

Glacier Travel and Crevasse Rescue

Notes



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AMGA-Certified Rock, Alpine & Ski Guide
IFMGA-Licensed Mountain Guide

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Contents

Introduction	3
Mindsets for Reducing Risk	3
More Information	3
Course Topics	3
Crevasse Rescue Gear	4
A Progression of Skills	5
Knots and Hitches	6
Roping Together	7
Ropes for Glacier Travel	7
Rescue Coils	7
Kiwi Coils	8
Team Spacing	9
Rope Management	10
Crevasse Rescue	11
1. Catch the Fall	12
2. Victim Self Rescues	13
3. Direct Haul	14
4. Team C	14
5. Build the Anchor	15
6. Transfer Load to the Anchor	15
7. Prepare Lip	16
8. Drop C	17
8. 2:1 Drop C	18
9. Add 3:1 to Drop C for 6:1	19
10. Move Master Point	20
Progress Capture	21
Mechanical Advantage	21
Counting Mechanical Advantage	22
The Crackulator	23
Background	23
Using The Crackulator	23
Step 1 Glacier and Skier Factors	24
Step 2 Recommended Level of Caution	25
Step 3 Recommended Actions	26



Introduction

Mindsets for Reducing Risk

1. **Learn** glacier travel and crevasse rescue from an AMGA ski or alpine-certified guide. They teach the modern industry standard.
2. **Practice** these skills because you hopefully never get to actually use them, but they could save a life. Without annual practice you won't be able to do a crevasse rescue. Just like CPR, or avalanche rescue.
3. **Update** your skills by following the industry standard set by the AMGA and IFMGA. There are 100 ways to do each technique, and these techniques change. Methods from 20 years ago are dated. These notes focus on the simplest, most effective techniques that follow the industry standard set by the AMGA and IFMGA.
4. **Highest priority** is avoiding a crevasse. Lowest priority is the haul system. In order:
 1. Take precautions to avoid a crevasse fall.
 2. Learn to build and use snow anchors.
 3. Practice self-rescue by ascending a rope with prusiks or mechanical ascenders.
 4. Although rarely needed, the haul system is worth practicing, only after mastering the first three priorities.

More Information

- **AMGA:** amga.com/alpine-videos/
- **ENSA brake knot:** youtube.com/watch?v=lgNR-VZMwHo&feature=youtu.be
- **Gear:** stockalpine.com/s/Backcountry-Ski-Gear-List.pdf
- **Petzl website:** petzl.com/US/en/Sport/Ski-touring
- **Vdiff:** vdiffclimbing.com/alpine/

Course Topics

- Your goals and trips
- Gear
- Harness setup
- Knots: overhands, figure eights, prusik, Munter, clove, autoblock
- Prusiking from a tree
- Snow anchors: ski and picket
- Arresting a fall
- Roping together, stopper knots
- Rescue coils and Kiwi coils
- Haul: direct haul, team C, Drop loop (2:1), drop loop with 3:1 (6:1)
- Optional: belaying, rappelling
- Glacier tour practicing the skills



Crevasse Rescue Gear

___ **Ice axe.** Light with a steel head. Have it reach your calf. Leash not recommended. Joe's choice: Petzl Gully for ski, Petzl Sum'tec for alpine.

___ **Crampons.** Steel only. Joe's choice: Grivel Air Tech New Matic or Petzl Vasak.

___ **Harness.** Light and simple with belay and gear loops. Joe's choice: Petzl Altitude, Petzl Tour, or Blue Ice Choucas.

___ **Climbing Helmet.** Joe's choice: Petzl Sirocco or BD Vision.

___ **Rope.** 1 x 60 m single-rated rope for summer. 2 x 45-60 m ropes for ski. Joe's choice: Petzl 60 m Rad Line for ski.

___ **Snow Anchor.** Skis with a ski strap, and/or a picket. Joe's picket choice: MSR Cable Picket.

___ **4 Locking Carabiners.** Bring two that are Munter hitch compatible (pear-shaped). Joe's choice: BD Vaporlock Screwgate Carabiner, Petzl Attache.

___ **4 Non-Locking Carabiners.** Light, wire-gate preferred. Joe's choice: Oz Carabiner.

___ **Belay Device.** Joe's choice: BD ATC Alpine Guide or Petzl Reverso 4.

___ **Ice Screw.** To place on the crevasse wall. Bring with tip cover and mesh coating. Joe's choice: Petzl 17cm Laser Speed Ice Screw or BD 19cm Ultralight Ice Screw.

___ **3 Prusik Loops*.** Made from 1.5 m (5-foot) lengths of 5 mm accessory cord. Tied into a loop with a Flemish bend.

___ **Cordelette*.** 6 m (20 feet) length of 5 mm accessory cord. Tied with a Flemish bend.

* If you don't have prusiks or cordelette, then bring 10 m (33 feet) of 5 mm accessory cord and we'll cut it to length.

