National school didn’t exist and it was the Technical committee itself to both study the techniques and teach them nationwide. The classes were initially addressed to the team leaders, but soon they started to include also the more “expert rescuers” in the aim of consistently and progressively build a national organization. After a hard work the Committee finally released the "Cave rescue techniques” handbook in 2002. This represented an important milestone and it concurred to the consistent spread of the cave rescue techniques nationwide, accelerating the Training programme implementation in Italy.

We soon realized that testing and teaching the new techniques was a too demanding task for only one body. It was only a short step from here to setting up a National school in 2004, where many of the authors of the handbook, who organized trainings at national level since 1995, merged.

We immediately set the target to standardize the National trainers’ teaching approach and soon the need arose to have the appropriate tools, more for illustrating the “art of teaching” than the technique itself. The many refresher courses internally held provided for the standardization of the techniques but failed to show how to transfer information and know-how to future teachers. The first attempts consisted in short videos: effective but hard to update, and they asked for a huge effort of shooting and cutting. Therefore we opted for writing handouts based on the same drawings and schemes as the handbook. The handouts were intended to support the teachers by highlighting the sequence of a typical class and the related topics by following a logical approach, with the aim to simplify the teaching methods. This is what gave birth to the “educational sheets”, eventually integrated with the topics of major importance (“Warning”) and the frequently committed errors (“Common mistakes”).

The National and Regional schools activities were carried out in parallel with the writing of the handbook in an on-going flow of proofreading, adjustments and updating, drawing from the experience gained during the exercises demanded by the training programme.

The handouts have been a reference point for the National and Regional trainers to date and the icons drawn by Ruben Luzzana for the different sections became a nice habit. The handouts were, in the Cave Rescue National School aim, to converge in an educational book conceived as a compendium of the Cave rescue techniques handbook. This compendium was thought as a tool at the trainers disposal, but the hard and long standardisation and simplification work resulted in the need to correct the techniques described in the older handbook.

These hand-outs were therefore more up to date than the handbook and were at a certain point given to the trainees: it was sufficient to replace the subtitle "Explain" with "Information". It eventually became natural to consider the hand-outs as the new reference point for the rescue techniques in use.

The techniques handbook inevitably ended with being rewritten: the contents were updated, new topics were integrated and the general approach was reviewed, while maintaining the initial

structure of the hand-outs and their strong focus to the teaching. The old handbook is still a reference for some subjects, such as the communication and managing of rescue operations.

This handbook is the result of the three years' work by the National trainers. It sees the light with some delay because cost-saving needs required for the entire graphic layout to be performed by the same authors. Surely a demanding task, which however made possible to manage "on our own" the making of the drawings, with the advantage of making them immediately available, alterable and updatable. This eliminated the need to work in close contact with an external graphic designer, who was contacted only for the lay-out.

The RescueRigger© software was used for the drawings and the trainers have set up a special library containing all the objects used by the Cave Rescue.

This work should definitely be considered as a milestone when speaking of the techniques in use today; however, as is tradition within the CNSAS, we don't want it to have the last word but to be the starting point of future developments.

As with the former publications, this handbook may not be error-free and, from the very moment of its publication, we will start to think about the improvements and amendments to be made, the new information to integrate, and the next handbook to be released, but this is all part of the game.

I do want to stress that no remuneration or other form of incentive have been paid to the authors.

Antonino Bileddo
Director of the National cave rescue school

Structure of the work

The handbook has largely a technical slant and it is organized in three sections:

- the first section details the basic techniques currently used during rescue operations; these are the techniques referred to for training the Cave rescue operators as well as the prerequisite background for every Cave rescue technician;
- the second section covers the advanced techniques, with a focus on specific situations that may arise during a casualty rescue where basic techniques alone may not suffice; these techniques require specific skills for being implemented and performed and they are the main focus of the training programme for a Cave rescue technician specialize in rescue techniques;
- the third and last section takes into account the emergency situations, where specific and incidental circumstances hinder the use of the equipment normally supplied to the rescue teams or whenever there is the need to rectify a severe mistake in a critical situation; these manoeuvres are addressed to expert technicians and they are part of the Cave rescue technician specialized in rescue techniques training course.

BASIC TECHNIQUES

Photo Giuseppe Antonini

Lifeline

Contents

BASIC CONCEPTS

Information › The lifeline is a theoretic model that should always be considered whenever rigging a pit, whether it being for personal progression or to lift/lower a stretcher.
It consists in a combination of the overall components connecting a person to a support, generally a rock, and it is composed of: rock, anchors, rope, blocks/descender/lanyards, carabiners, harness and a person.
The goal is to have a line for progression or rescue respondent to safety, performance, reliability, installation time and materials economy criteria.

Warning › The main quality of a rigger is to successfully cope with all aforementioned requirements, bearing in mind that the casualty and rescuers safety is a main concern paramount.

Proper sizing of a Lifeline

Information › The strength given by the different elements composing a lifeline should be largely higher than the maximum stress generated during the progression or manoeuvre. The lifeline components should also show a similar strength: it would be illogical to use a heavy carabiner made of steel with a rated load of 45 kN when the peak load of a 10 mm knotted rope doesn't exceed 21 kN. The selection of the equipment and techniques to be used depends on the maximum stress the progression and the stretcher handling manoeuvres can apply on the lifeline.

Warning › We also need to further distinguish personal progression from rescue manoeuvres, in which respect additional assessments should be carried out.

Arrest force and Injury threshold

Information › When creating a lifeline in a line for progression (service rope), you may want to consider the force that can be generated by a fall according to the arrest force as defined by the applicable laws (Italian Legislative Decree 81/2008). This legislation also regulates the maximum arrest force, which must be kept under 6 kN.
In principle, the more a rope is static and the greater the fall impact a lifeline - and namely a rope – has to arrest will be: it's a matter of deceleration speed; it is therefore vital to familiarize with the injury threshold concept.
Human body is able to bear a deceleration of max. 15 g (i.e. 15 times the gravitational acceleration of the earth) and just for a few seconds, while the borne deceleration is limited to no more than 2-3 g when falling upside down.
Considering a bodyweight of 80 kg multiplied by 15 g, we get an arrest force of 12 kN.

Warning › The maximum tolerable arrest force on an upright seated person without causing permanent injuries is 12 kN. Still, the safety threshold (injury threshold) recommended doesn't exceed 6 kN (600 kg): above this value, human organs and spine can experience more or less severe injuries, and eventually death.

It is consequently necessary that the equipment and techniques composing our lifeline are able to keep the arrest force below 6 kN in case of any intervention aimed to arrest a fall.

Energy and forces: the Fall Factor

Information

› A fall generates energies that need to be dissipated as far as possible by the lifeline components in a non-destructive way, whilst limiting the energies transferred to the human body.

Most of the energy is absorbed into the elastic elements; in caves, on the progression rope, the elastic element ultimately in charge of the energy absorption is the rope - carabiners, plates and rock play a minor role as they are relatively non-deformable. Human body should ˜not be involved in the energy dissipation as far as possible feasible.

Warning

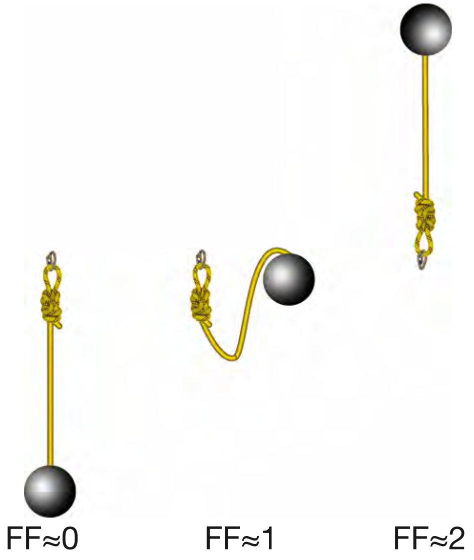
› During a fall, the rope in charge of holding the body stretches (strains) and it absorbs energy via the fibres elastic properties and the internal frictions, stretching until a certain point. This is when the above-mentioned arrest force (the maximum stress) develops and it shouldn't exceed 6 kN. The arrest force depends on the ability of a lifeline to absorb the generated energy.

At the same given conditions, different operating ways are available to keep the arrest force under 6 kN:

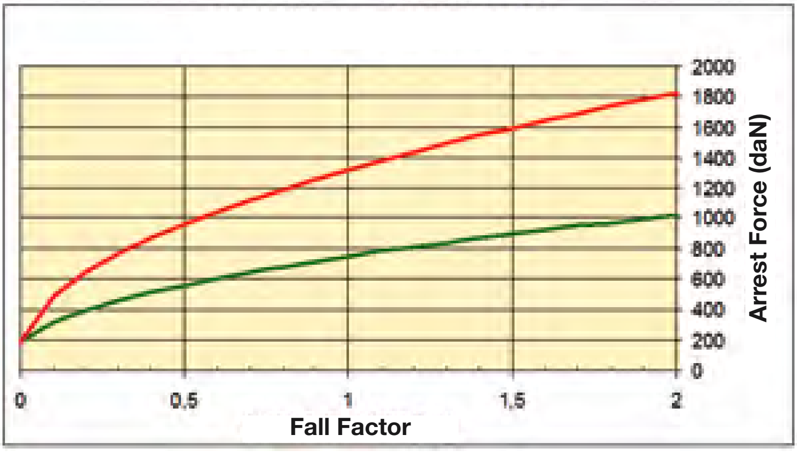
- increase the rope elasticity
- reduce the fall height and rope length ratio

The use of high energy absorbing rope (dynamic ropes specifically designed for climbing) is to be excluded: too elastic and hence uncomfortable to be used in a progression, not to mention their high susceptibility to abrasion. The only method left is to reduce the fall height and rope length ratio with the Fall Factor (FF).

$$FF = \frac{h}{L}$$



The following graph shows the FF and Arrest force ratios registered with a semi-static rope (red) and a dynamic rope (green).



Warning ⚠ › Semi-static ropes employed in rescue and for progression are designed to keep the AF under a level likely to cause permanent harms to a person falling in upright seated position only with a FF of 1. Exceeding this value can cause higher AF's and even the equipment failure.

When falling on a semi-static rope, a fall factor of 0.3 (i.e. a fall from 3 Mt with a 10 Mt rope) can ideally be sufficient to reach the injury threshold (6 kN), so it might happen that, in case of FF= 1, although the rope may not break, extremely severe injuries and even death may occur.

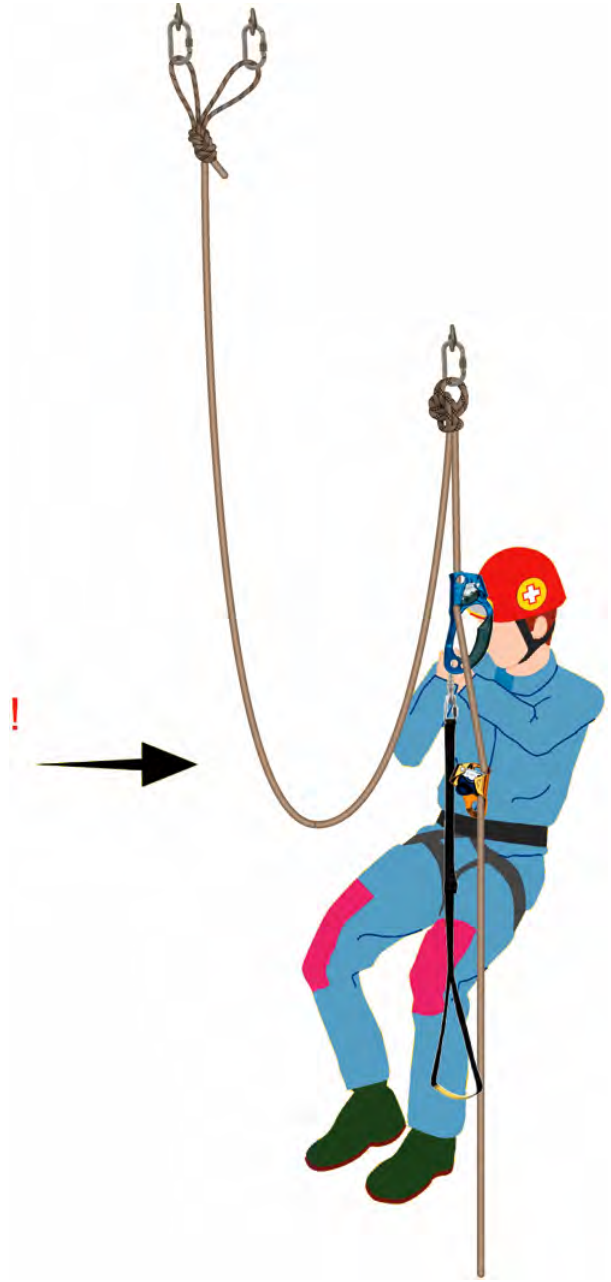
This is patently non acceptable and that's why we need to adopt all the necessary measures to avoid a fall with a FF higher than 0.3.

INDIVIDUAL PROGRESSION

Information

› In a rope for progression, the lack of specific precautions in personal equipment and in the use of materials may result in a FF near or higher than 0.3.
The typical example is the fall of someone secured to an anchor through a non-tensioned lanyard (see picture).

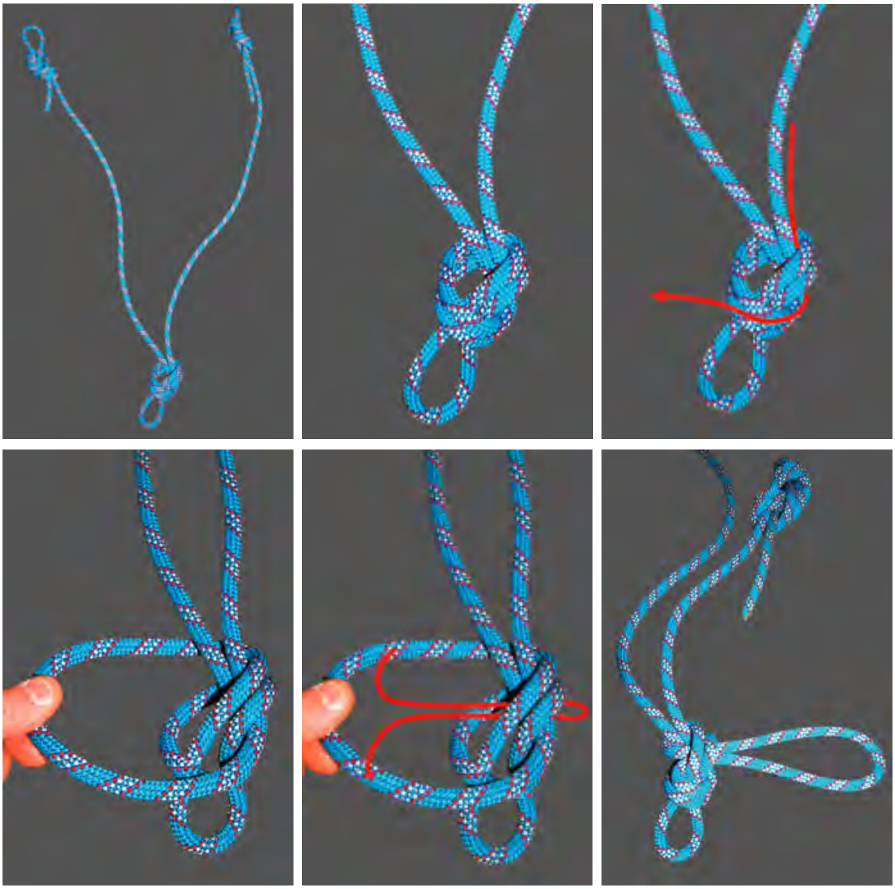
Another example is a rebelay made a little under the fitting: again, the FF generated in case of anchor failure can reach or exceed 0.3 (picture), especially if there is a great slack.



Conversely, apparent dangerous situations such as an artificial climb with static ropes can show a FF under 0.3 if the rebelays are correctly used (as to limit any frictions) and a dynamic belay (Munter Hitch) is adopted. The reason is that the last rebelays limits the height fall and, most of all, most of the energy is absorbed in the rope running through the Munter Hitch.

Warning ⚠

› In concrete, the major risks are related to the cowstail, as we are frequently secured to it and exposed to a potential fall (e.g. handrails and rebelays).
Consequently, if a fall factor ›1 cannot be completely excluded, we should use a cowstail showing proper absorption performances.
It has experimentally determined that the most reliable cowstail (in terms of energy absorption) are those made of dynamic rope with a trilonge knot at the top; a trilonge can in fact bear falls of up to 1.5 FF, allowing for a valuable excess even at the most critical operative conditions. Such a reassuring findings are also due to the well-known "knot effect", where the micro tensioning of the knot's loops facilitates the dissipation of the energy generated during a fall. Tests showed in fact that a cowstail reliability decreases after a year of intense use, after which the material starts loosing efficacy in terms of physical and mechanical properties due to wear and the knots become over-solicited because of the repeated suspensions. A cowstail should be replaced at least once a year in order to be reasonably safe.



Some words should be spent on the so-called hyper static cowstails made of Kevlar cord (even if doubled) or of dyneema sewn ribbon: in this case, laboratory tests showed either a high arrest force, significantly higher than the injury threshold, or the cowstails failure even with a FF = 1. According to the manufacturer's recommendation, these cowstails (positioning cords) should be used in a positioning situation (i.e. suspended on a tensioned cowstail), a situation unlikely to occur in caves because of the specific operating conditions.

Using these cowstails is therefore not recommended, while it would be advisable to tie a cowstail on a dynamic rope - namely using a trilonge knot.

MANOEUVRING TECHNIQUES

Information › Rescue techniques usually deployed tend to place a huge stress on the lifeline, although falls are not expected to occur.
So as a guide, the strength of the weakest element of your lifeline must be three times higher than the maximum envisaged stress, as rigs and materials resistance will be put under stress over an extended period of time. In other terms, rescue techniques generate certain tensions that wear the materials (aluminium alloys in particular) out, getting them close to their working limits even without reaching the rated failure load.
This is something of the uttermost importance, since it directly affects the rescue techniques to be adopted.

Warning › We'll use the "washing line" technique as a way of example. In special operating conditions, this technique might generate up to a 7kN tension, so the lifeline will be sized considering a 21kN resistance. This should be a "real" value, without considering the induced resistance due for example to the rope knots.
If the proper resistance cannot be assured, we'll clearly have to go for an alternative technique to generate lower tensions.
Staying with the "washing line" technique, the peak forces observed are quite high, very close to the working limit of some of the equipment employed for rescue (e.g. rope/blocks interactions).
Please note that coping with such an elevated tension requires more attention on the correct positioning of each lifeline component, such as the carabiners, which, though safely bearing 7 kN, don't tolerate any torsion or lever against the rock when put under high tensions.
If this is the case, you will opt for more suitable materials and, as regards the carabiners, super-light models featuring an advanced geometry (e.g. small-sized, narrow carabiners) are to be excluded.
One more example: plates. The best choice for our intended purposes rests on steel

plates; steel performs well under frequent use and extreme working conditions, it is more yielding and less susceptible to micro cracks compared to the aluminium alloys.

SAFETY: MISCONCEPTIONS AND INACCURACIES

Information

We'll now target safety in all material respects, with the precise intention of stimulating a critical reasoning on what safety really means.
Let's start from a definition of safety: "to know that the evolution of a system will not result in undesired consequences"; in other words: to be aware that the surrounding environment and our actions will not cause damages. As regards the rescue activities, we give a practical effect to this definition applying a logical scheme (check list):

1. risks analysis;
2. selection of the more suitable rescue techniques depending on the situation;
3. use of safe equipment;
4. appointing trained and experienced rescuers to manage the rescue operation.

Following the "We will not do anything that may cause damage" principle, the first (and most important) step consists in analysing the risks; after having localized the risks, we will choose the more suitable rescue procedure.

Warning

What are the effective risks connected with the rescue of a stretcher?
Rockfall, a rope failure, a severe operating mistake.
If we analyse these causes, we will find out that they can all be traced back to a human mistake - even a rockfall in a pit is the direct consequence of a human mistake, resulting from a superficial risks analysis (rope trajectory not having been verified, unexpected impact with the rock and subsequent detachment; attendance of not suitable areas of the pit, etc.).
Rockfall represents the most serious threat to the ropes integrity (apart from endangering the stretcher and the stretcher's operators, of course), as there is a high risk of both ropes (main and back-up) failure caused by the collision with a stone.

Hauling and belaying in vertical rescue

Information › When performing a vertical rescue in a pitch, a two-rope system (main and back-up rope) cannot provide safety, which is instead assured by clearing the loose stones from the pit walls and looking for an appropriate trajectory.
In case of rockfall, safety cannot be guaranteed doubling the line. Conversely, if we are able to exclude rockfall and other potential causes of rope damage, the use of a single rope (a practice admitted in given emergency situations) can be actually considered safe.
With that said, the lack of the back-up rope requires specific skills and experienced rescuers prepared to adopt some specific technical tricks to manage, e.g., the exit of a stretcher from a pitch, the passing of any knots, etc.
The back-up rope is a parallel line that can operate with the same performance of the main rope, the utility of the back-up rope is useful both as a holding element in case of damage of the main rope, therefore as an element of redundancy, than as a a secondary haul line that facilitate manoeuvres such as the exit from a pitch, the passing of a knot, stretcher adjustments etc.

Warning › In the light of the above, we need to redefine the belay rope role.

Hauling and belaying tyrolean traverse lines

Information › In a real situation, the failure of a load-bearing rope would be a disastrous event, unless you have lot of space under the tyrolean line trajectory: safety cannot be guaranteed simply by the main and back-up ropes, the core role of which is merely to pull and control the stretcher on the bearing-load rope.
In a similar situation, safety is assured by:

- avoiding any contact between the load-bearing rope and the walls (shear and/or abrasive edges);
- making "unbreakable" fittings.

Warning › Preventing any rope and anchor failure is in essence the only thing to do, knowing that the occurrence of any of the specified situations will almost certainly cause the stretcher falling into the ground. The same can be said about the diagonal tyrolean traverse: again, any failure of the load-bearing rope may result in dramatical consequences.

Angles and tensions

Information › Deviations play a crucial role during a cave rescue, as they can eliminate any friction that would otherwise be generated by the contact with the rock.
While the use of deviations - and first of all the mid-pit deviations - cannot be renounced, we should pay attention to the generated tensions, particularly those placed on the attachment points.

Warning › When taking up a given load, the deviation angle directly affects the applied load on pulleys and attachment points.
Some examples can better illustrate the tensions generated as angle changes and, consequently, as the main attachment points is differentiated from the secondary one, sizing the amount of anchors according to the existing forces.

STANDARDS FOR ROPES: CE MARKING AND UIAA LABEL

Information

› Materials marketed in EU must exhibit the CE (conformity) mark and meet the applicable European directives (rules).
These directives are accompanied by one or more technical standards (EN) detailing a series of requirements the product needs to meet to obtain the relative certification.
As regards the technical gear for climbing and caving (as well as the equipment for work-at-height), part of them are considered life-saving equipment and are subject to strict controls: these are the so-called **P**ersonal **P**rotective **E**quipment (**PPE**) of Category III. In order to obtain a CE marking, PPE's of Category III undergo to a conformity assessment carried out by a Notified Body, who verifies that the performances declared by the manufacturer meet the technical standards.
There are three categories of PPE ranked in ascending order: Category I includes, e.g., sunglasses, while helmets belong to Category II and ropes and carabiners fall under Category III.

Warning

› In addition to the mandatory CE marking, a PPE may also carry a UIAA label: it is a quality certification released by the International Mountaineering and Climbing Federation, gathering the world most important mountaineering organizations.
We emphasize that the UIAA safety label is not mandatory, but it is a quality certification for those products meeting UIAA standards, which are stricter than those set out by EC legislation and regard climbing equipment only. (There aren't any UIAA standards ruling, for example, semi-static ropes).
The presence of CE marking on PPE is an indication that it is safe and it meets safety requirements, but it also involves direct repercussions with respect to liabilities.
The use of similar equipment during organized activities imply liabilities at different levels, from the direct user to the organization in charge of the activity.

Fulfilment and liabilities

Information

› Within the organized cave rescue, professional rescuers need to have their own PPE's, and make them undergo to regular checks and replace them with new ones:
- in case of actual or suspected damage
- if tear and wear undermine the product safety;
- if the time limits recommended by the manufacturer are exceeded.

Warning

› It is to note that cavers may use any equipment under their own responsibility (except for insurance litigation) when carrying out an individual (personal) activity. On the basis of the unpredictable nature of rescue operations and of the inaccessible and hostile environments in which rescuers operate, CNSAS benefits, within the scope of the rescue activities, of specific exceptions to the local occupational safety laws (D. lgs 81/2008). As a consequence, CNSAS enjoys a relative freedom in choosing the equipment, and rescuers carrying out their institutional tasks are allowed to use mountaineering equipment - even if it's not properly considered as PPE's - as long as it is included in a list set out by the reference national schools. It is the case of descenders, which are used in an individual progression as an alternative to properly said PPE's descenders in virtue of their reliability and simplicity of use.

Warranty

› Each product is generally covered by a 3-5 year commercial warranty starting from the manufacturing date. Why the warranty is important: because starting from its expiration date, the manufacturer is not bound to repair or replace any defective product at no extra cost.


Photo Paolo Manca


Photo Paolo Manca

Knots

Contents

Among the many and different knots that can be used in cave rescue, we have selected only those fulfilling a series of requirements, such as strength, ease-of-execution, ease of release after bearing heavy loads, convenience-of-use and ease of visual check ("at a glimpse") by someone OTHER than the rigger.
There is a wide reference bibliography, CNSAS manuals included, proposing valuable options.

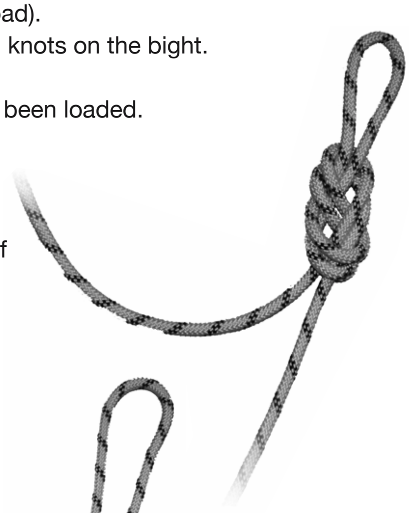
BASIC CONCEPTS

Information

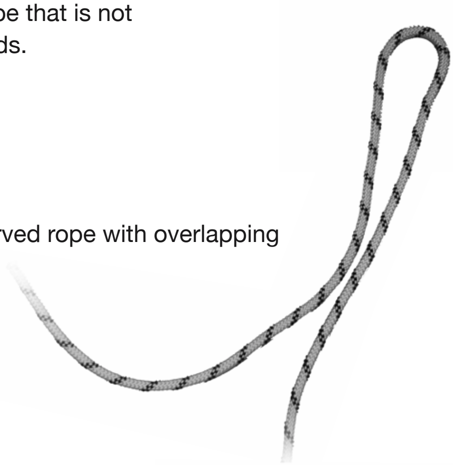
- We use different knots as one knot may be more suitable than another in a specific situation.
- A knot reduces the rope resistance (residual load).
- Knots can be divided in end of rope knots and knots on the bight.
- Knots have to be easy to tie.
- Knots have to be easy to untie after they have been loaded.
- Knots have to be stable under load.

Rescuers should familiarize with the correct use of the following terminology:

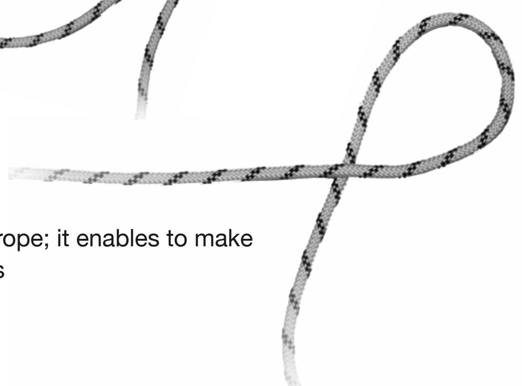
- **tail:** end or bit of rope that is not intended to bear loads.

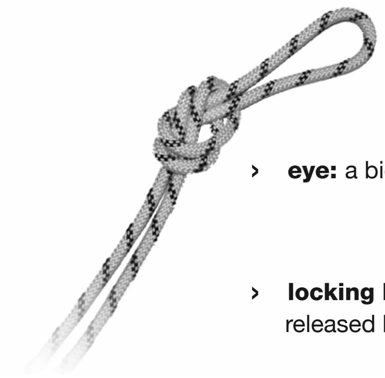


- **loop:** a length of curved rope with overlapping ends



- **bight:** a doubled-up section of a rope; it enables to make a knot without using the rope ends





› **eye:** a bight ending in a knot

› **locking loop (slippery hitch):** A stopper knot that can be released by pulling the free end.

Warning

- When making this knot, attention should be paid not to overlap the turns: the knot pattern has to be observed so to be easily recognizable also from a distance.
- Check the knot has been pre-tensioned before loading.
- The rope tail emerging from the knot has to be at least 20 cm long after having manually pre-tensioned the knot (and at least 40 cm long in case of overhand knots).
- Add a stopper knot if applicable.

Common mistakes

- The tail is too short.
- The knot has not been pre-tensioned.
- The knot is not well dressed.

TYPES OF KNOTS

Information

- Knots can be classified in four main groups: binding, bend, sliding and autobloc knots.
- It is important to familiarize with the appropriate terminology, i.e. "friction knot" instead of "savoy", etc.

Warning

- Immediately identify the knot's intended use.
  Binding knots: knots used to firmly bind a rope; they are ideal in securing a stretcher and for anchors in general.
- Bends: a bend is a knot used to join two or more rope sections or ropes together at their ends.
- Sliding knots: knots intended to be used as a friction device or for belay.
- Autobloc knots: knots used as a self-blocking belay on ropes and in emergency situations.

Common mistakes

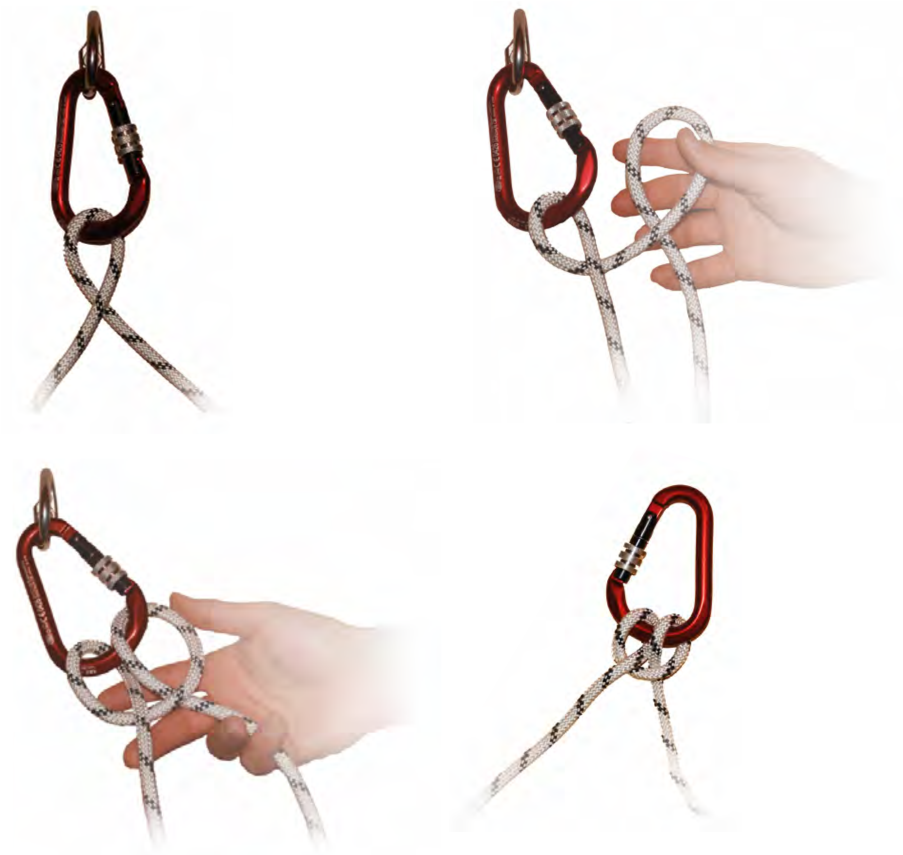
- Using different names to indicate the same knot.

BINDING KNOTS

Clove hitch

Information

- It uses very little rope.
- Easy and quick to tie.
- Easy to adjust before loading.



Warning

- Low residual load.
- Quite weak on large anchors, particularly if the load swings. In this case, a stopper knot is needed.
- When tied on small anchors (rings, carabiners), it is difficult to untie after tensile loads.

Common mistakes

- Forgetting to add a stopper knot.

Figure-8

Information

- Extremely easy to tie and identify.
- It shows a good residual load.
- Ideal for attaching service ropes (rebelays, anchors).
- It can be used also as a binding knot with a safety eye.
- It is very weak if used as a binding knot with ropes tending to undo the knot.

Warning

- Time-consuming to untie when under heavy loads.
- Time-consuming to adjust.

Common mistakes

- Overlapping the turns makes it harder to untie.
- Using the knot to attach a rope on a large anchor, i.e. a tree or a big rock: time is wasted in adjusting the knot.

BINDING KNOTS

Double Figure-8

Information

› Extremely easy to tie and identify.
› It shows a good residual load.
› Ideal to attach service ropes on near double anchors.

Warning

› Time-consuming to untie after being put under load.
› It is not easy adjust the rope length (shorten or lengthen).
› You need lot of rope to make it.

Common mistakes

› Overlapping the turns makes it harder to untie.
› Using it to attach a rope on distant anchors: it uses lot of rope and it is difficult to adjust.
› Adding a follow-through on the rope end would be time-consuming.

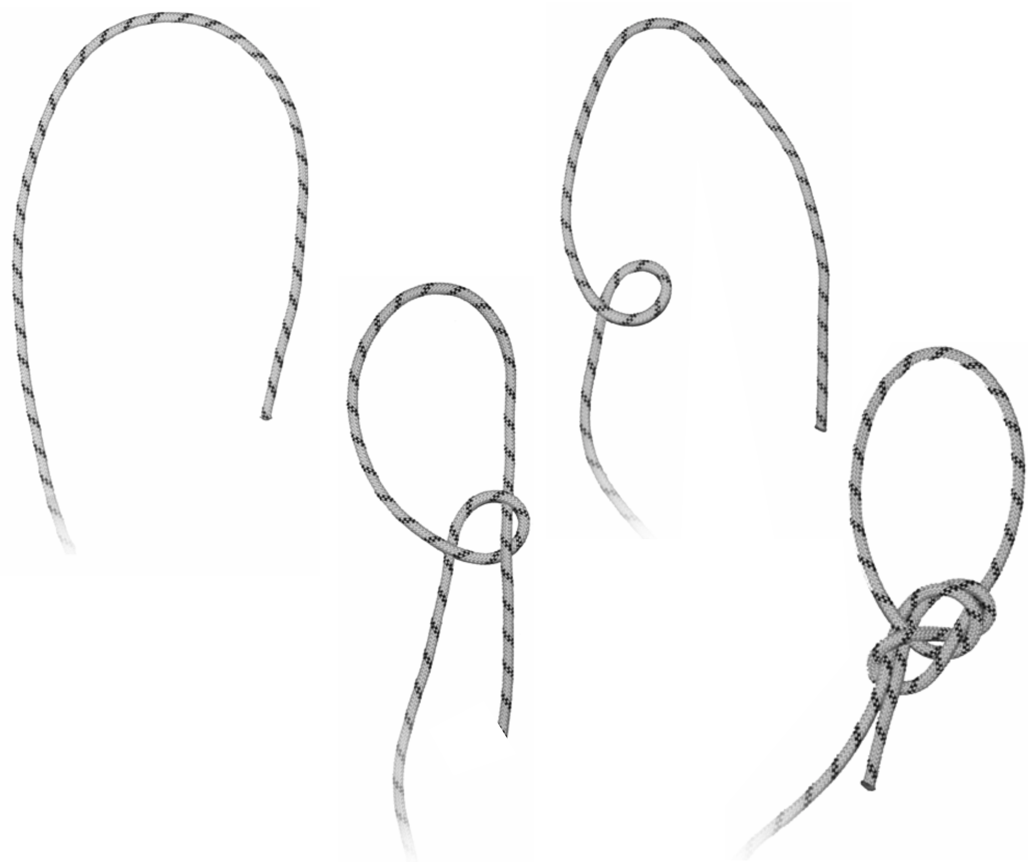
Information › It can be tied with a follow-through section to link two anchors together.

BINDING KNOTS

Yosemite Bowline

Information

- Easy to make with a follow-through.
- Easy to untie after being put under heavy loads.
- It shows a good residual load.
- Good to attach service ropes
- Ideal to use on natural anchors with a large diameter (trees or a column):



Warning

- It is not very strong and it requires a stopper knot or a Yosemite finish.
- It is not easy to learn.
- The eye cannot be used for attaching a cowstail or hanging other loads.

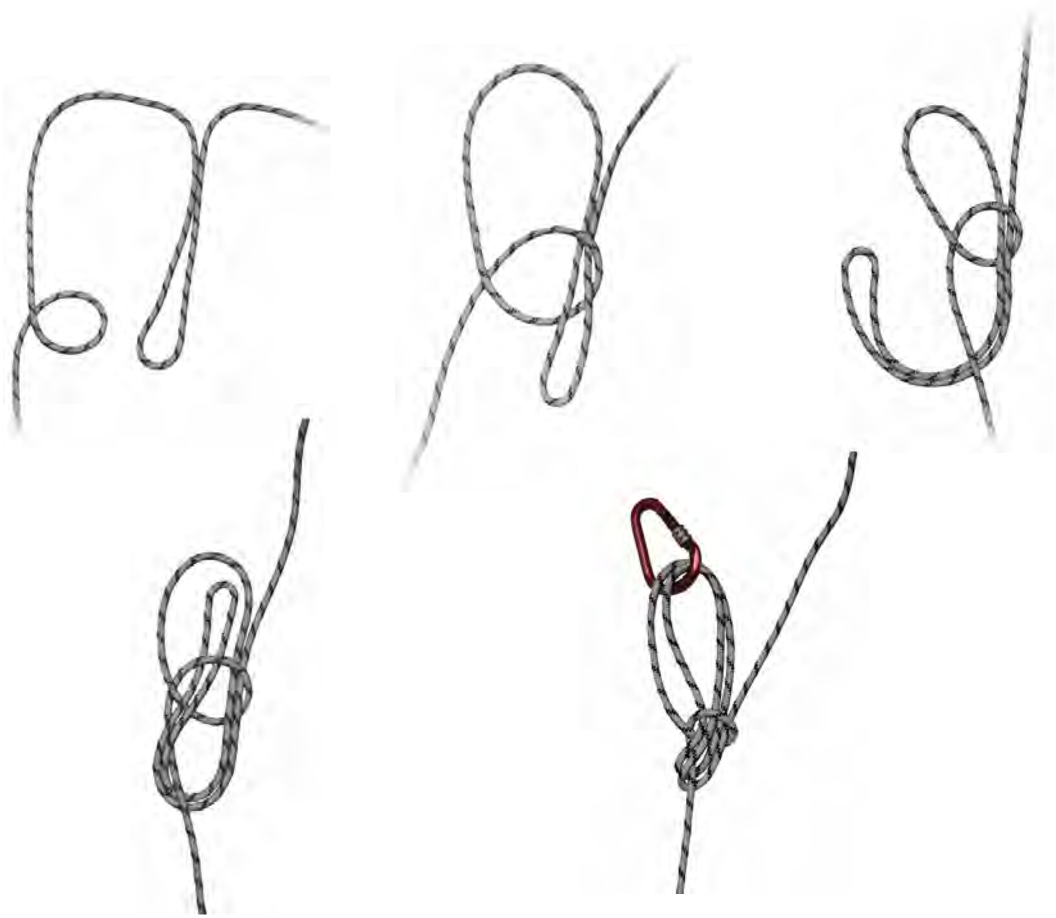
Common mistakes

- Forgetting the stopper knot.

Bowline on the bight

Information

- Extremely strong and easy to recognize.
- It shows a good residual load.
- Good for attaching service ropes without using carabiners.



Warning

- Pass both eyes in a carabiner and add a stopper knot.
- It is not easy to learn.

Common mistakes

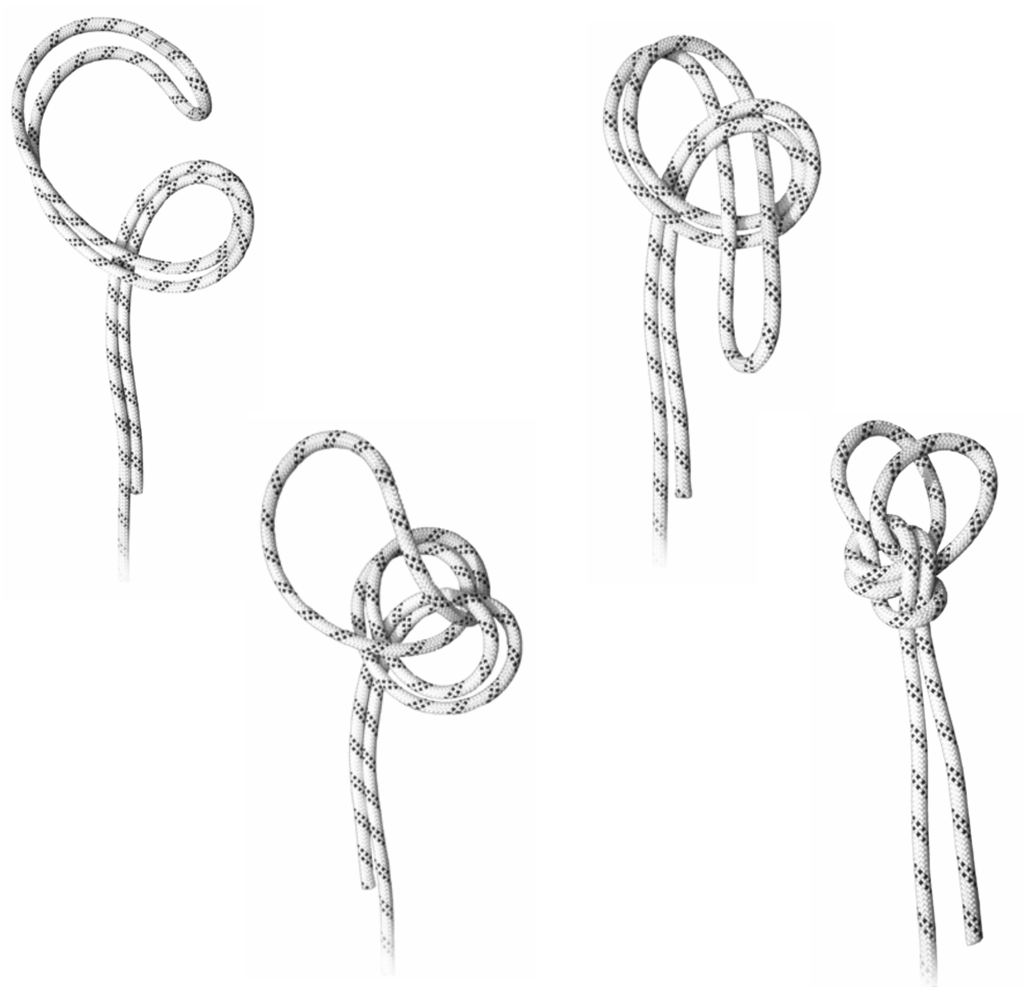
- Forgetting the stopper knot.

BINDING KNOTS

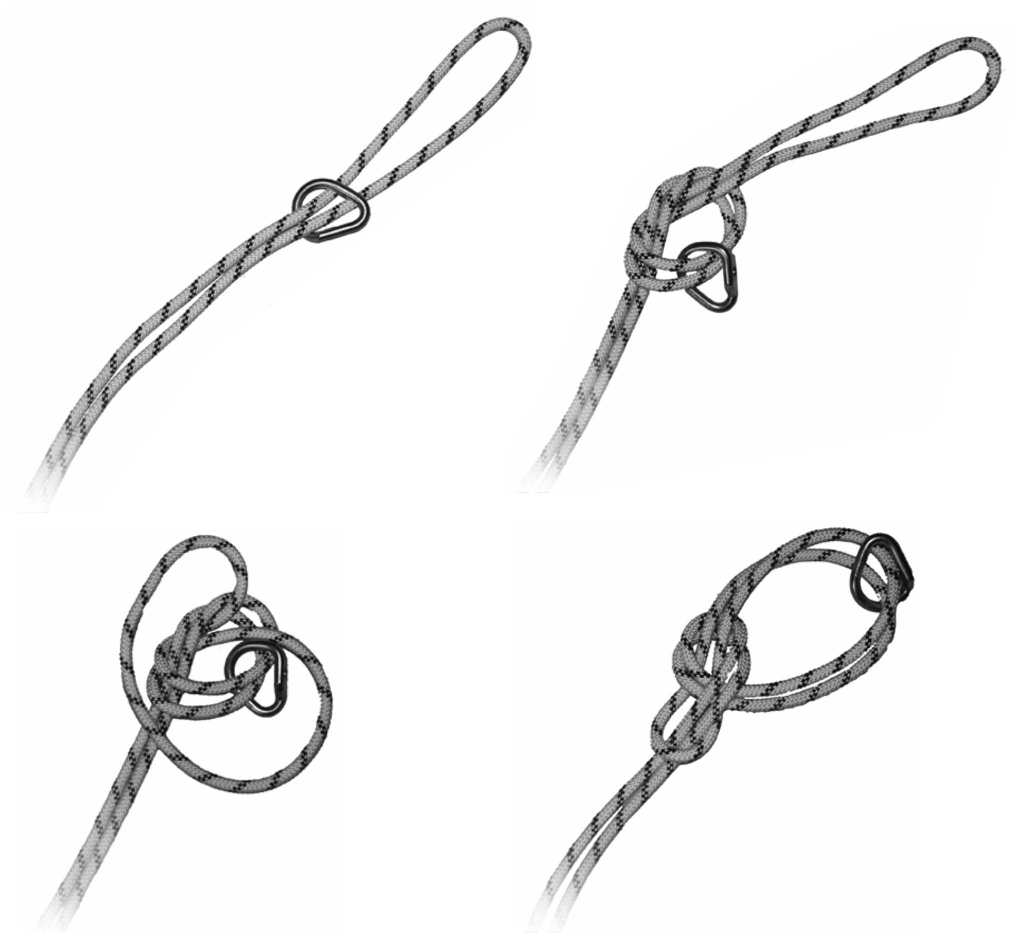
Double bowline

Information

- Strong and easy to recognize.
- It shows a good residual load.
- Good for attaching service ropes
- It doesn't need a stopper knot.
- It is the "double" knot that uses less rope.
- Easy to adjust.
- Easy to untie after being put under heavy loads.
- It is the ideal knot for attaching the ropes to a stretcher, as it can be tied also with very small eyes.



› It can also be installed on a ring (before screwing it onto the nail).



Warning ⚠

› It is not easy to learn.
› The eye cannot be used for clipping a cowstail or hanging other loads.

Common mistakes ✖

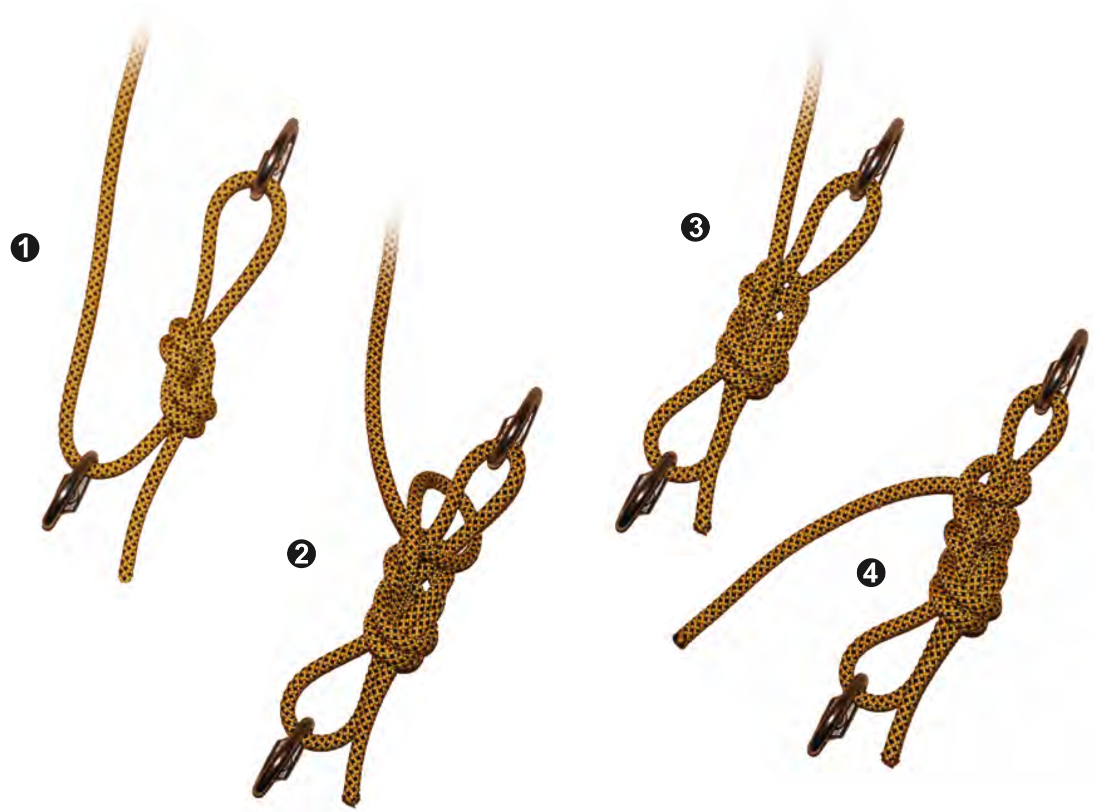
› Clipping the cowstail to only one eye: it might slide and undo the knot.

BINDING KNOTS

Gandalf knot

Information

- It allows to efficiently construct a series connection between two anchors.
- Easy to untie also if under heavy loads.
- Easy to adjust.
- It can also be tied on a double figure-8 and it can be pre-tensioned.



Warning

- Ending with a cow hitch instead of an Italian hitch.

Common mistakes

- Leaving the tail too short.
- Wrapping both eyes with the Italian hitch if tied on a double figure-8.

BINDING KNOTS COMPARISON TABLE						
Knot	**Strength**	**Ease of release**	**Adjustability**	**Learning**	**Stopper knot**	**Intended use**
Clove hitch	**	**	***	***	yes	Rig
Figure 8	***	**	**	***	no	Rig
Double Figure 8	***	**	*	**	no	Rig
Bowline	**	***	***	**	yes	Natural anchors
Double Bowline	***	***	**	**	no	Attaching a stretcher
Bowline on the bight	***	***	**	*	no	Traverse lines tens.
Gandalf knot	***	**	***	**	no	Anchors

BENDS

Flat overhand knot

Information

- Easy to tie.
- It "slides" onto the rock surface minimizing the risk of the knot getting stuck.
- Quite easy to untie also after heavy loads.
- It can be used to isolate a section of damaged rope or for shortening a rope.
- In case of kevlar or dyneema cord with a small diameter, add a back-up knot on the tails or use a double fisherman's knot instead.

Warning

- Each section of rope exiting the knot should be carefully tensioned.
- Once tensioned, the tails exiting the knot should be at least 40 cm long.
- Use it only for joining ropes with equal diameter.

Common mistakes

- Tails too short.
- Forgetting to pre-tension all the four sections of rope

Rethreaded Figure-8

Information

- It shows a good residual load.
- Quite easy to untie also after heavy loads.
- Easy to recognize.
- It can be used also for joining ropes with a slightly different diameter.

Warning

- Once tensioned, the tails exiting the knot should be at least 20 cm long.
- Don't overlap the turns, otherwise it is difficult to release.
- Don't use it to join kevlar or dyneema cords.

Common mistakes

- Forgetting to pre-tension it.

Munter hitch (a.k.a. HMS Halbmastwurfsicherung or Italian hitch)

Information

- Used to decelerate a lowering load speed (descender) and to secure moving loads (belay).
- Start tying from the loop with the tail standing above the loaded section of rope **(fig. 1)**.
- This knot has a lift and a lowering position.
- It is a fundamental knot in many manoeuvres.
- Lock it off with a Mule knot.

1


2


Warning

- When lowering: any contact between the running rope and the screw-lock shouldn't open the screw-lock.
- Lock the screw-lock.
- Use a HMS carabiner with screw-lock.
- When lowering, give rope using both hands and in parallel to the loaded rope; if possible, don't let the rope run onto your hands.
- The carabiner used for the Munter Hitch shouldn't trap the rope upstream against the rock.
- Using the Munter Hitch only for short descents (no more than 5 mt).
- If you're using the Munter Hitch for belay, the load arrest in case of fall should be as dynamic as possible, not retaining the initial jerk.

Common mistakes

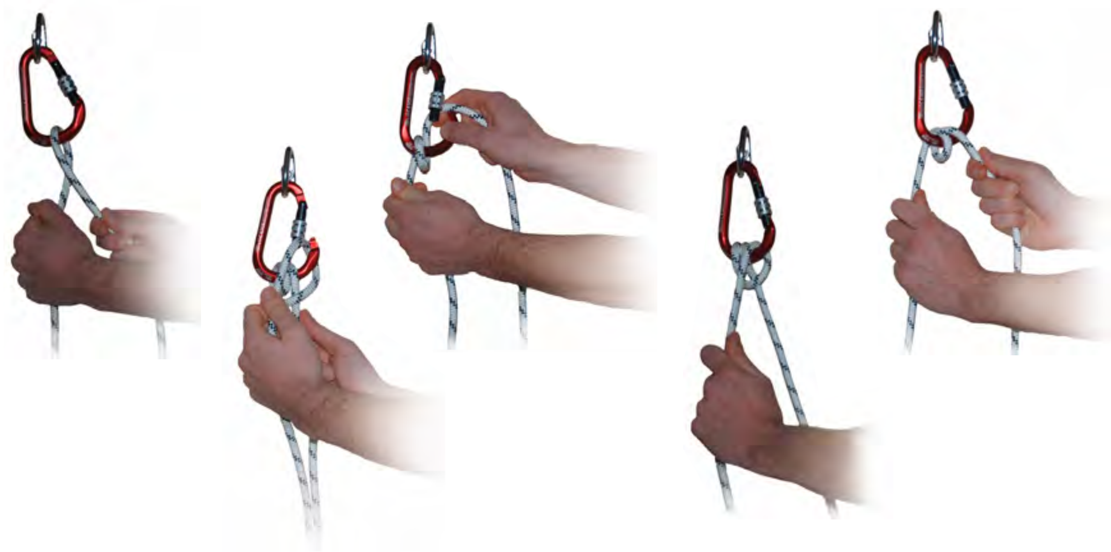
- Tying the knot braiding the upstream and the downstream rope.
- Retain the load letting the rope running through your hands (high torsion).
- The retained rope has a 90° angle compared to the loaded rope (high torsion).
- Choosing a carabiner of inappropriate shape (i.e. oval).
- Placing the manoeuvre rope so that the knot is uneasy to be checked for the rescuer.

SLIDING KNOTS

Super Munter Hitch

Information

- Its braking force is decidedly higher than the Munter Hitch's.
- When tying the knot, start making a loop and pass it in the carabiner, take the downstream rope and make an extra turn round the carabiner, then pass again the upstream rope in the carabiner to end the knot.
- The generated friction avoids an exaggerated tensioning of the locking loop, making the release procedures easier also under heavy loads. Namely, this knot is used because it is easy to release in the main rope ends of traverse line.



Warning

- It cannot be used for belay: the rope cannot be easily taken up and a possible fall wouldn't be dissipated.
- When lowering, any possible contact of the running rope against the screw-lock must not open the screw-lock.
- Lock the screw-lock.
- Use a HMS carabiner with screw-lock.
- While lowering, give rope retaining it with both hands and in parallel to the loaded rope; don't just let the rope run through your hands.
- The carabiner used for this knot shouldn't trap the rope upstream against the rock.

Common mistakes

- Tying the knot braiding the upstream and the downstream rope.
- Retain the load letting the rope running through your hands (high torsion).
- The retained rope has a 90° angle compared to the loaded rope (high torsion).
- Choosing a carabiner of inappropriate shape.

Munter mule Hitch tied off with an overhand knot

Information

- It is made of two locking loops tied in opposite directions.
- It allows to steadily block a sliding knot.
- The locking loop can be made even with a tensioned rope.

Warning

- Always observe the standard procedure (thumb downward and final pull upward): this limits the error and failure risks.
- The locking loop should be as close as possible to the carabiner, so to limit any slide once tensioned.
- When releasing the knot, counteract the locking loop proneness to twist back. For this reason, it would be better limiting its length.

Common mistakes

- Making the locking loop with the knot in lifting position.
- Make half of a turn instead of a complete turn when making the counter locking loop.
- Having the locking loop pointing towards the knot and not towards the sections of rope.

SLIDING KNOTS

Munter Mule Combination Hitch

Information

- It is made of two locking loops tied in opposite directions.
- It allows to steadily block a sliding knot.
- Compared to the Munter Hitch backed up with a Mule knot, this one allows to reduce any possible slippage during loading.

Warning

- Hard to tie when under heavy loads and there is a high crushing and pinching hazard.
- Hard to untie when under heavy loads: the knot could be too tensioned.
- When releasing the knot, counteract the locking loop proneness to twist back. For this reason, it would be better limiting its length.

Common mistakes

- Making the locking loop with the knot in lifting position.
- Making half of a turn instead of a complete turn around the rope.
- Using a Munter Mule Combination Hitch with a loaded rope.

AUTOBLOC KNOTS (ABK)

Two-Way Machard Knot

Information

- You need a high resistance (kevlar) cord.
- This knot gives its best when the cord diameter is approximately a half of the rope diameter (5-6 mm).
- The minimum number of wrappings is 5.
- Pull the knot from its head to release.

Warning

- It needs a manual pre-tensioning on the rope in order to work.
- The cord binding knot should never be in contact with the autobloc knot otherwise there's a risk of malfunctioning.
- The Autobloc knot should never stay trapped on the rock, otherwise the knot will not work.
- Do not use dyneema rope.

Common mistakes

- Failing to check the pre-tensioning of the autobloc knot before using.

AUTOBLOC KNOTS (ABK)

Braid knot

Information

- You need a high resistance (kevlar) cord.
- It is the only autobloc knot that can be used in association with a tape.
- It can be made starting from a ring or a single section.
- This knot gives its best when the cord diameter is approximately a half of the rope diameter (5-6 mm).
- The minimum number of braids is 5.
- It is a good idea to leave 3 or 4 cord wrappings at the head of the knot to make the release easier.
- Pull the knot from the upper limit to release.
- It is an excellent knot for a rescue with limited means and for emergency manoeuvres.

Warning

- It needs a manual pre-tensioning on the rope in order to work.
- Muddy and/or wet ropes usually require more braids.
- The cord binding knot should never be in contact with the autobloc knot otherwise there's a risk of malfunctioning.
- The Autobloc knot should never stay trapped on the rock, otherwise the knot will not work.

Common mistakes

- Tying the knot without crossing the rope sections in the proper order.
- Insufficient number of braids.

Photo Paolo Manca


Photo Paolo Manca

Anchors and attachment points

Contents

BASIC CONCEPTS

Information

- **Anchor:** we define an "anchor" a single grab point on the rock; it can be either artificial (bolt + ring/plate + carabiner) or natural (a tree, rock pillar etc.).
  - Artificial anchors require careful installation procedures.
  - Natural anchors require a careful evaluation in terms of position, stability and pull direction, as well as of any abrasion and rope cutting hazard.

- **Attachment point:** it is the end grab point to which lifting/lowering and belay systems are secured. It is rigged by connecting several anchors together or alternatively it consists of a single, highly resistant and reliable anchor point (i.e. a large rock pillar, a block etc.).
  Everything should be sized according to the applied loads, taking the possible sudden failure of one of the anchors into account.

- **Connections:** a parallel connection is when the anchors work in synergy and the load is split; a series connection is when a single anchor bears the full load but is secured by other anchors.
- **Bolts:** bolts should be at least in number of three for the haul rope and three for the backup rope in the main attachment points, while the minimum number of bolts is of two for the main rope and two for the backup rope in the secondary attachment points.

Warning

- Anchors are connected together using sections of an intact dynamic rope or sections of an A-type semi-static rope, preferably ending in an overhand knot.
- The angle formed by the rope sections connecting the outer anchor points should preferably fall within 90°, otherwise the load placed on the anchors is significantly increased.
- In case of brittle rock, the number of anchors should be based on the rock quality and a parallel connection is to be preferred.

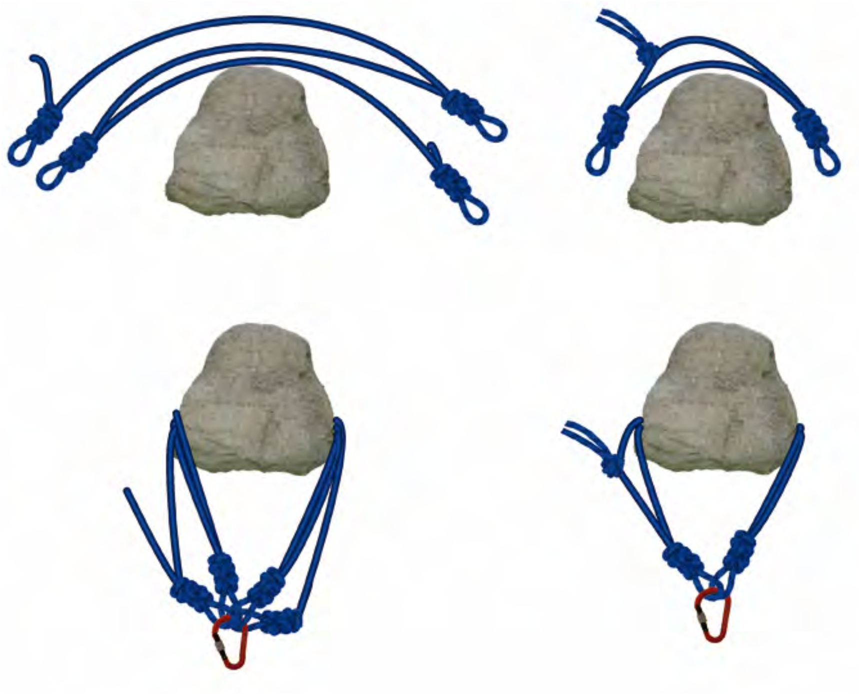
Common mistakes

- Place the anchor points at more than 50 cm from each other: longer rope sections would be required, as well as more working clearance (not always available).
- Increase the number of anchors even when it is unnecessary (it is more material and time-consuming, and it slows the rescue operations).
- Forget to tighten bolts or nuts.
- Forget to correctly arrange plates and rings depending on the direction of the applied load.
- Tying difficult-to-release binding knots (i.e. double fisherman's knot) to connect the rope sections.
- Fail to consider a natural anchor before start drilling.

NATURAL ANCHORS

Information

- The use of natural anchors speeds up the fitting procedures. The holding capacity needs to be evaluated, especially with the direction of the applied load in mind, as it can change during the operations.
- On rocks, rock pillars, concretions, stuck boulders etc., natural anchors need to be backed up with two or more independent wraps, so to assure the attachment point's holding capacity even if a rope section fails.



Warning

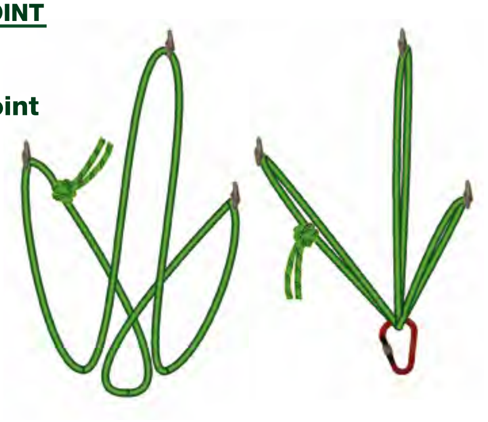
- Have only a rope section working and leave a small amount of slack in the other section for back-up.
- Before using a rock (rock pillars, edges etc) as a natural anchor, it is of the utmost importance to smooth any sharp corner that may damage the rope.

Common mistakes

- Incorrectly assess the direction of the applied load on the attachment point once the system is tensioned, risking the rope's slip-off.
- Wrap the rope only once or forget to make independent wraps, which cannot guarantee the proper safety margins in case the rope gets damaged.

MOBILE PARALLEL ATTACHMENT POINT

Single mobile parallel attachment point



Information

- It is built with a rope section preferably ending in an overhand knot and connected to the carabiner through a parallel attachment point.
- The load is evenly split on all the anchors, the risk of an anchor point failure is therefore very low.
- This mobile attachment point suits the load position during the rescue.
- It can be easily built also starting from the rope end.

- If the rope sections are very long, a semi-mobile parallel connection is used so to avoid significant shifts of the attachment point or an exaggerated lowering of the load in case of anchor failure.

- It is possible to build a parallel connection also using a ring with a cord ending in a Gandalf knot starting from one of the anchors.
- Easy to release also after being placed under high loads.
- The binding knot doesn't interfere with the carabiners.
- It is easily tied also using a rescue rope end.

