CHAPTER 20

WATERFALL ICE AND MIXED CLIMBING

As the temperature falls below the freezing point, liquid water changes to a solid. Even raging torrents can become spectacular, massive hanging waterfall ice formations. Water ice is formed by gradual buildup. The usual formation is not a single monolithic crystalline structure. Typically, ice formations are the result of a series of freezes, and they have a laminated, or layered, structure. Water ice can take many forms: smooth, broad slabs; flat runnels; cauliflower-textured walls; latticed sheets; chandeliered curtains; massive ice pillars; fantastic, free-hanging icicles.

Compared with the life cycle of glacial ice, the life spans of winter waterfall ice formations are all too brief. During a single winter season's freeze-thaw cycles, waterfall ice can form, collapse, then re-form, only to collapse again when the spring thaw arrives. When climbers visit the sites of winter ice climbs in warmer seasons, they may not be able to picture what is there in winter. Summer tourists traveling in Alberta, Canada, along the Icefields

Parkway in Jasper National Park can easily miss the wet spot that marks the location that attracts waterfall ice climbers from around the world in winter: the Weeping Wall's spectacular ice curtain, an acre of vertical ice.

The technical difficulty of waterfall ice climbing continues to rise. The sport has transcended the traditional style—simple ascension of ice formations—and now includes dry tooling (climbing on technical rock with ice tools and crampons to link formations of ice separated by rock). Climbing on mixed terrain (rock, thin ice, and ice) is not a new concept: it has long been part of ascending Scottish gullies in winter and climbing technical routes in the Alps. In the classic sense, mixed climbing meant having one foot on rock and the other on ice—usually thin ice. However, the focus of the sport has shifted. On a modern mixed route, climbers may spend as much or more time on rock as on ice. Often the crux of a route consists of making an athletic transition from rock to an overhanging curtain or spear of ice.

Waterfall ice and mixed-route climbers must exercise caution on terrain that changes abruptly from ice to rock and back, but they must also act with concern for the environment. The hard steel of ice tools and crampons does scratch and can break the rock surface and harm lichens or plants. When dry tooling, exercise care to minimize damage. When establishing mixed routes, give major consideration to the local ethics: avoid climbing in culturally sensitive areas (for example, cliffs with pictographs) and popular rock climbing areas.

Since much waterfall ice climbing occurs during the winter months and requires travel up steep slopes, in gullies, or below basins, snow conditions are a big concern. It is important to assess avalanche risk and exercise prudence any time you are venturing into the backcountry; see Chapter 17, Avalanche Safety.

EQUIPMENT

This section includes a few considerations specific to waterfall ice and mixed climbing. For discussions of snow and alpine ice climbing equipment, see Chapters 16, Snow Travel and Climbing, and 19, Alpine Ice Climbing.

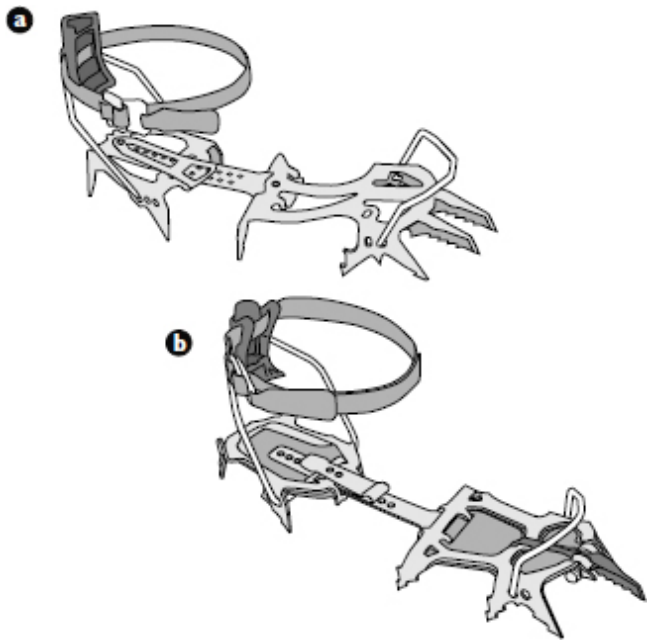

Fig. 20-1. Semirigid crampons with interchangeable front points: a, dual; b, mono.

CRAMPONS

For waterfall ice, the front points are more aggressively curved or angled downward than those used in general alpine ice climbing; the secondary points are angled more forward. On extremely steep to overhanging waterfall ice or mixed terrain, the crampons of choice are semirigid or rigid with vertical dual (fig. 20-1a) or mono (fig. 20-1b) front points. Monopoints are better for dry tooling and delicate ice. Some crampon front points are interchangeable, allowing worn front points to be replaced (rather than replacing the entire crampon) or to be switched from mono to dual front points or vice versa.

ICE TOOLS

While a straighter-shafted tool is a more versatile option for alpine ice climbing, a curved technical tool with ergonomic grip and reverse-curved pick (see Figure 19-4b in Chapter 19, Alpine Ice Climbing) is the standard choice for waterfall ice and mixed climbing. There are a variety of technical ice tools on the market (fig. 20-2). Each type has different characteristics (including grip, weight, and balance), so demo several models and choose the one that best fits your needs.

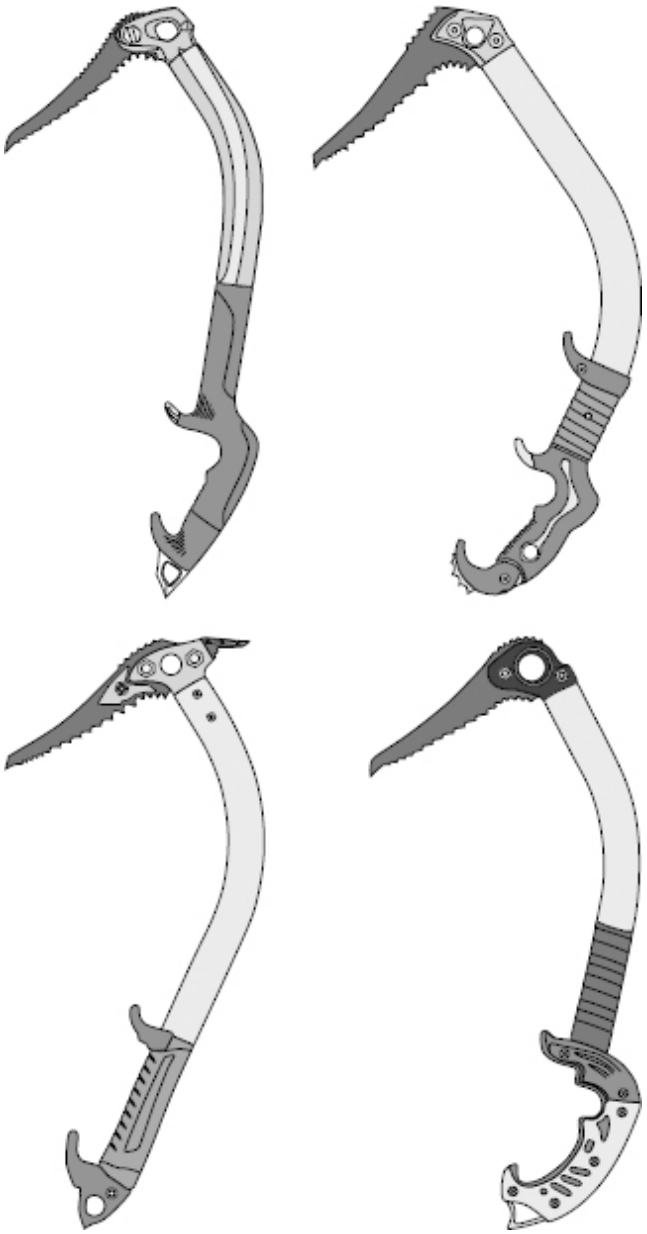

Fig. 20-2. Modern technical ice tools.