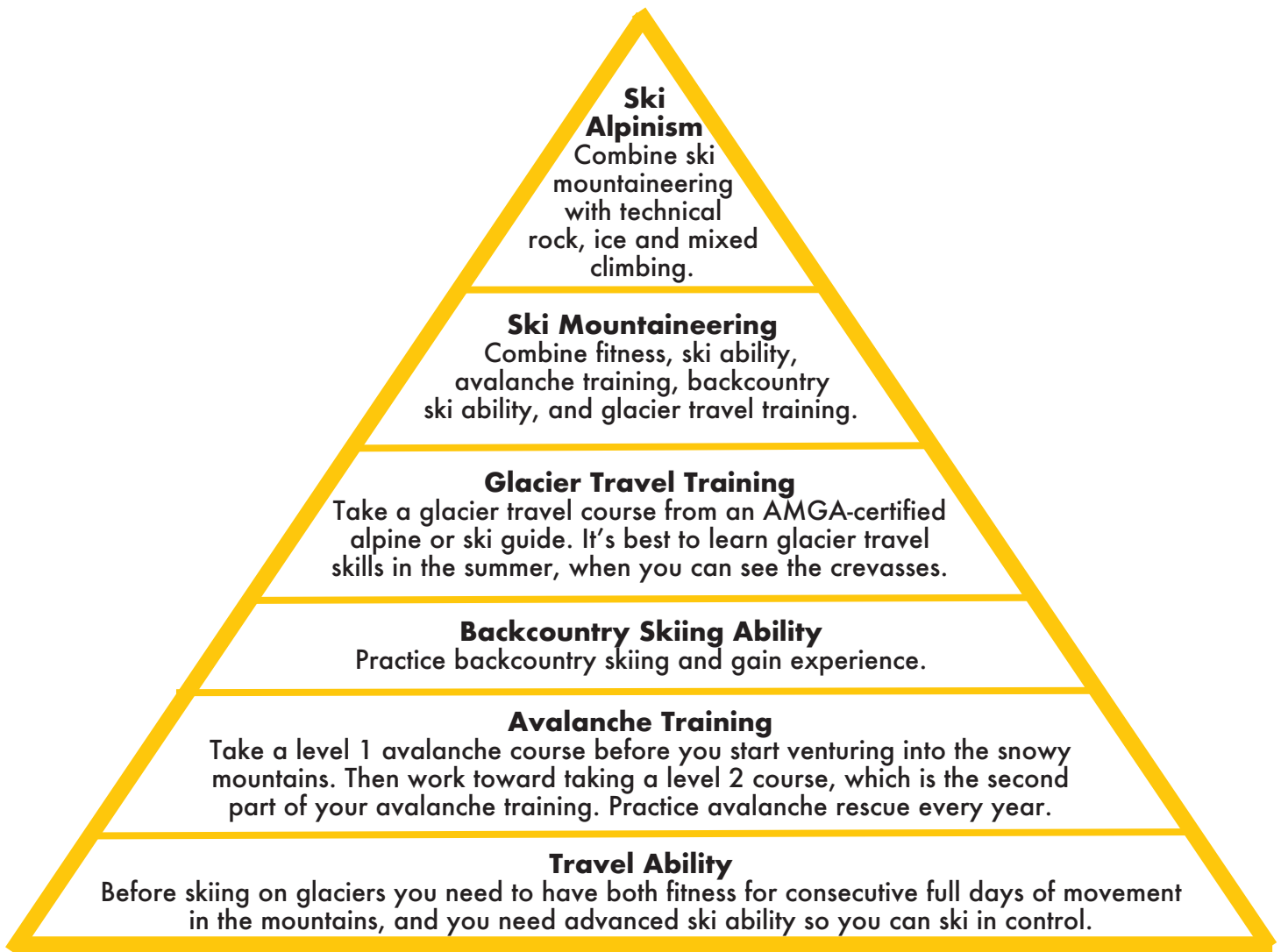
___ **Pully/Progress Capture.** Recommended. Petzl Nano Traxion or Edilrid Spoc.



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A Progression of Skills





Knots and Hitches

Keep things simple by limiting the number of knots and hitches you use. Recommended here are several hitches and variations of the overhand and figure eight. Dress and stress all knots.



Overhand on a bight. A bight is a doubled over piece of rope.



Flat overhand. For joining ropes for rappel. Dress and stressed with 18-inch tail.



Figure eight on a bight. Used as a mid-rope clip-in for glacier travel. Dressed and stressed with a 6- to 8-inch tail.



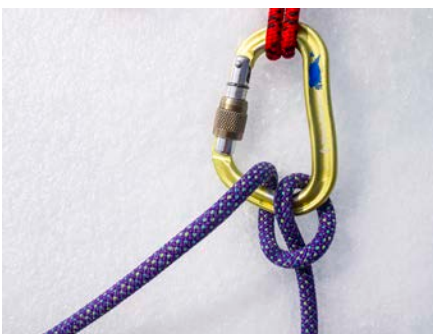
Figure eight follow through. For tying into the end of the rope. 6- to 8-inch tails.



Flemish bend. For joining ends together for prusik loops and cordelette. 4- to 6-inch tails.



Butterfly knot. Used for stopper knots or for a mid-rope clip-in.



Munter hitch. For belay and rappel.



Prusik hitch. Slides and grips on a rope for ascending and belay.



Clove hitch. For clipping into the anchor at the belay.



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Roping Together

1. **Storing extra rope:** use rescue coils and kiwi coils.
2. **Team spacing:** depends on the size of the crevasses and number of people on the rope.
3. **Rope management:** minimize slack

Ropes for Glacier Travel

- The simplest rope option is to get the skinniest **single-rated 60 m** rope you can find. Half-rated ropes also work, but stretch more which can increase the fall danger.
- The 60 m **Petzl Rad Line** is perhaps the best glacier skiing rope option because it is light. It is also expensive and not for use on rock.
- Static or **semi-static** rappel ropes work well.
- **45 m** is the minimum length necessary for a crevasse rescue haul system.
- Always **bring two** ropes for skiing on glaciers. In case the rope carrier falls in.

Rescue Coils

This is the best option for storing extra rope for non-technical glacier travel like the lower West Buttress on Denali. This option is cumbersome to adjust distance. Store the coils in your pack.



Glacier Travel Notes



A rope laid out and ready for the team to clip in.



Kiwi Coils

This option for storing extra rope is best for technical climbing terrain that can include glacier, rock or both. It is quick to adjust the length between climbers. Since climbers are tied into the ends, it's also easy to switch from glacier travel mode to pitched climbing mode.



Tie into the end of the rope and coil rope around shoulder.



Pull a bight past the tie in, and up through the coils, from the inside to the outside.



Take the bight behind both the tie-in and the rope leading to the next climber.



Tie and overhand knot around both the tie-in and the rope leading to the next climber.



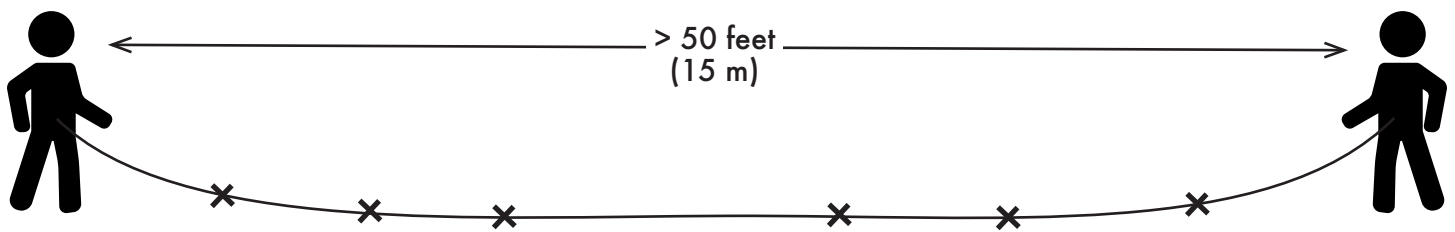
Dress and tighten the overhand. Clip a figure eight on a bight onto two lockers on the rope leading to the next climber.

Glacier Travel Notes



Team Spacing

Team spacing on the rope depends on the number of people and the size of the crevasses. More people on the rope provides more holding power for a crevasse fall. Three to four people on a rope is ideal. Rope teams of two should place stopper knots (butterfly knots) on the rope every six feet to catch on the crevasse lip.