Warning ⚠

- To correctly make a parallel attachment point, it is important to braid the section of rope connecting the outer anchors. However, it is advisable to check that the two rope sections exiting from each anchor point are not threaded in the carabiner on the attachment point from the same side.
- Use a HMS carabiner to facilitate the sliding of the rope and allow for a better distribution of the load on the anchors.
- If an anchor should fail, the sliding of the rope causes the lowering of the attachment point and the consequent fall of the load.
- A semi-mobile parallel connection is required if the anchors are too distant from each other or when the shifting of the attachment point might generate dangerous frictions on the rock.
- It is better that the binding knot works on the outer section of rope: the applied load is reduced and the knot will be more easily untied. The binding knot shouldn't interfere with the carabiners.

Common mistakes ✖

- Wrongly thread the rope sections in the carabiner of the attachment point, risking that the carabiner slips off if an anchor should fail.
- Bind knot interfering with one of the carabiner, poor load distribution.
- Use the narrow side of a HMS carabiner to rethread the attachment point rope, poor load distribution.

MOBILE PARALLEL ATTACHMENT POINT

Double mobile parallel attachment point

Information

- The haul and back-up attachment points are built starting from four anchor points. Three anchor points are then connected in parallel to the haul rope and three to the back-up rope, with two anchor points in common.
- It is vital that each attachment point is independent from the others: the accidental failure of the haul rope does not have to affect the back-up rope and vice-versa.
- Haul and back-up attachment points can be made using a single rope section:
  - Start from a rope loop.
  - Divide the rope loop into two independent sections tying a hitch on both anchors.
  - The anchors should be arranged in a diamond pattern with the two opposite anchors locked, although it is not mandatory.

  - It can be built also starting from the lifting rope end.

Warning

- Don't cross the rope sections emerging from the attachment points so to avoid any friction.
- Refer to the paragraph "Parallel attachment points" for further information.

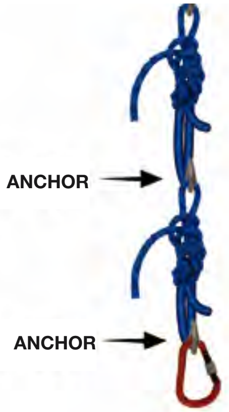
Common mistakes

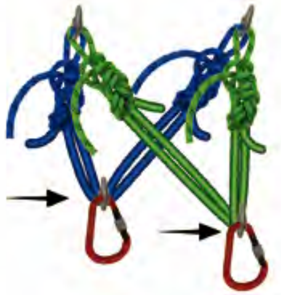
- Use much more material than required.

SERIES ATTACHMENT POINT

Information

- In a series connection, a single anchor point bears the full load, backed-up by the remaining anchors in case of failure.
- You have a fixed load application point and no swings.
- At the same given condition, the load application point falls higher than in the parallel connection, this makes this type of connection particularly suited for a rescue in pitches with small and narrow exit points (see the “Risolutiva” procedure).
- Use a Gandalf knot to connect the anchor points together as it allows for a proper tensioning.





- 4 anchor points can be series connected using a single cord and tying a double figure-8 loop and locking the remaining end tails with two Gandalf knots, one on each double figure-8 loop eye.

Warning

- This type of attachment point is not indicated in case of friable rock or high stresses.
- Rope sections connecting the anchors have to be pulled tightly.

Common mistakes

- The loaded anchor point is located above the back-up anchors, therefore increasing the fall factor.

PERMANENT PARALLEL ATTACHMENT POINT

Permanent attachment point with Gandalf knot

Information

- Tying a Gandalf knot on permanent rings allows to lock the attachment point in position and precisely determine the load direction.
- Each ring is independent: if a rope section should snap, the load won't fall and in case of anchor failure, the load lowering is limited.
- A HMS carabiner is not mandatory for connecting the rope loops (as the attachment point cannot move).

Warning

- The risk is that, in case of an anchor failure, the load is concentrated on only one of the remaining anchors.
- It is built using more rope sections.
- If the load undergoes to significant changes of direction, i.e. evacuation in counterweight or by Tyrolean traverse, the stress is more concentrated on one anchor than the others.

Common mistakes

- Fail to properly load all the sections of rope.
- Fail to correctly assess the changes in the stretcher trajectory.

Permanent attachment point on distant anchors

Information

- Useful for connecting very distant anchor points without using too much rope.
- The load direction should be precisely determined.
- Each section of rope is independent from the other.
- A HMS carabiner is not mandatory for connecting the rope eyes (as the attachment point cannot move).
- Build two loops of different length, overlap them and close them with a single double-eight loop.

Warning

- The risk is that, in case of an anchor failure, the load is concentrated on only one of the remaining anchors.
- If the load direction changes, the whole stress is concentrated on a single anchor.
- Time-consuming to adjust if the distance between the anchors is high.
- If the load undergoes to significant changes of direction, i.e. evacuation

Common mistakes

- Commit a mistake when building the three-point attachment.
- Knots loops have the same length (loops of different length allow for a better load distribution).

SUMMARY OF ATTACHMENT POINT CHARACTERISTICS						
Attachment point	**Mobile parallel**	**Semimobile parallel**	**Mobile parallel with Gandalf knot**	**Permanent parallel with Gandalf knotlf**	**Series with Gandalf knotf**	**Attachment on distant anchors**
Ease of execution	***	**	**	*	**	*
Adjustment	**	*	***	***	**	**
Distant anchors	*	*	*	*	***	***
Cope with friable rocks	**	***	**	***	*	***
Cope with significant changes in the load direction	***	**	***	*	*	*
Residual safety after an anchor failure	***	**	***	**	**	**
Residual safety after a section of the rope section is cut	Load release	**	Load release	**	***	***

Photo Paolo Manca

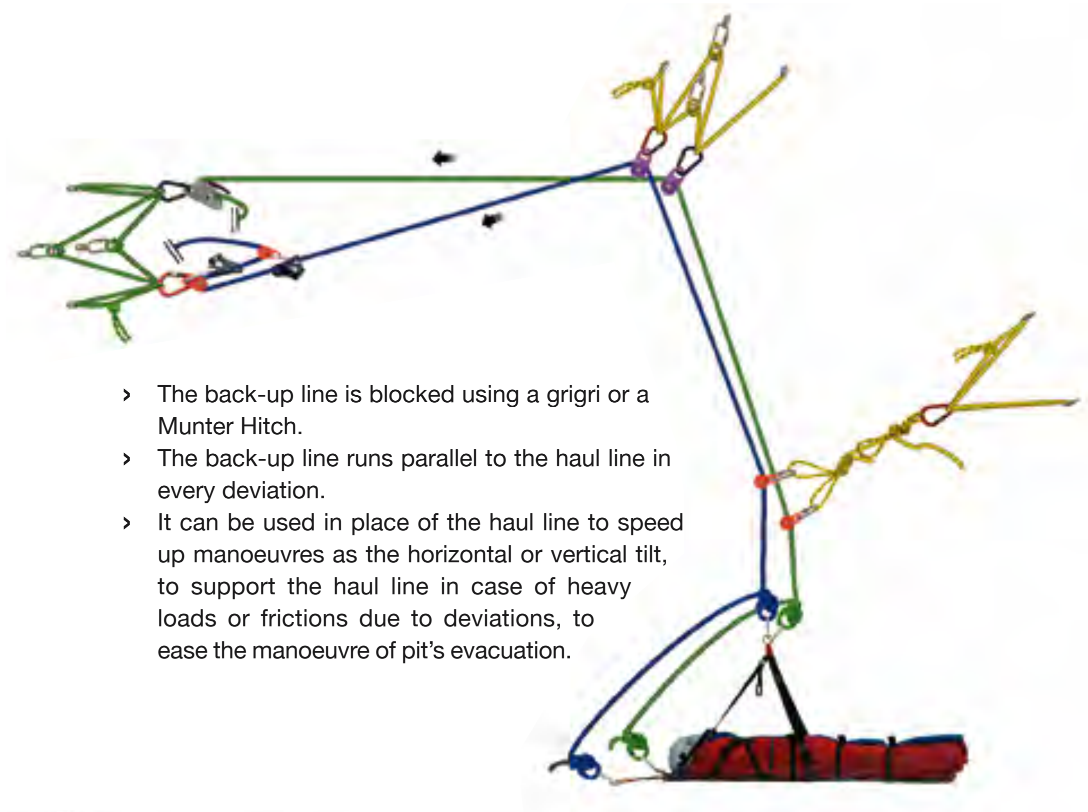
The back-up line

Contents

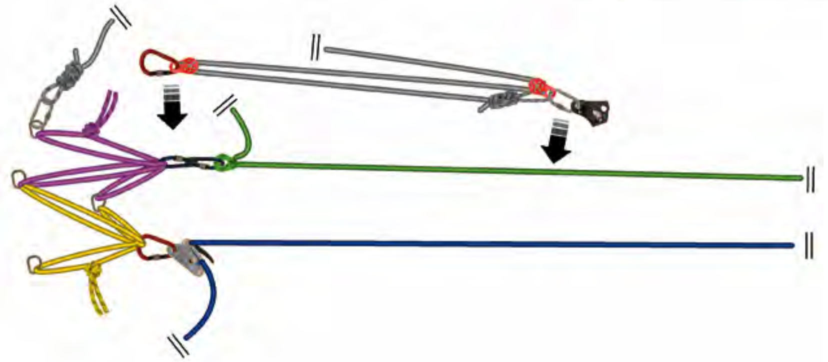
BASIC CONCEPTS

Information

- The Italian Cave Rescue Organization employs two ropes to move the stretcher.
- These two ropes have interchangeable roles and they perform the same functions, therefore they are parallel.
- The use of two ropes simplifies the manoeuvre execution and/or assures safety.
- The rope carrying the load is referred to as the “haul rope”, the other rope is referred to as the “back-up line”.

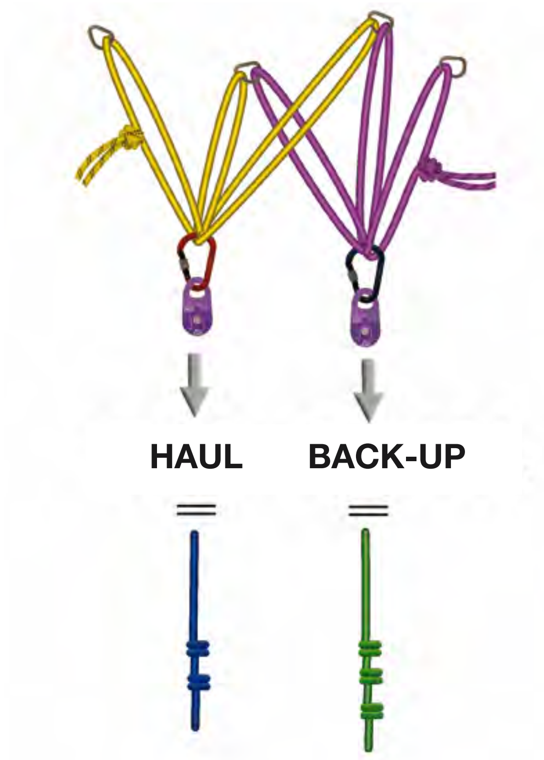


- The back-up line is blocked using a grigri or a Munter Hitch.
- The back-up line runs parallel to the haul line in every deviation.
- It can be used in place of the haul line to speed up manoeuvres as the horizontal or vertical tilt, to support the haul line in case of heavy loads or frictions due to deviations, to ease the manoeuvre of pit’s evacuation.



Warning

- The back-up line attachment point should always be independent from the haul line attachment point and be equally sized.
- The back-up rope should always be tensioned during the rescue procedure.
- Reversible locking systems (Munter Hitch or grigri) are used with the back-up line in order to allow for short descents in any time.
- To guarantee a smooth work-flow, the back-up line's attachment point can be retreated against the haul line's attachment point. The back-up line's attachment point must guarantee the stretcher's safety also in narrow and exposed areas.
- Where possible, the attachment point should be at man-height so to make the rescuers tasks easier.
- Where a pitch is closely followed by another one- and if there are no contraindications - it might be advisable to build only one back-up line directly at the top of the higher pitch.
- Two simple (stopper) knots are tied on the haul line end and three simple (stopper) are tied on the back-up line end: this system permits the rescuers standing at the bottom of the pit to distinguish the ropes.



Common mistakes

- Leave a slack in the back-up line when taking up the haul line.
- Build distant attachment or deviation points that prevent two ropes from running close and parallel to each other.
- Forget to tie the identification knots on the ropes lowered to the bottom of the pitch.
- Use a toothed ascender on the back-up line.


Photo Paolo Manca

Riggers kit

Contents

BASIC CONCEPTS

Information

- Each rigging team is equipped with its own kit. The kit is composed of three bags:
- A rescue bag with a tool pack;
- A drill bag;
- A ropes bag.

Warning

- Check the bags content before entering the cave.
- Rigging team members should be equipped with an extra personal tool pack in addition to the standard tool pack.
- Hereafter we will describe the standard equipment; rigging teams are free to integrate or reduce the kit's content according to their experience and to the cave morphology. Any changes should however be agreed with the team leader.

Common mistakes

- Rely only on the personal tool pack.
- Mixing up the bags content with that of other teams' bags.

RESCUE BAG AND TOOL BAG

Information › **Rescue bag**

- 1 tool pack
- 2 dynamic rope sections of 10 Mt
- 4 dynamic rope sections of 5 Mt
- 2 dynamic rope sections of 3 Mt
- 20 anchors (ring or steel plate + oval carabiner with screw-lock)
- 1 jigger with a fixed base and ascender (2 ascenders, 2 pulleys, 2 oval carabiners, 1 HMS carabiner)
- 1 jigger with a fixed base and grigri (1 grigri, 1 ascender, 1 pulley, 1 oval carabiner, 1 HMS carabiner)
- 4 Fixe pulleys (4 pulleys, 4 HMS carabiners)
- 2 high efficiency pulleys (2 “Petzl Rescue” pulleys + 2 HMS carabiners)
- 4 HMS carabiners
- 1 20 mt section of a semi-static, A-type rope.

› **Tool pack**

- 1 hammer
- 1 hand drill
- 1 13 fixed wrench
- 40 8-mm FIX anchors
- 20 SPIT anchors
- 20 high-resistance steel bolts (grade 8.8 or higher and length according to the anchors in the rescue bag)
- 1 knife

Warning

- To easily transport the rescue bag, its content can be distributed in the other bags of the team's kit; however this can be done only when entering the cave as it is vital to store the bags in their standard arrangement.
- At least two types of rings are available in the market and they are associated with bolts of different length.
- The riggers kit has to be packed following a "layered" pattern (alternating ropes and cords and the metal gear) in order to be balanced.

Common mistakes

- Change or customize the standard arrangement of the rescue bag without change or customize the standard arrangement of the rescue bag without the previous consent of the team leader and of the person in charge of the rescue operations.
- Put bolts of inappropriate length in the tool pack (i.e. for plates only or for rings only).
- Lack of anchors in the tool pack.
- Lack of anchors wedges in the tool pack.

DRILL BAG

Information

- 1 24V or 12V rotary hammer
- 1 fully-charged battery pack
- 2 bits for FIX anchors (8 mm)
- 1 bit for SPIT anchors (12 mm)
- 1 rope ladder with carabiner

Warning

- Secure a fix anchor bit using a rubber band and firmly tie the remaining bits onto the drill bag.
- Spindles and bits will be of SDS Plus type.
- The drill efficiency largely depends on the battery packs efficiency and on the drill bits quality.

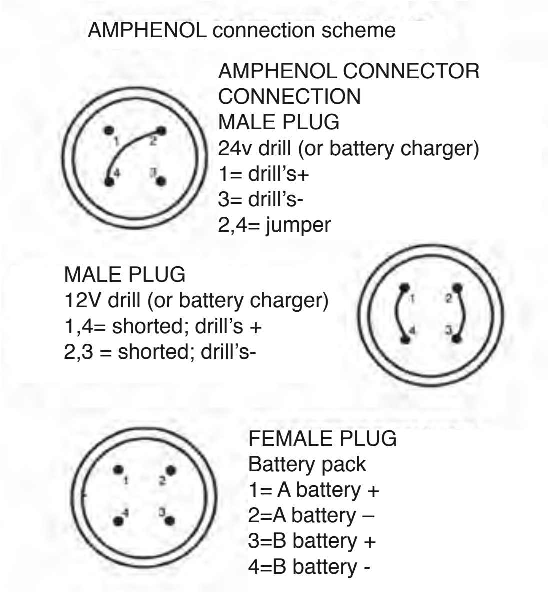
Common mistakes

- Forget to check the drill working conditions before entering the cave.
- Carry a battery group partially charged.
- Forget to check the drill bits for any damage or buckling.
- Use non-standard connectors with drill and battery packs.

Connection scheme

Information

- Drills, battery packs and battery chargers should be equipped with standard connectors.
- We use the AMPHENOL TUCHEL C16/1 connector or equivalent devices (CA series Hirschman).
- The generally adopted standard admits the use of the same battery pack (two 12V storage batteries) both with 12V and 24V drills.
- Use the connection scheme as in the following figure.



Warning

- The use of a different connection can short-circuit the system.
- Handle the connectors with care: rotate the relevant screw-lock and not the entire connector to prevent any cord twisting.

Common mistakes

- Connections non complying with the standard scheme.
- Wrong wire connection inside the connectors.

Ropes bag

Information Two ropes of the same length (default: increments of 20 meters: 40 + 40, 60 + 60, 80 + 80…), coiled one after the other and ending in a stopper knot. Tie the rope ends onto the bag cords in a plain visible way.

Warning

- Use a pair of bags in case of long ropes.
- Check the ropes length.
- Check that stopper knots are in place.

Common mistakes

- Mark the rope ends using a copper or a heat-shrink protective covering of excessive length: it easily gets stuck when taking up the rope.

Foto Piero Palazzo

Rigging team work-flow

Contents

BASIC CONCEPTS

Information

- The team is generally made up of three operators. Occasionally, their number may vary from two to four; a member of the team acts as the rigging team leader.
- Each rigging team is equipped with a riggers kit and a receiver.
- Where possible, a survey of the cave will be made available to the rigging team.
- The team will pay attention not to take by mistake the equipment belonging to other rigging teams or to the stretcher team.
- Each rigging team is associated to a sequence of telephone rings for communication purposes.

Warning

- In a rescue operation is common that two or more rigging teams work at the same time. The team will be self-sufficient in terms of food and lights.
- The team will timely communicate to the surface teams the need of rigging equipment and new batteries so to get the required material without stopping the rescue operations.
- The team will be responsible of its own material, paying attention not to mix it up with that of other rigging teams.
- Each team will leave the material in order for the next rigging team that will take their place.
- As soon as a team is replaced by another rigging team, it will check that the team leader and/or the rescue operations leader are informed of the shift.
- Each team has to bring with it at least tool packs bags complete with hammer, hand drill etc. One of the rigging sacks will be the standard sack included in the riggers kit.

Common mistakes

- Forget to check the bags content before entering the cave.
- Forget to check the drill's working conditions and the batteries charge before entering the cave.
- Forget to timely communicate the need of new batteries or further anchors.
- Forget to connect the receiver and to listen to the communications.
- Forget to keep the riggers kit in proper order. This mistake always results in longer downtimes and delays in the rescue operations and longer waiting times at the bottom of the pitch.

RIGGING TEAM LEADER

Information

- The "Rigging team leader" is the person in charge of the rigging team.
- His/her task is to coordinate the rigging team and is ultimately in charge to decide the techniques to be adopted in each situation.
- The rigging team leaders are responsible of assisting the rescue team leader in establishing the rescue techniques to deploy and in coordinating the displacement of riggers and their equipment. The team leaders of each different rigging team should plan, decide and communicate where to rig, how to organize the haul system and how to split the rigging work between teams.
- Generally, it is the rigging team leader who communicates via telephone or radio.

Warning

- During a rescue operation, the rigging team leader will allocate tasks among the riggers so to let each member do what he/she can do best in order to optimize time.

Common mistakes

- Fail to clearly communicate with the team members the chosen rescue manoeuvre and how they are supposed to carry it out.
- Leave the communication management to the other team members, except for occasional situations.

How to plan a rescue operation

Information

- When entering the cave, carefully note the places that need rigging and their succession; also, it is useful to have a general picture of how to rig and how the rigging teams may alternate.
- Discuss the setting up of rescue operations and the techniques to be used with the other riggers when descending the cave.
- Agree with the other rigging team leaders on where one team should start rigging and where another should lift the stretcher.
- Ask the rescue team leader and the doctor about the casualty conditions and agree on where rigging is necessary and where the stretcher bearers can arrange the casualty transport by themselves.

Warning

- Planning in arrears the rigging teams lifting and alternation work-flow spares repeated descents and ascents and optimizes the rigging teams alternation.
- Planning the rescue during the progression allows to have a broader picture of the situation, as you can identify where to stabilize the casualty and where to stop the stretcher, helping the rescue team leader in his/her task.
- Remember to clearly agree with the other rigging team leaders on where and how the different rigging teams will take up the stretcher.

Common mistakes

- Rig an excessively long section of the cave, with the risk of running the material out and being consequently forced to "borrow" it from the other teams.
- Halt the stretcher in dangerous or uncomfortable areas.
- Opt for a manual transport, over-estimating one's ability to cope with complex situations.

Technical and procedural choices

Information

- Devote all the needed time to study the manoeuvre to be used.
- Discuss the technique you plan to use and the stretcher path with the other team members.
- Choose a technique and make sure that all the team members are familiar with the rescue procedure.
- Give clear instructions to all the team members and allocate the different tasks so that they can be performed at the same time.

Warning

- Opt for the easier, quicker and less material-consuming technique, without compromising the overall safety.
- When choosing which technique to use, consider the casualty conditions (i.e. any contraindications to tilt the stretcher in vertical).
- Lack of a reference profile in charge of deciding the technique to adopt within the rigging team.

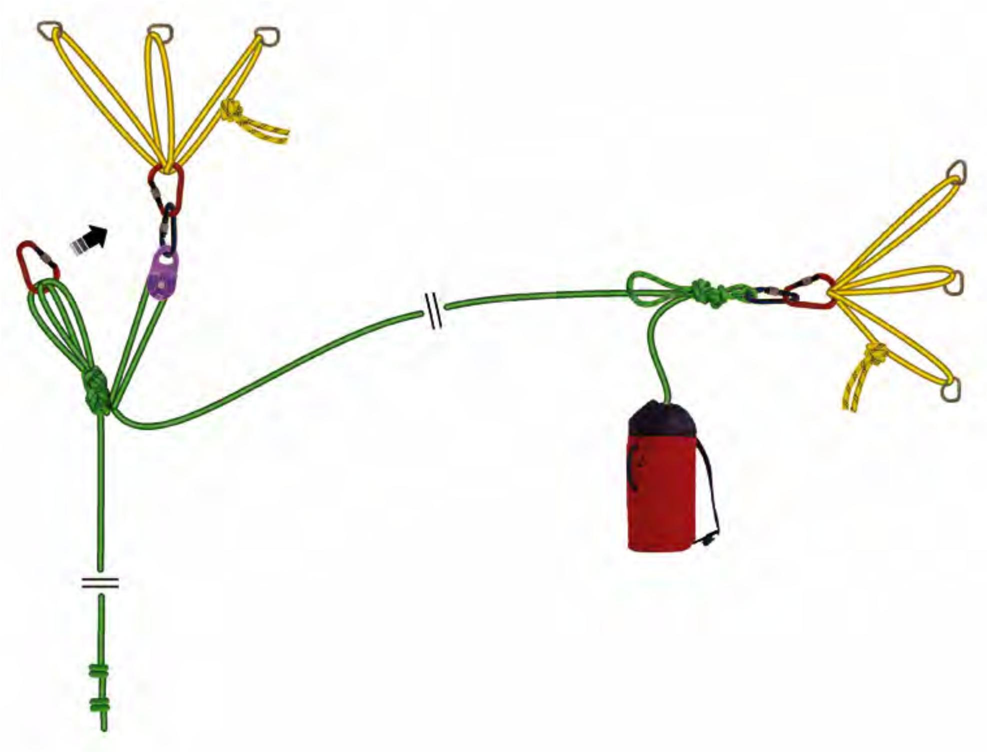
Common mistakes

- Waste time in discussions.
- Forget to talk about the rescue technique with the other riggers or to set the chosen technique clear.
- Place a rigger who's not familiar with the manoeuvre execution in the main attachment point.

SETTING UP A RESCUE SYSTEM

Information

- In the setting-up, privilege the mid-pit and the lower-lift areas, lower the main and the accessory ropes and finally set up any secondary deviations.
- Provide the attendant for a comfortable progression so that he/she can follow the stretcher during the rescue operations.
- Block the main and the back-up ropes to speed the stretcher-bearers exit up.
- Block the haul and back-up rope at the attachment point using a figure-8 with both sections of rope emerging from the mid-pit pulleys; these should also be blocked in the rear area.



- All sections of rope will have to end in a stopper knot.
- Don't leave swinging ropes which have not been secured upstream.
- Check the quality of the rescue system before the stretcher arrival by asking to the operators to hang on the haul and back-up ropes. This will avoid any unexpected mistakes during the stretcher lifting.

Warning

- Optimize the drill utilization: avoid proceeding with the "hole, anchor, plate, carabiner, new hole" method and drill all the needed holes at once to let the other rescuers use the drill.
- Carefully evaluate the ropes trajectory.
- Always dedicate some minutes to the pitch clearance: perform an accurate scaling or otherwise choose a safer lifting path.
- Evaluate whether the deployment of the chosen rescue technique could damage the telephone line.
- Check the rescue system and where necessary descend down the hauling and back-up ropes in case of long vertical sections or for the avoidance of any doubts.
- Tie three knots on the accessory rope end and two knots on the back-up ropes rope end.

Common mistakes

- Forget to consider the ropes elasticity, the attacks elongation, the angle generated by the tensioned ropes in the mid pit and the direction induced in the anchors by the applied stress.
- Wrong haul and back-up ropes blocking.

RIGGING TEAM: MEN AND MATERIALS WORK-FLOW

Information › A cave rescue operation involve a significant number of men and materials. For this reason, the adopted action plan plays a very important role both in limiting the use of men and materials and in assuring that rescue operations take place within reasonable times.
It is always possible to adopt different action plans in different moments during a rescue operation.

Warning › The following schemes of work are to be seen as mere guidelines the whole team should live by; in particular situations, exceptions might be evaluated to overcome a specific problem; the team members should however be aware that the standard procedure has to be resumed as quickly as possible.

Common mistakes › Leave the men and materials work-flow to the chance. This results in a loss of control of the team, in a rapid depletion of the rigging resources and in longer downtimes and delays due to the topping up of the bags and the search for the wasted material.

Scheme of work with alternation

Information

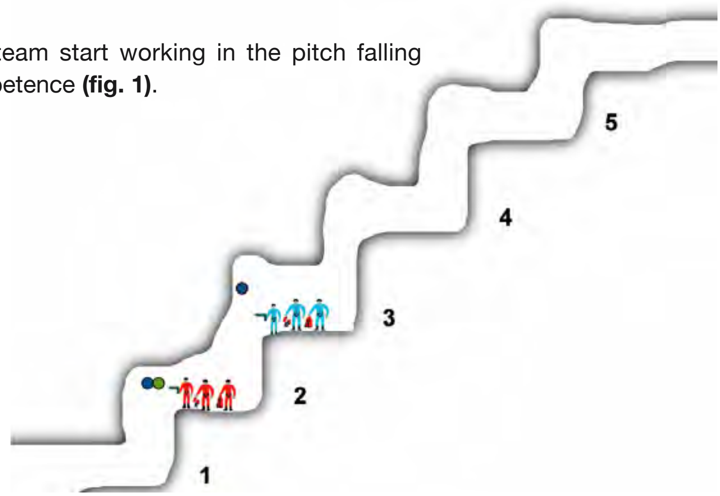
This is the standard scheme of work and it permits to lift a stretcher in a succession of pitches, limiting the use of men and materials. A familiarity with this method is required by the whole rescue team.

This method favours the movement of the whole team, forcing the stretcher to follow the same pace, with short and repeated halts; meanwhile, the riggers and their materials tend to precede the stretcher.

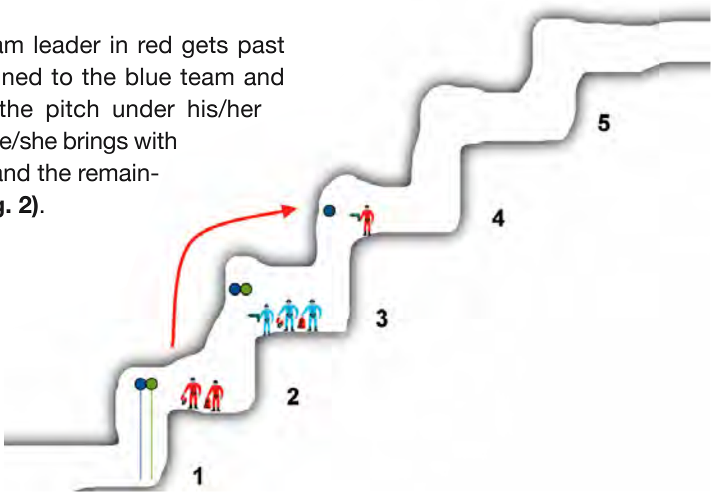
The following pictures shows an example of alternation with two rigging teams (in red and in blue) in a succession of pitches; the stretcher-bearers and the team leaders have been omitted in the pictures - please go to the relevant chapter for information on their work-flow.

The following example of alternation equally works when the stretcher lifting is alternated with the manual transportation. The example is based on two rigging teams but is applicable to more teams.

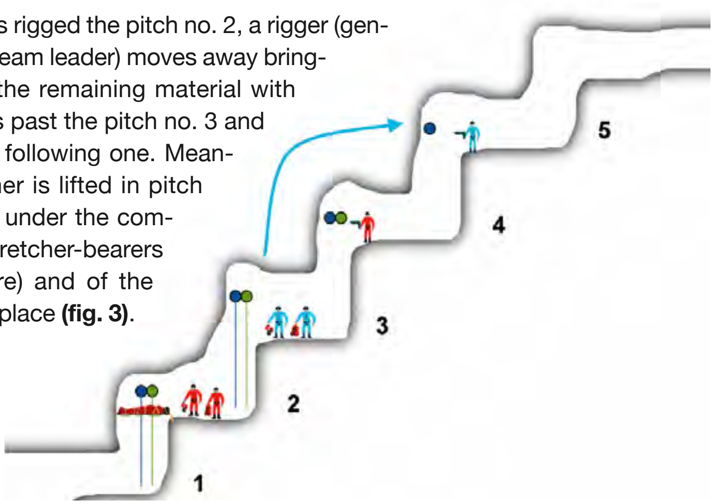
› Each rigging team start working in the pitch falling under its competence **(fig. 1)**.



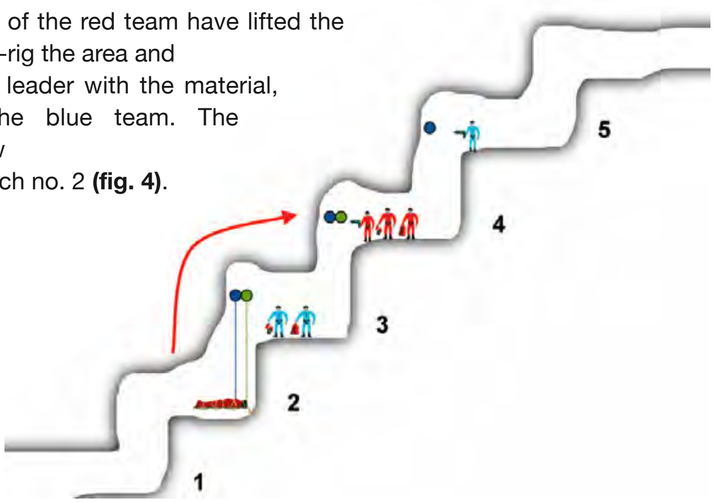
› The rigging team leader in red gets past the pitch assigned to the blue team and starts rigging the pitch under his/her competence. He/she brings with him/her a drill and the remaining material **(fig. 2)**.



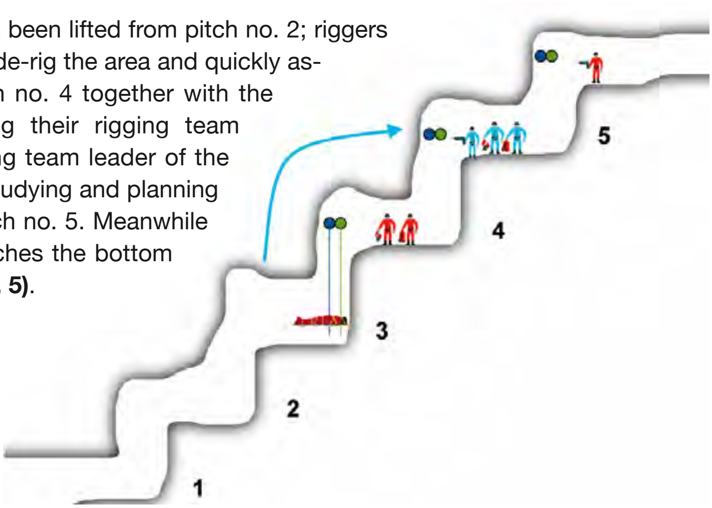
- The blue team has rigged the pitch no. 2, a rigger (generally the rigging team leader) moves away bringing the drill and the remaining material with him/her, s/he gets past the pitch no. 3 and starts rigging the following one. Meanwhile, the stretcher is lifted in pitch no. 1, which falls under the competence of the stretcher-bearers (not in the picture) and of the two riggers left in place **(fig. 3)**.



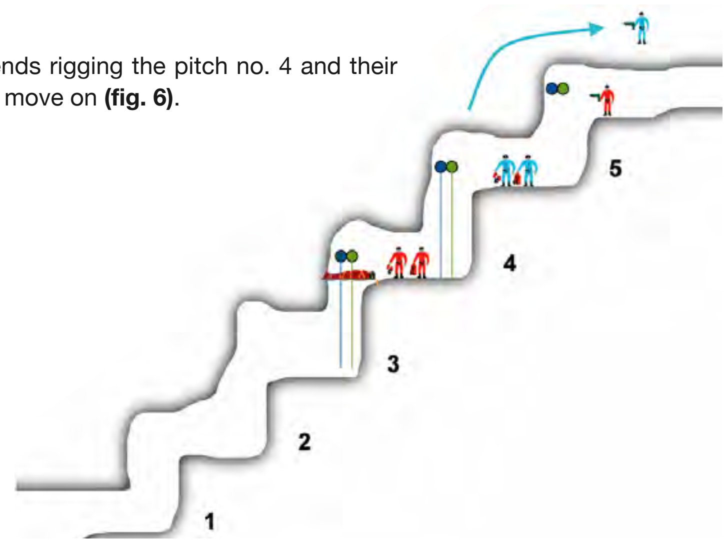
- Once the riggers of the red team have lifted the stretcher, they de-rig the area and reach their team leader with the material, passing over the blue team. The stretcher can now be lifted in the pitch no. 2 **(fig. 4)**.



› The stretcher has been lifted from pitch no. 2; riggers of the blue team de-rig the area and quickly ascend to the pitch no. 4 together with the material, reaching their rigging team leader. The rigging team leader of the red team starts studying and planning the rigging of pitch no. 5. Meanwhile the stretcher reaches the bottom of pitch no. 3 **(fig. 5)**.



› The blue team ends rigging the pitch no. 4 and their team leader can move on **(fig. 6)**.



Warning

- Subject to the specific needs, the ascending riggers have the precedence in the progression line; riggers involved in the dismantlement of the rigging must pass the stretcher before it is lifted in the following pitch.
- Riggers left in the area communicate the chosen lifting method to the rescue team leader and to the doctor, they wait for the stretcher-bearers and if necessary they instruct the stretcher-bearers on what to do next.
- Riggers must always have their team's material under control: the scheme efficacy largely depends on this.
- When possible, one of the riggers (generally the rigging team leader) moves on the next pitch falling under his/her competence with all the material left. If the remaining material is a lot and/or only one person can transport the material used, one rigger can stay there while the rest of the team moves on.
- Where the rigging is not complicated and there is little need for material (i.e. an attachment point for a counterbalance intended to help the stretcher-bearers), the material can be left in place; it will be up to the stretcher-bearers to take up the material and deliver it to the riggers.
- Once the stretcher has been lifted, the riggers quickly dismantle the rescue system (with the help of the stretcher-bearers), they recover and put the material in order, they get past the stretcher and they reach their colleague who's working in the next section to rig.
- When dismantling the rescue system, check your own material and try not to mix it up with the stretcher team's, the progression team's or the other rigging teams' material.
- It is occasionally possible to share part of the material with the other rigging teams (i.e. ropes to build a tyrolean line): in similar situations, each team will pack again its own kit as soon as possible.
- This scheme applies also when three rigging teams are in place.

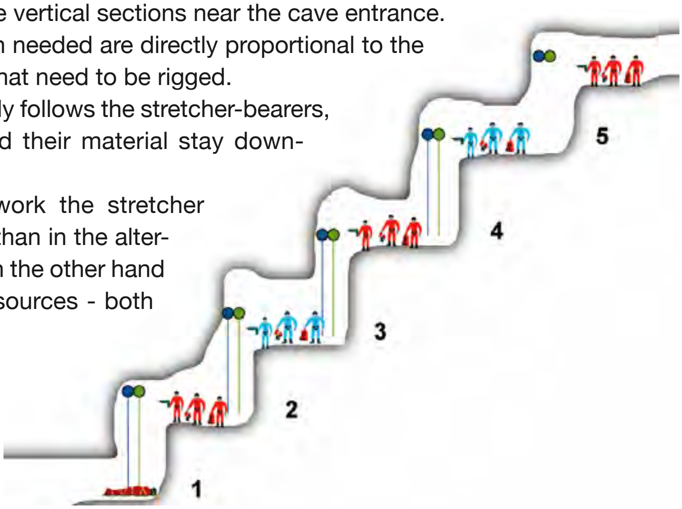
Common mistakes

- Mix up the material with the other rigging teams' material.
- Forget to observe the alternation in the rigging (rig a section in a non-sequential way).
- Leave the rigged area completely unattended.
- Forget to communicate to the team leader your own movements.

Scheme of work with fixed positions

Information

- This scheme is generally used in not very deep caves or in the final steps of the rescue operations, in the vertical sections near the cave entrance.
- The material and men needed are directly proportional to the number of sections that need to be rigged.
- The stretcher generally follows the stretcher-bearers, while the riggers and their material stay downstream the stretcher.
- In this scheme of work the stretcher moves more rapidly than in the alternated method, but on the other hand it uses significant resources - both human and material.



Warning

- Where there is a close succession of vertical sections, riggers should be ready to face long downtimes, as they might have to stay behind the stretcher not to slow down its lifting.

Common mistakes

The material left is not enough to complete the rigging.

Dedicated rigging teams

Information

- When, during a cave rescue, several complex situations need rigging (tyroleans, deep pitches with deviations etc.), it is possible to send a dedicated independent rigging team with the aim to speed up the operations.

Warning

- Where there is a close succession of vertical sections, riggers should be ready to face long downtimes, as they might have to stay behind the stretcher not to slow down its lifting.

Common mistakes

- The material left is not enough to complete the rigging.

Photo Paolo Manca

Stretchers

Contents

STRETCHER BAG

Information › Rescue stretchers bags are always equipped with:

A secondary semi-static rope of 20 Mt

6 HMS carabiners (for connecting the stretcher to the bridles)

3 Fixe pulleys + 3 oval carabiners without screw-lock (for the tyrolean line)

5 oval carabiners with screw-lock (for tying up the haul and the back-up ropes onto the central ring and looping them at the head of the stretcher + 1 carabiner for a possible displacement rope)

1 ascender

1 HMS carabiner

1 rope section of 5 Mt

- The stretcher bag is packed so to be used with any stretcher model. It contains all the required equipment for the rope transport.
- Part of the stretcher bag, the casualty helmet has to be suitable for protecting the casualty face during horizontal lifts.

- The casualty is usually installed in the stretcher wearing an isothermal suit. This suit is open on both sides: just lay down the casualty on the open suit and close it using the strapped fastening.

Warning

- Bridles should be stored directly inside the stretcher. This is the best way to be sure that the bridles match the stretcher model.
- The stretcher bag always goes with the stetcher.

Common mistakes

- Confuse the stretcher bags, the casualty bags, the first-aid bags and the medical bags: each bag is different from the other in terms of content and purpose.

TRANSPORTING AN EMPTY STRETCHER: THE "LONGE LINE"

Information

- It is used to simplify the transport of an empty stretcher.
- It is built with a cowstail section ending in a bowline knot at both ends; knots are threaded in the ring at the head of the stretcher and in the ring at the foot of the frame, respectively.
- For passing pitches and meanders, hang the stretcher clipping the longe line directly to the bag-bearing carabiner so that the rope section runs freely. This lets the stretcher tilt as required.

Warning

- The cowstail will be long enough to leave a 10 cm slack when the stretcher is suspended in vertical.

Common mistakes

- Stay trapped in the bag-bearing cowstail at the opposite side of the longe line when touching the ground after a vertical descent.
- The longe line is too short (the stretcher cannot hinge to the vertical).

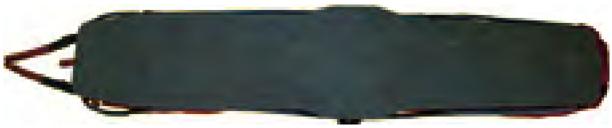
MODELS AND DESIGNS

Information

- An all-purpose ideal stretcher doesn't exist. It is therefore important to know the pros and cons of the available models and evaluating the most suitable one in each situation, depending on the casualty conditions and the cave morphology.

Alp Design Stretcher

- It is the most popular stretcher since the CNSAS has been established. Having been used for many years, it has been widely tested.
- It has a rigid tray and different handles, adjustable straps and locking loops for connecting bridles and lifting ropes.



- The rigid tray, that can be used as a spinal splint, has a smooth surface that significantly reduces the friction between the stretcher and the slide surface. This makes the transport easier but it reduces the stretcher stability during the halts. It is vital to assure the stretcher safety whenever required.
- The casualty is wrapped in a padded sheet for further insulation. Several external straps block the victim in position.
- One of the main drawback is the difficulty of installing a casualty taller than 1,80 Mt and/or of heavy build.
- The tray stiffness makes the stretcher difficult to be dragged in bendy passages, even when it's empty.

Internal straps

- The completely adjustable internal straps are divided in three different zones allowing for the casualty immobilization; these can be adapted to the suffered trauma.

- A corset blocks the torso.

- A thigh pad with a padded seat included at basin level.

- Straps to block the legs.

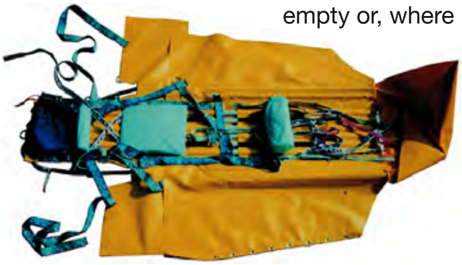
- In order to improve the casualty comfort on a rigid plank also for long periods, some mobile pads are available which can be placed behind the neck, the lower back and the knees.

CNSAS Mako Stretcher

- Recently released, it has been developed by the CNSAS Speleological Technical Commission (CTS).
- Its main characteristic lies in the rigid tray, which can be dismantled in 5 pieces storable in more bags, making easier to transport the empty stretcher especially in narrow or bendy passages, before the clearing teams can widen them.
- Internal straps are similar to those of the Alp Design stretcher.
- One of its drawbacks are the overall dimensions and the square bottom, which creates two corners that tend to get stuck, especially in bendy passages.

Steinberg Etruria Stretcher

- Developed in collaboration with CNSAS, its production has been discontinued, although some shops can still have it in their inventory.
- The load-bearing frame is composed of six aluminium slats; two inserts at basin level allow to separate the stretcher into halves; the shell is in PVC sheet.
- Easy to transport in bendy or narrow passages as it can be folded in two when it's empty or, where necessary, it can be completely dismantled.



- Internal straps are a bit complicated, but they present the major advantage to be individually adjustable around the casualty depending on the wound type.
- Less comfortable than the other models, it can only be used in association with its isothermal suit.
- Heavier than the other models.

Petzl Nest Litter

- Developed in collaboration with the French cave rescue, it is an improved version of the previous model (TSA Marbach). It is here reported for reference only, as it is still in stock.
- Basic straps.
- Designed for vertical lifts on a single rope, it lacks bridles for horizontal lifts, forcing to use cords or preferably daisy chains in association with CNSAS rescue techniques.

- It is semi-rigid and is unsuitable in case of spinal injuries without the help of an additional medical device.

HELMET

Information

- The head is protected by a modular helmet specially designed by CNSAS' CTS.
- The shell on the neck side determines the reference point for the casualty correct position and it is secured against the plank using a wide strapped fastening.
- The upper part is hinged through a top hook and together with the visor in polycarbonate it provides protection to the casualty face during the horizontal transport.
- The adjustable side straps assure the solid connection to the plank.

INSTALLING THE CASUALTY IN THE STRETCHER

Information

Preparing the casualty

- Place the stretcher next to the casualty (safe from dripping or stones fall hazard).
- Untie the straps and arrange them in the correct position.
- Place the pads in the lumbar and the knee regions depending on the casualty wounds and measure the casualty for the pads correct position.
- Place the opened isothermal suit on the stretcher.

Installing the casualty in the stretcher

- Lay down the casualty with the help of the required medical devices (collar, KED …).
- Position the head, place the helmet and a locking cap where needed. The provided pad will be placed between the neck and the shoulders (collar permitting).
- Continue with the torso, the thigh pads and the legs.
- Tight the straps in the same sequence (from head to toe). In order to ensure that if the right side and the left side have been equally tightened, compare the length of the straps exiting the buckles.
- With the previous consent of the doctor, you may also check the straps tensioning by tilting the stretcher in vertical position before closing the case.
- Close the case and the outer straps without applying an excessive tension. To speed up the outer straps release, these can be doubled in the buckles.

Warning

- Install the casualty with the consent and under the supervision of the medical staff.
- Behave with the utmost care towards the casualty.
- An ordinary helmet is unsuitable to protect the casualty, whose face would be bare. The helmet in the casualty bag must be provided with a visor.
- The operator in charge of installing the casualty cannot wear hanging objects that might hit the casualty.
- Two people are sufficient to install the casualty in the stretcher (for binding the straps).
- If a heatpack is used, place the exhaust pipe away from the casualty head: poisoning hazard!
- If you foresee to transport the casualty in vertical position for some distance, lift the stretcher and check the casualty head is in the correct position and the straps are tight before continuing with closing the outer case.

Common mistakes

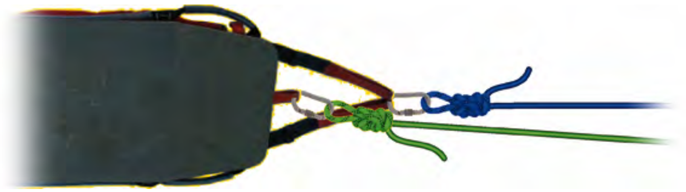
- Install the casualty without the consent and the supervision of the medical staff.
- Forget to extract and arrange the stretcher straps before laying down the casualty.
- Over-tighten the straps, preventing the casualty breathing or circulation.
- Leave the transport handles behind the case closing straps.
- Lift the stretcher from the outer straps wrapping the case (tightening the casualty) or from the loops at the haul rope attachment point (head compression).

CONNECTION TO THE LIFTING ROPES

Locking loops

Information

- The plank is contoured by several locking loops which are integral with sheet and straps.
- The two long loops at the head of the stretcher are traditionally defined as haul loops while the short loop is usually called the back-up loop.



- Latest released models have two added loops at the feet of the stretcher. These are intended for use with tyrolean lines or special rescue manoeuvres, where you need to work with the lower part of the plank (i.e. the risolutiva technique, the Scabar procedure or the tyrolean line).
- The outer straps called bridles are used for the horizontal lifting of the stretcher. Bridles are clipped to the dedicated loops on the stretcher using carabiners with screw-lock.

- Some models are designed to accommodate two separate bridles: one intended for vertical lifts and the other for traverse lifts.
- The haul rope loops are bound to the stretcher corners and they perform better in keeping the stretcher in vertical position than the shorter loop, reducing the casualty discomfort and counteracting the rotation on the vertical axis.
- Conversely, the short loop (back-up loop) enables to gain space in specific situations.

Warning

- Pay attention to properly connect the lifting ropes to their respective loops. Proceeding with the connection in the inverse order doesn't affect safety but it may cause problems during the manoeuvre execution.
- Always assure the stretcher safety regardless of the environmental conditions.

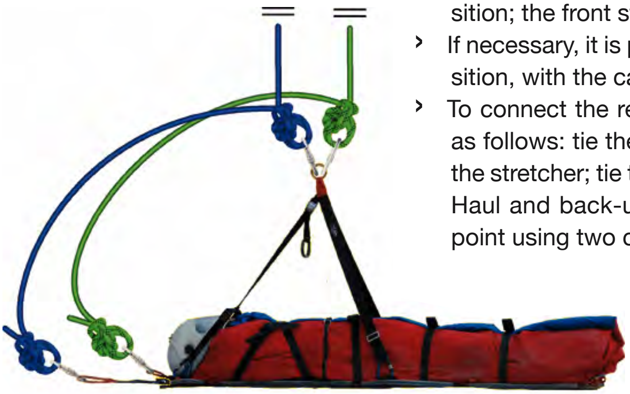
Common mistakes

- Braid the haul and the back-up ropes.
- Connect the ropes reversing the loops at the head end of the stretcher.

Bridles for horizontal lifting

Information

- The front side of the bridles is equipped with a spacer to be placed at the head end of the stretcher.
- Bridles have a lifting ring and a buckle for trimming so to precisely and quickly adjust the stretcher tilt.



- Bind the rear straps to the loops at casualty basin level in lifting position; the front straps is bound to the loops near the casualty head.
- If necessary, it is possible to place the stretcher in Trendelenburg position, with the casualty feet slightly higher than the head.
- To connect the rescue ropes following the standard procedure, act as follows: tie the hauling rope end to the long loops at the head of the stretcher; tie the back-up rope end to the short attachment point. Haul and back-up ropes are then bound to the lifting attachment point using two carabiners with opposed opening.

Warning

- Carabiners connecting the bridles at basin level must be of HMS type.
- The carabiners sleeve is turned to the feet. This is necessary to properly tilt the stretcher toward the vertical position, otherwise screw-locks would interfere with the sewn loop. Leave a slack of sufficiently long rope between the bridles rope attachment point and the attachment point at the head of the stretcher. This will avoid problems with the helmet and the casualty head.

Common mistakes

- Confuse the loops at the feet of the stretcher with those near the ankles and intended for connecting the bridles for tyorlean lifts.
- Connect the bridles using twisted tapes.

Bridles for tyrolean lifts

- Alp Design stretcher comes with special bridles intended for tyroleans.
- It is equipped with a spacer to connect to the head end of the stretcher.
- It is equipped with two rings for the pulleys positioning and the lift ropes connection.
- The locking loops at the head of the plank are the same loops used for the trim bridles, while the foot end is equipped with two further loops at ankle level.

- The Mako stretcher has an extra component to connect to the foot end, while the upper part uses the same bridles used for vertical lifts although shorter at basin level.
- The foot component is also equipped with a ring for connecting the rope.
- It has three suspension rings intended for the pulleys.

- Please refer to the chapter on the Tyrolean for information about the ropes tying for tyrolean lifts.


Photo Giuseppe Antonini

Photo Giuseppe Antonini

Stretcher team work-flow

Contents

THE STRETCHER TEAM

Information

- Its task is transporting the stretcher and assisting the casualty together with the medical staff.
- It forestalls the stretcher movements setting up and dismantling the camp at the defined halt areas.
- It brings all the required material for the casualty care.
- It is usually composed of 8 rescuers acting as bearers - one of them is appointed as the stretcher team leader.
- The bearers number can be increased or reduced depending on the type of transport, the casualty conditions and the cave morphology.
- The team is equipped with a stretcher, a stretcher bag, an helmet for the casualty, the necessary medical devices for the patient instalment, a receiver and a complete rigging sack.
- The team can be equipped with all the needed extra equipment according to the health-care professionals (first aid sacks, medical bags).
- The stretcher team is associated to a sequence of telephone rings for communication purposes.

Warning

- The team will be self-sufficient in terms of food and lights.
- Stretcher-bearers need advanced caving skills.
- Bearers are asked to quickly solve any unexpected situation that may arise during the stretcher transport.

Common mistakes

- Forget to regularly connect the receiver and listen to the communications.
- Leave the stretcher bag far from the stretcher.

The stretcher team leader

Information

- The Stretcher team leader is the person in charge of the stretcher team.
- His/her task is to optimize the stretcher team work-flow and manage the transport procedures.
- The stretcher team leader will give order on the horizontal transport. The orders will be communicated loud in a clear and concise way: go, stop, lower, lift etc.

Warning

- This task is generally assigned to the team leader, at least in the passages far from pitches, but it can be transferred to the deputy team leader or to a trained rescuer.
- The other bearers don't usually speak during the transport, breaking the silence just for ordering a "stop" when necessary.

Common mistakes

- Fail to clearly designate the stretcher team leader.

The first mover

Information

- One of the bearer will be appointed as the "first mover" charged of determining the best path for the stretcher.
- The first mover carries the stretcher bag and secures the stretcher in the most exposed passages.
- The first mover can help the progression by holding a rope attached to the head end of the stretcher and use it to haul or secure the stretcher when needed.
- The first mover agrees with the team leader and the medical staff the areas where the stretcher can be halted.
- In narrow passages, the first mover identifies the places where the stretcher needs to be halted and the bearers have to progress.
- The first mover pulls down or removes any obstacle that might block the way (rock's corners, stones etc.).

Warning

- The first mover can be the same team leader.

Common mistakes

- Fail to determine the best path for the stretcher, neglecting the rescuers and the casualty safety (caved in meanders etc.), the transport quality, the efficiency and the bearers waste of energies.

WORK FLOW FOR VERTICAL LIFTS

The stretcher-bearers

Information

- During vertical lifts, only two or three bearers attend the stretcher. They will be responsible of looking after the stretcher in pitches and helping the barrowboy at the start.
- The remaining bearers will precede the stretcher in a pitch and they help in the rescue procedures.
- Once the rescue is completed, the last bearers will take up any deviations down a pitch.

Warning

- For ascending, it is advisable to use the haul and back-up lines remembering to check that they have been properly installed.
- The stretcher bearers will bring forward all the equipment that is not closely necessary before the stretcher leaves the halt area.

Common mistakes

- Ascending on ropes which were not properly clipped into deviations nor blocked.
- Ascending on the haul and back-up ropes without the riggers previous consent.

The barrowboy

Information

- When hauling a stretcher in a pitch, a stretcher-bearer has to stay with the casualty in the progression rope.
- The team leader will appoint an expert rescuer to act as the barrowboy.
- The barrowboy's task is to check the stretcher position in all the transport steps, monitoring that it doesn't get stuck or it doesn't hit the rock walls.
- The barrowboy shall also handle any deviations down the lifting rope, eventually correcting the trim.
- It is the barrowboy's task to direct the rescue operations and give orders ("Tension, slacken, lift, lower, stop..."), adding more details when required ("Tension the back-up line", "Lift the haul and the back-up rope", "Lower the back-up rope" etc.).

Warning

- Exceptionally, the barrowboy can be an health care professional where the casualty conditions require so.
- In case of any communication problems, you may want to carry a radio to keep in contact with the rescuers.
- In the way up, the barrowboy will pay attention not to interfere with the stretcher, avoiding to hit it or rock it.
- To better control the stretcher, the barrowboy can connect to the stretcher via a rope, provided that the rope is long enough not to interfere during the climb up.

Common mistakes

- Fail to give clear and concise orders.
- Fail to stay close to the stretcher in the progression line.
- Stay behind the stretcher in the narrow passages.
- Team leader assuming also the barrowboy role.

Photo Paolo Manca

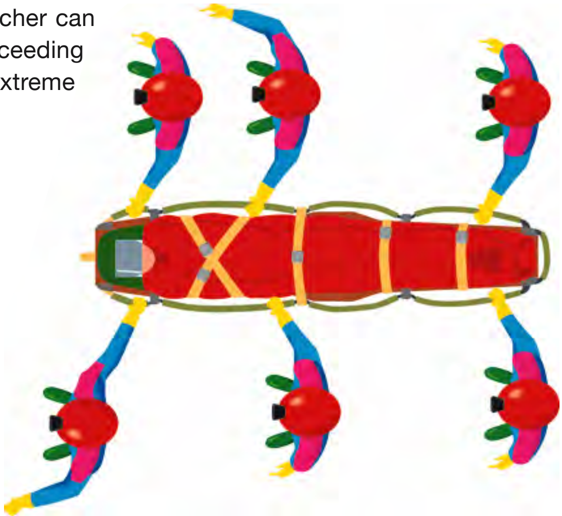
Stretcher transport techniques

Contents

BASIC CONCEPTS

Information

- The inevitable long stays of the casualty in the cave generally call for transporting the stretcher favouring the quality over the speed.
- An efficient stretcher team properly equipped is able to cope with uneven or problematic passages, lightening the rig teams task.
- Casualties have to be moved with the utmost care avoiding jerks and sudden moves.
- In horizontal passages that don't present particular obstacles, the stretcher can be moved by six bearers proceeding with small steps and with extreme care behind the first-mover.



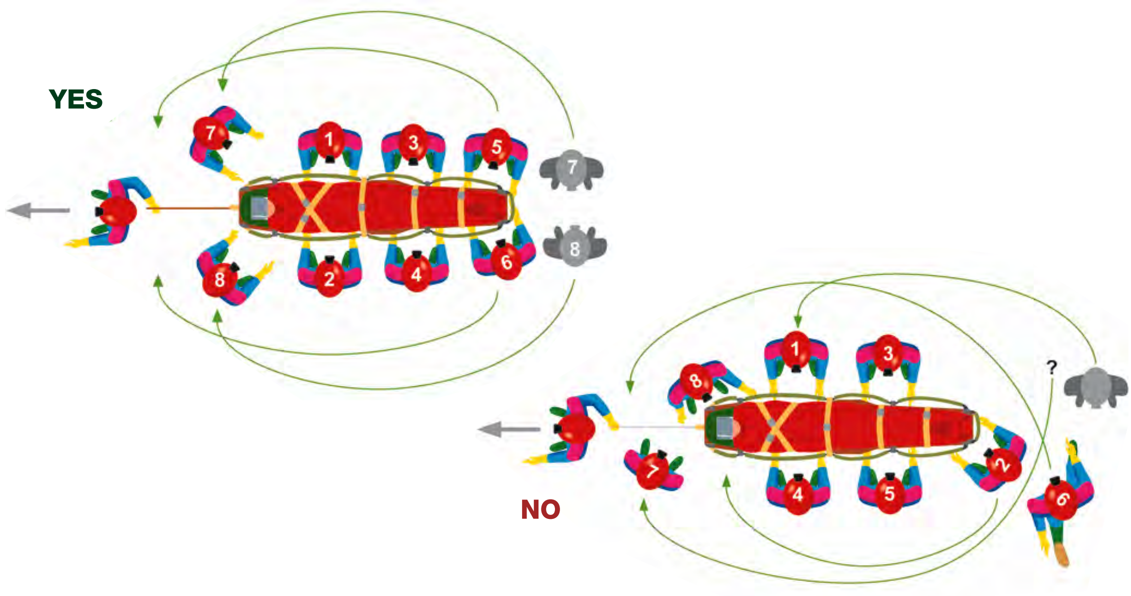
Warning

- Bearers have to avoid any hanging objects on the harness (tools, lamp etc.) that might cause nuisance to the casualty.
- Bearers will line up in even and symmetric way on both sides of the stretcher forming an homogeneous pair.
- Bearers will keep their arms out straight as far as possible.
- The stretcher will move in a coordinated way, according to the stretcher or the rescue team leader instructions.
- During the transport, the stretcher position should be kept as far as possible close to the one decided by the health care professional according to the casualty conditions: the head higher or lower than the feet, side tilt etc.
- The equipment and the stretcher bags don't have to be moved by the same operators at the same time, except in very simple passages.

Common mistakes

- Annoying the casualty when lifting the stretcher, i.e. grabbing the torso straps.
- Move in an uncoordinated way, swinging the stretcher.
- Talk or be distracted without listening to the stretcher team leader instructions.
- Fail to observe the stretcher team leader instructions.
- Not promptly call a halt in case of problems in the progression line.
- Walk in slippery or uneven slopes.

TRANSPORTING THE STRETCHER IN UNEVEN PASSAGES



Information

- In even passages, the "human chain" technique is used, consisting in passing the stretcher from hand to hand with the rescuers standing in place.
- The pair of rescuers standing at the end of the human chain will quickly move to the top to catch again the stretcher.
- At least eight stretcher bearers (and a first mover) are needed, split in four pairs.
- It is advisable to have bearers of similar height working in permanent pair.
- In the narrowest passages, the bearers will get past the stretcher either passing above or under it with extreme care.
- Where tunnels size doesn't allow for a human chain, the stretcher can slide on the bearers legs or on their back. Sometimes the bearer will literally carry the stretcher on his back, with the rest of the team assisting and balancing it.

Warning

- Stretcher bearers shouldn't waste their energies, instead they have to wait and be in a sufficient number of pairs before moving the stretcher forward.

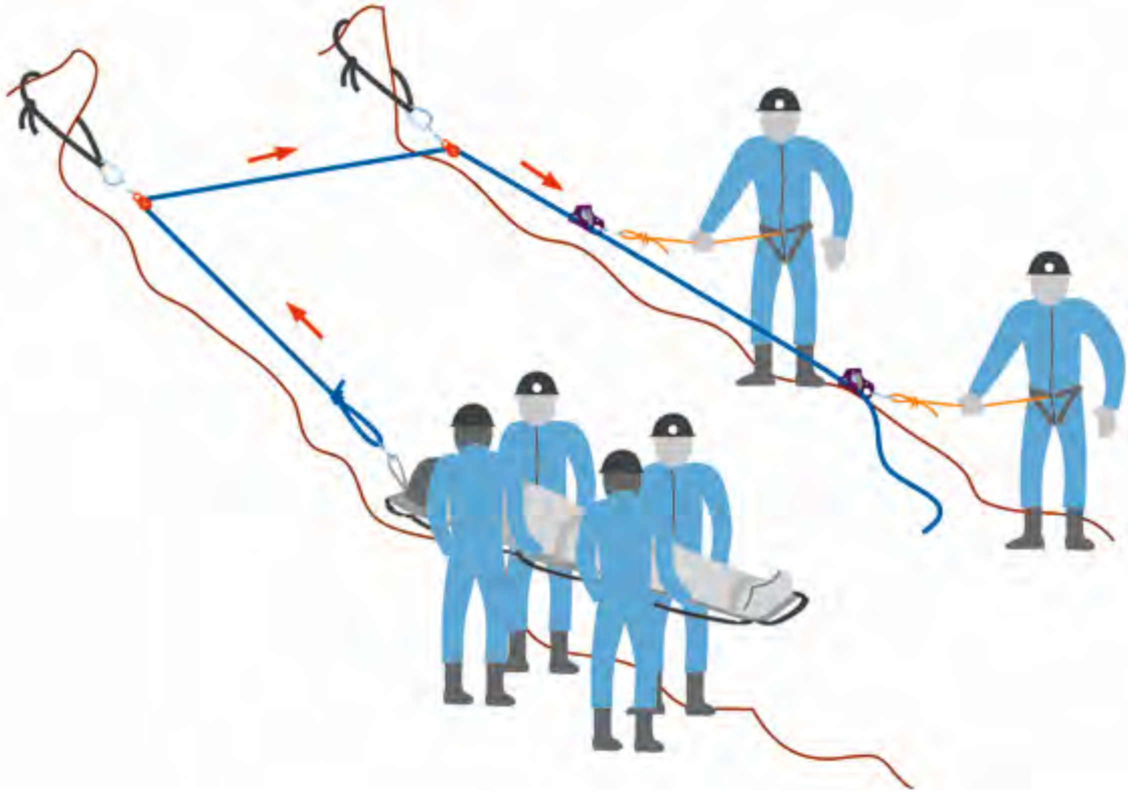
Common mistakes

- Move confusedly around the stretcher, messing up the arrangement in pairs intended to support the stretcher.
- Pass over the stretcher causing the fall of stones or debris on the stretcher.
- Fail to anticipate the passages complex to overcome with the stretcher.

TRANSPORTING THE STRETCHER ON SLOPES

Information

- On slopes or landslides, transporting the strecher uphill can be simplified by building a counterbalance.
- The area where the balance men are working should be moved from the stretcher trajectory using a deviation, to avoid any stones fall hazard.
- Where required, bearers can clip their cowstails directly to the stretcher, provided that they don't load their weight on it.



Warning

- For preparing the counterbalance, it is advisable to use the material available in the stretcher bag rather than that in the riggers bag.
- Where the slope has an uneven ground, the bearers will proceed by little steps, lifting and resting the stretcher in an alternate way.
- The stretcher team leader coordinates the stretcher transport together with the balance men.