WATERFALL ICE CLIMBING

Using crampons and ice tools, ice climbers move vertically on the varied ice found in frozen waterfalls.

CRAMPON TECHNIQUES

Footwork is the foundation of climbing techniques for steep waterfall ice. Good footwork allows climbers to keep most of their weight on their feet and

the strong musculature of their legs, rather than on their arms, saving precious arm strength. See figures in Chapter 19, Alpine Ice Climbing, for examples of good footwork. Good footwork ensures smooth weight changes and greater efficiency. Poor footwork causes climbers to flail, burn out rapidly, and fall.

Fig. 20-3. A pigeon-toed stance is sometimes needed to plant front points squarely.

Front-pointing is the mainstay of footwork on vertical ice (see Chapter 19, Alpine Ice Climbing, for details on front-pointing). A good ice climber not only looks up for good tool-placement opportunities but also continually looks down for front-point placements that ease the strain on the calves. As is true for tool placements, slight depressions make for ideal front-point placements. Similarly, a spot just above a small bulge can also be a nice placement.

After finding a likely spot, use a firm kick to set the front points in place. Except in rotten, chandelier, or extremely brittle ice (see “Unusual

Conditions" later in this chapter), no more than one or two kicks should be necessary. Make sure that your feet are perpendicular to the ice surface in both planes: keep heels low so that the secondary points engage the surface, making for a more stable placement, and make sure the toe of each boot is squarely facing the surface at that particular spot. A pigeon-toed stance (or its opposite, a duck-footed stance) may be necessary to plant the front points squarely (fig. 20-3). Monopoints can be slotted in old pick placements. Once your feet are placed, try to keep them steady until you are ready to move again. Nervous feet weaken the placement.

Keep feet shoulder width, or slightly less, apart to reduce the tendency to "barn-door" to one side. Use several short steps, rather than high-stepping, to reduce the stress on your quadriceps—although high-stepping can be necessary occasionally to get past bulges.

Beyond straight-in front-pointing, footwork that is much more akin to rock climbing techniques is very useful for the variety of features found on many waterfall ice climbs. Stemming and flagging for counterbalance, matching feet (see Chapter 12, Alpine Rock Climbing Technique), and heel hooking (see Figure 20-10) are very useful on waterfall ice.

ICE-TOOL TECHNIQUES

Just as the mainstay of footwork on waterfall ice is front-pointing, the most frequent tool placement is *piolet traction* or "tracking" (see Figure 19-23 in Chapter 19, Alpine Ice Climbing). Because it becomes very tiring to swing tools overhead, do everything possible to reduce the number of swings and placements you make.

When tracking, think of it as climbing on self-belay. Before trusting the integrity of each placement, test it by loading it with partial body weight. Do this test from the relative safety of a stable stance on the ice. This is a key concept: the goal is to create a position of strength and then to climb from that position. If each position is stable, you will climb with comfort and confidence. Do not fall into the trap of relying on a shaky placement, because this robs you of confidence and can lead to increasingly weak and unstable stances.

Selecting a placement and making the placement accurately are the keys to placing ice tools securely and quickly; strive to gain a solid placement with just one swing. One technique for hitting a precise spot is to tap the desired spot with the pick, then swing at that spot with force. The swing is more akin

to a racquetball swing, with its wrist snap just prior to connecting with the ball, than to a straight-wristed tennis swing. The steeper the droop of the pick, the more wrist action is needed to set the pick at the proper angle. (See "Ice-Tool Placements" in Chapter 19, Alpine Ice Climbing.) Many beginning waterfall ice climbers tend to drive their tools in too hard; take care to avoid this, because sinking a tool makes it much more difficult and tiring to remove it as you continue on. (See "Removing the Tool" in Chapter 19.)

While climbing, conserve energy by looking for secure placements that do not require you to swing the ice tool. Some old tool or monopoint placements may be deep enough that you can simply slot the pick in. Hooking opportunities abound on water ice. Large icicles often form in clusters on vertical sections, creating slots or gaps that are ideal for hooking placements. Larger columns can be hooked horizontally. Reverse-curved picks (see "Ice-Tool Placements" in Chapter 19, Alpine Ice Climbing) are best for hooking placements. Many ice-tool picks have teeth where the pick attaches to the shaft, which provide more secure hooking.

In good ice, vertically stagger the tool placements using the tracking technique (see "Climbing on Vertical Ice" in Chapter 19, Alpine Ice Climbing). By staggering the tools (rather than planting them side by side) and by relying on a single tool at a time, climbers reduce the number of tool placements, thus decreasing the workload on the swinging and gripping muscles of their arms and hands. If the ice is suspect (meaning the placement is too), plant both tools side by side, about 2 feet (0.6 meter) apart, before moving your feet up. This decreases the load on each placement and reduces the chance that a tool will shear out under the load.

Leashed Versus Leashless Tools

Leashes are generally no longer used on water ice tools. They have been replaced in recent years by a variety of grip-aiding devices on the shafts of the tools (see Figure 20-2). Freedom from leashes unexpectedly led to the development of a variety of new techniques and helped to raise standards of both ice and mixed climbing. Leashless tools make it easy for climbers to change tools from hand to hand, regrip the tool at the midshaft grip (which allows for upward movement without a new placement), and release the tool for a shake-out rest or to place a screw.

Climbing leashless requires the climber to adapt techniques to maintain arm and hand strength. Avoid overgripping the tool, which is a waste of energy.

When standing in place, relax your grip slightly, taking advantage of the grips and rests inherent in the tool.

Climbers who wish to use leashes to keep from dropping tools may choose to use "umbilicals." Umbilicals are tethers, usually of an elastic material, that connect the tool (usually by being clipped to a hole in the tool's spike) to the climber's harness (see Figure 19-6). Note that neither the umbilical nor its attachment point are belay strength and should never be used as part of a belay or personal anchor. They are solely to prevent the loss of a tool. Another consideration: if a climber is leading with gear racked to the harness, the umbilicals can become entangled in the hanging gear.

VERTICAL PROGRESSION

Just as in climbing on rock, climbing on waterfall ice involves a coordinated combination of climbing techniques used by a leader and a belayer, who are connected by the rope, anchors, and protection points.

