APPALACHIAN SEARCH AND RESCUE CONFERENCE, INC.

M O U N T A I N   R E S C U E

M A N U A L

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The Appalachian Search and Rescue Conference is a member of the National Association for Search and Rescue and a certified member team of the Mountain Rescue Asociation.

ASRC MOUNTAIN RESCUE MANUAL

I. ROPE HANDLING

A) Rope Care

Ropes (and other software) used in mountain rescue are susceptible to four categories of damage: chemical, radiative, thermal and mechanical.

The most common chemical agents responsible for rope damage are battery acid and petroleum products, both of which are found around cars. Accordingly, care should be taken to insure that unprotected ropes are carried only in clean car trunks. In general, all chemicals should be considered harmful and should be kept away from ropes, with the exception that paints or dyes may be used to mark the <u>ends</u> of a rope. Fortunately, water does not permanently damage a rope (although a wet rope is slightly weaker and a lot heavier), so one shouldn't fear wetness, except for the inconvenience.

Radiation damage occurs when a rope is exposed to the ultraviolet rays of sunlight. Fortunately, most of this damage takes place in the sheath; modern rope dyes mitigate the problem quite effectively; and at altitudes found in this area, the UV flux in sunlight is relatively low. Nevertheless, it is good practice to keep software out of the sun except while it is being used.

Thermal damage is a severe problem. Nylon melts at about $600^{\circ}F$, but structural damage (changes in the elastic properties and strength) can occur below the boiling point of water. Damaging temperatures can easily be attained in the careless employment of normal techniques, friction (particularly nylon running on nylon) being the usual mechanism for generating high temperatures. To guard against thermal damage, brakes should be run slowly, nylon on nylon friction must be assiduously avoided, and the rope must be protected from hot objects.

Mechanical damage seems like an obvious problem, but actually can be quite subtle. An obviously cut or abraded rope may be safe if the damage is only to the sheath, and an obviously undamaged rope may have been grossly weakened by previous strain or by the insidious cutting action of dirt ground into the core. The only sure way to know that a rope is sound is to know its history and to know that it has been handled competently.

Typical agents of mechanical damage are surface abrasion or cutting of the rope by sharp rocks or ice, internal cutting of core fibers by dirt pressed into the core when the rope is stepped on, rockfall (which can produce severe core damage with no apparent sheath damage), wear from mechanical ascendeurs and brakes, and strain from hard falls or unusually heavy loads. These things must be avoided as much as possible, of course, but to a certain extent they are inevitable. Consequently, all ropes eventually wear out. The decision to retire an old, but not obviously damaged, rope is a difficult one, but one which can be made much easier by the keeping of accurate records of rope use. To insure their usefulness and accuracy, these records must be faithfully made and periodically reviewed.

A modern rope is a remarkably strong, resilient and reliable tool, but if it is to be trusted, its vulnerabilities must be respected. In using software, the mountain rescuer should cultivate the mountaineer's sense of jealous protectiveness of his gear, which is summarized by the ancient dictum, "Don't step on the rope!"

E) Rope Management

A flexible cylinder some 60 meters long and 11 mm in diameter is bound to be awkward to manage, but with attention to detail, a little practice, and, most important, patience, the rope can be handled with remarkable ease. Although avoiding "rope salads" consumes valuable time, the time required to unscramble a wayward rope can be far more costly.

1) Stacking

The first step in preparing a rope for use is always to uncoil and stack it: the coil is held in one hand while the other carefully uncoils it and drops it onto the ground in a random pile or "stack." Amazingly, this stack will run more freely than the cleverest coil, and it will run from the top or the bottom. It is important, however, to pick a safe place for the stack, and to avoid projections on which the rope might snag.

2) Coiling

There are far too many methods of rope coiling to describe all of them here. Nevertheless, three useful methods which, for the sake of uniformity, should be learned by all ASRC members, are described. Idiosyncratic coiling methods are not discouraged as long as they do not damage the rope or make it difficult for another person to uncoil.

Coiling provides an excellent opportunity for inspecting and cleaning the rope, and the habit of doing so every time the rope is coiled should be developed. With practice, it takes no extra time to run the hand over every inch of the rope, brushing off dirt, and feeling for cuts and the lumps and depressions which indicate internal damage.

a) Speed Coiling

The easiest coil to do, and the best suited for throwing the rope, is the speed coil: the rope is simply folded back and forth across the hand in a series of large loops (fig. 1).

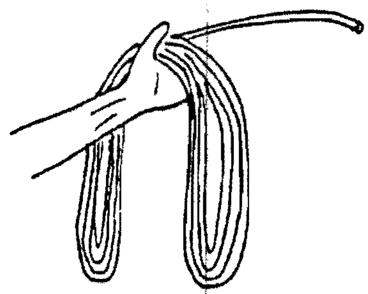


Figure 1. Speed Coil.

b) Mountaineer's Coil

For the mountaineer's coil the rope is wrapped from boot to knee while the rescuer kneels (fig. 2).

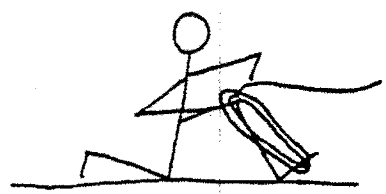


Figure 2. Mountaineer's Coil.

c) Lap Coil

For the lap coil the rope is wrapped from knee to knee while the rescuer sits with his feet together (fig. 3). The lap coil is especially well suited to people with short legs whose mountaineer's coils are too small for taller people to carry.

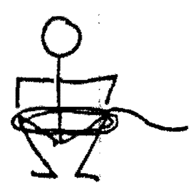


Figure 3. Lap Coil.

d) Tying Off a Coil

A coiled rope will come apart and become tangled unless it is properly tied off. Idiosyncratic tieoffs are discouraged since it is easy to tangle a rope by undoing the tieoff improperly. The accepted method is shown below (fig. 4). It must be done tightly and neatly to be effective.

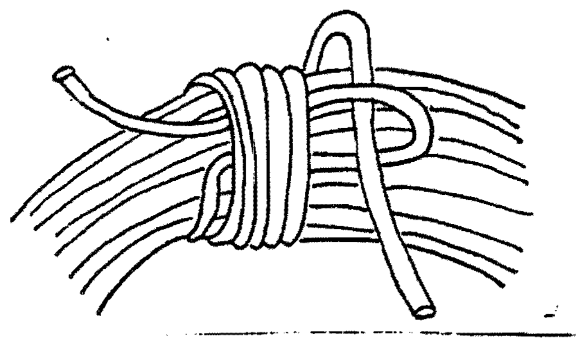


Figure 4. Rope Coil Tieoff.

3) Throwing

Several points should be observed when throwing the rope:

a) To avoid the embarrasment of throwing the rope away, or throwing himself away, the rescuer must secure himself and his end of the rope before throwing.

b) The call "Rope!" is always used to warn those below that a rope is coming down. Responses to this call must be heeded.

c) The speed coiled rope is thrown hard, overhand.

4) Carrying

A coiled rope is conveniently carried slung over one shoulder and across the body to the opposite hip. To keep the coils from sliding down and getting in the way, the tieoff is placed just behind the shoulder. If part of the rope is in use, the excess coils must not be carried across the body, but should be carried hanging straight down from the shoulder. This avoids the danger of strangulation should the rope suddenly be loaded.

C) Knots

Since a knot is the weakest point in a well designed rope system, and knot strength and reliability depend greatly upon tying technique, good knot tying habits are very important in mountain rescue. The correct knot for the job should be tied correctly and neatly, and should have its tails tied off with overhand knots. Neatness adds materially to knot strength since it maximizes bend radii. Knots in nylon untie themselves with amazing ease at the most inopportune moments, but tying off the tails prevents this.

The essential mountain rescue knots are illustrated below.

1) Bowline. The most important knot. It is used to put a non-slip, fairly high efficiency loop in the end of a rope. Its great virtue is that it is easy to tie: with practice, it can be tied one handed, while wearing mittens, . in the dark.

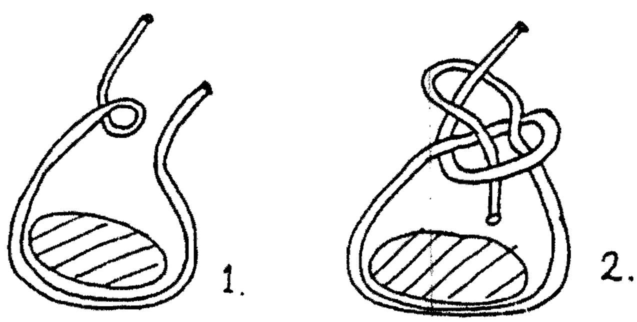


Figure 5. Bowline.

2) Bowline-on-a-coil. This is the same as a plain bowline except that it has more settling area. It is therefore much preferred for waist loops and for anchors to trees.

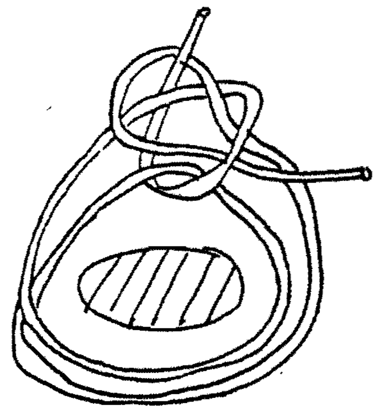


Figure 6. Bowline-on-a-coil.

3) Figure-8 loop. This is for putting a strong loop in the middle or end of a rope. It is somewhat stronger than the bowline, but harder to tie, especially when the end must be passed around or through something. The figure-8 loop must not be used if the standing parts are to be loaded colinearly.

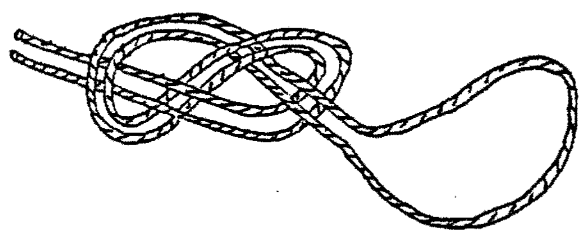


Figure 7. Figure-8 loop.

4) Butterfly. This knot is used to put a loop in the middle of a rope when the standing parts may be loaded colinearly. It is excellent for tying in to the middle of a rope or even for tying out a damaged spot in the rope.

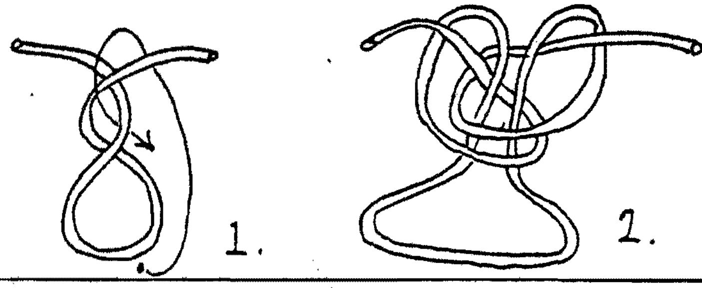


Figure 8. Butterfly.

5) Water knot (ring bend, overhand bend). This knot is used for joining ropes or webbing. It is fairly easy to untie, even after loading, but if it is not carefully tightened before use it is particularly prone to slipping, especially when wet.

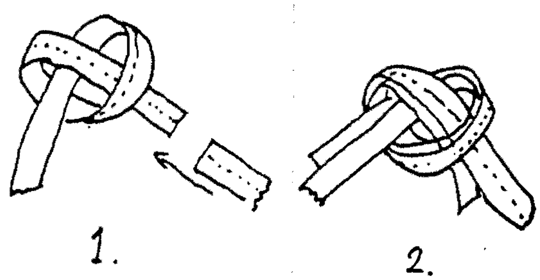


Figure 9. Water knot.

6) Prusik. This is a ratchet knot: when pushed by the knot, it slides; when pulled by the loop, it locks. The thinner the prusik rope size, the better this knot works, with 6mm being about the maximum size of nylon for use on 11mm nylon rope. However, 7/16" polypropylene holds well on 11mm rope and is very strong.

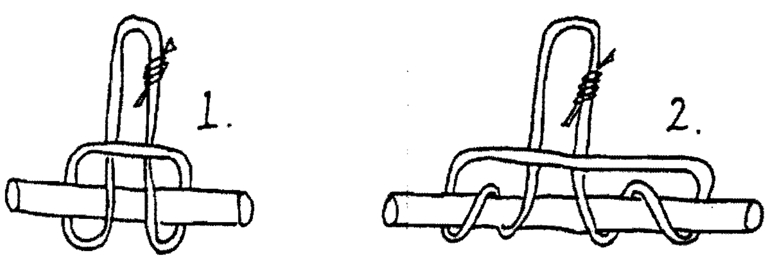


Figure 10. Prusik knot.