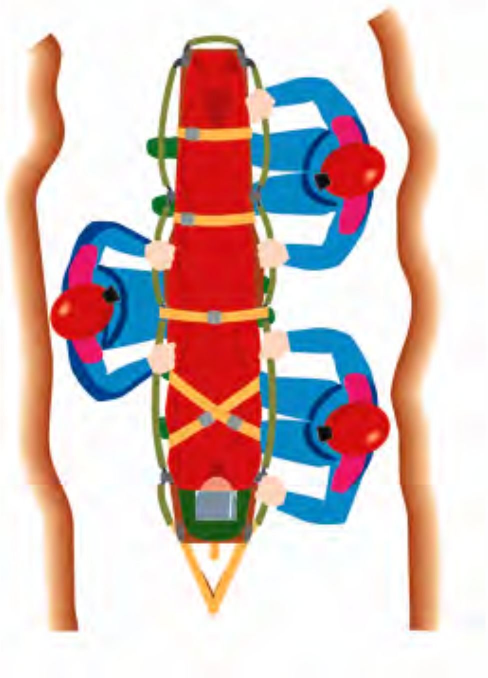
Common mistakes

- Load your weight on on the stretcher.

TRANSPORTING THE STRETCHER IN MEANDRES

Information

- In meandres, you may want to look for a place large enough for the stretcher to pass on the bearers legs.
- Otherwise, the stretcher can be transported at mid-height by an expert bearer, who clips the stretcher to his/her harness using a rope of sufficient length; in this case, the remaining bearers will aid the manoeuvre, guiding the stretcher in the meandre.



Warning

- Where required, a proper back-up line will be set up for the stretcher and the rescuers.
- If the holds are not enough to assure the bearers safety, a pendulum technique will be implemented.

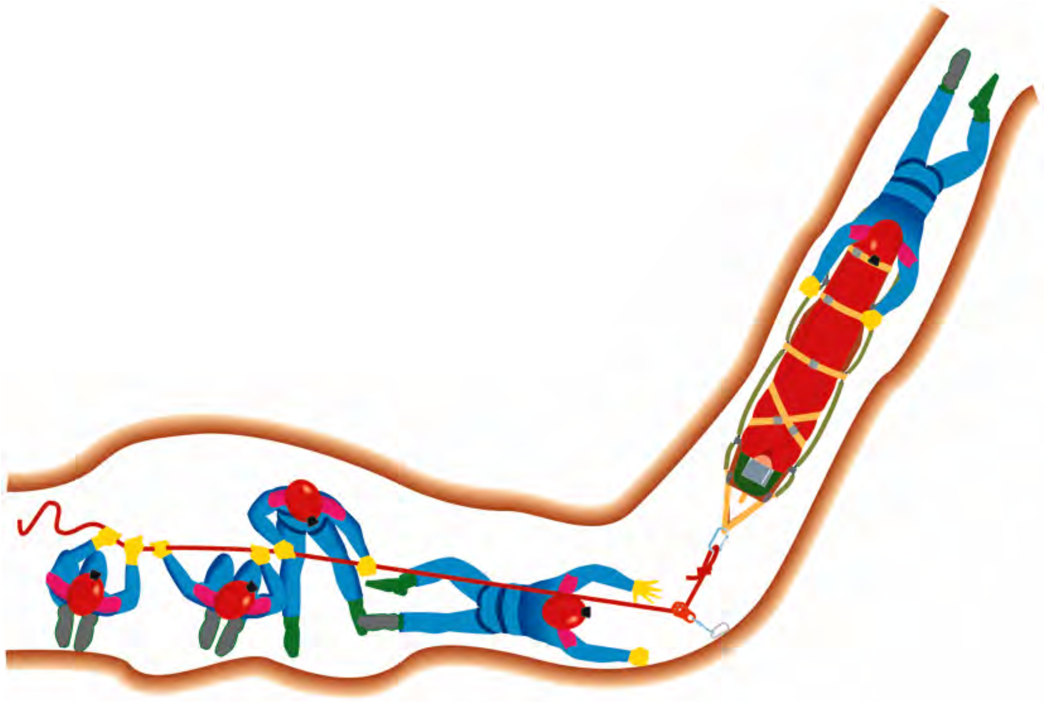
Common mistakes

- Fail to properly assess the stretcher dimensions.

TRANSPORTING THE STRETCHER IN NARROW TUNNELS

Information

- In narrow tunnels, the stretcher's transport can be made easier by installing a lifting rope at the head of the stretcher and deviations where necessary.
- Two bearers, one standing at the head of the stretcher and the other at the foot, will guide the stretcher making sure that it doesn't get stuck.



Warning

- The head of stretchers tends to get stuck; if possible, deviate the hauling rope on the tunnel ceiling whenever this technique is adopted.
- Non perfectly rigid stretchers can be uncomfortable for the casualty's back.
- If the tunnel goes uphill and the stretcher hangs on the rope, it might be difficult to pass a deviation.

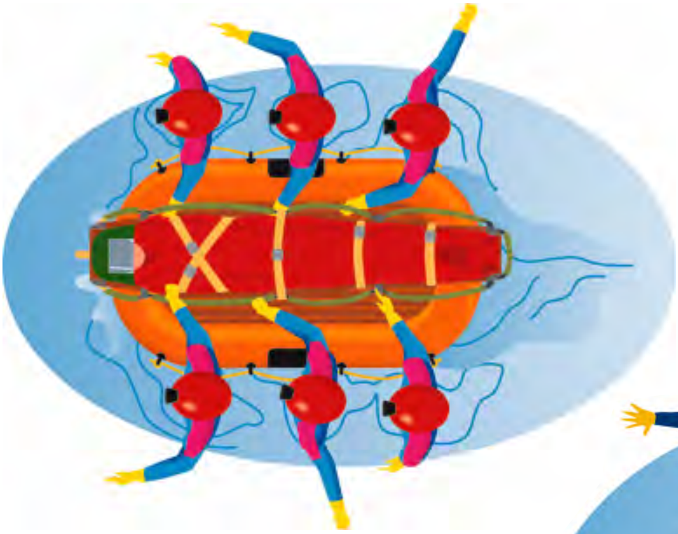
Common mistakes

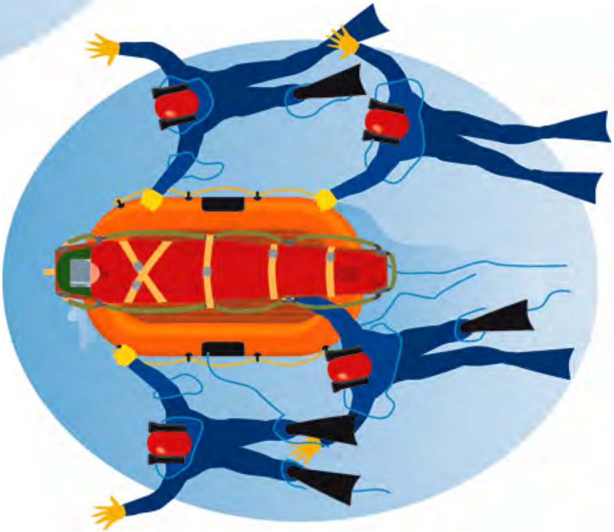
- Overdo the amount of deviations, increasing the already high friction.

TRANSPORTING THE STRETCHER IN AQUATIC ENVIRONMENTS

Information

- For passing flooded passages, usually traverse lines or pendulums techniques are adopted.
- Where there are many and repeated flooded passages, it is advisable to use an inflatable boat and load the stretcher on it. As a way of precaution, it is better to link a buoy directly to the stretcher. The buoy will be adjusted to support the stretcher load.
- Bearers have to stay with the stretcher when crossing an aquatic environment, either walking if water isn't deep or swimming; bearers will wear wetsuit and life jackets.





Warning

- The inflatable boat will be in optimal conditions and with double compartments.
- The flooded passage shall be free from shear stones that might puncture the boat.

Common mistakes

- Fail to properly assess the boat width.

Photo Giuseppe Antonini

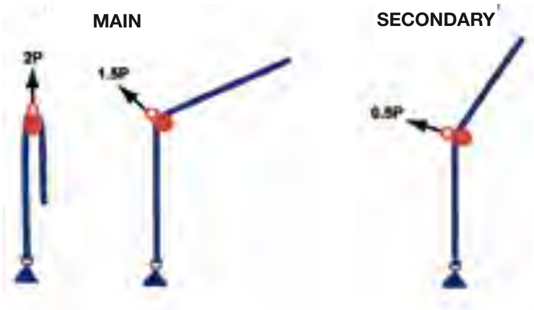
Main and secondary deviations

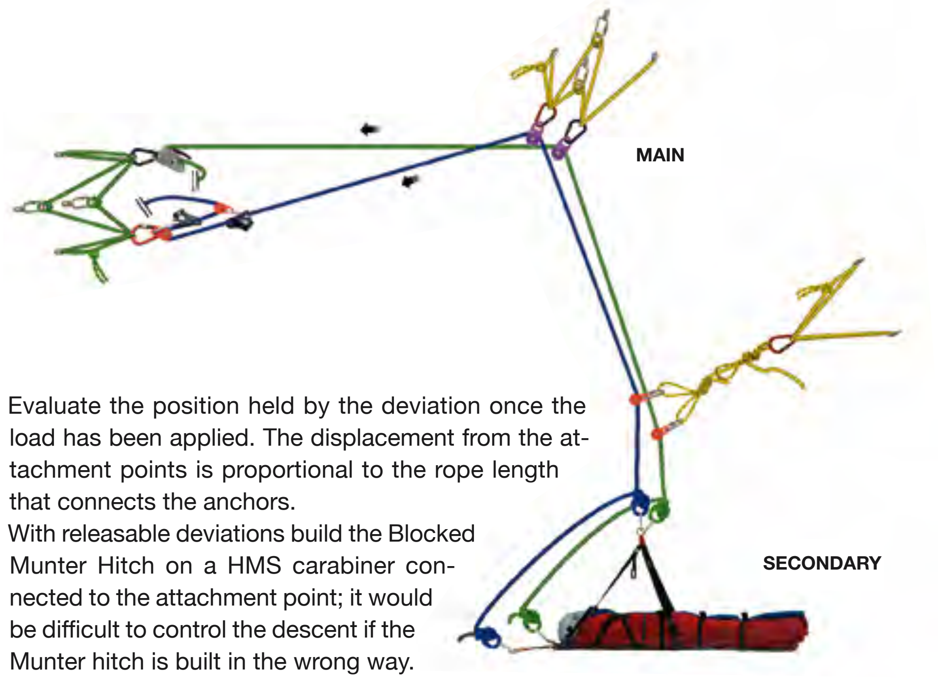
Contents

BASIC CONCEPTS

Information

- Deviations are used to control the stretcher trajectory and push it away from any obstacles.
- They deviate the haul ropes trajectory away from pitch walls to avoid rubbings and frictions.
- Deviations are classified in main deviations and secondary deviations depending on the borne load and the working angle.
  Mid-pitch deviations and tyrolean lines deviations are always considered as main deviations.
- Deviations can be built with pulleys directly connected to the attachment points (unreleasable deviation) or connected to the attachment points with releasable cord tied with a Blocked Munter Hitch (releasable deviation).





Warning

- Evaluate the position held by the deviation once the load has been applied. The displacement from the attachment points is proportional to the rope length that connects the anchors.
- With releasable deviations build the Blocked Munter Hitch on a HMS carabiner connected to the attachment point; it would be difficult to control the descent if the Munter hitch is built in the wrong way.
- With releasable deviations, the Blocked Munter Hitch cord should have enough slack and a free end in order to be completely released.
- Consider splitting the hauling in two or more sections if more than two deviations are needed.

Common mistakes

- Underestimate any exit issues and choose an inappropriate kind of mid-pit.
- Cross the haul and back-up ropes in the pulleys.
- Underestimate the need of deviations along the pitch and leave the whole stretcher movement to the stretcher-bearers.

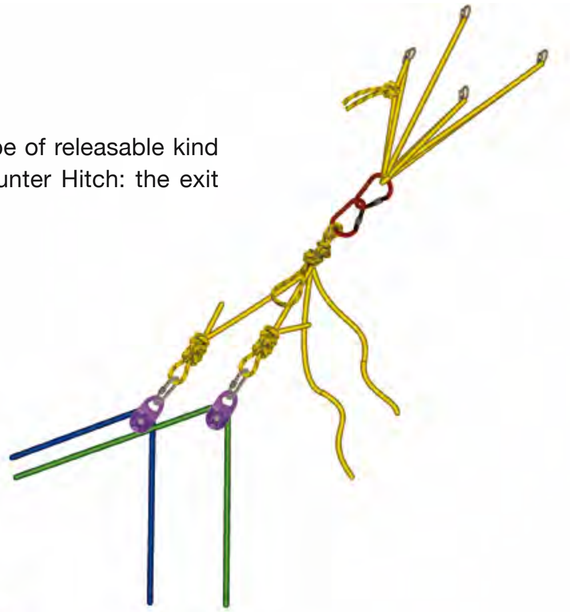
MID-PIT DEVIATIONS

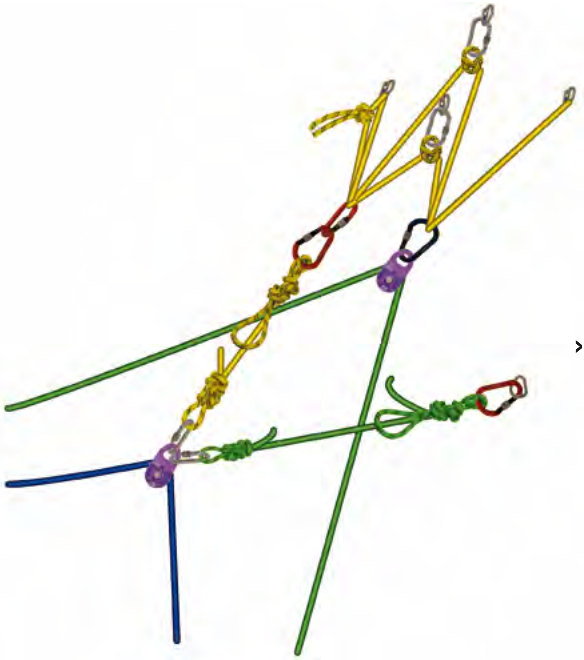
Information

- The mid-pit deviations should be placed as high as possible as to the pitch entrance: this simplifies the exiting of the pitch and it is a good compromise between exposition and operational comfort.
- Build the deviation attachment point connecting at least three anchors.

- The mid-pit is generally built with a double attachment point connected in series with a single cord.
- It is preferable to use a high efficiency pulley to reduce frictions, however different pulleys can also be used.
- The mid-pit deviation can be built of unreleasable kind: the attachment point will be higher, less material is occurred and there are less swings.

› The mid-pit deviations can be of releasable kind and built with a Blocked Munter Hitch: the exit from the pitch is faster.





› If the rope section connecting the anchors is long, the mid-pit assembly is likely to swing back and forth every time the haul rope is pulled, forcing the stretcher to oscillate.
In a similar situation, a fixed anchor can be added in the opposite direction of the haul to limit the swing.

Warning

› Reduce the length of the rope section-carabiner-pulley assembly as far as possible.
› Pretension the Blocked Munter Hitch so that the deviation doesn't lengthen excessively.
› Arrange a service rope for the operators to use it in case of exposed mid-pit deviation.

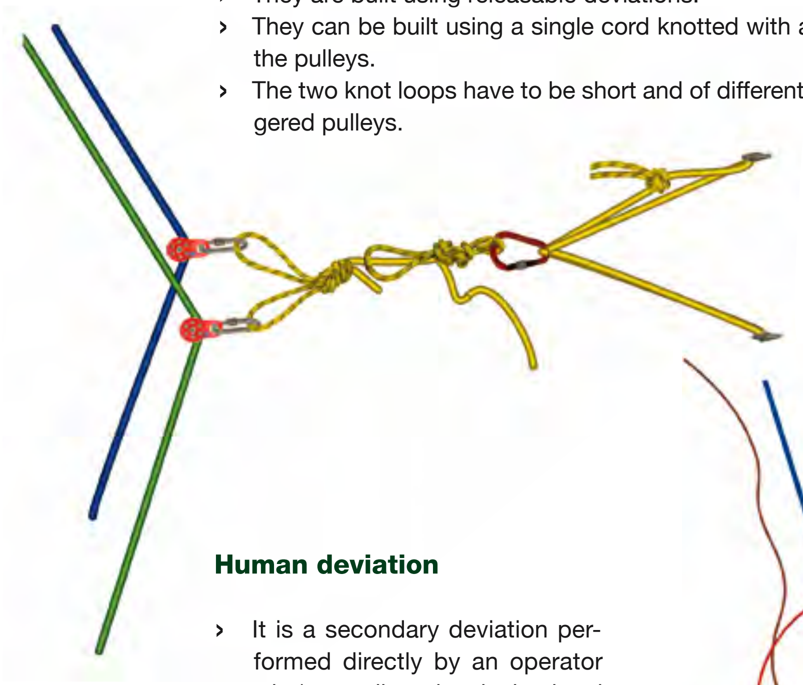
Common mistakes

› Place the attachment points too low with respect to the pitch entrance.
› Fail to foresee the stretcher trajectory along the pitch.
› Fail to foresee the deviation displacement during the different rescue steps.

SECONDARY DEVIATIONS

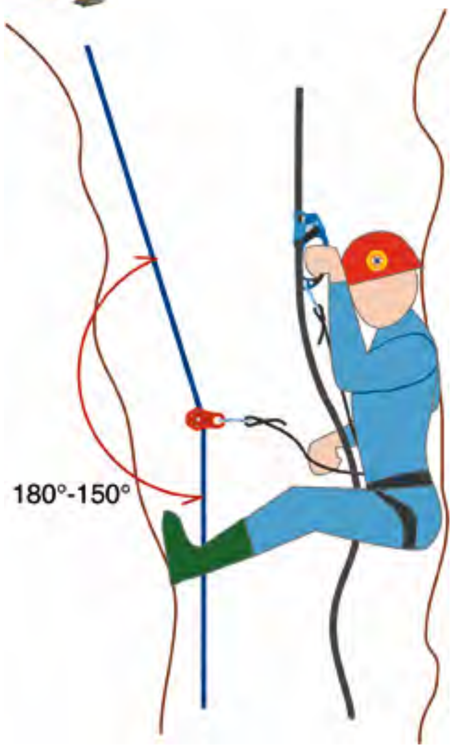
Information

- Secondary deviations are used to modify the stretcher trajectory along the pitch.
- The secondary deviation attachment point should be built connecting at least two anchors.
- They are built using releasable deviations.
- They can be built using a single cord knotted with a double figure-8 loop linked to the pulleys.
- The two knot loops have to be short and of different length - this will allow for staggered pulleys.



Human deviation

- It is a secondary deviation performed directly by an operator who's not clipped to the haul and the back-up ropes.
- It saves time and material.
- It is used for small deviations (150° < ∝< 180°)



Warning

- The Blocked Munter Hitch cord will be long enough to take the stretcher to the vertical section of the following deviation.
- The rescuer responsible for the human deviation can induce further swings to the assembly.

Common mistakes

- Cross the haul and the back-up ropes when building the deviations.

Displacement rope

Information

- It is used at the beginning of the rescue operations, when the stretcher needs to be moved away from water falls or splashes or, more frequently, to be taken along the pitch.
- It is generally built using the service rope included in the stretcher bag tied to an attachment point at the bottom of the pitch.
- It is clipped to the stretcher via a carabiner that holds the haul and the back-up ropes together just above the stretcher. It is the stretcher-bearer responsibility to unclip it as soon as it is no longer needed.

Warning

- It is used at the beginning of the rescue operations only.
- This rope is used to hold the stretcher without counteracting the haul rope.
- The Munter Hitch is loose and it doesn't have to be excessively loaded.
- When choosing the natural anchors, consider that the load directions shift during the haul, risking that the displacement ropes slip off.

Common mistakes

- Fail to release the displacement rope and lift it from the haul once it is no longer needed.
- Use it to pass obstacles in the higher part of the pitch. The risk is to have it work with open deviation angles with respect to the haul direction, producing high loads (tyrolean line effect).

Photo Paolo Manca

The Z-Rig

Contents

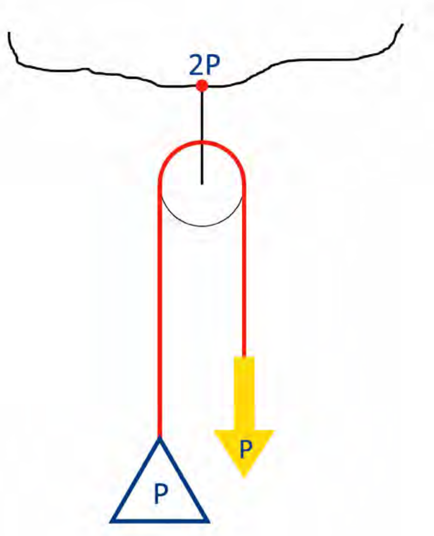
BASIC CONCEPTS

Information

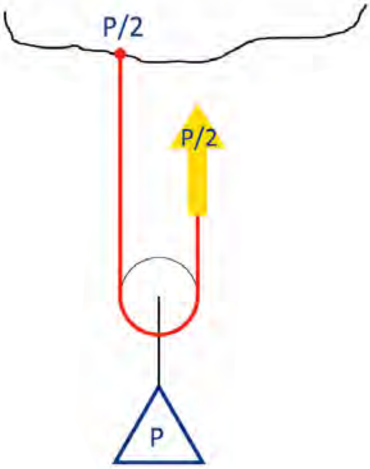
- The Z-rig is a reduction system composed of pulleys and ascenders. It allows to lift loads applying a force inferior to the weight to be lifted.
- We use a Z-rig system with a 3:1 coefficient.
  In a 3:1 Z-rig the force applied to lift corresponds to 1/3 of load's weight, assuming a theoretical situation where elastic deformation and friction are not taken into account; if those factors are considered, the force to apply increases up to ½ of the weight to lift.
- In practice the needed force corresponds to approximately to ½ of the weight to lift because of the frictions.
- The "geometry" of the system permits to lift a load to a height equal to 1/3 of the length of rope taken up in the Z-rig.

Z-rig working principles

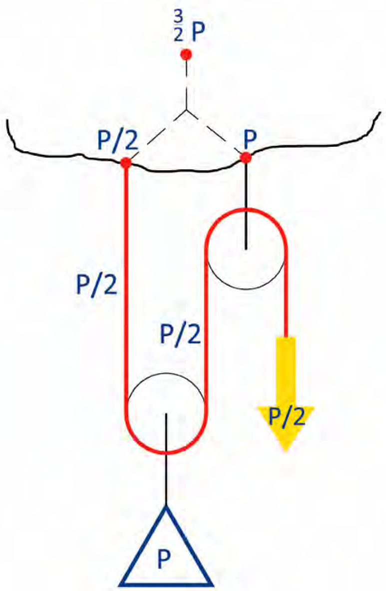
The following examples sum up the principles of the haul system. Frictions, rope elasticity or pulleys diameter are not taken into account.



1) Counterbalance: the same load (P in the figure) needs to be applied on the opposite side of the pulley to reach a balance. The load resting on the attachment point corresponds to stretcher + rescuer. The stretcher (blue triangle) is lifted at the height equal to the length of rope pulled out (yellow arrow, rescuer). Little effort is needed to overcome the frictions: the rescuer only has to gently pull the rope.

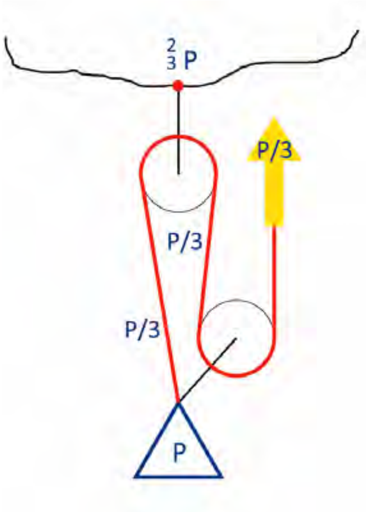


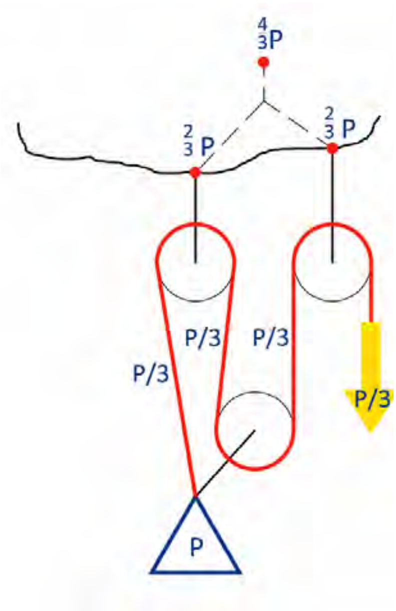
2) The load is hung on two sections of rope, therefore the weight is split exactly in two halves. Half of the weight rests on the attachment point and the other half corresponds to the effort required to lift it. The haul system has a 2:1 coefficient.



3) It is built by adding only one pulley with respect to case 2. The load is suspended on two sections of rope supporting half of the total weight "P" respectively. The anchored pulley needs the same load on the opposite side to be in balance, therefore we have a 2:1 coefficient as in case 2. In total 1 plus ½ of the weight rests on the attachment point. The benefit obtained with respect to the case 2 is an added comfort of pull. No further reduction is obtained.
The rope running in the pulley is twice longer than the lifted height.

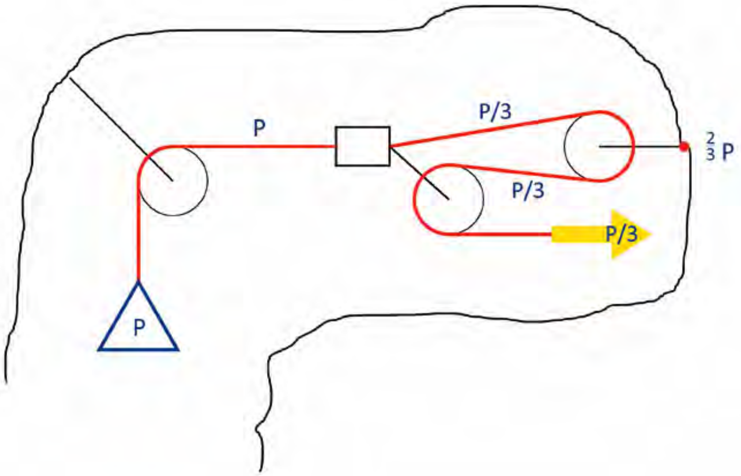
4) The 3:1 Z-rig haul system. Here the weight is fairly distributed on three sections of rope holding the load, therefore each section supports 1/3 of the weight. The attachment point supports 2/3 of the weight, as the remaining weight is discharged on the section of rope where the hauling force is applied. In the case of the z-rig, this applies when the rescuers pull the rope. Whenever the rope is released, the weight rests entirely on the attachment point (permanent ascender blocking the rope); all the weight is supported by the section on the left of the drawing. The triple of rope is needed with respect to the length of the trajectory.

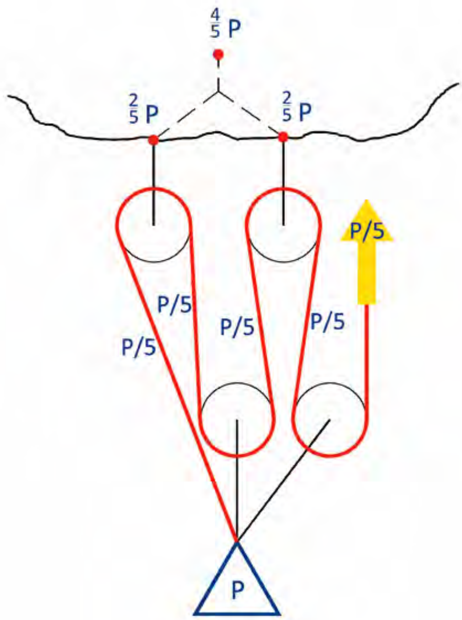




5) Similarly to what we have seen in the case 3, adding a pulley to the attachment point does not lead to a further reduction but only to more comfort in pulling the z-rig rope. As the rope is lifted, a further 1/3 of the load weight (4:3) rests on the attachment point. Again, the length of rope that should run in the anchored pulley at the exit of the z-rig is three times longer than the height gained.

The overall system can be rotated to 90 degrees and the operating principle doesn't change, as in the case of a haul with a z-rig at the top of a pitch.

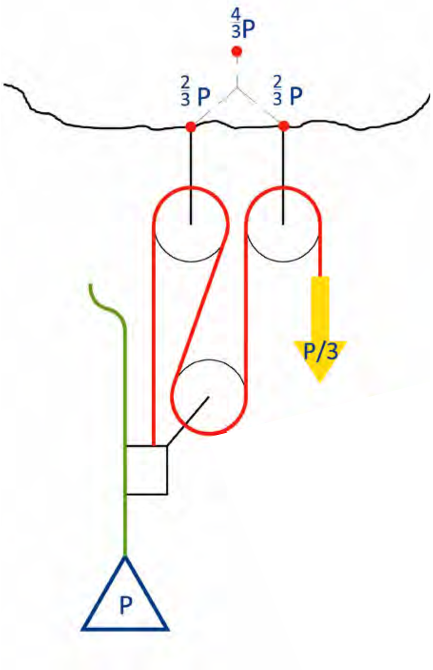




6) If you want to further increase the mechanical advantage, you need to add another pulley that is integral with the load (travelling pulley). The system shown here is a z-rig with a theoretical 5:1 advantage. The general rule for these hauling systems is that when the pulled rope is bound to the load (like in cases 1, 4, 5 and contrary to the cases 2 and 3) and you add pulleys on the load side, you reduce the effort required as follows:

- 0 pulleys (case 1): transmission ratio of 1
- 1 pulley (case 4): transmission ratio of 5
- 2 pulleys (case 6): 5:1 reduction coefficient

Adding pulleys on the attachment point side only deviates the rope trajectory with no reduction effects. These are merely theoretical yields: in practice beyond this case the frictions of the pulleys nullify the benefit obtained.



7) The independent z-rig.
The independent z-rig adopted by cave rescue teams is a haul system with a 3:1 coefficient. The sections of rope exiting the ascender that capture the rope to be pulled are in fact three. The sections of rope captured in the independent z-rig have to be as far as possible aligned to the pull direction, otherwise the system suffers a reduction of the mechanical advantage in addition to the well-known reduction induced by the frictions. That's why it is often preferable to add a third pulley that, as explained in the previous examples, doesn't alter the system transmission ratio but facilitates the alignment of the sections of rope during the haul.

CONSTRUCTION

Information

- The z-rig is made of two parts: an anchored one and a travelling one, both composed of pulley, ascender and an oval HMS carabiner with screw-lock **(fig. 1)**.
- We start building the anchored base with the ascender; the anchored base is connected to the attachment point via a HMS carabiner with screw-lock; then the travelling part is built.
- The anchored base can be replaced by a handle coupled to a Turbo pulley from Kong **(fig. 2)**, by a Grigri **(fig. 3)** or by a Stop descender **(fig. 4)**.

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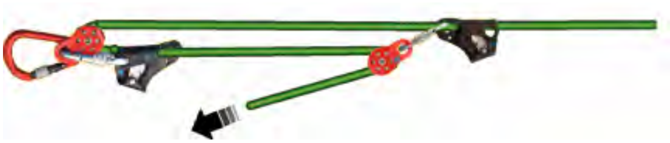

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2

4

Warning

- For an anchored base of a z-rig built with a compression ascender (half compression z-rig) to work efficiently, an oval - HMS carabiner with a rounded-section bar and a pulley with wide flanges (as Fixe pulley from Petzl) should be used.
- The Turbo pulley from Kong tends to open the flanges if used on the compression anchored base. When different pulleys are not available, it is recommended to mount the anchored base of the traction z-rig.

Common mistakes

- Mount the anchored base in the reverse direction with respect to the haul.
- Mount the travelling part crossing the ropes and increasing the frictions.

Photo Antonino Bileddo

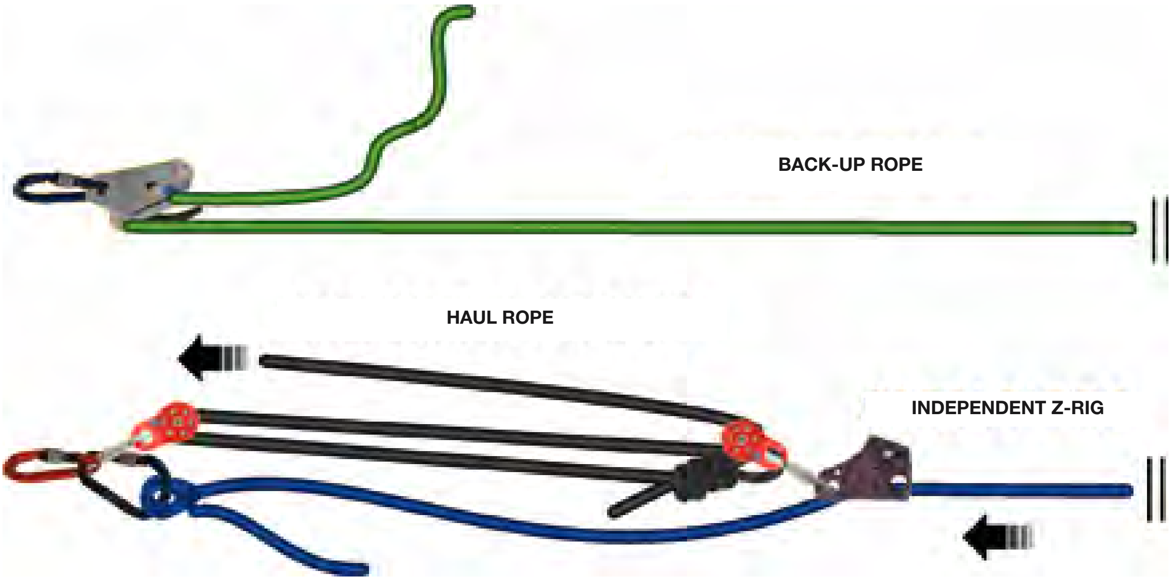
Independent z-rig

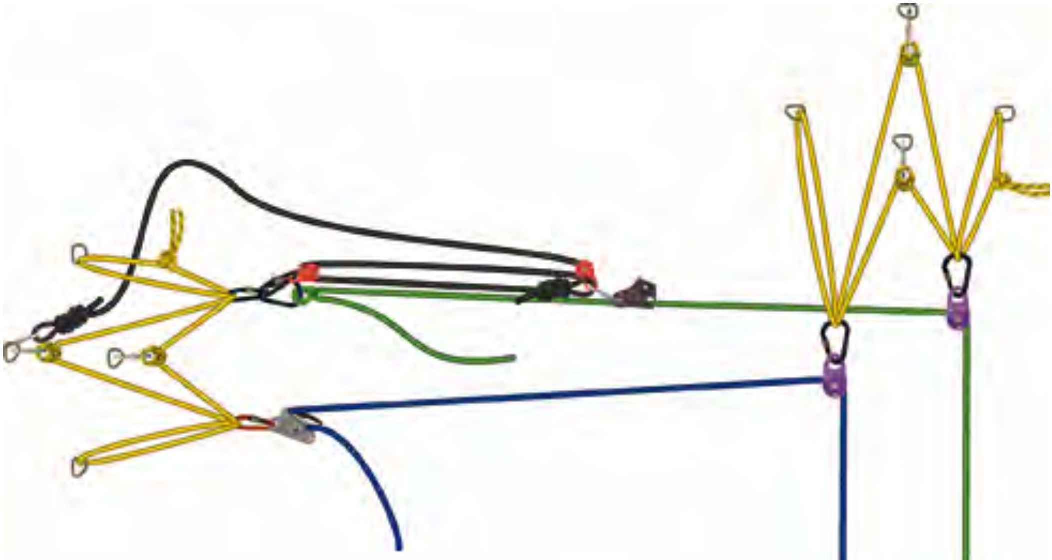
Contents

BASIC CONCEPTS

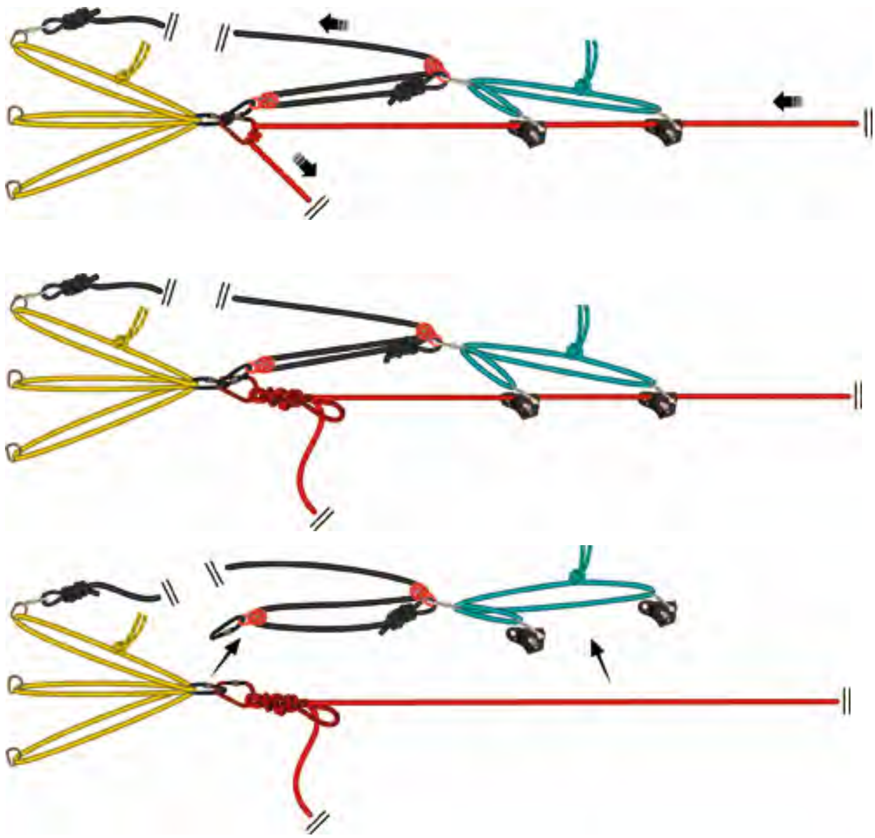
Information

- The independent z-rig is a variation of the traditional z-rig, compared to which it presents many benefits, particularly in the most complex manoeuvres where it is frequent to pass from haul to back-up or where you need to tension a load-bearing part of a tyrolean traverse line.
- This system leaves unchanged the reduction delivered by the traditional z-rig (3:1). The reduction delivered by the traditional z-rig (3:1).
- It is independent and releasable in any given moment from the haul (or the back-up) line.
- The independent z-rig can be released from the haul line and be rapidly mounted on the back-up line, obtaining a highly versatile interchangeable system.
- The haul and back-up ropes are independently bound with a locking system as a Munter Hitch or a grigri.
- It is a non-self-locking z-rig that it is built in parallel to the haul and the back-up line with: a travelling base, a rope section and a pulley introduced in the attachment point.



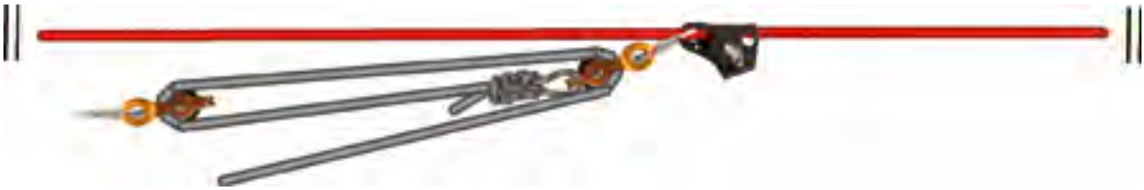


› The independent z-rig is an excellent tool for tensioning the load-bearing part of a tyrolean traverse line, that has to be always connected to the attachment point via a releasable system.



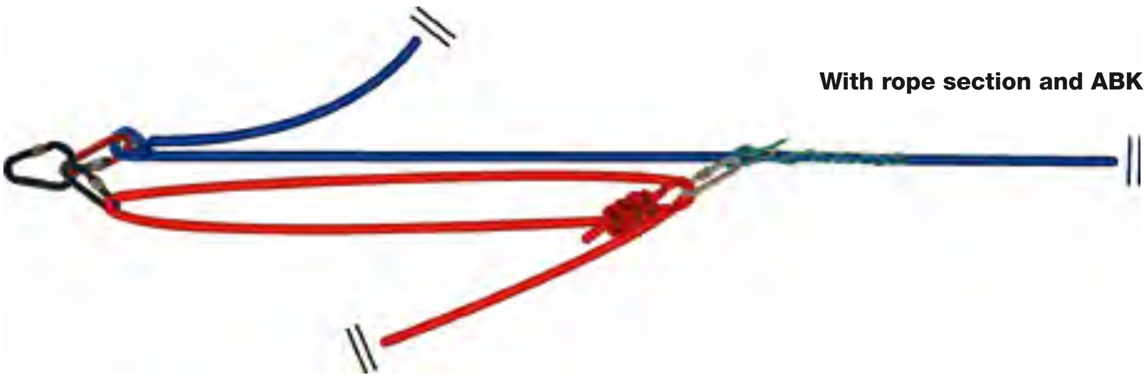
- In order to be ready for use, it is possible to carry an assembled independent z-rig in the bag, paying attention to pack it down properly so that the ropes don't get braided.
- Being extremely simple, the system can be built with different configurations, also using the so-called "emergency" material (ex. rope section, rope end, ...).

With rope end



With Turbo pulleys

With rope section and ABK



Warning ⚠

- The use of an independent z-rig requires the presence of a rescuer to take up the rope in the Munter hitch or in the grigri and to monitor the correct operation: an extra person is therefore needed with respect to the traditional z-rig.
- If the locking system is a Munter hitch, the free end of the independent z-rig should be bound to an anchor forming a close loop between the Z-rig and the attachment system. This system can retain the stretcher in case of human error of the Munter hitch operator.
- In order to work efficiently, the independent z-rig should be mounted as far as possible in line with the haul rope and be preferably clipped to the main attachment point.
- It is more efficient if the independent z-rig pulls for a long stretch and the z-rig travelling base gets close to the attachment point, the independent z-rig is released when locking system at the main attachment point is blocked and tensioned.
- Build the independent z-rig with a semi-static rope section to limit the system elasticity.

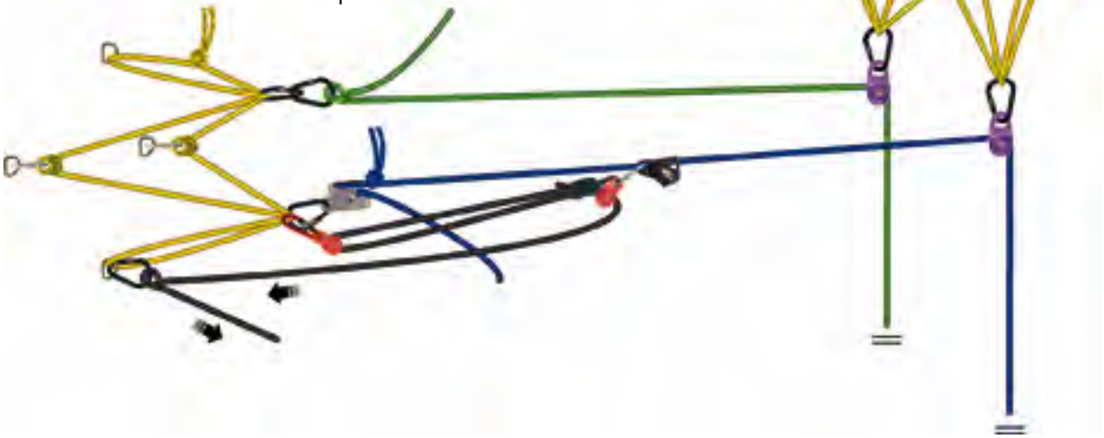
Common mistakes ✖

- Short rope pull that results in a loss of system efficiency due to the tensioning of the Munter Hitch and of the rope section comprised between the attachment point and the travelling ascender.
- Introduce the travelling pulley in the twin holes at the head of the ascender: in this case the system requires a lot more time to be dismantled.
- Clip the carabiner of the anchored pulley directly to one of the anchors; in this case the system works out of its axis and the load rests on a single anchor during the haul.
- Block the Munter Hitch performing the closing loop with the knot in haul position.

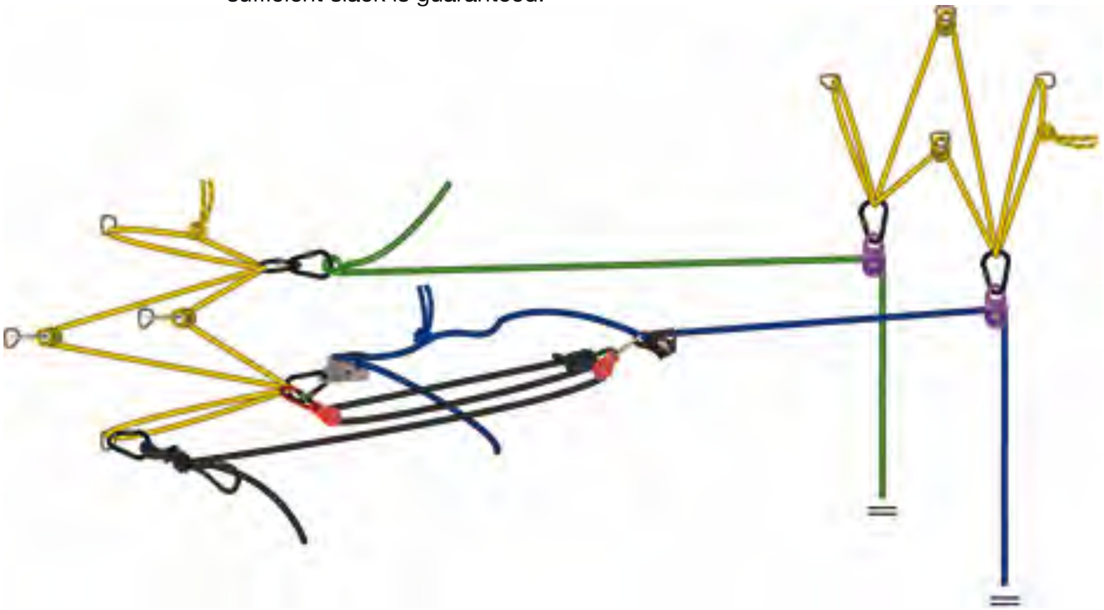
PASSING THE KNOT WITH A Z-RIG HAUL SYSTEM

Information

- Take the knot up against the gri-gri or the Munter Hitch.
- Protect the system tying a Munter Hitch with the rope exiting the independent z-rig on one of the attachment point anchors.



- Continue to take up the rope with the z-rig (a 3:1 coefficient is maintained), while a rescuer assures the system protection recovering the Munter hitch until sufficient slack is guaranteed.



- Block the Munter hitch in the section of rope, dismantle the gri-gri (or the Munter hitch) and reassemble it right after the knot.

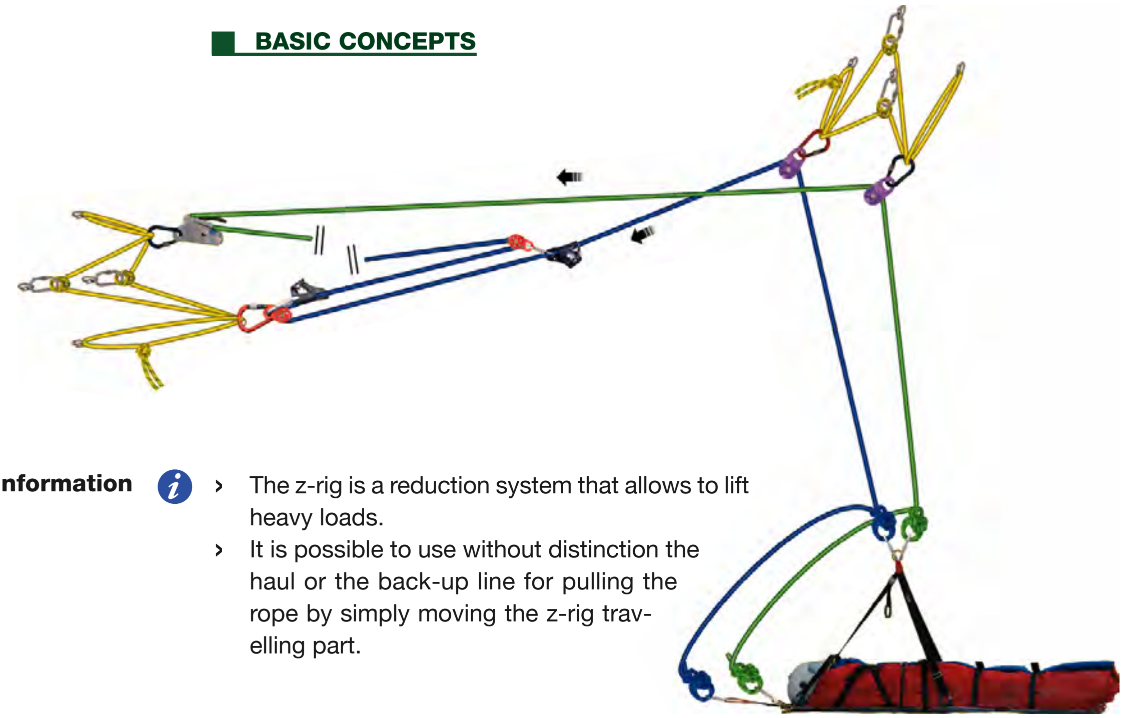
Photo Antonino Bileddo

Photo Paolo Manca

Z-rig haul system

Contents

BASIC CONCEPTS



Information

- The z-rig is a reduction system that allows to lift heavy loads.
- It is possible to use without distinction the haul or the back-up line for pulling the rope by simply moving the z-rig travelling part.

- Back-up ropes are clipped to a main deviation placed at the head of the pitch.
- The trajectory along the pitch can be rectified with one or two secondary deviations.

Warning

- Pay attention to the generated frictions - in such hauling systems it is easy to put the haul rope under high stresses. When more than three operators are required to pull the z-rig haul rope, it means that the system is put under high stresses (stuck stretcher, frictions against the rock, too many deviations).
- Carefully evaluate the operating space available to the operators assigned to the haul: a limited space imply short pulls, with consequence of stretcher's vertical oscillations and minor efficacy.
- When the rope is pulled with the z-rig, lift simultaneously the other rope.

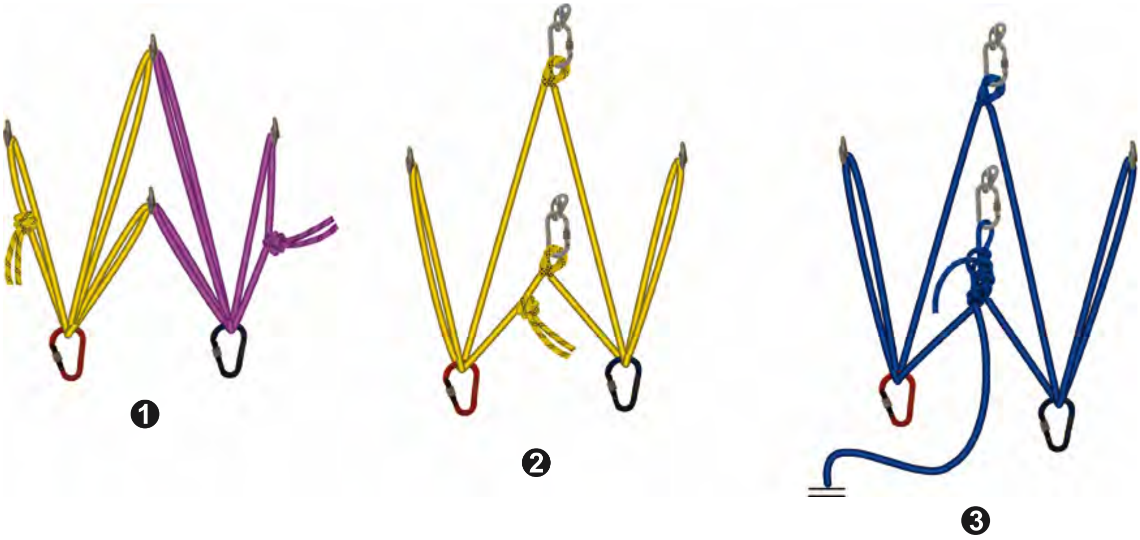
Common mistakes

- Have few operators available for the lifting operation.
- Arrange the back-up rope in a position that hinders the action of the operators pulling the rope.
- Build the main attachment point area in a way that forces the operators to work in an unstable area, exposing the stretcher to a stone fall hazard.
- Pull the rope with excessive energy and jerk the rope (using your shoulders rather than your arms): the stretcher is lifted in fits and starts and with oscillating movements that provoke the casualty discomfort.
- Fail to foresee a handrail to protect the operators in the exposed places.
- Fail to signal any difficulty in the back-up rope lifting while the haul rope continues to be taken up (risk of stretcher get stuck).

MAIN ATTACHMENT POINT

Information

- It is a regular main attachment point for the haul and the back-up rope built with one of the variation described in the relevant chapter. Here under we propose some solutions: double parallel mobile attachment point with two sections of rope **(fig. 1)**, with one section of rope **(fig. 2)**, with the rope end **(fig. 3)**.



Warning

- Haul and back-up lines need to run in parallel as far as possible.
- The attachment point should be receded with respect to the pitch entrance so to have enough space for working and evacuating the stretcher.
- The attachment points should be placed as far as possible at man height to simplify the rescue operations, the tools control and the travelling of the travelling ascender.
- It can be useful to arrange a service cord to recharge the pull system where the mobile ascender is in an uncomfortable position.

Common mistakes

- Build the attachment points too low and/or too near to the pitch entrance.
- Have obstacles between the main attachment point and the mid-pit: these might interfere with the haul line (sharp edges, progression rope, …).
- Fail to consider the mid-pit displacement when loads are applied.
- Fail to consider the possibility to lift the stretcher using the haul and the back-up ropes in the upper pitch.
- Cross the haul and the back-up ropes during the assembly.
- Lower the haul and the back-up ropes without the distinguishing knots (2 knots for the haul rope, 3 knots for the back-up rope).

MID-PIT DEVIATION

Information

- The mid-pit deviation is a main deviation, therefore each single attachment point should be built connecting at least three anchors.
- Choose its position in order to make the stretcher evacuation as easy as possible; its positioning is unavoidably influenced by the pitch morphology.
- It needs to be placed as high as possible to simplify the stretcher evacuation, bearing in mind that if it is higher than the main attachment point, loads and frictions on the mid-pit pulley will increase during the rope pull.
- Both ropes should be deviated. Generally the back-up pulley is in an outer position with respect to the back-up pulley.

Warning

- Once the load has been applied, the pulley tends to arrange itself along the angle bisector formed by the two rope sections exiting the pulley.
- Pay attention not to cross the ropes in the mid-pit pulleys.

Common mistakes

- Invert the haul and the back-up pulleys order.
- Fail to consider the movement of the pulleys once the load is applied.

STRETCHER EVACUATION

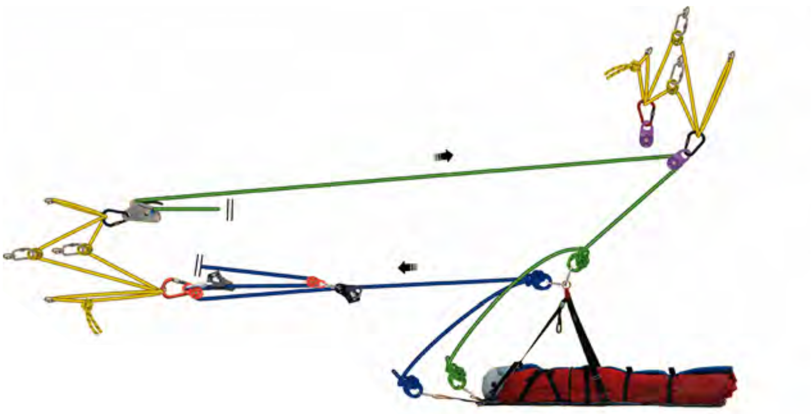
On anchored pulleys

Information

› The mid-pit is built with two anchored pulleys.

Manoeuvre execution

› When the stretcher arrives at mid-pit, block the back-up rope.
› Slacken the haul rope and detach it from the mid-pit pulley.
› Resume the haul rope pull and simultaneously lower the back-up rope.



Strong point

› Easy to tie.
› Little material employed.
› The mid-pit can be handled by a technician in proximity of the pitch entrance.

Drawbacks

› It can be used only for exits with high mid-pit attachment points.
› It is not applicable in exposed mid-pit.

Warning

› It requires extra care: the stretcher will in fact be left connected to both ropes, but some time during the manoeuvre execution it is left suspended at mid-pit only on the back-up rope.
› It can only be performed if the distance between the mid-pit and the pitch entrance is lower than the stretcher length (if the back-up rope should fail, the stretcher would be lowered to the ground).
› It is crucial to respect the rope connection order at the lifting point to avoid that the stretcher turns upside down when exiting: the haul rope should be clipped at the head of the stretcher and the back-up rope at the feet of the stretcher.

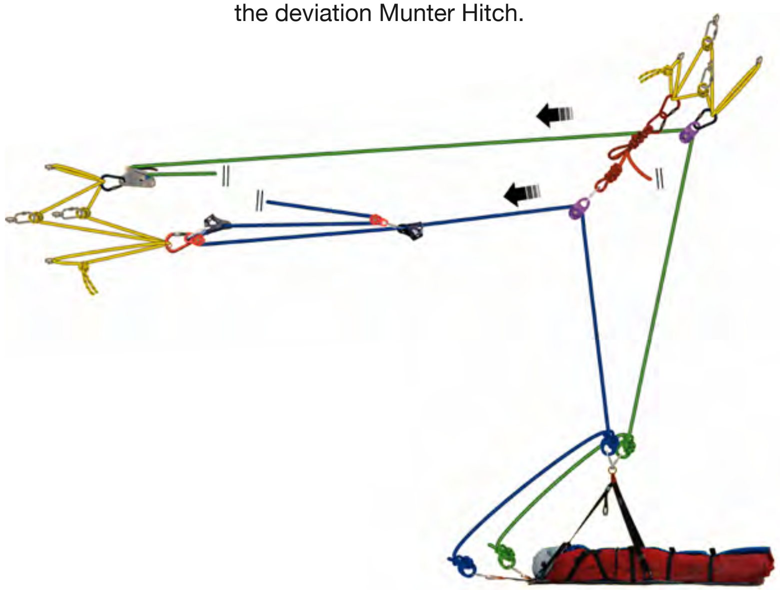
Travelling pulleys with a Blocked Munter Hitch in the haul rope

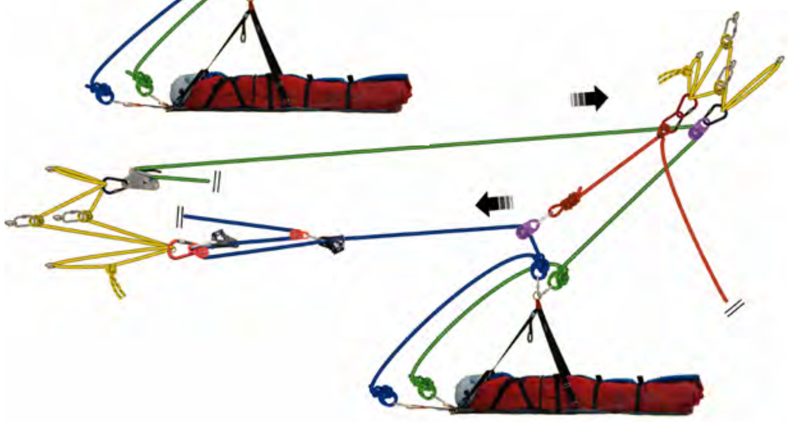
Information

- The back-up mid-pit pulley is of anchored type while the haul pulley is built with a travelling deviation.

Manoeuvre execution

- When the stretcher arrives at mid-pit, release the Blocked Munter Hitch in the haul rope.
- Continue to pull the haul rope and simultaneously lower both the back-up rope and the deviation Munter Hitch.





Strong point

- Quicker execution with respect to the previous technique.

Drawbacks

- The mid-pit attachment points have to be placed rather high.
- More material is needed with respect to the evacuation with anchored deviations.
- A person needs to stay at mid-pit to regulate the Munter Hitch.

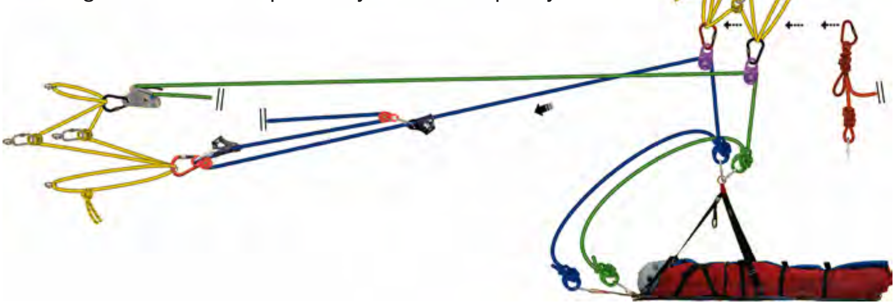
The "washing line" technique

Information

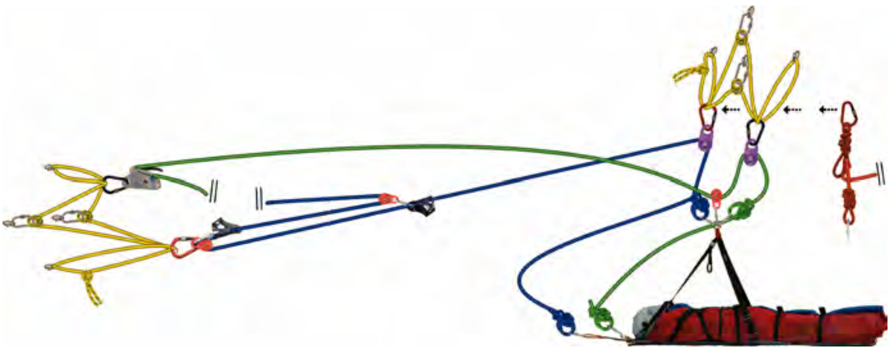
- It is a manoeuvre that facilitates the stretcher evacuation when the mid-pit cannot be arranged in a raised position.
- It needs mid-pit deviations of anchored type.
- The manoeuvre consists in suspending the stretcher on the back-up section of rope that goes from the mid-pit to the main attachment point through a pulley specially connected to the lifting ring.
- If the mid-pit is exposed, the stretcher has to be accompanied "from the feet", arranging an extra back-up rope built with a section of rope connected to the haul mid-pit attachment point via a Blocked Munter Hitch.

Manoeuvre execution

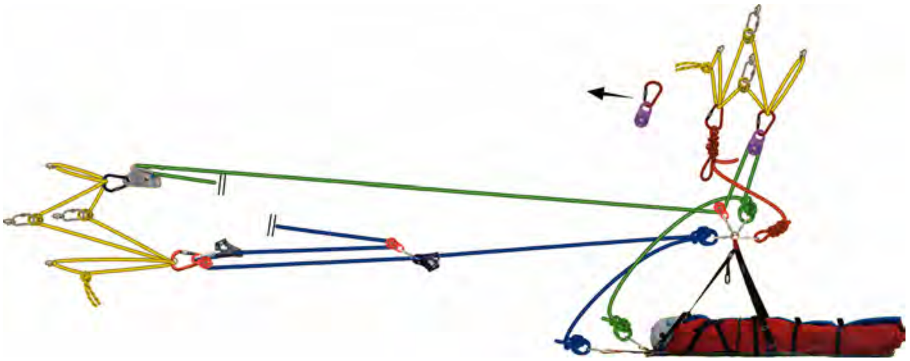
- Bring the stretcher in proximity of the haul pulley.



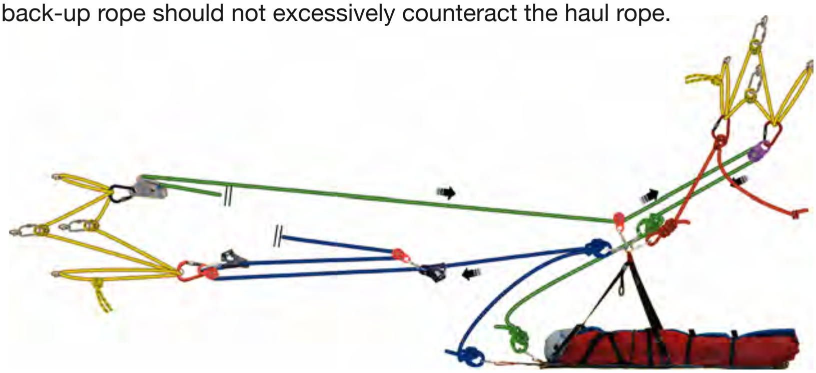
- Lower the back-up rope until you have sufficient slack to introduce the extra pulley between the haul and the back-up rope.



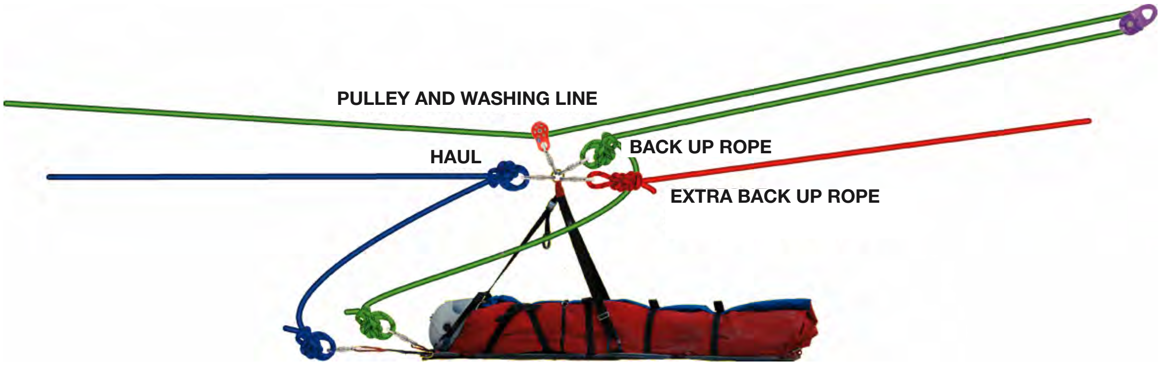
- Take up the back-up rope slack.
- Connect the stretcher to the extra back-up rope by means of a carabiner placed on the lifting ring from the side of the feet.



