Pelvic Tilt and Claw Kicking
A Single Movement

In an earlier article on poling, I cited Lindinger's observation that little time has been dedicated to the analyses of the swing phases of the skiing motion. In my article I diagrammed the loss of moment of inertial (free) speed/force if the arms break at the elbows and lift too vertically rather than adding to the forward momentum by following at a more open angle to the ground.

The same moment of inertia and biomechanical analyses can be applied to the lower body segments. The result is a better understanding of the manner in which the ski optimally addresses the snow surface and the kick is begun earlier than we have traditionally imagined it, and in a somewhat different way.

When it comes to understanding speed and the role of technique in achieving it, sprint coaches and researchers have had the most to say, not surprisingly, because mechanics are the key to the hundreths of seconds which decide whether a runner wins or loses. And when a top trainer describes a shift in his concept of speed mechanics, it is worth examining. In this case, the German author is Winfried Vonstein, writing in NSA 2-3, 1996, p. 161ff: "Some reflections on maximum speed sprinting technique."

> In traditional training theory, at least in Germany, the emphasis is on the driving phase of the legs behind the body's centre of mass: in this way, the body is pushed forward by an extension of the hip, knee and ankle joints. Speed would, therefore, be limited mainly by the strength of the extensor muscles, especially in the thighs (m. quadriceps femoris)
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> This traditional approach disregards the results of technique and functional-anatomical analyses, according to which the phase before the centre of mass (usually called the "braking phase") is more important in realizing maximal sprint speed than the phase behind the centre of mass.....The differences are measurable and most significant in the maximal (high speed) sprint phase. Differences in acceleration are much smaller. ….According to this, a detailed analysis of the maximal sprint phase shows that the differences seem to be related to technique. [Two of the elements of technique are] From a relatively high knee action there follows a very active striking/clawing movement of the foot onto the track. [And] the knee extension seems to be slight. However, the ankle and especially the hip joints are fully extended.....
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> It is through ground reaction forces that an athlete is able to run/sprint. This implies that only when the foot is on the ground (in the supporting=braking/driving phase) can forces act and thus influence horizontal speed.
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> Therefore, we have to answer two questions:
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> 1.What is the effective technique during the support phase?
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> 2.How should the preceding swing phase be executed in order to have an optimal effect on the support phase?
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> First of all, negative forces must be small and positive forces large. The legs and feet are the important components that do the work between the between the body and the ground. From the subjective point of view, as the body is moving forward the

ground moves backward.

This implies that negative forces can be small only if the athlete succeeds in synchronizing his leg/foot speed and direction with the “ground speed.”

Therefore, we must consider the movement of the foot and the sort of curve this movement produces. We see that an optimal foot movement has a curve like a “kidney bean”(see Figure 2).

This movement (foot curve and direction) is closely related to the body's posture, which depends on the position and stability of the pelvis. If the pelvis is tipped backwards it hinders maximum speed sprinting. This position of the pelvis has a great effect on the action of the leg and foot (see Figure 3).

The evident affect of the position of the pelvis on the foot movement curve is illustrated by the “shaded” pelvis.

This action can often be seen in younger athletes who try to run faster by leaning forward. Unfortunately, they fail to do so, since this biomechanical modification causes in increase in negative forces.

The aim must be to achieve the “unshaded”" foot movement curve and, as a result, the related position of the pelvis.....

[Technical points] The knee extension must be of minor priority and is hardly of importance in producing speed in the maximum sprint movement....In addition the ankle extension cannot be decisive for horizontal speed. Consequently, the extension of the hip (through about 50 degrees) must be of the greatest importance.

In maximum speed sprinting the following muscles are responsible for hip extension: the gluteal muscles..... the adductor muscles....the hamstring muscles. Although the gluteal muscles are very strong hip extensors, their influence on horizontal speed is only a minor one: At the moment of touch-down in sprinting, the hip angle is already so obtuse that the gluteal muscles cannot contribute much more to the development of horizontal speed.

Thus the primary hip extensors in that specific movement are the hamstrings!

This can be illustrated by a diagram of electrical activities (EMG) of some muscles in different movements.... This diagram supports the contention that the hamstrings are the main extensor of the hip and, as such, are the primary muscles responsible for producing maximum horizontal speed in sprinting. Also, the pulling action in maximum sprint training is preferred to the pushing action.”

Although not all skiers are sprinters, all skiers do want to achieve greater speeds; and as many top middle and long distance runners have found, sprint coaches have taken the most time to figure out how. Nor is it surprising that coaches who have emphasized initiating the kick with the hamstrings and “clawing” the kick have had good success, among them Frode Lillifjel and Nikolai Anikin (as demonstrated by Sara Kamilewicz).