Tracking

Follow these steps to combine crampon and ice-tool techniques to "track" your way upward:

1. While standing on front points and with one ice tool in *piolet traction*, place the other ice tool high, at full arm's length; immediately relax, weighting that tool (fig. 20-4a).
2. With the upper tool still weighted (your arm fully extended), move your feet up, using small steps, to stances between ankle and knee height. Ideally, your body position should form a triangle with the apex at the high tool placement (fig. 20-4b). If your feet are too far to one side or the other, you will tend to "barn-door," swinging out of balance to that side.
3. Loosen, but do not yet remove, the lower of the two tools, and look above for the next placement for it.
4. In one motion, stand upright by pushing with your feet and pulling on the upper tool, remove the lower tool, and place it in the chosen spot, again preferably at full arm's length (fig. 20-4c).
5. Relax, weight that tool, then loosen your grip on it, and move your feet up. Once you are certain this new placement is secure, you can remove the lower tool (fig. 20-4d).
6. Repeat these steps. As you repeatedly move through the sequence, you will be "tracking" the tool placements with your feet, moving a little

laterally with each move to maintain that triangular position and keeping your feet centered on the tools.

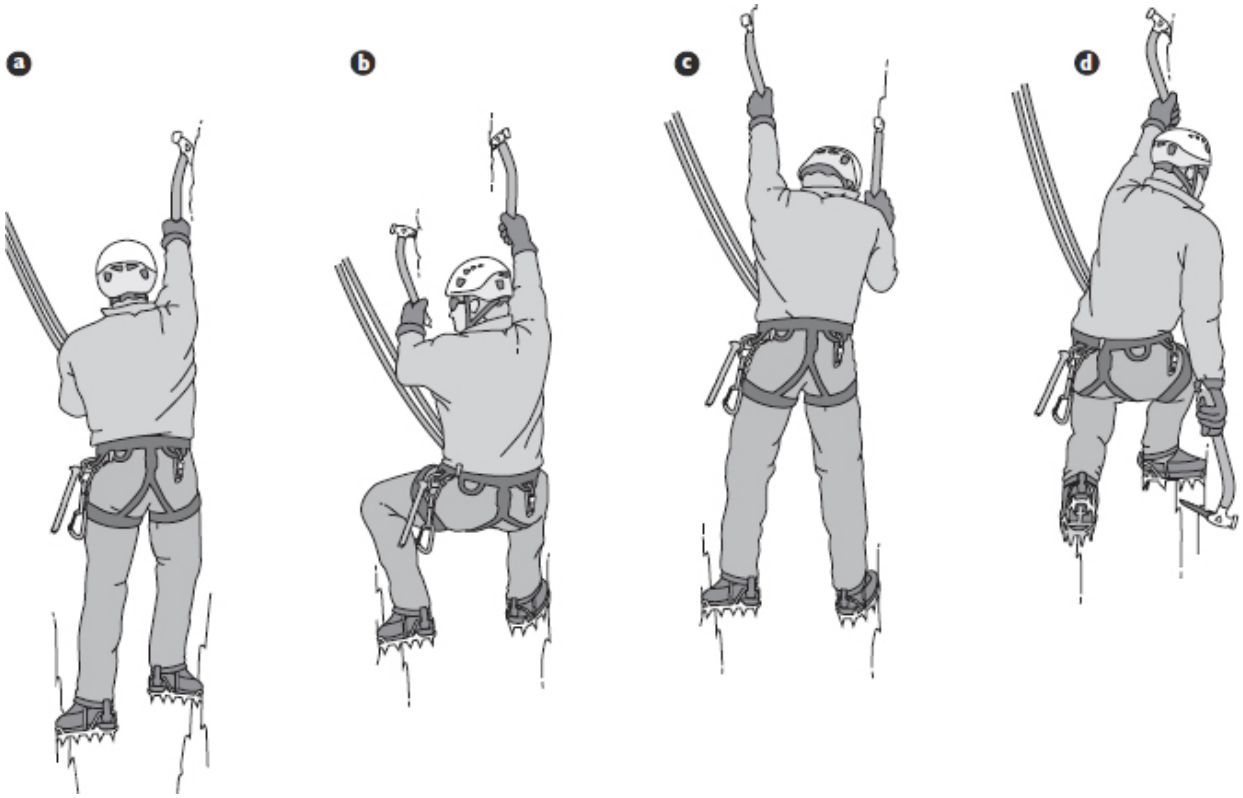

Fig. 20-4. Proper tracking technique: a, place one tool at arm's length and weight it; b, move feet up in small steps; c, stand up and place the other tool at arm's length; d, weight the tool and move the feet up.

Belaying

Setting up belay anchors and belaying on waterfall ice uses the same procedures as those discussed in "Belaying on Ice" in Chapter 19, Alpine Ice Climbing. Take extra care in locating belays away from the fall line to avoid being showered with debris from the leader. In gullies, site the belay to one side of the route, seeking protection from the sidewall. On pillars or curtains, try placing the belay behind or to the side of the formation, but be aware that although this position provides greater protection from falling ice, it will make communication more difficult and rope drag a possibility. Look for a compromise between protection and convenience in belay stances.

Leading

Most waterfall ice climbs are led and followed in pitches, though many long climbs offer sections suitable for running belays. Ice pitches may be climbed with a single rope or with two ropes using either double-rope or twin-rope technique (see "Double- and Twin-Rope Techniques" in Chapter 14, Leading on Rock).

PROTECTION

Waterfall ice routes can be protected using both rock and ice gear, which affects racking and placements.

Rock Gear

Some waterfall ice climbs have options for using rock gear. On gully climbs, the rock sidewalls can provide protection opportunities. On freestanding columns or curtains, look behind the ice for placements in the back wall; these most likely will need to be extended by slings to prevent rope drag. In the winter, cracks tend to be filled by ice; as a result, pitons are used more frequently than on summer climbs, though the full variety of clean protection can be used as well.

Natural Protection

Waterfall ice offers more opportunities for natural protection than do the flows and steps of alpine ice, and many natural placements are quicker to set up than ice screws. Runners can be placed around small ice columns (fig. 20-5). A long ice screw tied off with webbing can be inserted between two columns or through a slot in an ice curtain, then rotated sideways and used as a sort of deadman for temporary protection (for a description of deadman anchors in snow, see Chapter 16, Snow Travel and Climbing). In thin curtains, two holes can be punched in the curtain and then threaded with webbing or accessory cord as for a V-thread anchor. (See "Setting Up Ice Anchors" in Chapter 19, Alpine Ice Climbing.)