Two-Person Rope Team Spread apart at least 20 m (60 feet) with three butterfly or ENSA stopper knots every 2 m (6 feet) from each person.



Four-Person Rope Team Spread apart at least 10 m (30 feet) between each person.



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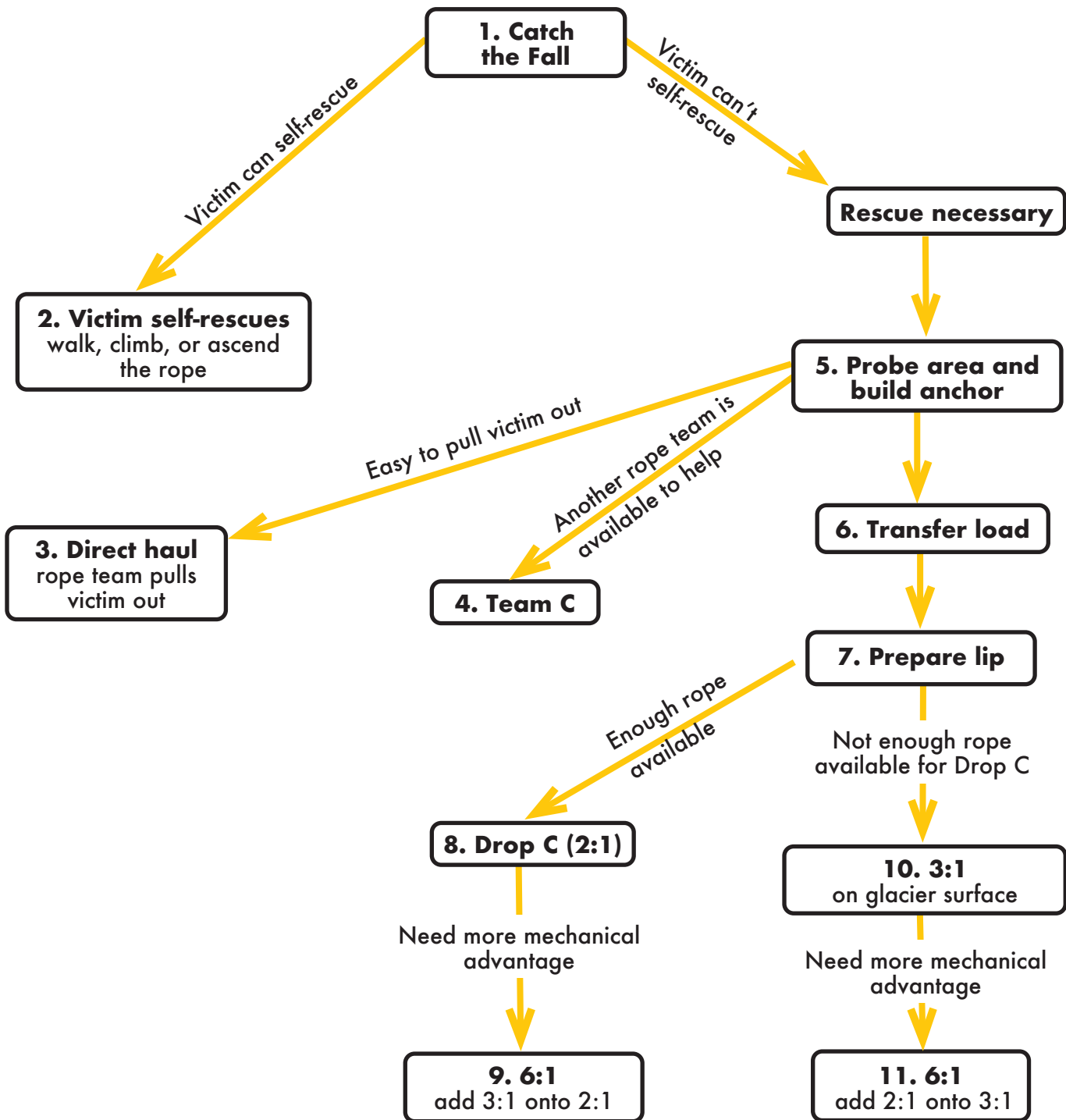
Rope Management

Managing the rope is a balance between having enough slack so you're not pulling on your teammates and minimizing slack that could increase the distance of a crevasse fall. During normal glacier travel have the rope touching about 2 m (6 feet) in front of you and then dragging along. When crossing a suspect bridge, tighten the rope until it's in the air.