7) Hendden knot. This is a prusik substitute for use with webbing. It is most used when a strong prusik is necessary, but polypro is not available. Its disadvantages are that it is directional and more prone to jamming than the prusik.

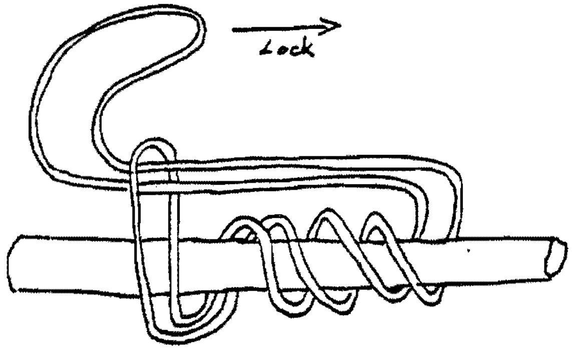


Figure 11. knot.
Headden

D) Anchorage.

The setting of strong and reliable anchors is a complex and subtle art which cannot be fully treated here. However, all mountain rescuers must be able to rig the anchors which are discussed.

Any anchor must be strong enough to withstand its anticipated load and must be reliable enough that minor disturbances, such as load variations, will not cause it to fail. The object being anchored to must be sound and secure, all materials must be in good condition, the anchor must be properly designed and executed, and it must be properly used.

1) Runners.

A runner is a piece of rope or webbing tied in a loop with a water knot or grapevine knot.

The simplest application of the runner is simply to hang it over a rock outcropping and clip on a carabiner (fig. 12). Made with new 1" tubular

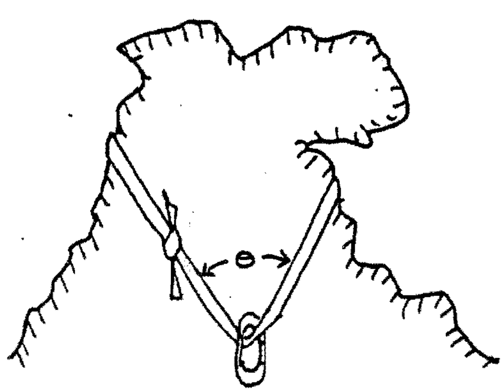


Figure 12. Runner.

webbing, such an anchor has a strength of nearly 2000 kp if the angle θ is small. The strength drops rapidly as θ increases: for $\theta=90^{\circ}$, the strength is 71% of that for $\theta=0^{\circ}$; for $\theta=120^{\circ}$ -- 50%. The strength may also be degraded by sharp edges on the rock which could cut or abrade the runner. This anchor is unreliable if an upward pull can occur.

To use a runner on an object (such as a tree) which cannot have things hung over it, two schemes are used: the girth hitch and the doubled runner (fig. 13).

Girth hitch. Doubled runner.

Figure 13.

The doubled runner is approximately twice as strong as a single runner, but may be unreliable if it slips up or down or if the carabiner becomes cross loaded.

The girth hitch has the advantage of being very reliable, but its strength is about the same as the single runner's (actually, friction around the tree improves the strength somewhat). When made with 11mm rope, the girth hitch is a superior anchor.

The best knots for tying into a carabiner are the bowline or the figure-8 loop.

3) Tree wrap anchors

The end of a rope can easily be tied around a tree using a bowline or a bowline-on-a-coil, but when time is available, a stronger anchor can be made by using a tree wrap as shown in figure 14. This

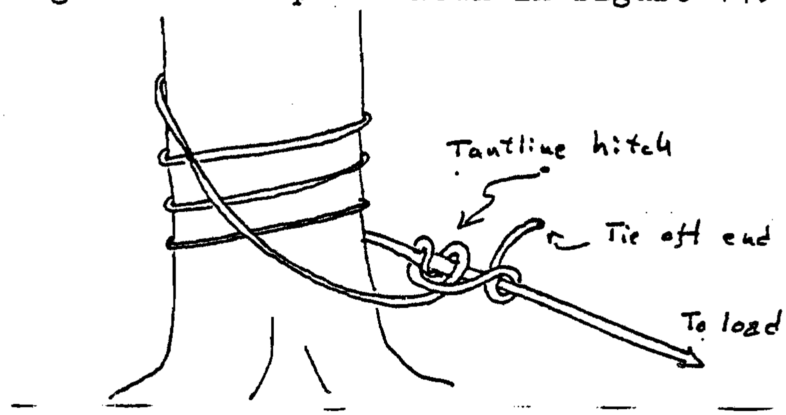


Figure 14. Tree wrap anchor.

anchor is nearly 100% efficient, since all the tension in the rope is taken up by friction around the tree and there are no loaded, small radius bends in the rope. An added advantage is that the tree wrap anchor can be rigged or derigged while the rope is taut (e.g. when rigging a tyrolean traverse).

To use the tree wrap anchor in the middle of a rope, or when the tail is too long to conveniently tie a *tautline hitch*, *it* can be replaced by two half hitches tied with a loop with the loop clipped to the standing parts with a carabiner (fig. 15).

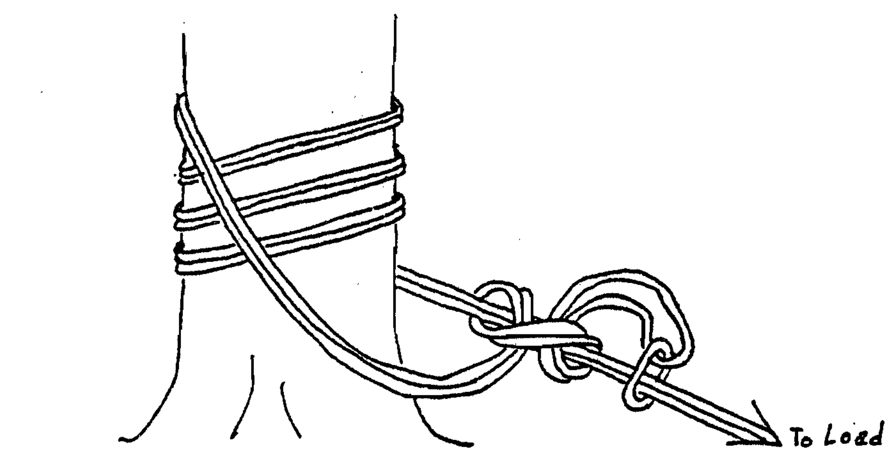


Figure 15. Tree wrap anchor in the middle of a rope.

II. BELAYING

In mountaineering and rock climbing, the terms "belay" and "belaying" are used only to denote the technique of using a rope to protect a climber in the event of a fall. In mountain rescue, however, the terms take on a somewhat broader meaning, referring not only to protection but also to the use of the rope in aiding the litter team to ascend or descend steep slopes safely and smoothly. The simple braking and hauling systems used in mountain rescue belays are described in Section V, Semi-Technical Evacs. This section discusses the techniques employed by the belayer and the procedures to be followed in using any kind of belay.

A belay system consists of many separate components, each of which must be fail safe (or "bombproof" in the climbing jargon) in order that the entire system be useful. Close attention to detail is necessary to assure a safe belay.

A) The Belay Stance

Although the sitting hip belay is the most secure stance, the standing hip belay is often preferred because it is easier to implement. In either case, tension on the rope must not pull the belayer off balance or out of position. Three techniques are used to eliminate this danger:

1) Aiming insures that tension on the rope will come from a known direction, allowing the belayer to be prepared for it. Belays must always be aimed. If the belay does not have a naturally well defined aim, an anchor must be placed to provide one.

2) If the belayer will hold considerable force himself, he must be tied in securely. Tie-ins are always necessary for belaying climbers or when the belayer is in an exposed position, but tie-ins are seldom necessary when using tree wrap belays or mechanical brakes. In doubtful circumstances, a

tie-in should always be used. It should be as short as possible.

3) The stance itself should be chosen carefully. Good footing is important in both seated and standing belays and the belayer must be colinear with the tie-in and the aim. The belayer should directly face the aim (see fig. 16). The rope passes across the

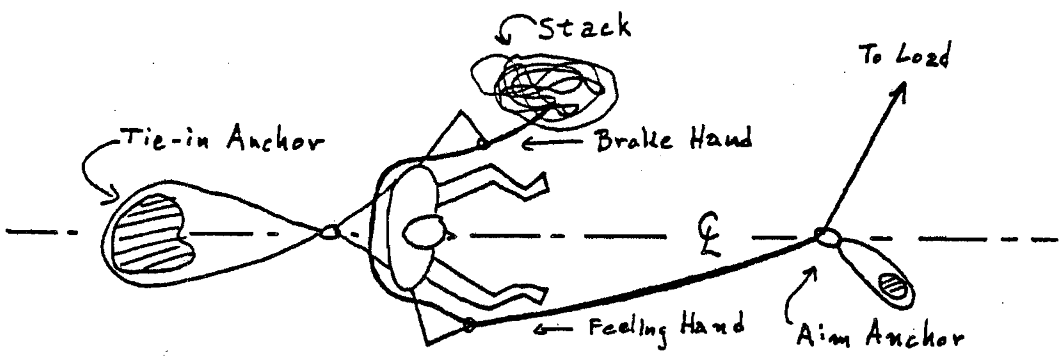


Figure 16. The Belay Stance.

belayer's hips (<u>not</u> his waist or thighs) above the tie-in if the aim is below the belayer, or below the tie-in if the aim is above the belayer. The belay stance ahould not be placed in a precarious position in order to get a view of the climber or litter team: this is not necessary. If voice communication is a problem, someone should be suitably placed to relay calls.

B) Technique

The belayer's function in the belay system is to control the tension and length of rope in the system and to hold the rope during a fall

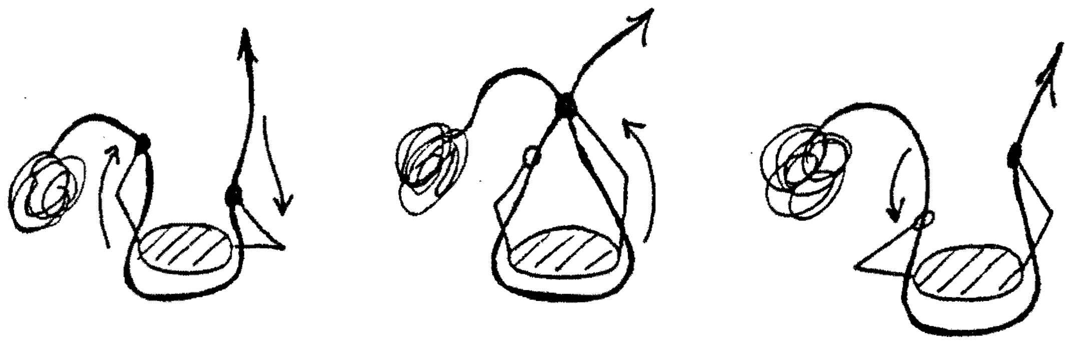
When the belay is employed strictly for protection, there should be no slack in the system, but there should be no tension either. When the belay is used for hauling or braking, the tension depends upon the weight of the load, the angle of the terrain and the extraneous friction in the system. It can range from nearly zero to as much as 500 kp. The belayer must be quite sensitive to the changing demands of the load. Leather palmed gloves or mittens are essential, both to protect the belayer's hands and to provide friction on the rope.

The forces exerted on the belayer during a fall can be very large (instantaneously over 1000 kp) and falls often occur without warning, so it is important that manipulation of the rope not interfere with the belayer's constant readiness to catch a fall.

The belayer's two hands are identified as the "feeling hand," which holds the rope to the load and senses tension of the belay, and the "braking hand," which holds the end of the rope which goes to the stack and, in conjunction with rope friction across the belayer's hips, provides the braking force to hold the loaded rope. While the belay is on, the braking hand must <u>never</u> leave the rope. To prevent the braking hand's being pulled around behind the belayer's back, he keeps his elbows close to his body and does not allow them to pass behind his hips.

1) Falls. Whenever the rope is heavily loaded (as in a fall), the braking hand is quickly placed between the legs so as to maximize the amount of rope friction around the belayer's hips.

