Until death do us part

Dedicated to my colleagues, who lost their lives in short-roping accidents.

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When we stand on the summit of a mountain, we have the opportunity to contemplate the daily grind of our lives with more detachment. Everyday absurdities of existence are often seen with more clarity when we are not directly embroiled in their turbulence ourselves. Thus mountaineering can contribute to shifts in the way we live our daily lives. As mountaineers, and more specifically as mountain guides, we should from time to time reverse this process by reviewing our guiding practices, which we use routinely on the mountain, from below to gain more rational perspectives.

"I am attached to you"

The rope is securely anchored in our general consciousness as a symbol of safety in the mountains. Every climbing company advertises that clients will only ascend safely while attached to the rope of their guide. Both in English and in German, being "attached to someone" is a term used to describe love and togetherness. In our psyche attachment is synonymous with safety and belonging. Should an accident happen and the people involved were not roped up, the verdict is, as expected: "They were not roped together. Gross negligence." When a roped team falls, it is said that people "were tragically pulled to their deaths". One seldom hears of a fall occurring because people were roped together. The rope, in fact, can only do one thing: translate force from one end of itself to the other[1]. If two climbers are both moving while roped together and the rope is not attached to a fixed anchor, then the climber himself is an anchor - a moving one. When compared with the holding properties of fixed anchors, which have been extensively researched and documented, the holding ability of climbers is generally unknown and is reduced to the amount of friction between the mountaineer and the surface on which he is presently climbing.

Should we fall into a crevasse when walking roped together across a glacier, we rely solely on friction forces - those between the holding climber and the snow surface, as well as those between the rope and the edge of the crevasse. A great enough distance between people on the rope, a large rope diameter, knots along the length of the rope, or even objects tied into the rope, can all help significantly to increase the friction at the crevasse edge and so reduce the danger of party members being pulled into it together. These preventative measures are only effective when moving on soft snow surfaces. Unfortunately, when climbing, every now and then we must also go uphill; even a glacier is of course not always even. Thus on a slope we also have to deal with gravity, which in addition works against the friction forces on the holding climber. Every leader of a roped party is familiar with this dilemma: if, while ascending, the last person falls into a crevasse, it does not bode well for those climbers ahead of him. The situation is even less favourable if the leader falls into a slot while descending.

If a roped party climbs simultaneously on a firm snow surface, the friction forces are reduced dramatically. If a party member falls on only a 30° solidly frozen slope, the fall of the entire party is the inevitable consequence[1].

Short-roping

It is just in that seemingly harmless transition zone between flat glacial terrain, where we walk roped together, and steep ice, where we climb with fixed belays, that we find a terrain trap in which many climbers move, naively trusting their rope partner to save them in the case of a fall. For us, as guides, walking in this transition zone is routine. The use of crampons fools us into thinking we have a higher holding ability. We hold the rope nice and tight, so that in the case of the client slipping they cannot gain much momentum. In reality however, all we are doing as guides is holding ourselves up on our own legs, and holding the weight of the rope between us and our client; nothing more. We are giving the client the impression of a level of safety we cannot actually offer. This "safety" is purely psychological.

In addition, many climbers falsely assume that while short-roping, the dynamic properties of the rope itself can, through the rope's stretching, absorb all of the fall's energy, thereby reducing the pulling force that arises. While this does occur when climbing with fixed belays, the energy absorbing properties of the rope are negligible when both ends of the rope are attached to moving people. The forces resulting from a short-roping fall are also comparably small and the available rope length is very short. Whether a child is walking a large dog using a lead made from a chain or a modern climbing rope, it makes no difference when the dog sees a rabbit and suddenly takes off after it. If the child cannot let go of the lead, it will be mercilessly pulled along.

This transition zone, where we are accustomed to short-roping, is the type of slope which an able skier would ski down without batting an eyelid. How many slopes do we know of that are steep and often icy and yet are skied by hundreds? When would a ski instructor ever decide to rope up their ski school group in order to offer them "safety" in the case of a fall? The entire group would, without a doubt, plunge down the hill and the ski instructor, if he survived the descent, would be summoned to court for gross negligence. The difference between a ski instructor and a mountain guide who is short-roping, lies in the fact that the ski instructor practises skiing with their group for days on end before tackling the steep slope. If one of the ski students has not grasped the vital skills then they are sent back to the learners slope. Walking with crampons, however, is learned very quickly and the immediate transfer of these skills to steeper slopes is very tempting - albeit only with the "safety" of a short rope.

