Is Skating Like Skating?

A Case Study in the Evolution of US Ski Science

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The connection between ski skating and ice skating has driven much of the reflection on ski skating from its earliest beginnings. Yet as skiers thought it natural and best to imitate speed skaters, little notice was paid to research skaters were doing at the same time. As irony would have it, while skiers were pushing off through the heel or whole foot and skate boot designers were "stabilizing" (immobilizing) the ankle, in the manner of speed skates, the skaters realized that an immobilized ankle was a hindrance to optimum movement patters and were seeking a way to utilize full plantar flexion (toe-off). What interests me as a coach and historian of the sport is that as we were fully engaged in developing a skating movement in one direction, the skaters were just as fully engaged in developing a similar movement in the opposite direction. The irony is completed by the fact that so resolute were early ski analysts to learn from the skaters, they also neglected to notice subtleties in the skating movements of some of the best early ski skaters, most of whom retrained the flexibility in their ankles, and at times even used softer classical binding plugs to help them toe-off better.

In 1983 Dutch scientists and designers began experimenting with a "klap-skate" which featured a hinge point beneath the ball of the foot and thus allowed total plantar flexion. Like so many sports, speed skating had become the subject of extensive research, and where I cannot presume to do it justice, it may be informative for skiers to follow the work of one lead researcher, Gerrit Jan van Ingen Schenau.

Van Ingen Schenau had already become involved by 1982, when he published "The influence of air friction in speed skating" (*J. Biomech*. 15:449-458). In 1985 he published a paper on "The control of speed in elite female speed skaters" in the same journal. In 1987 another article appeared, "On the technique of speed skating" (*Int. J. Sport Biomech*, 3:419-431). Also in 1987 he published a study, along with his usual team of collaborators, on "The influences of jumping technique on the biomechanics of jumping" (*Med. Sci. Sports Exerc*., 19:4). This one caught my eye as much as the more detailed speed skating analyses. It found that flexing more deeply in the knees both actually slowed the resulting lift off and mobilized less force. I discuss this study in my book (*No Pain, No Gain?* 2202, p. 239). I remember some of our top skiers working on sessions of "powering up" by staying low and deeper in the knees, thinking that if they felt more powerful, they would be generating more power and speed. Van Ingen Schenau's study suggested the opposite. The feeling of greater muscle work and tension does not necessarily lead to greater physiological or neuromuscular efficiency.

For skiers the lower body position had been an attracting characteristic of speed skaters. It had made them appear streamlined, muscular and bullet-like. A 1999 study by a group which included Jim Stray-Gundersen, an MD who was part of the USST staff for some years, would eventually describe the limitations of this position for skaters but suggested they could adapt to it. The article documented "Evidence of restricted blood flow during speed skating" (*Med.Sci.Sports Exerc*., 31:10, pp. 1433-1440). There was greater lactate accumulation during skating in the low vs. higher position due to either "higher intramuscular forces, the long duty cycle of the skating stroke, or both." How to reduce these constraints was not directly addressed. It was only noted that skaters would "sit" in a progressively lower position throughout the training years and that that implied they could adapt to the lower position and "gain the biomechanical advantages of the low position." The biomechanical rationale for those "advantages," however, was not given. The trials for the study were done in October,

1996, the study published in 1999. Although notice is taken of van Ingen Schenau's other work, no mention is made of research into the klap-skate.

One brief detour to another sport. Bikers dealt with similar constraints on breathing and blood flow as the skaters and their solution would soon also lend useful perspective to skiing. A more traditional aerodynamic position, with flatter back and hips a little back, had been able to reduce open surface area and thus wind resistance. But the cost had been a more flexed hip through the top of the pedal stroke, “often disturbing pedaling quality. By moving the saddle forward and slightly upward, the hip is opened up, interference between legs and chest is less likely and the position resembles more normal cycling.” (*Road Cycling*, eds. Robert Gregor and Francesco Conconi, IOC Medical Commission Publication, 2000, p.. 38) Whereas the chest/hip angle was opened from 34.6 degrees to 42.7, at the cost of more wind resistance, it was more than compensated for because circulation was enhanced and the position of the hip more over the axle provided a biomechanical advantage. Bikers were ultimately come to conclusions similar to the speed skaters: a little higher and more forward position would prove biomechanically more effective.

By the mid-90's klap-skate results were being carefully analyzed throughout Europe, and their relevance to ski skating was becoming more clear. The same year as the American speed skating study was undertaken, 1996 (published in 1999), van Ingen Schenau and his team confirmed his studies first published in 1987 which had mentioned the klap-skate. The new article in 1996, “A new skate allowing powerful plantar flexions improves performances” (*Med. Sci. Sports Exerc*. 28:531—535) showed that the biomechanical advantages were substantially in the other direction, in a higher position resulting from full plantar felxion. I read van Ingen Schenau's article in 1996 and also a German study which appeared in a journal Tim Gibbons passed along to me: *Information/Dokumentation Sport*, Institut für angewandte Trainingswissenschaft, Leipzig. The article was a collaboration of a group of researchers and was entitled “Investigations into the klap-skate” (Untersuchungen zum Klapschlittschuh), and it was one of a number of sport analyses (including biathlon and cross-country skiing) made in an effort to plan the next Olympic cycle 1996-2000.