2) Up-Rope. The maneuver used to decrease the length of rope in the system is called "up-rope." It is carried out in three distinct steps, each of which is executed on one beat of a smooth dactylic (waltz) rhythm. The procedure must be mastered using either hand as braking hand. The braking hand may be thrust between the legs to catch a fall at any time during the procedure.



ONE — Both hands pull rope around body.

two — Feeling hand slides forward and grasps both ropes ahead of braking hand.

three — Braking hand slides back. Feeling hand releases opposite rope.

Figure 17. Up-Rope

3) Slack. The maneuver used to increase the length of rope in the system is called"slack." The tension in the belay is usually enough that the belayer simply pays out rope without removing either hand. However, the belayer never forces a climber to pull his own slack: the climber has enough problem overcoming friction in the rest of the system without having to pull rope from around the belayer too. When a climber or litter captain calls for slack and it is not clear how much he wants, the belayer slacks about one meter. If more is needed, it will be requested.

When the belayer is lowering a climber or litter, he uses his braking hand to control the rate of descent while the load pulls rope into the system.

C) Procedures and Calls

If the belayer is to be responsive to the needs of the climber or litter captain, fast, accurate and succinct communication between them is imperative. Under the difficult conditions which prevail in the field, this communication is provided by a set of standard shouted signals or "calls." These calls are part of a rigid procedural framework which is designed to insure that both the belayer and the climber or litter captain always know the status of the belay. Since this communication is entirely aural, noise and confusion are a direct threat to the success of the operation and to the safety of the rescuers and the patient. Unnecessary noise in the vicinity of a belay is therefor intolerable. When there is difficulty in hearing calls, a rescuer should be placed as a relay.

A glossary of belaying calls is given below. The procedural contexts of many of the calls are given in the sections indicated. Underlining indicates that, when heard, the call should be repeated back, or "echoed," as an acknowledgement. Note that most calls occur in pairs: a statement and a response, or in the case of readiness calls, a call from each end of the belay indicating its status. The only exceptions are "Rock" and "Falling," which require immediate action.

BELAYING CALLS

1) Readiness Calls.

a) ON BELAY is given by the climber or litter captain. It indicates his readiness to the belayer: it is <u>not</u> a question.

b) BELAY ON is given by the belayer to indicate his readiness to the climber or litter captain; it is <u>not</u> a question.

The belay is not operational until <u>both</u> (a) and (b) have been called, however the belayer assumes the belay to be operational from his call of BELAY ON. The calls may be given in either order.

c) OFF BELAY is given by the climber or litter captain when the belay is no longer required.

d) BELAY OFF is the belayer's acknowledgement of OFF BELAY.

The belay is not terminated until <u>both</u> (c) and (d) have been called.

2) Procedural Calls

a) CLIMBING is used by the climber to indicate that he is about to begin moving. It is redundant, but very useful nevertheless. It is not used by the litter captain.

b) CLIMB AWAY is the acknowledgement of CLIMBING.

c) <u>UP ROPE</u> is used by the climber or litter captain to indicate that there is unwanted slack in the belay. It is also used by the litter captain in place of CLIMBING or to request tension on a haul line.

d) <u>SLACK</u> is used by the climber or litter captain to request about one meter of slack in the belay.

e) TENSION is a climber's request for a rope assist. It is not considered sporting in recreational climbing.

f) <u>PRELOAD</u> is given by the litter captain just before loading the rope at the top of a steep pitch. The belayer stops the rope and the litter team loads it to get the stretch out before going over the edge.

g) DOWN SLOW is the litter captain's request for a slow descent.

h) DOWN FAST is the litter captain's request for a fast descent. "Slow" and "fast" in this context are relative to the terrain.

i) STOP is the litter captain's request for a stop. It is also used by the belayer to indicate that he is out of rope.

j) READY, SWITCH is used by the belayer in the "Brute Force Hauling System" to reverse the high and low groups of the haul team.

3) Warning Calls

a) ROCK. Something is falling! Shield the patient! Take cover!

b) FALLING. Catch me! Used by the climber or litter captain.

c) HALFWAY is used by the belayer to warn that half the rope has been used.

d) TWO-OH is used by the belayer to indicate that not much rope is left and the next available belay site should be taken. This call derives from the old mountaineering signal which meant, "20 feet of rope left," but in rescue work, "not much rope" is a relative quantity which depends upon terrain and the availability of good belay stances. In straightforward circumstances, 10 meters is a good rule of thumb.

III. LITTER BEARING

A) The Litter Team

1) The basic litter team consists of 6 litter bearers (3 on a side) on non-technical or easy semi-technical terrain, or 4 litter bearers on steep semi-technical terrain. The positions are denoted by "right front," "left middle," etc., where front means in the direction of travel (not the orientation of the patient).

2) The litter captain is the left front ("driver's seat") litter bearer. Note that any litter bearer may be called upon to be litter captain. The litter captain is in charge of managing the litter team.

3) At his discretion, the Medic may or may not serve as a litter bearer.

4) Additional team members should range themselves ahead of the litter, ready to rotate in. They should clear trail and carry excess equipment.

5) A "seventh man" at the end of the litter is often helpful.

B) Litter Handling

1) Lifting.

a) Litter bearers arrange themselves two at the patient's head, two at his waist, and two at his knees; facing in; both hands on the rail.

b) Litter captain: "Ready, (pause) lift." Litter bearers not ready should indicate so during the pause. Counting ("one, two, three, lift.") is not used.

c) Litter bearers lift the litter, keeping their backs straight and pulling out rather than up. The litter must be raised slowly and smoothly.

2) Moving the Litter

a) Litter captain: "Forward."

b) Litter bearers walk out of step, keeping their arms bent. A smooth ride for the patient in essential.

c) The litter must be kept level or head up.

d) Forward litter bearers call out obstacles on their sides (e.g. "Rock on the right.")

e) Load straps give a rough ride for the patient and should used only in <u>his</u> best interest, that is, they should be used only if the increase in litter bearer efficiency is worth the cost of a rough ride. The strap is run across the shoulder and is held by the straight outside arm, Load straps must not be tied to the litter bearers.

f) To stop, the litter captain calls, "Stop."

3) Lowering

a) The litter bearers face in, both hands on the rail.

b) The litter captain checks under the litter for projections which might hurt the patient.

c) Litter captain: "Ready, (pause) down."

d) Once down, the litter must be propped into a comfortable attitude for the patient.

IV. NON-TECHNICAL EVACUATIONS

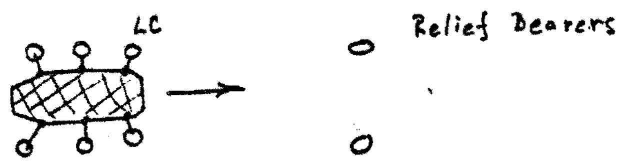
A) Non-Technical Terrain.

Non-technical terrain is level enough or smooth enough that a belay is not considered necessary. On non-technical terrain, a falling litter bearer poses no threat to the safety of the patient or the litter team.

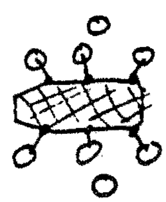
B) Rotation.

During long evacs, litter bearers may be relieved by the procedure of rotation, described below. The entire procedure is carried out with the basket in motion.

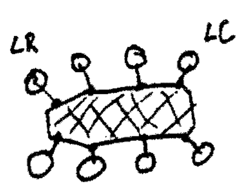
The two relief bearers walk about 10 meters in front of the litter.



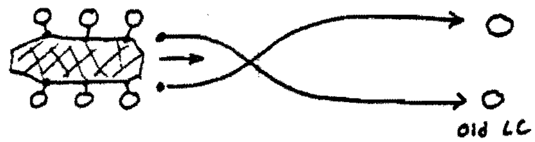
LC: "Ready to rotate." Relief bearers stand off the trail.



The litter passes between the relief bearers.



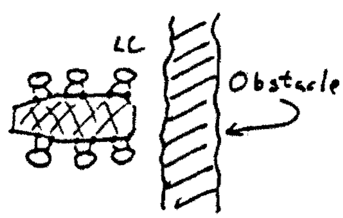
The relief bearers grasp the basket at the rear. LR: "Rotate." All move forward on the litter; the two front bearers peel off.



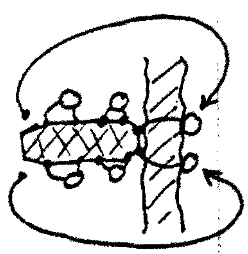
The relief bearers cross the trail and move out forward. When they rotate back in, they will have exchanged sides on the litter.

C) Laddering.

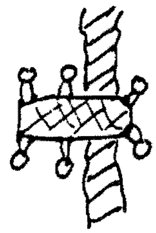
Laddering is the procedure used to carry the litter over (or through) obstacles which cannot simply be stepped over.



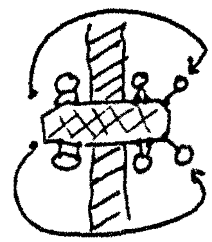
LC: "Stop. Ready to ladder." The middle bearers reach back to accept the rear load. They <u>do not step back</u>.



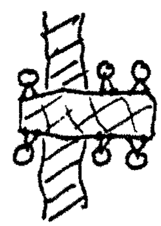
The two rear bearers peel off and go to the front of the litter. Note that there is now a new litter captain. LC: "Ladder." The basket is passed forward.



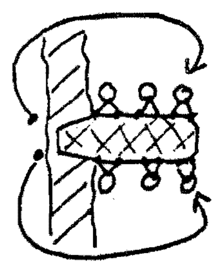
LC: "Ready to ladder." Peel off.



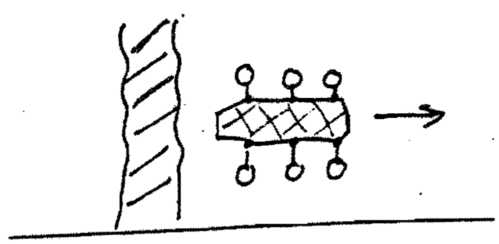
LC: "Ladder." Pass basket forward.



LC: "Ready to ladder." Peel off.



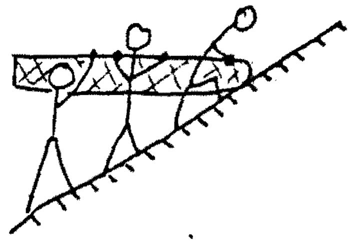
LC: "Ladder." Pass basket forward.



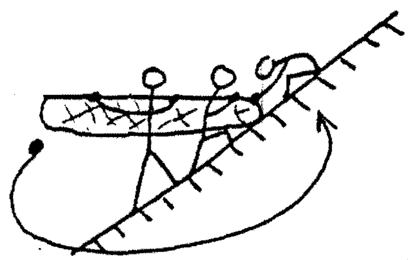
LC: "Forward." The litter is again under way.

D) Toenailing.

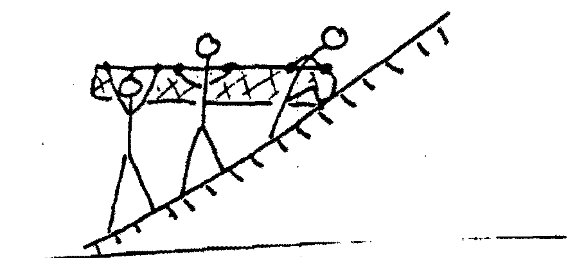
A variation on the laddering technique useful for climbing short, steep pitches is "toenailing" the head end of the litter into the slope while the rear litter bearers move up.



LC: "Ready to ladder." Peel off.



LC: "Ladder." Pass the litter up. Don't jerk!



The process is repeated as many times as is necessary.

V. SEMI-TECHNICAL EVACUATIONS

A) Semi-Technical Terrain.

Semi-technical terrain is rugged enough or steep enough that it is difficult or dangerous to move the litter without a belay, but not so steep or exposed that individual rescuers need be belayed. In descending, the belay might more strictly be termed a brake system since it is used to control the descent of the litter, and in ascending, the belay sometimes takes the form of a rudimentary hauling system. Nevertheless, the term "belay" persists where it is not confusing.

B) The Evac Team

On semi-technical terrain, the standard evac team comprises nine members, usually arranged as a litter team of six and a rope team of three. On steep slopes, however, when much of the weight of the litter is supported by the rope, some variations are used. Descending, only four are needed on the litter, and reducing the team to this size gives a lighter load on the belay and more visiblity for the litter bearers. The two excess team members can be well employed carrying extra equipment (which is particularly annoying on steep slopes). Ascending, using the "Brute Force Hauling System" (D.5), the litter can be managed by only three, with the other six members on the rope team. When the angle is steep enough that a reduced litter team is used, the litter bearers tie in to the basket.