- Lower the haul rope and remove the rope from the mid-pit pulley.
- Take up the haul rope; the stretcher is raised thanks to the tyrolean line effect produced on the back-up rope.
- Continue to take up the haul rope and simultaneously lower the back-up rope and the extra section of rope so as to keep the stretcher lifted only for the strictly necessary amount of time.
- The back-up rope should not excessively counteract the haul rope.



- The ropes connection order on the lifting point is fundamental. From head to toes: haul rope, "washing line" pulley, extra section of accompaniment rope.



- The washing line pulley has to be clipped to the stretcher at the bottom of the pitch.

Strong point

- The stretcher follows a higher trajectory with respect to the previous techniques thanks to the tyrolean traverse line.
- It allows to adjust the evacuation height of the stretcher with greater precision.
- It allows the stretcher evacuation also with distant mid-pit.
- The manoeuvre can be inverted and used to lower down the stretcher in a pit.

Drawbacks

- It can generate very high tensions on the lifeline elements, particularly on the mid-pit attachment points.
- More complex and slow with respect to the other techniques.

Warning

- The manoeuvre stresses extensively the mid-pit attachment points because of the tyrolean line effect.
- The mid-pit anchors work in two directions: with the load applied vertically during the rope pull and with the load applied horizontally during the evacuation manoeuvre.
- Haul and back-up lines should work in a synchro in order not to overload the system.
- It is preferable not to pass the knot in the inner part of the washing line
- Keep the stretcher as low as possible with respect to the pitch entrance.

Common mistakes

- Keep the back-up line excessively tensioned or the stretcher excessively raised with respect to the real needs.
- Fail to foresee an extra back-up rope when the mid-pit is far from the exit.
- Wrongly position (already at the bottom of the pitch) the carabiners connecting the haul rope, the secondary pulley and the back-up rope on the lifting attachment point.

Photo Paolo Manca


Photo Paolo Manca

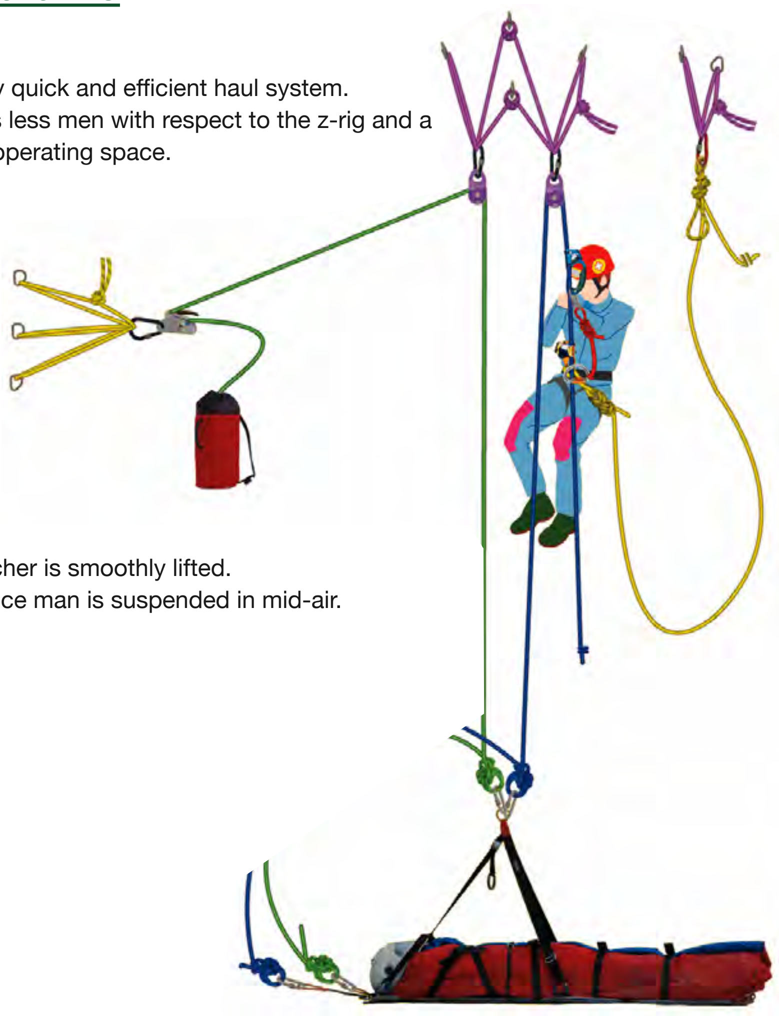
Counterbalance haul systems

Contents

BASIC CONCEPTS

Information

- It is a very quick and efficient haul system.
- It requires less men with respect to the z-rig and a reduced operating space.



- The stretcher is smoothly lifted.
- The balance man is suspended in mid-air.

Warning

- It is a delicate manoeuvre and requires an expert rescuer.
- The rescuer risks to provoke the fall of stones during the manoeuvre when the stretcher lays directly under him/her.
- Evacuating the stretcher from the pitch needs a careful evaluation and arrangement.
- The counterbalance is more efficient if the balance man can descend for at least two meters and ascend for long segments.

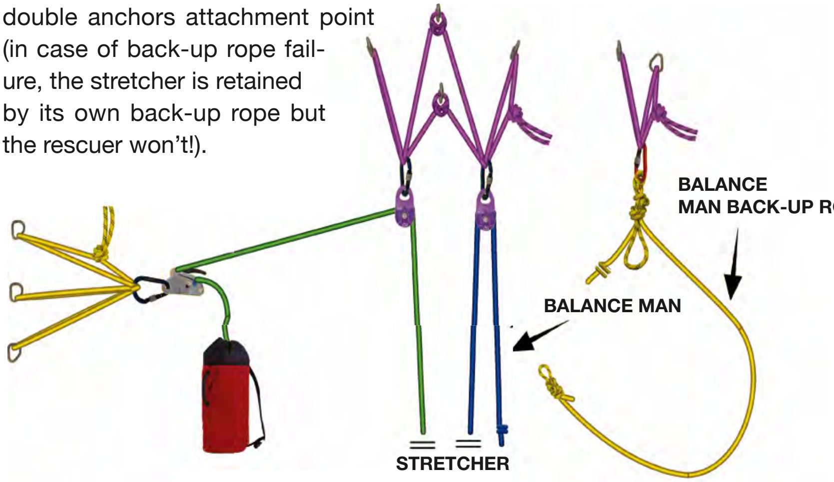
Common mistakes

- Use an excessively short back-up rope section for the balance man, hindering the ascension for long segments.
- The balance man is clipped to the cowstail and uses it for stepping up.
- Lower the balance man under the stretcher: in this way he/she can no longer control the counterbalance.
- Perform the counterbalance discharging part of the his/her weight against the walls.

ATTACHMENT POINTS

Information

- Build the mid-pit using two main deviations with anchored pulleys.
- The attachment points of the two deviations have to be placed as high as possible and be parallel-connected with travelling cord rings so to follow the haul pulley movements from the pull stage until exiting the pitch.
- Use a high efficiency pulley for counterbalance in order to reduce the frictions.
- The counterbalance mid-pit deviation should always be placed in an outer position, from the opposite side of the main attachment point in exposed position.
- The balance man stands in outer position with respect to the counterbalance pulley, so not to interfere with the stretcher during its evacuation.
- The back-up rope will preferably be assembled on a Grigri and a haul system to use during the stretcher's evacuation from the pit should be foreseen.
- Build a back-up line for the rescuer using a section of dynamic rope connected to a double anchors attachment point (in case of back-up rope failure, the stretcher is retained by its own back-up rope but the rescuer won't!).



Warning

- The applied loads resting on the counterbalance attachment point are generally heavier than those registered with the z-rig (the system supports both the stretcher and the rescuer weight).
- Avoid to use long deviations along the pitch as far as possible.
- Once the ropes are lowered down the pitch and while waiting for the stretcher, block the ropes and use them as service ropes to accelerate the stretcher-bearers climb-up.
- Connect the ropes to the lifting point arranging the back-up rope towards the head of the stretcher and the haul rope towards its tail.
- Arrange the balance man back-up rope connecting the rope section to the maillon rapide or the harness closing loops via a follow-through knot.

Common mistakes

- Build a mid-pit with excessively low attachment points or with attachment points that don't allow for a mid-air haul.
- Invert the position of the mid-pit pulleys, positioning the back-up pulley in outer position and the counterbalance pulley toward the pitch exit.
- Invert the ropes connection to the stretcher bridles.
- Fail to arrange the back-up section of rope for the balance man.

EXECUTION

Information

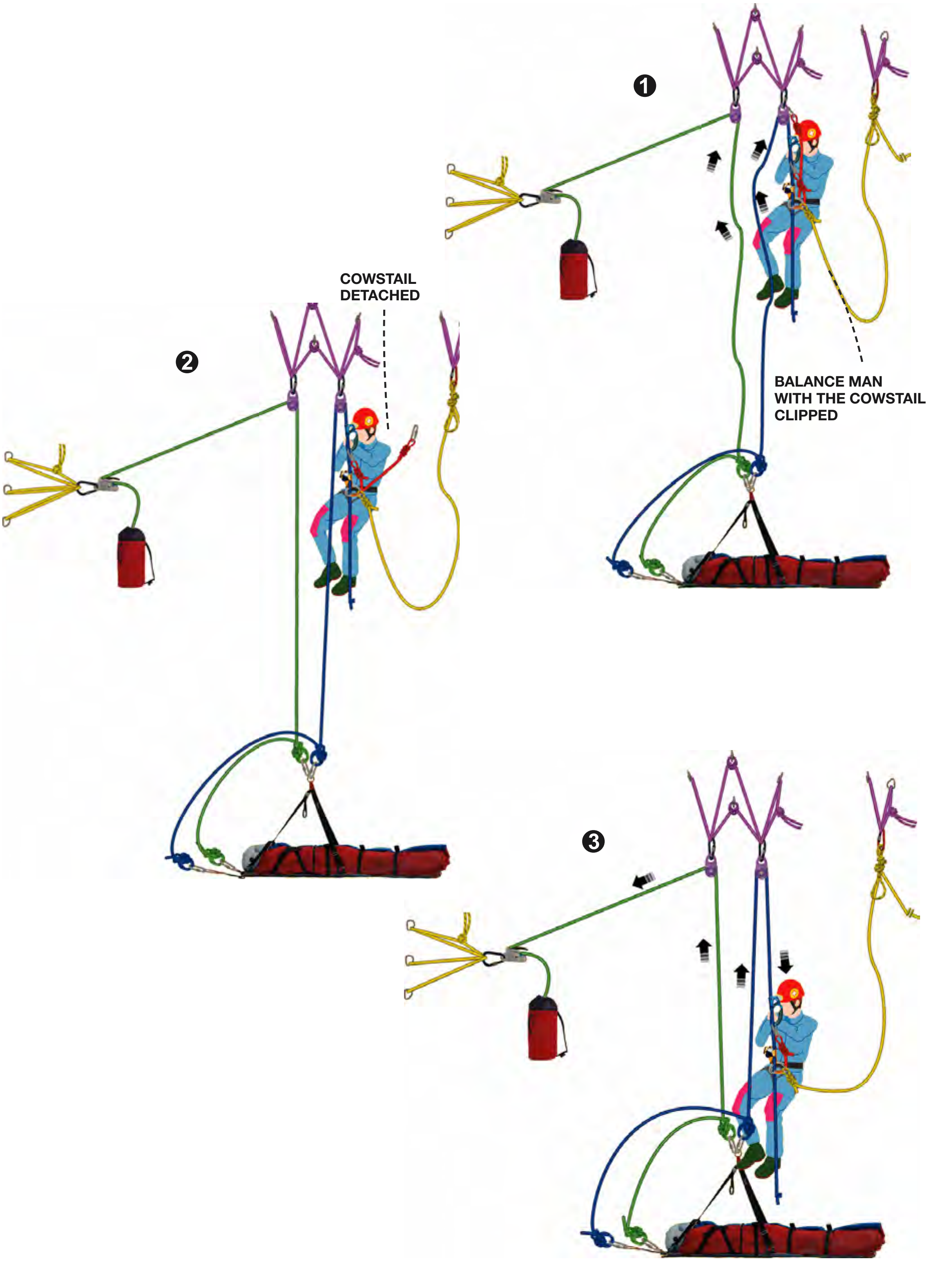
- The balance man stands in the mid-pit with the cowstail clipped to the attachment point of the counterbalance pulley and clipped into the back-up rope.
- Once the stretcher is connected, the rescuer gradually loads the counterbalance rope using the ascenders. **(fig. 1)**.
- When the stretcher is under load, the rescuer detaches the cowstail still clipped to back-up rope. **(fig. 2)**.
- He/she lifts the stretcher pulling upwards the rope standing behind the counterbalance pulley. **(fig. 3)**.

Warning

- It is necessary to pay extreme caution to the fall stones hazard triggered by the balance man.
- The balance man weight needs to be similar to the stretcher weight.
- The balance man can use the back-up rope for lifting the stretcher if necessary.
- The balance man should never descend under the the stretcher in order to keep the stretcher under control.
- The balance man can hold the counterbalance rope tails with both hands during the climb-up if the stretcher is lighter than he/she is: this prevents the stretcher to be raised without control.
- The rope down the rescuer should not hamper the manoeuvre and/or get in contact with the rock.
- The rescuer should clip the cowstail onto the attachment point for lowering only after the change of the tools.
- Once the pull is concluded, the rescuer taking in charge the stretcher should ensure that the balance man has clipped the cowstail before unfastening the ropes from the stretcher.

Common mistakes

- Clip the cowstail at mid-pit before changing tools in case of reverse of direction.
- The balance man rope stays on the wrong side of the pulley, hampering the exit of the stretcher.
- Lean on the rock or on other attachment points discharging one's weight and inducing the stretcher to lower.


1
BALANCE MAN WITH THE COWSTAIL CLIPPED
COWSTAIL DETACHED
2
3

STRETCHER EVACUATION

The stretcher evacuation follows the same pattern seen with the z-rig, with some basic differences:

- The mid-pit is always of permanent kind.
- The stretcher is evacuated from the pitch by pulling the back-up rope. It is therefore necessary to mount a z-rig on it.
- The counterbalance rope acts as a rear-end accompaniment rope. That's why its mid-pit pulley needs to be placed in outer position.

There are two methods for evacuating the stretcher. The first one is generally faster and simpler, but it requires very deep pitches; the second one, the washing line, is extremely effective in low-angle exits.

Traditional evacuation

Information

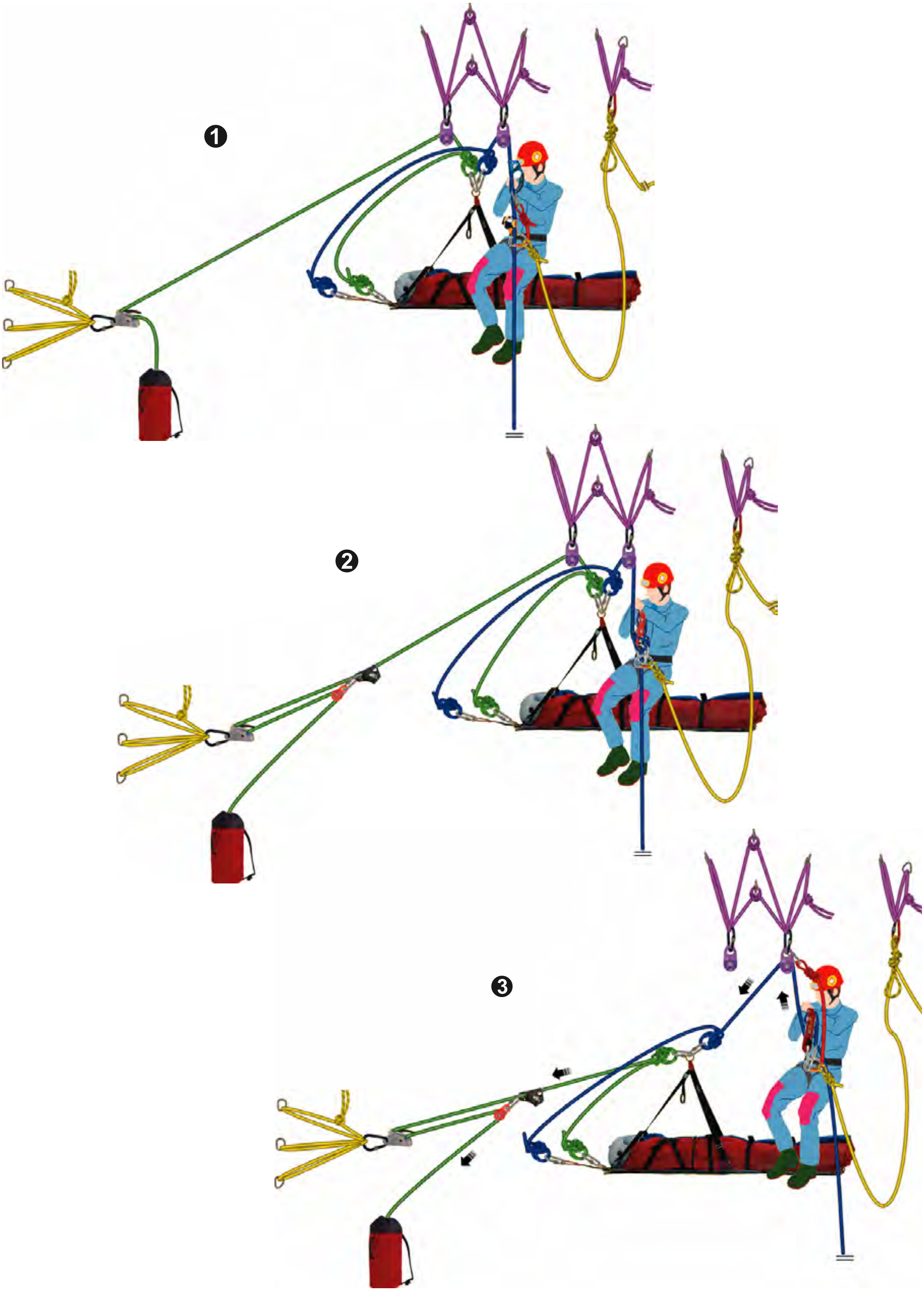
- Bring the stretcher in proximity of the counterbalance pulley.
- Reverse direction by mounting the descender and subsequently clipping the cowstail onto the mid-pit attachment points. **(fig. 1)**.
- Prepare a pull system that uses the back-up rope (z-rig or independent z-rig).
- Slacken the back-up rope, release it from the mid-pit pulley and re-tension the rope. **(fig. 2)**.
- Bring the stretcher near the pitch exit by pulling the back-up rope and simultaneously lowering the counterbalance rope with the descender. The balance man adjusts the height of the stretcher. **(fig. 3)**.

Warning

- The manoeuvre itself is basically simple and efficient but an expert balance man is needed.
- The mid-pit attachment points have to be placed high so to facilitate the stretcher evacuation.

Common mistakes

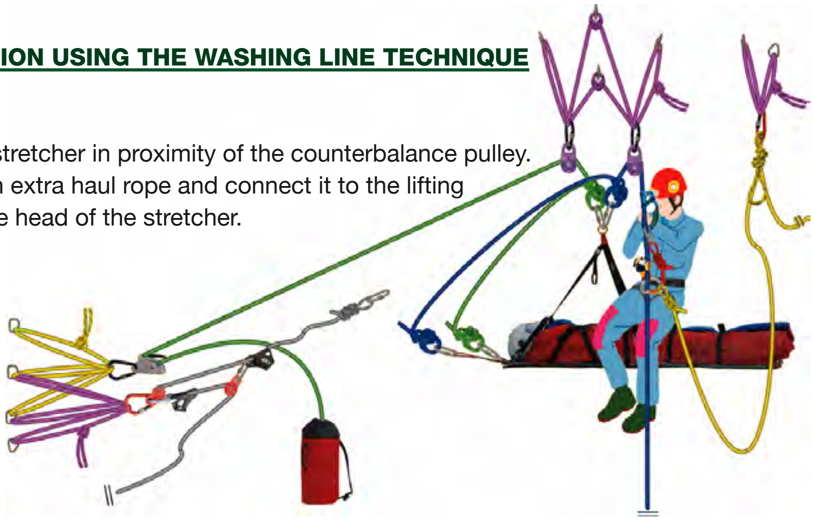
- Start the stretcher evacuation operations before the stretcher reaches the counter-balance pulley.
- Discharge the stretcher weight before the balance man clips the cowstail onto the counterbalance attachment point.
- Mount the back-up and haul rope in inverted way onto the stretcher, inducing the lifting point to twist during the evacuation.
- Keep the stretcher higher than required, overloading the attachment points (tyrolean line effect).


1
2
3

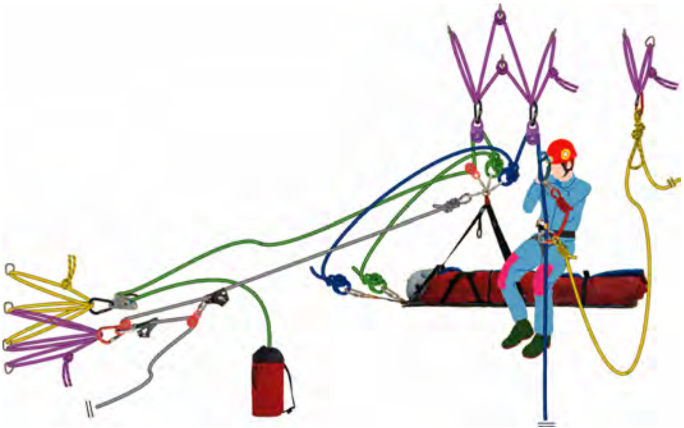
EVACUATION USING THE WASHING LINE TECHNIQUE

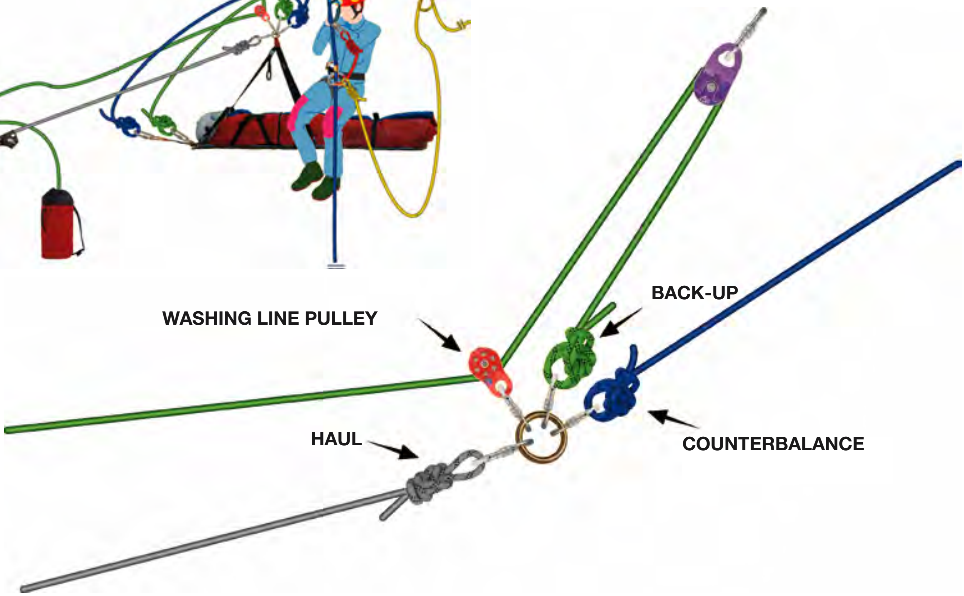
Information

- Bring the stretcher in proximity of the counterbalance pulley.
- Arrange an extra haul rope and connect it to the lifting point at the head of the stretcher.



- Lower the back-up rope until you have sufficient slack to insert the extra pulley between the haul and the back-up rope.





- Re-tension the back-up rope.
- Reverse direction by mounting the descender and subsequently clipping the cowstail onto the mid-pit attachment point.
- Take up the haul rope while lowering the back-up rope and the counterbalance. The counterbalance acts as rear-end accompaniment rope for the stretcher, guaranteeing its safety.

Warning

- It is necessary to arrange an extra attachment point to haul the stretcher. This extra attachment point should be of traditional kind (three anchors); the back-up rope end or the service rope section used for the rescue bag can be used as pull rope.
- The manoeuvre requires the proper arrangement of the carabiners on the lifting point.
- It was demonstrated that the manoeuvre develops high loads on the anchors. It is necessary to pay special attention and care in implementing the mid-pit attachment points.
- The method used for exiting the stretcher should be communicated to the stretcher-bearer or to the mid-pit operator.
- The height of the stretcher from the ground is determined by the back-up rope; giving rope results in the stretcher lowering and vice versa.
- The back-up grigri should be handled with care because it is put under heavy loads and it might jerk.
- The balance man should ease the stretcher evacuation and at the same time shouldn't leave much slack in the rear-end accompaniment rope.

Common mistakes

- Fail to arrange the pulley for the washing line or connect it in the wrong position.
- Fail to arrange the attachment point for the extra haul rope.

Photo Antonino Bileddo

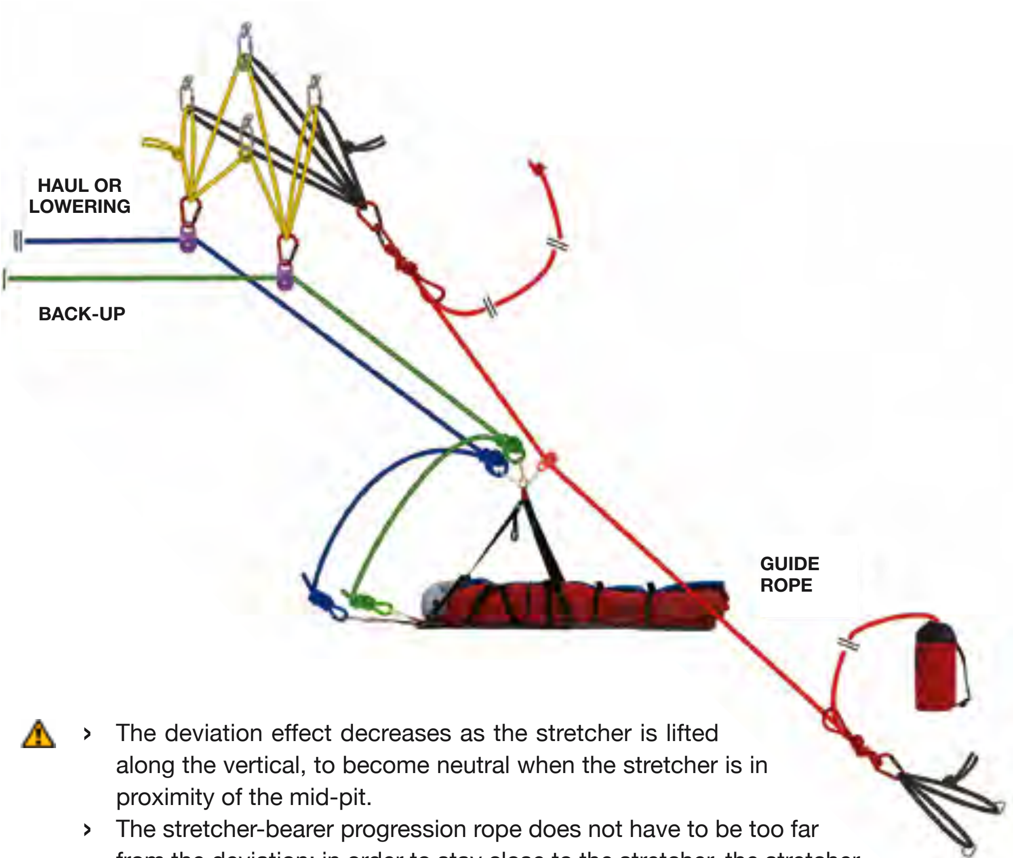
Diagonal tyrolean traverse

Contents

BASIC CONCEPTS

Information It is a haul technique used in vertical sections, when it is necessary to avoid specific obstacles (water falls, slippy landslides, etc).

- It is similar to the haul techniques used in pitches, with the addition of a third extra rope. The third rope, called the "guide rope", deviates the stretcher trajectory from the vertical.
- It is used when the guide rope shows an angle of more than 60°.
- The loads generated on the guide rope decrease with the increase of its angle.



Warning

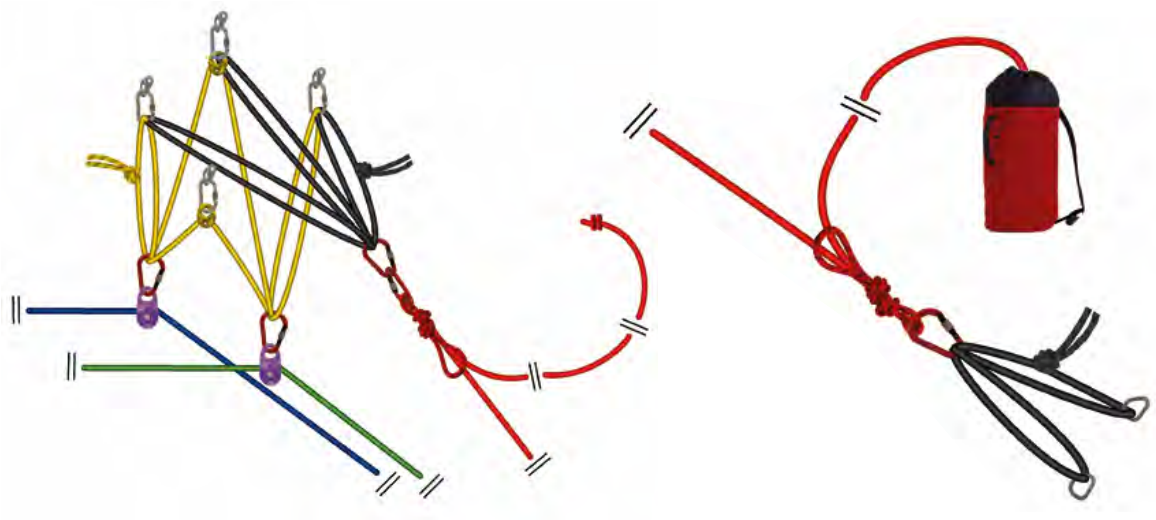
- The deviation effect decreases as the stretcher is lifted along the vertical, to become neutral when the stretcher is in proximity of the mid-pit.
- The stretcher-bearer progression rope does not have to be too far from the deviation; in order to stay close to the stretcher, the stretcher-bearer can clip the cowstail to the guide rope, paying however much attention not to induce uncomfortable swings to the stretcher.

- Rig as if it was an horizontal tyrolean traverse, with the back-up rope placed beneath the haul rope and on the opposite side.

ATTACHMENT POINTS AND ANCHORS

Information

- Due the low loads borne by the guide rope, the attachment point on top of the vertical can use three of the mid-pit anchors backed-up with an extra rope section.
- For the same reason, the guide rope attachment point at the bottom of the pitch can be built on two anchors only.
- The guide rope has to be releasable from both ends in every moment, therefore you may want to arrange enough rope both upstream and downstream to lower a stretcher on the mid-pit vertical.
- The releasable attachment point can be built with a Blocked Munter Hitch.



Warning

- Place the upstream attachment point in the highest and most receded position possible. This simplifies the stretcher evacuation.
- The guide rope trajectory should be checked before beginning the manoeuvre by simulating the rope pull with a rescuer hung on the rope.
- If the guide rope shows an angle of less than 60°, it is preferable to add a rear back-up rope.

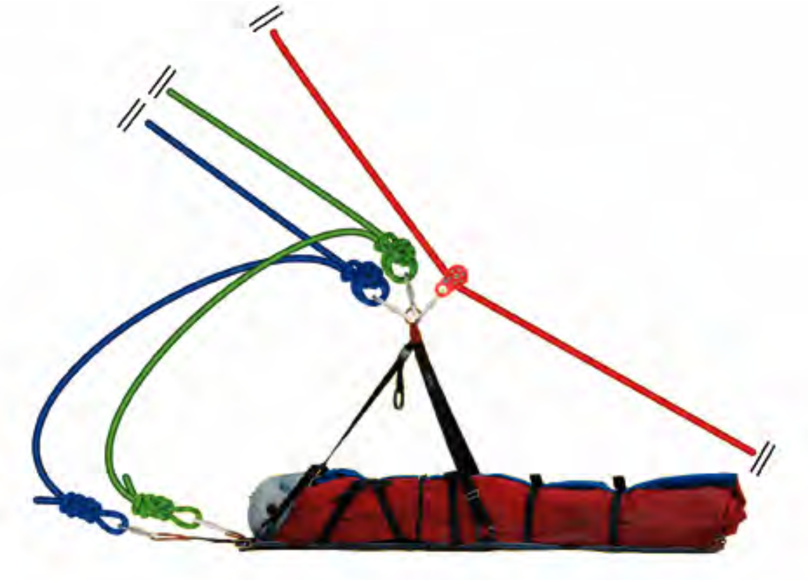
Common mistakes

- Have the guide rope attachment points placed too low or fail to adequately tension the rope.
- Little slack at both guide rope ends can compromise the rope management.

CONNECTION OF THE STRETCHER

Information

- The haul and back-up ropes are connected to the lifting point ring and clipped to the head of the stretcher as usual.
- The stretcher is connected to the guide rope using a pulley which is clipped to the lifting point through a carabiner.



Warning

- The connection order for the haul and the back-up ropes to the lifting point depends on the technique adopted for exiting the pitch, using the same criteria used in a vertical pitch.
- It is not necessary to use a high performance pulley for connecting the stretcher to the guide rope.
- The pulley should be clipped to the lifting point, behind the haul and the back-up ropes so as to make the stretcher proceed with the head upwards.
- In case of narrow deviation angles, the default connection system can have the guide rope rubbing against the feet of the stretcher; on the other hand, this system simplifies most of times the stretcher evacuation.

Common mistakes

- Clip the haul rope to the guide rope pulley.

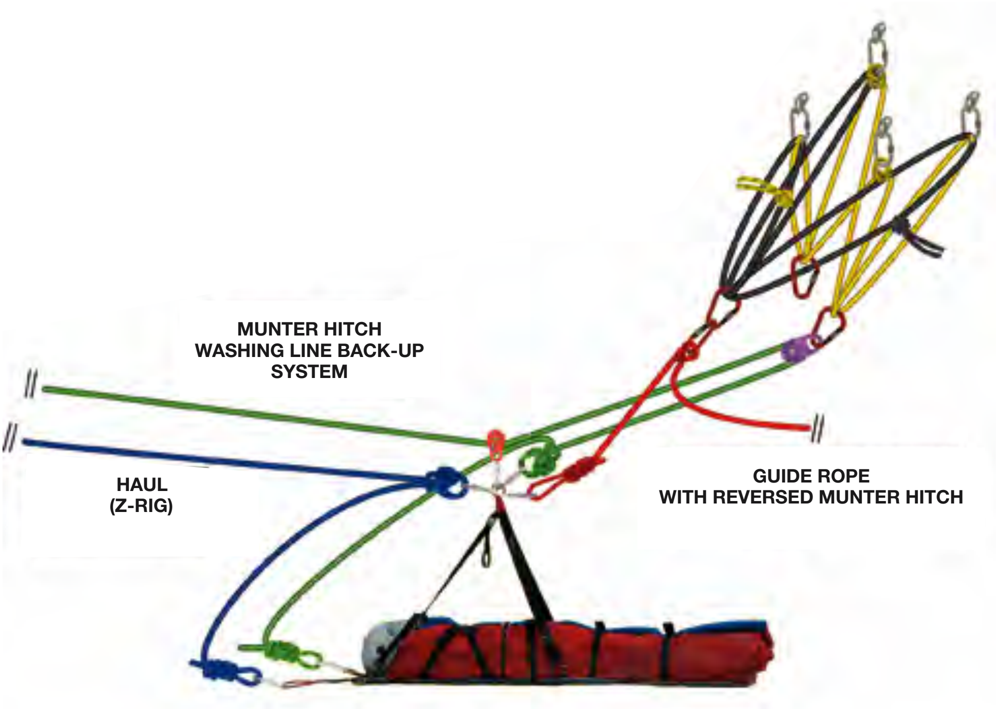
STRETCHER EVACUATION

Information

- Once the guide rope is slackened, the stretcher stays hung up to the mid-pit pulleys. Now you can proceed as you normally would in a vertical pitch rescue, and if needed the "washing line" technique can be used.
- The guide rope pulley can be used to build a "washing line", provided that it is correctly clipped to the lifting point.

Warning

- It is preferable to slacken the guide rope from above, where the stretcher is close, to avoid any communication problem with the downstream area.
- Once slackened, the guide rope can be used to secure the stretcher to the mid-pit during the evacuation. When using a z-rig haul system associated with a washing line, the tail exiting upward the guide rope can be used as a back-up, "reversing" the Munter Hitch.



Common mistakes

- Clip the rope to the stretcher lifting point in the wrong position with respect to the lifting and exit procedures.

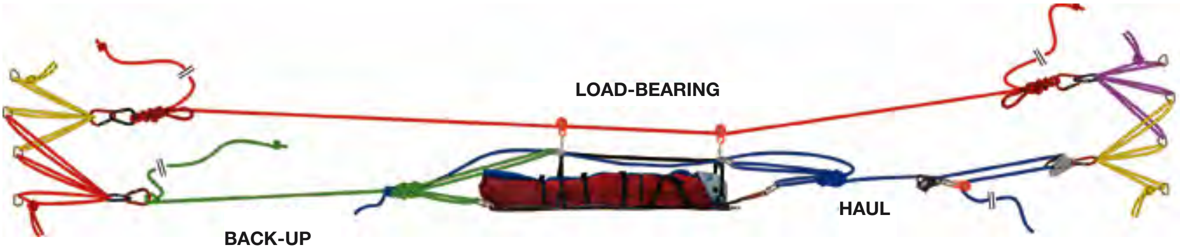
Photo Paolo Manca

Horizontal tyrolean traverse

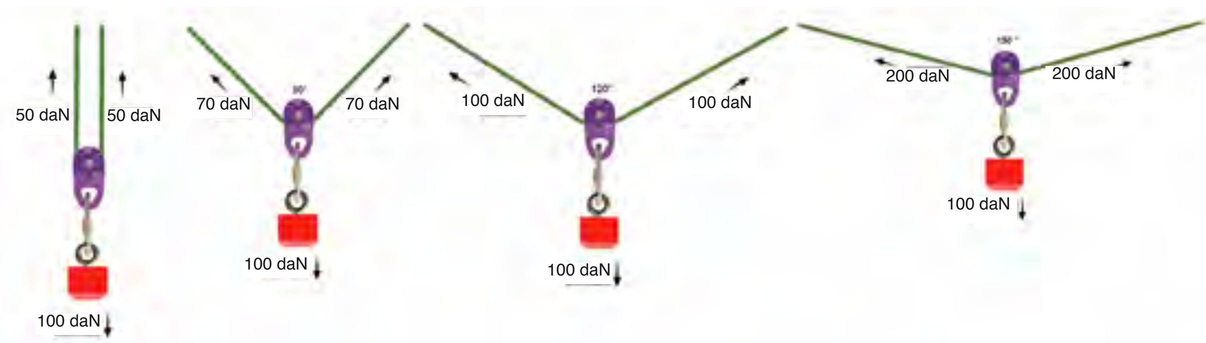
Contents

BASIC CONCEPTS

Information This technique is used to pass sub-horizontal sections, where the cave morphology or the presence of obstacles make faster techniques non applicable. A third rope, called "load-bearing rope", is used in this technique: it supports and guides the stretcher all along the rescue operations.



- The forces applied on the tyrolean attachment points depend on the load-bearing rope tensioning, on its angle and on the stretcher weight.
- When the load-bearing rope is properly tensioned, the stress applied on the attachment points is higher than the stretcher weight.
- Increasing the load-bearing rope angle, the load applied on the attachment points decreases.
- Changing the load-bearing rope tensioning results in a distribution of the load across the rope sections (and consequently across the attachment points) exiting upstream and downstream the stretcher. See the following diagram as a way of example:



- Tests carried out by a dedicated technical commission appointed by CNSAS suggest that in the tensioning phase, irrespective of the technique used, peak loads of about 5 kN are developed. The loads significantly decrease once the tensioning is concluded and when the load-bearing rope is subsequently blocked, attaining 2.5 kN with peak values of 4 kN.
- The doubled load-bearing rope allows to reduce the lowering effect. As a result, the stretcher drops during the haul, being its weight distributed across two rope sections. A double length rope and two pulleys are required for each bridle attachment point.

Warning

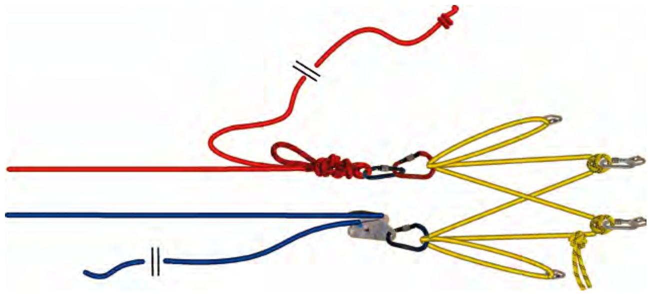
- This technique generates elevated stresses on the ropes and applies high loads on the attachment points; also it is very material- and time-consuming.
- Carefully evaluate the load-bearing rope trajectory, especially if the stretcher passes in proximity of obstacles.
- Adequately evaluate the angle with respect to the horizontal line: if it is greater than 60°, you need to double the haul rope by removing the back-up rope at the foot-end of the stretcher (diagonal tyrolean traverse).
- Synchronize the back-up rope lowering with the haul rope pull: ropes need to be under tension all the time.

Common mistakes

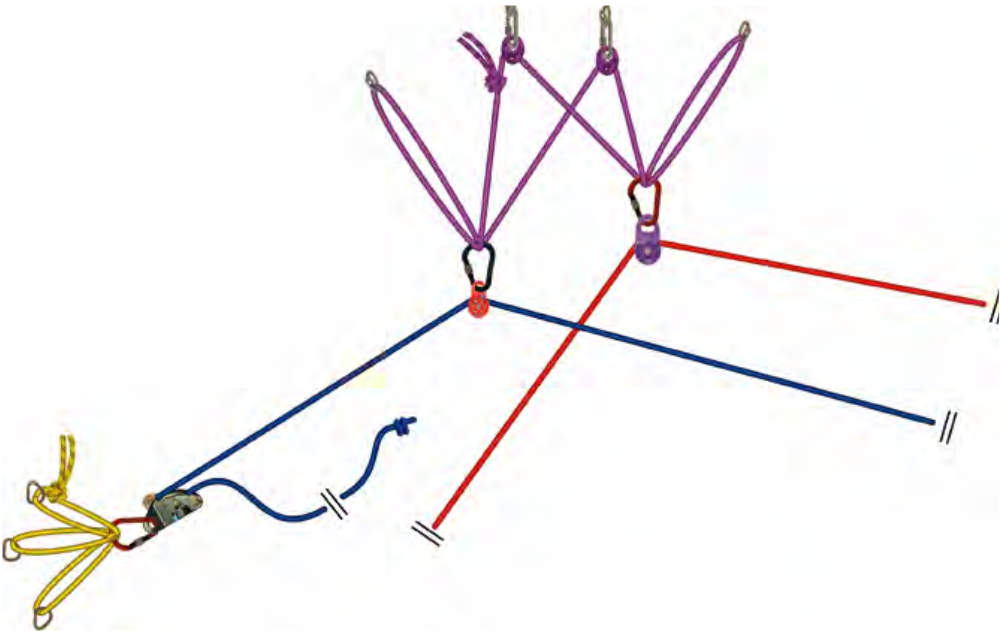
- Fail to place a back-up rope or place it on the same side as the haul rope, preventing some manoeuvres to be performed and not retaining the stretcher in case of load-bearing rope failure.

PREPARATION

Information



- The attachment points in the load-bearing rope and on the back-up rope at the start and the attachment points in the load-bearing rope and in the back-up rope at the arrival have to be built connecting at least 3 anchors together (at least 4 anchors, of which 2 in common).
- If the load-bearing rope should fail, the stretcher is retained by the haul and the back-up ropes, it is therefore necessary to clip them on equally strong attachment points.
- The load-bearing rope has to be releasable from both ends in every moment, preferably using 2 Super Munter Hitch knots. Alternatively you can use a grigri on one side, bearing in mind that the grigri is often hard to release when put under heavy loads; it is particularly important in the unlock phase to pay attention to when the equipment rope is released: it can occur suddenly.
- The load-bearing rope and the haul/back-up line standing before both binding systems (knots, grigri or counterbalance) should be long enough to allow the stretcher to be lowered to the ground if necessary.
- The haul and back-up attachment points have to be in an easily manageable position, if needed they can both be deviated to stay parallel to the load-bearing rope.
- The attachment points need to be in an arrear and elevated position so to provide an obstacle-free trajectory for the stretcher.

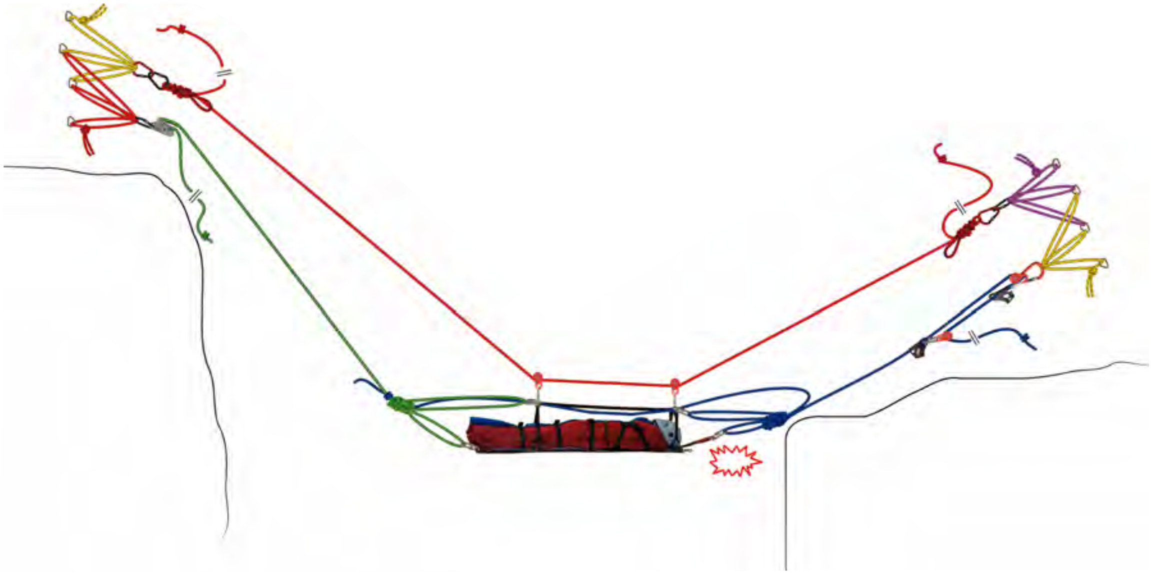


Warning ⚠

- Never use toothed ascenders to block the load-bearing rope (risk of weakening the rope).
- The grigri shows a tendency to jam, never use it on both load-bearing rope ends.
- Check in time the tyrolean line trajectory and the working conditions by hanging an adequate load on it.
- If the load-bearing rope fails and the haul and back-up ropes are pulled, the stretcher is lowered of at least 2 meters every 10 meters of tyrolean line: take it into account.

Common mistakes ✖

- Little extra rope at the load-bearing rope ends is sufficient to prevent the stretcher from be lowered if needed.
- Block the Super Munter Hitch in the pulling direction rather than in the lowering direction: the knot can jam.
- If the attachment points at the start or at the arrival are too low, the stretcher may be forced to pass unexpected obstacles along the way.
- Fail to foresee a lifting system at the arrival. Also in case of a downstream tyrolean traverse, the stretcher risks to end up by being lower than the target area.



TYING THE STRETCHER

Information

- Arrange the bridles in the appropriate attachment points, paying attention not to braid the tapes.
- Build the haul and back-up rope ends tying a double figure-8 with loops of different length, leaving a 4 meters-long tail for the haul rope.
- Connect one haul rope eye to the long loops of the stretcher and the other eye to the bridles ring.
- Pass the end exiting from the knot in the spreader rings and pull it beyond the stretcher tail.
- Connect one back-up rope eye to the attachment point at the stretcher feet (handle/cord/side attachment points), and the other eye to the lifting beam feet.
- Rethread the back-up rope knot with the haul rope end tying a Gandalf knot.
- This type of connection shows the double advantage of protecting the bridles in the horizontal direction, and to allow the passing of a deviation on the tyrolean traverse (see the dedicated chapter).
- Tie the haul and the back-up line with a Bunny ears both to the stretcher and to the bridles so that both rope eyes are tensioned at the same time and swings are minimized.

Warning

- Insert the tail in the rings and not in the pulleys carabiners; in case a deviation is present on the load-bearing rope, it is vital that the carabiner can be removed from the safety ring.
- It is necessary to build an attachment point for the back-up line at the feet of the stretcher if the manufacturer didn't provide for it (like in the Alp Design stretcher). A rope section is rethreaded in the plank back rings (or around the handles).

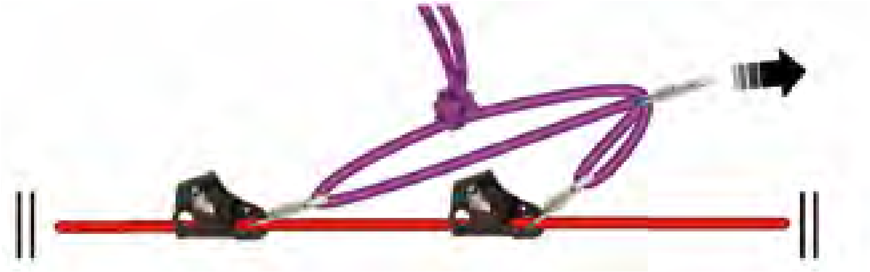
Common mistakes

- Connect the haul and the back-up line either to the bridles or to the stretcher: swings increase during the stretcher lifting.
- Insert the tail in the pulley carabiners rather than in the bridles rings.
- Fail to check if the loops that bind the stretcher and the bridles are adequately long.

ROPE TENSIONING IN Z-RIG

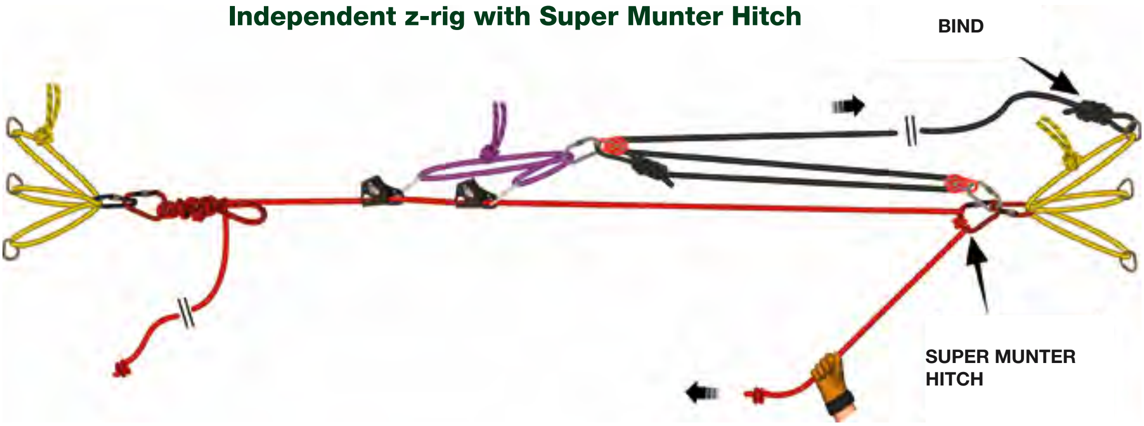
Information

› When tensioning the tyrolean with a z-rig, two ascenders coupled in parallel with a cord must be used on the load-bearing rope to split the load and avoid damaging the rope sheath. Alternatively an auto-block knot built with a kevlar cord can be used.



› The last tensioning phases should be performed with the ascenders close to the load-bearing attachment point in order to improve the tensioning system performances.

Independent z-rig with Super Munter Hitch



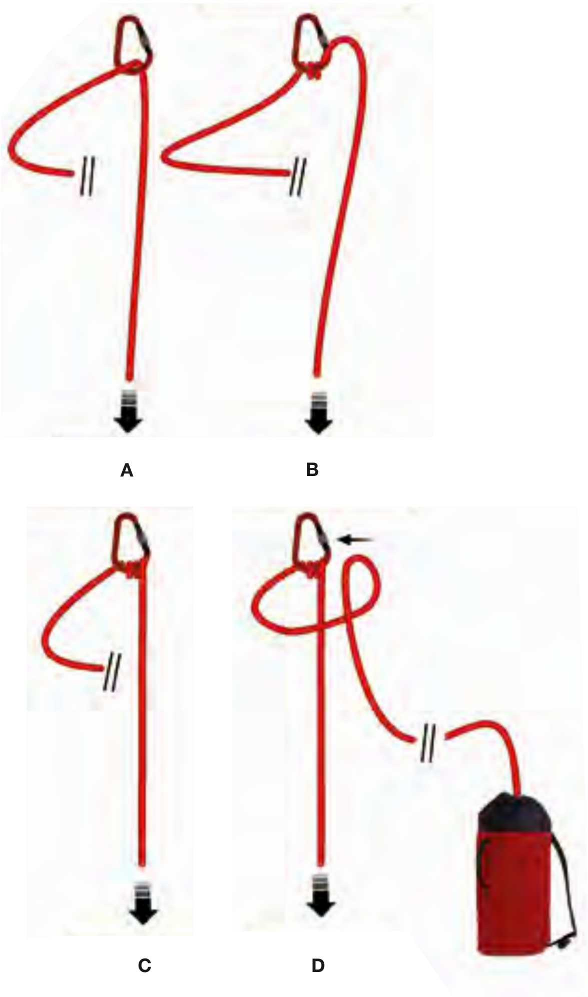
Information

To make the Super Munter Hitch slide easily during the tensioning, it is preferable to have only two rope loops running in the carabiner and wait for the z-rig to pull the travelling part to complete the knot.

Strong point:
- Effective tensioning.
- The tensioning can be improved by increasing the z-rig performances up to a 5:1 reduction coefficient. The independent z-rig can be effectively moved and used also on the haul rope.

Drawbacks:
- You need a person consecrated to the Super Munter Hitch management.

Warning
- Bind the independent z-rig tail to an anchor.



Traditional z-rig with Grigri

Information

Strong point:

- A z-rig is built using a grigri for the anchored part.
- Easy tensioning system.
- Effective load-bearing rope clamp.

Drawbacks:

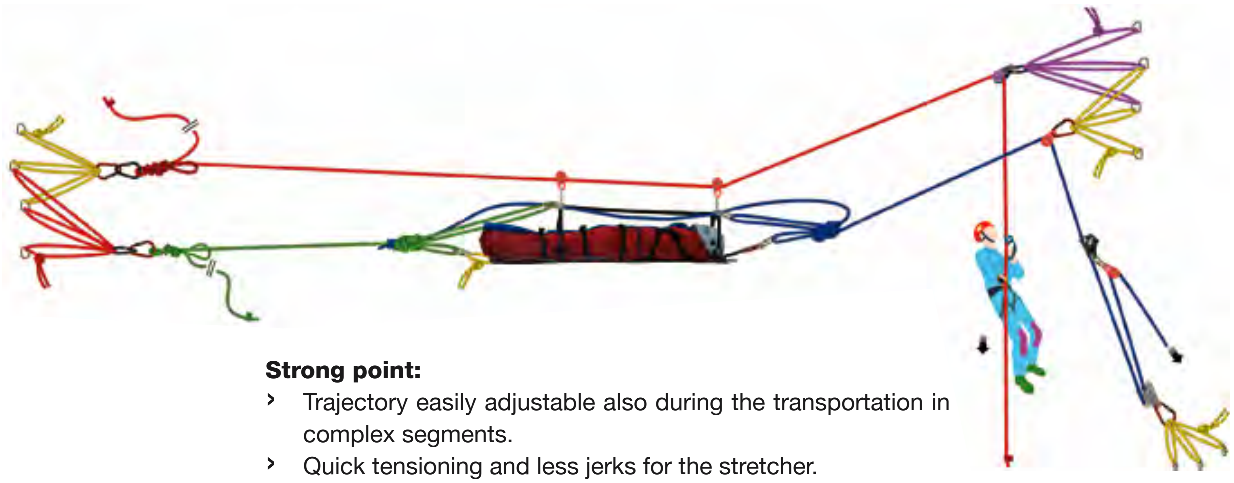
- The grigri easily jams. In this case, lower the load-bearing rope from the opposite side; alternatively the grigri can be bound the the attachment point by means of a rope section tied with a Super Munter Hitch.

Warning

- During the tensioning, the stretcher weight cannot be loaded on the load-bearing rope. It is necessary that the rescuers hold the rope or clip it later.
- If the load-bearing rope is very high, a lifting system should be foreseen for the stretcher to be clipped.

ROPE TENSIONING WITH COUNTERBALANCE

Information The counterbalance allows to adjust the stretcher transit height to address possible obstacles (boulders or particular morphologies). For the stretcher to be effectively lifted, the haul line needs to run as parallel as possible to the load-bearing rope. It is possible to use a pulley for deviating the haul line to a more comfortable zone for the lifting.

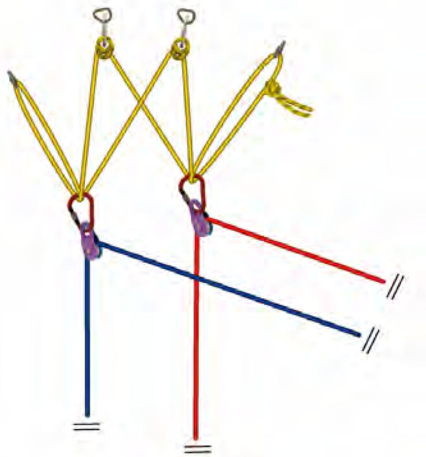


Strong point:

- Trajectory easily adjustable also during the transportation in complex segments.
- Quick tensioning and less jerks for the stretcher.

Drawbacks:

- Heavy loads on the counterbalance pulley for maintaining the load-bearing rope high.
- Two or more people committed to the counterbalance also during the manoeuvre.
- Lot of space needed for the balance men.
- Low tensioning of the load bearing rope.



Warning

- Arrange high and receded attachment points for the pulleys to facilitate the passing of obstacles near the area (ex. pitch edge).

Common mistakes

- Fail to foresee a release system for the load-bearing rope at the opposite end of the counterbalance.

Counterbalance tensioning 1

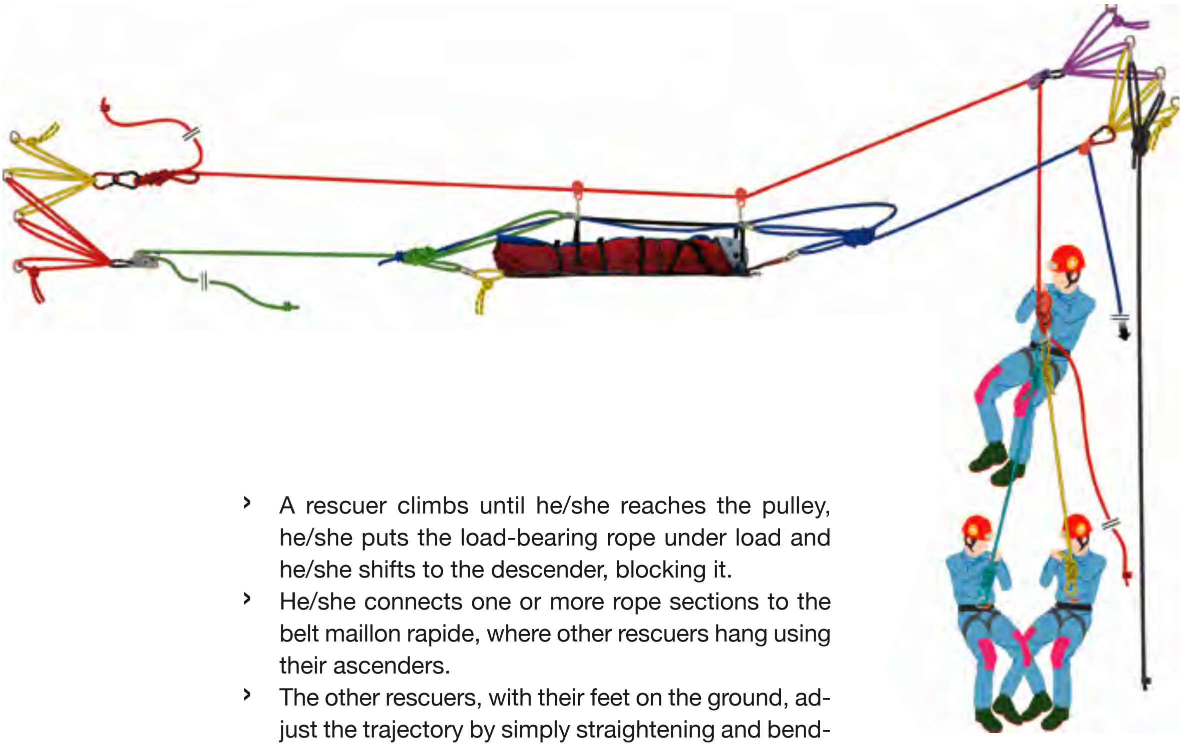
Information

- Use a high efficiency pulley for the counterbalance on the load-bearing rope.
- Two balance men hang on the rope exiting the pulley.
- A third balance man might be needed.
- A haul or a service rope section might be arranged for the balance men if the height from the ground requires so.

Slackening the load-bearing rope to lower the stretcher

- The lower balance man shifts from the ascenders to the descender using a Mule knot.
- A rescuer ties himself to the lower balance man (deadweight).
- The higher balance man releases himself from the load-bearing rope.
- The balance man with the engaged descender starts to lower and simultaneously the haul and the back-up ropes are slackened.

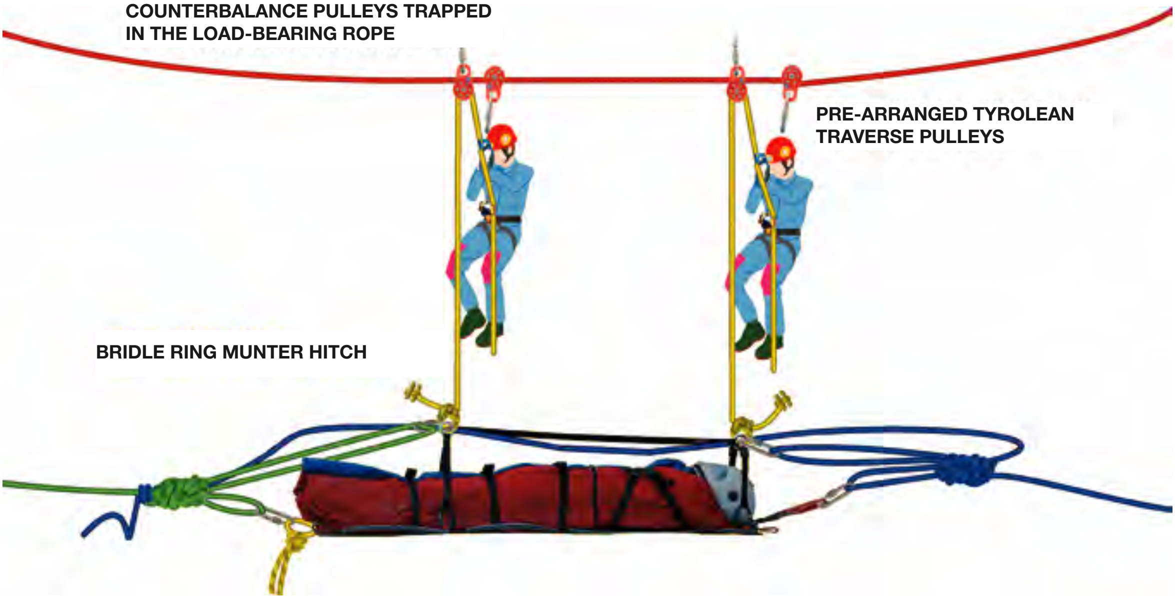
Counterbalance tensioning 2



- A rescuer climbs until he/she reaches the pulley, he/she puts the load-bearing rope under load and he/she shifts to the descender, blocking it.
- He/she connects one or more rope sections to the belt maillon rapide, where other rescuers hang using their ascenders.
- The other rescuers, with their feet on the ground, adjust the trajectory by simply straightening and bending the legs.
- Finally, the first rescuer unloads the load-bearing rope unblocking the descender and descending.

