

Functional Ankle Strength in Alpine Skiing

Functional ankle strength in alpine ski racing requires that the athlete have the ability to generate and transmit force rapidly into the ski through the ankle joint.

Mike Kenney, USST Men's Coach & Trainer
September, 2014

Coming up through the Jr. Alpine ranks in the 1970's our Austrian coach spent time in our dryland sessions on ankle specific exercises. We focused mostly on the tibialis anterior muscle which activates anterior ankle flexion (dorsi flexion) and various exercises that develop both the peronious longus and brevis muscle groups. While these muscles appear insignificant, they support the ankle in the everted position and assist in foot steering and subtle pressuring of the edge. A collateral benefit is injury prevention through connective tissue adaptation during repeated high intensity exercises (1).

Decade's later working with the US Men's World Cup group as a trainer and coach, I am surprised that there is no sport specific maintenance program for the ankle joint. Among the reasons I can think of for this omission are: there is no strength testing protocol available and the sparse musculature surrounding the ankle and the joint structure that serves to articulate the ankle joint is a challenge to isolate and develop. An additional, perhaps obvious, reason is that it appears there is not much going on inside a stiff, tightly buckled ski boot in terms of range of motion. In this article I will make the case that the unique physiological demands in ski racing require the racer to have a high degree of eccentric, isometric and concentric strength and coordination to stabilize and activate the ankle joint.

Hidden underneath the suits and plastic ski boots of any athlete with superior technique is someone who can sustain and best manage the ever increasing force loads and precise pressure development required in modern ski racing. As a coach and trainer I am interested in looking at any weaknesses in the kinetic chain of movement patterns that will lower an athlete's performance potential. Do all the movements required link together in a strong efficient manner? Strength deficits or imbalances that appear along the kinetic chain can appear from the ankle joint up through the legs, hips and core. As overall strength and power (through muscle hypertrophy) and muscle endurance have increased through advanced training methods, it is important to keep an eye on the ankle as a critical link in the kinetic chain that transmits power cleanly and efficiently into the ski.

An enhanced connective tissue network is necessary to withstand greater force capabilities of growing muscle (2). Compared with muscle tissue, the metabolic turnover of tendinous connective tissue is many times slower due to poor vascularity and circulation (3). This would indicate there is a *significant lag time* between general strength and mass increases and the ability of the connective tissues at various sites to increase their load bearing capacity. In particular these include *sites such as the foot and ankle*: the junctions between tendon or ligament and bone, within the body of the tendon and ligament, and in the network of fascia within the skeletal muscle (4). These points should be taken into consideration when assessing an alpine athletes' physical maturity relative to standard alpine physical testing protocol.

From a biomechanical viewpoint the ankle joint has a big job to do. It must have the strength to withstand and transfer the power generating forces of the legs, body mass and G forces, and have the resilience to absorb vibration and maintain a level of sensitivity to the snow, all while being held in a flexed position. In a normal turn, three subtle movements are occurring simultaneously and synergistically: anterior ankle flexion, ankle eversion or supination, and rotary movement comprised of the inward or outward torquing forces sometimes referred to as foot steering.

Applying these movement patterns on a wide range of snow densities and surface textures create a whole spectrum of vibration frequencies and amplitude. Even inside a locked down ski boot rattling along on ice, proprioceptors located in the ankle are constantly giving feedback to the brain. These varied conditions necessitate soft relaxed feet to glide on soft snow to near maximal isometric muscle recruitment while initiating and stabilizing while holding an edge on icy chunked up snow or tight radius turns. An ankle joint that is over engaged on rough icy terrain causes the ski to lose its ability to absorb vibration and will bounce and chatter losing line and speed the same way an athlete with an overall strength deficit slides a turn instead of actively holding a clean edge.

The recent trend toward tighter and courses set with more swing and a wider variety of turn radii will further challenge and broaden the required skill base of racers. Only a well conditioned athlete with a fully functional ankle joint is able to spontaneously adapt and keep the ski running clean with the least friction in every snow condition.

