



# Double Poling in Cross-Country Skiing

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## Abstract

Double poling in cross-country skiing is one of the fundamental classic techniques, alongside to the diagonal stride technique. Aside from free-style or skating technique, double poling is probably the one XC skiing approach that has changed most over the past fifteen years or so. This is due to professional athletes having added more strength to their upper body and upper leg muscles on top to their already well-developed endurance capabilities. One of the reasons for this “power shift” are sprint competitions in world cup and Olympic races. Another driving force of enhanced double poling is the fact that elite athletes in Ski Classics have adopted this technique for their races quite heavily. Meanwhile cross-country and roller ski Worldloppet races are dominated by “double polers”.

## Introduction

A variety of excellent articles has been published about double poling. In most cases, these papers are focused on double poling from a biomechanical, technique, coaching and performance point of view. They are dedicated to junior and elite cross-country skiers, see [1] to [6] for example. While this paper will draw on previous research, it is not a strictly scientific paper but dedicated to provide hobbyists and am-

bitioned cross-country skiers a guideline for how, if and when to use double poling. Before digging into the details, let’s have a quick look at the two double poling techniques in cross-country (XC) skiing:

1) Double poling without kick. It is usually used in flat terrain and at the transition from flat to downhill passages. It has been evolved significantly over the past two decades. The focus of this paper is on this DP version. Fig. 1 shows a sketch.

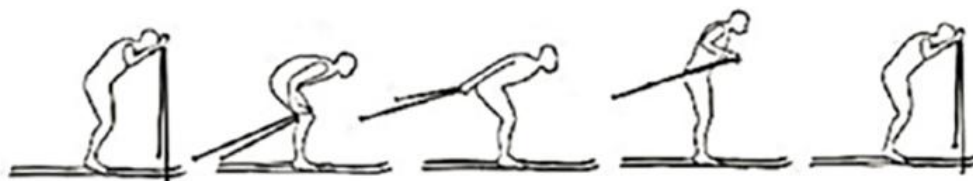


Figure 1: Double poling (DP) – ref. [1].

2) Double poling with kick. This technique comes into play when flat terrain moves into slight uphill passages before the technique changes

to diagonal stride, or it is used if snow conditions are slow on the flat. Fig. 2 shows the principle of the DP kick technique.

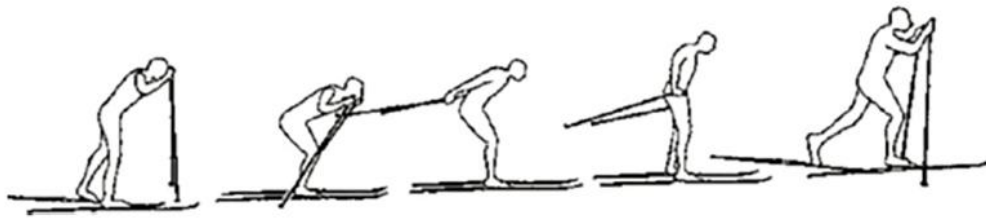


Figure 2: Double poling with kick (DP kick) – ref. [1].

Like in all sports, XC skiing has evolved significantly since the last century. Noteworthy to mention is the appearance of the free-style or skating technique which goes back to the 1970s when the Siitonen step was “invented”. According to history Pauli Siitonen was the first to add a one-sided skating step to the double poling. However, others like Gerhard Grimmer used this technique as well, e.g. at the 1971 Holmenkollen race when the skis lost grip at changing weather conditions. Nonetheless, we could say from the early 1980s on the true skating technique evolved over time. But what happened to the classic technique? Certainly a couple of things appeared. In diagonal stride, the uphill running approach in classic XC skiing, Norwegian stars Petter Northug and Johannes Høsflot Klæbo set new standards. They have mastered the use of short running-like strides instead of the classic long-gliding strides in steep uphill. Hence, kids now learn the “Klæbo run” in XC skiing exercises. The course profiles of classic-technique world cup races are usually designed with lots of pretty steep climbs. See the FIS homologation manual [7] for details on climb gradients and other course specifications. Therefore, elite athletes are forced to use a variety of techniques, like diagonal stride, herringbone (in very steep uphill) and double poling with and without kick, in these races. Nevertheless, if the course design is at the low end of the FIS specifications for climb gradients, you can sometimes see athletes using double poling exclusively even during a classic-technique world cup race. In other competitions, for example in Ski Classics and classic Worldloppet races, the situation is very different. The course profiles are usually not as steep as in world cup races. As a result, elite athletes use double pol-

ing exclusively. In most cases classic skis are used, but sometimes skating skis (with shorter length) can be seen too. The entire ski base is prepared with glide wax only. There is obviously no need for grip wax if double poling is the one and only technique. When exclusive double poling racing became popular, XC skiers started to use longer poles with lengths comparable to skating poles. This appears useful since a powerful DP stride calls for a high upper body position and a high arm position at pole plant, i.e. when the hands are at the highest point (see Fig. 1., first and fifth position). Some years ago, FIS issued a regulation to limit the maximum pole length [8]. For classical technique, pole length must not exceed 83% of the competitor’s body height (while it is limited to 100% of body height for skating).

