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Why are great skiers not like trees?

Answer in the Central Division Facebook page.

The Q Angle Effect:

An Opportunity to Significantly Impact Your Advanced Students

By Chuck Roberts

The Q angle (Quadriceps angle) is an angle formed by a line from the ASIS (anterior superior iliac spine) to the mid-point of the Patella (knee cap) and a vertical line from the midpoint of the patella. It is an anatomical feature of the human body that is typically more pronounced in women than men. Figure 1 depicts the difference in Q angle between men and women. Men typically have a Q angle on the average of 14 degrees while women typically have a Q angle on the average of 17 degrees. This tends to yield the knock-kneed stance often observed in many female skiers, as shown in Figures 3a and 3b, that hinders edge engagement, limits independent leg movement and causes excessive skidding in turns (Reference 3). This also makes it difficult for females to perform Ollies on a snowboard and land properly from an aerial maneuver on a snowboard or skis. Young female ski racers are often affected by Q angle changes as they mature.

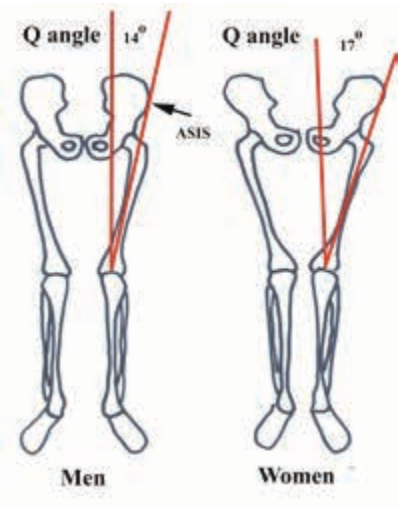

Figure 1

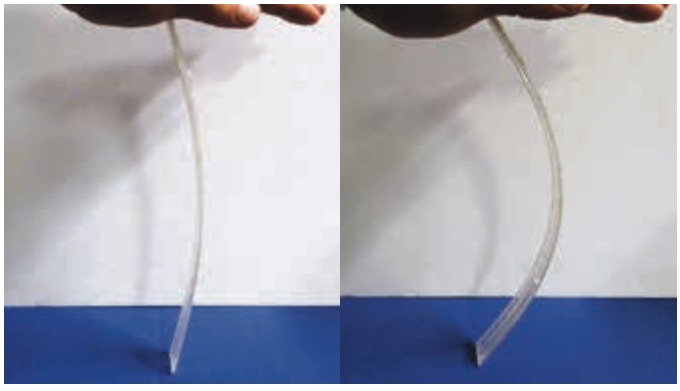

Figure 2a *Figure 2b*

Figure 2 illustrates the mechanics of the leg with respect to Q angle. The ruler on the left (Figure 2a) has a slight bend simulating a small Q angle. It can carry an axial force before buckling. The ruler on the right (Figure 2b) has more bend simulating a larger Q angle. This condition requires less force to buckle than the ruler on the left. This illustrates that the larger the Q angle, the less force is required to buckle the leg or cause a knock-kneed stance.

Figures 3a and 3b show a female skier with non-parallel leg shafts (knock-knees). While turning, the compression force acting along the inside leg has caused it to buckle medially, resulting in the knock-kneed stance. The outside leg is prevented from inward lateral movement by the inside knee. This condition can be aggravated by hip rotation in the direction of the turn.

Figure 3a

Figure 3b

Figure 3c

As an instructor, this issue with your students yields an opportunity to make a significant difference in their performance, allowing them to achieve a higher skiing/snowboarding level. There are many things you can do to help. Boot fit and cant angle can make a difference and is a good Segway into the importance of addressing the mechanics of proper alignment of the skis to make sure both skis are flat on the surface when standing. Another recommendation is strengthening of muscle groups such as the hamstrings. Many women have developed quadriceps muscles, but hamstring strength and inner thigh muscles are less developed. Recommend that the student review the physical training curriculum at a particular gym and look for pelvifemoral and hamstring strengthening as an exercise regimen to reduce the knock-kneed stance.

continued on page 10

continued from page 9

OK, now what can you do to help during a lesson. Several exercises come to mind. One good one is to traverse on the uphill ski. The problem knock-kneed skiers have is difficulty engaging the new uphill edge. This exercise helps strengthen the leg muscle groups over time and allows the student to get more comfortable with inside ski edging. Railroad track turns on a gentle slope are also helpful in that inside ski edge engagement is reinforced, but be careful of too wide a stance. Emphasize tipping the little toe on the new inside ski to get that inside ski carving and out of the way of the outside ski. Moving the inside knee out of the way and toward the inside of the turn helps. Another cause of knock-kneed stance is the rotation of the hips in the direction of the turn. This causes the inside leg to collapse, the outside leg to stiffen and a knock-kneed stance. Emphasize hips facing downhill, utilizing your normal bag of teaching tricks. One or a combination of these exercises may reduce the Q angle effect during the lesson. The skier in Figure 3c has successfully corrected the knock-kneed stance as indicated by the parallel leg shafts.