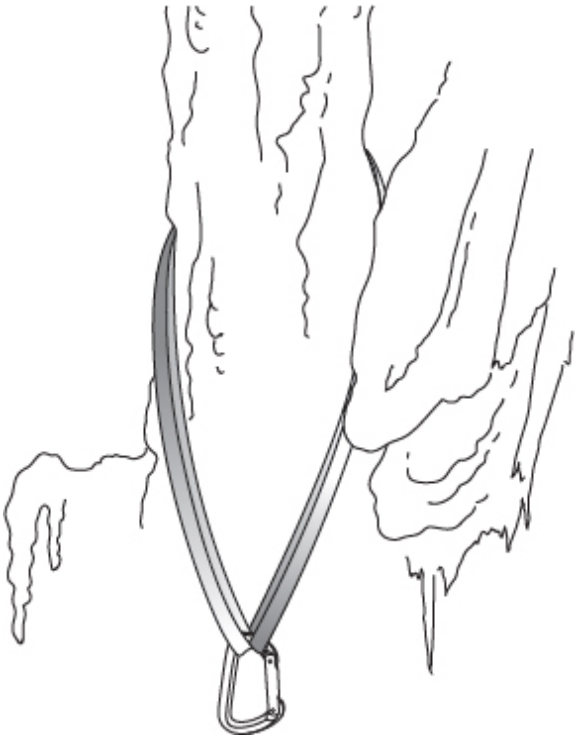

Fig. 20-5. Runner threaded around an ice pillar.

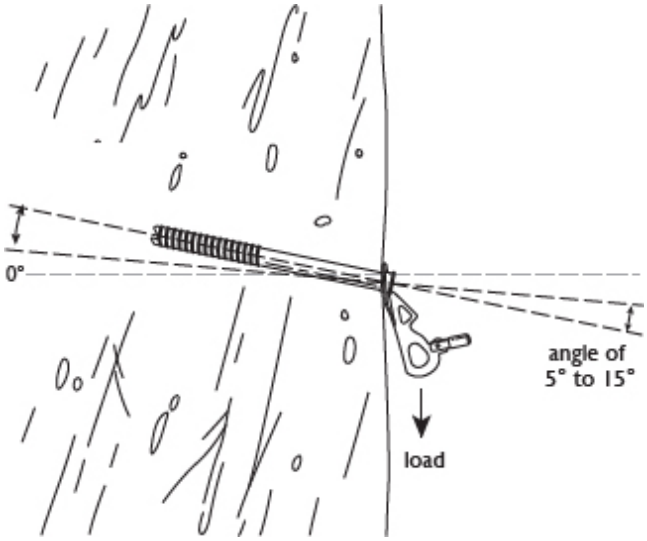

Fig. 20-6. Ice-screw placement is strongest angled 5 to 15 degrees downward in cold, solid ice.

Ice Screws and Ice Pitons

Ice screws remain the most common type of protection used on waterfall ice (see Figures 19-7 and 19-8), but ice pitons, pound-in protection designed for thin ice and mixed climbing, may also be part of the rack.

Ice screws. Placing ice screws is described in "Protection with Ice Screws" in Chapter 19, Alpine Ice Climbing. Significant testing has been done to determine the strength of ice-screw placements in solid water ice at cold temperatures. Surprisingly, under those conditions the strongest screw placements are those with the screw head angled downward 5 to 15 degrees off perpendicular, pointing toward the direction of pull (fig. 20-6). This configuration can reduce fracturing of the ice when loaded by a leader fall.

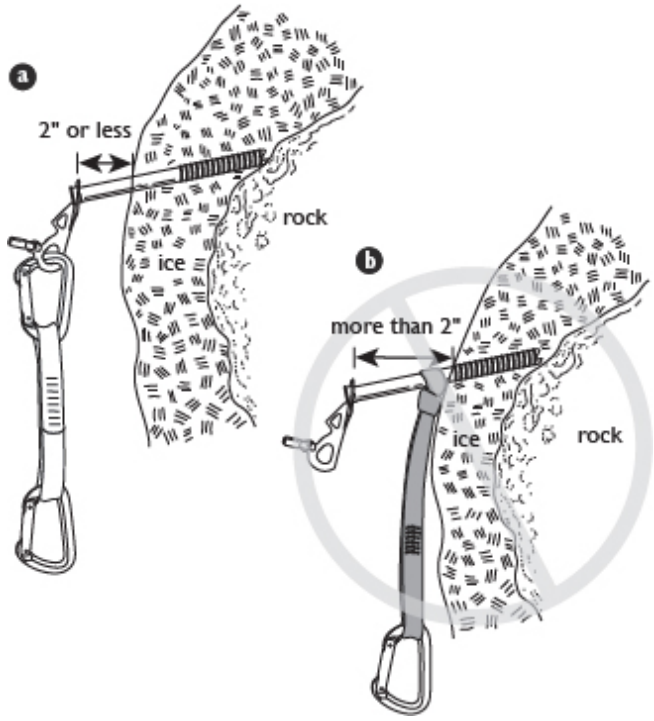

Fig. 20-7. Ice-screw placement in thin ice over rock: a, screw protrudes 2 inches (5 centimeters) or less, clip hanger as normal; b, screw extends more than 2 inches (5 centimeters), tie screw off close to the ice. Note that this second, highly suspect placement is not recommended and should be followed by a stronger placement as soon as possible.

It is best to use a screw of a length that can be sunk to the hilt. If the ice is too shallow for a screw to be placed all the way in to its hanger, remove that screw and use a shorter one in a new spot; never reuse an existing screw hole unless it has had a chance to melt and refreeze—much of the strength of the placement is due to the frozen core of ice inside the screw. Carry a variety of screw lengths to decrease the chances of needing to tie off a screw. If the screw protrudes no more than 2 inches (5 centimeters) from the surface of the ice, clip the hanger as you normally would (fig. 20-7a). If the screw protrudes more than 2 inches from the surface, the placement is highly suspect. Tie off the protruding screw with a runner next to the ice (fig. 20-7b). Tie off a screw

only as a last resort. When screws fail under loading, they do so by fracturing the ice below them and bending toward the direction of load. In the case of a tied-off screw, the webbing then slides to the hanger and is cut by its sharp edges.

Ice pitons. Another type of protection is the ice piton. Ice pitons are removable protection used to hook features in either ice or rock (fig. 20-8). They can be slotted into holes in ice curtains or between the laced-together icicles in chandelier ice and then set with a light tap. Ice pitons can also be driven into iced-up cracks, hence their name.

Protecting the Leader

Many more options for protecting the leader can be found on waterfall ice than on alpine ice. Alpine ice is limited to using ice screws, with occasional rock protection to the side or in rock "islands." On waterfall ice, rock gear can often be placed to the side of or even behind an ice column, or natural protection can be creatively used in the ice itself, in addition to ice-screw and ice-piton placements.

Fig. 20-8. Ice piton.