## Training of Double Poling

As with many sports, dryland training is a good means to improve performance and technique.



Figure 3: Double poling training with roller sled – copyright Renate Tröbe.

A classic exercise for strengthen the upper body muscles required for DP is the roller sled. This approach as well as the elastic pulling rope have been used by many generations of junior XC skiers during their education. Yet the pulling rope is not really an efficient tool – and kind of outdated these days.

## Roller Sled

The roller sled is essentially a carriage placed on a gym bench that fits into the gym's wall bars. By placing the bench higher or lower on the wall bars, the pulling resistance of the roller sled can be adjusted. Two firm ropes with hand loops, also connected to the wall bars, mimic the poles. Fig. 3 shows the author exercising on a such a roller sled.

The body posture on the sled is essential for a good efficiency of this drill. Sitting on the sled in body upward position, as depicted in Fig. 3, comes very close to the body position of real DP. Both breast and shoulder muscles are trained simultaneously. In the old days, this drill was mostly executed by laying down with

the belly on the sled. In this position the arm swing starts at a higher point (refer to Fig. 1., first position) which comes close to modern DP. But only the shoulder muscles get trained and the body posture is rather unrealistic.

## Strength Training

Obviously not all XC hobbyists have access to a roller sled. No worries, a good gym is usually equipped with various pulling machines that do the job. A high-pull machine is perfect for the exercising of DP. It trains the big muscles of the back (trapezius and latissimus) and of the shoulders (deltoid) together with the six-pack (abdominus) and the lateral core (anterior) muscles. Fig. 4 (A) shows the muscles affected.



Figure 4: Double poling training with high-pull machine.

The high-pull cycle starts at the pole plant position, Fig. 4 (B); goes through the poling phase, Fig. 4 (C), and ends in the pole-off phase, Fig. 4 (D). Then the arm swing goes back up to the plant position - and a new cycle starts. An interesting article about the contribution of upper-body

strength, body composition and maximal oxygen uptake for predicting double poling power can be found in [9].

## Ski Ergometer

Now turn to ski ergometers. I do not mean the special treadmills for

XC skiing, that are used in sports labs for athletes' performance checks with roller skis. Well, there are XC treadmills for home use. They require a large garage and certainly quite some pocket money. The lower-budget versions of ski ergometers are in most cases dedicated pulling machines. Some have sliding foot bars (mimicking the skis) and arm pulls

(mimicking the poles), like the Nordic Skicrosser. Some have small treadmill belts on the left- and right-hand side for use with actual ski poles, like the XC PRO. And some others are special high-pull machines like the Ercolina and the SkiErg. Pricing of these "budget" ergometers ranges roughly between €1,000 and €5,000. Fig. 5 depicts the Concept2 SkiErg.



Figure 5: Double poling training with the SkiErg – courtesy of Concept2

### *Roller Skiing*

Between the winter seasons, roller skiing is the number-one training method for XC skiing. It sets the foundation for a good technique on skis. Additionally, roller skiing is also a good means for exercising DP. It is a classical technique, hence the usage of classic roller skis. These rollers have at least one wheel with a ratchet to prevent rolling backwards. Or in other words: to mimic the grip of the ski. If you use classic roller skis for training of DP on a steep uphill, the ratchet makes life a bit easier because you cannot roll back downhill. But it's less realistic. So, if you really want to have a challenging uphill DP training session, simply use skating roller skis. They don't have a ratchet.

Quite some papers deal with DP exercises on roller skis, in most cases with sessions done on a treadmill. This makes a biomechanical analysis easier because conditions in this situation are more consistent and repeatable versus actual skiing on snow. Some very good papers are [2] to [4].

### *Other Lab Practices*

An interesting approach, not for training sessions, but for analyzing the DP technique in the lab is described in [5]. In this article, actual skis and poles have been used. The pressure distribution under the skis was measured by means of a pressure mat. Forces acting on the poles were analyzed by pressure sensors in the poles. The tests were performed in

traditional DP technique and in sprint DP technique. The latter is typically characterized by higher upper body and higher arm positions at pole plant and by a lifting of the heel (heel raise). The DP sprint technique has been shown to generate much higher forces with slightly larger contact areas on the ground at a reduced contact time. By comparing the distributions of the pole forces in traditional and in sprint DP technique, it was found that the drive-forward energy in sprint technique is larger.

