How Boot Fit and Function Affect Student Success

By GREG HOFFMANN and ELLEN POST FOSTER

kiing is a simple sport conceptually. We go up a snow-covered hill in a mechanized lift and then glide down the hill with the help of gravity. For most of the skiing population, it is relatively easy to attain a comfortable skill level and to experience much of the mountain. However, it is more difficult to become an all-mountain skier and safely have control over your destiny at any given moment on any given terrain. Too



often, equipment hinders performance and does not allow skiers to achieve this goal.

Boots are the Achilles heel for many skiers. We will describe how the parts of the ski boot affect particular bones and joints of the body, and how they relate to specific skiing skills. This information will help you to understand and identify ski boot-related considerations that impede your students' ability to progress.

Manufacturers of skiing equipment have a difficult job to create boots that fit and function effectively for everyone because, clearly, people's physiques, body mechanics, and skill levels are different. Therefore, the skiers you teach may not have the appropriate boots. Acquiring knowledge about various boot components, stance balancing, and assessing alignment will help you to determine whether or not the boots are the cause of your students' problems, and if you should recommend a visit to a reputable bootfitter.

BOOT COMPONENTS

The word lower, also known as clog or shoe, describes the part of the boot that surrounds the foot and ankle (photo 1).



The shape (also called the last) of the lower is designed to accommodate different foot sizes and proportions. Looking at the profile of a boot, consider the distance between the heel and the instep/tibia flex location. It is noticeably greater for a boot that is designed to



accommodate a bulkier foot in comparison to a boot that is configured for a smaller, low-volume foot. This is the most critical of all fit zones and much more important than forefoot width. This dimension must match the foot in order to keep the heel in the back of the boot, have even tongue contact, and flex the boot effectively.

Just as the lower engulfs the foot, the cuff embraces the leg (photo 2). The cuff should fit closely so that movement of the lower leg exerts pressure on the cuff. This force is transmitted to the ski though the spine of the boot. The forward lean of the cuff affects fore/aft balance and the position of the hip. It should allow the skier to stand balanced over the center of the foot. Forward lean should not restrict the range of motion necessary for extension movements. The amount of forward lean can be increased by adding a shim between the liner and the back of the shell. Many boots come with a detachable shim, which can be removed to make the boot more upright.

The boot board (also called the zeppa) lies at the bottom of the lower. All boot boards are higher in the heel than the forefoot (photo 3). The boot board angle, or ramp



angle, balances the foot and ankle front to back, ball of the foot to heel. The boot board relates directly to the foot and ankle, which affects the lower leg and therefore, the position of the knee. Both the ramp angle of the boot board and the forward lean of the cuff are critical for controlling fore/aft pressure on the skis.

The foot should feel snug and secure within the liner of the boot without tight buckle tension. A thinner liner will allow for greater feel of the snow because the foot and leg are closer to the lower and cuff. A thicker more cushioned liner may feel good, but may not perform on snow as well. The liner can be modified to alleviate pressure points or by adding material for a tighter fit (photo 4).



STANCE BALANCING

In skiing, dorsiflexion of the ankle refers to flexing the leg over the boot towards the toes. Instructors commonly call this movement "closing the ankle." Ankle joint dorsiflexion is crucial for maintaining fore/aft balance, absorbing excess pressure on the skis, and crossing uneven terrain smoothly.

Lack of flexibility (dorsiflexion) in the ankle prohibits the skier from



matching the angle of the boot that is created by the ramp angle and forward lean. For example, if the ramp angle has 6° of slant and the forward lean has 16° , subtract these two numbers to find the amount of dorsiflexion that a skier needs to match the angle the boot creates. The result is 10° standing statically and more when the boot is flexed (fig. 1). If a person has less than 10° range of motion in the ankle, his or her heel will feel light in the boot when the lower leg matches the forward lean. As a result, the heel hovers above the footbed, and the skier

Figure 1

a. The ramp angle of the boot board is 6°.
b. The forward lean of the boot is 16°.
c. The forward lean (16°) minus the ramp angle (6°) equals the necessary ankle dorsiflexion (10°).

often attempts to find solid ground by sitting back at the hips.

The addition of a heel wedge to the boot board will increase the ramp angle and resolve the situation just described. This additional heel wedge is a filler that brings the ground up to the foot in order to balance the foot. It serves a very different purpose from adding a heel lift solely to change a skier's stance and hip position, which is not recommended. Conversely, the ramp angle may need to be lowered for an ankle that displays excessive range of motion of approximately 20° or greater. This allows the skier to flex far enough forward so that the functional tension that occurs at the ankle's end range of motion applies force to the cuff that will be transmitted to the ski. Rigid or excessively mobile ankle joints should be assessed by a qualified bootfitter because subtalar joint movement below the ankle joint can disguise the actual amount of dorsiflexion in the ankle (fig. 2).