THE RACK FOR WATERFALL ICE CLIMBING

A typical ice climbing rack for a multipitch, pure ice climb might contain some or all of the following gear:

- Four long (19- or 22-centimeter) screws for anchors and/or constructing V-thread anchors

- Six to 12 ice screws of varying lengths appropriate for the thickness of the ice
- Eight to 14 quickdraws and/or alpine draws (see Figure 14-7 in Chapter 14, Leading on Rock)
- Two long runners or cordelettes for equalizing belay anchors
- An ice piton (as shown in Figure 20-8) for quick pound-in protection
- A V-thread tool (as shown in Figure 19-9 in Chapter 19, Alpine Ice Climbing)
- A few pieces of 6- to 8-millimeter accessory cord for constructing V-thread anchors
- A knife for cutting webbing and cord

Racking

Most ice climbers rack ice screws and other ice gear on their harness (see Chapter 19, Alpine Ice Climbing). Here is one suggested harness arrangement for racked gear (see also "The Rack for Waterfall Ice Climbing" sidebar):

- **Rack most of the gear needed on lead on the same side as your dominant hand.** Place ice screws in front, arranged front to back by length, short to long, with teeth pointed to the rear. Next, rack quickdraws behind the screws. Rack a few screws and quickdraws on your nondominant side in the event you need to place a screw with that hand.
- **Use the rear gear loops on both sides to rack gear that will not be needed immediately.** This includes longer screws for belay anchors or for creating V-threads, a belay device, free carabiners, a pulley, a V-thread tool, and a cordelette.

Placing Gear on Lead

Placing ice screws while leading on steep ice can be very physically demanding. To conserve energy, minimize the number of screw placements; typically, on a waterfall ice pitch, far fewer protection placements are made than would be placed on a rock pitch of similar length. Similarly, climbers develop techniques for placing screws that minimize the effort expended.

For example, avoid the temptation to place a screw high (above shoulder height) to gain that momentary top-rope protection (having the rope above you). In this position, it is very difficult to put enough pressure on the screw

so that its threads will bite into the ice. The most efficient placement is right at waist level. You have better leverage and can use your whole body weight to push the screw into the ice. Also, your arm remains below the level of your heart so blood flow remains constant.

Fig. 20-9. Placing an ice screw on lead.

Here is one technique for placing screws on lead:

1. Get a good stance for both feet and (if you are right-handed) plant the left tool high (at arm's length); weight the tool, hanging straight-armed. Use the tool placement for balance only; maintain your weight on your feet, as shown in Figure 20-9.
2. At waist level, use the right tool to chip away any rotten or soft ice at the desired placement and make a starter hole for the screw if needed. Secure that tool—clip it to your harness, or place it solidly in the ice out of the way.

3. Place the screw with your right hand (fig. 20-9); attach a quickdraw or runner to the screw hanger; clip in the rope.
4. Retrieve the right tool; place the tool high and weight it; shake the left arm out as needed and continue climbing.

Occasionally body position, ice quality, or solid tool placements may dictate that a screw be placed with your nondominant hand. Practice placing screws with that hand and always rack a few screws on the nondominant side of your harness.

UNUSUAL CONDITIONS

Unlike the more homogeneous ice of most alpine ice climbs, waterfall ice comes in an amazing and beautiful (and, many times, terrifying) array of formations, shapes, textures, features, and quality. These characteristics can make for difficult climbing with little opportunity for protection.

Pillars. Pillars are formed when meltwater drips off a free-hanging icicle until the resulting ice stalactite and stalagmite join. Climbable pillars can range in size from less than a body's width to many feet across. Although big pillars are climbed using the tracking technique (see "Tracking" earlier in this chapter), small pillars require much more varied techniques. The tools must be vertically staggered so as not to weaken the pillar by having the two tools too close together. If placing screws in the pillar might weaken it, place protection in the adjacent rock. Both the tools and the front points might need to be placed in a pigeon-toed angle to keep the points and picks going straight into the ice, perpendicular to the ice in both planes. On really narrow pillars, a combination of front-pointing with one foot and flagging or heel hooking is effective (fig. 20-10). Assess pillars carefully before climbing them. Abnormally warm or cold temperatures can weaken them, as can sudden temperature swings, especially from warm to cold.

Free-hanging ice. Free-hanging ice is formed when a pillar or curtain has not touched down onto ice or the ground or has broken off. Most of the techniques for climbing free-hanging ice are the same as for climbing pillars, as are the stability concerns. Use delicate tool and crampon placements. Place protection in the adjacent rock walls. Place screws in the ice only above its point of attachment to the rock. If screws are placed low in the formation and the formation fails, the climber, connected to the falling block, will be dragged down.

Fig. 20-10. Combination footwork: front-pointing and heel hooking.

Chandelier ice. When thousands of small icicles melt and become laced together into a dense latticework, it is called chandelier ice. This ice formation is fairly common, beautiful to see, hard to climb, and difficult to protect. Belays must be situated to avoid the constant rain of debris from the leader. Most of the time, there is little delicacy to climbing a chandelier. Kick your feet deep into the ice structure in hopes of finding secure purchase. Place the tools similarly, although you can be more creative with them. You might hook the slots between two larger icicles, stab the entire head of the tool directly into the ice and then rotate the tool 90 degrees so the hammer or adze and pick straddle the newly created slot, or thrust the entire tool (and your arm) through the lattice and grasp the tool midshaft, using it as a deadman-style placement. You may not be able to place a solid screw, but natural protection may exist.

Cauliflower ice. Cauliflower ice forms at the "drip zone" of ice climbs, usually near the ground or above large ledges where spraying or splashing water has frozen into unusual shapes resembling everything from cauliflowers to open artichokes. The formations can range in size from several inches to several feet wide and deep. Cauliflower ice offers many opportunities for

hooking tools. Formations with solid domes can often be flat-footed (see Chapter 19, Alpine Ice Climbing), but use caution climbing the "petals" of ice that resemble more of an open artichoke; they can break easily. Cauliflower ice is best protected by screws set in larger bulges or in the solid center ice of these formations.

Onion skin ice. Another type of spray ice, onion skin ice forms when water sprays onto a layer of fresh snow and freezes, forming a crust of ice over the snow, sometimes several inches thick. These are notoriously unstable formations, however, since the ice is not attached to a solid surface. When climbing through onion skin ice, make sure to place a screw before moving onto it: but do not place a screw in an onion skin.

Brittle ice. The result of very cold temperatures, brittle ice usually appears only on the surface layers of ice formations. Work through the hard, brittle layers to get to the more plastic ice below, and in the process a cascade of falling ice will result, ranging in size from small chips to very large dinner plates. Be sure to stagger the placements of the tools far enough apart that the fracturing created by one tool does not reach the other, causing both placements to fail. Also, beware of falling dinner plates, which can dislodge front points. Place ice screws in the better ice found beneath the brittle layers.

Rotten ice. Often the result of being baked by the sun or weakened by percolating water, rotten ice can run much deeper than brittle ice, even through an entire formation. Rotten ice is difficult to climb and harder to protect; a lengthy section of rotten ice may be all but unclimbable.

Thin ice. Thin ice ranges from just a glaze of ice over the rock to ice a few inches thick. Thin ice can be very exciting and fun to climb. The thinnest ice is *verglas*: thick enough to obscure the underlying rock but not thick enough to gain purchase in with picks or points. Thicker ice is easier to climb, as long as temperatures are cold enough for cohesion to be maintained between the ice and the underlying rock. Make both tool and crampon placements with the gentlest of taps, swinging tools just from the wrist; sometimes placements must be scratched into place by chipping and hooking. Protection is usually found in the rock surrounding the ice. Extremely short screws may offer only psychological protection at best.