## Double Poling on Snow

A large quantity of videos for exercising DP skiing on snow can be found on the Internet. Certainly, one to recommend is the DSV Skilanglauf Inside series. In this video Axel Teichmann explains the details of DP skiing and shows some useful gym exercises [10]. One of the distinguishing elements of the modern DP technique compared to the older fashion approach is the heel raise (Fig. 6).

Improved forward drive and speed can be achieved with a high arm position during pole plant. By doing so the poles can be planted almost rect-

angular to the track surface. This calls for a high upper body and high hip position. Both can be achieved better by lifting the heels during pole plant. An exhausted analysis of the heel raise at different velocities and different terrain gradients (flat and uphill) can be found in [4]. Another one, comparing DP techniques of female and male athletes, is given in [6]. That study analyzed biomechanical data derived from an XC skiing competition (Norwegian championship in 2016). About 82% of the skiers used heel raise during the race. Faster skiers used a stronger heel raise (i.e. with heels up higher and for a longer time) combined with more vertically planted poles.



Figure 6: Sketch of double poling with heel raise.

## Conclusions

To sum it up, what does all this mean for ambitious amateur XC skiers? If you seriously consider participating a classical XC competition with double poling only, here's a kind of check list:

- Perform specific strength training for your upper body and core.
- Add some DP only sessions to your roller skiing training in summer.
- Have at least one pair of skis that you use for DP only.
  - Some ski manufactures offer dedicated double-poling skis.
  - Some even for distance (at classic ski length) and for sprint (skating ski).
  - Recommendation: You can use a classic ski with higher camber (e.g. if you normally use medium for classic, take stiff for DP).
  - Wax your pair of DP skis with glide wax over the entire length (there's no grip wax zone anymore).
- Add some distance DP only sessions to your skiing training in winter.
  - Try high pole plant and heel raise first on flat terrain.
  - The height of heel raise is not so important.
  - But focus on a good timing between the arm swing and the heel raise.
  - If you don't feel comfortable with heel raise, don't worry, it's not a must.

- Train DP on uphill. You should master the same gradients in training as they will appear in competition (so check out the course profile).
  - Recommendation: If an uphill gets too steep for DP, your fallback solution is herringbone technique. But as you won't have grip wax, you will be slow (make sure you don't start skating, this means disqualification).
- Consider the weather conditions.
    - At cold temperatures (say well below -5°C) and fine-grained snow, grip wax is hard. Only thin layers of it are put on the ski. So, it has little effect on the overall glide behavior. Meaning a classic grip wax ski will be almost as fast as a DP ski in flat and downhill terrain.
    - At warm snow or icy klister conditions a DP ski will outpace a classic grip wax ski in flat and in downhill terrain.

## About the Author



Andreas Laute is a product manager at a European semiconductor manufacturer. He got a Dr.-Ing. degree in electrical engineering and radio-frequency techniques. Educated at a sports school, he is now pursuing cross-country skiing and other sports as a hobby. Aside of his business profession Andreas is interested in sports science and training methodologies.

## References

- [1] B. Welde, T.L. Stöggl, G.E. Mathisen, M. Supej, C. Zoppiroli, A.K. Winther, B. Pellegrini, H.C. Holmberg. The pacing strategy and technique of male cross-country skiers with different levels of performance during a 15-km classical race. Research Gate, Nov. 2017.
- [2] S. Lindinger, T.L. Stöggl, E. Müller, H.C. Holmberg. Control of speed during the double poling technique performed by elite cross-country skiers. Medicine and Science in Sports and Exercise, 41(1), 210-220, 2009.
- [3] T.L. Stöggl, H.C. Holmberg. Force interaction and 3D pole movement in double poling. Scand J Med Sci Sports, May 2011.
- [4] T.L. Stöggl, H.C. Holmberg. Double-poling biomechanics of elite cross-country skiers: at versus uphill terrain. Medicine and Science in Sports and Exercise, 48(8), 1580-1589, 2016.
- [5] S. List, J. Hollenbacher, M. Scherge. Doppelstocktechnik – Bewegungsanalyse und Vortrieb, Snowstorm, Gliding, 2 (2019).
- [6] M. Jonsson, B. Welde, T.L. Stöggl. Biomechanical differences in double poling between sexes and level of performance during a classical cross-country skiing competition. J. of Sports Sci., 37(14), 1582-1590, 2019.
- [7] FIS Cross-Country Homologation Manual, June 2020.
- [8] Guidelines Max Pole Length Classical Technique, Nov. 2016.
- [9] S. Østeras, B. Welde, J. Danielsen, R. v. d. Tillaar, G. Ettema, Ø. Sandbakk. Contribution of upper-body strength, body composition, and maximal oxygen uptake to predict double poling power and overall performance in female cross-country skiers. Journal of Strength and Conditioning Research, 30(9), 2557-2564, 2016.
- [10] DSV Skilanglauf Inside: Fehlerkorrektur Klassik Doppelstockschiub.