Photo Giuseppe Antonini

STRETCHER SUSPENSION



Information

- The stretcher is connected to the haul and back-up ropes at its head and feet and then it is mounted on a pre-tensioned load-bearing rope.
- The pulleys carabiners mounted on the load-bearing rope will be oval carabiners without screw-lock, with the opening facing down.
- If the load-bearing rope stands too high right from the start and if a counterbalance cannot tension it, the stretcher can be still be counterbalanced on the load-bearing rope.

Warning

- The balance men pulleys should be trapped in the load-bearing rope to gain more space.

Common mistakes

- Fail to arrange the counterbalance system for the suspension before tensioning the load-bearing rope.
- Fail to check that the trapped pulleys arrange themselves in the bridles rings vertical (bear in mind that when the stretcher is counterbalanced, the pulleys tend to get closer to each other).
- Lack of coordination between the two balance men movements, with the conse-quent risk to tilt the stretcher in abnormal positions.

Photo Giuseppe Antonini

Photo Giuseppe Antonini

Pendulum haul system

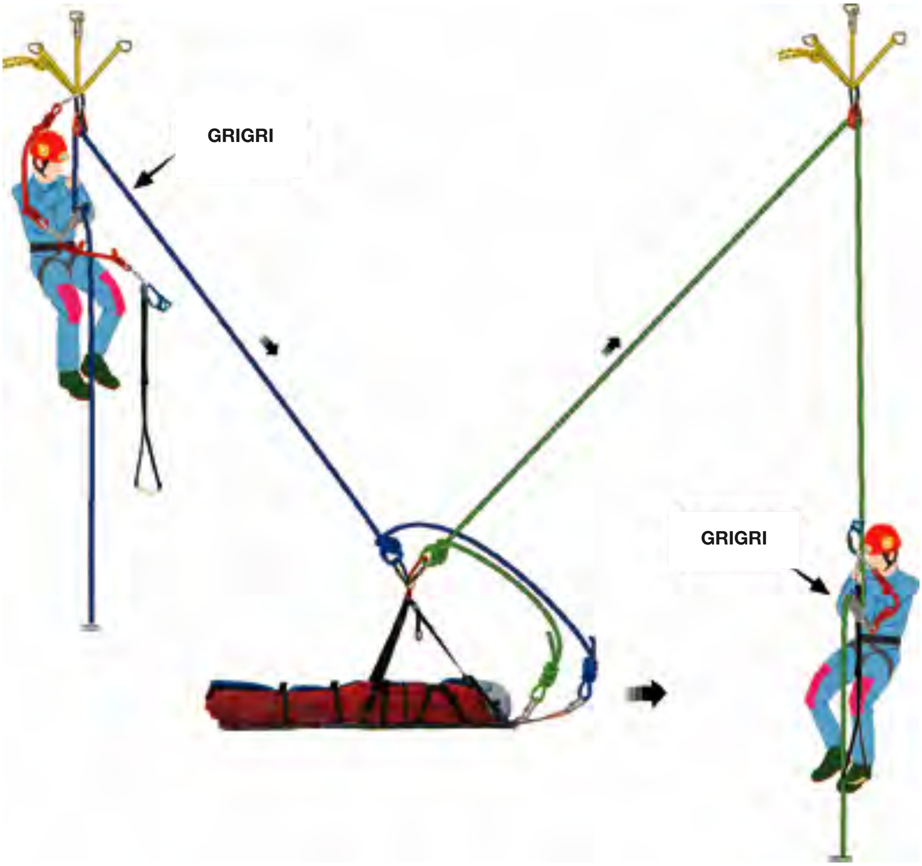
Contents

BASIC CONCEPTS

The pendulum haul system can be employed for transporting the stretcher in the deeper meanders or for overcoming obstacles such as depressions or cave-ins as an alternative to more complex techniques (ie. tyroleans).

Information

- It consists in the combined use of several counterbalances placed one after the other: on one side the stretcher is lowered and on the other it is lifted.
- An angle under 60° between the two counterbalance ropes is recommended.
- When the stretcher reaches the vertical line of the second balance man, it can be lifted by a third counterbalance and the manoeuvre starts all over again; the person in charge of lifting the stretcher reverses the direction and starts to lower, while the third balance-man lifts the stretcher.



Warning

- The counterbalances shouldn't be rigged too distant one from the other: the angle between the two counterbalance ropes should not be greater than 120°.
- Angles greater than 120° generate high tensions on the anchors due to tyrolean effect and affect capabilities of manage properly the stretcher movement.
- Counterbalance attachment points should be rigged as high as possible.
- Using the grigri instead of the chest ascenders can simplify the shift from the lifting position to the lowering position (reverse direction).

Common mistakes

- Lack of coordination between the two balance men.
- Fail to keep the stretcher secured to both ropes when passing from one counterbalance to the other.
- Rig the counterbalances far from obstacles, therefore having poor control on the stretcher height.

Photo Paolo Manca

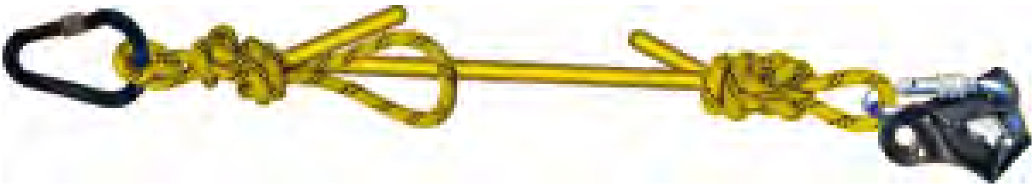
BAS – Releasable rope locking system

Contents

BASIC CONCEPTS

Information

- The BAS is a rope locking system that can be released.
- The BAS is used to secure the stretcher whenever the haul or the back-up rope needs to be removed, i.e. for passing a knot beyond the anchored part.
- It is built using a section of rope which is blocked to one end with a Munter Hitch and is connected to an ascender on the other end.



- The twin holes are used to connect the rope section to the ascender as shown in the image. Check that the back-up rope is in the carabiner. In this way, the ascender will work efficiently in every situation.

Warning ⚠

- A BAS is built with: an ascender, a carabiner (preferably an HMS carabiner) and an oval carabiner plus a 5-meter rope section (it can be the rope end).
- When using the BAS in association with a z-rig, it is possible to build the BAS using the z-rig travelling ascender.
- The connection between the BAS and the attachment point should be independent.

Common mistakes ✖

- Connect the ascender using only one hole.
- Connect the ascender clipping the twin holes but failing to include the rope in the carabiner.

Photo Giuseppe Antonini

Vertical and horizontal tilt

Contents

BASIC CONCEPTS

Information

- The stretcher is generally lifted in horizontal position. However, there are exceptions to this rule, i.e. if the pitch is too narrow to allow for the plank evacuation.
- In similar situations, the stretcher needs to be lifted in vertical position. There are several techniques that can be used to shift the stretcher from the horizontal position to the vertical position and vice-versa.

Warning

- Tilting the stretcher in vertical position is a manoeuvre that can be performed only with the previous consent of the doctor and it needs to be planned together with the team leader.
- Tilting the stretcher in vertical position generates pressure on the casualty chest.
- Before beginning to lift the stretcher, fine-tune the buckles by trying to incline the stretcher in vertical position.
- Some stretchers have a device allowing to trim the stretcher with respect to the vertical position. Such device is useful when the stretcher doesn't need to be completely tilted in vertical.
- If the pitch requiring the stretcher vertical tilt is short, it is better to directly lift the stretcher in vertical position.

Common mistakes

- Fail to incline the stretcher in vertical position at the bottom of the pitch to check the buckles.

MANOEUVRE

Information › **Vertical tilt:** the stretcher is secured to the haul and the back-up ropes as usual. To tilt the stretcher in vertical position, proceed as follows:

- Lock the back-up line and continue pulling the haul rope until the back-up rope is slackened.
- Remove the carabiner of the back-up rope from the lifting point and clip it to the head-end of the stretcher **(fig. 1 and 2)**.
- Lock the haul rope, take up the back-up rope until the stretcher is in vertical po sition and the haul rope is slackened.
- Remove the carabiner of the haul rope from the lifting point and clip it to the head-end of the stretcher **(fig. 3)**.
- Continue taking up the haul rope **(fig. 4)**.

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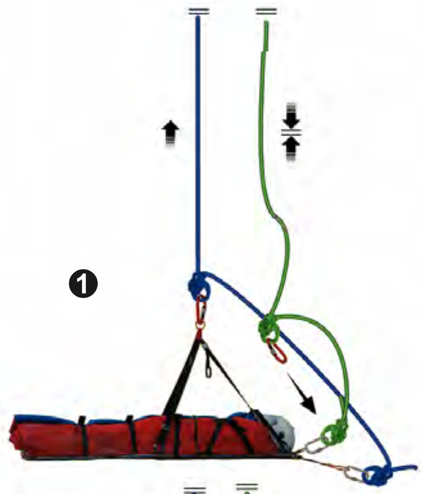

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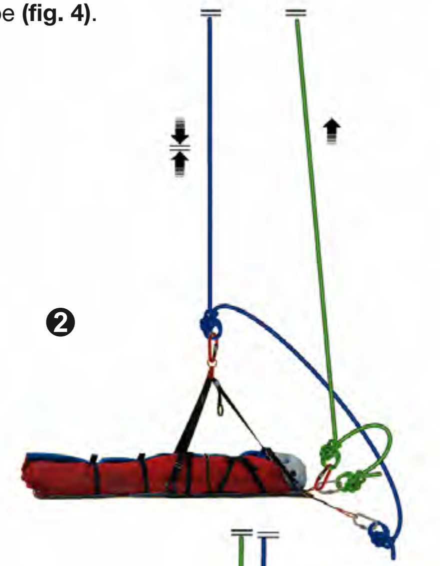

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❹


› **Horizontal tilt:**

- Lock the back-up line and continue lifting the haul line until the back-up line is slackened.
- Remove the back-up rope carabiner from the head-end of the stretcher and clip it to the lifting point **(fig. 1 and 2)**.
- Lock the haul rope, take up the back-up rope until the stretcher is in horizontal position.
- Remove the haul rope carabiner from the head-end of the stretcher and clip it to the lifting point **(fig. 2)**.
- Take up the haul rope.

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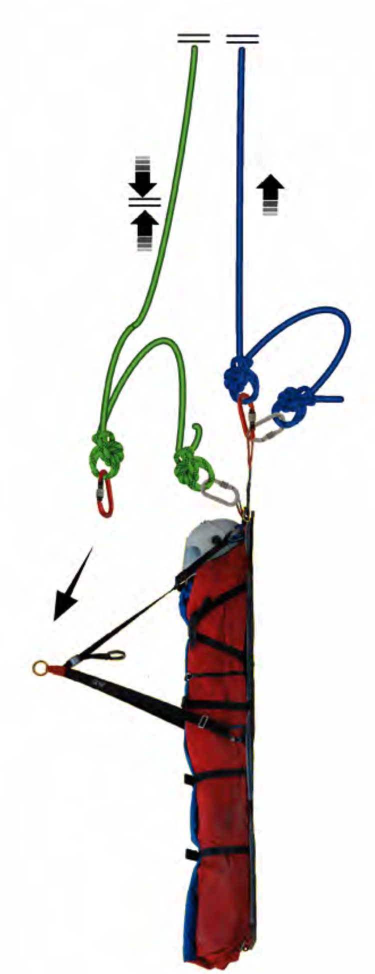

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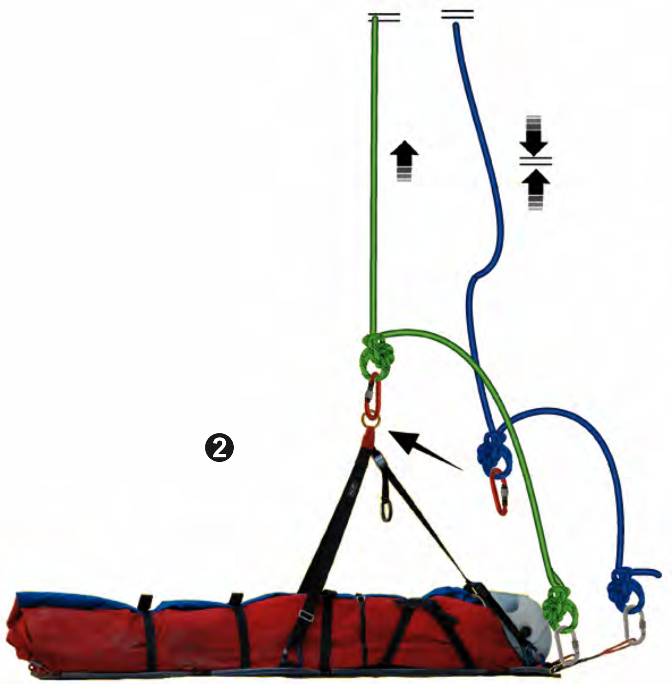


Warning

- Check that the stretcher-bearer is able to communicate with the team standing at the top of the pitch.
- The stretcher-bearer should be able to correctly distinguish the haul rope from the back-up rope by their connection (haul rope on the short attachment point, back-up rope on the long attachment point).
- If a short bottleneck is present, the stretcher can be pulled with the back-up rope, keeping the haul rope clipped to the lifting point. The manoeuvre is faster but the stretcher is more unstable (it is pulled by the short attachment point at its head-end) and the haul rope can compress the casualty.
- The horizontal tilt shouldn't be performed in close proximity of a bottleneck in order to enjoy enough working clearance.

Common mistakes

- Confuse the haul rope operations with the back-up rope operations.

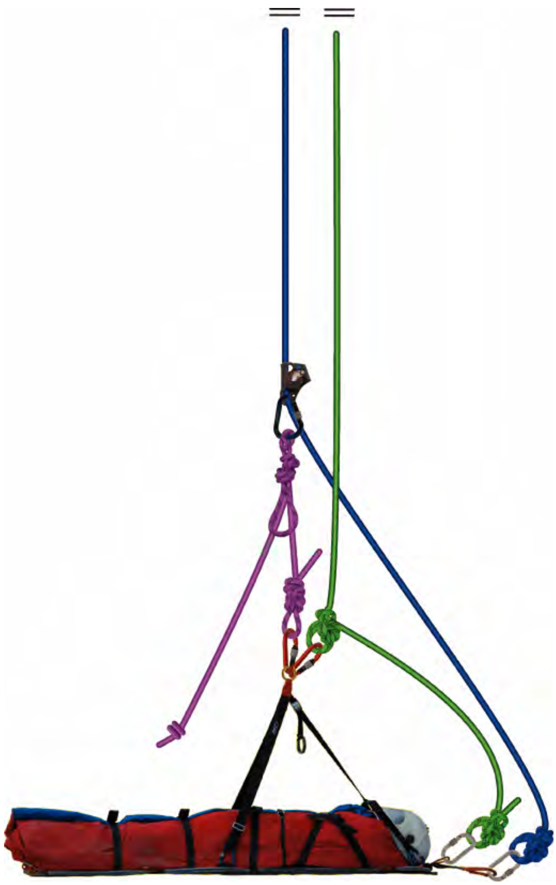
INDEPENDENT MANOEUVRE

Information

› Whenever the communications between the stretcher-bearer and the team standing at the top of the pitch are difficult, it is better assigning the operations directly to the stretcher-bearer.
Proceed as follows:

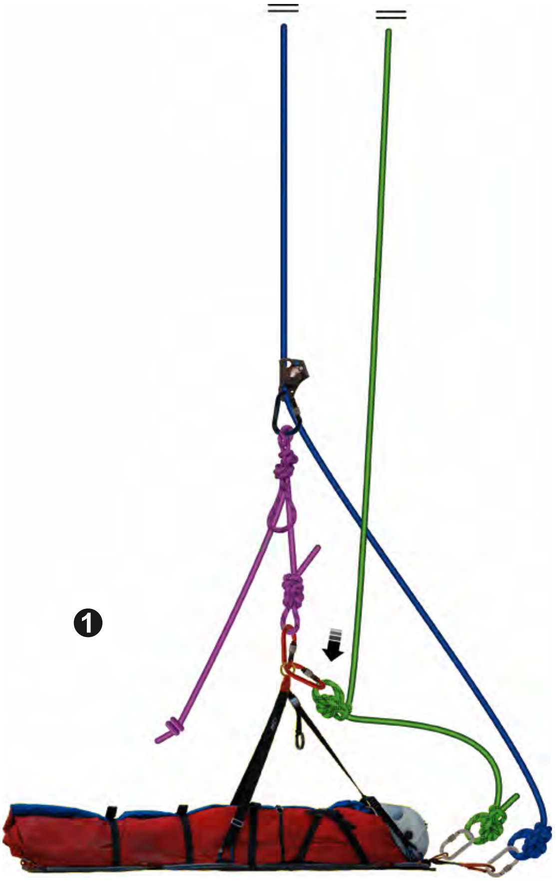
Stretcher arrangement

- Clip a section of rope (min. length: 5 meters) to the lifting attachment point.
- Bind the section tied with a Munter Hitch to a HMS carabiner with screw-lock which is inserted in an ascender.
- Clip the haul rope to the head-end of the stretcher and thread it in the ascender; remember to leave a little slack.
- The haul rope is connected to the lifting point and then it is properly clipped to the head-end of the stretcher.



› **Vertical tilt:**

- Stop pulling the stretcher.
- Remove the back-up rope carabiner from the lifting point and clip it to the head-end of the stretcher. If the rope is not enough (the back-up rope cannot be slackened), undo the knot **(fig. 1, 2)**.
- Release the Munter Hitch and lower the stretcher until it stands in vertical position.
- Resume pulling the back-up rope until the bottleneck is passed.



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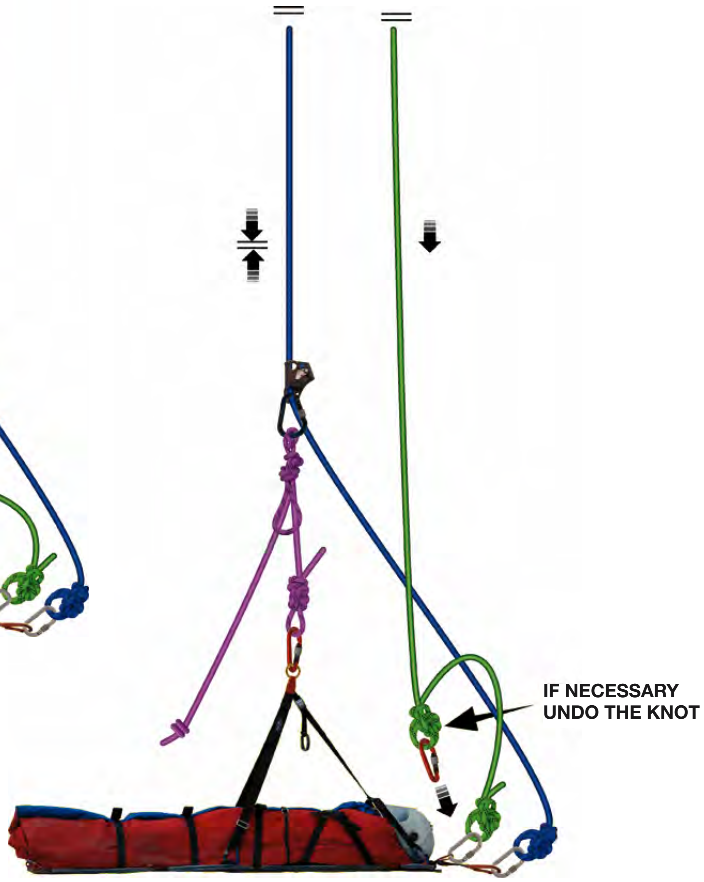

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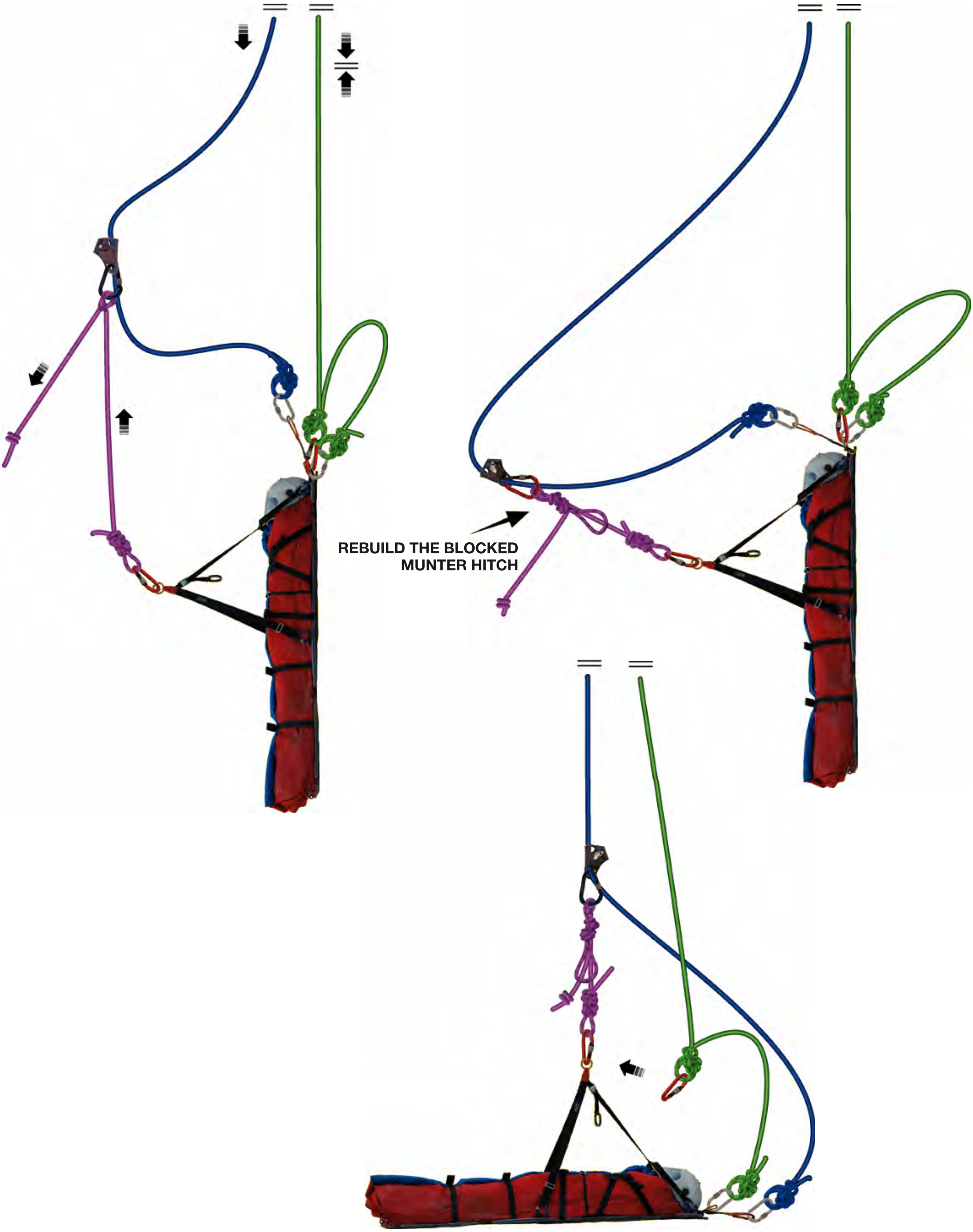
› **Horizontal tilt:**

- Block the back-up rope.
- Rebuild the section of rope with a Munter Hitch and the ascender; slacken the haul rope and take up the Munter hitch (if no other bottlenecks are expected, the haul rope can be directly tied to the lifting point).
- Take up the haul rope until the stretcher stands in horizontal position.
- Restore the back-up rope on the lifting point.


REBUILD THE BLOCKED
MUNTER HITCH

Warning

- During the vertical tilt, the stretcher significantly drops; check to have the necessary clearance.

Common mistakes

- Use an excessively short section of rope, which is insufficient to completely release the ascender.
- Tie the Blocked Munter Hitch in the section of rope within the lifting point carabiner, rather than in the ascender carabiner.

Photo Giuseppe Antonini

Photo Antonino Bileddo

Changeovers

Topics

BASIC CONCEPTS

- Specific techniques have been developed to reverse direction from ascent to descent and vice-versa.
- It is rarely necessary to reverse direction, however it can be required if a critical situation arises or in association with specific techniques (i.e. with the pendulum haul system, if the stretcher is stuck in an edge, following an incorrect operation, for passing a knot and so on).
- These techniques consist in converting the haul system in a lowering system (or vice-versa) without compromising the casualty safety.

QUICK DESCENTS ON A Z-RIG

Information

Whenever you need to lower the stretcher for a short distance during a z-rig haul, proceed as follows.

- Bring the travelling part close to the anchored part.
- Tension the z-rig rope until you are able to push away the ascender's toothed cam in the anchored part using your fingers.
- Gradually release the haul rope until you are able reach the travelling part.
- Release the cam blocking the anchored base.
- Start all over again for further descents. The back-up rope follows the stretcher movements, as usual.

Warning

- The 3:1 reduction coefficient is still present: the team only supports 1/3 of the stretcher weight, but it rests completely on their arms.
- This technique can be employed for short descents, up to a couple of meters.
- The rescuer needs to be ready to close the ascender's toothed cam of the z-rig.

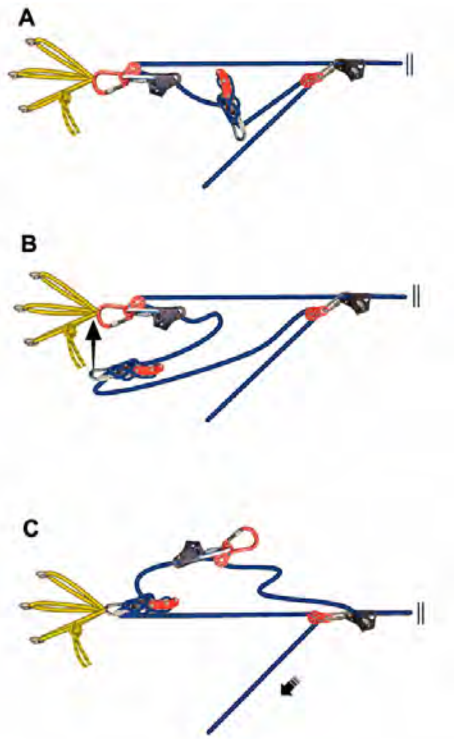
Common mistakes

- Open the ascender in the anchored part.
- Forget to bring the z-rig travelling part close to the anchored part: the travelling part might hit the mid-pit pulley, causing the system jam.

CHANGEOVER ON A Z-RIG

Information

The manoeuvre consists in replacing the z-rig with a descender.



- Stop the haul and the back-up ropes.
- Install the fully-locked descender on the rope that exits the anchored part of the z-rig. It is better installing the descender in vertaco mode. A regular progression descender can be used **(fig. A)**.
- Clip the descender to the main attachment point **(fig. B)**. Add a HMS carabiner to the attachment point in order to easily fit the descender.
- Tension the z-rig, now working with a 2:1 reduction coefficient, and manually brake the section of rope within the z-rig. Release the z-rig from the attachment point and from the rope **(fig. C)**.
- Manually lower the haul rope until the descender is under load. Release the descender's full lock and descend.

The back-up rope follows the stretcher movements, as usual.

Warning

- While the stretcher is manually braked with a 2:1 rig, it is important to keep the back-up rope tensioned to minimize the effects of an accidental z-rig failure.
- The descender can be easily mounted in the opposite direction, it is therefore advisable to proceed as follows:
- Connect the descender to your harness.
- Get close to the attachment point and install the descender in vertaco mode.
- Release the descender from your harness and connect it to the attachment point.
- Take up the rope in excess and make a full lock.

Common mistakes

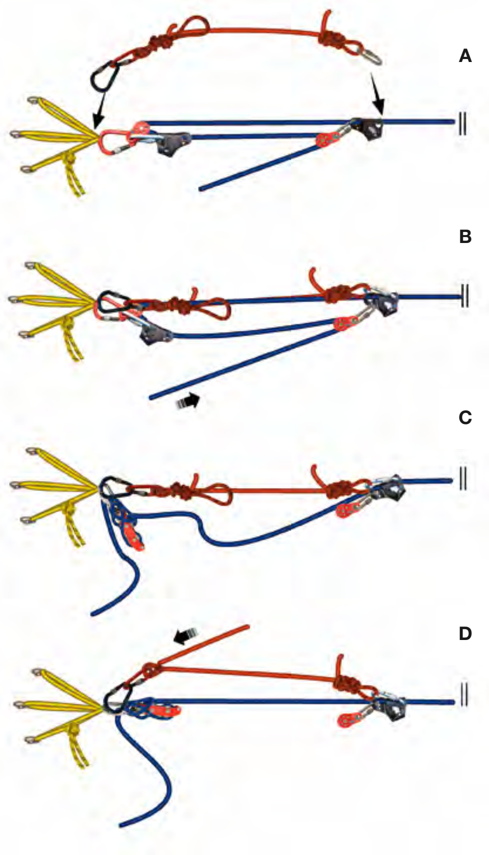
- Connect the descender to the anchored part of the z-rig, hindering its disassembly.

CHANGEOVER ON A Z-RIG – THE BAS VARIATION

This technique is used when the back-up rope is missing or is out of service (i.e. tyrolean traverse lines) or when there aren't enough rescuers. This technique employs a BAS and the haul rope is not taken up in a 2:1 z-rig nor it is manually retained by the operators.

Information

- Stop the haul and the back-up ropes.
- Connect a BAS (using the travelling ascender of the z-rig) to the main attachment point using an extra carabiner **(fig. A)**.
- Lower the haul rope for a short distance by acting on the ratchet cam as in the short descents on a z-rig (first paragraph) until the BAS is fully tensioned **(fig. B)**.
- Disassemble the anchored part of the z-rig, insert the rope in the ascender, complete with a full lock and secure it on the main attachment point **(fig. C)**.
- Release the BAS and slacken the rope until the haul rope is tensioned **(fig. D)**.
- Disassemble the BAS.
- Release the ascender and start the descent.



Warning

- Check in time the travelling part position so to smoothly release the BAS.
- Insert the descender in the main attachment point on a carabiner other than the one used for the BAS.
- The cord tensioning involves a short descent braking the z-rig by hands.

Common mistakes

- Insert the rope in the descender in the wrong direction.
- Secure the BAS on an anchor rather than on an attachment point.
- The BAS ascender is far from the anchored part: the section of BAS could be insufficient or it can come up against the mid-pit pulley.
- Fail to have sufficient equipment to perform a changeover.

CHANGEOVER ON A COUNTERBALANCE

Information

This manoeuvre is performed by the balance man who changes tools while hanging from the rope. The balance man inserts the descender and fine-tunes the descent.

- Stop the haul and the back-up ropes.
- The balance man shifts from the ascenders to the fully-locked descender.
- The technician acts on the counterbalance to climb until reaching the mid-pit pulley (as a result, the stretcher is lowered).
- The balance man clips the cowstail as close as possible to the mid-pit attachment point.
- The balance man releases the full lock and lowers the stretcher using his/her own descender.

Warning

- The balance man will clip the short cowstail only after the change of tools.
- Follow the stretcher movements with the back-up rope during the balance man positioning.
- The balance man will ascend for a short distance by manually pulling him/herself on the rope from where the stretcher is hanging (i.e. by pushing down the stretcher rope).
- If you're standing too close to the counterbalance pulley, you should go down for a short distance before descending.

Common mistakes

- The balance man's ascender is stuck against the mid-pit pulley (this happens when the balance man changes tools standing too close to the pulley or if he/she clips the cowstail close to the attachment point before reversing direction).
- Poor loads evaluation (balance man/stretcher).

CHANGEOVER FROM DESCENT TO ASCENT

Information Sometimes it can be necessary to reverse direction during a descent, generally for short distances, in order to correct any possible failures arising during the manoeuvre execution. The back-up rope follows the stretcher movements, as usual.

Changeover from descent to ascent with descender

Replace the descender with a z-rig.

- Stop the haul and the back-up ropes and fully lock the descender.
- Install the travelling part **(fig. A)**.
- Take up the rope using a 2:1 z-rig and manually brake the rope; a rescuer installs the anchored part of the z-rig in the rope slack **(fig. B)**.
- Attach the anchored part to the attachment point.
- Release the haul rope by putting the z-rig under load.
- Remove the descender and start hauling.

A

B

Changeover from descent to ascent on a counterbalance

This manoeuvre is performed by the balance man who changes tools on the counterbalance rope.

- The haul and back up rope are blocked and the descender is fully locked.
- The balance-man removes the short cowstail (clipped close to the attachment point) and changes tools.

Warning

- A travelling ascender complete with pulley can be added to pull the stretcher for a very short distance with descender in the main attachment point; take up the rope using a 2:1 reduction coefficient and manually brake the load.
- The balance man can lift the stretcher for a short distance during a descent on counterbalance by full-locking the descender, removing the cowstail and descending until the stretcher reaches the needed position. The stroke is limited by the long cowstail length.

Common mistakes

- Connect the anchored part of the z-rig in the descender carabiner, hindering its disassembly.

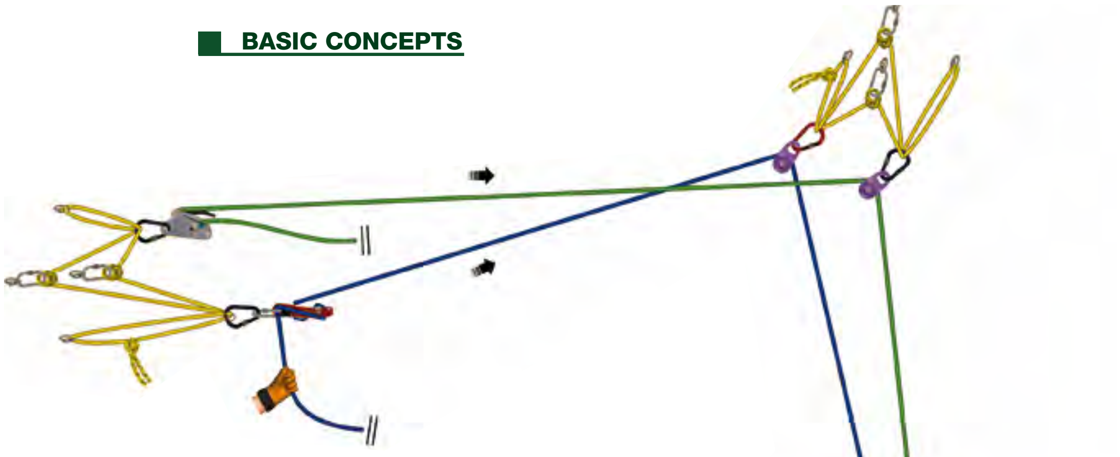

Photo Paolo Manca

Photo Paolo Manca

Descent

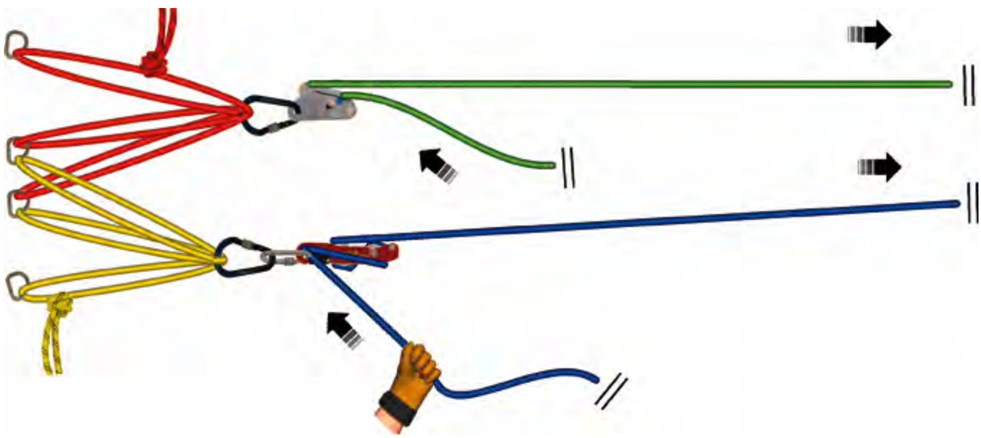
Contents

BASIC CONCEPTS



Information

- It is about lowering a stretcher down a vertical line. The stretcher is lowered with two ropes, a descent rope and a back-up rope.
- A descender is used for lowering the stretcher.
- A grigri or any descent technique can be used as back-up line.
- The stretcher is connected to the ropes as usual.
- The ropes are clipped to the pitch head by means of a main deviation.
- One or more secondary deviations can be used to rectify the trajectory down the pitch.



Warning

- The descender needs to be mounted in "vertaco" mode.
- If a Munter Hitch is tied on the back-up rope, close attention should be paid when “feeding” the rope in order to keep parallel the sections of rope exiting and entering the knot; this to avoid rope twists that might interfere with the manoeuvre.
- A sufficient number of rescuers needs to stay at the bottom of the pitch to follow and lay the stretcher down.

Common mistakes

- Insufficient room for the descent team.
- The rescuers work in an unstable zone exposing the stretcher to a stone fall hazard.
- Fail to foresee a handrail/back-up system for the team in the exposed places.
- Fail to let the back-up rope follow the progressive lowering of the descent rope.

MAIN ATTACHMENT POINT

Information

- It is a regular main attachment point made of two independent attachment points built with at least three anchors each.

Warning

- The descent and the back-up ropes should run as far as possible in parallel.
- The main attachment point should be in a receded position to allow to connect the stretcher to the ropes in a place distant from the edge of the pit.
- The attachment points should be preferably placed at man-height to simplify the tools management.

Common mistakes

- Fail to consider the presence of obstacles between the main attachment point and the mid-pit, interfering with the descent trajectory (spikes, progression rope etc.).
- Fail to consider the mid-pit displacement when loads are placed.

MID-PIT DEVIATION

Information

- The mid-pit deviation consists in a main deviation. The same rules observed with the z-rig haul are applicable here.
- Its position should be chosen so that the stretcher entrance operations are as smooth as possible. It will be preferably be located higher than the pitch entrance, depending on the pitch morphology.
- Both ropes are deviated. Typically the pulley in the back-up rope is located in a more exposed position with respect to the pulley in the descent rope.

Warning

- After loading the pulley, it tends to arrange itself along the angle bisector produced by the vertical line and the rope that connects the mid-pit attachment point to the main attachment point.
- Do not cross the ropes while clipping them in the mid-pit pulleys.

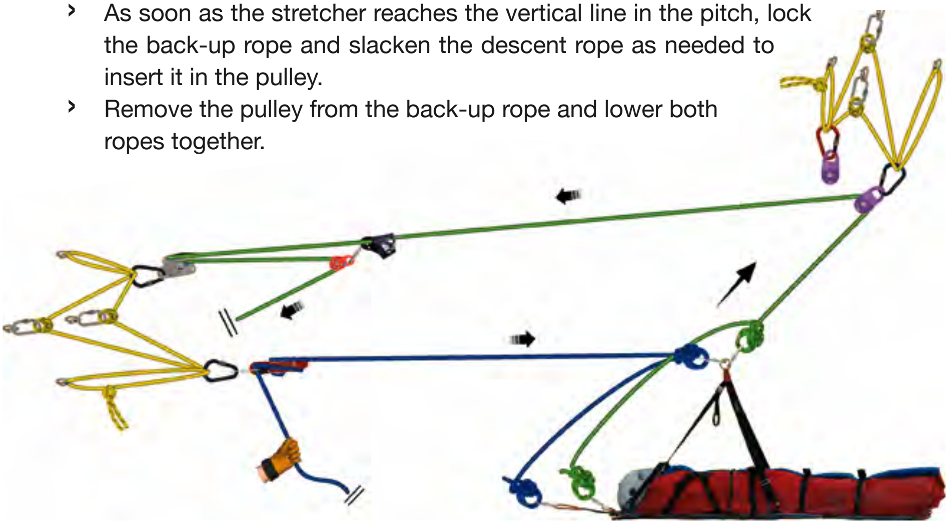
On anchored pulleys

Information

The mid-pit is built using two anchored pulleys, while the back-up line is installed on a grigri.

Manoeuvre execution:

- Pull the stretcher with the back-up rope clipped to the mid-pit employing a z-rig, and lower the other rope at the same time.
- As soon as the stretcher reaches the vertical line in the pitch, lock the back-up rope and slacken the descent rope as needed to insert it in the pulley.
- Remove the pulley from the back-up rope and lower both ropes together.



Strong points

- Easy to do.
- Little equipment used.
- A rescuer standing close to the pitch edge can supervise the mid-pit deviation.

Drawbacks

- It can only be used with high mid-pit attachment points placed close to the pitch entrance.
- It is not applicable if the mid-pit is exposed.

Warning

- It needs special care because the stretcher hangs from only one rope in the mid-pit at a given time.
- It can be employed only when the distance between the mid-pit and the exit is smaller than the stretcher length (if the mid-pit deviation of the back-up rope should fail, the stretcher would drop to the ground).

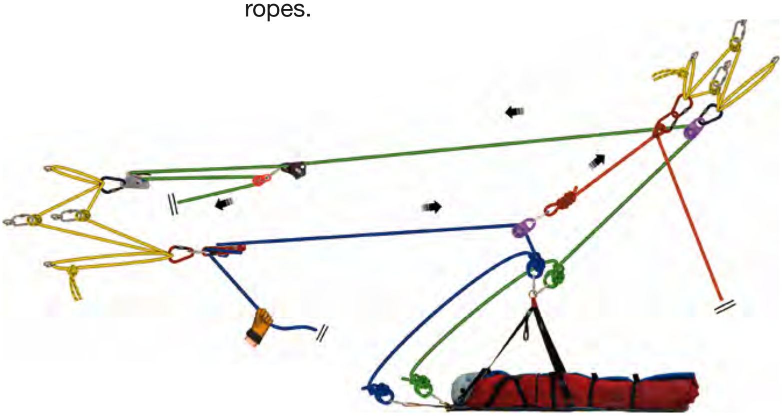
Travelling on a Blocked Munter Hitch tied on the haul rope

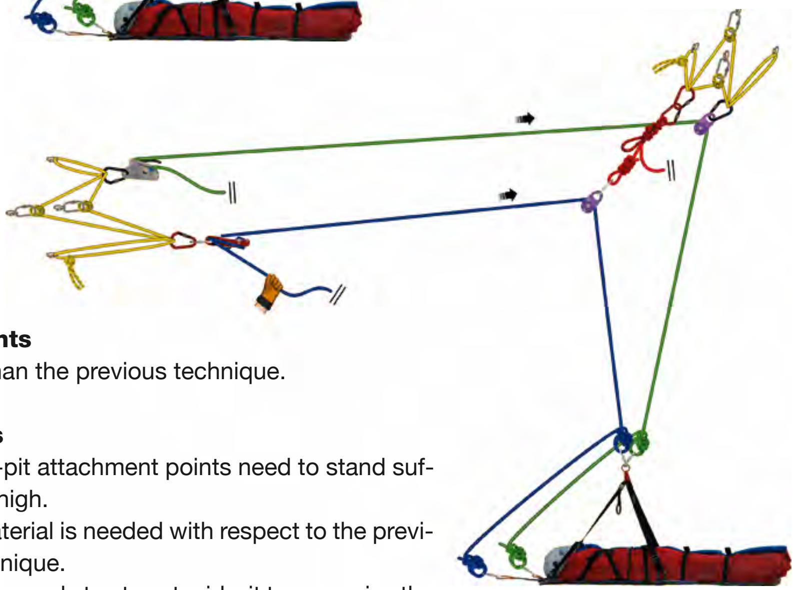
Information

- The back-up rope has an anchored pulley, while the pulley of the descent rope is built with a travelling deviation. The back-up rope is on a grigri.

Manoeuvre execution:

- Lower the stretcher with the descent rope and if necessary take up the back-up rope with a z-rig until the stretcher is suspended from the ground (with the stretcher bearers aid).
- Pull the rope in the deviation Munter Hitch as the stretcher approaches the vertical line.
- As soon as the stretcher reaches the vertical line in the pitch, lock the back-up rope and slacken the descent rope as needed to pull the deviation Munter Hitch to the required height.
- Lock the deviation Munter Hitch and continue lowering the stretcher using both ropes.





Strong points

- Faster than the previous technique.

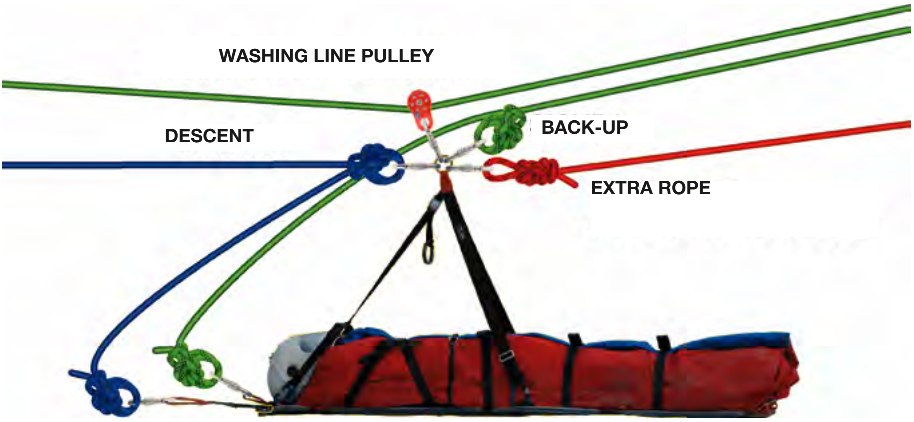
Drawbacks

- The mid-pit attachment points need to stand sufficiently high.
- More material is needed with respect to the previous technique.
- A rescuer needs to stay at mid-pit to supervise the Munter Hitch.

The "washing line"

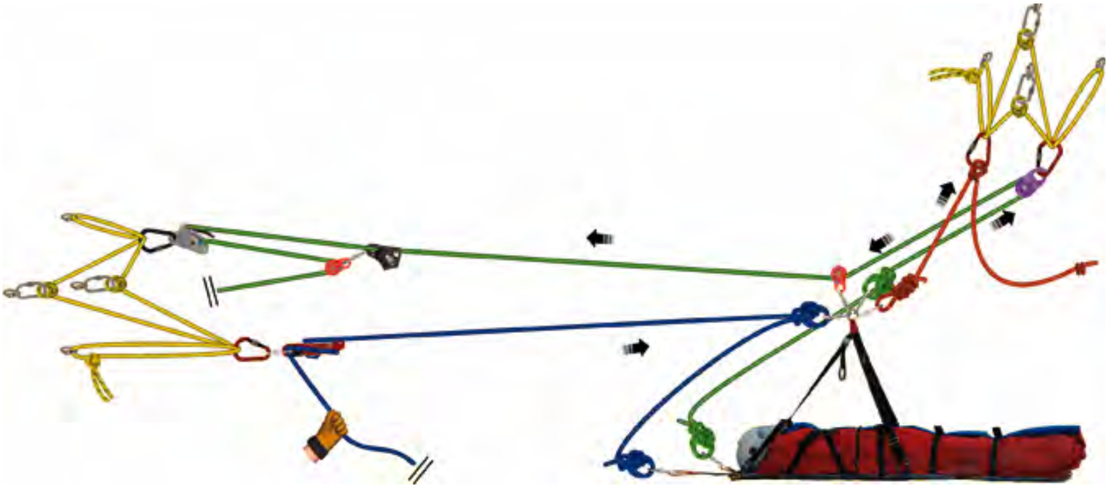
Information

- This manoeuvre simplifies the stretcher entrance in a pitch whenever the mid-pit cannot be assembled in an elevated position.
- The mid-pit deviations are of anchored kind.
- The manoeuvre consists in suspending the stretcher in the section of back-up rope going from the mid-pit to the main attachment point using a pulley. The pulley is connected to the stretcher lifting point.
- If the mid-pit is exposed, connect the back-up rope to the foot-end of the stretcher by arranging an extra section of rope connected to the mid-pit attachment point through a Munter Hitch.
- The connection sequence of the ropes to the lifting point is fundamental. From head to toe: descent, washing line pulley, back-up, extra section of rope.

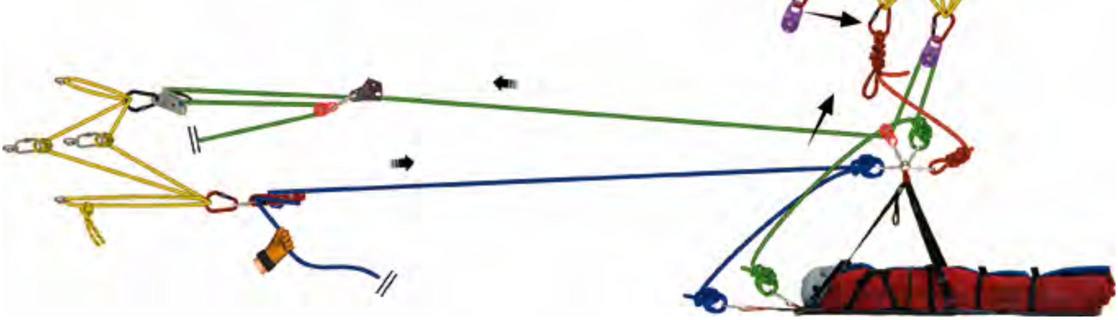


Manoeuvre execution:

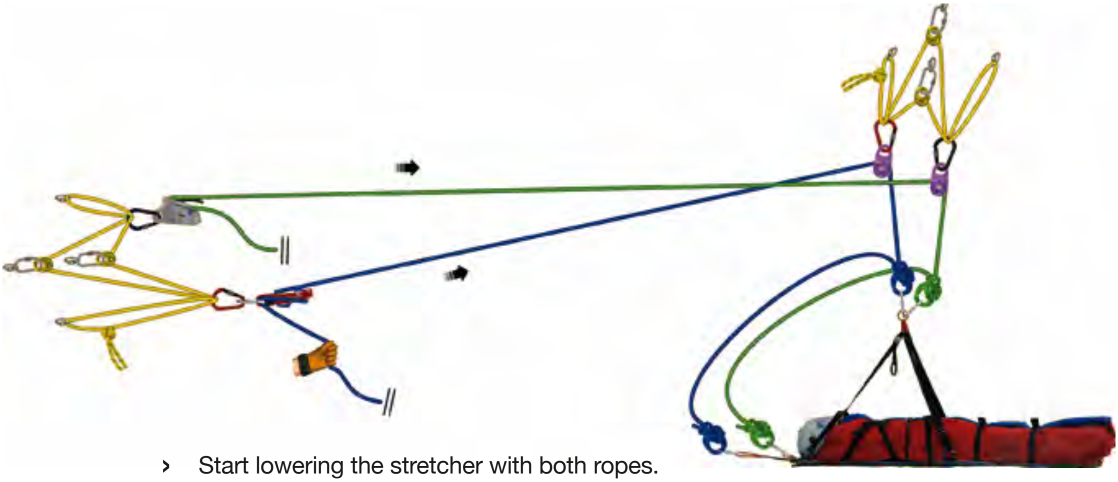
- Arrange the back-up rope using a z-rig haul system (grigri and travelling part or independent z-rig).
- Pull the stretcher with the back-up rope and brake it with the descent rope; in this way the stretcher will be lifted by the tyrolean effect produced on the back-up rope.
- Keep pulling the stretcher with the back-up rope while slacking the descent rope in order to keep the stretcher suspended only for the bare minimum; keep the stretcher secured by removing the slack in the extra section of rope.
- The descent shouldn't excessively counter the back-up rope pull.



› When the stretcher reaches the pitch vertical, lock the section of back-up rope, lower the descent as needed to insert it in the mid-pit pulley and lock it (with descender complete with a full lock).



› Lower the back-up rope until there is enough slack to remove the washing line's extra pulley (the stretcher's weight is borne by the descent rope); remove the back-up rope slack and remove the section of rope.



› Start lowering the stretcher with both ropes.

Strong points:
- The tyrolean effect allows the stretcher to stay higher than the techniques previously seen.
- It allows to enter the pitch also with a distant mid-pit.

Drawbacks:
- High load on the mid-pit attachment points.
- More complex and slower than the previous techniques.

Warning

- The mid-pit anchors are forced to work in two directions: with an horizontal load (pitch entrance) and with a vertical load (descent).
- Descent and back-up ropes need to work in sync not to unnecessarily stress the system.

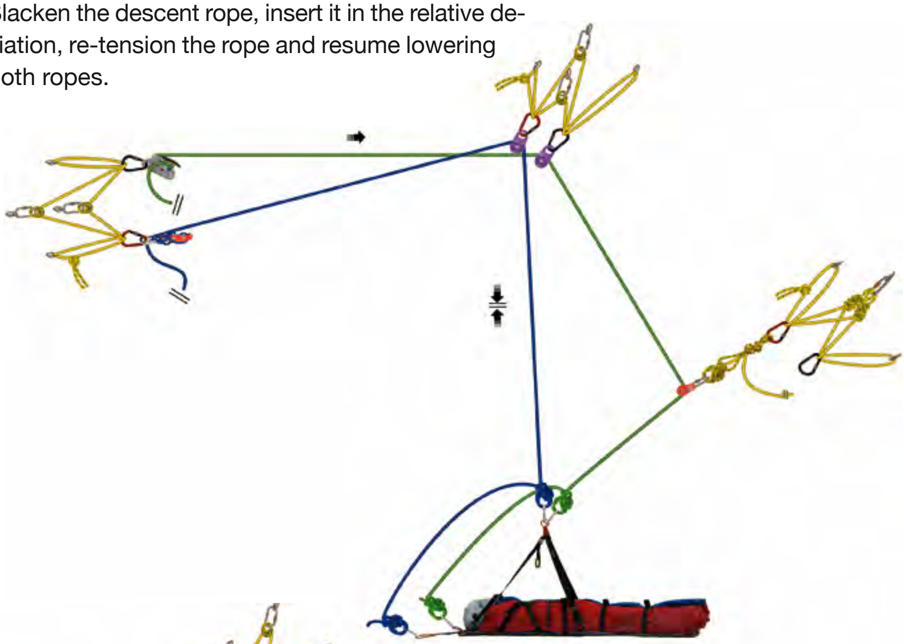
Common mistakes

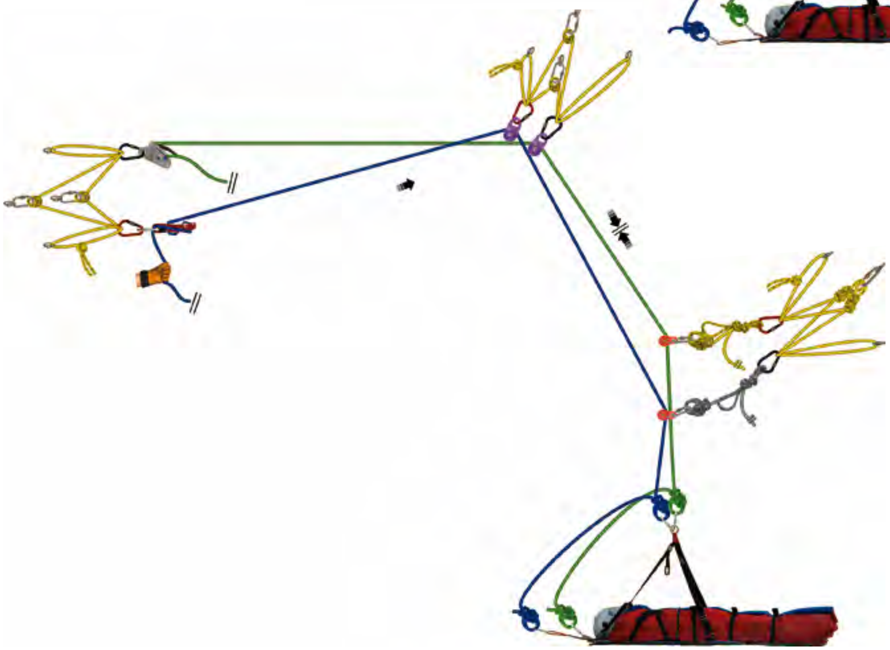
- Have the descent rope excessively tensioned and the stretcher excessively elevated with respect to the real needs.
- Fail to foresee an extra back-up rope at the feet-end of the stretcher in case the mid-pit is far from the pitch entrance.
- Wrongly locate the carabiners used for connecting the descent rope, the secondary pulley and the back-up rope at the lifting point.

Secondary deviations

Information

- Stop lowering the haul rope as soon as the stretcher is at deviation height. Keep feeding the back-up rope until there is sufficient slack to insert the rope in the deviation (a rescuer can help the stretcher-bearer if the deviation is far from the vertical). Eliminate the back-up rope slack and put the rope under load by slackening the descent rope.
- Slacken the descent rope, insert it in the relative deviation, re-tension the rope and resume lowering both ropes.





Descent with counterbalance

Information

- To lower the stretcher during a counterbalance haul, the balance man needs to clip the short cowstail to the mid-pit attachment point.
- Check that the balance man doesn't interfere with the trajectory followed by the stretcher for entering the pitch.

Photo Paolo Manca

Passing the knot

Contents

BASIC CONCEPTS

Information

- This technique is used to pass a binding knot on the haul or on the back-up rope.
- In order to pass a knot, it is necessary to temporary loose the knotted rope, during this operation the stretcher is protected by a BAS (Releasable locking system).
- The knot used to tie two ropes together or to isolate a damaged section is a flat overhand knot because it is compact and easy to untie even after heavy loads.
- Whenever you can tie only one of the two ropes, prefer the back-up rope.

Warning

- If you need to tie binding knots on the haul and the back-up ropes, offset the knots by several meters from each other.
- The connection between the BAS and the attachment point should be independent and bound to the sections of rope by means of two carabiners (these can be pre-arranged before starting the operations).
- The BAS can be built with the technicians personal equipment and the haul/back-up rope end.

Common mistakes

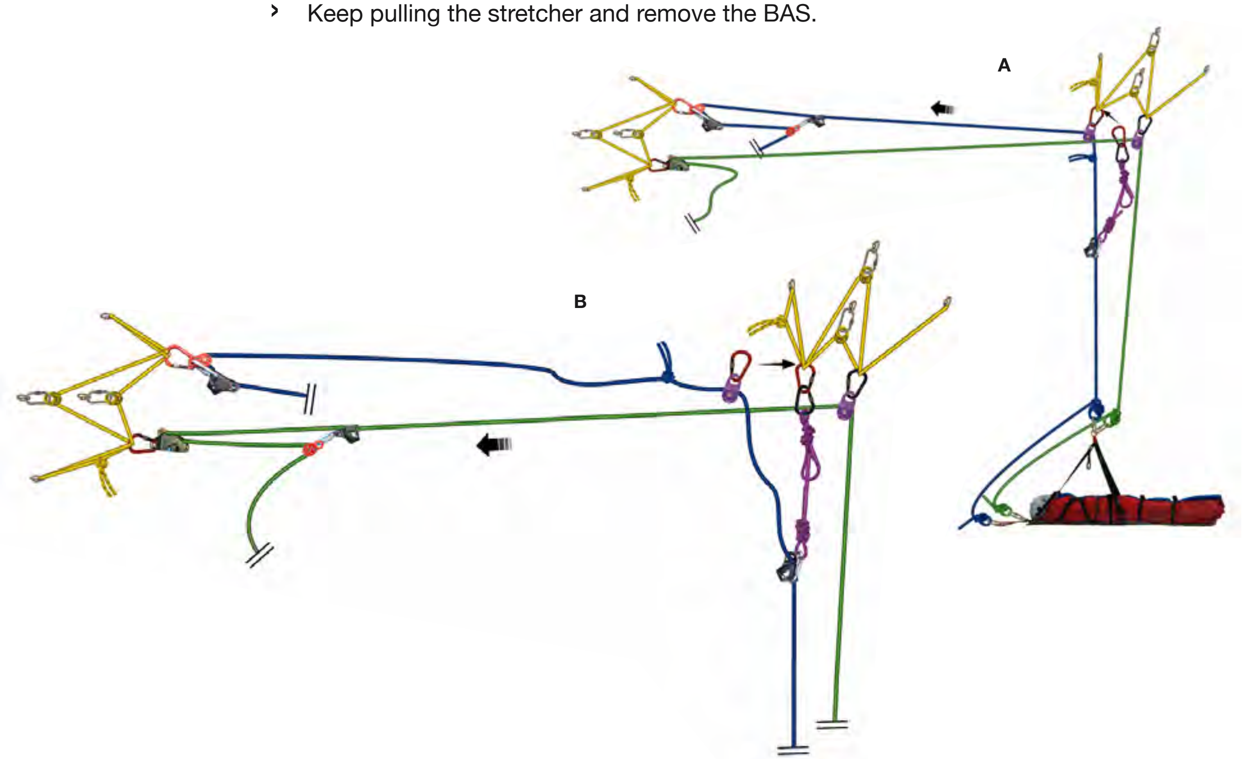
- Tie a knot both on the haul and the back-up rope neglecting to offset the knots by some meters.
- The technician neglects to pre-arrange the extra tools necessary for executing this manoeuvre.

PASSING THE KNOT WITH A Z-RIG HAUL SYSTEM

In mid-pit deviation

Information

- Bring the knot close to the deviation pulley.
- Secure the haul rope by connecting the BAS to the mid-pit attachment point **(fig. A)**.
- Pull the back-up rope to lift stretcher using a z-rig (add the travelling part) and at the same time manually take up the rope in the BAS ascender until there is enough slack to bring the knot beyond the pulley.
- Remove the pulley, install it on the opposite side of the knot **(fig. B)**; now tension again the haul rope.
- Keep pulling the stretcher and remove the BAS.



Warning

- Keep the ascender low with one hand (or one foot) to maintain the BAS tensioned and use the other hand to take up the rope.
- It is preferable to fasten the BAS to the attachment point and then to the rope in order to prevent the BAS from accidentally slide down the rope onto the stretcher.

Common mistakes

- Clip the BAS to the carabiner of the mid-pit pulley hindering or preventing its opening.

In the main attachment point

Information

The manoeuvre consists in bringing the knot beyond the z-rig anchored part; therefore it is necessary to put the back-up rope under load.

- Bring the knot few centimetres from the z-rig anchored part.
- Secure the haul rope by connecting the BAS built with the z-rig travelling part **(fig. A)**.
- Pull the back-up rope to lift stretcher using a z-rig (add the travelling part) until there is enough slack to bring the knot beyond the anchored part. Remove the anchored part in the haul rope and install it on the opposite side of the knot **(fig. B)**.
- Remove the anchored part in the haul rope and install it on the opposite side of the knot **(fig. C)**; now tension the haul rope.
- Remove the BAS.
- Keep pulling the stretcher and pass knot beyond the travelling part pulley as well.

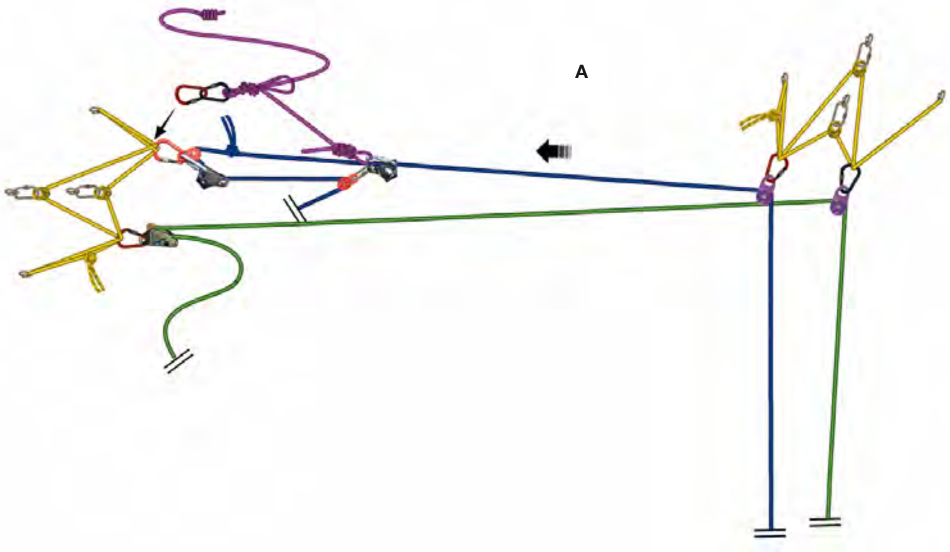
Warning

- While pulling the stretcher with the back-up rope, keep tensioned the BAS by taking up the section of rope going from the ascender to the z-rig anchored part.

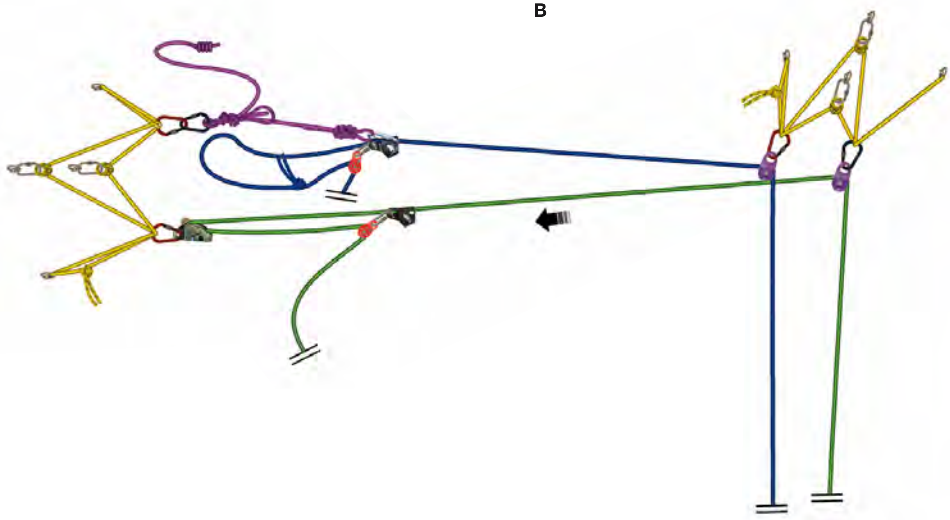
Common mistakes

- The BAS is clipped to the carabiner in the z-rig anchored part, hindering or preventing its opening.