Crevasse Rescue





1. Catch the Fall





2. Victim Self Rescues

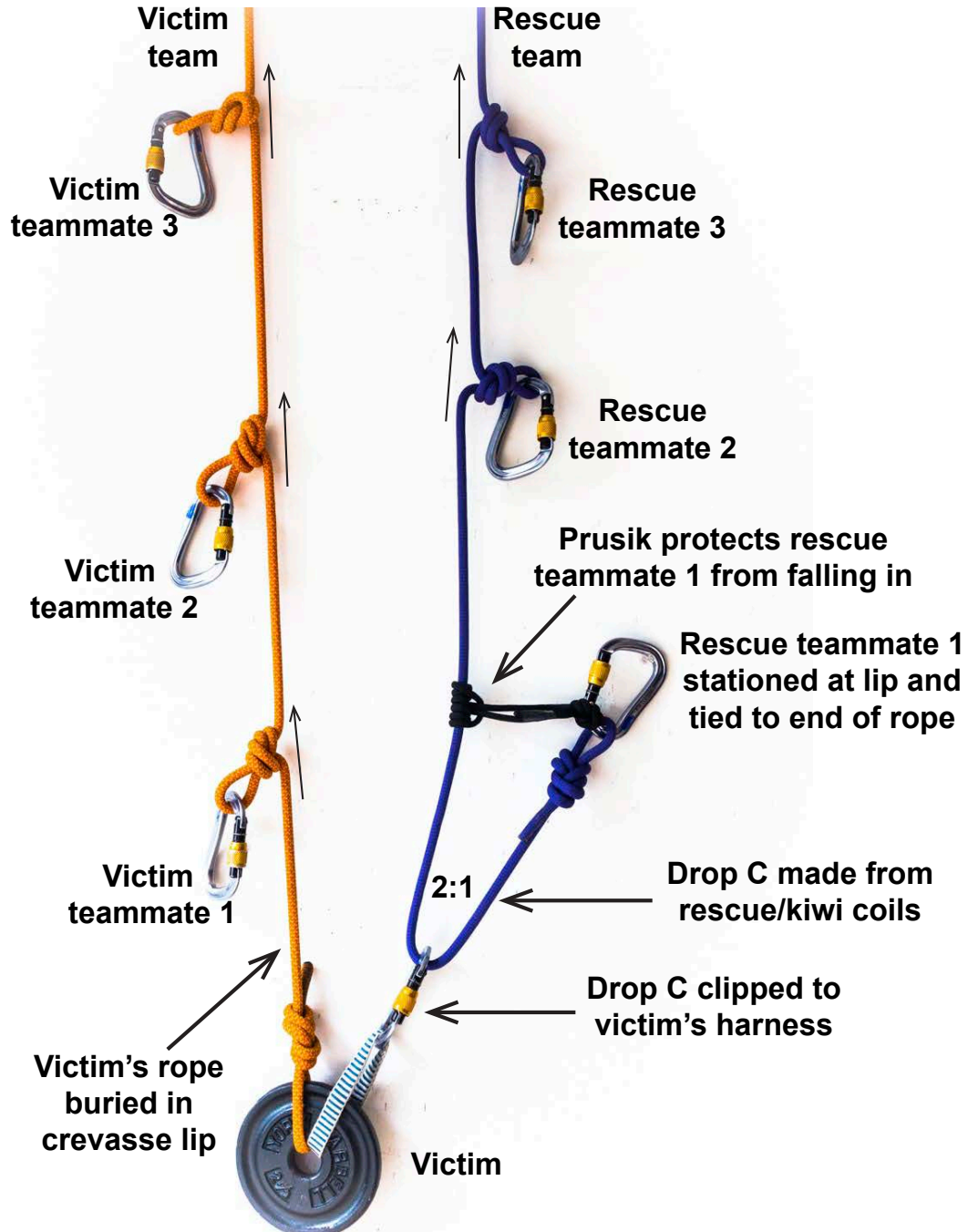




3. Direct Haul

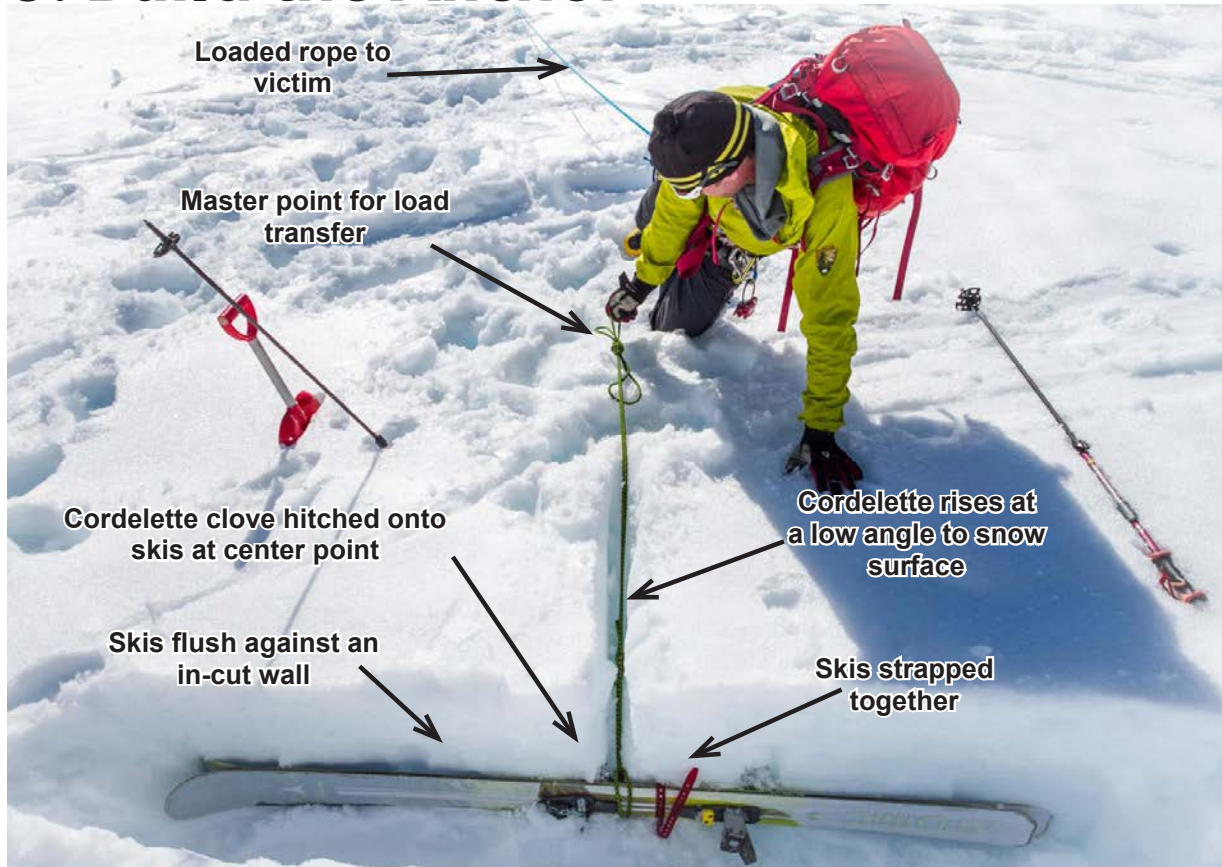
The team pulls the victim straight up and out. This can sometimes work if the rope isn't dug into the crevasse lip.