I can already hear the indignation of my colleagues, who for years have skilfully and competently short-roped their clients on steep slopes. We see the pictures in all the climbing catalogues and guidebooks. I have guided in this manner myself for many years.

"You just have to do it properly", you hear again and again, after a short-roping accident claims another from our midst. Accidents, of course, only ever happen to others. This mindset is a recipe guaranteeing our own inclusion in such statistics in the future. The holding ability of the climber leading a roped team, moving together, is for the most part only wishful thinking. Because the technique is so widely used, short-roping has become the norm. But even the most experienced guide is not exempt from the laws of physics. Interestingly, there is no book available on the market outlining short-roping techniques. During the process of my research I have found there is a great variety of short-roping methods employed in different countries[2]. These varying techniques have been developed empirically; they are practically untested and amusingly contradictory.

Method

How does a person standing upright react to a pulling force from one side? In order not to fall over, the person must reposition their centre of mass in such a way that the pulling force can be countered and balance regained. If the falling process happens slowly enough, simply leaning back is sufficient. Should the pulling force occur suddenly, the person must react very quickly and take a compensatory step in the direction of the force. The obvious next step is to conduct experiments that involve attaching a force meter to the rope to measure how much force a climber can hold on a slope. If we gradually increase the pulling force, the guide leans back. This leads to an impressive tug-of-war on the steep slope. The possible forces the guide can hold are dependent on the strength of the guide and can range up to and above his own body weight. This is a deceiving result. What a shame we cannot request that our clients only fall slowly, to give us enough time to lean sufficiently in the opposite direction. Such static experiments do not help us any further.
In 1982, Pit Schubert from the German Alpine Club's Safety Group (DAV-Sicherheitskreis) conducted comprehensive falling experiments on firm snow slopes[1], which even then yielded sobering results. In these experiments, peak forces measuring between 50N and 400N (approx. 5kg and 40kg), were sufficient to pull the climber down the slope. The publication of his results led to a change in mindset of many climbers and a corresponding decrease in short-roping accidents in the following years.
If we only measure the peak forces that occur in falling experiments, of course we obtain an incomplete result. A peak force, which only happens for a fraction of a second, can misleadingly imply a high holding ability.
Because we are dealing with a sudden occurrence of force, a dynamic experiment is necessary. The force, which is time dependent, must be integrated over the duration of the force's influence. In other words, the impulse is transferred to the holding climber by the falling climber and is then transferred through the feet of the holding climber to the surface beneath him (if the holding climber does manage to hold the fall). Up to the date of publication, the impulses that occur have not yet been systematically measured, as such an experiment is very time consuming and expensive. The experiment depends on a great number of variables such as: slope gradient, snow conditions, the weight, strength and reaction time of the person holding a potential fall, the weight of the falling person, the roping method used, and so forth. Thus we could expect a great spread of results. For me, it was of particular interest to find out how great the probability is that the guide holds a force which arises suddenly, using different roping techniques, while going uphill, downhill, or remaining stationary.

We thus built an angled surface with a 30° slope, covered it with carpet, and built a tower for the rope to run over and to hold a falling weight. From this we calculated the probability of a test person holding a particular falling weight under different conditions[3]. This test person, the "guide", wore crampons and climbed up, climbed down, or remained stationary on the slope. During this time the rope was always held lightly taut, as the rope travelled through low-friction pulleys. Without warning the test person, a weight was clipped onto the rope on the tower via a "shunt", in such a way that the weight did not freefall (Fig.1). The tower design allowed the application of this weight to be performed out of sight of the test person.

Three different methods of roping up - i.e. "securing"- were investigated:
▮ Long loop (hand loop is a straightened arm's length from the harness). The transfer of force to the harness occurs only once the arm is completely straightened.
▮ Short loop (hand loop is a bent arm's length from the harness). The transfer of force to the harness occurs before the arm is fully straightened.
▮ Direct attachment to harness (no use of hand loop). The transfer of force to the harness occurs immediately.