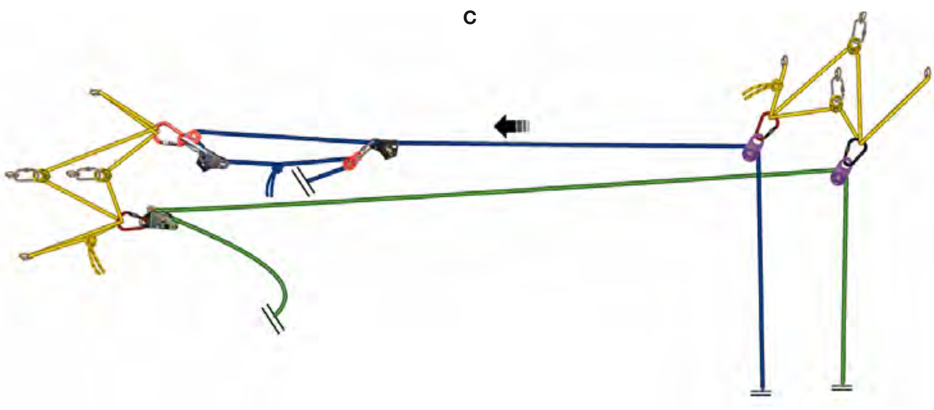
A



B



C



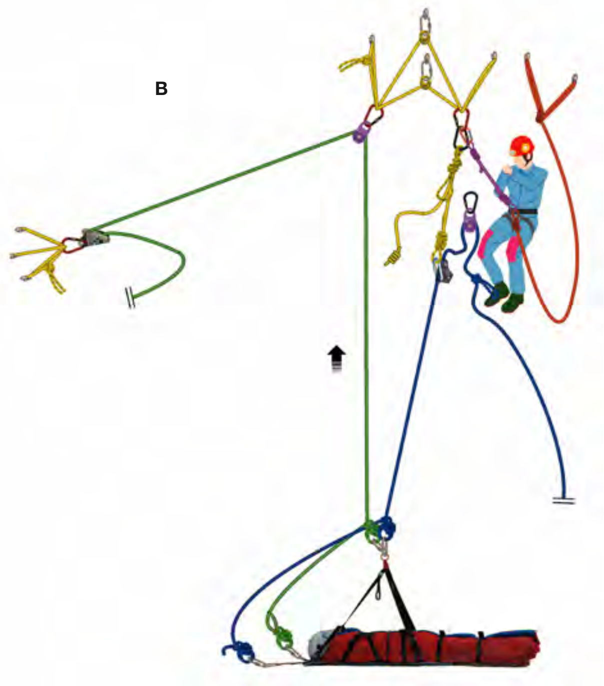
PASSING THE KNOT WITH A COUNTERBALANCE Z-RIG

Information

- Bring the knot close to the counterbalance pulley.
- Secure the haul rope by connecting the BAS to the counterbalance attachment point **(fig. A)**.
- The rescuer will first connect to and subsequently detach him/herself from the counterbalance rope.
- Pull the stretcher with the back-up rope.
- At the same time, take up the rope in the BAS ascender.
- Take up the rope until there is enough slack in the counterbalance rope to bring the knot past the pulley **(fig. B)**.
- Put the counterbalance rope under load and remove the BAS from the rope.

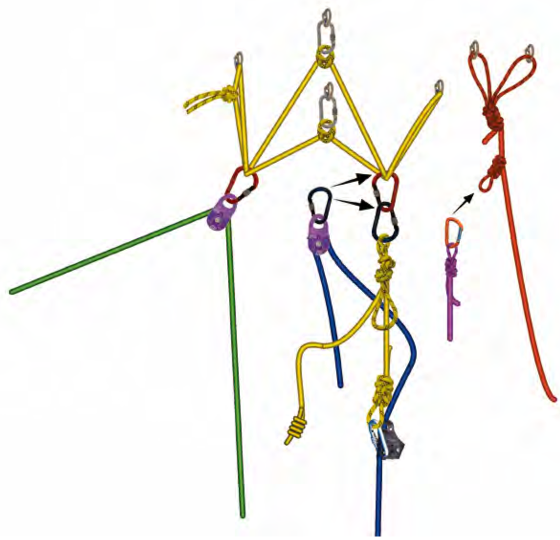
A

B



Warning

- The counterbalance pulley can be connected to the BAS extra carabiner if this is convenient for executing different manoeuvres.
- The balance man shouldn't clip the cowstail too close to the attachment point. S/he can clip the cowstail at the wanted height by tying a knot on his/her back-up rope.
- It is preferable to fasten the BAS to the attachment point and then to the rope in order to prevent the BAS from accidentally slide down the rope onto the stretcher.



Common mistakes

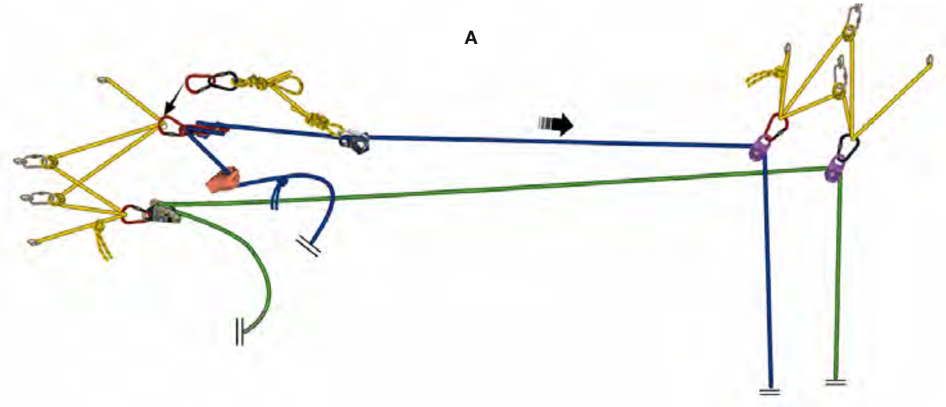
- The BAS is clipped to the carabiner in the counterbalance pulley, hindering or preventing its opening.
- The rescuer clips him/herself to the pulley carabiner, preventing its disassembly.

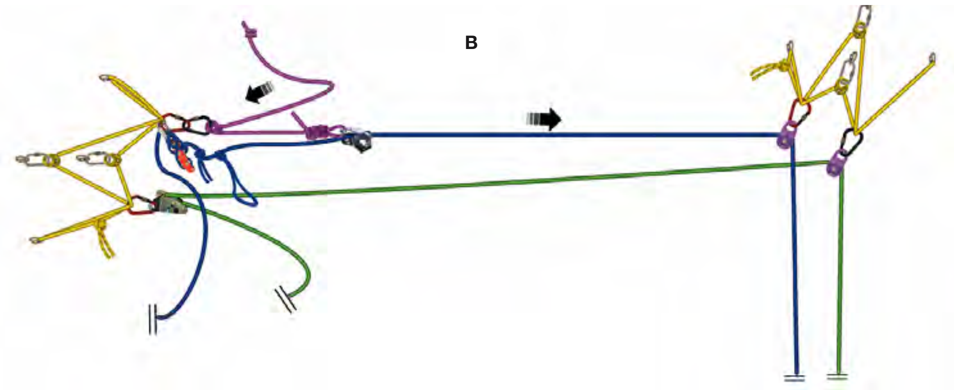
PASSING THE KNOT DURING A DESCENT

In the descender

Information

- Bring the knot 1-2 meters from the descender.
- Secure the descent rope by connecting one BAS to the descent attachment point **(fig. A)**. Adjust the BAS length so that the ascender is kept as close as possible to the descender.
- Keep lowering the rope using the descender and put the BAS under load.
- Remove the descender, pass the knot and re-install the descender with a full lock **(fig. B)**.
- Release the BAS and lower the stretcher until the descender is under load.
- Remove the BAS, release the full lock in the descender and continue the descent.





Warning ⚠

- It is convenient to have the descender attached to an extra carabiner to simplify the manoeuvres execution.
- The BAS section could be too short to load the descender once it has been installed with the knot tied downstream. If this is the case, tie a flat overhand knot to shorten the rope before releasing the BAS.
- It is possible to perform a flat overhand knot including the binding knot to obtain a shortening knot (see the following figure).

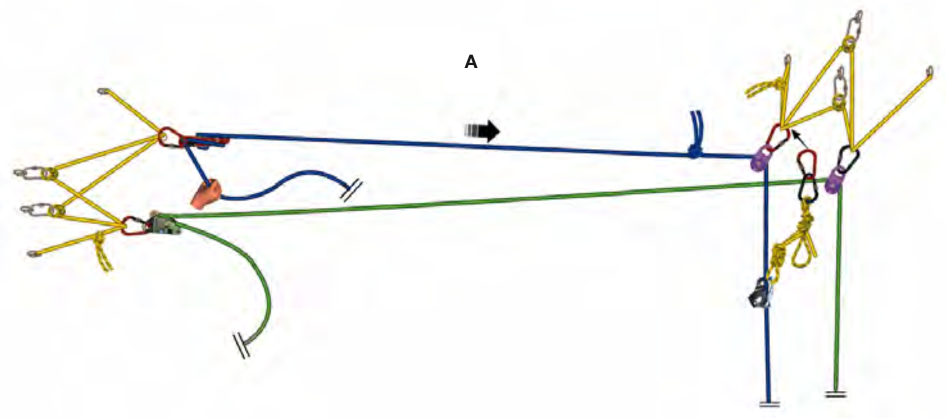
Common mistakes

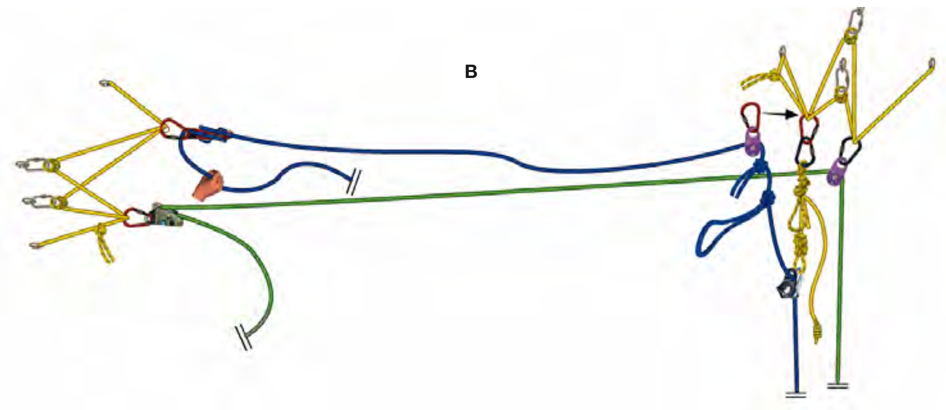
- Let the knot get close or even stuck against the descender: this prevents the section of rope to be placed under load.
- The BAS section is too short.
- The BAS ascender is placed too distant from the descender. The section length can be inadequate: correct by tying a shortening knot.

In the mid-pit deviation

Information

- Bring the knot 1-2 meters from the mid-pit.
- Bind the descent rope to the mid-pit attachment point by means of a BAS **(fig. A)**. Adjust the BAS length so that the ascender is kept as close as possible to the pulley.
- Continue lowering the stretcher with the descender until the BAS is under load.
- Remove the pulley, pass the knot and re-install the pulley.
- Release the BAS and lower the stretcher until the system is under load.
- Release the BAS and continue lowering.





Warning

- Coordinate the movements with the lowering of the back-up rope.
- The BAS should be locked so that the section of rope is sufficient to perform the manoeuvre (i.e. short) and in order to allow for its retrieval after the release. After installing the pulley with the knot standing downstream and before releasing the BAS, it is possible to tie a shortening knot, also including the binder knot, in case you are not sure that the BAS isn't long enough to put the system under load.
- It is preferable to fasten the BAS to the attachment point first and then to the rope in order to prevent the BAS from accidentally slide down the rope onto the stretcher.

Common mistakes

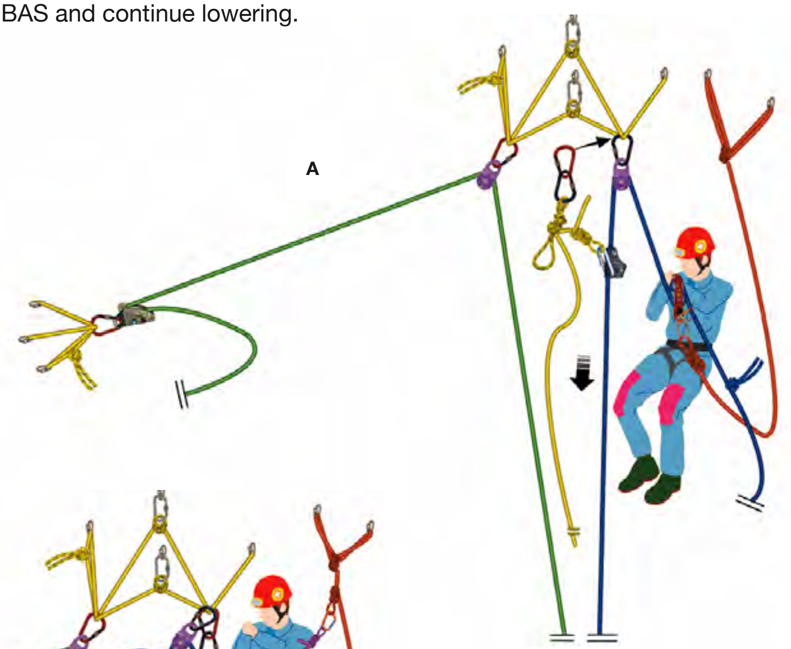
- Let the knot get close or even stuck against the descender: this prevents the BAS to be placed under load.
- Clip the BAS to the carabiner of the mid-pit pulley hindering or preventing its opening.
- The BAS section is too short or the BAS ascender is too distant from the mid-pit pulley.

In counterbalance

Information

- Bring the knot 1-2 meters from the descender.
- Secure the descent rope by connecting the BAS to the mid-pit attachment point **(fig. A)**. Adjust the BAS length so that the ascender stays close to the pulley.
- Continue lowering the rope using the descender and put the BAS under load.
- Remove descender and pulley and re-install them after the knot.
- Tie a shortening knot, also including the binder knot if needed, so to reduce the slack between the binding and the BAS **(Figure B)**.
- Prepare to descent with the descender fully locked.
- Release the BAS and lower the stretcher until the system is under load.
- Release the BAS and continue lowering.

A



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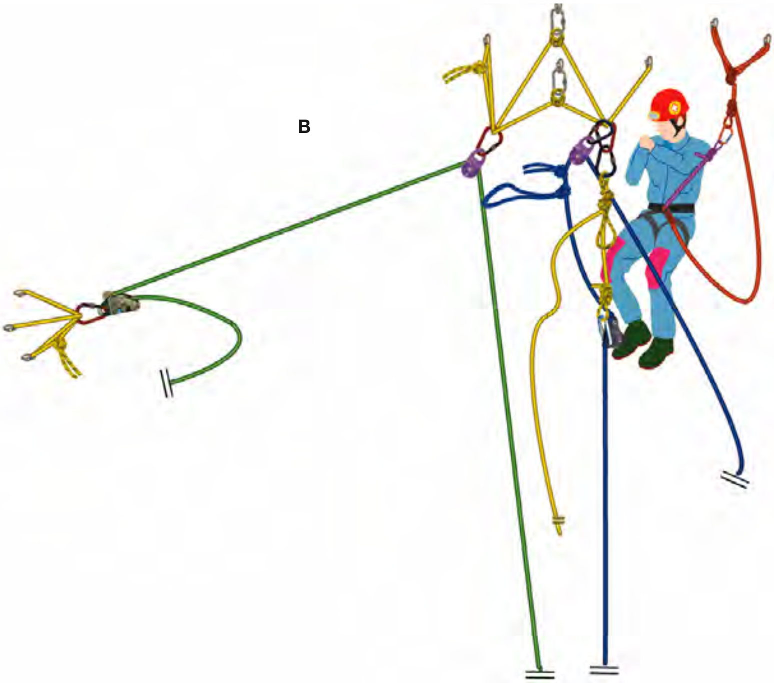


Warning ⚠

- It is preferable to fasten the BAS to the attachment point first and then to the rope in order to prevent the BAS from accidentally slide down the rope onto the stretcher.

Common mistakes ✖

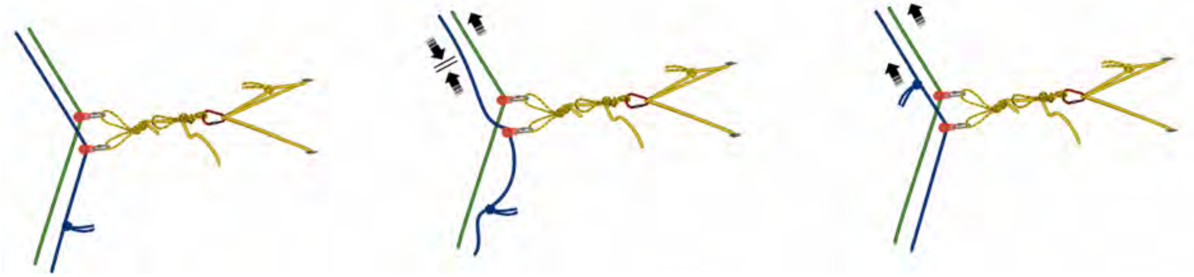
- Let the knot get close or even stuck against the descender: this prevents the BAS to be placed under load.
- Clip the BAS to the carabiner of the mid-pit pulley hindering or preventing its opening.
- The rescuer clips him/herself to the pulley carabiner or directly to the carabiner, preventing its removal to pass the knot.
- The BAS section is too short: the rope isn't long enough to put the system under load.
- The BAS ascender has been placed too far from the mid-pit pulley: the BAS section could be too short.
- Tie the shortening knot in the wrong position.

PASSING THE KNOT WITH MAIN AND SECONDARY DEVIATIONS

Information It is not necessary to install a BAS on the secondary deviations; proceed as follows:

During the haul:

- Lock the haul rope just before the knot reaches the deviation pulley. Haul with the back-up rope to loose the haul rope deviation bearing the knot.
- Remove the deviation and re-install it past the knot.
- Now take up the rope until the haul rope is under load.



During the descent:

- Stop lowering 2-3 meters before the knot reaches the deviation, preventing the knot to come up against the pulley.
- Lock the back-up rope and continue lowering the descent rope so to put the haul rope under load.
- Loose the descent rope until there is enough slack available for removing the deviation and re-install it after the knot.
- Lower the back-up rope until the descent rope is under load again.

Warning ⚠

- If there is more than one secondary deviation, a technician should be focused on the knot and perform all the steps in the deviations. This is possible only when the rope for progression has been split in proximity of deviations, allowing the stretcher attendant and the technician devoted to the passing of the knot for individually and contemporary ascend.
- The team member in charge of the deviation might find difficult to communicate with those engaged in lifting the stretcher from the pitch edge if the distance is huge. In similar cases a radio should be used.

Common mistakes ✖

- During the descent, let the knot get close or even stuck against the descender: the stretcher stays hung on the deviation obliging to undo its blocked munter hitch to release it. This complicates the manoeuvre.

Photo Paolo Manca

Rope self-rescue

Contents

BASIC CONCEPTS

Information

Every cave rescue member needs to be completely familiar with the rope self-care techniques. During a cave rescue operation, the possibility that a rescuer can experience an accident cannot be excluded. The team members have to cope with the emergency in time and safely also when the available equipment is limited.
Complex manoeuvres are often involved and these require a regular and qualified training. This is the path the Cave Rescue Organizations should follow, training and educating its own teams. A cave rescue operation usually involves several technicians and we cannot completely exclude the possibility that one of them experiences an accident.

What to do if an accident occurs

As soon as an accident occurs, the victim and the people around him/her undergo to a huge psychological distress. A common reaction is to underestimate the situation. This can jeopardize the whole team, leading to risky behaviours and triggering a sudden chain reaction. On the other hand, an accident is by nature a rare and unexpected event. You are never ready enough to cope with it in the best way. The regular and careful training is necessarily the only instrument available to fill this gap. A cave rescuer needs to be familiar with the self-rescue techniques and be ready to face the more challenging situations. In order to properly carry out the self-rescue manoeuvres in a real-case scenario, a constant training is needed.

Tools available for a self-rescue

Having tools and technician readily available eases the self-rescue operations, but this is rarely the case. It is the case of two riggers ascending in pairs, isolated from the rest of the team, or if an accident occurs to the first-aid team. This section illustrates some techniques that solely use the tools used by the casualty and the rescuer for progression: as a consequence, these techniques are applicable by a single rescuer having little material at disposal.
Remember, some other tools MUST be part of the personal equipment, a part from the usual progression tools: two carabiners, one of which should be a HMS, a pulley, a knife and a cord as a minimum requirement.

Harness hang syndrome (suspension trauma)

Among all the various accident scenarios possible, the one involving an injured suspended on the rope is particularly alarming. When a victim is suspended upright on the harness unable to move for a period of time, (i.e. the victim is unconscious, injured or simply exhausted), the vitals can rapidly and dramatically worsen. The physical and pathological mechanisms underlying this syndrome

are directly related to the position held by victim (i.e. unconscious or unable to move). The harness compresses the femoral vein and as a result the venous blood is prevented to return to the heart; this process triggers a chain reaction determining the onset of a multiple organ failure, that can have fatal consequences. Scientific papers in the field (we consider the papers published from 2002 to 2011) suggest that the suspension trauma can lead to death in 7 to 30 minutes. The basic elements determining the shortening or lengthening of the above said time-range are the type of harness and the fatigue and dehydration conditions of the casualty, a part from any major trauma. The case reports indicate the fatigue as the main risk factor, with the consequent exhaustion. In similar conditions it is therefore dangerous to have a fatigued individual ascending/descending deep pitches or facing complex rope techniques. It is advisable to let the casualty rest wrapped in a space blanket to recover energies.
Based on such data, it is reasonable to state that self-rescue procedures need to be completed within 5/10 minutes, including the time needed to reach the casualty.

Warning

- It is fundamental to familiarize with techniques designed to manage the more complex situations.
- To master the self-rescue techniques, a training both in crags and in caves is needed.

Common mistakes

- During a coordinated cave rescue operation, feeling safe and protected by the team and under-evaluating the common sense rules; actually pairs of technicians often act autonomously, far from the reach of the rest of the team.
- Consider the training in a crag sufficient. The real conditions of a cave differ from the simulations in a crag, crags are useful just for start learning the self-care techniques.

REMOVING A CASUALTY

Information

The presence of a casualty hanging from a rope represents, among all the possible scenarios, a situation in which the success completely depends on the team's training and readiness.
Disengage a casualty from the rope is a complex technical issue and more solutions are possible. The factors influencing the choice of one technique against another include but are not limited to: the presence or not of a secondary rope; the decision to remove the victim from below or from above; choosing to work bound to the casualty or not; the environment in which a rescuer needs to operate.
There are several possible alternatives, but one of the main technique employed consists in the direct intervention of the rescuer, who lowers the victim by means of a counterbalance ("pendulum" evacuation). This method represents the best compromise between rapidity of execution, efficiency, safety and flexibility.

The pros:

- There is no need to raise the casualty by force.
- This method employs only the casualty progression equipment or if necessary the rescuer equipment.
- During the descent, the rescuer hangs from the casualty and not the opposite: the rescuer better controls the casualty, who can be protected from any collisions during the descent; the rescuer can "exit the manoeuvre" and free him/herself in any given moment.
- The lowering of the casualty to the bottom of the pitch is managed better than when the casualty hangs from the rescuer.

Warning

- The pendulum is not the only method available to remove a casualty. Several alternatives exist, each one with its own pros and cons.
- The self-rescue is not limited to removing a casualty from a rope; the needed skills include the passing of rebelays, knots and handrails on the rope for progression. A rescuer should be able to manage without supervision any emergency using only the personal equipment.
- The very first thing to do in any self-rescue procedure is evaluating the situation: the environment (dangers in the pitch, difficulties to progress, rigs and rope conditions), the accident (stones fall, flood hazard), the casualty (is he/she conscious or not? Can he/she cooperate?).
- In a similar situation, the available time for the intervention itself can be limited. If you add the time needed to analyse the situation and to join the casualty, you'll see you only have few minutes left before the onset of a harness hang syndrome. Despite the emergency, it is extremely important to put oneself in the condition to operate guaranteeing the rescuer and the casualty safety.

Common mistakes

- Fail to take into account the environmental conditions, with the risk of a chain reaction.
- Start the self-rescue operations carrying useless tools slung across the shoulders or hanging from the tool bag, messing up the operations.

REMOVING A CASUALTY WITH THE PENDULUM TECHNIQUE

Information

- Carefully evaluate the residual risk.
- Climb the rope to join the casualty and pay attention not to induce swings or pendulums.
- Remove the casualty foot (or feet) out of the footloop.
- Carefully move at the casualty side and link the short cowstails in a way that these don't interfere with the following steps **(fig. 1)**.
- Remove your chest ascender and transfer your weight on the upper ascender **(fig. 2)**.
- Clip the descender on the casualty harness maillon (facing the rescuer), insert the rope in the descender without full-lock **(fig. 3)**.
- Disengage the casualty upper ascender from the long cowstail while leaving the carabiner attached to the upper ascender; run the casualty long cowstail through the same carabiner to use it as a pulley for the pendulum **(fig. 3)**.
- Step on the footloop and link the casualty long cowstail to your harness maillon **(fig. 4)**.
- Activate the pendulum by raising the casualty as needed to take his weight off the chest ascender **(fig. 5)**.

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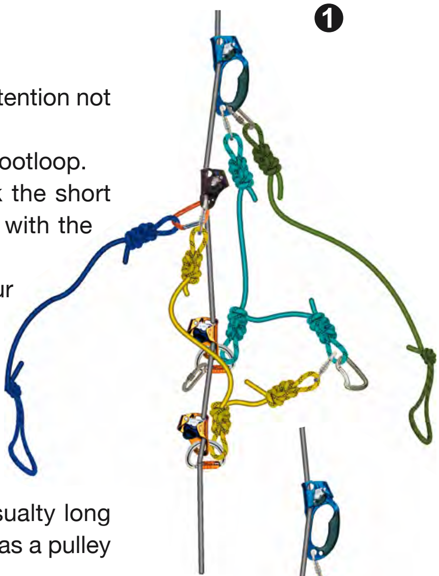

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- Disengage the chest ascender **(fig. 6)**, take up the slack just above the descender and do a full lock **(fig. 7)**.
- Reverse the pendulum direction until the casualty weight is again on the descender **(fig. 8)**.
- Step up on the footloop, detach the pendulum long cowstail from your harness maillon **(fig. 9)**, retrieve the casualty's upper ascender and position yourself under the casualty and attach yourself as close as possible to the casualty harness maillon (it is easier if you attach a carabiner to the lower side of the victim's harness maillon beforehand).
- Check the tools are correctly arranged and retrieve your travelling ascender **(fig. 10)**.
- Undo the full lock and lower yourself keeping if necessary a half lock on the descender.
- Since you arrive at the pitch floor, don't land immediately the casualty under the rope vertical line (stones might fall) and move to a safer place instead, with the casualty weight still on the rope.

8

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Warning

- You can clip a carabiner into the upper eyehole of your chest ascender in order to attach yourself close to the casualty.
- The manoeuvre requires a strict neatness of execution. Each step should be carried out without crossing the ropes.
- Fail to take into account the environmental conditions, with the risk of a chain reaction.
- Start the self-rescue operations carrying useless tools slung across the shoulders or hanging from the tool bag, messing up the operations; however two carabiners and two cords are extremely useful.
- The safety line length of the casualty's upper ascender determines the ascender position during the pendulum. After the upper ascender is linked to the rescuer's maillon rapide, it should be pushed as high as possible to make the pendulum effective (increased stride).
- This manoeuvre is necessarily influenced also by the causalty's cowstail model: if this is made in webbing or if it is connected to the upper ascender with a maillon rapide, the pendulum can become complex. As an alternative, you can use your long cowstail.
- Provided that the casualty's short cowstail allows for it, you can attach your eyehole instead of the carabiner. If the eyehole is particularly short, the casualty's carabiner can be removed to make room for your carabiner.
- Both footloops can be used during the manoeuvre.
- You can install the descender by linking the rope directly to the descender's carabiner ("vertaco" mode) in order to enjoy an increased control during the descent (especially with small diameters ropes) but do this only if you are absolutely sure you don't have to pass any binding knot.

Common mistakes

- The cowstails crossing obstruct the pendulum, hindering the casualty raising.
- Fail to retrieve the rope in the casualty's descender by immediately doing a full lock.
- Attach yourself too low with respect to the casualty.

PASSING A RE-BELAY ON DESCENT

Information

These are ancillary methods complementing the main method employed to remove a casualty from the rope. They have been developed to pass a rebelay or a binder knot while lowering the victim. Two methods are here illustrated for passing the knot. Each method has its own pros depending on the existing situation.

Please remind that rebelays can be eliminated only if and when there is no risk to make loose stones falling down or to cut the rope during the descent (high risk: the pressure induced by two people against the rock is more than double both because of the reduced section of rope and the victim plus the rescuer's weight).

The rescuer is underneath the casualty and controls the casualty's descender.

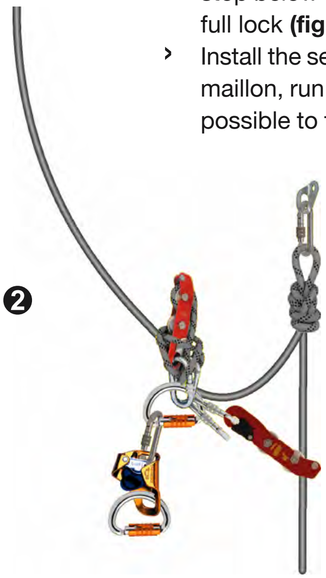
Common mistakes

- Try to join the casualty from below and consider to modify the progression rope trajectory, without considering the time required for doing it and the difficulties associated with the release of old rigs and the opening of maillon rapide where applicable.

PASSING A RE-BELAY WITH A "DOUBLE DESCENDER"

Information

- This method is based on two descenders; it consists in transferring the load after the rebelay without raising the casualty or yourself.
- Arrive at the rebelay and stop at rebelay height (never stop below the rebelay) with the descender, then do a full lock **(fig. 1 and 2)**.
- Install the second descender on the casualty's harness maillon, run the rope after the rebelay and as close as possible to the knot; complete with a full lock **(fig. 3)**.



- Descent using the upstream descender until the downstream descender is under load **(fig. 4)**.
- Remove the upstream descender and safety line.
- Undo the full lock in the downstream descender and descent **(fig. 5)**.

Warning

- If the upstream section of rope is not long enough, you can do a half lock.
- Install the second descender with the gate facing you.

Common mistakes

- Lowering yourself too low with respect to the rebelay. Now you are prevented from doing also a half lock or, when transferring your weight on the downstream descender, the rope may be too short.
- Fail to adequately lock the rope in the downstream descender: once the weight is on it, you could descent too much and be prevented from completely disengage the upstream descender (which remains loaded in the rope loop end).
- Connect a cowstail to the rebelay.
- Install the descender with the gate facing the casualty.

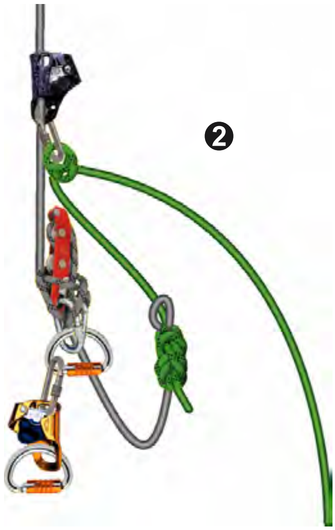
PASSING THE KNOT WITH A "TEMPORARY REBELAY"

Information

This is the fastest and easiest way for passing a knot; where the conditions are favourable, it is the method of choice. It consists in creating a “temporary rebelay” which will be passed in the same way as previously seen.

- Climb up as close as possible to the knot and do a half lock: once the full lock is done, you should have approx. 30 cm of rope between the knot and the descender **(fig. 1)**.
- Install an ascender complete with carabiner just before the descender.
- Tie a hitch just underneath the binder knot and run it through the ascender carabiner: now you have a "temporary rebelay" **(fig. 2)**.

1



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- Proceed in the same way as for passing a regular rebelay **(fig. 3-5)**.

5

Warning

- This method can be employed only if you are sure that the rope is long enough to arrive at the bottom of the pitch.
- If below there is a rebelay with a particularly short eyehole, the rope might not suffice to perform this manoeuvre; if necessary, consider eliminating the rebelay.

Common mistakes

- Climb too close to the knot: the rope is not enough to do a full lock.
- Connect the cowstail to the temporary rebelay.
- Install the descender with the gate facing the casualty.

PASSING THE KNOT USING THE PENDULUM HAUL TECHNIQUE

Information

This manoeuvre, although longer and more complex than the previous one, has the advantage of resolving any situation.

❶

- Take the descender up against the knot, preferably excluding the safety line carabiner (use your feet to retain the rope if needed) **(fig. 1)**; if the safety line carabiner cannot be excluded, proceed as follows:
  1. Install an ascender complete with carabiner above the descender.
  2. Clip the casualty's long cowstail to your harness maillon and run it freely through the ascender carabiner; otherwise you can use a footloop (as shown in the figure) linking the casualty's harness maillon to your harness maillon; unclip yourself from under the casualty's harness maillon and transfer the weight on the pendulum **(fig. 2a)**.
  3. Start the pendulum by raising the casualty until the descender is no longer under load **(fig. 2b)**.
  4. Disengage the safety line carabiner **(fig. 2c)**. Reverse the pendulum direction and take the descender up against the knot **(fig. 2d)**.

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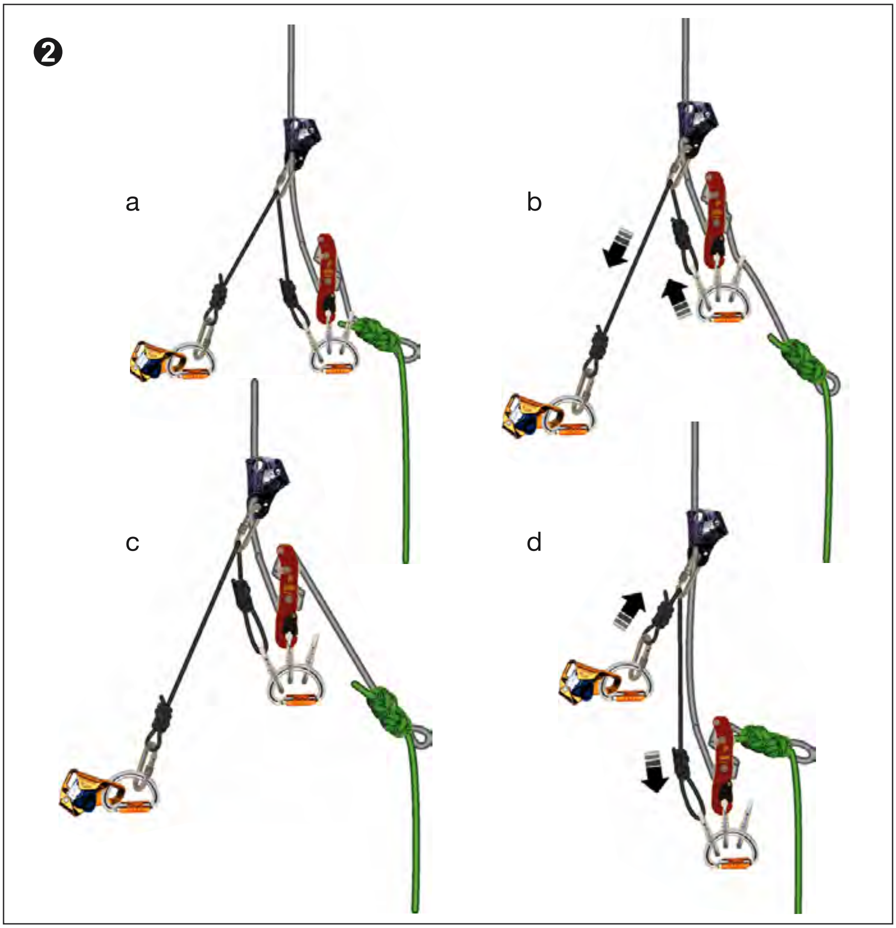

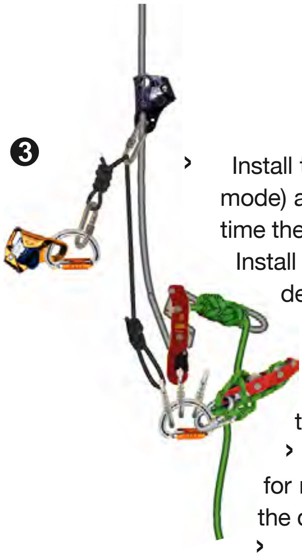

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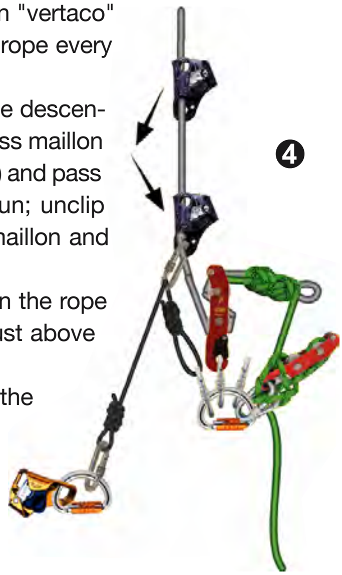
- Install the second descender beneath the knot (also in "vertaco" mode) and do a full lock; take care to firmly block the rope every time the rope is passed through the descender.
  Install an ascender complete with carabiner above the descender. Clip a footloop between the casualty's harness maillon and your harness maillon (or to a long cowstail) and pass it through the ascender carabiner, free to run; unclip yourself from under the casualty's harness maillon and transfer the weight on the pendulum **(fig. 3)**.
- If you have already installed the ascender on the rope for removing the brake, it is sufficient to lower it just above the descender **(fig. 4)**.
- Start the pendulum to raise the casualty until the upstream descender is no longer under load **(fig. 5)**. Disengage the upstream descender and reverse the pendulum direction until the casualty weight is on the downstream descender **(fig. 6 and 7)**.
- Loose the pendulum, remove the ascender and clip yourself close to the casualty's harness maillon **(fig. 8)**. Undo the full lock and continue the descent.



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Warning ⚠

- The footloop should be knot-less, otherwise the stride won't be enough to lower the casualty on the downstream descender. If this is not the case, you can wrap some loops of rope around, i.e., a carabiner in the middle of a pendulum to shorten the rope going from the knot to the upper ascender. By doing this, the casualty will be lowered for a shorter distance and his/her weight will be immediately be transferred on the downstream descender when the pendulum direction is reversed, unloading the pendulum as a result.
- Remember to take up any slack between the downstream descender and the knot before doing the full lock.
- The full lock done on the downstream descender has necessarily to be firmly tensioned: if the full lock allows the rope to run freely, the pendulum might remain loaded.

Common mistakes ✖

- Fail to remove the safety line carabiner before arriving up against the knot.
- Place the upper ascender used for the pendulum too high: once the upstream descender is released, the pendulum won't have enough stride to transfer the casualty weight on the downstream descender.
- Forget to remain secured during the pendulum and the following steps.
- Install the descender with the gate facing the casualty.

ADVANCED TECHNIQUES

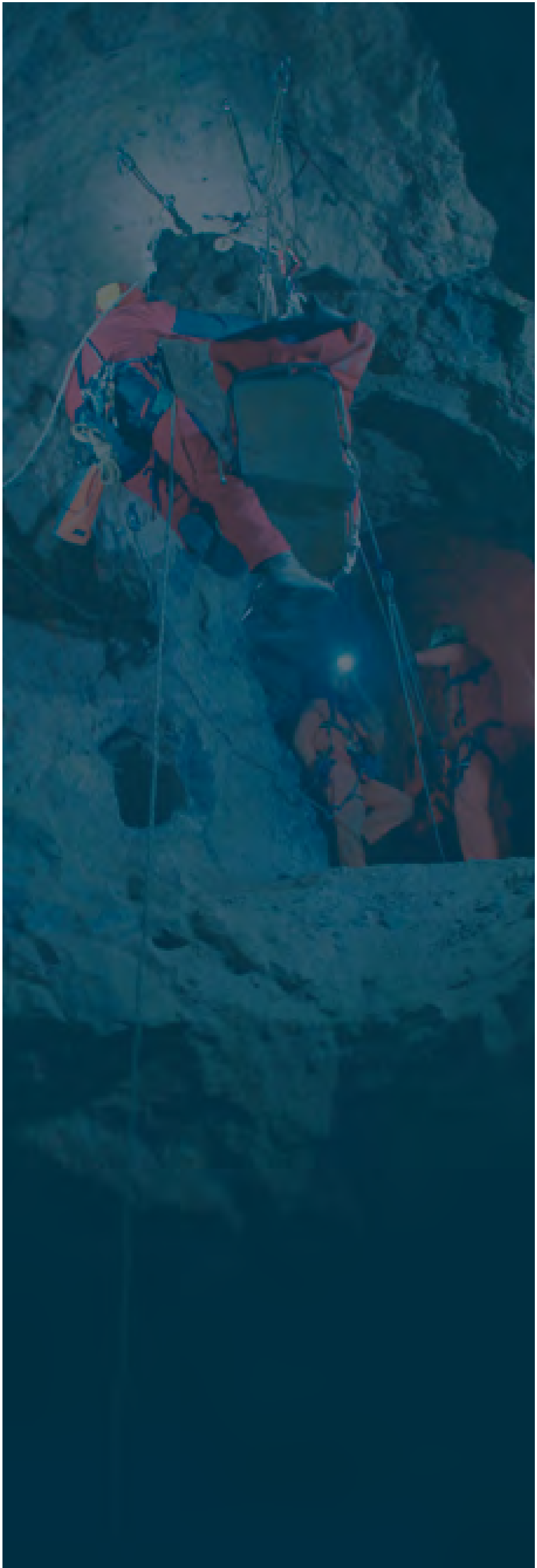


Photo Antonino Bileddo

Introduction

Contents

BASIC CONCEPTS

Information

› Advanced techniques are defined as rescue methods that permit to complete a rescue in those situations where basic techniques are ineffective.

Warning

› Some methods described in this section can be employed also with only one rope (single rope); here an error could jeopardize the casualty and/or the rescuers.
› The advanced techniques should be selected, arranged and used by expert rescuers who are able to:
• objectively evaluate risks and safety issues;
• avoid mistakes;
• coordinate the rescue operations.
Such team members are extremely useful and even crucial for the completion of a rescue operation and to achieve such competences both specific training and broad experience in rigging are needed.
› To employ advanced techniques for completing a rescue demands higher responsibilities for the interested team.
› Learning and training in advanced techniques increase the familiarity with the basic techniques and broadens the view of the rescue possibilities.
› This handbook presents some selected advanced techniques which meet simplicity, efficiency and flexibility criteria.
› There are many possible modifications that can be adopted to cope with a specific situation; these modifications can be adopted solely by expert rescuers showing an appropriate level of competence and in the observance of the usual safety parameters required by the cave rescue.

Common mistakes

› Employ these techniques without mastering them with confidence.
› Employ these techniques neglecting to properly consider skills and experience of the rest of the team.
› Employ these techniques when there is no need for it.

Photo Antonino Bileddo

Photo Antonino Bileddo

Lightweight riggers kit

Contents

BASIC CONCEPTS

Information › A cave rescue can pose problems of different nature. Defining a single rule is almost impossible when it comes to the tools to choose. The standard rescue equipment is intended to provide for broad operational margins with the purpose of disposing of the required tools to rig complex environments. A rescue operation can involve several scenarios where a team is forced to operate with little material. Two possible scenarios are:

1) rescues in deep vertical caves, where the transport of the needed tools represents a technical and human-resources issue by itself;

2) lost of a rigging bag during the rescue operations and the consequent distribution of the remaining rigging tools among all the teams.

The first scenario is an operational choice that should be knowingly implemented by all the rescue team-members; the second scenario represents an unforeseen event, i.e. an event dictated by non-intended circumstances: here the more expert team-members should be ready to face the situation with prompt efficiency. Senior rescuers have to be able to work with reduced material. This section proposes one possible lightweight riggers kit.

STANDARD RIGGERS KIT

Information

Detailed information on the standard riggers kit are given in the dedicated chapter. We underline that the bags content cannot be left to the chance. The number of anchors, carabiners and cords has been conceived to permit the stretcher evacuation on a tyrolean, the more material consuming method.

Warning

- The tools weight is a relevant issue that directly affects the efficiency of whom transports them, with severe repercussions in terms of safety, exhaustion and reduced performances.
- A regular rigging bag can weight up to 14 kg before entering the cave and can gain 1/3 of its initial weight once muddy.
- This is even truer when talking of ropes and sections of rope: they not only collect mud but they also absorb water, arriving to double their initial weight.
  The tools should be kept tidy in order to be transported and managed in the best possible way. The more tools you have, the more chance you have to forget them or mix them up.
- Rigging teams should manage their own bags in a completely autonomous manner.
- Mixing up the bags content with that of other rigging teams' bags results in delays and downtime.
- It is the rigger's (and generally the rescuers') duty to look after their cave tools.

LIGHTWEIGHT RIGGERS KIT

Ropes bag

Information

One A-type semi-static rope, of adequate length depending on the cave morphology. One rope out of two is eliminated from the riggers kit, ideally the back-up rope; a 60-meters rope is given to the stretcher team to provide for the stretcher safety.

Warning

- The riggers team travels with one rope less, which means almost 4 kg saved if the rope is dry and/or clean, many more if the rope is muddy.
- In operational terms, what changes here is that when the stretcher is at the bottom of a pitch, the first stretcher attendant to climb up links a rope end to his/her harness and take it at the top before lifting the stretcher. By doing this, the stretcher evacuation is not subject to delays.

Drills bag

1 hammer drill complete with a battery pack, 2 8-mm bits, 1 rope ladder with carabiner.

The progress made in the material development - lighter and more efficient drills and batteries - allows to reduce the bag weight.

Warning ⚠

- Some drills don't have a SDS Plus Spindle: attention should be paid to choose the right hammer bits.

Rescue bag

- 1 tool pack complete with Spit and Fix anchors
- One 10 meters section of dynamic rope
- Three 5 meters section of dynamic rope
- 15 anchors (rings only)
- 5 carabiners with screw-lock
- 2 fixe pulleys
- 1 high-efficiency pulley
- 1 grigri
- 4 HMS carabiners
- One 20-meters section of A-type semi-static rope

The following tools were eliminated with respect to the regular riggers kit:
› 4 cords (1 of 10 mt, 1 of 5 mt, 2 of 3 mt).
• Build the main attachment points with the haul rope end.
› 5 rings.
• Use the natural anchors as much as possible.
› 15 anchors carabiners.
• Run the attachment points cords directly through the rings.
› 1 z-rig with anchored part.
› 1 z-rig's travelling part complete with grigri.
› 1 high-efficiency pulley
› 2 fixe pulleys
• Missing pulleys and ascenders can be integrated with the riggers and stretcher bearers' personal gear: we stress that every rescue team-member have to carry a personal pulley, two carabiners (one of HMS type) and 1 cord to use for the auto-block knots.
• The use of an independent z-rig permits to eliminate one anchored part.

The lightweight riggers kit weights 7 kg less with respect to the regular kit, and when there is mud, the weight saved exceeds 9 kg. Each rigger saves 3 kg.

Warning ⚠

› The shown kit refers to the minimum material contained in the riggers kit. The riggers team are free to integrate it if applicable.
› Reducing the employed material requires higher technical skills by each team-member:
• Increased skill in exploiting natural anchors.
• Consistent use of the personal gear: ascenders, carabiners, pulleys and cords.
› It is all about adopting a different approach:
• Use optimized material for building rescue systems
• Streamline the whole rescue operation.

In brief, using a lightweight kit requires a brand new set-up that doesn't compromise safety and efficacy. Each team-member is invited to increase his/her own technical experience to get used to work with the bare minimum. The benefits are not only in the bags weight. The whole rescue operation takes place in a more linear and streamlined manner; less material is required but increased training and skills are demanded.

Photo Antonino Bileddo


Photo Antonino Bileddo

The Risolutiva method

Contents

BASIC CONCEPTS

Information

› This method allows to exit a pitch with a very low roof and a 90° angle, like tunnels or similar structures facing the top of the pitch. It can be used only with the previous consent of the doctor due to the vertical tilt. The stretcher is lifted in horizontal position as much as possible and it is tilted in vertical just before exiting.

Key points:

- Stretcher lifted by the feet-end.
- Rotation, pivot in the pitch edge, and entry in the tunnel horizontal position.
- Specific connection of haul and back-up ropes to the stretcher.

The Risolutiva can be performed in two different ways that differ in how the stretcher is lifted by the feet: in one case you lift it with a counterbalance on the section of rope and in the other you link the haul rope directly to the feet-end of the stretcher.

STRESS!

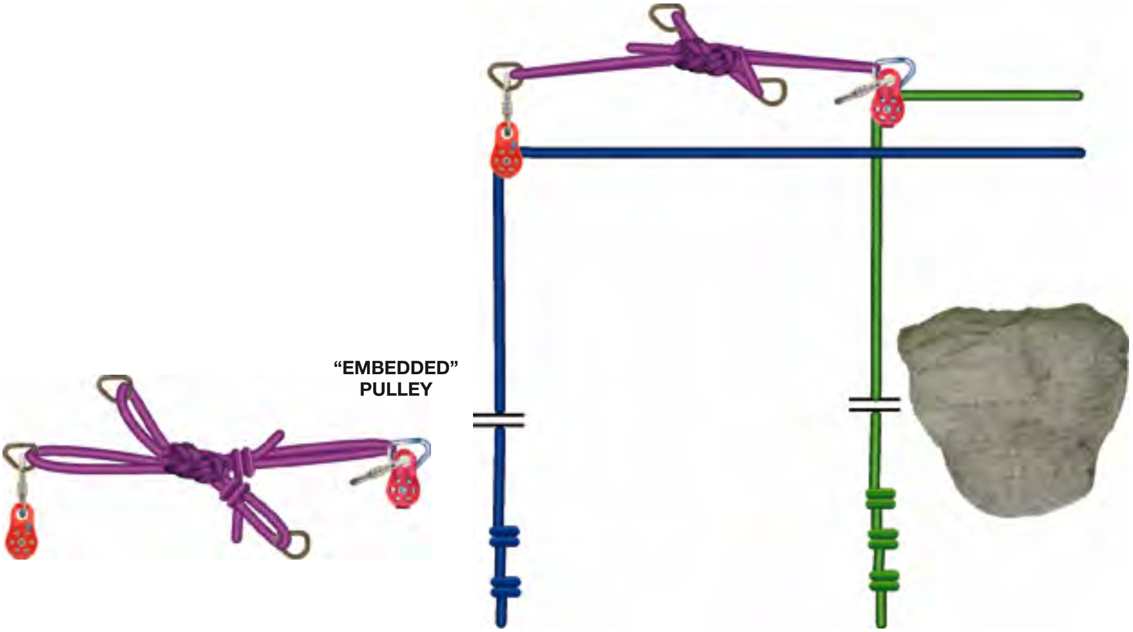
Warning

› Passing a pitch in a bottleneck represents an extremely delicate step, requiring a careful coordination.
› Before tensioning the rope at the feet-end attachment point, land the stretcher at the pitch entrance.
› Haul and back-up systems should stand back from the pitch entrance not to hamper the stretcher evacuation.
› To lift the stretcher from the feet-end, a careful coordination with the head-end rope pull is needed; otherwise the stretcher could be stressed on the pitch edge.

SETTING UP

Information

- Place the back-up rope pulley on the roof, right above the pitch entrance.
- Place the haul rope pulley in a slightly more exposed position (less than 60 cm), enough to allow to lift the stretcher away from the pitch wall.
- Use four anchors for the haul and the back-up ropes as usual but link them in series to gain vertical space.
- In order to gain further space, you can directly “embed” the back-up rope pulley on a ring.



The example shows a mid-pit attachment point with four anchors series-connected through a double eight loop and two Gandalf knots.

Common mistakes

- Use a pulley with narrow flanges embedded in the ring: it generally slips down the carabiner and deforms the flanges.
- Place the back-up rope pulley in an exposed location, hindering the immediate landing of the stretcher on the pitch entrance and negatively affecting the "pivot" effect on the pitch edge.

THE RISOLUTIVA ON COUNTERBALANCE USING A SECTION OF ROPE

Information

- The stretcher-bearer uses a counterbalance to lift the feet-end of the stretcher with the aid of a section of rope as he/she exits. The stretcher rotates by pivoting on the pitch entrance.

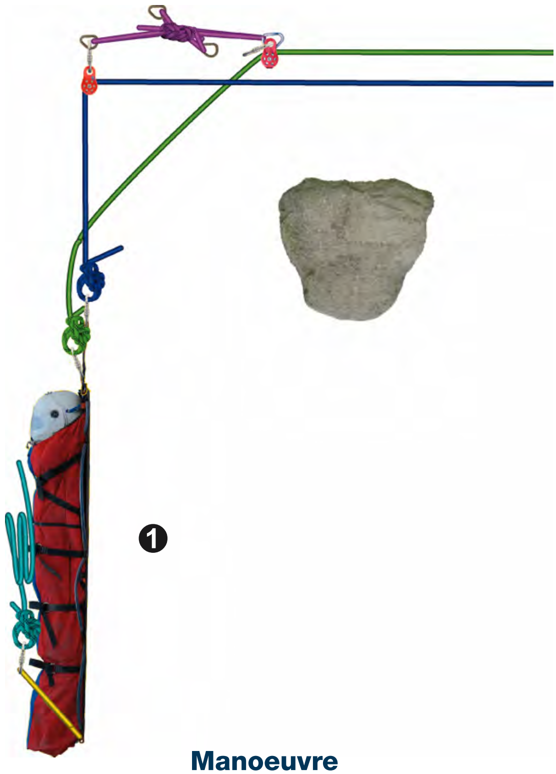
Stretcher binding

- Pre-arrange a 5 meters rope: connect it to the lifting points at the feet-end of the stretcher (or in alternative run a cord through the side handles at the feet-end), coil it and fix it in a easy to reach place (e.g. under the buckles at chest height).
- Standard connect the haul and the back-up ropes and clip them to the head-end of the stretcher; here you should pay attention to place the haul rope attachment point behind the back-up rope's short attachment point (braided haul and back-up ropes).

Warning

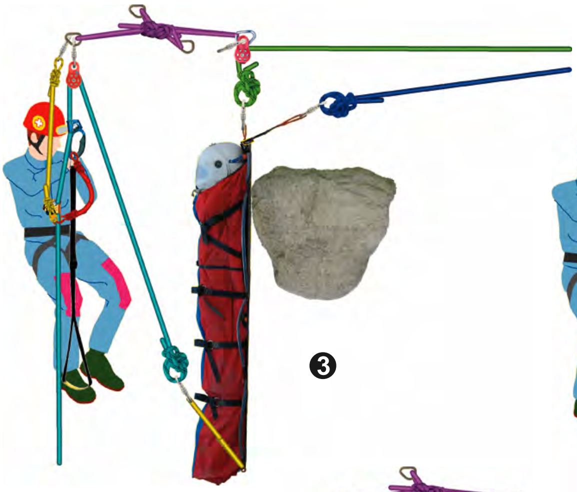
- Passing a pitch in a bottleneck is an extremely delicate manoeuvre that needs a careful coordination among the teams.
- Before tensioning the rope at the feet-end attachment point, land the stretcher at the pitch entrance.
- Haul and back-up systems should stand back from the pitch entrance not to hamper the stretcher evacuation.
- To lift the stretcher from the feet-end, a careful coordination with the head-end rope pull is needed, otherwise the stretcher could be stressed on the pitch edge.


Photo Paolo Manca



Manoeuvre

- The stretcher is lifted in horizontal position as far as possible. The barrowboy performs the vertical lift in due time, paying attention to undo the connection knots between the haul and back-up ropes and the lifting buckles.
- Continue lifting with the haul rope **(fig. 1)**.
- Approx. 2 meters from the mid-pit, start lifting with the back-up rope: this will permit the stretcher to approach the pitch entrance **(fig. 2)**.
- You can lift with the back-up rope until the pulley is reached, if needed (this is the maximum lifting height admitted for the head-end of the stretcher).
- The stretcher-bearer takes up the rope tail and ascends until clipping the cowstail to a mid-pit anchor; now he/she can release him/herself from the rope for progression.
- Slacken the haul rope to release it from the mid-pit pulley and take up the slack.
- The stretcher-bearer runs the section of cord through the released pulley (former haul pulley) and connects his/her ascenders to build a counterbalance **(fig. 3)**.
- Now the haul rope is pulled, meanwhile the back-up rope is lowered and the counterbalance lifts the stretcher from the feet. These movements need to be synchronized (the haul rope only maintains the tension and the load is mostly lifted by the counterbalance at the feet-end of the stretcher). The stretcher, now lifted from its feet, tilts from the vertical to the horizontal position using the pitch entrance as a pivot. **(fig. 4)**.
- As soon as the stretcher starts rotating, release the back-up rope from the mid-pit pulley and take up the slack.
- Continue pulling the haul and the back-up ropes and lifting the stretcher feet. Complete the manoeuvre with the stretcher comfortably landed **(fig. 5)**.



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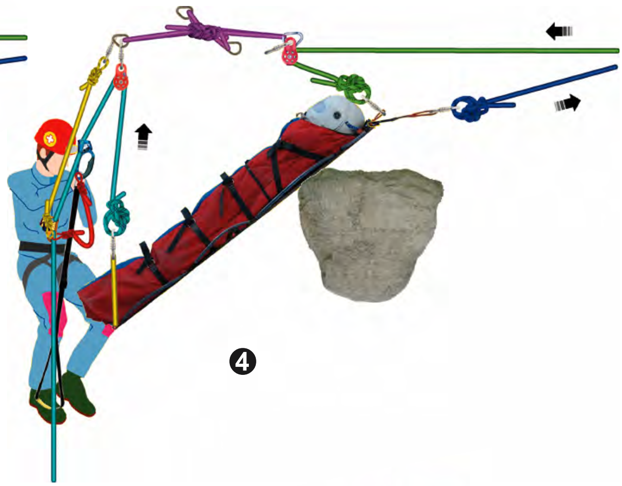

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❺

Warning ⚠

- When the stretcher is lifted up in a pitch, the back-up rope is pulled; its tangle with the haul rope may induce a stretcher rotation that should be contrasted by the stretcher-bearer.
- The stretcher-bearer lifts the stretcher in counterbalance with his/her cowstail clipped.
- The counterbalance should lift the stretcher at the same time when the haul rope is pulled, otherwise the stretcher can lose balance.
- Correctly connect the haul and the back-up ropes to the head-end of the stretcher prevents them to be crossed when exiting.
- The back-up rope should be disconnected from the pulley before it can interfere with the casualty head

Common mistakes ✖

- Wrongly connect the haul and back-up ropes to the head-end of the stretcher.
- Fail to pre-arrange the section of cord at the bottom of the pitch.
- Place the section of rope in a place that is hard to reach for the stretcher-bearer.
- The stretcher-bearer gets in the way of the stretcher because s/he stays above it.
- Wait to pull the back-up rope preventing the stretcher from being landed at the pitch entrance.
- Generate high diverging tensions in the haul and back-up ropes during the stretcher exit: the attachment points at the head-end of the stretcher could get damaged **(fig. 4**).

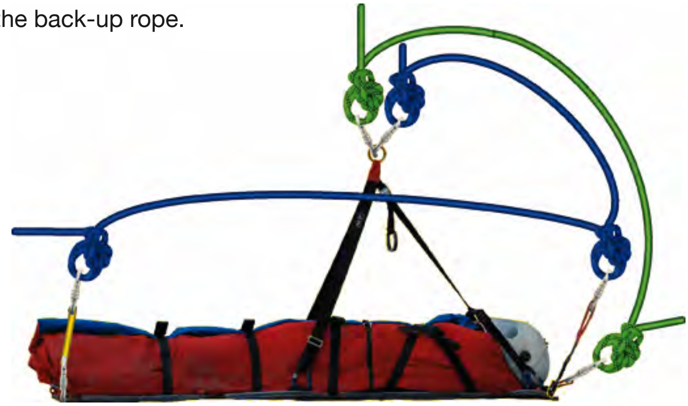
RISOLUTIVA WITH THE HAUL LINE CONNECTED AT THE FEET-END OF THE STRETCHER

Information

- This method allows to lift the feet-end of the stretcher directly with the haul rope. It is used when the balance man doesn't have enough working clearance at the pitch head.

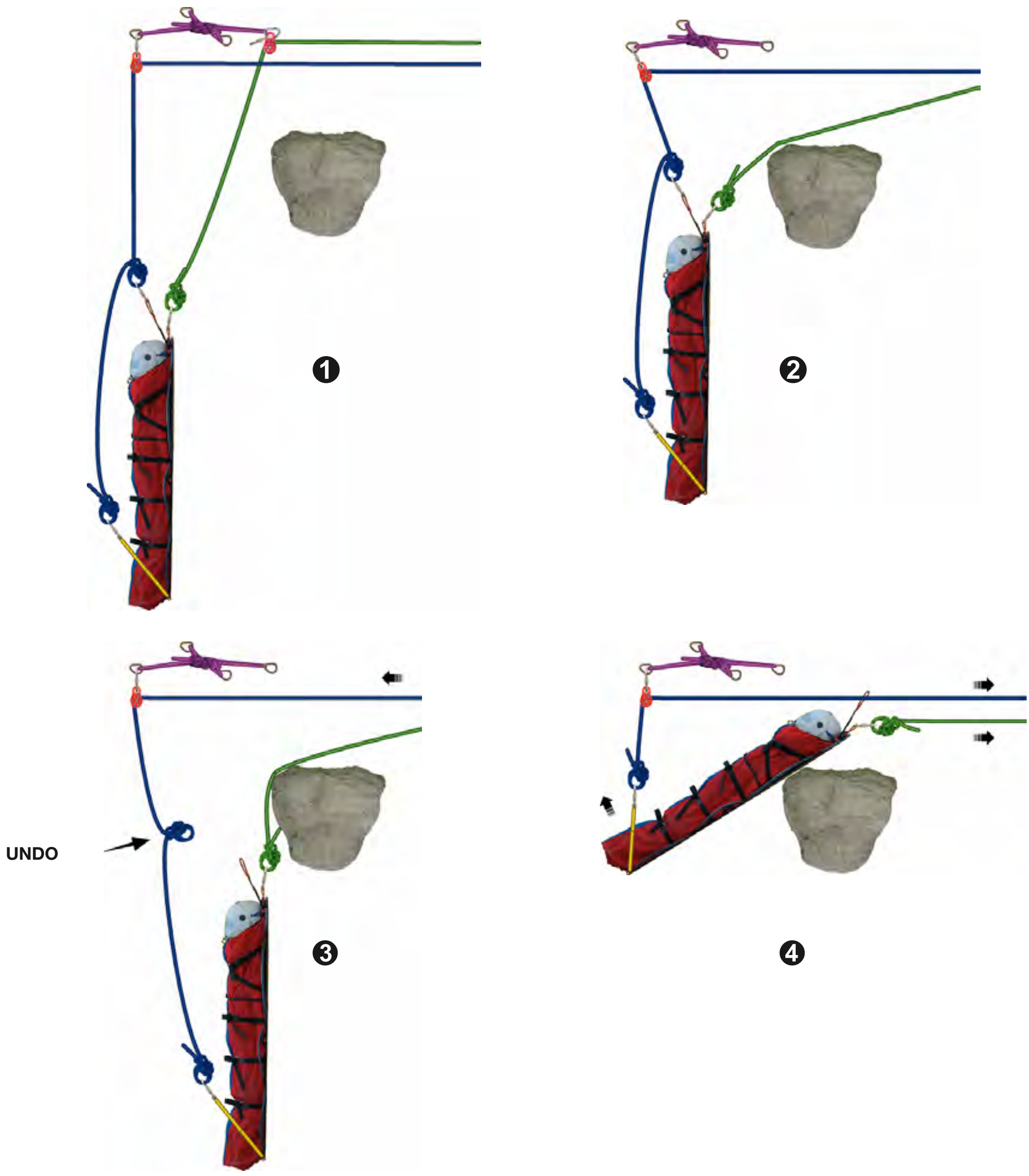
Stretcher binding

- Use a cord to pre-arrange an attachment point at the feet-end of the stretcher (you might also run a cord through the side handles at the feet-end of the stretcher).
- Connect the haul rope in the following sequence: link the rope end at the feet of the stretcher, then at the head of the stretcher (long attachment point) and finally at the lifting point.
- Build the attachment point at the head-end of the stretcher using an easy-to-release knot that is as short as possible.
- Standard connect the back-up rope.