Extra rescuers should be deployed well off the fall line of the litter so as to avoid kicking rocks onto the litter team or catching the rocks inevitably knocked loose by the litter team.

If possible, the Rescue Specialist should avoid litter bearing and rope handling duties.

C) Litter Rigging.

The Stokes Litter is illustrated in figure 18 along with its rigging.

"
$15

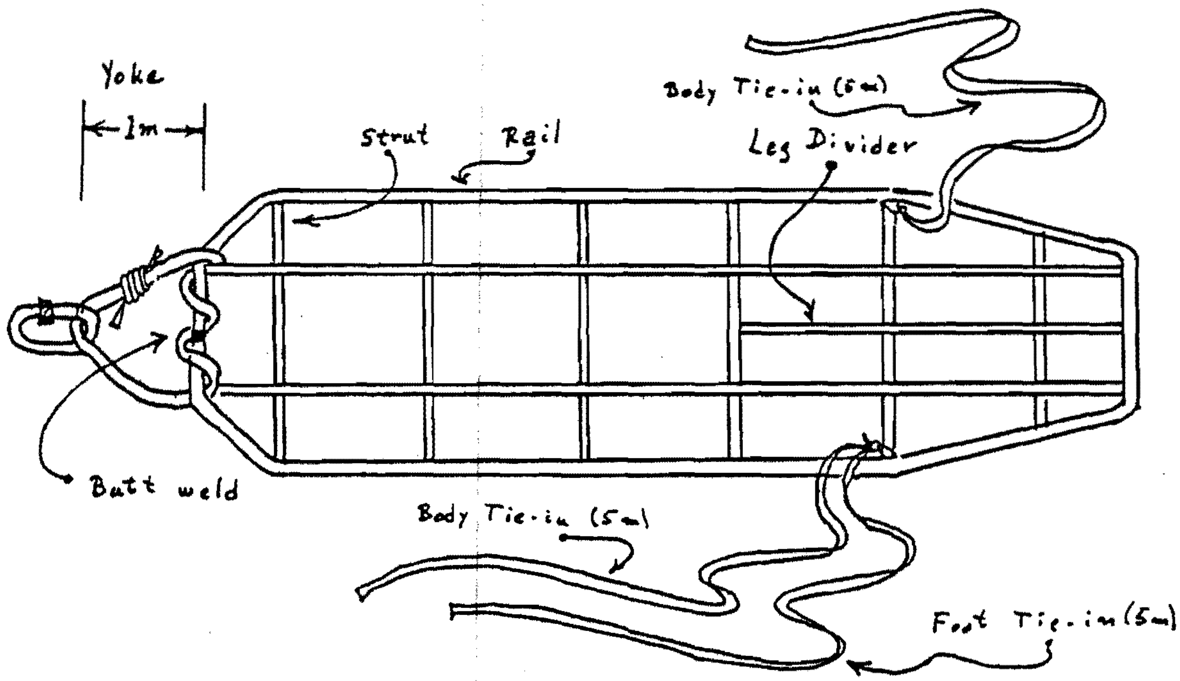


Figure 18. The Stokes Litter.

1) The Yoke

The yoke is attached permanently to the head rail of the litter, with wraps as shown to minimize flexure of the butt weld. The yoke biner is a locking type and should never be removed. For storage, the yoke biner may be clipped to a strut.

The belay rope is clipped to the yoke biner with a figure-8 loop.

2) Patient Tie-Ins.

There are three patient tie-ins attached to the litter: two for the patient's body, and one for his feet. All are of 9/16, 3/4, or 1 inch tubular webbing, 5 meters long, and permanently tied to indicated struts with overhand loops, one on one side, and two on the other. For storage, they may be run to the forward strut and back a few times and tied off with half hitches, or they may be used to secure equipment in the litter.

Figure 19 illustrates the basic patient tie in scheme. In actual practice, of course, the scheme will be varied to suit the patient's injuries. For example, crotch straps made from well padded cravats may be used to prevent a patient with leg injuries from sliding down in the basket.

To avoid abrasion of the patient tie-ins, they are never run over the litter rail, but to the struts instead.

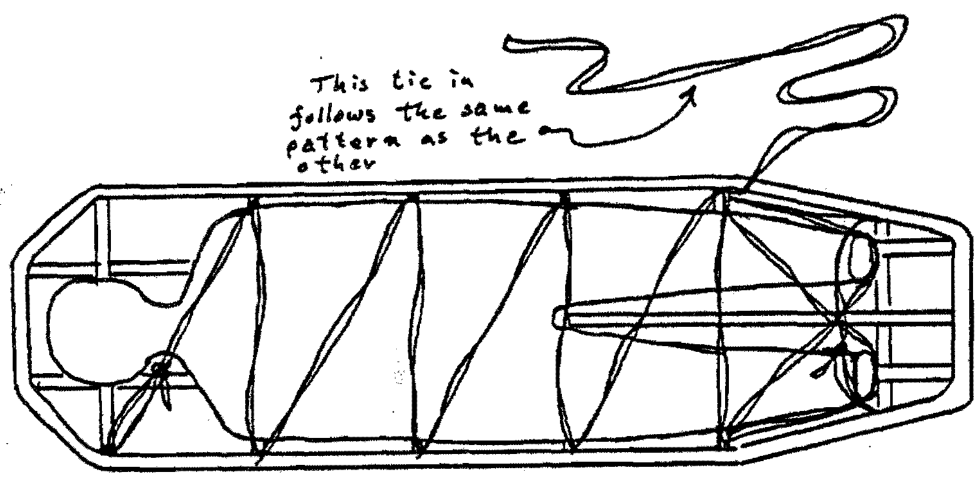


Figure 19. Patient packaging.

3) Litter Bearer Tie-Ins.

Litter bearer tie-ins are items of personal equipment which no one should lack. The tie-in is a 6mm rope* runner approximately 50 cm long. It is snapped in to the litter rail forward of a strut and supports the litter bearer's weight (fig. 20).

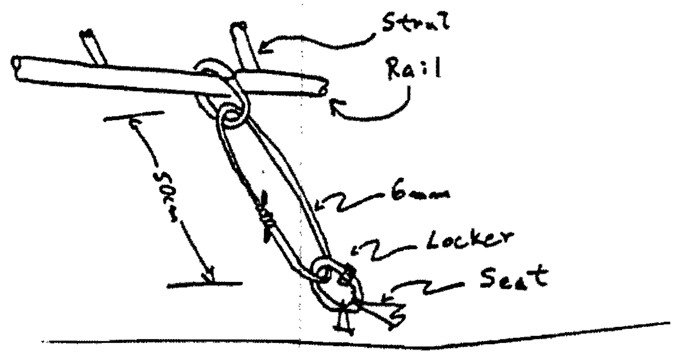


Figure 20. Litter Bearer Tie-In.

It is sometimes necessary to shorten the tie-in by doubling it.

D) Belays.

Belays for semi-technical evacs fall into three categories:

a) Tree wrap belays, which are used both to protect the ascending litter and to brake the descending litter,

b) Mechanical brakes (using the CMI-8), which are used on steeper descents, and

c) The Brute Force Hauling System, which is an aid used for steep ascents.

Because of its high strength, low stretch and excellent handling characteristics, 11mm Bluewater Caving Rope is preferred for litter belaying, but Goldline or kernmantel climbing rope are also useful.

* 7/16" polypropylene is also very useful.

1) The Tree Wrap Belay.

Sufficient friction for most evacs can be had by belaying to a tree, as illustrated in figure 21, but if the belayer feels the need for a tie-in, the tree wrap should be abandoned in favor of a mechanical belay. Minimum tree diameter for this system is about 10 cm. It must have good roots.

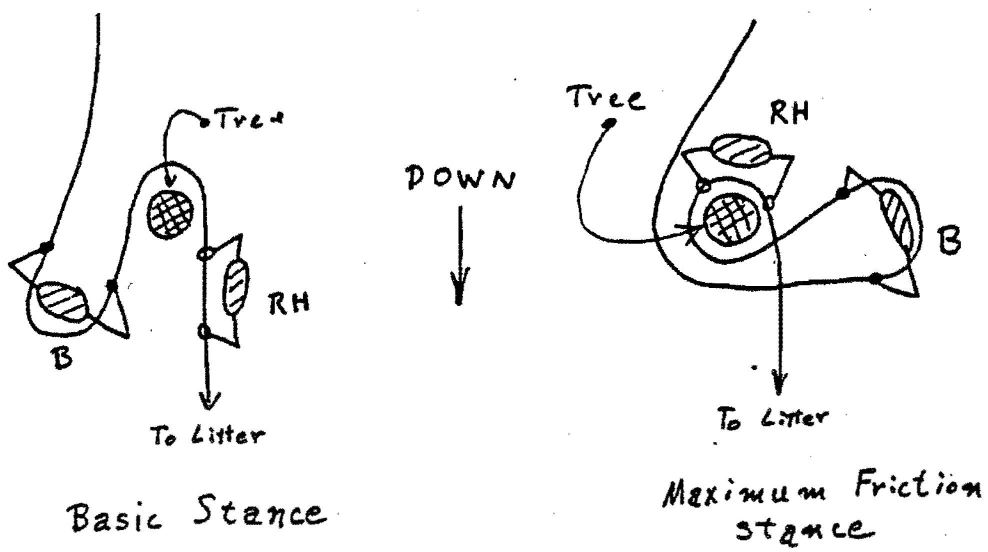


Figure 21. Tree Wrap Belay.

Note that this stance can be taken or dropped in the middle of the rope. More than one wrap around the tree is an invitation to entanglement.

The rope handler (RH) is used only in ascents to relieve friction around the tree during up-rope. He must be very careful during a fall not to get his fingers caught between the rope and the tree. In the basic stance, this is a minimal problem, but in the maximum friction stance, he must be on his toes all the time. Usually, however, if the load is such that the maximum friction stance is necessary on an ascent, the litter team will need the aid of a hauling system.

6'
15' x
$ 30

2) Mechanical Belay

For semi-tecnical descents, the mechanical brake of choice is the CMI Figure-8 descendeur rigged with a locking biner and a 9 or 11 mm rope runner or 1 inch tubular webbing runner. The anchor must be bombproof. The rigging is illustrated in figure 22.

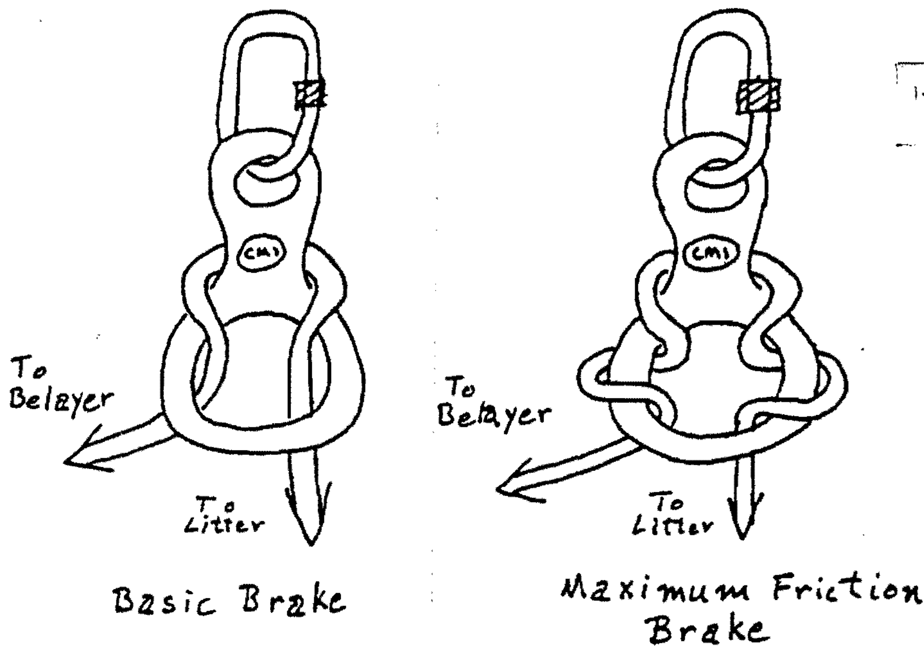


Figure 22. CMI Figure-8 Brake.