4. Team C

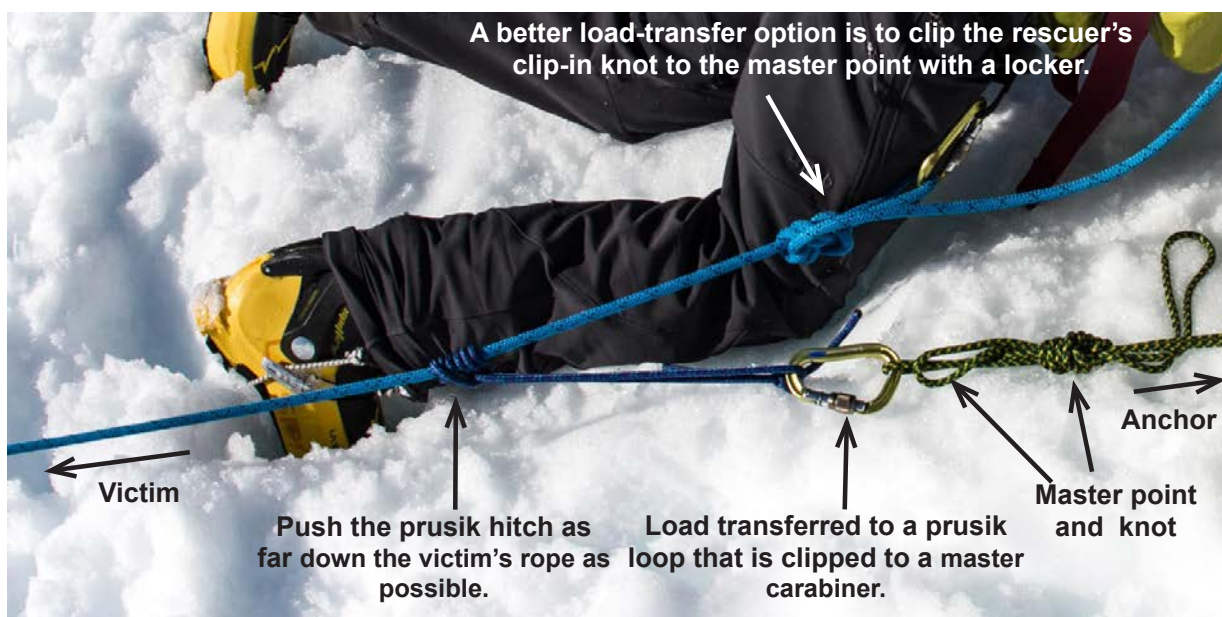




5. Build the Anchor



6. Transfer Load to the Anchor





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7. Prepare Lip



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- 16 -

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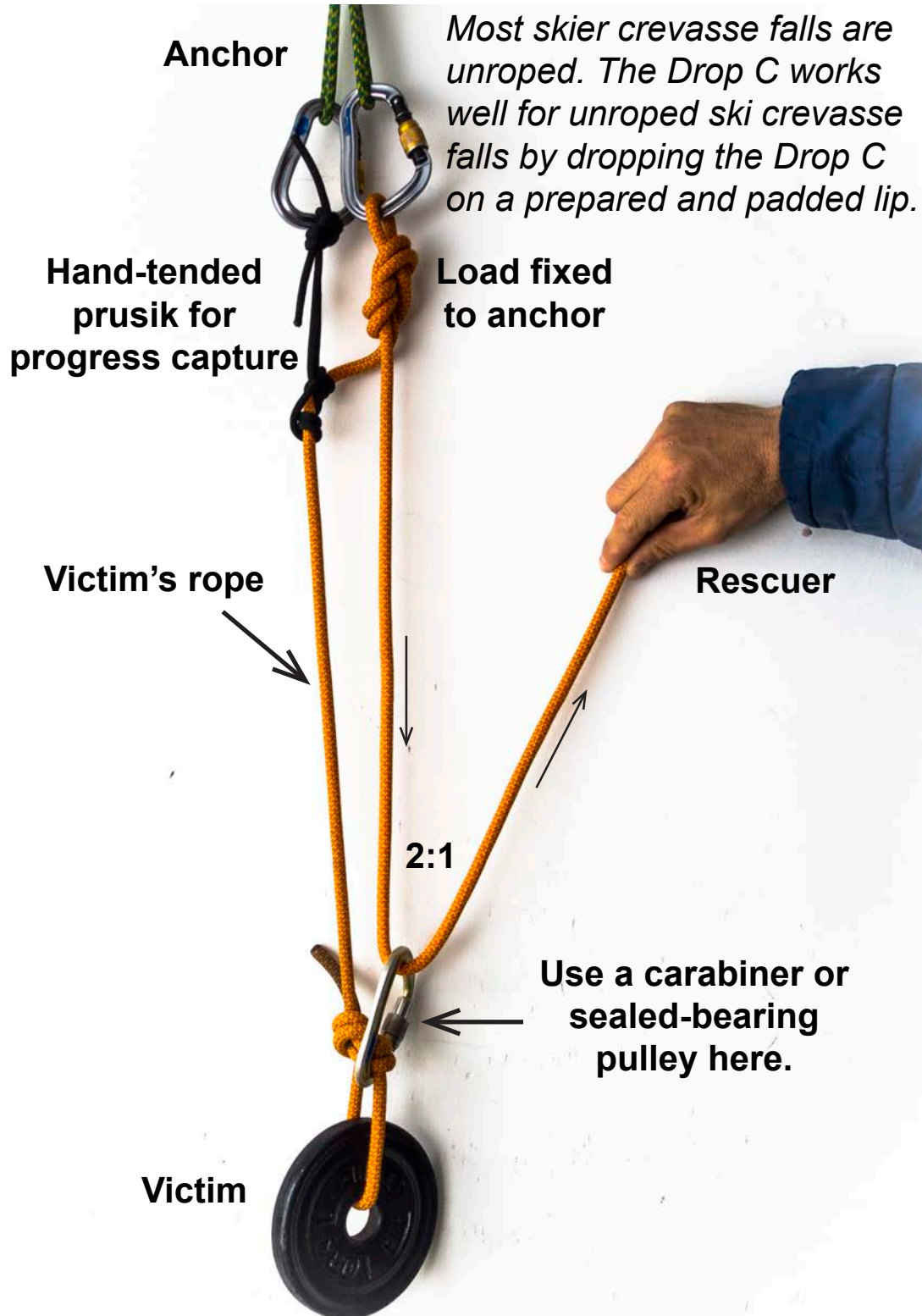