Something more general can be said about pelvic tilt as well. It has been known for 50 years in the physical therapy and rehabilitation profession that pelvic tilt is an essential movement/posture in lifting weights of any kind. You pull in your belly button and pinch you buttocks together. The posture does not feel as heroic, but the sensation of added stability and spine alignment is immediate. Greater

safety accompanies great power outputs. The difference is easy to feel if you first press, say, a crowbar over your head while standing at your “best” posture and then repeating the lift with your pelvis tilted.

These diagrams and photos of the dynamic movement/position of the pelvis show the potential gains in natural efficiency through pelvic tilting. The skier is Arianna Follis, Italy.

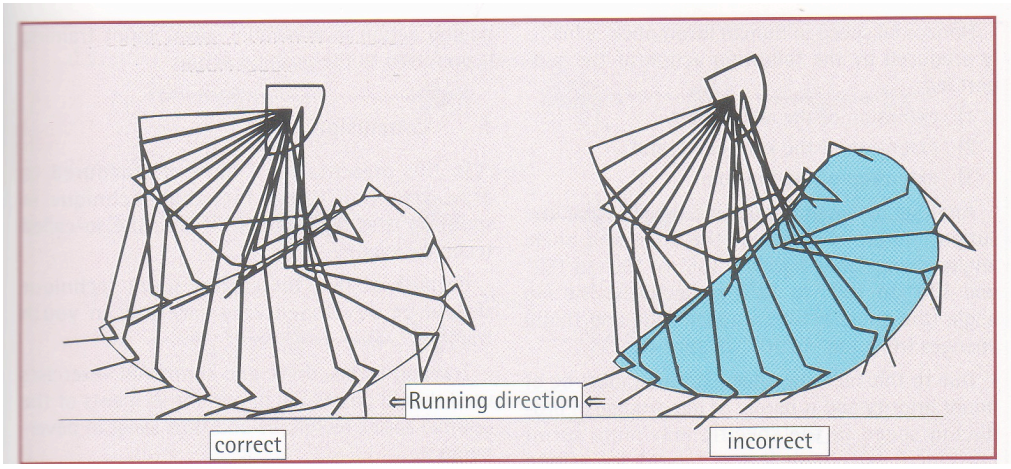

Fig. 3

Imagine a ski on the sprinter's foot coming forward in the blue pattern as opposed to the white.

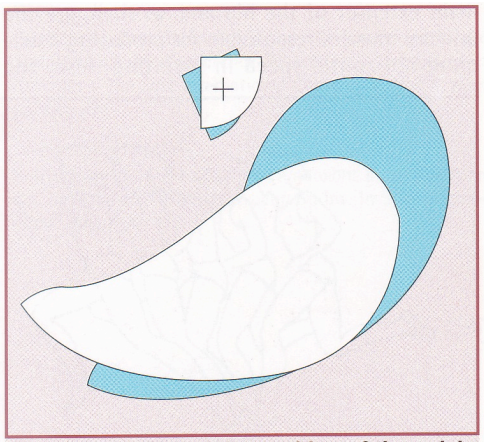

Fig. 2

2.

1.

Pelvis tilts under, as in white diagram for sprinters above, allowing ski to touch naturally farther forward and more softly and rapidly (swing point from flexing low back)

Below: Charlotte Kalla

How do I Practice Tilting and Clawing for Skiing?

Pelvic tilt can be visualized and felt a couple of ways. The first has been mentioned: pull your belly button back towards your backbone and pinch your buttocks together. What is essential to the movement is not the pinching but the sensation of your butt "scooping" under a little, as if it was hinged at the base of your spine, as you step and rise onto the forward swinging ski. More visually, hold your hand at your side, fingers down, palm facing forward. Imagine your belly button is in the middle of your palm, say, an inch above the start of your fingers. You might even mark a dot there. Then move the dot back and see how naturally your fingers curl forward under. Now imagine your hip coming forward the same way, initiated from the sacroiliac joint. The poles are fixed; the hips swing through, like a gymnast on the bar. It is basic to human self-propulsion. Kayakers pull the boat to the paddle. Swimmers pull the body to the hand. Both also are accomplished optimally by initiating the swing with pelvic tilting. Perhaps the one time cross-country skiers feel the tilt is when they get into an alpine tuck on downhills. Then you feel it, and you also feel the freedom of the skis on the snow. That is what I am after, and we recognize that the hip joints are the natural second joints to flex in the swing

forward, not the first.

Looking at the sequence photos, you see the forward moving leg/hip(s) as the poles are about to pass the thighs. That means the poling back and pelvic tilt forward take place simultaneously. They are a single movement. It is as if the top and bottom of a “G”(I like “G” because the front post seems like a leg) meet and pass each other. Or it's how you generate momentum on a swing set. Or imagine any four-legged animal (cheetah) running: the front paws pull the ground toward the center, the rear paws/hips curl under reaching forward the grasp the ground just released by the front paws/shoulders. Alpine skiers know about this as they move to keep the ski gliding as freely as possible. Rounding the pelvis under, they say, frees the hips. And cross-country skiers already do it when they are in a tuck.