Figure 4

For your advanced female skiers, they may look great on intermediate slopes but may ski knock-kneed on steeps and during aggressive dynamic turns as shown in Figure 4. This is because the more aggressive turns apply a higher axial force in the leg, causing it to collapse. In your advanced female skiers, a symptom of this is lifting the inside ski to get the inside leg out of the way, rather than rolling the inside ski out of the way. Leg strengthening should help at this level since your student has demonstrated the proper parallel leg shaft position in less aggressive maneuvers.

It is interesting to note that racing coaches encounter a change in ski racing technique among female racers as they mature. What happens is a reduction in edging and turn initiation skills as Q angle increases.

Figure 5a

Figure 5 shows the effect of Q angle on female freestyle skiers landing jumps. In Figure 5a, the skier jumps upward and lands (Figure 5b) with the classic knock-kneed stance. For big air female jumpers this causes a problem when landing since the inside ski edges may become engaged, resulting in crossed skis or splits and loss of control. Being aware of Q angle effects on your freestyle female skiers may help explain some of the challenges they experience when performing landings from high end maneuvers.

Figure 5b

It is interesting to note how Q angle affects snowboarding. Figure 6 shows two examples of ineffective positioning where Q angle coupled with hip rotation causes the trailing leg to collapse, the leading leg to stiffen and the center of mass to move toward the tail of the board (as evidenced by the back leg being more flexed than the front). The upper body twist with respect to the lower body is ineffective in that heel side edge engagement is difficult, often resulting in skidding. This condition occurs mostly on turns to the heel side since the hips tend to be blocked on the toe side turn. Emphasizing the A-frame stance with the hips parallel to the board is a place to start. Utilizing torsional flex of the board with ankle movement (gas pedal, Reference 1) gives confidence to the rider, making rotation in the direction of the turn unnecessary. Typical exercises here are grabbing the thighs with both hands to prevent hip rotation, pointing the leading arm parallel to the board at all times and crossing the leading arm over the chest and grabbing the trailing shoulder. The rider in Figure 7 who does not exhibit the Q angle effect, has proper alignment and positioning. She has kept her hips parallel to the long axis of the board, eliminating the upper body rotation that causes problems with the heel side turn.

Figure 6a

Figure 6b

Figure 7

Many female riders have been set up with stance angles of 0 degrees leading foot and 0 degrees trailing foot. Setting the bindings with a duck stance up to +15 degrees leading foot and -15 degrees trailing foot (along with increasing stance width) reduces the effect of Q angle and allows the inner thigh muscles to help support the quadriceps. Encouraging a bow-legged stance may help reduce the knock-kneed position. Encouraging putting weight on the little toes may help. The purpose of this is to reduce the pronation of the foot which facilitates the knock-kneed stance. Of course orthotics that are designed to reduce pronation may help. At the conclusion of the lesson, a recommendation of strengthening the hamstrings and quads to improve riding may be in order.

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continued from page 10

Q angle also has an effect on performing Ollies (Reference 2). Typically, one shifts the weight toward the nose of the board (Figure 8a) and then over the tail of the board (Figure 8b), storing energy in the bent board. Pushing upward with the trailing leg (extension, Figure 8c) along with the release of stored energy in the tail of the board results in getting air (the Ollie, Figure 8d). With most men, pushing upward is not a problem. For women, the higher Q angle tends to cause the trailing knee to move to the center of the board absorbing some of the spring and resulting in significantly less air time. Figure 8d shows the approximate movement of the knee of a female (outlined in red) which absorbs some of the spring required in an Ollie. If the trailing knee is collapsing toward the center of the board, emphasize to the student to move it toward the tail to get the most spring possible out of the Ollie. Check binding set up, since a change in foot position to a more duck stance or a wider stance may help. The Ollie is a basic maneuver and is used in advance maneuvers on boxes, rails and jumps.

Figure 8a

Figure 8b

Figure 8c

Figure 8d

The female rider in Figure 9 is traveling up the compression side or the take-off of a jump. This adds a significant vertical load on the body that should be resisted so the rider can extend the legs and pop from the lip on the jump. In Figure 9, the vertical load has caused the legs to buckle to the knock kneed stance which tends to absorb the vertical load and limits the ability to pop at the lip and get air time.

Figure 9

This has been a brief review of how Q angle affects the performance of female skiers and riders. The knock-kneed stance may have prevented your students from progressing to more advanced turns and maneuvers. As always, be aware of discomfort on the part of your students who may require more time or smaller increments to adjust to a new binding stance or a particular exercise. Knock-kneed problems may not be solved during one lesson, but the instructor has the opportunity to guide the student toward success with exercises during the lesson and advice on strengthening and equipment set up.

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