Manoeuvre

- The stretcher is lifted in horizontal position as far as possible. The stretcher-bearer performs the vertical lift in due time, paying attention to undo the connection knots between the haul and back-up ropes and the lifting buckles.
- Continue lifting with the haul rope **(fig. 1)**.
- Before the head of the stretcher passes the pitch edge, release the back-up rope from its mid-pit pulley and put the rope under load **(fig. 2)**.
- Loose the haul rope to release it from the head of the stretcher and remember to undo the knot; take up the slack (the backside of the stretcher will approach the pitch entrance still hanging from the back-up rope) **(fig. 3)**.
- Coordinate the haul rope that lifts the stretcher from the feet with the back-up rope (the haul rope is only used to keep the tension and the load is mostly lifted by the back-up rope connected to the feet-end of the stretcher). The stretcher, now lifted from its feet, tilts from the vertical to the horizontal and uses the pitch entrance as pivot. **(fig. 4)**.
- The stretcher-bearer can contribute to the stretcher evacuation from below.



Warning ⚠ › Pull the haul and the back-up rope at the same time during the stretcher evacuation, otherwise the stretcher can lose balance.

Common mistakes ✖

› Forget to release the haul and back-up ropes from the lifting point and to undo their knots after the vertical tilt is concluded.

› Forget to undo the haul rope knot after releasing the rope from the head-end of the stretcher.

Photo Paolo Manca

The Scabar technique

Contents

To Fabio Scabar:

The end of the winter 2010 took Fabio away from us. We passed from hope to astonishment, and the truth is still hard to bear. The least that the National Cave Rescue School could do was dedicating a manoeuvre to Fabio, because his job, his memories and his presence will never cease to exist.
We had the chance to share a piece of our path with him and this still makes us feel proud.
Proud to be his friends and partners. Proud to have met such an humble and expert man. We decided to dedicate to Fabio one of the most delicate rescue techniques. This is our way to express our gratitude for a person that will stay forever in our hearts.

R.I.P. Fabio

BASIC CONCEPTS

Information

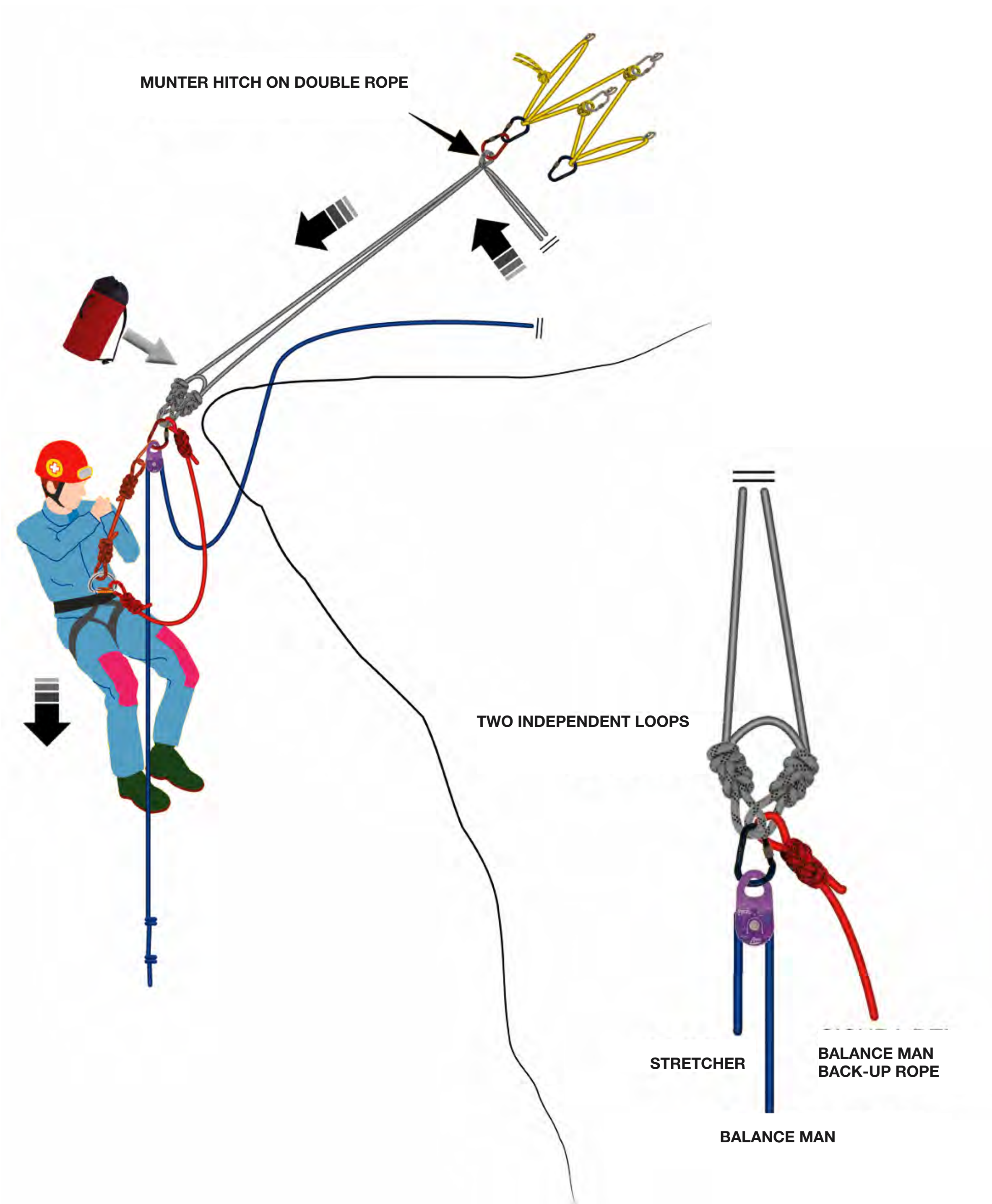
- This method is used whenever the mid-pit attachment point cannot be rigged above the pitch entrance (entry pitches, rock in bad conditions, distant walls or roof etc.).
- A counterbalance is built just below the pitch entrance to lift the stretcher.
- If the attachment point for the counterbalance pulley cannot be built right under the pitch entrance using natural anchors (i.e. the rock is brittle), an attachment point can be built from the back anchors ("remote attachment point") as hereafter described.
- Arrange a "remote attachment point" by placing a main attachment point backward with respect to the pitch entrance, where two independent sections of rope are connected using a Munter Hitch (tie the knot with both ropes as if they were twin ropes); do two independent loops at the opposite ends of both sections of rope; clip a HMS carabiner complete with the counterbalance pulley to these loops.
- The balance man clips both cowstails to the pulley carabiner and the loop and descends until reaching a position that minimizes the frictions.
- The balance man carries the lifting rope previously run through the pulley with him/her. One end of the above mentioned rope joins the stretcher, while the opposite end stays with the team at the main attachment point - it will be used for the evacuation. Once the balance man is in place, the Munter Hitch is locked against the attachment point with a locking loop.

Warning

- The balance man back-up rope is arranged by connecting a section of rope directly to the counterbalance attachment point.
- The counterbalance can be deviated right under the remote attachment point, if needed, to let the stretcher be lifted into the void.
- The balance man needs to get close to the wall with his/her body and the knees bent before he/she reaches the chosen counterbalance position to prevent the counterbalance pulley from staying too low.
- Bear in mind that the stretcher will be hanging from the counterbalance pulley once the remote attachment point is built. The counterbalance pulley will therefore further drop after the stretcher gets hung.
- Use a bag as a protection to limit any damage in the remote attachment point ropes against particularly abrasive corners.

Common mistakes

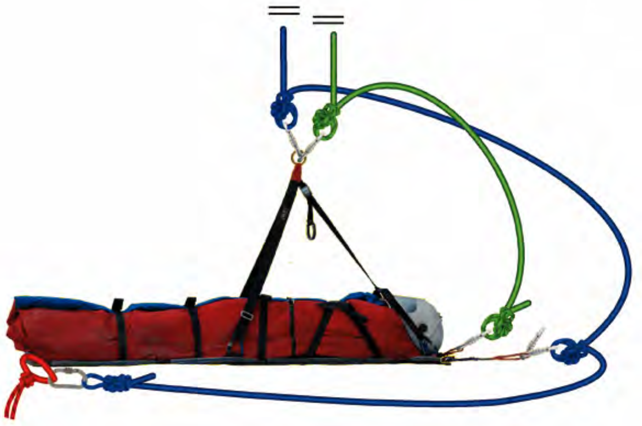
- The counterbalance pulley is excessively lowered and as a result the stretcher stays too low in the conclusive stage, forcing the team to perform supplementary manoeuvres for evacuating the stretcher.


MUNTER HITCH ON DOUBLE ROPE
TWO INDEPENDENT LOOPS
STRETCHER
BALANCE MAN
BACK-UP ROPE
BALANCE MAN

CONNECTING THE ROPES TO THE STRETCHER

Information

- Connect the lifting rope end to the feet-end of the stretcher (to the buckles or otherwise run a cord through both handles); run the rope through the backside of the stretcher and connect it to the long attachment point on the head-end of the stretcher and tie a double bowline.
- Standard connect the back-up rope.

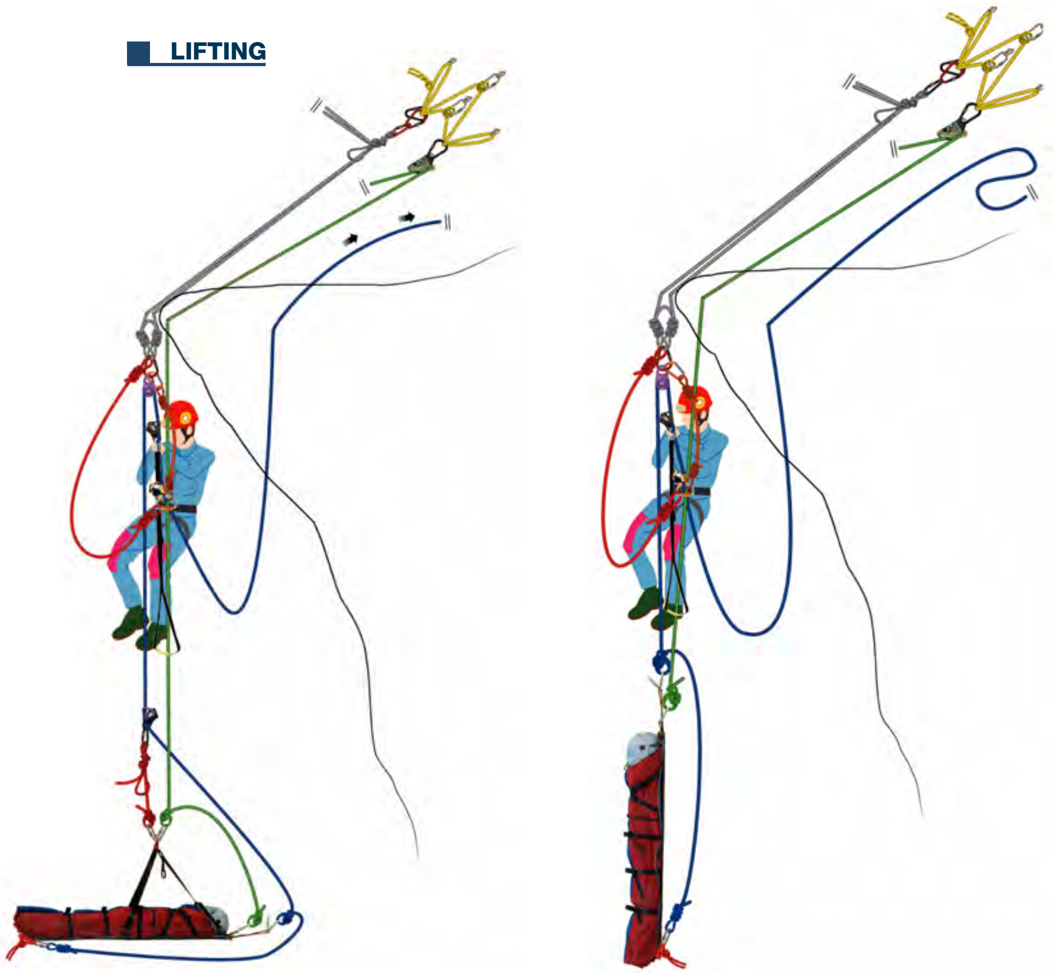


- In case of deep vertical pitches, the stretcher is lifted in horizontal position to be tilted in vertical only at the end.

- A supplementary carabiner is pre-arranged on the long attachment point in either case, to link the exiting haul rope.

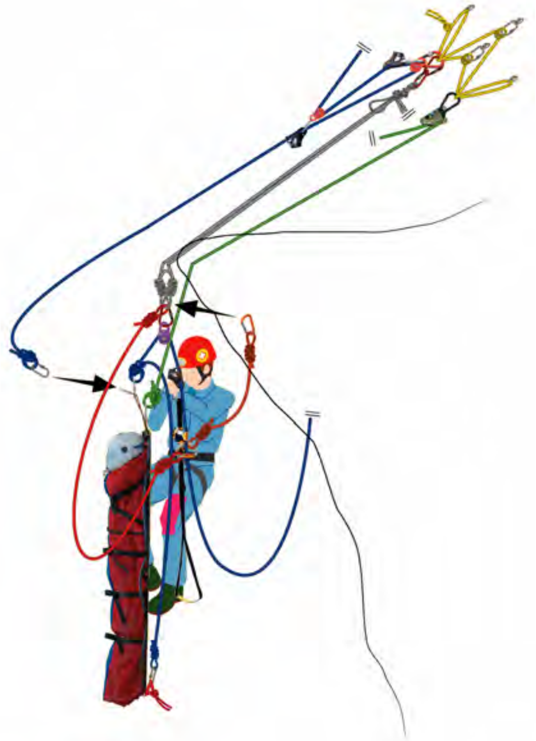
Photo Paolo Manca

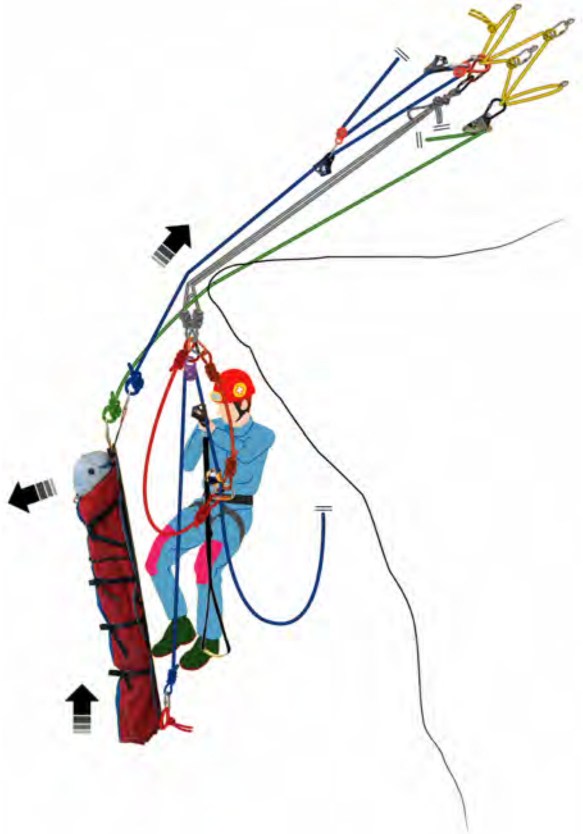
LIFTING



Information

- Bring the stretcher under the counterbalance pulley in vertical position.
- Lower a haul rope (exiting haul rope) from the main attachment point; this rope is pre-arranged with a z-rig (you can use the opposite end of the counterbalance or back-up rope). This rope is connected to the long attachment point at the head-end of the stretcher.
- The balance man - who is connected to the remote attachment point using an independent carabiner with respect to the carabiner connecting the pulley - reverses the counterbalance direction and takes the stretcher weight off the exiting haul rope.
- The balance man undoes the knot on the stretcher attachment point and pulls the counterbalance still hanging from the cowstail.
- The stretcher is lifted thanks to the coordinated action of the counterbalance (feet-end) and the haul rope (head-end). The counterbalance starts lifting the stretcher from the feet for a small stride, then the haul rope takes up the head-end of the stretcher, which gets closer to the wall. This procedure is repeated until the stretcher lifting point passes the pitch entrance.
- During the evacuation, the stretcher rotates by pivoting on the edge of the pit.
- A team member who's connected to a service rope should stand near the edge of the pit to assist in the stretcher evacuation.





Warning ⚠

- During the evacuation, the stretcher should be lifted only by the counterbalance at the feet so to prevent the plank to be excessively stressed.
- If you find the stretcher still stands too low after the counterbalance lift, you can install the pulley on an attachment point which is built with an autobloc knot on a kevlar cord tied on both sections of rope. Place this pulley higher and then continue with the counterbalance lift.

Common mistakes

- The balance man fails to clips his/her long cowstail when the stretcher starts exiting the pit.
- When binding the stretcher, fail to run the rope through the backside of the stretcher, with the consequent risk that the rope compresses the casualty.

Photo Paolo Manca

Rigging long vertical sections

Contents

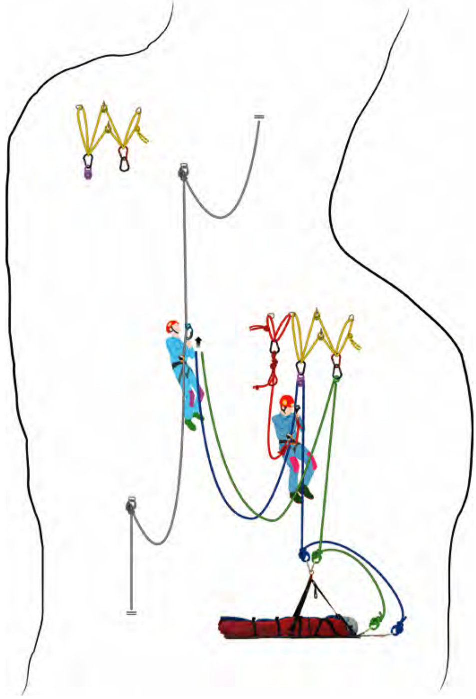
BASIC CONCEPTS

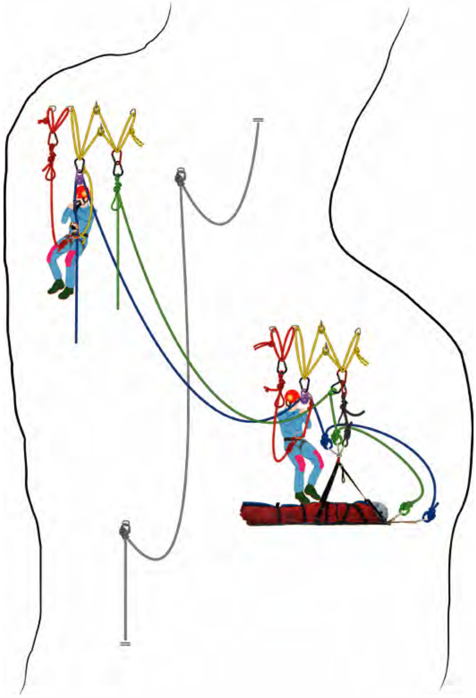
This method permits to lift or lower a stretcher on a long vertical section using only a pair of standard ropes (haul and back-up) and rigging multiple attachment points. The stretcher lifting or lowering is done by segmenting the vertical section in two or more halt areas (mid-pit attachment points) depending on the environment morphology and the ropes length. During the lift, a rescuer precedes the stretcher and brings the haul and back-up rope ends to the next halt area. This allows for a smooth and on-going lifting and avoids long waiting times at the intermediate halt areas.

LIFTING

Information

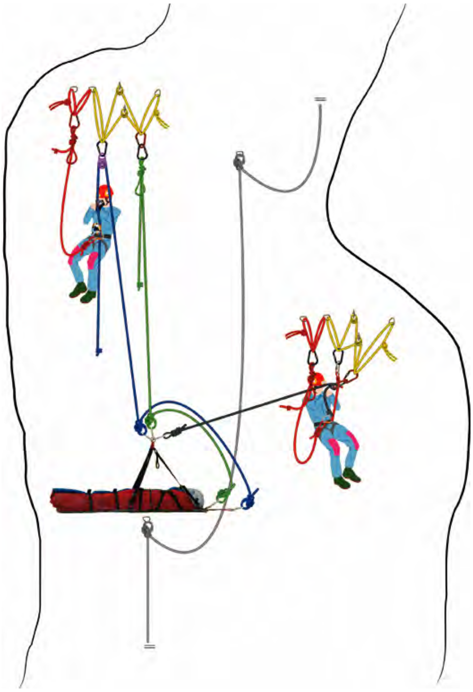
- When the stretcher joins the halt, secure it by connecting a section of rope with a Blocked Munter Hitch tied on it.
- Meanwhile a "relay" team member runs the haul and back-up rope ends through the counterbalance pulley and through the back-up system in the upper halt area.
- Disconnect the back-up rope from the lower attachment point and take up the slack from the upper halt area.

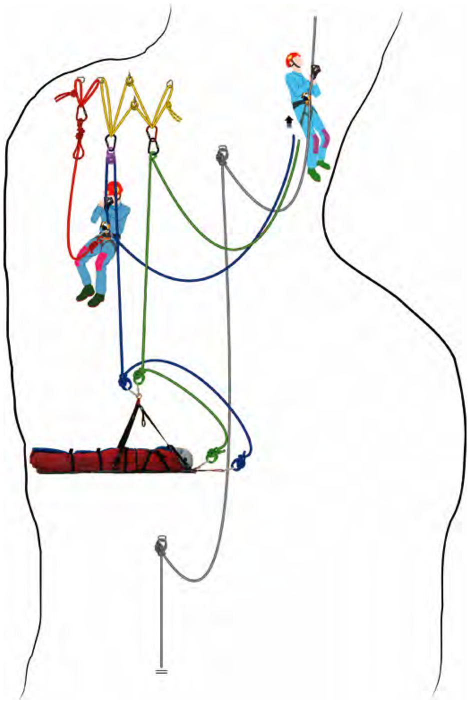




- Reverse the counterbalance direction and transfer the stretcher weight on the section of rope.
- Remove the stretcher from the counterbalance - now unloaded -and take up the slack from the upper halt area.
- Build a certain number of halt areas along the pitch (mid-pit attachment points intended for the haul and back-up ropes) depending on the environment morphology and the length of the shorter rope.
- Continue lifting the stretcher on a counterbalance.
- As the stretcher is lifted, a "relay" team member brings the haul and back-up rope end to the next halt area (ascending on the service rope).

- As soon as the stretcher is lifted from the upper halt area, release the safety section of rope and gradually transfer your weight on the haul rope.
- Repeat this manoeuvre in the following halt areas until reaching the pitch head.





Warning

- A balance man and back-up rope man stand at each halt area (omitted in the drawing).
- The relay cannot be considered if a stones fall hazard is present, this method can be employed only if it is possible to protect the stretcher.
- The distance between two halt areas cannot exceed the ropes length.
- It is generally one rigging team only to be in charge of rigging the halt areas.
- As soon as the stretcher starts being lifted, it can stay in the halt areas only for the time needed to release the safety section of rope.
- The relay team member climbing up with the ropes end should tie the usual knots in order to distinct the haul rope from the back-up rope.

Common mistakes

- Bring the haul and back-up ropes to the next halt area only after the stretcher joins the area where the lifting has been performed: the ropes go down the pitch and tangle up.
- Start lifting the stretcher before the halt areas have been rigged: the stretcher and the halt area team stay hung until the next halt areas are ready.
- Mix up the haul and the back-up rope from one halt area to the next one.

LOWERING

If you need to lower the stretcher, proceed as follows:

- Pre-arrange a section of rope with one end linked to the stretcher lifting point and coiled in an easy-to-reach position for the stretcher-bearer use.
- Lower the stretcher to the previous halt area.
- The stretcher-bearer throws the safety section of rope to the team member standing at the next halt area, who pulls the rope using a Munter Hitch as far as possible and locks it with a Blocked Munter Hitch.
- Lower the stretcher until its weight rests on the section of rope.
- Feed the back-up rope in the upper attachment point and build a Blocked Munter Hitch on the back-up attachment point standing downward.
- Feed the lowering rope until there is enough slack to pass it through a descender clipped on the downward attachment point and fully-locked.
- Release the section of rope until the stretcher weight rests again on the lowering and back-up rope in the lower halt area.
- Release the haul and back-up rope and resume lowering.
- Remove the ropes from the upper halt area and bring their ends down and leave them to a descending team-member as the stretcher is lowered to the previous halt area.


Photo Giuseppe Antonini

Photo Paolo Manca

Deviating a tyrolean traverse line

Contents

BASIC CONCEPTS

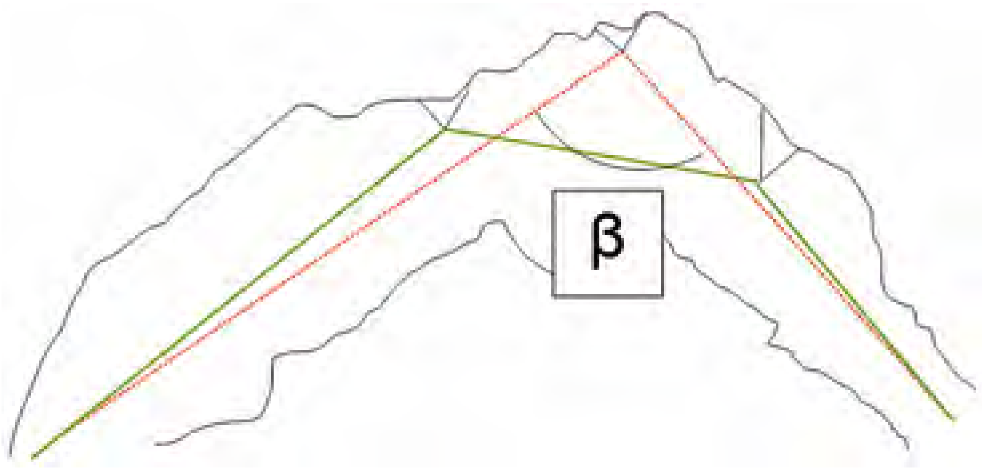
Deviating a tyrolean traverse line can be required for bypassing an obstacle or changing direction - both on the horizontal and on the vertical plane.

Information

- For deviating a load-bearing rope, you need to carefully consider the rope trajectory and the deviation angle. The greater the angle between two deviated sections of load-bearing rope is, the lower the force applied on the deviation will be.
- A load-bearing rope deviation is considered as a main deviation, meaning that at least four anchors are necessary to build two attachment points.
- It is advisable to connect the deviation attachment point to the load-bearing rope using a pulley: this way the friction generated when the rope is pulled is minimized. If there are no pulleys available, two carabiners can be used.

Warning

- The more the deviation angle (angle β) is acute and the more it will be difficult to pass it. It is preferable rigging the deviation so to have the greater angle possible, eventually using a second deviation where needed.



Common mistakes

- Narrow angles, with the consequent risk of slow and difficult passages.
- Pull the tyrolean by running the load-bearing rope on more deviations which have narrow angles and no pulleys: the generated frictions make impossible to pull the rope as needed.
- Build tyrolean lines and deviations before considering any faster and/or easier alternatives.

PASSING A DEVIATION

There are several methods to pass a deviation on a tyrolean line based on the deviation angle and the cave morphology. The rescuer needs an extra pulley complete with carabiner and a cord. Tie the binding knots between the haul and back-up ropes and the stretcher limiting the loops size as far as possible.

Push - Pull

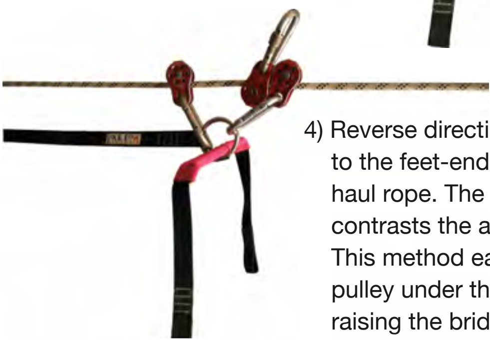
Information

- This is a very fast method to use whenever you need to pass wide deviation angles. The deviation is passed by clipping and unclipping the pulleys to the stretcher in sequence thanks to a third pulley.
- The figures show in detail the pulleys position and the movements allowing to pass the anchored deviation. How the lifting ropes are connected and how the stretcher is secured during the manoeuvre is illustrated below:

1) Take the upper pulley up against the anchored deviation.

2) Continue pulling the rope until the anchored deviation makes the bridle ring raise and get closer to the load-bearing rope by counteracting the haul rope action.

3) Install the third pulley above the anchored deviation.



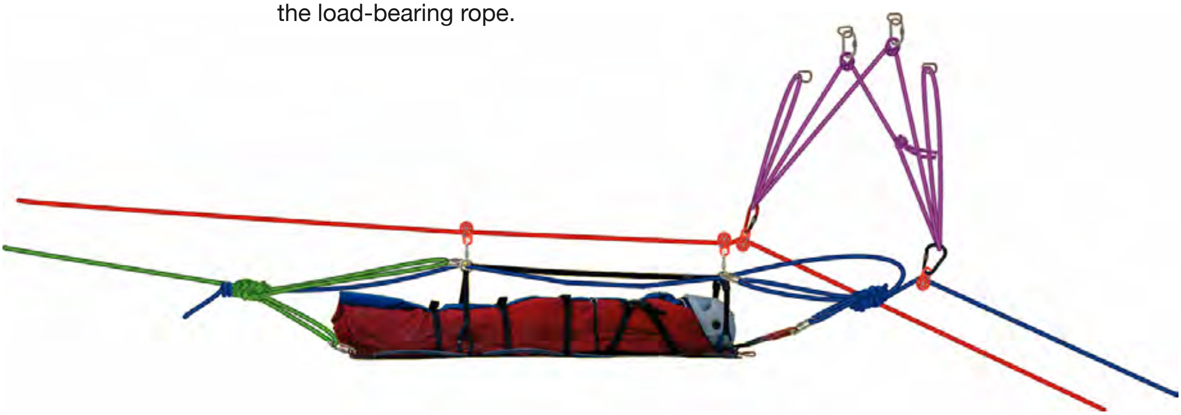
4) Reverse direction and pull the rope clipped to the feet-end of the stretcher; slacken the haul rope. The recently installed pulley contrasts the anchored deviation pulley. This method eases the release of the pulley under the anchored deviation by raising the bridles, which get closer to the load-bearing rope.

5) Continue pulling the haul rope and repeat the above steps with the following pulleys.

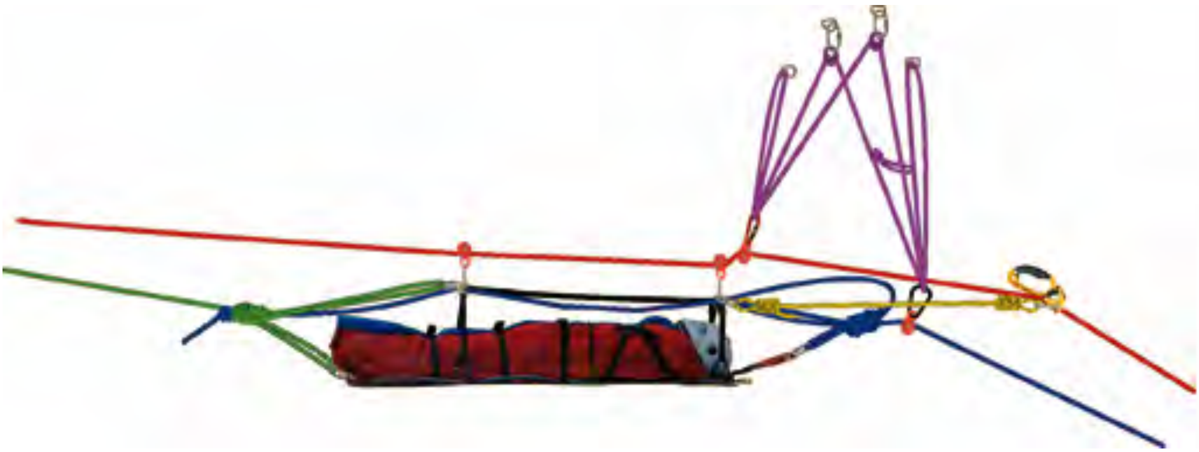
Ropes connection and stretcher protection

During the manoeuvre, the haul and the back-up ropes are necessarily deviated so to run parallel to the load-bearing rope. A cowstail simplifies the manoeuvre implementation, making the anchored deviations' length and location less crucial with respect to the load-bearing or haul/back-up ropes. Follow the following steps to guarantee the stretcher safety when passing an anchored deviation:

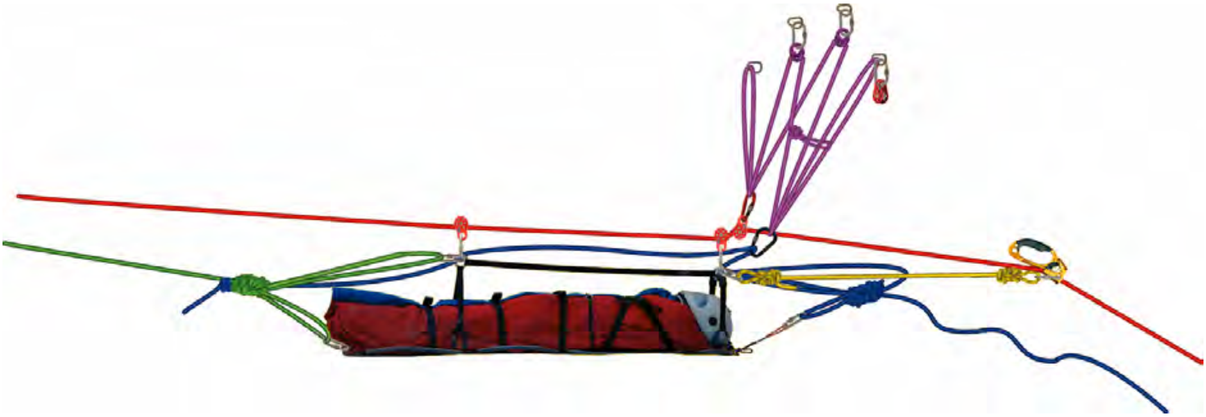
1) Take the stretcher up against - or as close as possible to - the anchored deviation on the load-bearing rope.



2) Bind the stretcher to the load-bearing rope with a fixed cowstail and an ascender - run a rope through the ascender twin holes. This will prevent the stretcher from sliding down the load-bearing rope when the haul rope is slackened.



3) Use a carabiner to clip the haul rope deviation to the section of rope going from on bridle ring to the other, then unclip the carabiner (or the pulley) that deviates the haul rope. The manoeuvre is easier to do if the haul rope is slackened. Use the push-pull method to pass the deviation.



4) Resume pulling, remove the fixed cowstail and repeat the push-pull method on the following pulley.

5) After the anchored deviation is passed to the load-bearing rope, restore the pulley on the back-up rope. The pulley should be installed on the back-up rope before removing the carabiner from the section of rope going from one bridle ring to the other.

6) Continue pulling.

Warning

- It is crucial to communicate with the team members standing at the two ends of the tyrolean line.
- Make sure the stretcher is correctly connected to the haul and back-up ropes; it is a good idea to leave the binding knot to one end of the stretcher (Gandalf knot backed-up with a bunny knot tied at the feed-end or at the head-end of the stretcher).
- Make sure that the rope braid connecting the haul to the back-up rope runs through the bridle rings and not in the pulleys carabiners.
- Make sure you have a third pulley for the push-pull method.
- Make sure you have a section of rope tied with a blocking or an auto-block knot to keep the stretcher in position during the first part of the push-pull.

Common mistakes

- Neglect to consider the load-bearing deviation as a main deviation.
- Tie the binding knot between the haul and the back up rope in the section of rope going from one bridle ring to the other.
- Not have a standing cowstail available.
- Not have the third pulley available, which is needed to complete the push-pull manoeuvre.
- Fail to clip the carabiner to the section of rope going from one bridle ring to the other.
- Forget to restore the deviation on the back-up rope.
- Use carabiners with screw-lock on the pulleys.
- Be unable to communicate to the team-members standing at the deviation and at the main attachment points.

Counterbalance on footloop

This method permits to cope with difficult situations such as particularly narrow angles, little operating clearance and/or no possibilities to stand on the floor. It can be implemented in every situation. It can be autonomously performed and a secondary section of rope is needed. The manoeuvre includes raising the stretcher by means of a counterbalance built on a section of rope with the purpose of relieving the weight from the load-bearing rope and allow for the pulleys change and passing the deviation.

Setting-up

Information

› Previously run a cord around the stretcher, under the plank and through the carabiners on the bridles attachment points. This will prevent the cord from slipping at the stretcher ends.

Lock the section of rope by maintaining the knot below the bridle ring.
Run the other end of the cord through an extra carabiner, which is linked to the deviation parallel attachment point.

Photo Antonino Bileddo

Sequence:

1) Take the stretcher up against the load-bearing rope deviation. Previously wrap a cord around the stretcher, under the plank and through the carabiners on the bridles attachment points. Then run the cord through an extra carabiner which is clipped to the deviation attachment point.

2) Raise the stretcher with the counterbalance until unloading the pulleys against the deviation (load the counterbalance on the footloop and if necessary run it through the chest ascender). Install a pulley above the deviation and clip it to the bridle ring.

3) Remove the downstream pulley, remove the counterbalance and repeat these steps on the following pulley.

Warning

- The knot tied on the counterbalance rope should stay as close as possible to the stretcher and below the bridle ring.
- The cord doesn't have to compress the causalty's head or sides.
- You need to install the pulley above the deviation before removing the pulley under the deviation.
- Remember to restore the deviation also on the haul/back-up rope.
- Counterbalance the stretcher once to install the pulley before the deviation and once more to remove the pulley after the deviation.

Common mistakes

- Fail to run the counterbalance cord through the connection carabiners, with the risk to have to cord slipping under the stretcher's plank.
- Remove the downstream pulley before installing the upstream pulley, leaving all the weight loaded to the counterbalance section of rope.

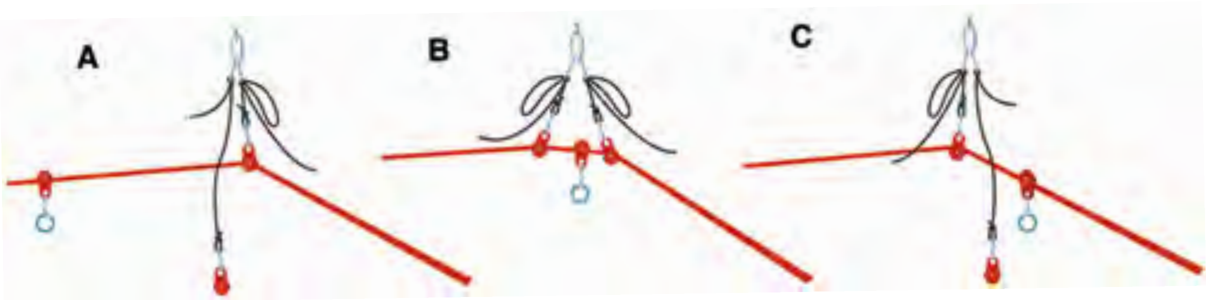
Releasable deviations

This method has been shown useful whenever the load-bearing rope is allowed to loose tensioning (i.e. there is enough operating clearance or the load-bearing rope is built with a counterbalance and it can be re-tensioned).

Information Here the load-bearing rope deviations can be released. As the stretcher passes, it is the deviation to be removed instead of the pulley. A parallel deviation is built on the same attachment point and it will replace the previous deviation as the stretcher passes.

Proceed in the following sequence:

1. Take the stretcher's pulley up against the deviation.
2. Clip the parallel deviation (after the stretcher's pulley), tension the deviation and lock it with a Blocked Munter Hitch.
3. Release the upstream deviation and remove it.
4. Repeat the above steps on the following pulley/s.
5. Once the stretcher has passed, restore the haul rope deviation and transfer it to the back-up rope.



The parallel deviation can be built with a 3:1 z-rig: pass a cord though the carabiners and lock with a Blocked Munter Hitch. This permits to tension the deviation and minimize the loss of tension on the load-bearing rope.

Warning

- Whenever a deviation is unclipped, the load-bearing rope loses tension mainly because of the lengthening of the deviation caused by the slide of the knot's full-lock. This loss of tension increases every time you pass a pulley: this can seriously compromise the tyrolean functions due to the change of trajectory.

Common mistakes

- Install more mobile deviations on the load-bearing rope.
- Fail to install the haul deviation in a higher position with respect to the tyrolean deviation: the stretcher pulley cannot join the deviation.
- Forget to restore the deviation on the back-up rope.
- Excessively slacken the deviation after the first pulley is passed, hindering the passing of the second pulley.

Photo Paolo Manca

Self-rescue: passing an handrail

Contents

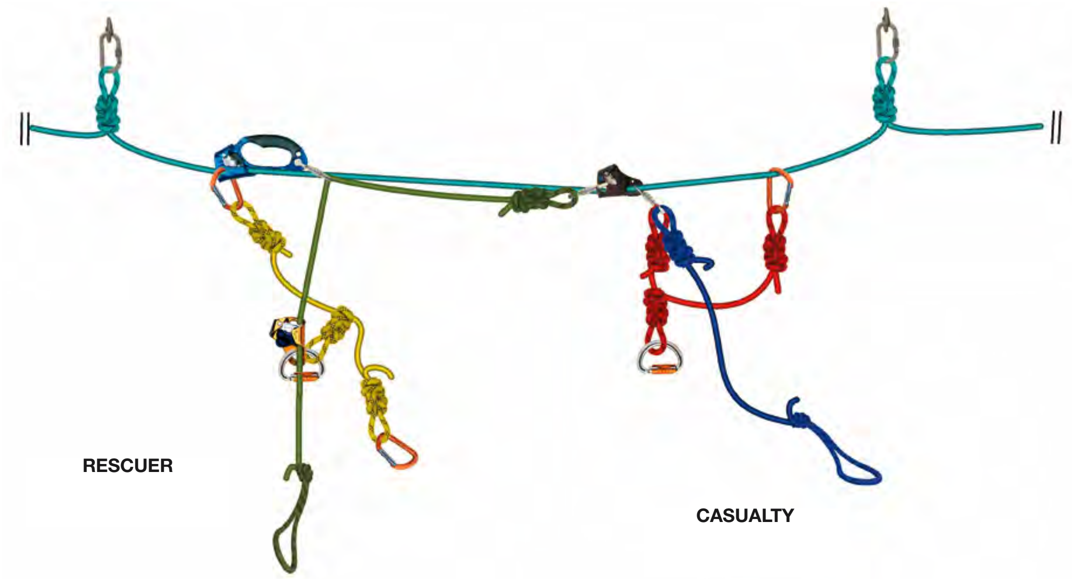
PROGRESSING ON AN HANDRAIL OR A TYROLEAN

Information This self-rescue technique is useful for evacuating a casualty from an horizontal progression on rope. It shows its efficiency with tyrolean lines and handrails, even if these are long and with several rebelays. Carefully consider which handrail end you want to use to evacuate the casualty and where there is more room for accommodating the casualty.

Preparing the haul system: the casualty

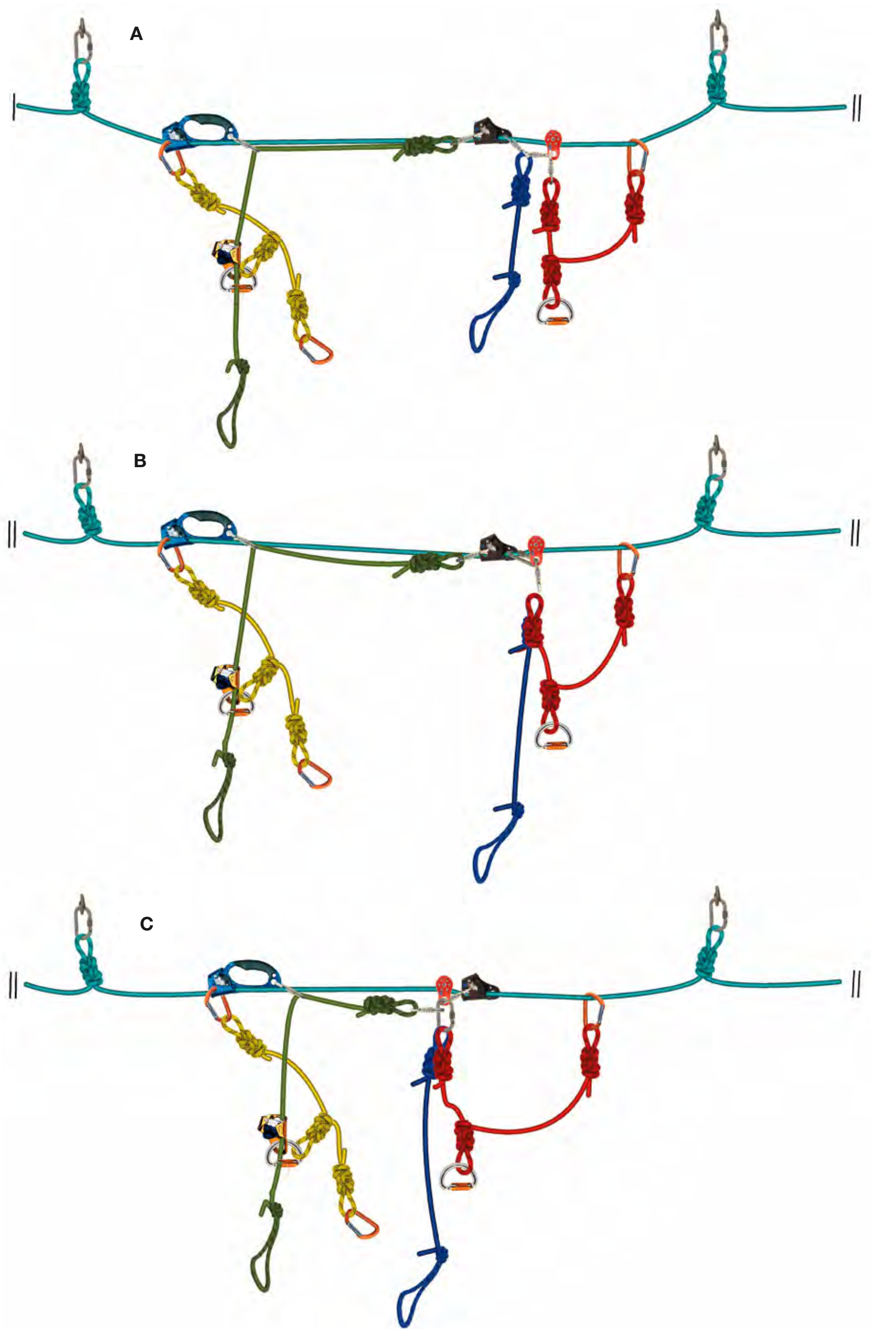
Information

- Secure the casualty to the handrail with a second cowstail.
- Unlock the casualty's travelling ascender from his/her long cowstail.
- Install the travelling ascender on the carabiner in the cowstail from where the casualty is hanging and clip it to the handrail rope, with the gate facing the exit direction (see the figure).



Warning

- As an alternative, if you have a pulley you can use one of the methods shown in Figures A, B or C; these are designed to ease the casualty haul on long strides.
- The solution C allows to bring the casualty as close as possible to the rebelay.



Warning ⚠ › If the casualty weight rests on the long cowstail, raise and clip him/her to the ascender with the short cowstail. Put a pendulum in place using the footloop to raise the casualty.

Preparing the haul system: the rescuer

- Run your travelling ascender on the handrail, with the gate facing the progression direction.
- Clip the long cowstail's carabiner to the ascender's twin holes without forgetting to trap also the handrail rope in it.
- Link your footloop to the twin holes in the casualty's travelling ascender using a carabiner.
- Run the footloop through a carabiner serving as a pulley: the latter is to be linked to the lower hole in your ascender trapping also the handrail rope in it.
- If rebelays are placed at short distance on the handrail, it is more convenient to directly use these rebelays for counterbalancing (see the next paragraph).

Progression

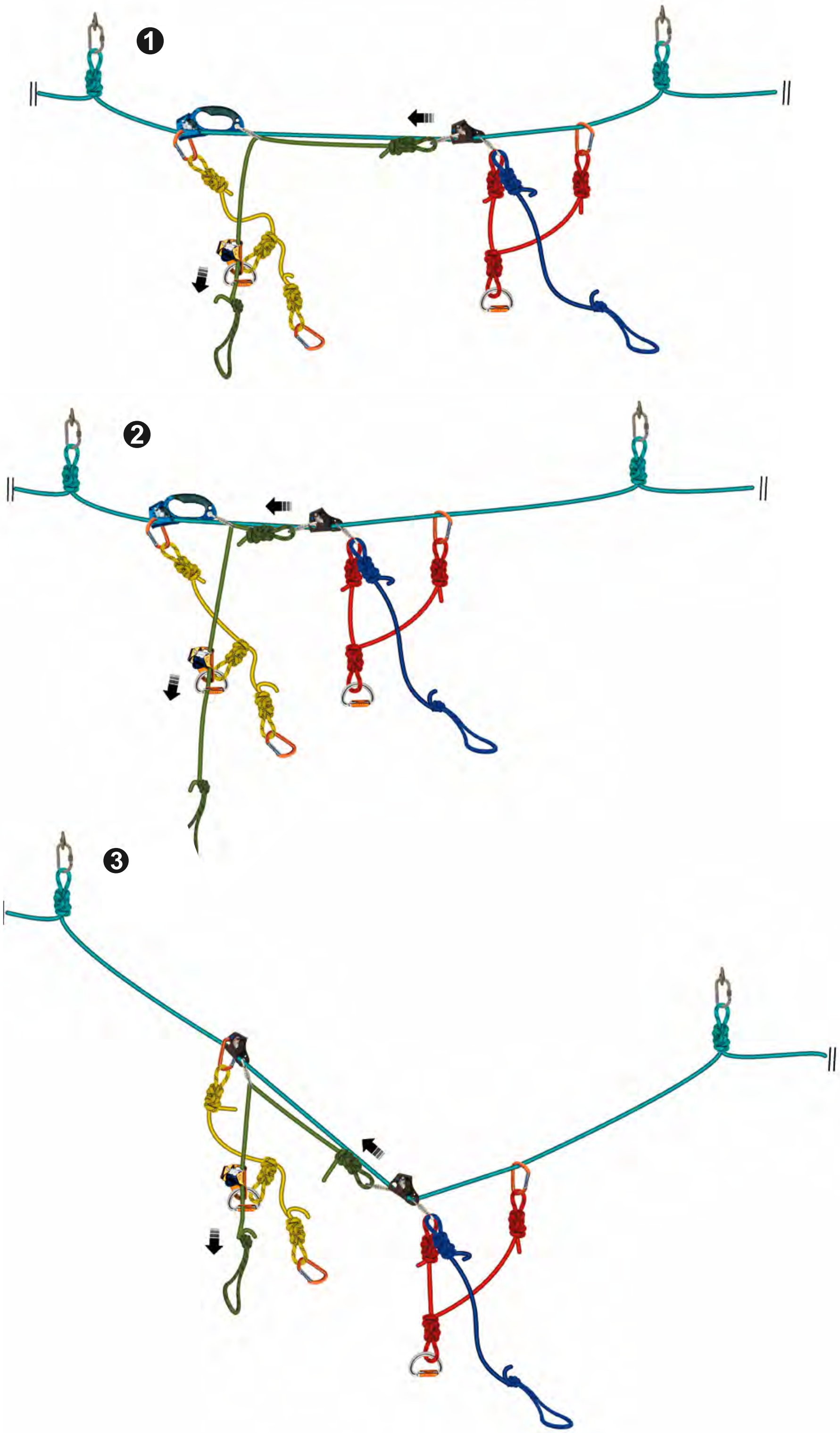
- Run the footloop into your chest ascender and counterbalance on it to make the casualty progress; repeat until reaching the rebelay.
- If you are standing in the void, you need to unload your ascender to move it forward: in similar situations, you need to use the casualty's footloop to unload your own.

Warning

- For an increased safety, replace the carabiner clipped into you long cowstail (which is linked to the twin holes) with a carabiner with screw-lock.
- If the casualty's short cowstail is too long, shorten it (i.e. by clipping the carabiner in the cowstail to the harness maillon).
- Be careful not to have the knot in your footloop getting stuck under the chest ascender.
- If the footloop is too short, use a longer cord.
- If you are descending down a loose rope, tie an ABK braid knot.

Common mistakes

- Run the cowstail through the ascender (either yours or the casualty's) forgetting to pass also the rope in it: the rope might escape the ascender.
- Fit the counterbalance footloop directly onto the carabiner in the casualty's cowstail: here the cowstail carabiner can arrange itself diagonal to the rope generating high frictions.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3

PASSING A REBELAY ON A PENDULUM

Information

When you are at the rebelay, proceed as follows:

- Clip your short cowstail to the rebelay.
- Install your ascender in the next section of rope, using the same connection method previously discussed.

- Connect the casualty's long cowstail to the next section of rope.
- Clip a carabiner into the rebelay to use it as a pulley.
- Link a footloop directly to the casualty's maillon rapide and then move it on the pulley-carabiner in the rebelay.

› Link yourself to the footloop with a chest ascender, detach the short cowstail from the rebelay and start the pendulum until the casualty's short cowstail is unloaded.

› Link the casualty's ascender and short cowstail to the next section, using the same connection method previously discussed.

› Reverse the pendulum direction and restore the footloop in order to use it for the progression in the next section of rope.

Warning ⚠ › Bring the casualty as close as possible to the attachment point before passing the rebelay.

Common mistakes › Disorderly implement the manoeuvre, crossing the cowstails and the footloops.

LIGHTWEIGHT ADVANCED TECHNIQUES

Introduction

Contents

BASIC CONCEPTS

Information

- This chapter introduces some methods that can be used whenever sparing equipment could be either necessary (partial or full loss of the riggers kit) or strategic (in-depth operations).
- They provide a level of safety and efficiency that is similar to those of standard methods only if they are implemented by a properly trained and experienced team.
- Their advantage is that they only require rope, cords, carabiners and pulleys to be implemented: pieces of equipment virtually easy to find in the riggers kit or even in in the personal equipment.
- Prefer the natural anchors for rigging.
- Ascenders can be replaced by autobloc knots or by the personal ascenders supplied to the rescue team.
- These methods can be put in place using a single rope.
- The illustrated techniques were selected according to efficiency and comfort-of-use criteria with respect to the cave rescue needs.
- Learning and practising these methods is important not only in view of an emergency situation, but also and foremost for acquiring more familiarity with the manoeuvres and learning how to cope with little material.
- They also form the starting point for further develop the rescue techniques and reduce the riggers kit weight.

Warning

- The proposed solutions shouldn't be regarded as the benchmark for a cave rescue but as a technical training to fix serious situations in critical conditions.
- They can be used only by experienced and tight teams.
- They require a constant check of the haul and lowering systems.
- They result in a delay in completing the passing of a knot, a changeover, a vertical/horizontal tilt, the passing of a deviation etc.
- It is the single rescuer to determine, based on his/her experience, when these methods can be safely employed using a single rope or if a second rope is to be added.
- If you are using a single rope and you foresee to load the stretcher weight on an autobloc knot (i.e. BAS), tie a mock end-of-the-rope knot before the ABK knot.

Common mistakes

- Implement these methods when it is not strictly necessary and without the team leader previous consent.
- Employ these techniques without mastering them with confidence and without considering the skills and experience of the rest of the team.


Photo Piero Palazzo

Vertical and horizontal tilt with emergency tools

Contents

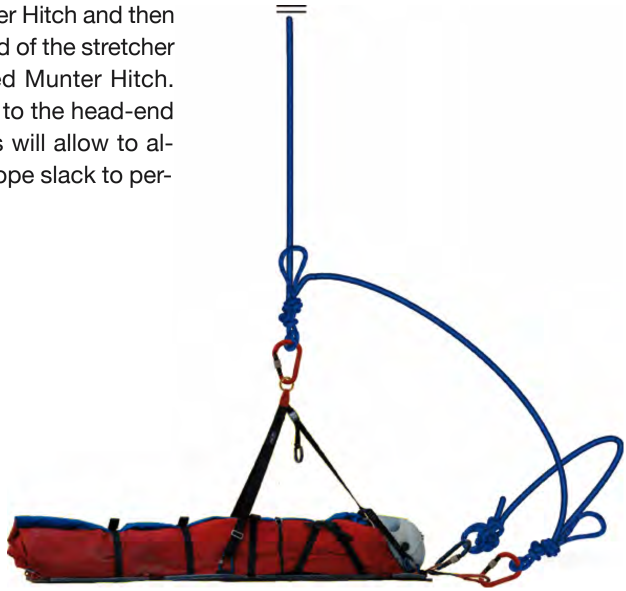
BASIC CONCEPTS

Information

- We introduce here some methods that allow for adjusting the stretcher trim with the exclusive use of emergency tools and a single rope.
- These are particularly useful when the stretcher is to be lifted in a pitch with one or more localized bottlenecks.
- The stretcher is normally lifted in pitches in horizontal positions, except for some special situations linked to the pitch morphology.
- Manoeuvres are performed by transferring the stretcher weight from the lifting rope to a BAS (using if necessary an ABK instead of an ascender) and vice versa.

Preparing the stretcher

- Tie the lifting rope into the lifting point with a Blocked Munter Hitch and then clip it to the head-end of the stretcher with another Blocked Munter Hitch. Fasten the rope end to the head-end of the stretcher. This will allow to always have enough rope slack to perform the tilt.



Warning

- Tilting the stretcher in vertical position is a manoeuvre that can be performed only with the previous consent of the doctor.
- Before start lifting the stretcher, incline it in vertical and fine-tune the buckles.
- If the pitch requiring a stretcher in vertical position is short, it is better to tilt the stretcher in vertical position right from the start, with the previous doctor consent.

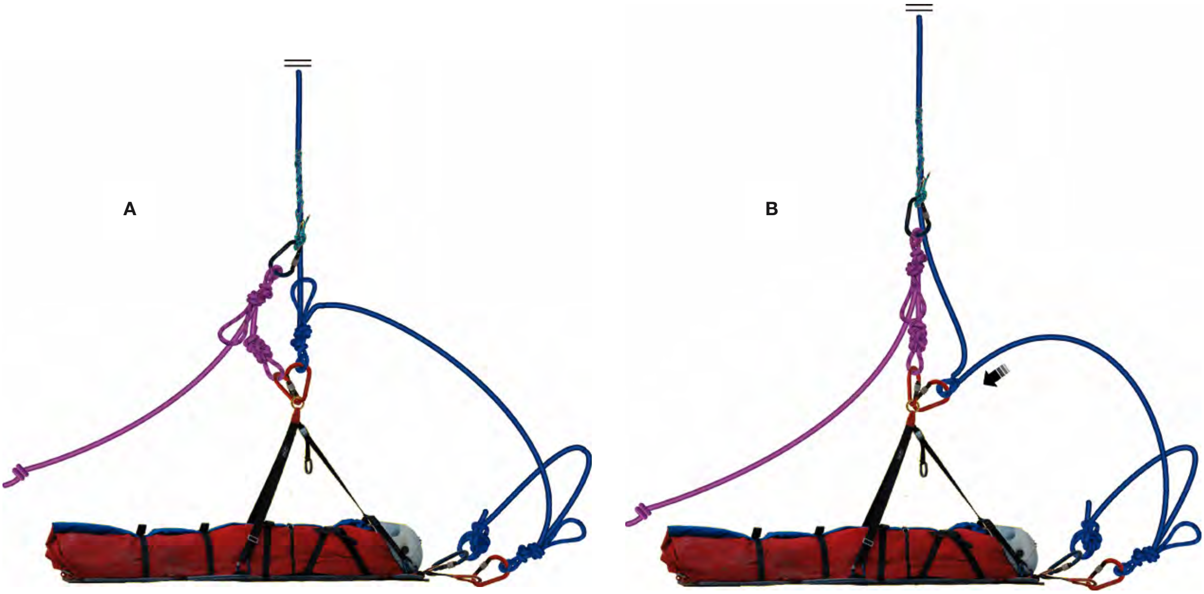
Common mistakes

- Fail to incline the stretcher in vertical position at the bottom of the pitch to check the buckles tightness.

VERTICAL TILT

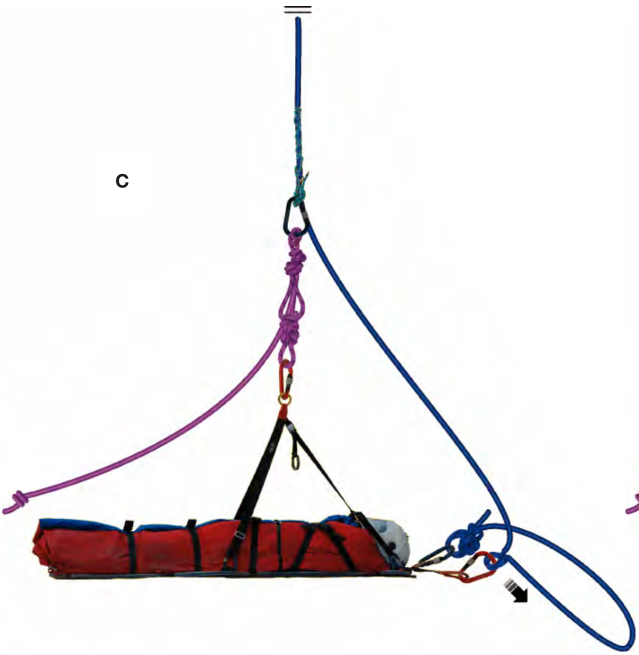
Information

- Stop lifting the stretcher.
- Clip a section of rope (10 meters min.) to the lifting point.
- Tie a Blocked Munter Hitch to connect the section of rope into a HMS carabiner with screw-lock which has been previously run through an ABK **(fig. A)**.
- Undo the Blocked Munter Hitch on the lifting rope to load the section of rope **(fig. B)**.



› Fully undo the Munter Hitch on the haul rope, release the Blocked Munter Hitch on the head-end of the stretcher and take up the slack to tension the rope going from the head-end to the lifting point **(fig. C)**.
› Again, lock the Munter Hitch at the head-end **(fig. D)**.

C



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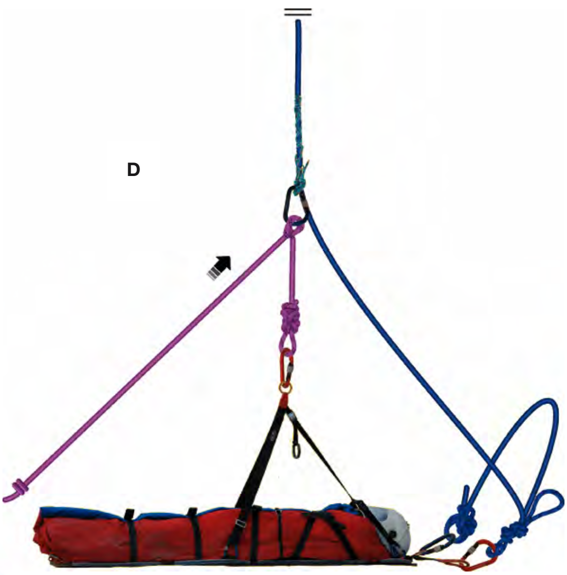


- Release the Blocked Munter Hitch and transfer the weight from the section of rope to the haul rope to tilt the stretcher in vertical **(fig. E)**.
- Resume lifting the stretcher until the bottleneck is passed.

E

Warning

- Because you are using a single rope, it is preferable not to start lifting the stretcher by the loaded section of rope on the ABK: if it hits the pitch wall it can accidentally slide.
- The vertical tilt results in the stretcher fall, be sure there is enough clearance.

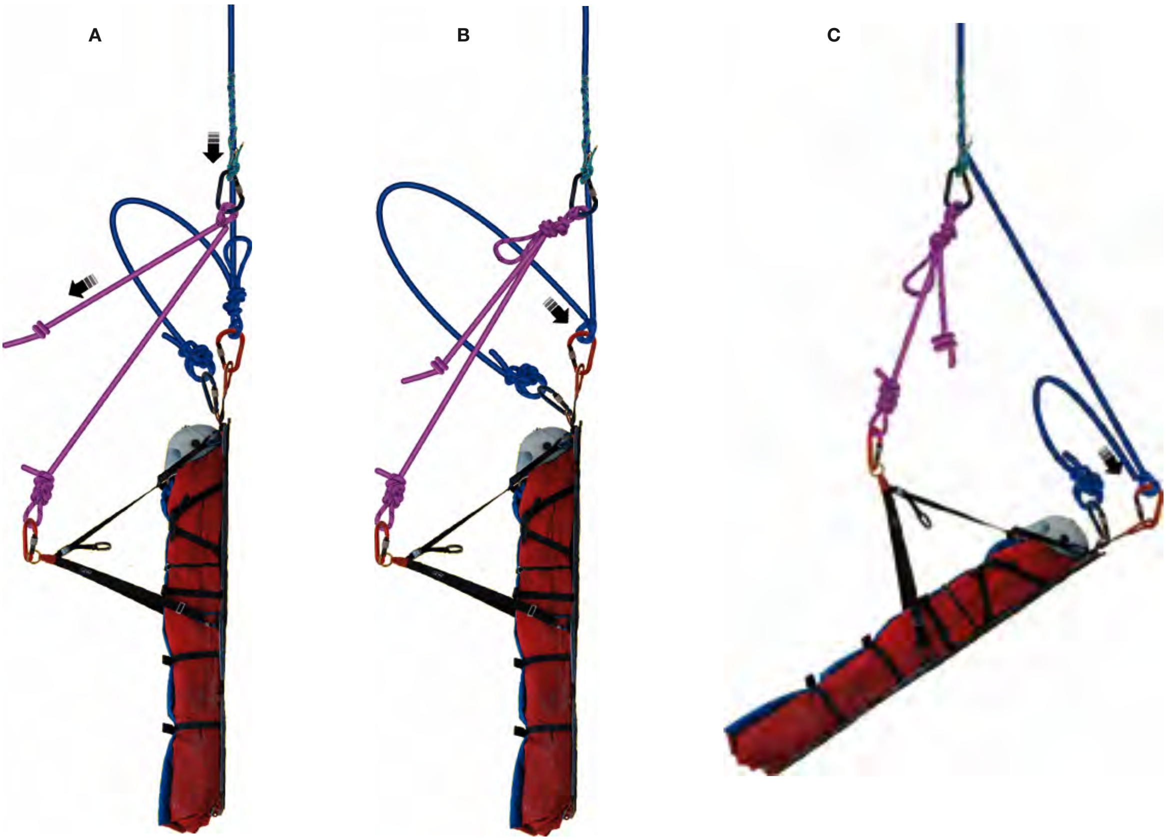
Common mistakes

- The section of rope is too short.
- Tie the Blocked Munter Hitch of the section of rope in the carabiner at the lifting point instead of tying it on the carabiner in the ascender.