The heat handling capacity of these brakes <u>is</u> sufficient for most evacs, but there is no great margin of safety. The belayer must constantly monitor the brake temperature with his ungloved feeling hand, and if it gets too hot to touch, slow the descent and cool the brake. Snow, water, or even saliva are useful for this. Normally, excessive heating indicates excessive speed, and therefore can be avoided.

On slopes too steep or unstable for the litter team to move uphill, it can be assisted by a hauling system which uses the rope team as a counterweight (see sec. 5).

3) Descent Procedure

The deployment of the evac team for descents is illustrated in figure 23. The tree wrap belay is shown, but the same procedure is applicable when the mechanical brake is used.

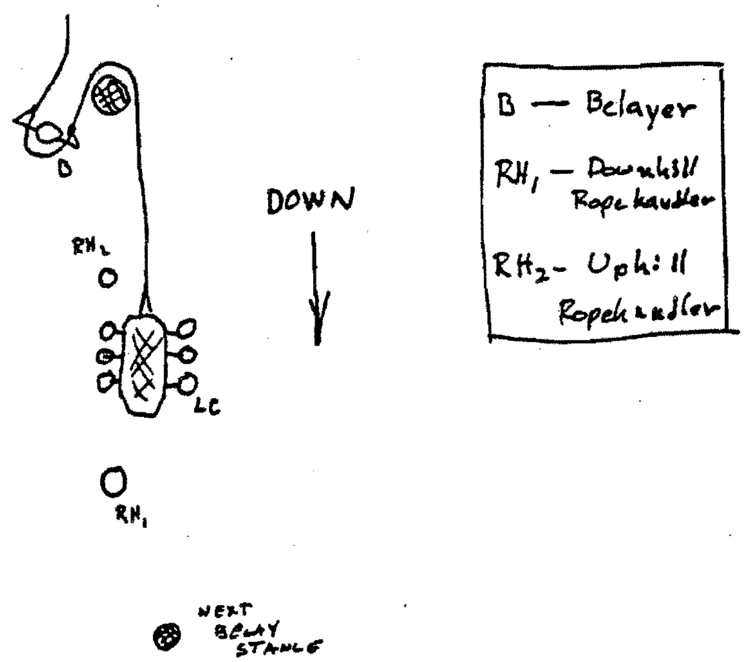


Figure 23. Semi-Technical Descent

The downhill ropehandler (RH_1) scouts the route and watches for potential belay sites. The uphill ropehandler (RH_2) acts as "seventh man," keeps the rope clear and sometimes relays calls. The belayer controls the descent. When "Two-Oh" is called, the downhill ropehandler indicates his choice of belay stance to the litter captain, who stops the litter just below it. When "Off Belay" and "Belay Off" are exchanged the rope team rotates as shown in figure 24 while the Medic checks the patient.

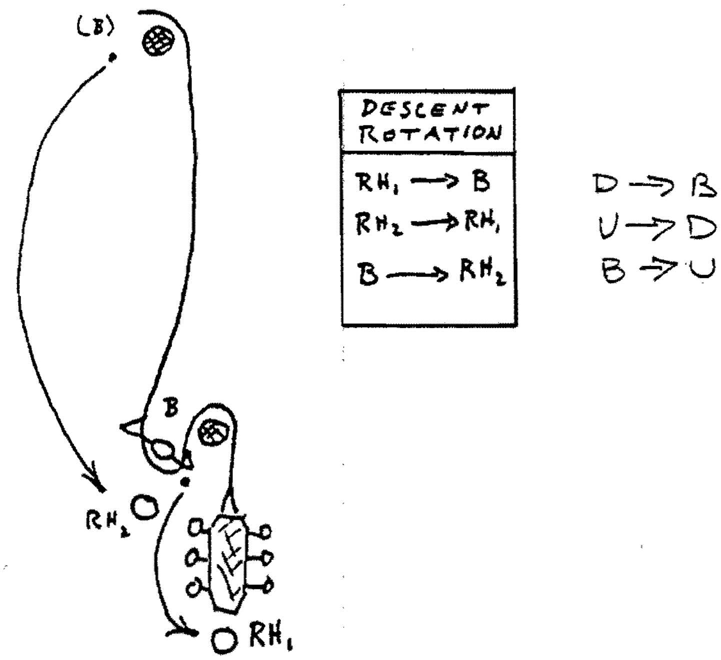


Figure 24. Descent Rotation.

The litter may begin the descent again as soon as the new belayer is ready. This takes only a few seconds. The old belayer (now the uphill ropehandler) will have to hustle to catch the moving litter, but he should swing wide to avoid kicking rocks onto the litter team.

If mechanical brakes are being used, each member of the rope team should have a rig. However, if only two rigs are available the evac can still be executed smoothly.

4) Ascent Procedure

The deployment of the evac team for ascents is illustrated in figure 25.

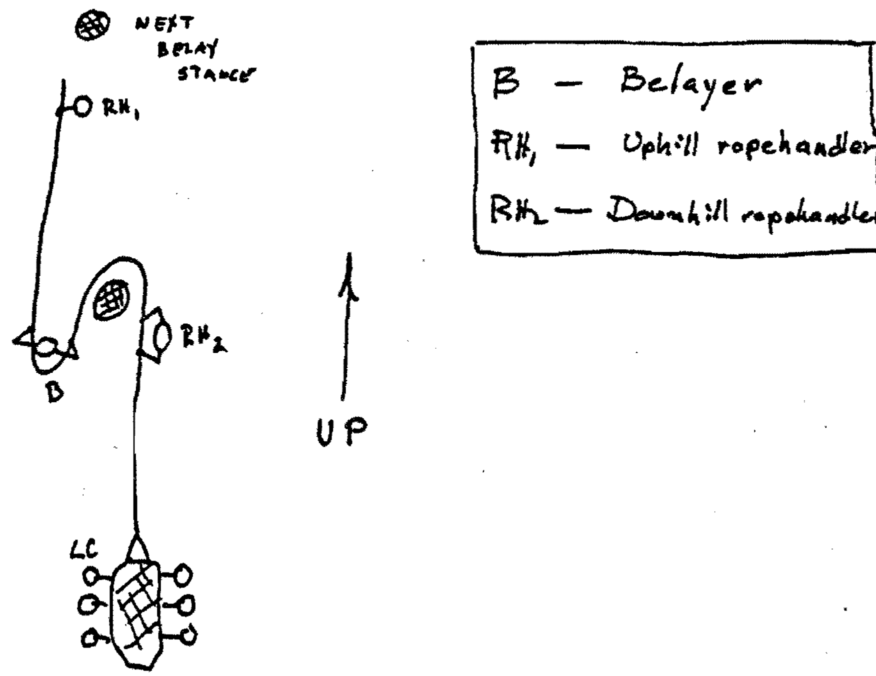


Figure 25. Semi-Technical Ascent.

The uphill ropehandler (RH_1) scouts the route and carries the end of the rope with him. The belayer (B) and the downhill ropehandler (RH_2) work the belay. When the litter is off belay, the rope team rotates as shown in figure 26 and the Medic checks the patient.

A strong belayer can often start the ascent again immediately, belaying without a ropehandler, but this is tiring, so the new downhill ropehandler should hustle up to the new stance to relieve tree friction as soon as possible. Nevertheless, the ropehandler moving up should swing wide to avoid kicking rocks on the litter.

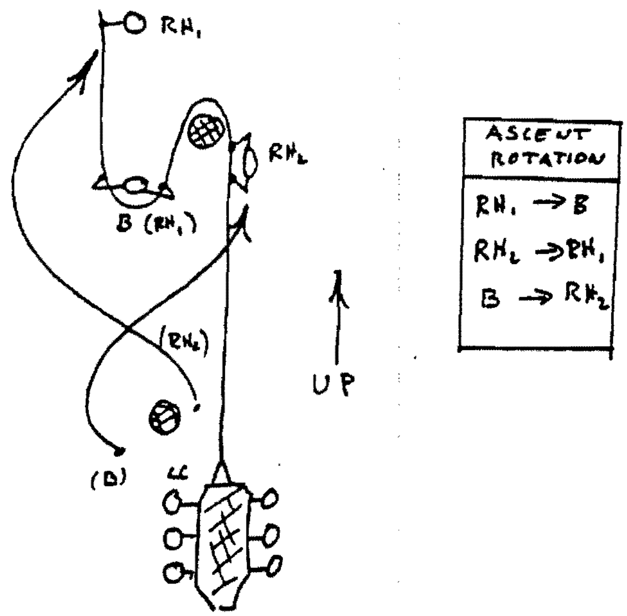


Figure 26. Ascent Rotation.

5) The Brute Force Hauling System

When ascending steep or unstable slopes, the litter team is reduced to three, and the hauling system illustrated in figure 26 is used to assist the litter team up the pitch.

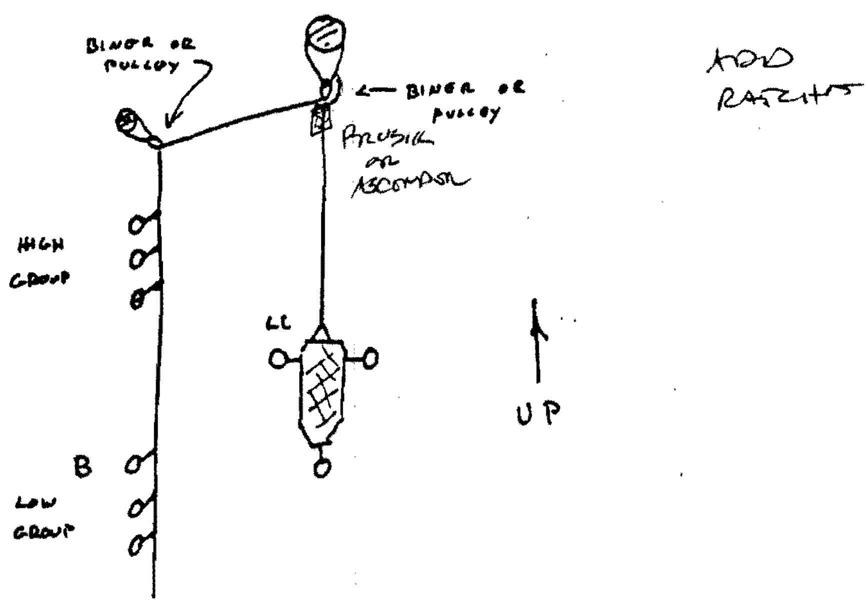


Figure 26. The Brute Force Hauling System

Rope team members tie in to the rope with prusik knots on their litter bearer tie-ins and divide into two groups (3 per group is usually adequate). The rope team member designated as belayer exchanges the usual calls with the litter captain, and on "Up Rope" the low group locks its prusiks and descends, hauling up the litter. After about 20 meters, the belayer calls "Ready, Switch" and the high group locks prusiks and descends while the low group unlocks and hand-over-hands up the rope. Just before the two groups collide, the belayer calls "Ready, Switch" and the procedure is reversed. The cycle continues until the litter captain calls "Stop". On this command, the entire rope team locks prusiks until the litter is off belay. The anchors are then cleaned and the rope team moves up to the next belay stance.

VI. COMMON TECHNICAL PROCEDURES

A) The "Z" Hauling System

A 3:1 mechanical advantage can be achieved on a haul line by the use of the "Z" System, illustrated in figure 27. The "Z" is very useful for raising litters, tightening Tyrolean Traverses, and hauling equipment.

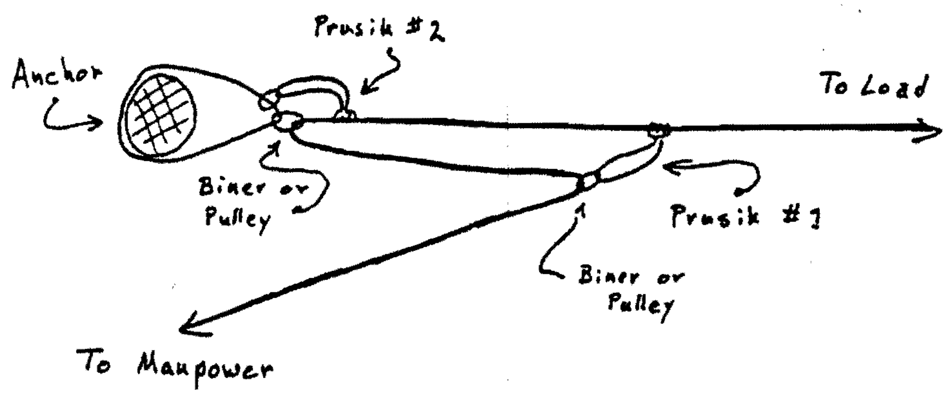


Figure 27. The "Z" Hauling System.