Rapidly and thoroughly, the German group had done ts own analyses of top skaters, referenced van Ingen Schenau's studies from 1989 and 1996, and included the subjective responses of athletes trying the new skate. Within a year (1997-98) all the world records in speed skating would fall and the gains achieved attributed to the klap-skate and the plantar flexion it allowed. As van Ingen Schenau would concluce in 2000, “A hinge under the ball of the foot enhances the effectiveness of plantar flexion during the final 50ms of the push-off with klap-skates and increase work per stroke and mean power output.”(*Med. Sci. Sports Exerc*., 32:3, p. 635) Increased performance was accompanied, not surprisingly, bby an increase in mechanical efficiency. “This increase in mechanical efficiency could explain the ability to increase stroke frequency next to the 11-J increase in work per stroke.” (p. 639)

The German researchers made the following observations but warned at that point against hasty generalization. The echoes of our discussions of skiing, however, are unmistakable.

1.The skater ran in a somewhat elevated body position, produced more lift force and gained a shorter route (with regard to forward direction. (p. 108)

2. The foot extension can be better timed with the klap-skate and therefore produces a more effective forward impulse, since during this the grip on the ice is not lost so quickly. (p. 113)

3. The knee angle opens earlier. The dynamic phase is thus lengthened relative to the static

phase... The proportion of static muscle work in the movement, which with conventional skates is well over 50%, is thus reduced! (p. 114)

4. The altered distribution of the foot push-off forces leads to the conclusion that during the total stride much more is done over the balls of the feet....At the point of total power the ball portion is significantly higher than the heel portion.....With the klap-skate the total force was 5% lower but the speed 5% higher than with conventional skates. (p. 114-115)

Several of the athletes' comments confirmed these findings and should ring true to skiers as well (p. 120)

1. You have to keep your center of gravity over the push-off [Cf. With changes in bike seat position mentioned above]. Otherwise you notice that the skate runs away by itself...

2. It is more difficult to feel technique because the push-off seems to happen more softly. The hip push is harder to feel. The movement of the body is more flowing...One skates more relaxed.

3. In competition-specific training I had significantly lower lactates than with the Alph (conventional skate)....Lower lactate build up and heart rates were apparent in endurance training.

I quote the article's total final conclusion because it gives perspective on speed skating which applies well to ski skating, in general because it emphasizes a recovery of more of what the body does naturally, propelling itself by complete and coordinated use of all the body segments from a comfortably relaxed and alert action-attitude, what I have at times, and borrowing from the Russians, called “flight attitude.” More particularly, the notions of active and rapid plantar flexion, and a higher position and, as a result, a shorter line of travel clearly recommend themselves to skiers.

“ The push-off with the klap-skate produced a greater forward impulse with less 'hardness,' which. Because it allows more tension free movement, elicits a higher running speed. The foot extensors[controlling planta flexion], most particularly the calf muscles, are more decisively engaged. There results a coupling/synchronization of the opening of the knee- and ankle joint angle which has a positive effect in muscle activity/extensors and enables a more dynamic overall movement. In addition, it allows for a more effective, that is, shorter line of travel. Plantar flexion and synchronization can be improved with improving technique.” (p.115)

The positive consequences of applying such notions to skiing are several and decisive, and are the subject of ongoing writing.

As skating on skis was evolving, therefore, American skiers and coaches had taken notice of speed skating, fixed on what the first saw and proceeded apace. In some critical aspects of technique that direction still persists. Passing us like a train in the dark, speed skating was actually racing in the opposite direction and heading to a place where world records would be broken wholesale. Adapting to “siting” or pushing off with the whole foot or through the heel were not to be a part of the skater's modern style.

In *Cross-Country Skiing*, IOC Medical Commission Publications (Blackwell Science, Malden, MA, 2203), Heikki Rusko, editor, also comments on this difficulty for skiers. He cautions: “In skating, 'push from the heel' is a suggestion that coaches have been using to guide young skiers since the skating revolution in the mid-1980's. Its origins come from speed skating, which had much to teach ski

skaters in the early years. On speed skates prior to the invention of the klap-skate, it was essential to minimize plantar flexion at the ankle which tended to tip the skate blade into the ice, increasing frictional force. A focus on pushing from the heel was physically appropriate on speed skates. Unfortunately, that advice applied directly to ski-skating was not adequately tested for validity. Unlike traditional speed skates, ski skating boots are not rigidly attached to the ski at the heel and have always allowed motion similar to the modern klap-skate. A natural component of human walking, running and jumping is plantar flexion of the ankle near the end of the foot contact with the ground. This has anatomical/physiological advantages involving the stretch-shortening cycle of the calf muscle....But, in oversimplifying, such phrasing ['push from the heel'] fails to use to advantage the built-in human mechanisms for enhancing force generation and energy conservation and which contribute to faster skiing." (p, 86f.)

To our question "Is Skating Like Skating" our answer is "Yes," but in a distinctly different way than many Americans had and have been thinking. It is my hope that this discussion can aid in understanding some of these past thought processes, and those of our colleagues in other sports, and thereby help skiers use to better advantage those God-given human mechanisms, both physical and intellectual, which accelerate both our learning curves and help us ski more naturally and faster