HORIZONTAL TILT

Information

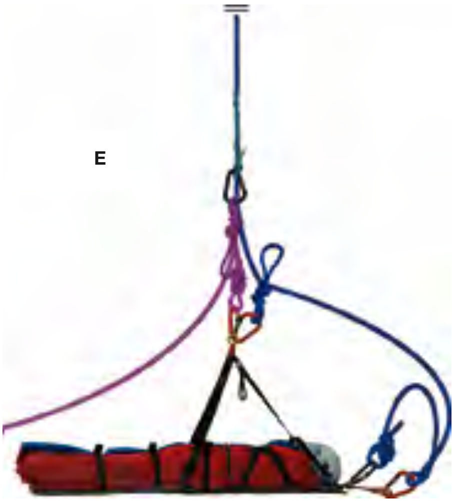
- Lower the ABK as much as possible and lift the Munter Hitch in the section of rope **(fig. A)**.
- Lock the section of rope with the Blocked Munter Hitch and lower the head-end of the stretcher by releasing the Munter Hitch in the haul rope **(fig. B and C)**.



› If you have enough rope, build a Blocked Munter Hitch on the lifting point **(fig. D and E)**.

D

E



› Block also the Blocked Munter Hitch at the head-end **(fig. F)**.
› Release the Blocked Munter Hitch in the section of rope until the stretcher weight rests on the haul rope.

F

G

Photo Paolo Manca

Passing the knot on a single rope

Contents

BASIC CONCEPTS

Information

- These methods are used whenever binding knots must be tied on the haul rope.
- For implementing this manoeuvre, it is necessary to temporary loose the rope in which the binding knot was tied; use a BAS to temporarily secure the stretcher.

Warning

- The connection between the BAS and the attachment point should be independent and bound to the sections of rope by means of two carabiners (these can be pre-arranged before starting the operations).
- The BAS can be built using the rescuers' personal equipment and the lifting rope end.
- The methods used for passing a knot on a single rope in descent are the same used for hauling.

Common mistakes

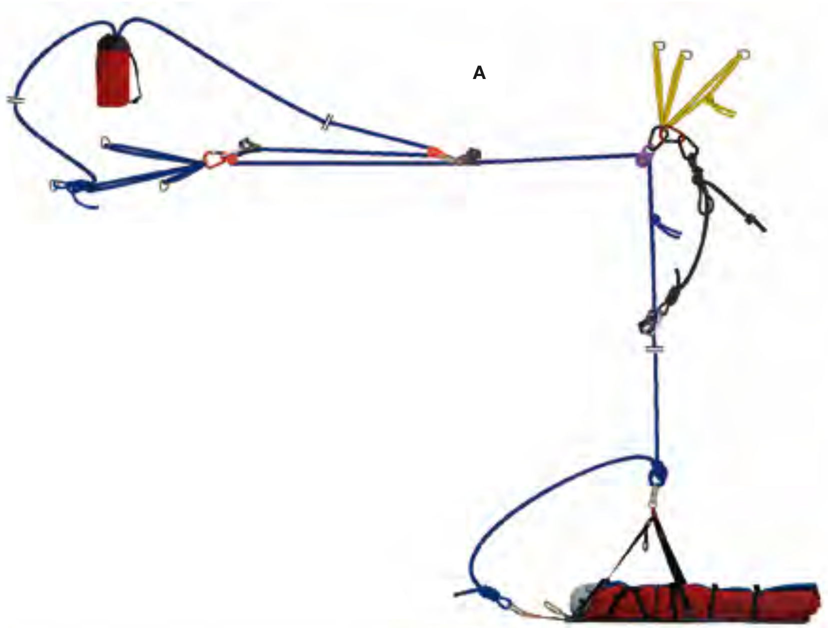
- Neglect to pre-arrange the extra tools necessary for performing this manoeuvre.

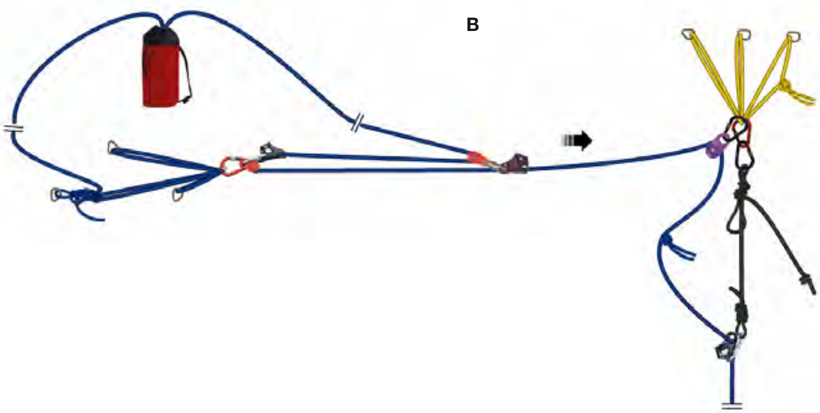
PASSING THE KNOT WITH A Z-RIG HAUL SYSTEM

In mid-pit deviation

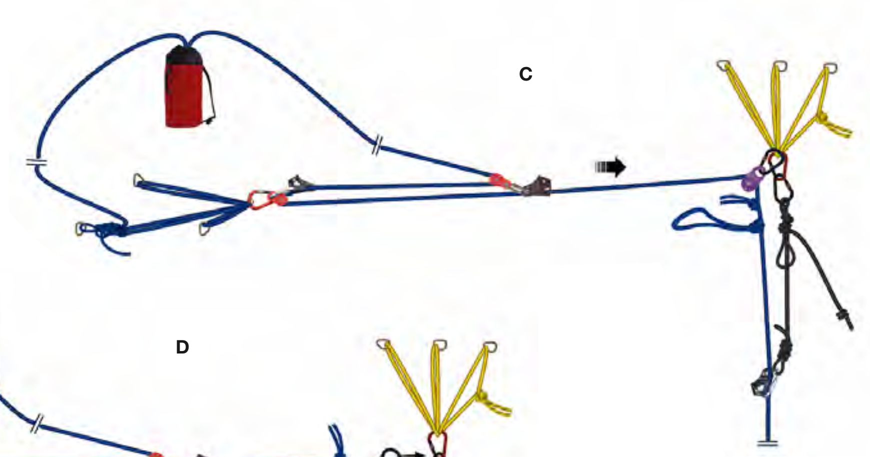
Information The manoeuvre includes temporarily hanging the stretcher from the BAS and a creating a sufficient slack in the rope to remove the pulley and pass the upstream knot.

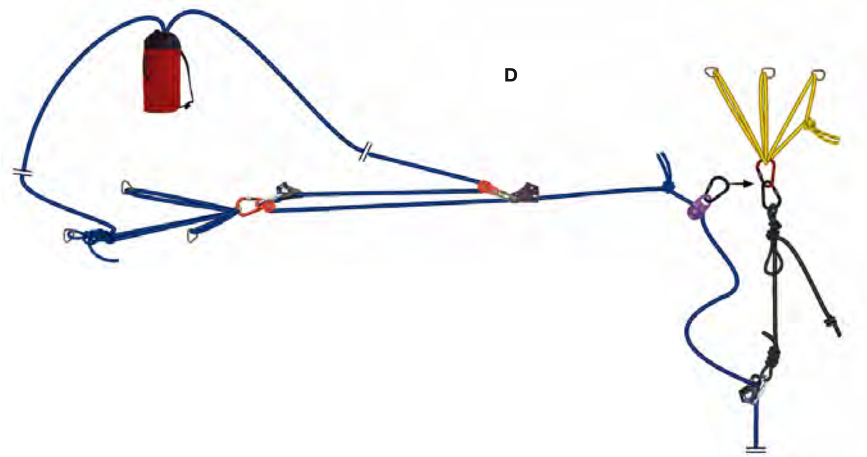
- Bring the knot few centimetres from the mid-pit pulley.
- Secure the haul rope by connecting the BAS to the mid-pit attachment point. Be sure that the binding or the ABK knot on the BAS is at least 1 meter down the knot **(fig. A)**.
- Lower the haul rope (short descents technique) until the BAS is loaded **(fig. B)**.





- Tie a shortening knot (flat overhand) between the binding knot and the ascender on the BAS, include also the the binding knot if necessary **(fig. C)**.
- Take up the haul rope so to have the knot a few centimetres away from the pulley while keeping the BAS under load by pushing it downward.
- Lower again the haul rope (short descents technique) until the BAS is loaded.





Warning ⚠

- Undo the shortening knot and use the slack of rope to remove the pulley and re-install it with the knot standing on the opposite side **(fig. D)**.
- Keep pulling the stretcher and remove the BAS.
- Building the shortening knot right from the start allows to save time to complete the manoeuvre.
- Embedding the binding knot within the shortening knot allows to have more rope available even when the space between ascender and knot is reduced.

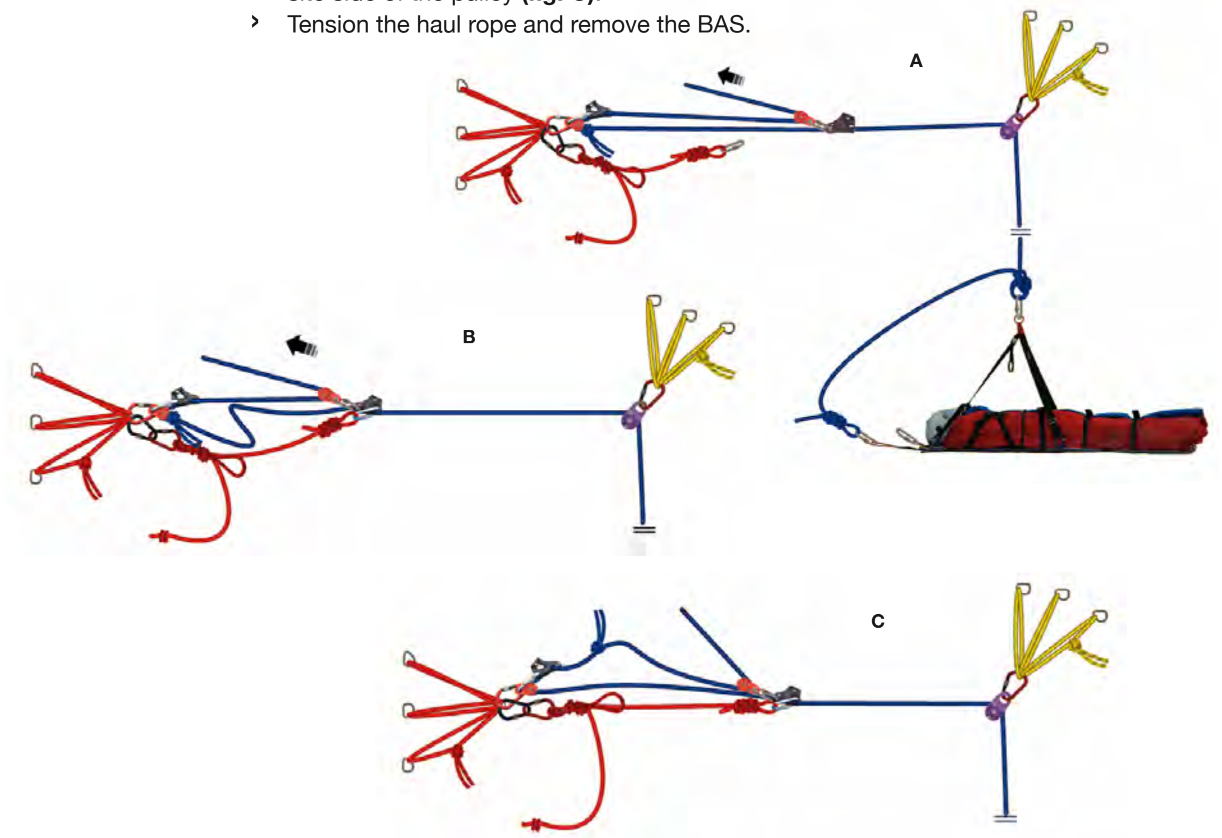
Common mistakes ✖

- Shortening the BAS' section of rope too much results in not having rope enough to pass the knot before the pulley.
- The BAS is clipped to the carabiner in the mid-pit pulley, hindering or preventing its opening.
- Run the BAS' ascender through the rope before it is clipped to the attachment point, with the risk that it slides to the rope end.

In the main attachment point

Information

- Bring the knot few centimetres from the z-rig anchored part.
- Connect the Blocked Munter Hitch of the BAS to the attachment point **(fig. A)**.
- Place the z-rig travelling part so that its distance from the cord end of the BAS allows for the sufficient slack to run the knot past the pulley. Don't place the travelling part too far from the BAS' cord to let the rest of the team continue lifting the stretcher smoothly **(fig. A)**.
- 2:1 haul the z-rig and control the rope speed with your hand until you are able to clip the carabiner of the BAS to the z-rig travelling part **(fig. B)**.
- Now the z-rig anchored part is unloaded: remove it and pass the knot on the opposite side of the pulley **(fig. C)**.
- Tension the haul rope and remove the BAS.



Warning

- The BAS can be built using the rescuers' personal personal equipment and the haul/back-up rope end or a section of it.

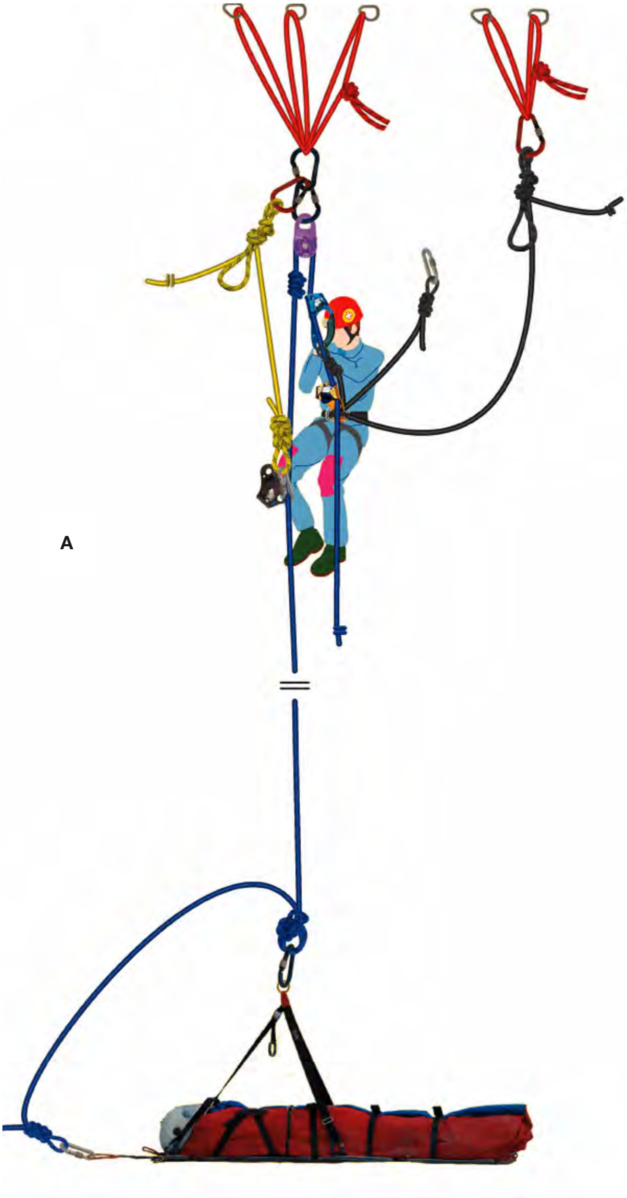
Common mistakes

- The BAS is clipped to the carabiner in the z-rig anchored part, hindering or preventing its opening.

PASSING THE KNOT WITH A COUNTERBALANCE Z-RIG

Information

- Bring the knot close to the counterbalance pulley.
- Secure the haul rope by linking the BAS to the counterbalance attachment point. Be sure that the ascender or the ABK knot on the BAS is at least 1 meter below the knot **(fig. A)**.



A

- Reverse the counterbalance direction to tension the BAS (the balance man needs to descend only for a small stride with the ascender) **(fig. B)**.
- Create a slack in the rope by continuing lowering with the ascenders so that a shortening knot (flat overhand) can be tied between the binding knot and the ascender on the BAS, include the binding knot itself if necessary **(fig. C)**.
- Lift in counterbalance until the binding knot joins the pulley **(fig. D)**.
- Push the BAS downward; reverse the counterbalance direction until the BAS is loaded.
- Undo the shortening knot and use the slack of rope to remove the pulley and re-install it with the knot standing on the opposite side **(fig. E)**.
- Keep pulling the stretcher and remove the BAS.

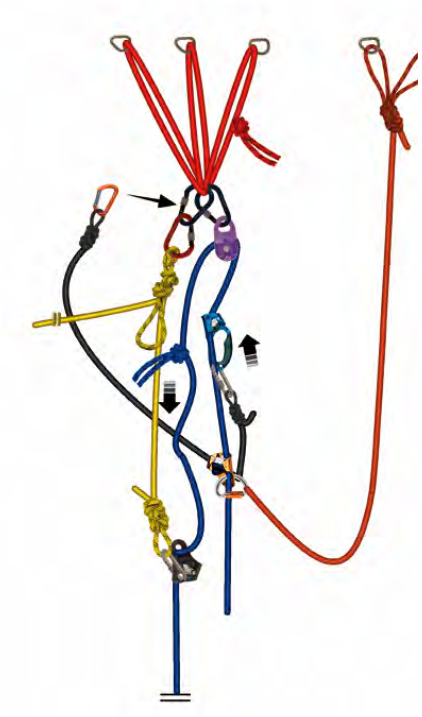
Warning

- Building the shortening knot right from the start allows to save time to complete the manoeuvre.
- Embedding the binding knot within the shortening knot allows to tie the knot even when the space between ascender and knot is reduced.

Common mistakes

- Shortening the BAS' section of rope too much results in not having enough rope to pass the knot before the pulley.
- The BAS is clipped to the carabiner in the mid-pit pulley, hindering or preventing its opening.
- Run the BAS' ascender through the rope before it is clipped to the attachment point, with the risk that it slides to the rope end.

B



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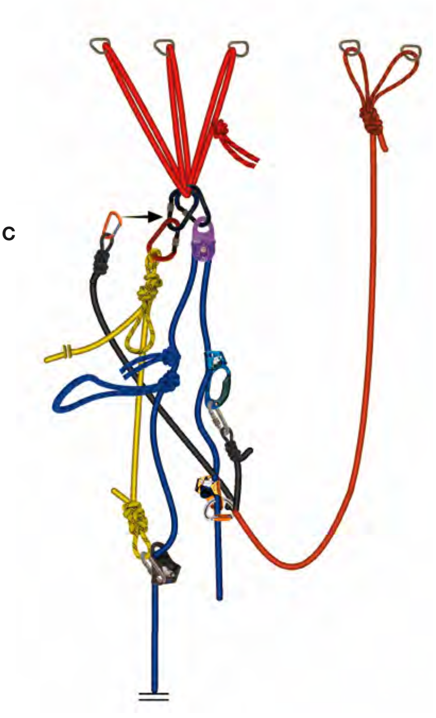

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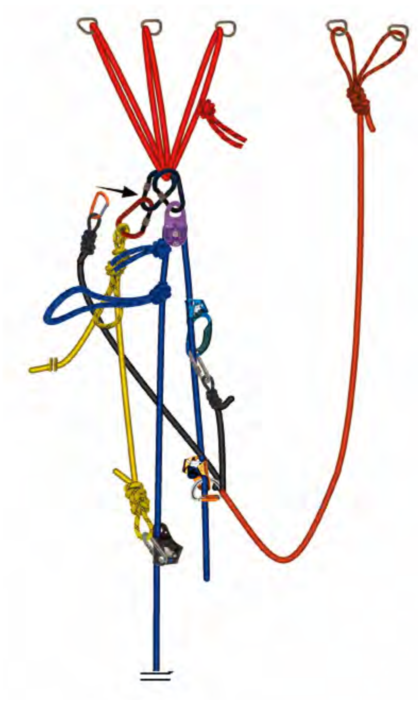

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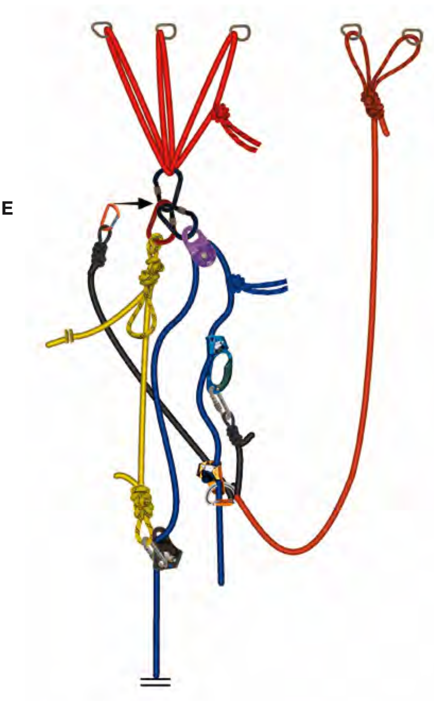
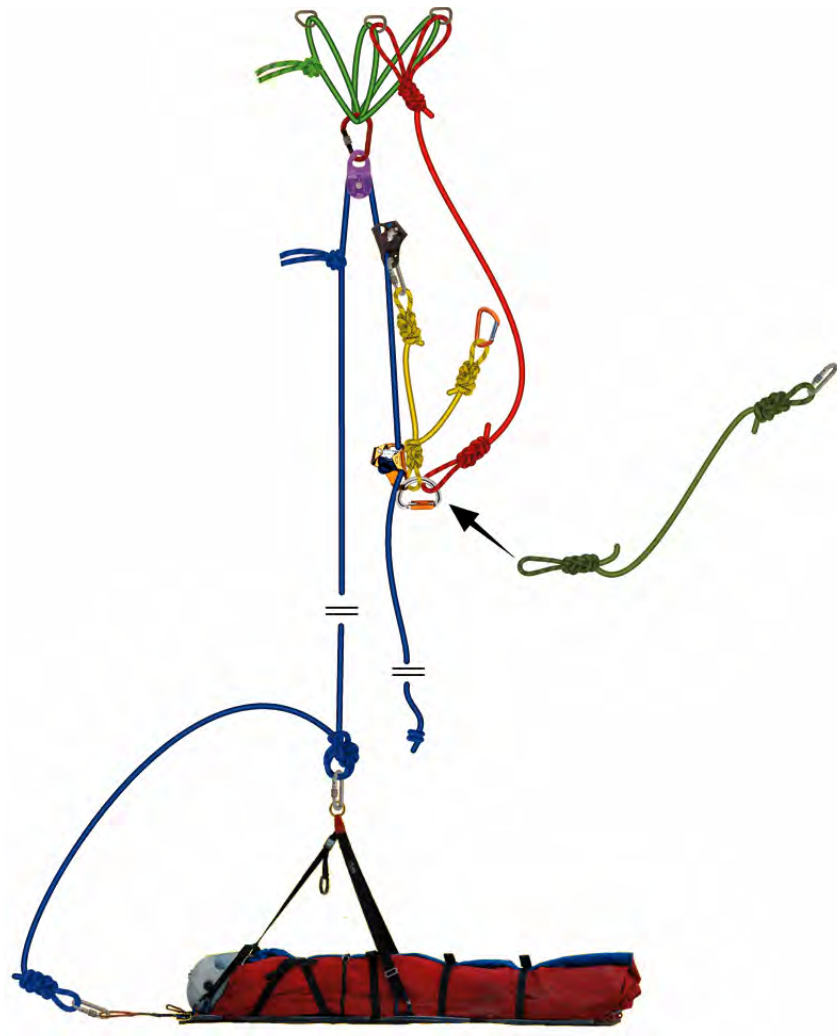


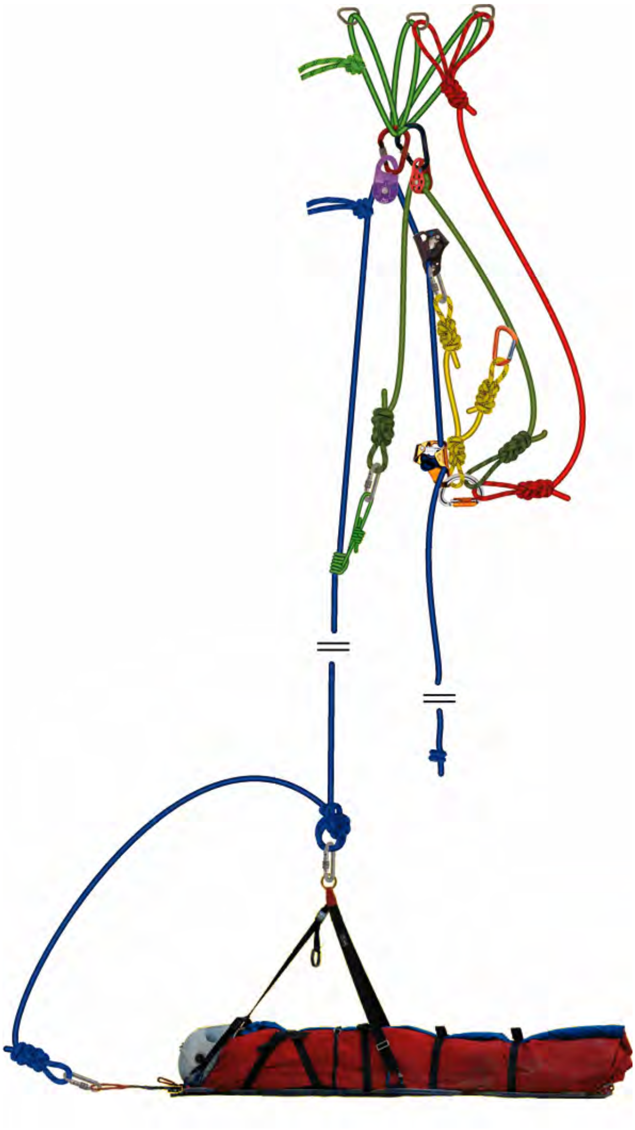
PASSING THE KNOT ON COUNTERBALANCE WITH AN EXTRA PULLEY

This technique may represent an alternative to the former technique, allowing the mid-pit technician to independently pass the knot with little equipment. It can be used during a counterbalance or a z-rig pull. When used during a z-rig pull, this technique offers the same benefits as the shortening knot technique. It cannot be used in the lowering phase.

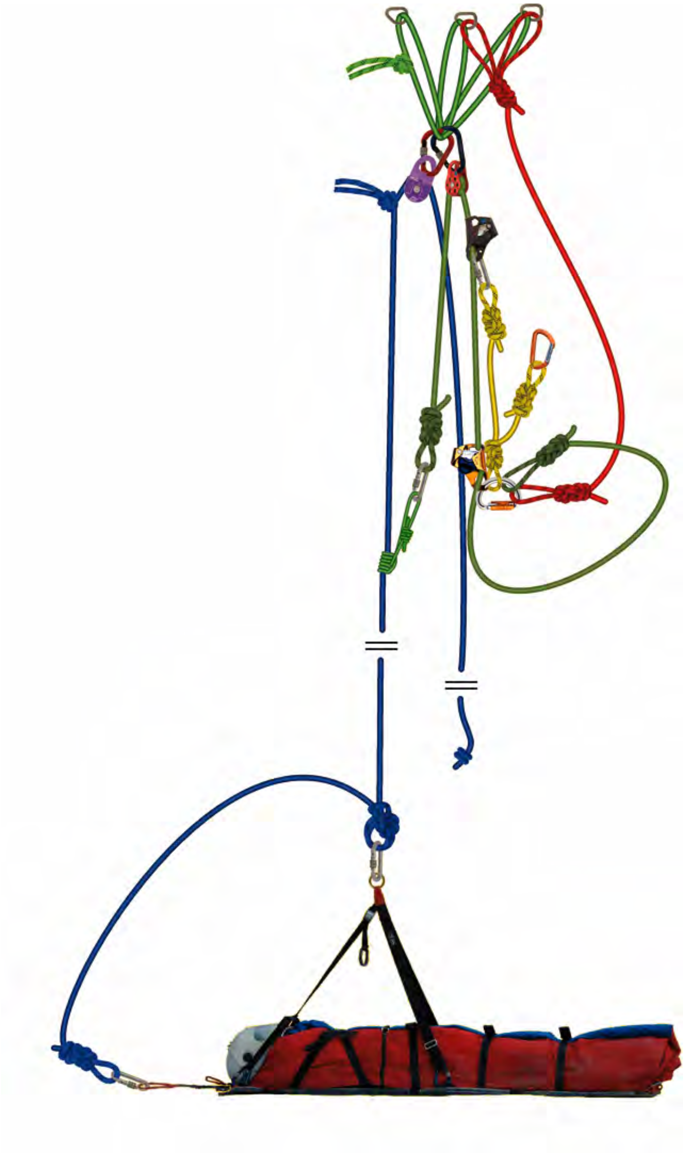
Spiegazione

- Connect an extra pulley to the mid-pit pulley's attachment point.
- Bring the knot close to the lifting pulley.
- Link a section of rope to your technician.

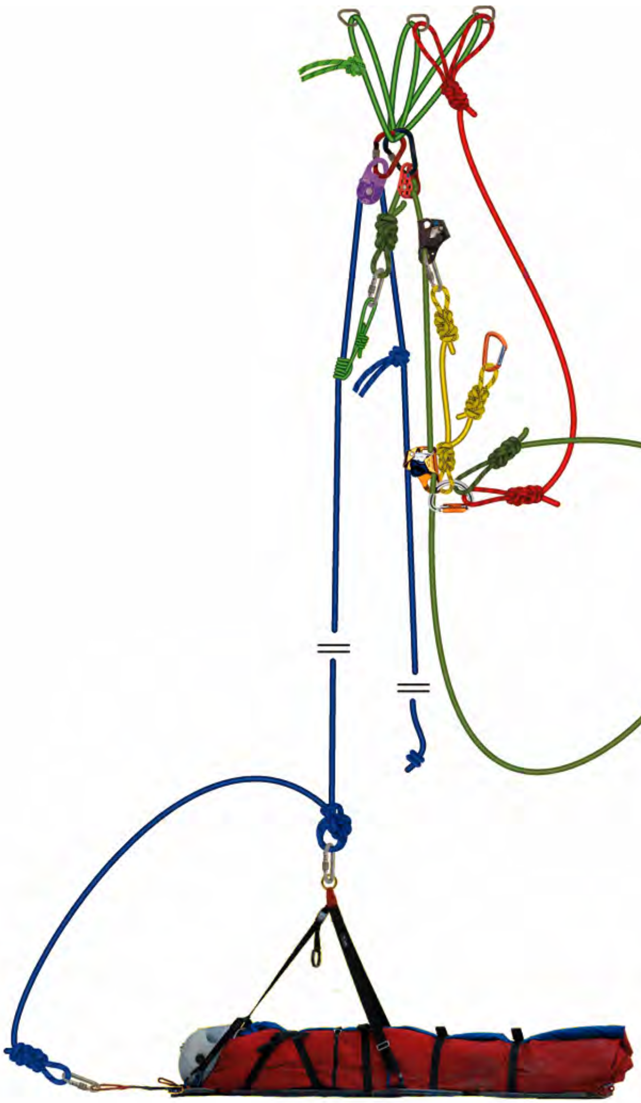




- Run the section of rope through the extra pulley and connect it to the haul rope by means of an ascender or an ABK at least 1 meter down the knot

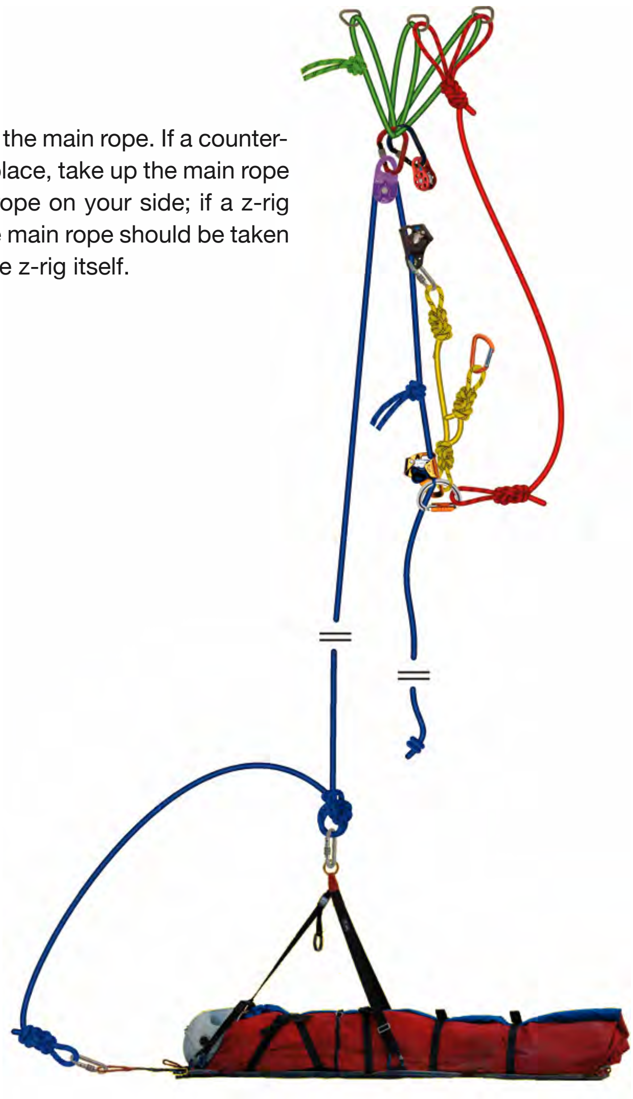


› Use the ascenders to pass the section of rope.



› Take up the rope by means of a counterbalance until there is enough slack to remove the mid-pit pulley. Then install the mid-pit pulley on the other side of the knot. Perform this manoeuvre near the mid-pit.

- Resume taking up the main rope. If a counter-balance pull is in place, take up the main rope by switching the rope on your side; if a z-rig pull is in place, the main rope should be taken up by engaging the z-rig itself.



Attenzione

- The section of rope connected to the balance-man's harness acts as a back-up rope when moving the chest ascender and the cowstail from one rope to the other. Now the stretcher hangs on the technician with only one ascender.
- During a z-rig pull, consider that a technician should act in counterbalance, although standing near the mid-pit.

Errori tipici

- Start the manoeuvre when the knot is not close to the mid-pit pulley: this imposes the use of a section of rope longer than needed.
- Connect the section of rope excessively near the knot in the haul rope: this prevents having enough rope to pass the knot upstream the pulley.
- Clip the extra pulley to the carabiner on the mid-pit pulley, hindering or preventing its opening.

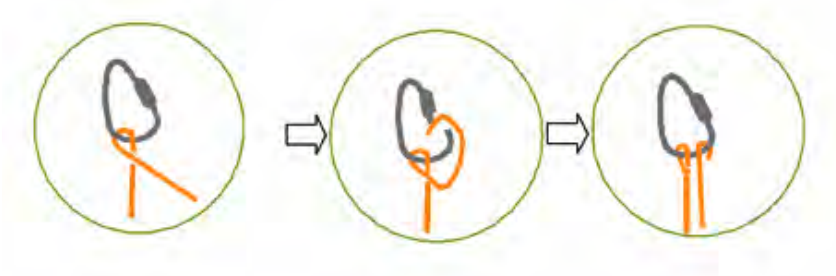
PASSING THE KNOT WITH MAIN AND SECONDARY DEVIATIONS

Information It is not necessary to install a BAS on the secondary deviations. This method can be implemented either when lifting or lowering.

- Take the knot up against the deviation.
- Install and extra deviation under the binding knot.
- Release the Blocked Munter Hitch on the deviation you need to pass by loading the recently-added deviation.
- Remove the deviation and continue lifting or lowering.

Warning ⚠

› In order to reduce the loss of tension when the parallel deviation is installed, build a 3:1 haul system with the cord on the carabiners and closed by a Blocked Munter Hitch can help.



› A team member should act as a sort of "knot man" with the task of following the knot along the vertical line and passing all the existing deviations. This team member doesn't have to interfere with the stretcher bearer. For this reason, the rope for progression should be rebelayed in proximity of deviations to permit the stretcher bearers to climb at the same time as the knot.

› The deviation man could find difficult to communicate with the team that is lifting the stretcher from the pitch edge if the distance is huge. In similar cases a radio should be used.

Photo Paolo Manca

Passing anchored deviations on a single rope

Contents

BASIC CONCEPTS

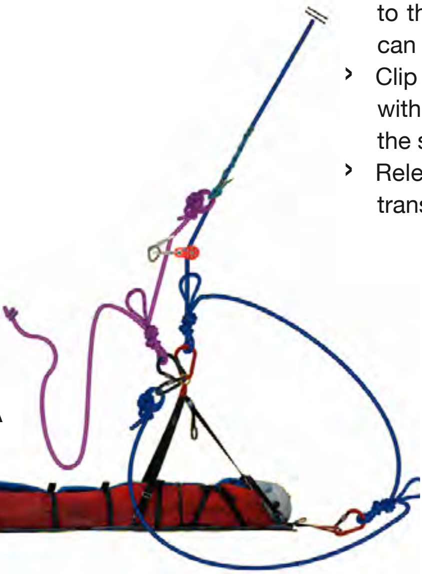
Information

- This method allows for passing anchored secondary deviations. It is not necessary to implement these methods for passing the mid-pit deviations, where you still have one rope end at your disposal for performing any entry/evacuation manoeuvre.
- Bind the stretcher as if it was a single rope technique, i.e. with two Blocked Munter Hitches tied on the lifting point and at the head-end of the stretcher and then back to the lifting point.

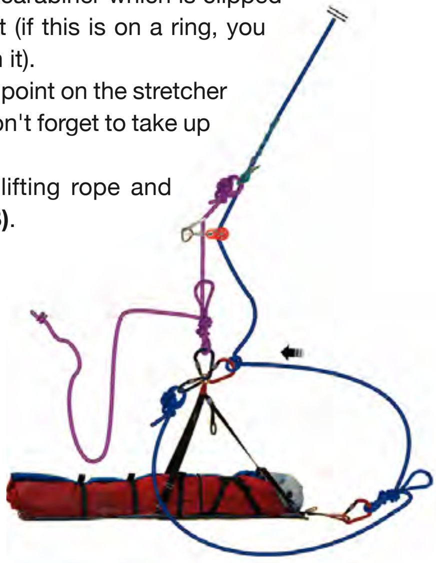
WHEN LIFTING

- Immediately take the stretcher under the deviation pulley.
- Build a BAS (use an ABK if necessary) and install it approx. 50 cm above the deviation.
- Pass the BAS' section of rope in a carabiner which is clipped to the deviation's attachment point (if this is on a ring, you can run the section of rope through it).
- Clip the other rope end to the lifting point on the stretcher with a Blocked Munter Hitch and don't forget to take up the slack **(fig. A)**.
- Release the Munter hitch on the lifting rope and transfer the load on the BAS **(fig. B)**.

A

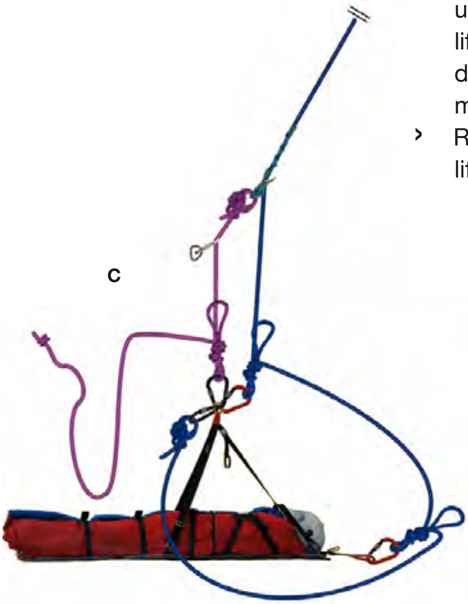


B

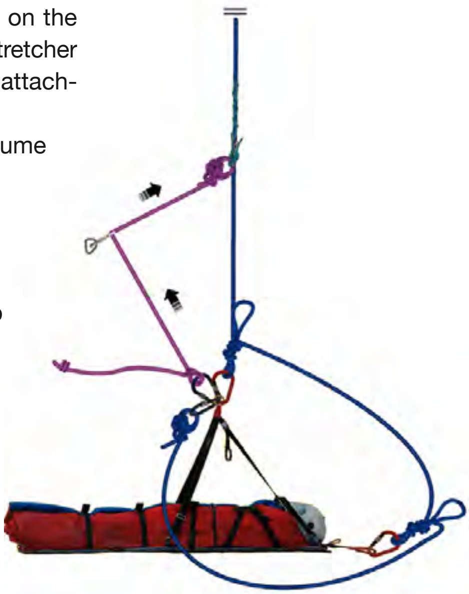


- Remove the lifting rope from the deviation and re-build the Blocked Munter Hitch on the stretcher attachment point, and take up the slack **(fig. C)**.
- Release the BAS' Munter Hitch and feed the rope until the load rests again on the lifting rope, bringing the stretcher directly under the upper attachment point.
- Remove the BAS and resume lifting **(fig. D)**.

C



D



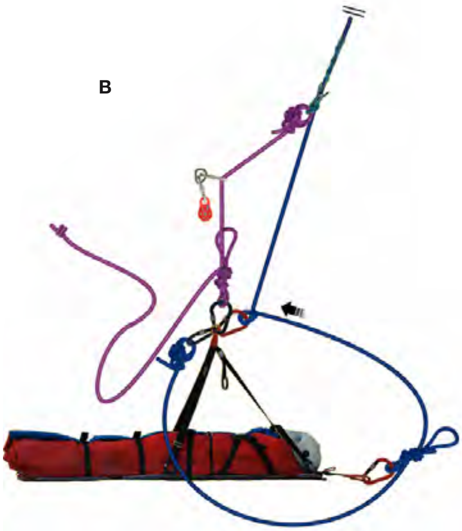
WHEN LOWERING

- Lower the stretcher at deviation level.
- Build a BAS (use an ABK if necessary) and install it before the deviation.
- Pass the BAS' section of rope in a carabiner which is clipped to the deviation attachment point (if this is on a ring, you can run the section of rope through it).
- Clip the other rope end to the lifting point on the stretcher with a Blocked Munter Hitch and don't forget to take up the slack **(fig. A)**.

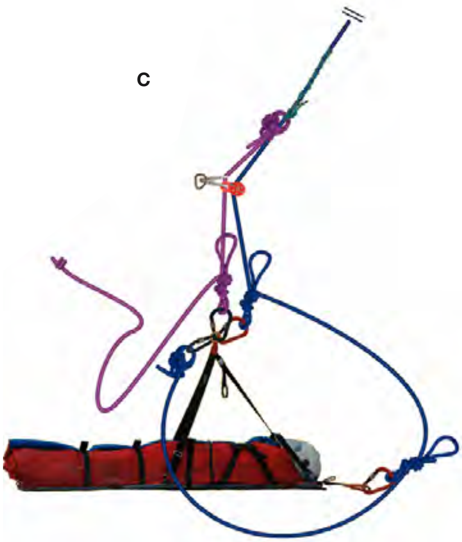
A

- Release the Munter Hitch on the lowering rope and transfer the load on the BAS **(fig. B)**.
- Slacken the lowering rope until you are able to run it through the deviation pulley, then take up the slack and lock it up **(fig. C)**.

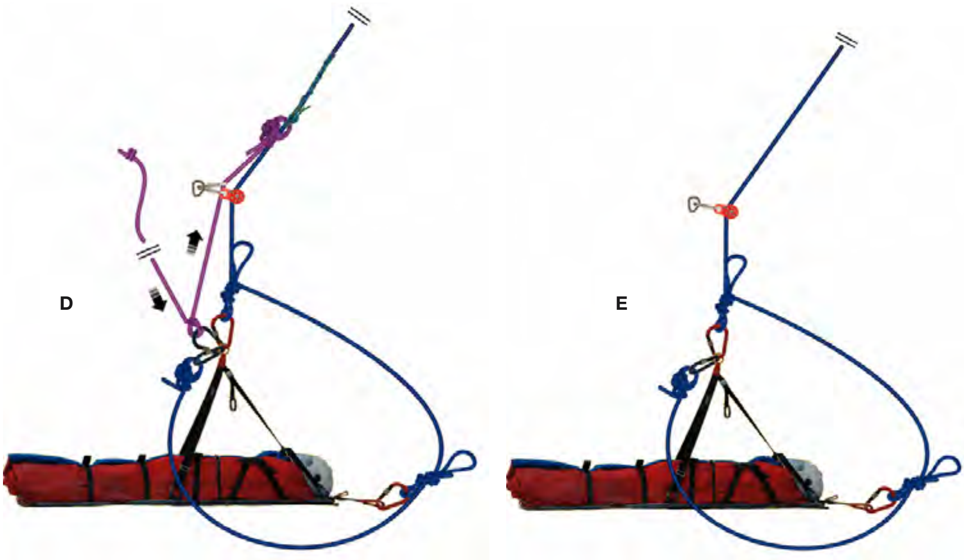
B



C



- Release the BAS' Munter Hitch and feed the rope until the load rests again on the lowering rope, bringing the stretcher directly under the deviation **(fig. D)**.
- Disengage the BAS and resume lowering **(fig. E)**.



Warning

- When you transfer the load on the BAS by lowering the Munter Hitch on the lifting point, the available rope couldn't suffice; in this case you can lift the rope by undoing also the Munter Hitch at the head-end of the stretcher.
- As the manoeuvre is performed, the stretcher necessarily moves from the deviation vertical to the upper attachment point vertical; the barrow boy should be ready to follow the stretcher and direct the Munter Hitch and to move closer to the deviation and disengage the BAS.

Common mistakes

- Fail to join the stretcher after passing the deviation because the rebelays for the utility rope are placed at the wrong level.

Photo Paolo Manca

Washing line with a single rope

Contents

BASIC CONCEPTS

Information

- The washing line technique addressed in the basic techniques can be employed also when lifting (or lowering) a stretcher on a single rope.
- The evacuation from the pit with the washing line method requires the use of a single rope.
- Main attachment point and the mid-pit attachment point are built as described for a single rope rescue.
- The stretcher is regularly connected to the lifting rope.

Warning

- The rope ends can be connected to the stretcher's lifting ring via a bowline;
- A z-rig and a lowering system are connected to the same main attachment point.

Common mistakes

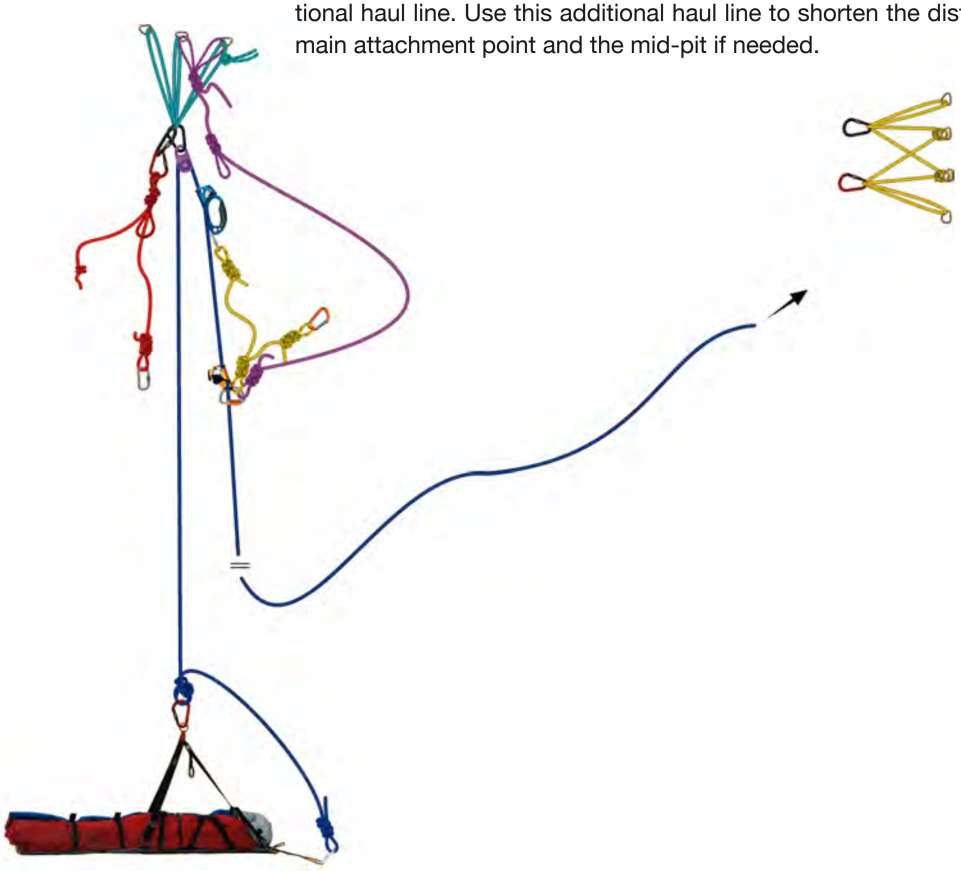
- Maintain the stretcher higher than what is needed during the exit phase, stressing the system.
- Keep the Munter Hitch tied on the additional back-up line tensioned from mid-pit, hindering the z-rig operations.

COUNTERBALANCE HAUL SYSTEM

Arrangement

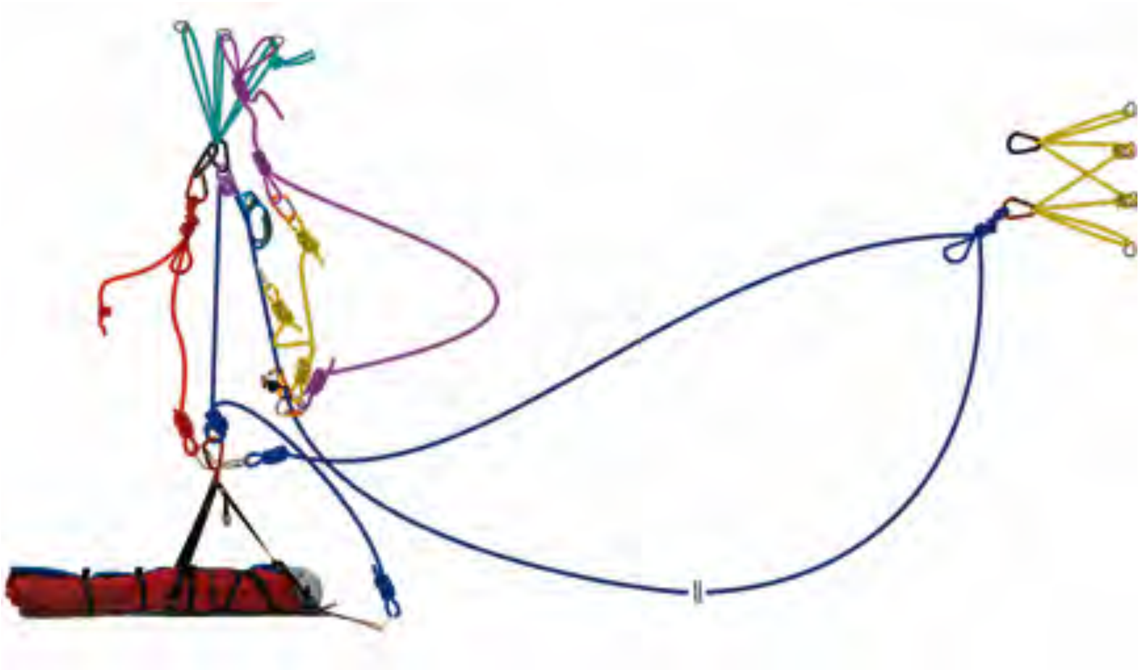
Information

- Arrange the lifting rope in the mid-pit pulley so that the balance man stays between the stretcher and the main attachment point when the stretcher is lifted. As a result, here the balance man acts differently with the respect to the regular counterbalance technique, where the balance man stays in outer position.
- Build a back-up line for the balance man using a section of rope. Build a loop a little under the pulley in the section of rope, so that the rescuer clipped to this loop finds him/herself standing in an optimal position for executing the manoeuvre.
- Use another section of rope to build an additional back-up line for the stretcher. Link the section of rope to the mid-pit deviation via a Blocked Munter Hitch tied in a carabiner which is independent from the pulley's.
- Bring the extra rope above the balance man in the main attachment point and connect it to the main attachment point with a grigri or tying a Munter Hitch. This section of rope will act as washing line (back-up rope in the lowering phase) during the exit.
- Use the rope end standing downstream the lowering system to arrange an additional haul line. Use this additional haul line to shorten the distance between the main attachment point and the mid-pit if needed.

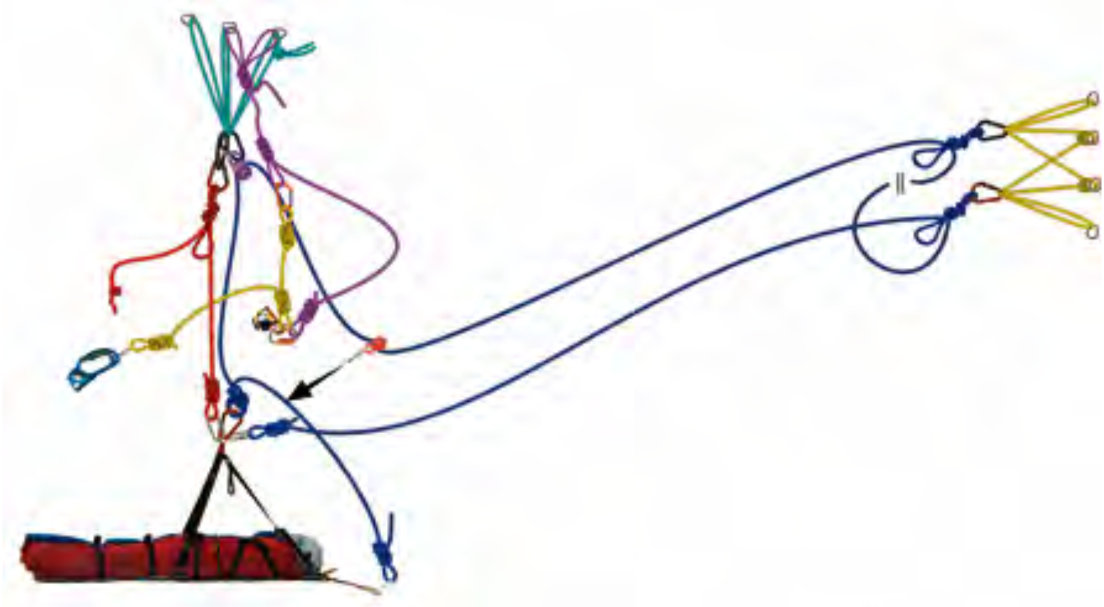


Execution

- Bring the stretcher near the mid-pit pulley.
- The balance man will clip the cowstail to the loop previously built in the back-up line, at the same level of the mid-pit pulley.
- Connect the additional back-up rope end to the lifting ring at the feet of the stretcher.
- Connect the additional haul rope end to the lifting ring at the head of the stretcher.



- The balance man lowers on the ascenders to reverse the counterbalance direction until the stretcher is loaded on the releasable section of rope in the additional back-up line and he/she removes the ascenders from the lifting rope.
- Add a pulley on the part of rope that was released: from now on this will act as back-up line.



- If needed, lower the back-up line until there is enough slack to clip the pulley to the lifting ring, half way from the carabiner in the additional haul line and from the carabiner in the additional back-up line.

- Undo the Blocked Munter Hitch tied on the additional back-up line and lower the stretcher until it is loaded on the back-up rope.
- Exit the stretcher by taking up the additional haul rope while lowering the back-up line.

- Follow the stretcher using the Blocked Munter Hitch to lower from the mid-pit; pay attention to tension only the additional haul and back-up ropes.

Attenzione ⚠

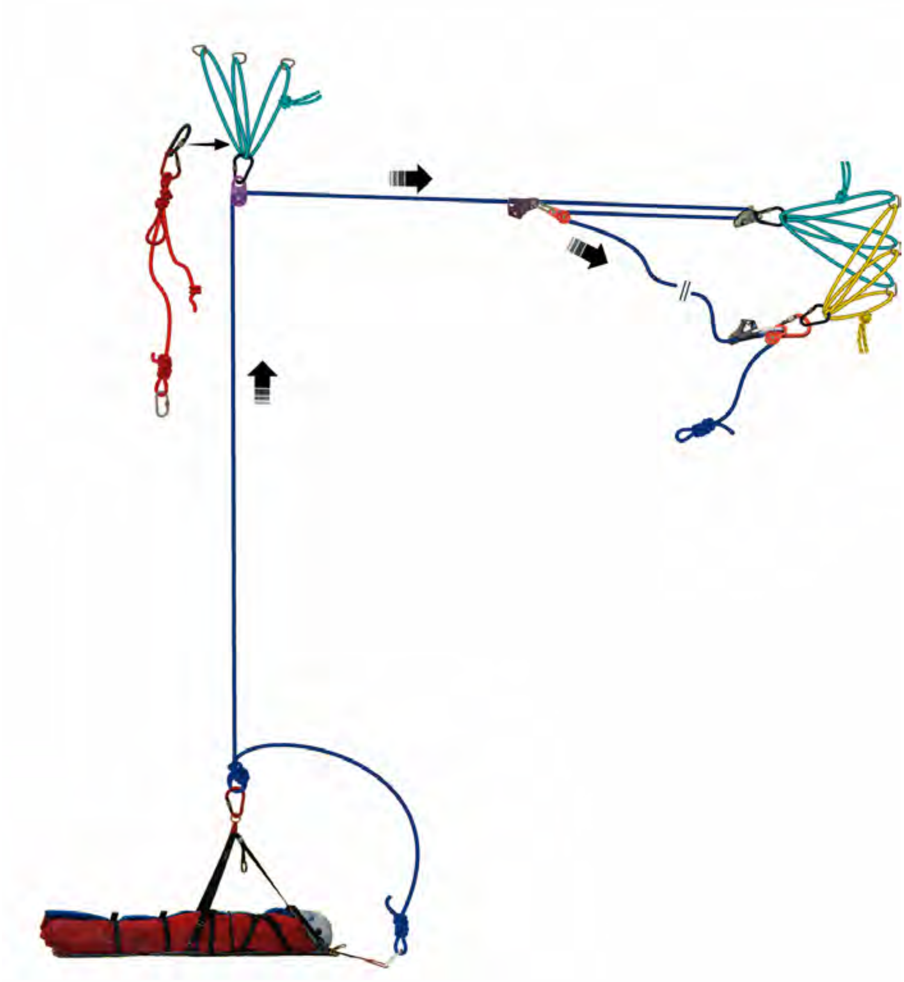
- The balance man "reloads" the rescue system by ascending on the ascenders while grabbing the sections of rope standing upstream and downstream the counterbalance pulley so to keep the stretcher still.
- If the rope downstream the z-rig is long enough, the travelling pulley can be directly connected to the lifting ring. This will eliminate the need of the ascender and of "reloading" the z-rig.

Z-RIG HAUL SYSTEM

Arrangement

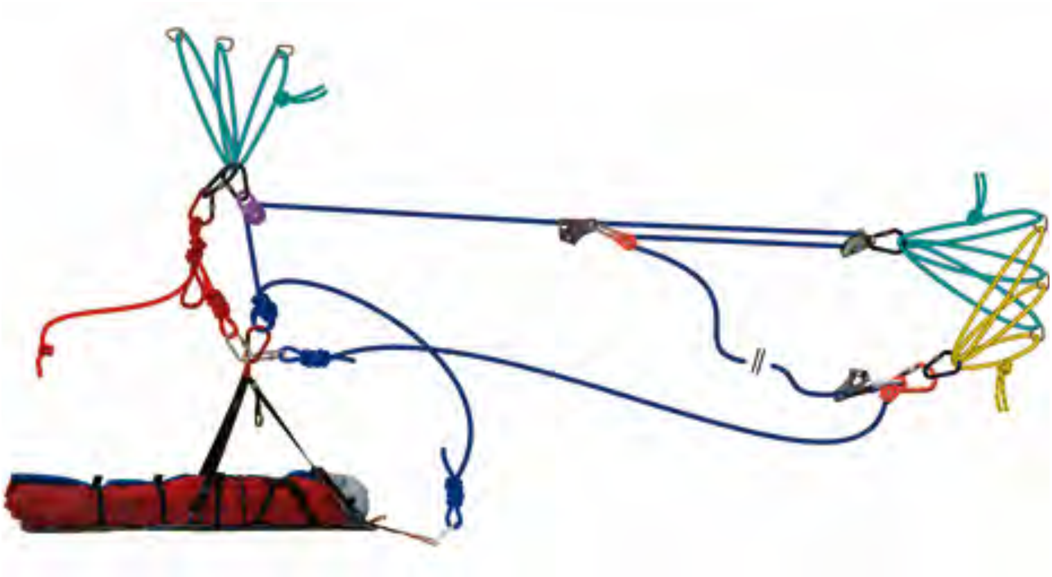
Spiegazione

- Arrange a regular z-rig on the lifting rope. Build the anchored base using a grigri or an independent z-rig.
- Use the bottom of the lifting rope to arrange an additional haul line. Use this additional haul line to shorten the distance between the main attachment point and the mid-pit if necessary.
- Use another section of rope to build an additional back-up line for the stretcher. Link the section of rope to the mid-pit deviation via a Blocked Munter Hitch.

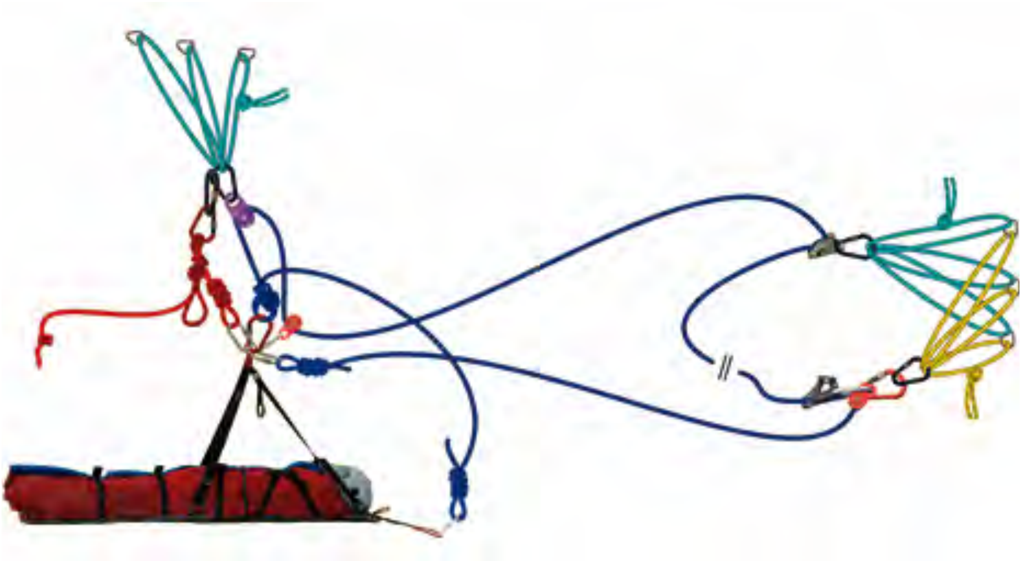


Execution

- Lift the stretcher and bring it near the mid-pit pulley.
- Connect the additional back-up rope to the stretcher's lifting ring and clip the carabiner to the ring at the feet-end of the stretcher.



- Connect the additional back-up rope to the stretcher's lifting ring and clip the carabiner to the ring at the head-end of the stretcher.
- Remove the z-rig travelling part and lower the stretcher with the grigri until the stretcher is loaded on the additional back-up rope. When there is enough slack in the rope, run the washing line pulley in the lifting rope and connect it to the stretcher's lifting ring, half way from the carabiner of the additional haul line and the carabiner of the lifting rope.



- Undo the Blocked Munter Hitch and lower the stretcher to load it on the lifting rope.
- Exit the stretcher by taking up the additional haul rope while lowering the back-up line.
- Follow the stretcher using the Blocked Munter Hitch to lower from the mid-pit; pay attention to tension only the additional haul and back-up ropes.

Attenzione ⚠

- When the rope doesn't suffice to arrange the additional haul line at the beginning of the manoeuvre, wait until the stretcher is lifted for a certain distance.
- If you don't have a grigri available to build the z-rig anchored base, or if an independent z-rig was not arranged, switch the haul rope with the back-up rope in the mid-pit pulley to invert the respective functions; this can be done once the stretcher is loaded on the additional back-up rope. Now the additional haul rope can be connected to the main attachment point using a Munter Hitch instead of a z-rig.

Photo Giuseppe Antonini

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