The following points should be noted when using the "Z."

1) Although the mechanical advantage of the system is 3:1, its efficiency is reduced considerably by friction of the rope running over rocks and by the use of carabiners rather than pulleys.

2) For heavy loads (such as litters), high strength prusiks, such as 7/16" polypro or 1" tubular webbing with headen knots, must be used. Mechanical ascendeurs must not be used except for light loads.

3) Prusik #2 must not be permitted to slip through the anchor biner.

4) The "Z" must not be allowed to straighten or the mecanical advantage will be lost.

B) The Zip Line

The Zip Line is a quick method of transferring equipment (but not people) from the top of a cliff or steep slope to the bottom. A double rope is rigged from an anchor at the top to two people (or one person and a tree) at the bottom (see fig. 28). The equipment to be transferred is clipped to both ropes and allowed to slide down. The rate of descent is controlled from the bottom by the separation of the rope ends. It is often necessary to let the load fall freely at first and then slow it near the bottom.

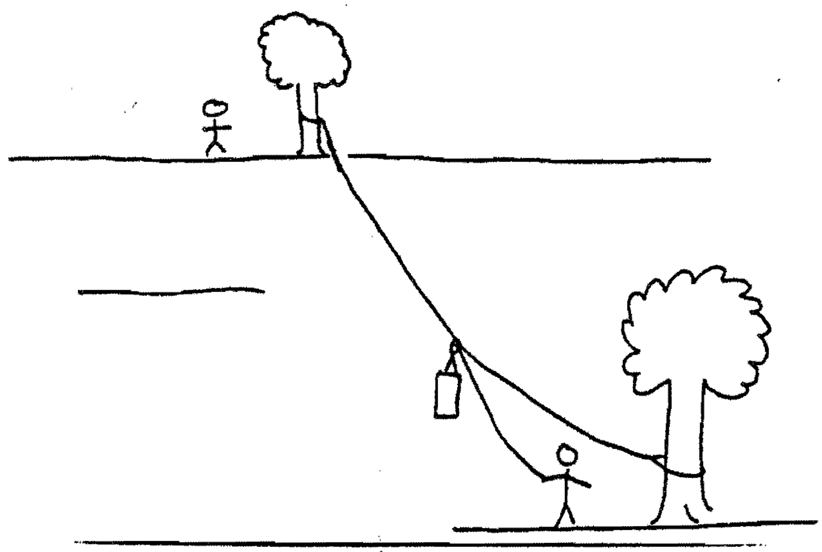


Figure 28. The Zip Line.

C) The Tyrolean Traverse

A tyrolean traverse is a rope stretched tightly between two anchors and reaching across a difficult or dangerous obstacle such as a stream or deep ravine. The traverse is used to quickly and safely transfer people, litters and equipment across the impasse.

1) Rigging

One person must cross the impasse to rig the traverse. First, however, he loops the rope around the anchor on the near side. Once on the far side, he rigs a tree wrap anchor and a Z system as shown in figure 29 (the prusiks are 7/16" polypro or 1" tubular webbing and ~~KBS~~ headden knots). He then tightens the traverse as much as possible. It is highly desireable to rig the traverse to slope gently downward if possible. This makes crossing much easier.

When the traverse is tight, prusik #1 is removed and the end of the rope is tree wrapped to the anchor to back up prusik #2. When trees are not used as anchors, the end should be tied to a separate anchor with a figure-8 and as little slack as possible.

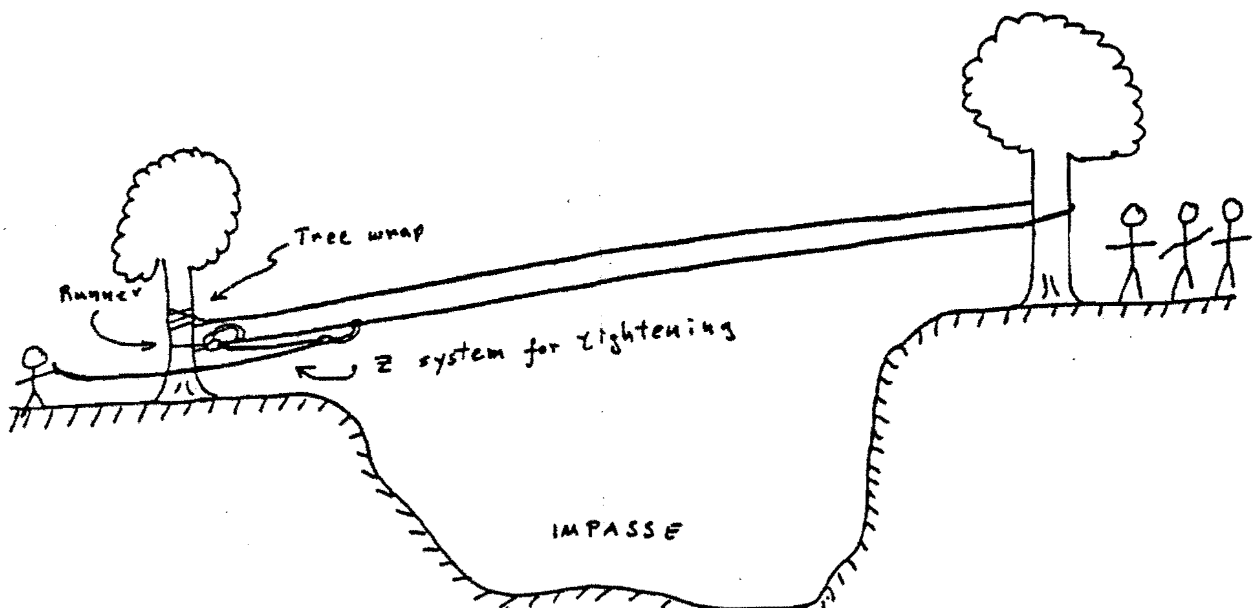


Figure 29. Rigging a Tyrolean Traverse.

2) Traversing

a) Equipment

Equipment is simply clipped to the traverse and hauled or lowered by a tag line as shown in figure 30.

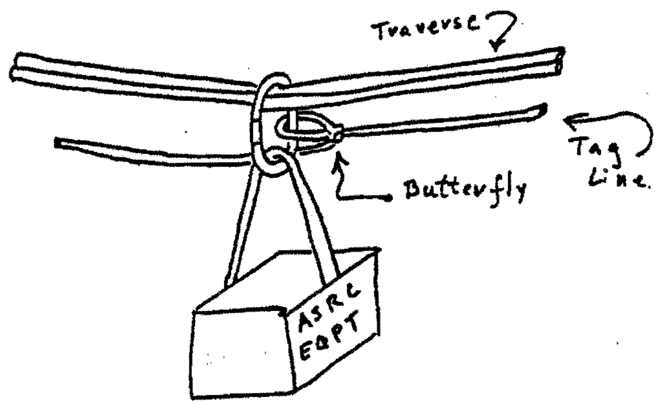


Figure 30. Transferring equipment on the Tyrolean Traverse.

b) People

The individual rescuer clips to the traverse as shown in figure 31. The extra

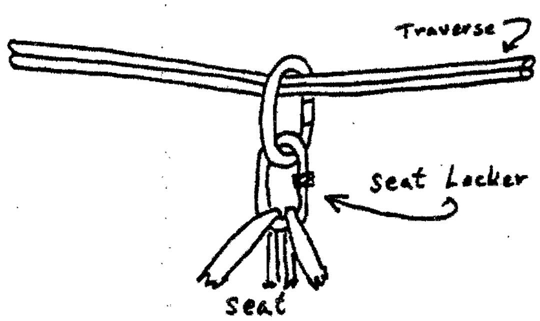


Figure 31. Clipping to a Tyrolean Traverse.

carabiner makes it easier to get on and off the traverse, and also protects the seat locker from overheating and melting the seat. Gloves are worn to prevent rope burns, and to protect the hand if it gets pinched in the rigging.

After mounting the traverse, the rescuer calls "On Traverse" before starting across. He calls "Off Traverse" when he has dismounted at the far side.

Uphill traverses are made by prusiking.

c) Litters

The litter is clipped to the traverse as shown in figure 32, and hauled or lowered using the tag lines.

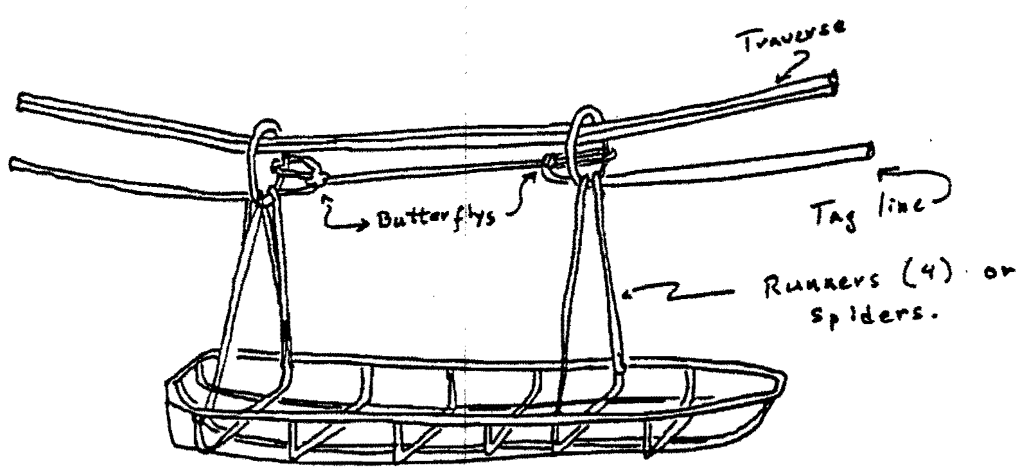


Figure 32. Rigging a litter to the Tyrolean Traverse.

If the Medic wishes to ride along with the litter, he clips in in the usual way, or he may hang from one of the litter biners by his litter bearer tie-in.

CAP GSAR COLLEGE

WILDERNESS RESCUE

ASRC MOUNTAIN RESCUE MANUAL SUPPLEMENT

This supplement has been prepared for use at the Virginia Wing CAP Ground Search and Rescue College, August, 1977. Much of the material contained in it will be incorporated into the ASRC Mountain Rescue Manual which will be published in the near future.

I. Carabiners

The most frequently used and most important article of climbing hardware used in wilderness rescue is the carabiner. A carabiner is a strong metal snap-link used primarily for making convenient but high-strength connections between various parts of a belay system. There are numerous other uses as well. The parts of a carabiner are illustrated in figure 1.

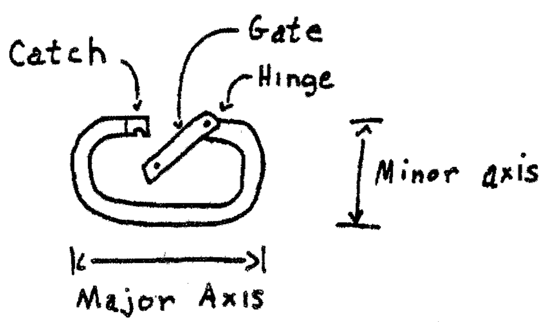


Figure 1. Carabiner.

Carabiners come in many different shapes, but there are basically three categories of these: oval, "D" and modified "D." See figure 2.

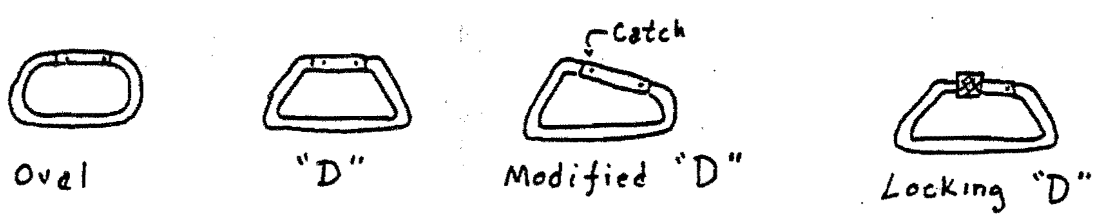


Figure 2. Carabiner types.

The weakest part of a carabiner is the catch. The "D" shape reduces stress on the catch, thereby increasing the strength of the carabiner. The "D" shapes are therefor stronger than the ovals. For example, the old SMC oval had an average strength (for major axis loading with the gate closed) of about 3000 pounds, whereas the SMC "D" has a strength of about 4700 pounds. These biners are identical in materials and construction except for the difference in shape.