Bulges and ledges. These formations (discussed fully in Chapter 19, Alpine Ice Climbing) in water ice entail the same concerns that exist in climbing alpine ice.

DESCENDING

Some waterfall ice climbs, especially gully routes, allow walk-off descents to one side or the other. Most, however, are descended by a combination of down-climbing and rappelling. The techniques of down-climbing ice are discussed fully in Chapter 19, Alpine Ice Climbing; please review them there.

Rappelling

The principal techniques for rappelling on ice are the same as for rappelling on rock. Many rappels on popular waterfall ice climbs are done from fixed anchors, usually a combination of bolts and/or chains, slings on trees, or abandoned V-thread anchors. As with any fixed anchor, inspect these thoroughly before trusting them. Make sure the bolts are secure. Check the slings or accessory cord on the tree or the V-thread anchor for damage, wear, or burn marks, and check all knots. When in doubt, remove and replace the material. Check found V-threads to ensure that they are still solid. If any found anchor is suspect in any way, or if there are none, place your own. The technique for building a V-thread is fully discussed in Chapter 19, Alpine Ice Climbing. Any V-thread should be backed up with a screw until the last climber removes the backup screw, then rappels. Before the last climber rappels, ensure that the rappel lines are not frozen into place or jammed, so they can be pulled free from below.

MIXED CLIMBING

Mixed climbing combines climbing on rock, snow, and ice—and sometimes on frozen mud and moss as well. Mixed climbing might mean climbing a rock route in the winter, with ice-filled cracks and snow-covered ledges. Or it may involve making an alpine ascent up an icy face broken by a rock band. Or it may be climbing with one crampon on rock and the other on ice, one hand inserted into a crack and one ice tool placed in a frozen smear. Modern "sport" mixed climbing has come to mean climbing sections of rock between discontinuous sections of ice, often with preplaced bolted rock protection.

EQUIPMENT AND TECHNIQUES

The equipment used for mixed climbing most likely is whatever the climber was using right before the ice ran out. On a glacier climb, this means

mountaineering crampons and a mountaineering ice axe. On a harder alpine ice climb, it most likely means a mountaineering ice axe with a technically curved pick used in combination with a shorter ice tool, likely a hammer, and semirigid crampons. On a frozen waterfall with a mixed section, it is likely to be technical ice climbing tools and crampons.

Crampons

When climbing a mixed route, climbers are usually wearing crampons. Although considerable rock may be showing, it may be impractical to remove crampons only to put them back on when the route returns to the ice. Whichever crampons you choose, be sure that they are fully compatible with your boots. They must fit well to enable the delicate and precise movements required to climb rock while in crampons.

Vertical front points. Many mixed climbers prefer technical crampons with vertical front points (see Figure 20-1a). Monopoint crampons (see Figure 20-1b) are particularly handy for precision accuracy on minuscule ledges, vertical seams, and other subtle features. Monopoints are also advantageous because the point mimics the pick of an ice tool. On ice a monopoint can be placed in the pick hole made just a few moves previously.

Horizontal front points. Some mixed climbers prefer crampons with horizontal front points (see Figure 16-5c in Chapter 16, Snow Travel and Climbing). Such crampons have greater stability because their horizontal alignment matches the features found in the sedimentary strata of many mountain ranges. They also are less prone to shearing away because of their greater surface area.

Crampon Technique

Ultimately, crampon choice is secondary to proper technique. A good mixed climber selects a foothold and delicately places a crampon point or points in the spot. Smooth weight transfer is critical while gradually testing the foothold until it is completely weighted. Once that foot is weighted, it is important to keep it still, to prevent the points from rotating out of a crack or off a ledge. Careful footwork is the key to mixed climbing. With proper technique, climbers will not scratch the rock and their crampon points will remain sharp for any difficult ice climbing lying ahead.

Hands on Rock

Although it may be impractical to remove crampons for a rock section, it often makes sense to secure ice tools and grasp the rock directly with your hands. It may be next to impossible to find a pick placement on a downsloping rock ledge or fist-sized crack, but that same ledge or crack may easily yield a workable handhold.

For extensive climbing using your hands on rock, it may be necessary to clip the tool to your harness or otherwise secure it. This can be accomplished either by using a specialized carabiner designed for this purpose (see "Racking Devices" in Chapter 19, Alpine Ice Climbing) or by sliding the shaft of the ice tool into a spare carabiner. Be sure there is no possibility of the ice tool coming out accidentally. Dropping a tool on a one-pitch sport-style mixed route may be annoying and embarrassing, but dropping a tool on a committing alpine route could have devastating consequences.

The surest method of securing an ice tool is to clip the axe-head hole in to a spare carabiner or gear racking device on the harness. To remove the tool, grasp the head of the tool and open the carabiner gate with a thumb.

Once one or both hands are free, use them as on any rock climb. Fist jams, handholds, liebacks, and down-pressure can all be used to give your body the proper balance and positioning to support delicate footwork. Chapter 12, "Alpine Rock Climbing Technique," covers the variety of rock climbing holds and techniques.

Keep in mind that while climbing with your hands on rock, you most likely will be wearing gloves. Technical mixed climbing, like technical rock climbing, requires dexterity. Handholds, carabiners, and protection must all be manipulated efficiently. It is therefore impractical to climb mixed terrain with a bulky glove system. Most mixed climbers wear one pair of low-profile, close-fitting gloves while climbing; keep a second pair warming in a jacket pocket; and stash a third, warmer pair in the top lid of their pack for belays.

Ice Tools on Rock

When the holds become too small for your hands or the cracks are filled with too much ice, it is time to use ice tools. When using an ice axe or ice tools on rock, consider how to employ every part of the tool creatively.

Hooking. The straightforward technique of hooking is the most common method for using the pick of the ice tool to climb rock. However, it is critical

that, while pulling through the move, you hold the shaft of the tool steady against the rock (fig. 20-11a). If you pull outward on the spike end of the shaft, the pick will skate off the hold (fig. 20-11b). You can also use the hammer or adze of the ice tool to hook rock holds, although you must exercise caution, because the pick will be pointing toward you. To find a hook placement in a crack, look for constrictions just as you would look for a small stopper placement.

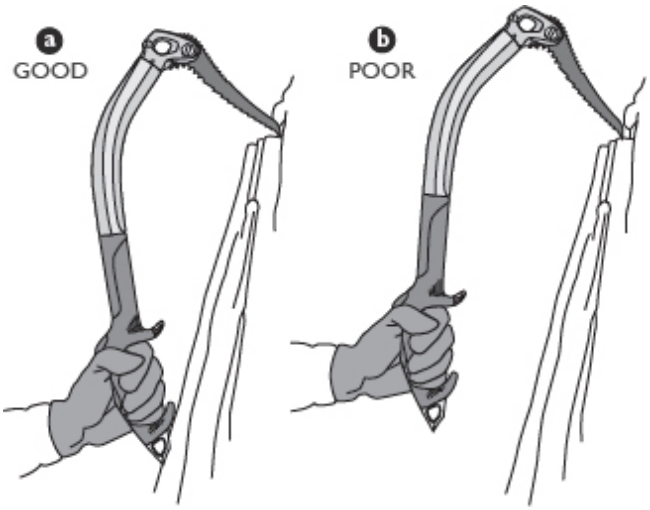

Fig. 20-11. Hooking technique: a, with downward force (good); b, with outward force (poor).