8. Drop C



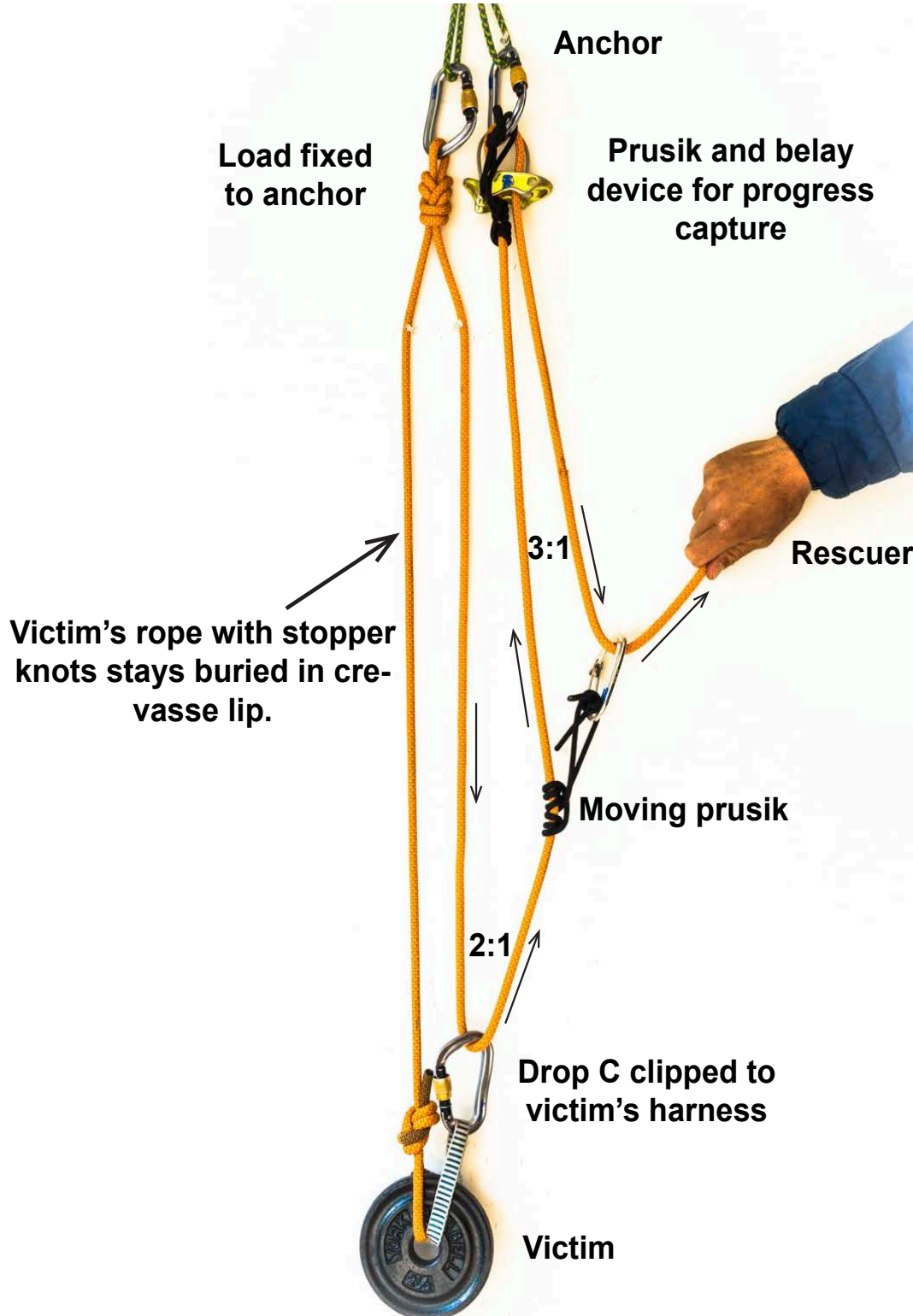


8. 2:1 Drop C





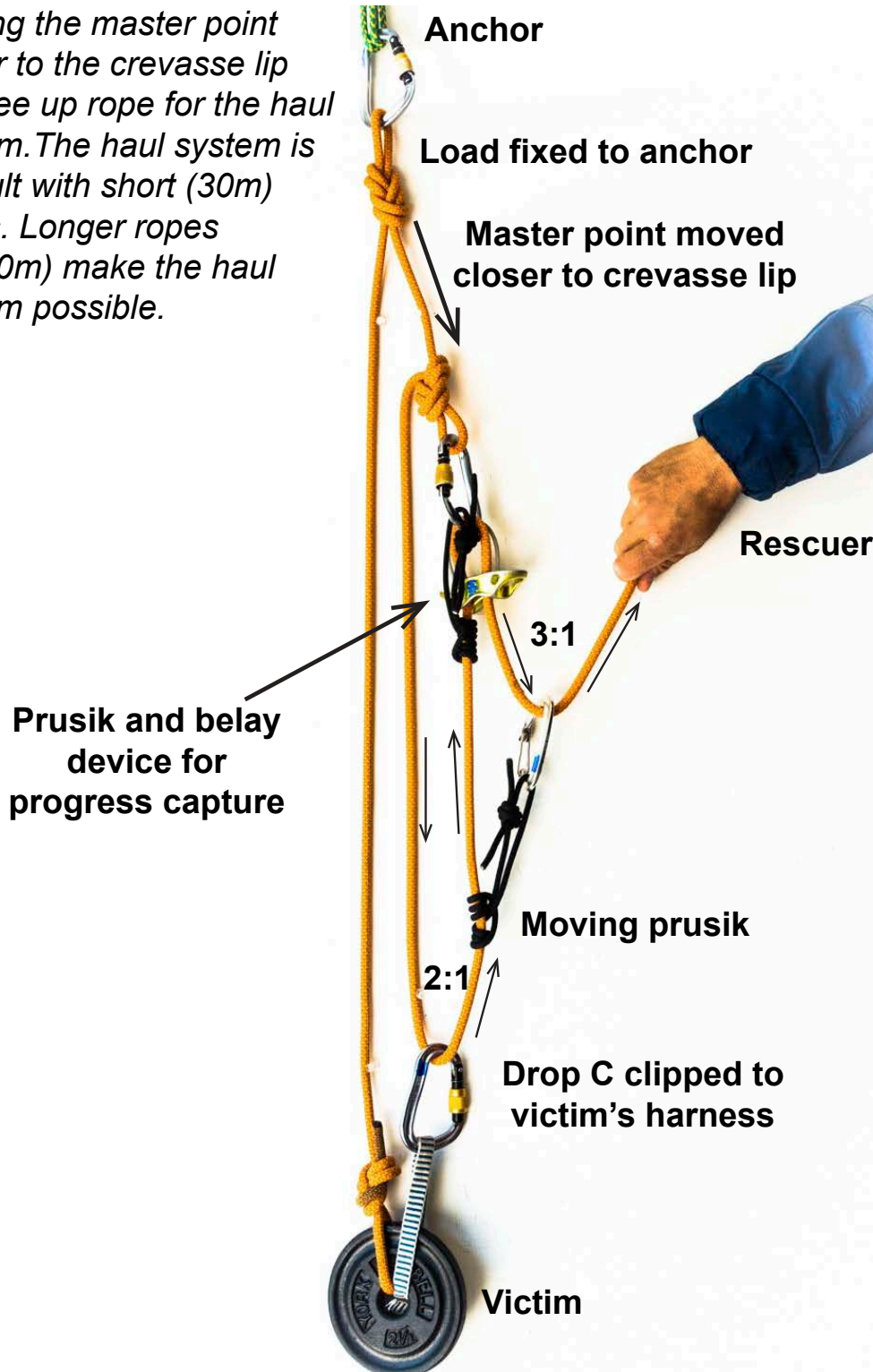
9. Add 3:1 to Drop C for 6:1





10. Move Master Point

Moving the master point closer to the crevasse lip will free up rope for the haul system. The haul system is difficult with short (30m) ropes. Longer ropes (40-60m) make the haul system possible.