The modefied "D" shape reduces weight without sacrificing strength or useability.

The strength of a carabiner is reduced drastically (to below 2000 pounds) when the gare is open, so in applications where the gate is likely to be accidentally opened, the locking (or "safety") carabiner is used. The locking sleeve screws down over the catch to keep the gate closed.

Most modern carabiners are made from very strong aluminum alloys, but there are still a few steel carabiners available. Inexpensive steel carabiners are, oddly enough, not as strong as aluminum ones, but there are several good steel carabiners. Their only drawback is their weight.

The composition of the alloy used is very important to the strength of a carabiner. For example, in 1975 the old SMC oval mentioned obove was improved with better metallurgy and catch design. This new "Ultra 4000" oval has a strength of about 3900 pounds. Forged aluminum "D"s, such as the Chouinard ar the Bonaiti Ultralight have strengths over 5000 pounds.

For rescue work, 3900 pounds (major axis, gate closed) should be considered the minimum acceptable strength for a carabiner.

In using carabiners, several dangers must be avoided. The low open gate strength has already been mentioned. A locker biner should be used when this is a problem, but if a locker is not available, two regular carabiners with gates opposed will work as well (see figure 3). For true opposition,

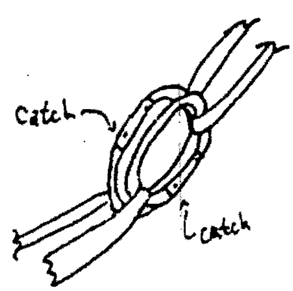


Figure 3. Opposed gates.

the catches of the of the two carabiners must be on opposite ends if one of the biners should accidentally turn so that the gates ore together (see figure 4).

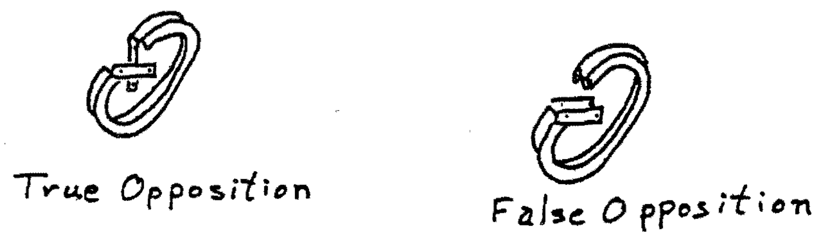


Figure 4. True and false opposition.

When a carabiner is used resting against a surface, the gate should be positioned away from the surface so that it will not be pushed open (figure 5).

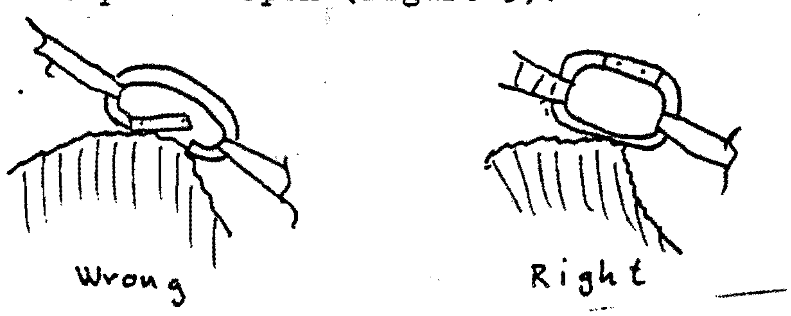


Figure 5. Carabiner against a surface.

The strength of a carabiner is very low for loading on the minor axis. This configuration is called cross loading. Care must be taken that cross loading is not permitted. Figure 6 shows two typical cross loading examples.

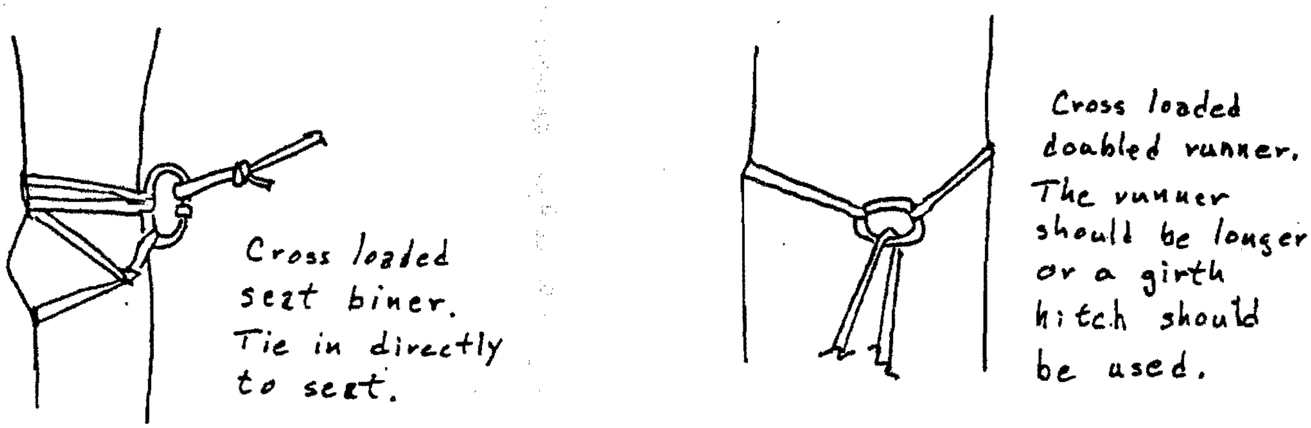


Figure 6. Cross loading.

The strength of a carabiner is also degraded when it is loaded in a way that tends to bend it (figure 7). This configuration is called side loading and must be avoided.

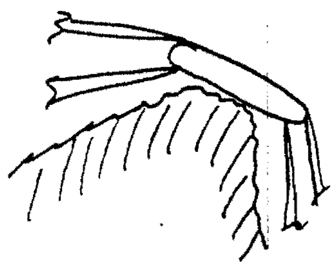


Figure 7. Side loading.

In caring for carabiners, the main consideration is smooth and reliable operation of the gate. Usually very little maintenance is required , but occasionally grit must be cleaned from the hinge and locking sleeve. Petroleum solvents are good for this, but the solvent must be completely removed before the biner is used again. A very small drop of a penetrating lubricant (such as LPS or CRC 5-56) may be applied to a stubborn hinge, but in general no lubrication is necessary or desireable. Petroleum products damage ropes!

If the catch or hinge of a carabiner is bent so that the gate does not work properly, the carabiner should be retired. Bending couses severe weakening of the metal.

Burrs should be removed with emery cloth or a file.

II. Testing of Ropes.

The reliable testing of rope is impossible. For this reason, good rope care practices, frequent inspection, and complete record keeping are extremely important to insure the rope's reliability.

It is possible, however, to test a rope in the field by tying one end to a solid anchor and having five or six people pull on the other. This is called pull testing. A good pull test loads the rope perhaps 500 pounds, or about 10 % of its breaking strength, thus ruling out failures at that stress or below. No damage is done to the rope by this procedure.

Since a rope may be loaded to 3000 pounds in severe service, pull testing in this fashion is no great insurance against foilure, but it is some. Frequent pull testing is therefor adviseable, but it should not lead to overconfidence. If a rope is damaged or strained, it must be considered faulty: successful pull testing does not guarantee the soundness of a rope. <u>There is no substitute for proper rope care</u>.

III. The ASRC Seat Harness.

The ASRC seat is a tied webbing harness with the virtue that it may be cut in any two places without failing completely. The seat is made from about 5 meters (more or less, depending on the size of the user and the number of waist wraps desired) of one inch tubular webbing. The seat is prepared as shown in figure 8.

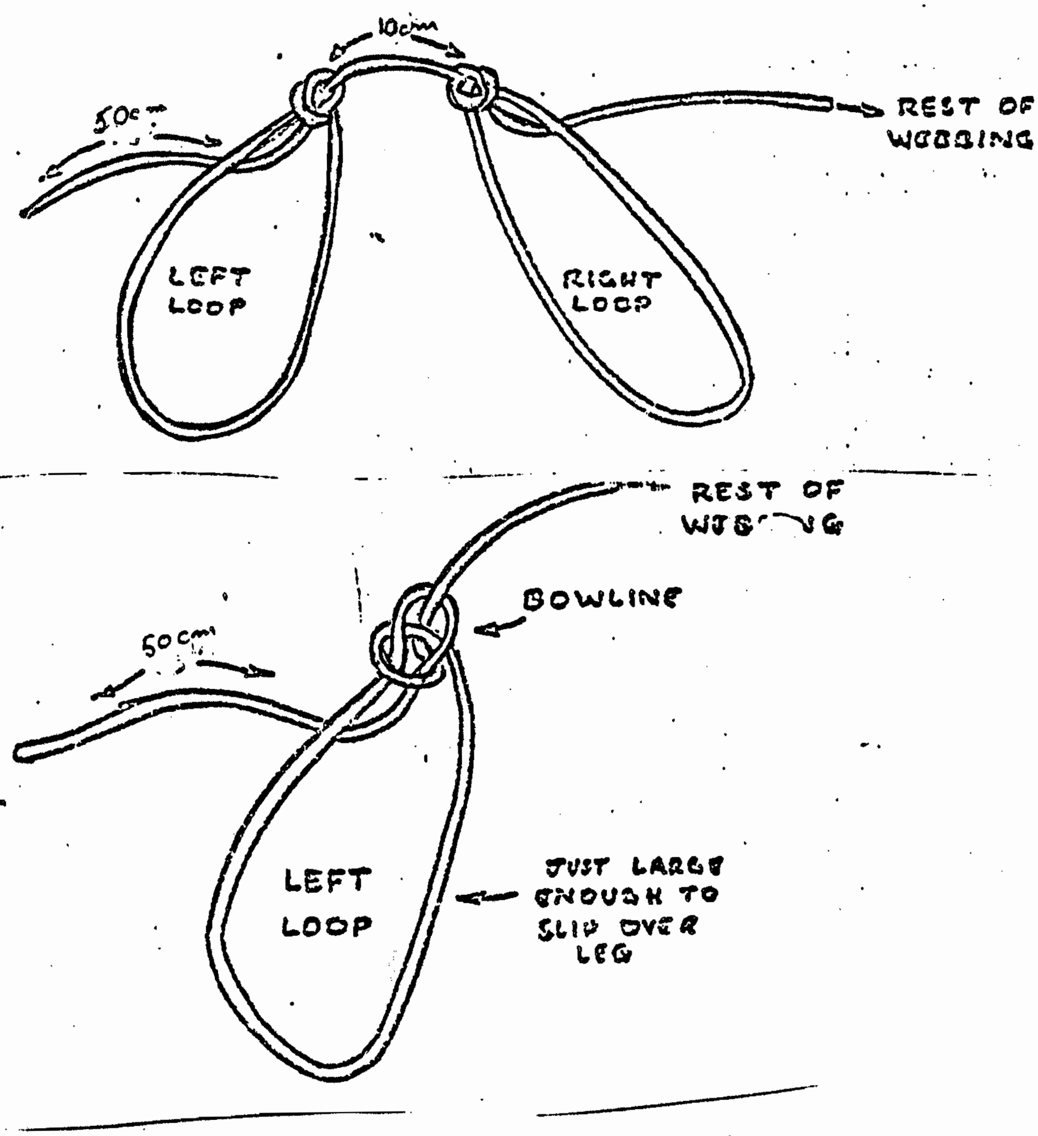


FIGURE 8
ASRC SEAT CONSTRUCTION

The ASRC Seat is worn as shown in figure 9.