While walking, the "guide" held the rope using both "short loop" and "long loop" methods, in a tightly tied-in hand loop with a bent arm. The hand was positioned in front of the rib cage in order to allow maximum arm extension upon holding a fall. This method allows distribution of energy absorption over a maximum possible path to give the guide the greatest reaction time. Thirteen test persons/guides were tested in 193 falling experiments.

Results

Without exception, the lowest holding rate was measured when the rope was tied directly to the harness (Fig. 2). This is understandable, as the test person can only counter the falling force by shifting his own centre of mass. If the pulling force acts directly on the harness, in close proximity to the centre of mass, it is very difficult for the test person to shift their centre of mass and their available reaction time is greatly shortened. This result was confirmed subjectively by the participants when asked about their preferred roping method after the experiments. Surprisingly, there were no significant differences in the holding rates with "long loop" results compared with "short loop" results. These results were also confirmed by the test persons; their opinions about preferred roping method were divided 50:50. The best holding rates were measured with uphill climbing, the worst with downhill climbing (Fig. 3). Results from a still-standing position were between these. Holding success was very dependent on the weight of the test person and the reaction time of each individual was of greatest importance, (fatigue and age were quite an influence on this). When the pulling force acted on an extended arm - one not bent up in front of the rib cage - the holding rate was also greatly reduced.
All test persons could hold the falling weight of 10kg. In contrast, only the strongest and very few could hold the 40kg falling weight, and even then only when they were expecting the pull, so were already leaning in the opposite direction, in other words, performing an unnatural movement! The probabilities of holding 20kg and 30kg falling weights lay in between these extremes.
If we account for the fact that all participants were expecting a fall to definitely occur in the near future, then we must also factor in the effect of surprise if the situation were genuine - thereby adjust the real holding rates to be lower again. If we consider that an 80kg adult resting on a frictionless 30° ice surface produces a force of around 400N on the guide, this would equate to the 40kg falling weight in the experiment. This sobering result can be summarised in the following way:

"Only in the ideal scenario can a guide expect to hold a client's fall on a 30° icy slope. As a rule, a fall of the roped team will eventuate. To hold more than one client on such a slope may be deemed impossible."

Short-roping on an icy slope of only 30° is nothing but a comfortable way of holding the rope. It becomes a death trap for all participants because it is as good as impossible that all participants will self-arrest simultaneously. It must therefore be seen as an exceptional stroke of good luck when a guide is able, through his own self-arrest, to hold the entire party after a fall on a hard snow surface. Rather than increasing safety, when short-roping on a 30° firm snow slope, we increase the risk of a fall for both the client and ourselves.

Conclusions

Just as we judge avalanche danger, we must consider a number of factors when we move together on a rope, which I would like to illustrate with the shown diagrams (Fig. 4). The green area represents the relatively safe zone, the red area the zone where danger of being pulled down the slope together is high. The diagrams refer to travelling roped up with one client only, on snow and ice slopes where there is no danger of falling into a crevasse. For an unguided, roped party, there can be only one outcome: when the danger of being pulled downhill together exceeds the threat posed by crevasses, the rope should come off or fixed belays should be set. For the guided roped party, the issue appears significantly more difficult. Reducing the risk of falling means reducing the probability of a fall happening, and through making appropriate terrain choices minimizing the consequences of a possible fall. As guides we can only reduce risks to a minimum; however we cannot eliminate them completely.
There is a wide range of possibilities for guides to offer a high degree of safety while travelling in transition terrain. Especially today as glaciers become increasingly broken and the occurrence of hard ice and firm snow becomes more common, guides must look back to techniques that until now have gained little attention or have gone out of fashion:

- Long rope and travelling together while using running fixed points (Fig. 5). It is better to carry (and set) ten ice screws than to add to the tragic statistics.
- "Teleferique" method uphill (Fig. 6) - i.e. travelling with an ascender (Jumar) or prussik knot when ascending with groups.
- "Teleferique" method downhill (Fig. 7) - This method, which I developed, is extraordinarily easy, totally safe and quick to set up. The rope diameter, size of the braking ring and type of carabiner have to be well fitted to each other. Several rope lengths can easily be travelled one after the other, because the brake is reversible. The brake works independently of potential misuse by clients and is controlled by the guide via tension on the rope.