I find it interesting to look back through the decades and witness the evolution of incremental performance leaps where certain athletes have contributed to the development of the sport in terms of their footwork. Ingemar Stenmark was the first to rail turns cleanly without the aid of a shaped (parabolic) ski. He was followed by Marc Girardelli whose strength component allowed him to exert massive rotational forces into his skis and enabled him to pull tighter radius turns, and then Alberto Tomba who was able to apply a high power component to the picture with quick explosive turns in slalom and add more radial acceleration with higher G forces in GS. The Herminator (Herman Maier) added mad intensity and fitness to solid technical fundamentals bringing him a long tenure at the top. This brings us into the recent century watching two different American men stamp their unique styles' into the annals of technical innovation in ski racing. Let's look at the role that the ankle has played in pushing up the performance ceiling by Bode Miller in the last decade and the dominance of Ted Ligety in this decade. Two different styles have resulted in many winning performances.

Some observers would look at Bode's success and say it was achieved through sheer athletic ability and risk taking while being the fastest to adapt to the new shaped ski technology. A closer look at the clues inherent in his technique might be found when he first broke onto the World Cup scene. He always seemed to be in the "back seat", skiing off the tails of his skis. However, what many observers failed to notice is that while he sometimes appeared to be flailing trying to find his forward/aft balance-- he was actually exerting pressure with massive forward ankle flexion and inward rotation. This resulted in creating a torque force that immediately put him on a strong platform to arc and push off of, even while taking a straighter line. From a slightly more aft position, he creates the least amount of friction between skis and snow and thus is fast. On moderate and flat slopes he mastered the ability of bending the tail of the ski to initiate the turn by pulling up on the front of his skis with strong anterior ankle flexion while levering off the back of the boot. This

technical ability of bending the ski from an aft position has the additional benefit of creating a more aerodynamic profile during tuck turns in speed events.

Recently I had the opportunity to watch some of the best American juniors training GS. The set was 25M on a steep pitch with a lot of offset, quite turny on soft grippy snow. A couple of athletes were wrestling with the new 35M radius skis having to actually step their skis around to complete some of the tight turns because they were not able to pivot and redirect on the soft snow. The athletes on the 27M had to work at it, but were able pull clean arcs. It occurred to me it has taken most of the men on the World Cup tour all season to learn how to ski efficiently on the new radius. Then there was Ted. The commentators exclaim, "Look at the fantastic angles he creates above the gate!..." How is he able to establish pressure and commit to incredible inclination angles so early and run clean rails on such a high line? The answer is precise timing with his patented "back pedal move" (and often using his inside hand for balance on the snow) that is *coupled with* massive forward ankle flexion. This move generates force to establish a radically inclined balance platform and he can simply bend his skis and start his turn where others can't. He initiates on a high edge angle and powers through the turn creating his own unique clean and fast turn shape. Take a look at the bottom steep pitch on the Gran Risa (Alta Badia, Italy) GS in 2012 and pay attention to the work his ankles are doing while his upper body exhibits a high level of dynamic lateral balance linking up clean turns on the most difficult terrain.

In summary, the performance levels of elite ski racers in the future will be determined by those who can develop pressure on the ski rapidly in a consistently accurate manner while withstanding the high forces involved. Be sure your ankles are up to the task!

Mike Kenney is a US Ski Team World Cup and Olympic Men's Alpine Ski Coach and Trainer. Over the last decade he has worked closely with Bode Miller and Ted Ligety as well as US "A" team and "B" Team members as a 4 event and Combined Coach.

References & Glossary

1. Baechle, Earle. Essentials of Strength Training and Conditioning. 4: pg.69, 2000
2. Ibid. pg. 70
3. Kannus,P.,L. Jozsa, A. Natri, and M. Jarvinen. Effects of training, immobilization and remobilization on tendons. Scand. J of Med. Sci. Sports 7(2):67-71. 1997
4. Ibid pg. 69

Eccentric Muscle Action:	Lengthening of muscle fibers under load.
Concentric Muscle Action:	Shortening in the length of muscle fibers under load.
Isometric Muscle Action:	Relatively constant length of muscle fibers under load.
Kinetic Chain:	A term used in exercise science to describe a sequence of connected movements.
Back Pedal Move:	In the transition phase of a turn the feeling of moving the foot up and backward to initiate clean edge with stronger ankle flexion.
Retraction Move:	In slalom the action of pulling both feet back rapidly in the transition in order to support stronger initiation and gain elevation.
Rapid Force Development:	RFD describes the ability to exert high pressure forces into the ski in a short amount of time.