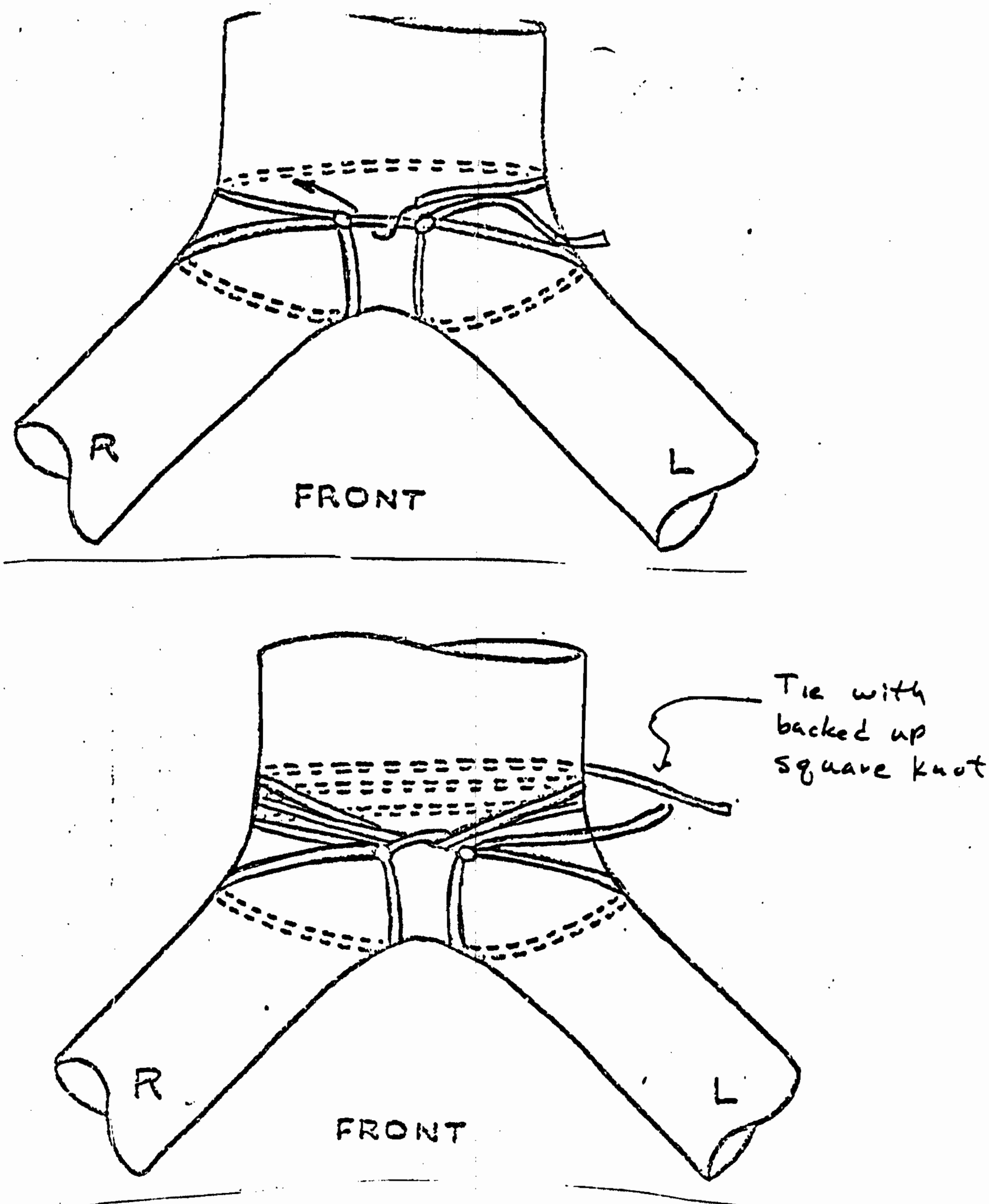


FIGURE 9

USE OF ASRC SEAT

For rappelling or tying in to a litter, a locking carabiner may be clipped around all the waist loops and the short section between the leg loops. When tying in to the end of a rope, tie the rope directly to the harness with a small bowline; do not tie in to the carabiner or cross loading may result.

IV. Rigging the Army Stretcher for Semi-Technical Evacuations.

Although not nearly as good as the Stokes Litter, the Army (D-Ring) Stretcher may be effectively used for semi-technical evacs. Rigging is illustrated in figures 10 and 11.

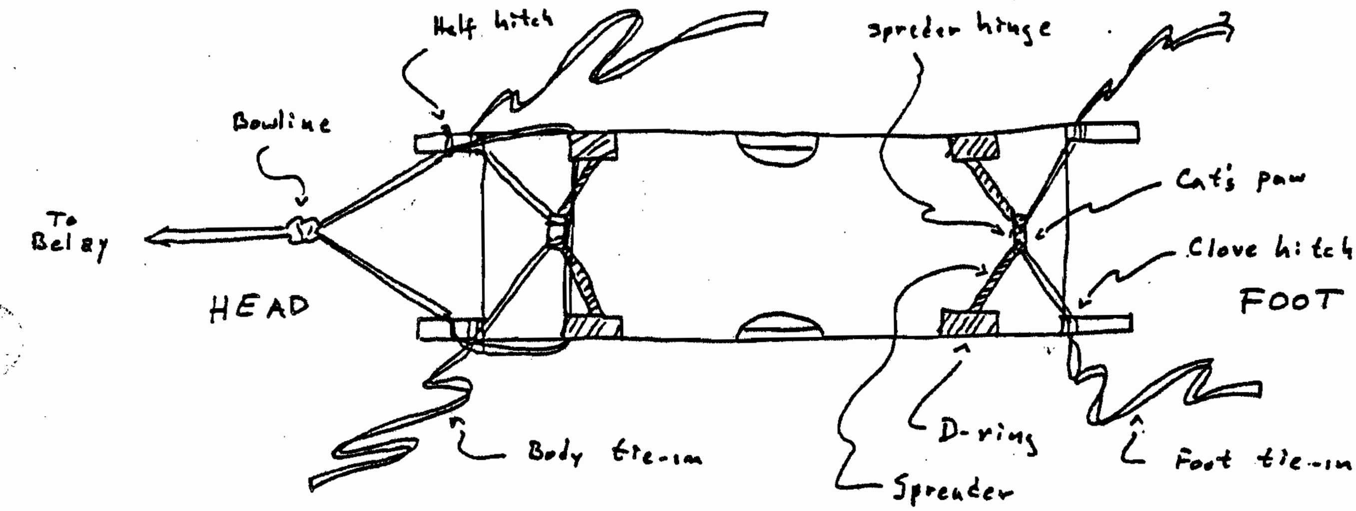


Figure 10, D-Ring Rigging

Bottom Views

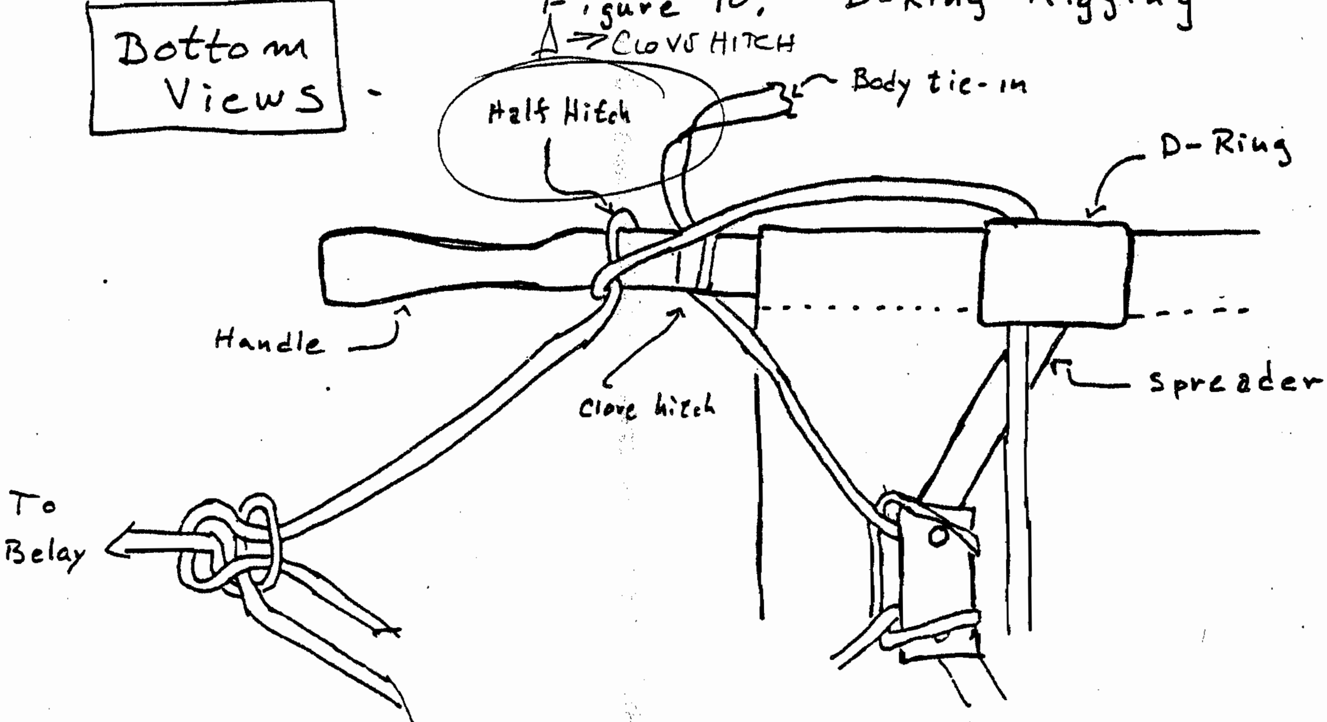


Figure 11. Detail of Rigging

The patient tie-ins are made from 15 meters (each) of one inch tubular webbing. Each piece is tied to the hinge of the spreader with a cat's paw and then to the stretcher handles with clove hitches. This prevents the stretcher from accidentally collapsing. It must be done tightly to be effective.

Instead of using a yoke, the belay rope is directly to the head end of the litter witha bowline. The loop of the bowline passes through the D-rings (which bear the load), and half hitches are placed around the handles for stability. Of course, if the litter is left permanently rigged, a yoke could be attatched in the same fashion, but this is somewhat cumbersome for storage and non-technical use.

The patient is secured to the litter as shown in figure 12. Usually there will be considerable excess foot tie-in. The reason that the foot tie-in is made so long is so that there is no danger of loading the patient into the litter backwards and so that sufficient rope will be available if the patient's injuries demand modification of the tie-in scheme

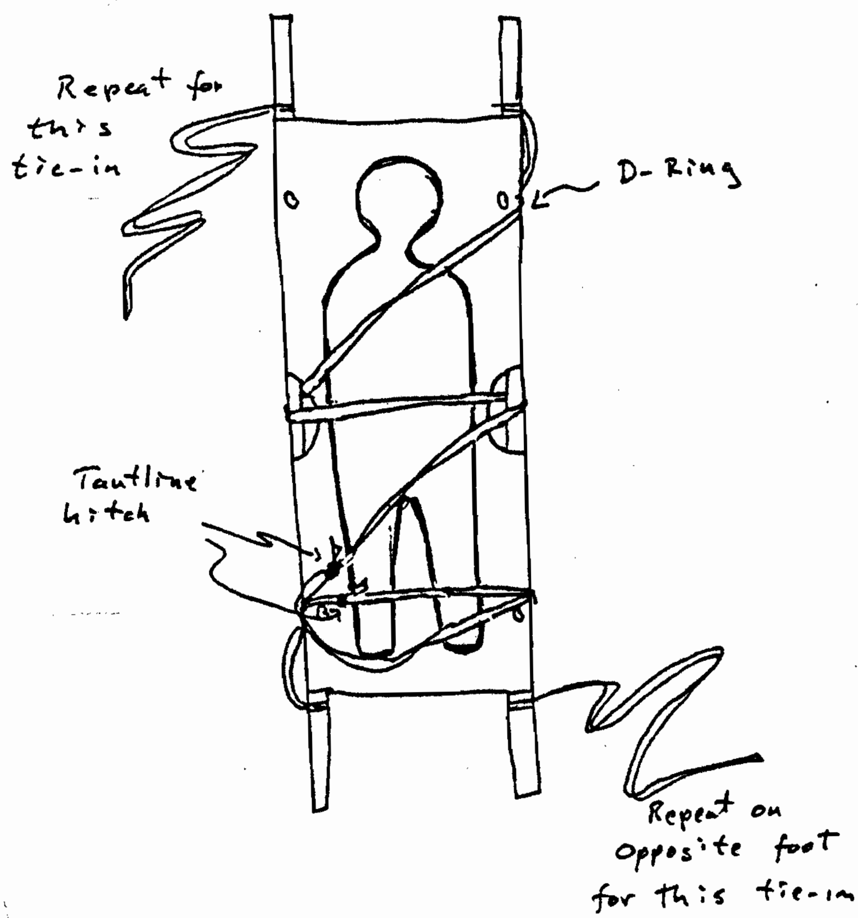


Figure 12. Patient Packaging using the Army Stretcher.