Progress Capture



The 53-gram Petzl Nano Traxion is both a 91% efficient pulley and a cam for progress capture.



Prusik for progress capture using a belay device (e.g., BD ATC) to mind the prusik so it doesn't flip back through the master carabiner.



The 35-gram Petzl Tibloc is a simple, light ascender that works for progress capture but must be tended as it doesn't always engage.

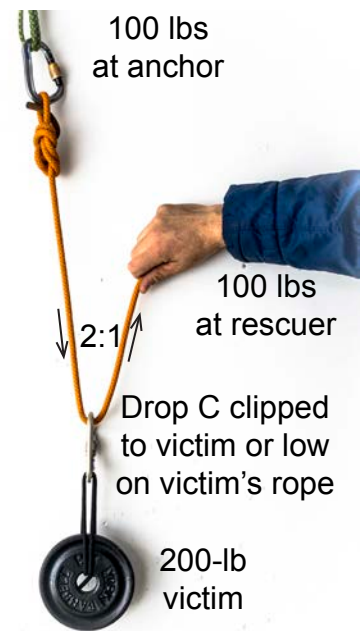
Mechanical Advantage



1:1 direct haul with no mechanical advantage.



1:1 redirect with no mechanical advantage, but added friction from the carabiner.

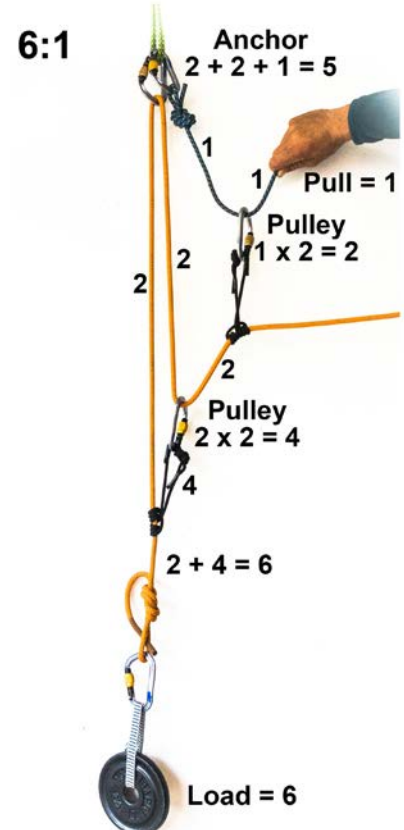
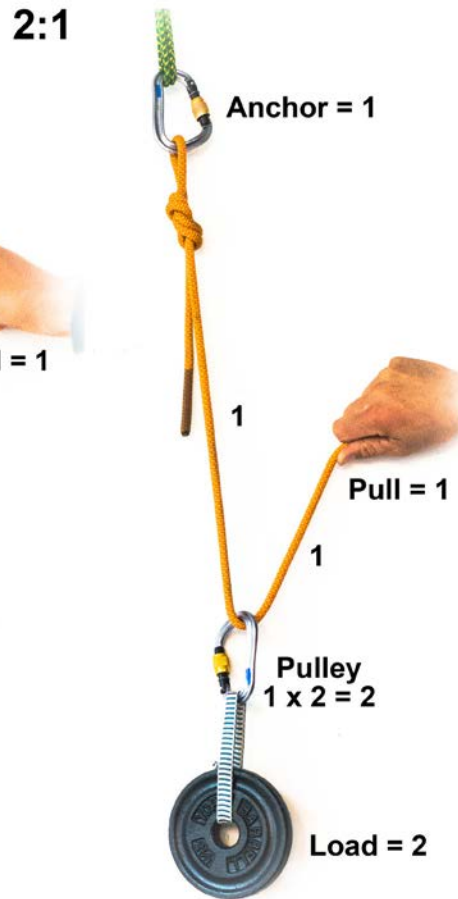
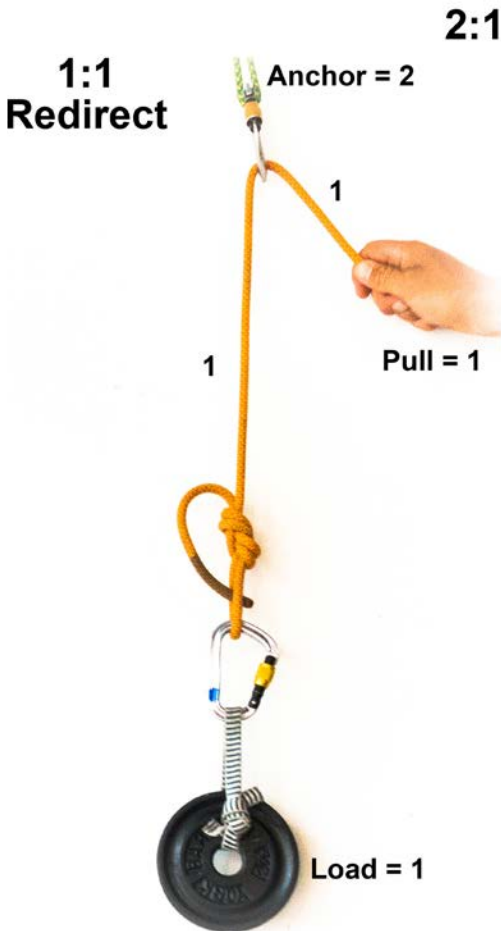


2:1 mechanical advantage haul, ignoring friction. Equivalent to a drop C.



Counting Mechanical Advantage ^{3:1}

- Start the calculation as 1 from the pulling side.
- There is equal force on the rope on either side of the pulley.
- Pulleys multiply the force by 2 on the load side of the pulley.
- Don't count the force on the anchor to determine the output.
- Add the outputs.





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The Crackulator

The Crackulator is a decision-making aid designed to help glacier skiers better understand how to avoid crevasse falls. It is modeled after the Canadian Avaluator for decision making in avalanche terrain.

Background

Summer mountaineering courses teach a simple rule: always rope together when walking on snow-covered glaciers. Falling in a crevasse is dangerous and sometimes fatal. Roping together can reduce the consequences of a crevasse fall. For glacier skiers, however, the rope-together rule is not always appropriate because skiing can be less risky than walking on glaciers.

Skis distribute our weight better than boots alone, reducing the chances of breaking through a crevasse bridge. Also, most glacier skiing is done in spring, when the seasonal snowpack and crevasse bridges are thickest. Even so, the risk of falling in a crevasse still exists.

While using a rope does reduce the risk of crevasse fall, skiing downhill roped together inhibits free skiing and can introduce new risks such as being pulled off balance by your rope mates. The rope can also increase the consequences of an avalanche. When to use precautionary actions such as roping together is not always obvious.