- Appropriate boots and well-fitting crampons, and no loose clothing or straps that can be tripped over.
- Reduce the walking pace.
- Correct walking rhythm, with support from an ice axe and/or ski poles.

Last but not least, as guides we must seriously think about when and where we let our clients have more responsibility, in other words, allow them to walk without a rope. Just as a ski instructor prepares their students for skiing steeper slopes, we must carefully prepare our clients by practising walking in safe and easy terrain, walking on snow and ice slopes with and without crampons and studying self-arresting techniques. Only once the client has reached the experience level required for secure footing, do we let him walk in suitable terrain without a rope. The client then moves with harness on, without a rope and is belayed by the guide only on the more exposed or difficult sections, using fixed or placed anchors. Such an increase in the client's responsibility must go hand in hand with good route selection and step cutting. The good old "guide's ice axe" can be brought to the fore again; although short, light ice tools give us a modern appearance, they are useless for cutting steps. In addition, we must acknowledge this transfer of greater responsibility to the client with an unequivocal legal contract - which is already the established modus operandi for expedition-style mountaineering. ■

References

[1] Pit Shubert, Sicherheit im Fels und Eis (Safety on Rock and Ice), volume 1, 7th edition, page 230 onwards, ISBN 3-7633-6016-6
[2] www.alpinerecreation.com/ShortRope.pdf, page 28
[3] www.alpinerecreation.com/ShortRope.pdf, page 63 onward

Captions

The late Gottlieb Braun-Elwert was an internationally qualified mountain and ski guide. In 1978 he emigrated from Germany to New Zealand, where he set up the company Alpine Recreation together with his wife Anne. Gottlieb was instrumental in bringing the New Zealand Mountain Guides Association (NZMGA) up to international level.

Fig. 1 Method. The test person wore crampons on a 30° ramp, the rope was held gently taut for the duration of the experiment and a variety of heavy weights was attached to the rope by means of a "shunt". In this manner, the test person not only had to hold the short peak force but also the subsequent ongoing pulling force – as in the field. The sobering result: It is impossible to hold more than one client while short-roping.

Fig. 2 Results measured using different short-roping techniques. The worst holding values on the 30° ramp were measured, as expected, using the "direct attachment" technique where the force is immediately transferred onto the harness. Somewhat surprisingly, the holding rate achieved using the "long loop" technique was not significantly better than when using the "short loop" technique.

Fig. 3 Results measured using different walking directions. As expected, the holding rate was highest when the pulling force was applied during the ascent and lowest when the test person was descending.

Fig. 4 Holding probabilities are dependent on slope angle and snow conditions. The relatively safe zones are shown in green, whereas the red regions depict a high danger of being pulled down the slope together while short-roping with only one client.

Fig. 5 Moving together with intermediate fixed points. The group climbs together on a long rope. The guide sets fixed points with unidirectional runners, for example, Tibloc or Ropeman. There is plenty of space between runners and there is always only one person between any two fixed points.

Fig. 6 "Teleferique method" uphill. After the guide has climbed ahead and secured the rope, one person after the other follows using an ascender or prussik. The rest of the group waits in a safe place and holds the rope taut. The last participant is belayed by the guide. In the illustration below a participant is belaying himself by means of a short sling, a Ropeman and an additional screwgate carabiner.

Fig. 7 "Teleferique" method downhill. After the guide has established an anchor and safe standing area, the clients are tied on below the anchor with a so-called braking ring. The guide descends, establishes the next anchor point and controls each client's descent from below, using the tension in the rope. If the guide pulls on the rope, the braking ring blocks and becomes a simple rope brake. The size of the ring and the shape of the carabiner must be selected according to the diameter of the rope. After everybody has reached the next anchor point, the guide climbs back up, removes the top anchor, descends and sets up the next anchor a rope length further below.