In either double-poling or V2, of course, the legs come through forward together, and it is helpful to practice those techniques consciously tilting while poling. You will notice how stably you glide and how nicely and freely the ski touches the ground/snow.

With diagonal striding it is best learned/felt by focusing on the same side arm and leg (we usually think diagonal as left arm, say, swinging forward with the right ski). This “closing” of the arm and hip/leg movements on the same side better mimics double-poling, and the wonderful stability and lightness of the movement becomes apparent.

This combination movement (better said than a “combination of movements”) should be practiced on both double-pole machine and what I call a speed wheel. It is a 20” wheel supported just off the ground and propelled by a clawing motion of the foot. It is clear here also how critical tilting is as the very initiation of the hip/leg swing forward. It just makes the whole movement happen, like a whip. The standing leg remains more stable, balance is more easily maintained, and the lower leg/foot kicks out over the wheel more naturally and with less muscle stress/fatigue. Of course, we practiced it more simply by putting a foot over dandelion out front and ripping the blossom off backwards.

Oh, another final comment: since the whole pelvic tilt – claw kick movement originates in your lower core, part of your strength work should include leg/knee lifts on an inclined plane. In other words, lying on your back, holding on to something over your heard, curl your knees to your chest, the base of your spine pressed flat against the board, in (you guessed it!) a pelvic tilt.

Here is some further rationale, working from the foot back to the sacroiliac joint:

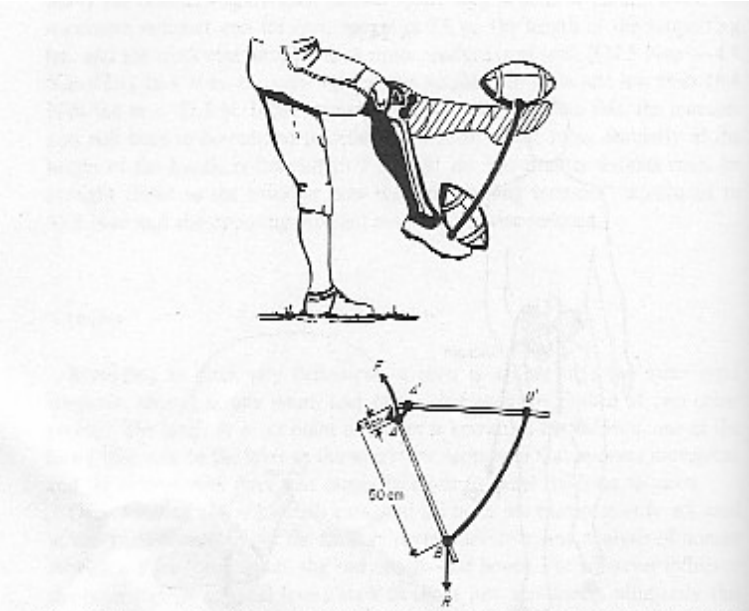

Fig. 62. An example of the use of a lever to increase the speed at which a body part is moved.

"This lower leg rotates about a fulcrum at the knee joint as a result of the force exerted by the muscles that extend the knee and against the resistance of the force exerted by the ball on the foot. If the lever moves through an angle of 30 degrees during the time the ball is in contact with the foot, the point A to which the muscular force is applied moves through an arc of 2.6cm (That is assuming the dimensions shown in Fig. 62). ….....During this same time the point B at which the ball makes contact with the foot moves through an arc of 26cm, exactly 10 times as great. Because it takes exactly the same time for A to travel 2.6cm as it does for B to travel 26cm the average linear speeds of A and B are also in the ration of 1:10. Thus the lever can be used to effectively increase the speed at which a muscular force is capable of moving the body." (James Hay, *The Biomechanics of Sports Techniques*, 3rd Edition (New Jersey, Prentice Hall,1985) p. 118-119.)

Cf. Rolf Wirhed, *Athletic Ability and the Anatomy of Motion,* Wolfe Medical Publications, Ltd. 1984. pages 44 and 68.

If 5-10cm in movement of the hip joint is gained by pelvic tilt, the force required of the iliopsoas is relieved; but

the speed of forward swing is still multiplied by the lever length of the leg.....

For the above reason the leg at the knee swings through its lengthened arc in the same time as the leg at the hip. That swing is them amplified according to the same principle as the knee opens and the foot swings through. The additional exponential increase of the speed of the forward swing of the leg caused by the initial pelvic tilting (difference between sacroiliac and hip joints) is thus substantial.

Petter Northug