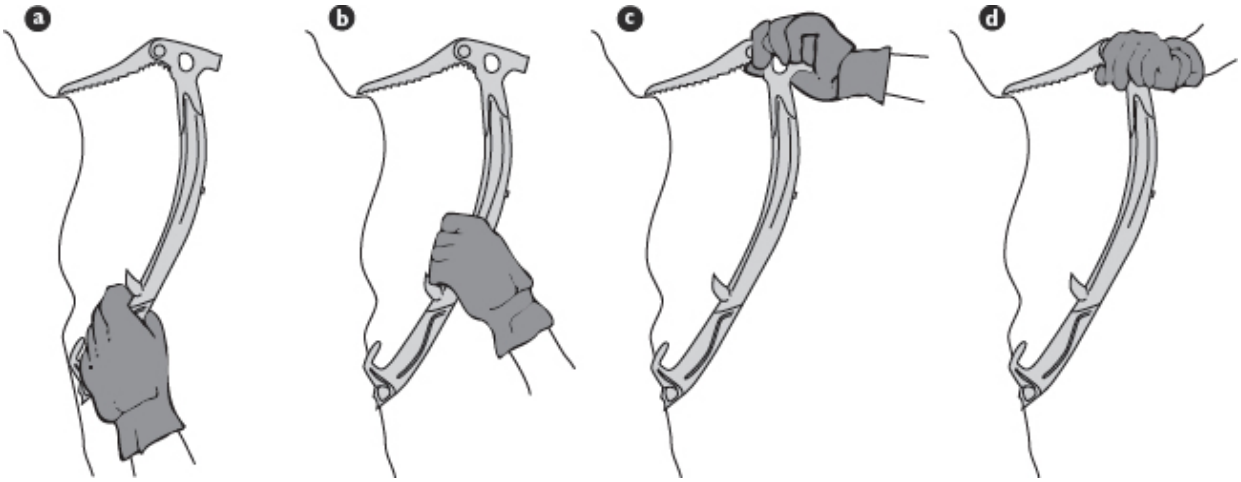

Fig. 20-12. Turning a hooked hold into a mantel move: a, hook the ledge; b, work your hand up the shaft; c, climb up, grasping the head of the tool; d, work your feet higher and mantel.

While moving up, it is sometimes advantageous to turn a hook placement (fig. 20-12a) into a mantel by sliding your hand up the shaft (fig. 20-12b) and

grasping the head of the tool (fig. 20-12c and d). This technique is especially handy if the next tool placement is far above you.

Torquing. Slide the pick into a crack that is a little too wide to be secure, and twist the shaft of the tool until the pick is securely wedged (fig. 20-13). As long as you maintain adequate pressure, the placement will be secure. Or torque by using the hammer, adze, or even the shaft of the tool.

The stein puller. A very stable technique, the stein puller is most often performed by inserting the pick upsidedown into a downward-facing seam or flake (fig. 20-14). Then, just as a bartender would pull down on a bar tap handle, pull down on the shaft of the tool, engaging the pick into the hold and forcing the head of the tool against the rock, creating opposing force. The harder you pull down, the stronger the tool placement becomes.

A great advantage of the stein puller is that a hold above your head can be hooked (fig. 20-15a); then you can climb up (fig. 20-15b), turning the stein puller into a mantel without removing the tool from the rock (fig. 20-15c and d).

Fig. 20-13. Torquing a tool in a crack.

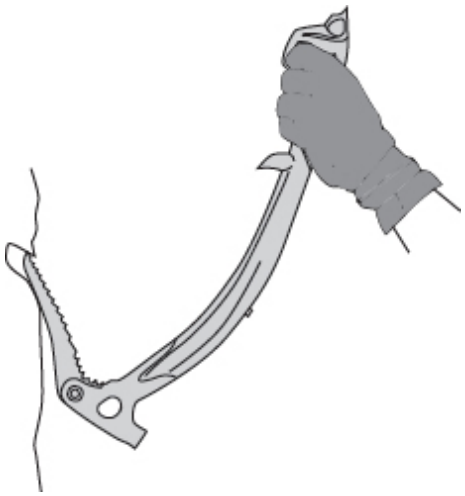

Fig. 20-14. Stein puller.

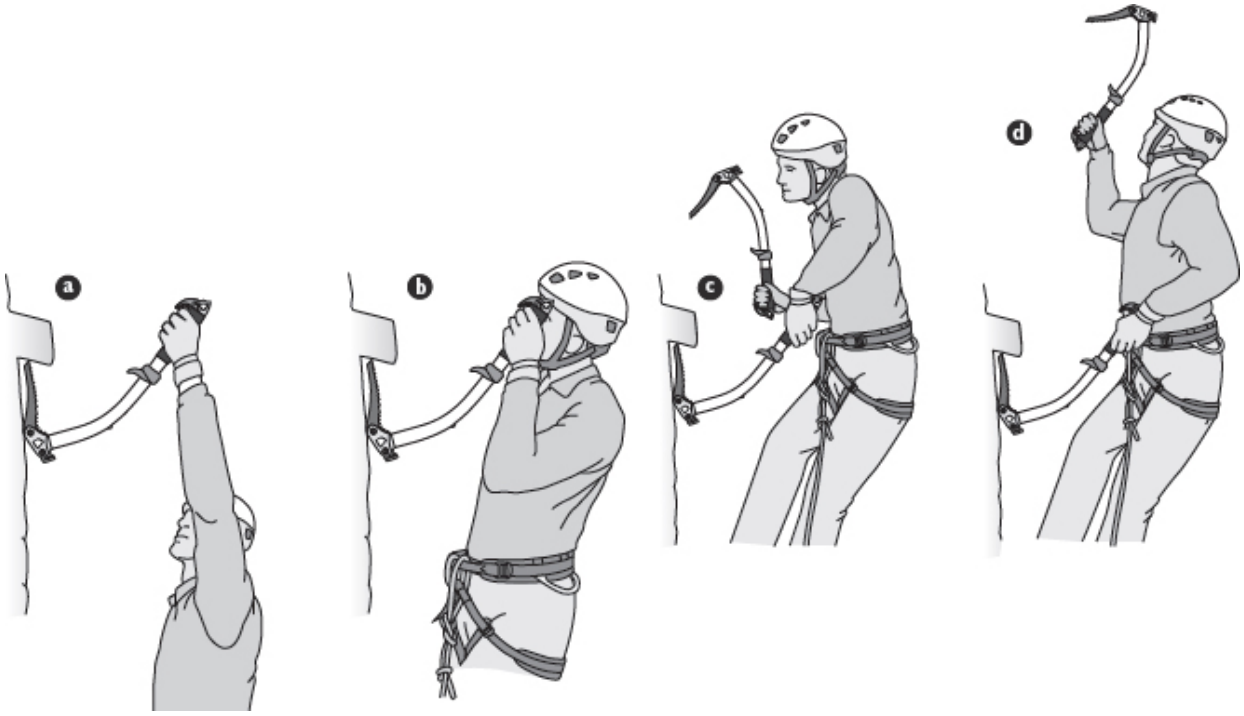

Fig. 20-15. Using a stein puller to mantel:
a, place the stein puller;
b, pull on it to work your feet higher;
c, mantel on the tool;
d, reach up and place the other tool.