Using The Crackulator

The Crackulator has three steps. Step one identifies the factors affecting crevasse fall potential at a location. Step two recommends a level of caution for this combination of factors. Step three recommends actions necessary to reduce crevasse-fall risk for that level of caution. In other words, 1) these are the factors, 2) this is how they are weighed, and 3) this is what to do about it.



Step 1 Glacier and Skier Factors

Identify the glacier and skier factors that raise the risk of a crevasse fall. Using those factors, identify the highest score for each factor: the glacier factors high score and the skier factors high score.

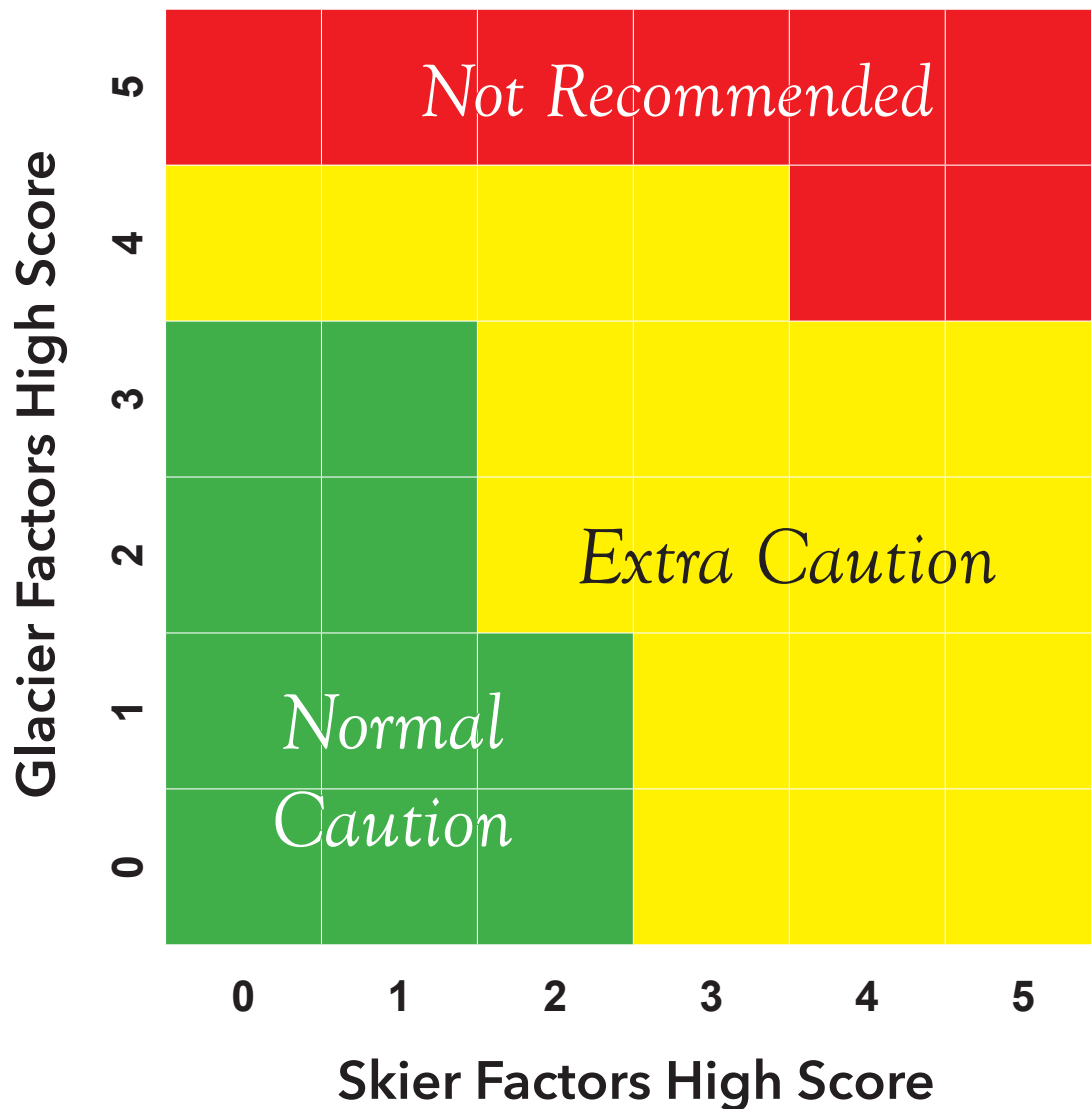
Score	Glacier Factors
+5	Are there both crevasse and avalanche danger?
+5	Would holding a fall be questionable?
+4	Is the light flat or visibility reduced?
+3	Is the snow soft (fist to four finger hand hardness)?
+2	Is the snow less than two meters deep?
+1	Are there known or visible crevasses?
	Glacier Factors High Score

Score	Skier Factors
+5	Are you in doubt?
+4	Have you spent less than 10 days on a glacier?
+3	Are you skiing uphill?
+2	Is the glacier unfamiliar?
+1	Are you a beginner or intermediate skier?
+1	Are you tired?
	Skier Factors High Score



Step 2 Recommended Level of Caution

Apply the glacier and skier factors score from step 1 to the axes of this matrix to determine a recommended level of caution.





Step 3 Recommended Actions

Apply the recommended level of caution from step 2 to this table to see recommended actions. Combine these recommended actions with your experience and judgement to determine a course of action.

Normal Caution

Normal caution does not mean you are safe, just less likely to fall in a crevasse. All glaciers present some crevasse fall danger to skiers. Follow these recommendations when skiing on any glacier, regardless of your ability or what seems to be low danger.

- 1. Take a glacier travel course.**
- 2. Practice rescue.**
- 3. Bring rescue gear.**
- 4. Wear your harness.**
- 5. Spread out.**
- 6. Always keep one ski on.**
- 7. Consider roping together.**
- 8. Manage the rope with spacing, stopper knots and minimal slack.**

Extra Caution

These are conditions that require extra caution but do not appear dangerous enough to warrant no-go. Extra caution is where the most uncertainty lies and therefore presents the most difficult decision making.

- 1. Apply all of the recommendations for normal caution.**
- 2. Rope together when skiing uphill.**
- 3. Test snow depth and bridge thickness with your probe.**
- 4. Consider turning back.**

Not Recommended

Due to the small margin for error, skiing with minimal risk in these conditions requires hundreds of days of glacier experience.

- 1. Have no-go or turning back as your number one option.**
- 2. Find an alternate route.**
- 3. Rope together on both uphill on downhill.**