A custom footbed is an insole that is made by a bootfitter specifically



- A. A neutral stance; the foot is balanced.
- B. The hips are back to compensate for lack of dorsiflexion in the ankle.C. Stance is low with hips back to compensate for excessive dorsiflexion.D. The hips are too far forward to compensate for excessive dorsiflexion.

for an individual client (photo 5). It accommodates the shape of the bottom of the person's foot and balances the foot from side to side. Custom footbeds provide comfort and stabilize the foot within the lower to enhance performance. The footbed supports the foot in a neutral position and allows it to act like a balanced tripod: the three

points of contact are located at the center of the heel and behind the first and fifth toes (at the metatarsal heads). The footbed distributes pressure across the foot so that both the big-toe side and little-toe side can be accessed (weighted) to edge the ski.

Within the lower, the combination of balance from side to side (custom



footbed) and front to back (boot board ramp angle) create the suspension that allows a skier to adjust the blending of skills with subtle movements and to develop a light touch on the snow. Just as the components of the lower create suspension, the cuff creates the transmission as the lower and cuff work together to transfer pressure to the skis.

The cuff shaft adjustment provides a means to tilt the cuff sideways so that it



matches the angle at which the lower leg leaves the lower (photo 6). If the skier's legs are not centered in the cuff shafts, he or she will be forced to compensate physically to attain a neutral stance. This can lead to discomfort and compromise performance. Notice in photo 7 that the skier's legs are tight against the inside of the cuffs. The cuffs need to be moved inward to match the angles of the legs. In comparison, the skier's legs in photo 8 are centered in the cuffs.

After the previous steps are taken to support the foot in a neutral position and to align the cuff of the boot with the natural angle of the skier's leg, overall alignment should be assessed to determine if canting is necessary (photo 9). Canting involves modifying the boot sole angle to improve the skier's alignment. If a bootfitter determines that the center mark of a skier's knee mass does not line up with the center mark (mold line) of the ski boot while standing on a level surface, then canting should be considered. Although the aim is for both marks to line up, some skiers prefer to be slightly inside (negative alignment) or outside (positive alignment) this mark. In a knock-kneed stance, the center of the skier's knee mass falls considerably to the inside of the center line of the boot. This stance is referred to as under-edged because the ski remains relatively flat in a turn. The under-edged skier must move farther to the inside of a turn than a neutrally aligned skier in order to attain the same edge angle. In contrast, a bowlegged stance aligns the center of the skier's knee mass noticeably to the outside of the center line of the boot. This creates an over-edged stance whereas movement toward the inside of a turn results in more edge than is necessary. Over-edged skiers cannot achieve a strongly aligned position from the hip to the foot because the edge engages before the knee is in alignment. While some skiers opt for this strongly positive set-up for carving on hard snow, it hinders their ability to soften the edge when skidded turns are warranted for other conditions. Most skiers prefer a neutral alignment, which provides more options for versatility in turn size and shape, and for skiing varied terrain and snow conditions.

Canting should not be done to the footbed or boot board inside the boot because it will take the foot out of a neutrally supported position. Depending on the degree of cant planed into the sole of the boot, modification to the toe and heel lugs may be necessary to maintain DIN standards. No matter how insignificant any adjustment appears to be, there are consequences elsewhere for the skier system. A rule to keep in mind is that modifications made to the outside of the boot, such as adjusting the cuff or planing the sole of the boot, affect the joints above the boot. Any adjustments pertaining to the ankle joint or foot are made inside the boot.

STANCE AND ALIGNMENT

As an instructor, it can be difficult to determine whether stance, alignment, or fit issues hinder a skier's ability. If after instruction, your student cannot change a movement pattern given his or her overall athleticism, limitations due to equipment should be considered. The following guideline will help determine if a student will benefit from the expertise of a qualified bootfitter.

The best maneuver to assess a skier's stance and alignment is a slow-speed, steered turn since steering blends rotary and edging skills to create a skidded turn that has a smooth, round-shaped arc. This turn is basic to all levels of skiing, and it can be performed whether your students are on rental, carving, or powder skis. At slow speeds, it is easier to recognize incorrect movement patterns that may be the result of the function or fit of the skier's boots.

In general, notice if your student stands comfortably tall over the feet with joints flexed fairly evenly. Or, does he or she sit back, lean too far forward, or stand in a low position that requires muscular exertion? Look to see if fore/ aft balance is maintained while the skier extends to flatten the skis at the start of the turn, and flexes to increase the edge, continuing the turn through completion. If in balance, your student should be able to simultaneously turn the skis and tip them onto edges. The rotary movement should come from the legs turning and not from the upper body. Throughout the turn, notice if the edge angle is similar on both skis (the objective), or if the angles are largely different. Observe if there is a knockkneed or bowlegged appearance to your student's stance. Look for symmetry in the turns: a significantly weaker turn in one direction is cause to question the student's alignment.

This visual assessment can be augmented with questions such as, "Are your feet sliding forward or moving sideways in your boots?" and, "Where on the bottom of your feet do you feel the most pressure?" The responses may confirm your observations and indicate that the fit and/or construction of the boots are interfering with your student's ability to ski competently or improve.

Whether you are questioning your student's ski boots or wondering about your own, be aware of the human factor. Even a small adjustment that is tailored for an individual's physique can greatly improve performance and comfort. Why focus on ski boot fitting? It could be the answer to skiing more challenging terrain, refining skills to surpass the next level of certification, or just enjoying the glissade. 52°

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