Fig. 20-16. Stacking.

Matching. Another technique that is particularly useful while dry tooling is called matching. Just as on a rock climb when you place both hands on one hold, one hand on top of the other, one hold is used for both ice tools. One of the great things about the pick of the ice tool is that it is so narrow. Both tool picks can easily fit side by side on the same hold, as long as the hold is wider than about ¼ inch (6 to 7 millimeters). When matching, be sure that the hold is strong enough to withstand the force that can be generated by the two ice tools.

Stacking. Another technique used frequently in dry tooling is stacking. If there is one very good tool placement surrounded by bad ones, try hooking the pick of the well-placed tool with the other tool (fig. 20-16). When stacking, make sure once again that the hold is strong enough to withstand the force of two ice tools.

Body Positioning

In order to ascend mixed terrain well, climbers must combine precision crampon and tool placements with calculated body positioning. Rarely do they simply pull down on hooked placements and walk their feet up the wall.

For instance, picture a ledge that slopes down to the right. In order to hook this ledge and keep the tool placements stable through a series of foot placements, pull down and to the left (fig. 20-17). Conversely, a right-leaning lieback is futile unless your crampons are in a position to allow you to push your body sideways to the right (fig. 20-18).

With a lot of practice on mixed terrain, climbers gain confidence in their crampon and tool technique. Climb as many mixed routes on top-rope as possible, no matter how hard the routes may look. If a certain move is elusive, examine your body positioning. A slight change in the way you are leaning may be the difference between frustration and exuberance.

Protection

Previous chapters contain detailed discussions of various types of protection used on rock (Chapter 13, Rock Protection), snow (Chapter 16, Snow Travel and Climbing), and ice (Chapter 19, Alpine Ice Climbing). Also see "Protection" under "Waterfall Ice Climbing" earlier in this chapter and "The Rack for Mixed Climbing" sidebar. Here is an additional consideration when climbers are combining the various types of protection for mixed climbing.

Fig. 20-17. Lieback to the left.

If there is a choice between a rock anchor and a snow or ice anchor, use the rock anchor. It is relatively easy to evaluate the soundness of rock anchors, but this is not so with most snow or ice anchors. It might be necessary to do some digging and grooming to clear away snow, ice, and debris in order to place a piece of protection in the rock. Powdery snow can be knocked off with your hands, but an ice tool will probably be needed to clear hard snow or ice. If a crack is filled with ice, a piton or ice piton may be useful. Wired nuts can be pounded into cracks with the pick of the ice tool to create solid placements.

Fig. 20-18. Lieback to the right, pushing with feet.

Belaying and Reducing Forces on the Climbing System

Because of the possibly dubious nature of mixed protection, a dynamic belay is required. As always, use a strong multipoint multidirectional belay anchor with well-placed screws or pitons. (See Chapter 10, Belaying, and "Belaying on Ice" in Chapter 19, Alpine Ice Climbing.)

A dynamic belay may be partially obtained by using a rope that has a relatively low impact force (4 to 7 kilonewtons), which means it is stretchier and provides a softer catch. (See Chapter 9, Basic Safety System, for more on dynamic ropes and their specifications.) Most half-rope systems offer lower impact forces. Keep in mind that because low-impact-force ropes are stretchier than larger-diameter climbing ropes, a climber will fall a greater distance and so must watch out for ledges.

Minimizing rope drag is also important (see more in Chapter 14, Leading on Rock) when leading on shaky protection. If the rope zigzags up the route between points of protection and a fall occurs, the friction generated at the bends in the rope will prevent the rope from elongating as it should by design. If this occurs, a disproportionate amount of force will be applied to the protection nearest to the fallen climber. Keep the rope running as straight as possible, using double-rope technique and long runners for protection located off to the side.

THE RACK FOR MIXED CLIMBING

A mixed climbing rack contains gear that is appropri- ate for the climb. Some modern, sport mixed climbs are fully bolted, requiring only a set of quickdraws for protection. Longer classic mixed climbs require a full rock rack combined with a full ice rack. A typical mixed climbing rack might contain some or all of the following gear:

- Six to 12 ice screws of varying lengths appropriate for the thickness of the ice
- An assortment of nuts and Tricams that can be slotted or pounded into cracks
- Spring-loaded camming devices (SLCDs)
- An assortment of pitons for ice-filled cracks
- Several runners, alpine draws, or quickdraws
- A few long runners or cordelettes for threading gaps between the rock and the ice or ice columns
- An ice piton for quick protection, icy seams, and frozen moss
- A V-thread tool
- A few pieces of 6- to 8-millimeter accessory cord for constructing rappel anchors
- A knife for cutting webbing and accessory cord

Leading

Leading on mixed terrain can be an exhilarating experience, but it is not for everyone. By its very nature, mixed leads tend to be bold and committing. Taking a leader fall while wearing crampons and holding ice tools is serious business. Before you decide to lead a mixed pitch on ice gear, be honest about

your ability to climb it responsibly. If you decide that you can indeed climb and protect the pitch safely, here are a few tips to keep in mind:

- **Examine the crux(es) carefully.** Figure out the moves before you get there. Devise a plan and a backup plan for protecting and climbing through the crux.
- **Once on route, place gear at rests,** before the hard parts, instead of halfway through a crux sequence.
- **Calculate your moves and climb with confidence.**
- **Relax and breathe deeply;** this will calm stressed nerves.
- **If you are stumped by a sequence of moves, down-climb to the last rest spot, reevaluate, and try again,** perhaps using a slightly different technique. If the sequence remains elusive, down-climb or lower off.
- **Be prepared to leave some gear behind.**
- **If a fall is imminent, check the landing zone.** Be sure that you will fall away from the trailing rope, which your crampons or tools could damage. Disengage your tools, then your crampons, and push away from the wall. Aim picks on ice tools away from you and to the sides. Direct crampons toward the wall and keep your knees slightly bent to absorb the impact.

CLIMBING IN THE WINTER ENVIRONMENT

The extreme conditions of winter can create fantastic, almost surreal landscapes. On clear winter days, the bright blue sky is a perfect backdrop for the vivid blues of water ice formations. The ice glistening in the sunlight leads skyward.

Waterfall ice and mixed climbing build on the skills of alpine mountaineering and can involve severe conditions that require specialized equipment, a high level of skill, and a tremendous will to succeed. Equipped for the winter environment, the waterfall ice and mixed climber combines the disciplines of rock climbing and ice climbing with snow travel and backcountry risk management. But more importantly, waterfall ice and mixed climbers have an excellent understanding of their own abilities; they climb not for glory or recognition, but to fully experience the freedom of the hills.