Mobility and stability in an elite female alpine skier – a case study

Bråten, M.[1], Eriksrud O.[1]

[1] The Norwegian Olympic Sport Center, Oslo, Norway

Introduction

Alpine skiing is a physically demanding sport with requirements for mobility, stability, strength, power and endurance. The physical tests used in alpine skiing include general (Neumayr et al., 2003; Raschner et al., 2012) and specific endurance tests (Raschner et al., 2012), isolated measures of strength and work (Neumayr et al., 2003; Raschner et al., 2012), different power tests (Gorski, Rosser, Hoppeler, & Vogt, 2014; Raschner et al., 2012) and change of direction (Gorski et al., 2014). Measures of mobility and stability have not been reported in the literature. The reason for the lack of mobility tests might be that it is hard to determine mobility requirements for alpine skiing. Kinematic analysis of alpine skiing is difficult, however some data of three-dimensional trunk movements in giant slalom have been reported (Sporri, Kroll, Haid, Fasel, & Muller, 2015) and knee and hip kinematics in anterior cruciate ligament (ACL) injuries (Bere et al., 2013). However, kinematic analysis of ACL injuries, due to short video material analyzed during an injury situation, can not be considered normal, and might therefore not considered as appropriate mobility requirements for alpine skiing. The purpose of this case study is to 1) present mobility and stability data of one international level female alpine skier, and 2) based upon reference data and between limb comparisons document the effect of a mobility intervention.

Subject description

NL is a female alpine skier (age 26, height 168 cm, weight 63 kg) participating in the world cup. NL was tested in preparation of her summer training program. She reports that it feels less mobile and more difficult to produce force through the right lower extremity. Her goal was to get an evaluation and to determine if mobility and stability could be an issue for the lack of performance through her right lower extremity.

Examination

Mobility was tested bilaterally using the 1080 MAP Movement quick screen for hand and foot reaches with the addition of rotational tests with foot reaches. 1080 MAP allows for both a quantitative and qualitative analysis of mobility and stability (Eriksrud, 2013). Both tests were performed on a testing mat (Athletic Knowledge Nordic AB, Stockholm, Sweden) featuring nine concentric circles at 10 cm intervals and eight vectors projecting from the center of the mat at 45° intervals. The vectors used for both tests were: 1) Left 45° (L45), 2) Right 45° (R45), 3) Left 135° (L135) and 4) Right 135° (R135) (Figure 1). The four hand reaches, on each foot, was done while standing on one foot in the middle of the mat, toe touch opposite foot, while reaching with one hand along the vectors described above (Eriksrud, 2013). The foot reach quick screen is based upon the star excursion balance test (SEBT) (Gribble, Hertel, & Plisky, 2012), with the addition of hip internal and external rotational tests in standing. Each reach tests is normalized to anthropometric measures, while the rotational tests are not. Reach scores, hand and foot reaches separately, are then combined to give an overall mobility/stability score. In the profiles presented below the yellow area and circles represent the tested individual, while the grey area indicates the average of the group (national team female alpine skiers, n=4). This allows for comparisons and analysis to a group of athletes in the same sport and at the same level. In addition, all tests are qualitatively analyzed.

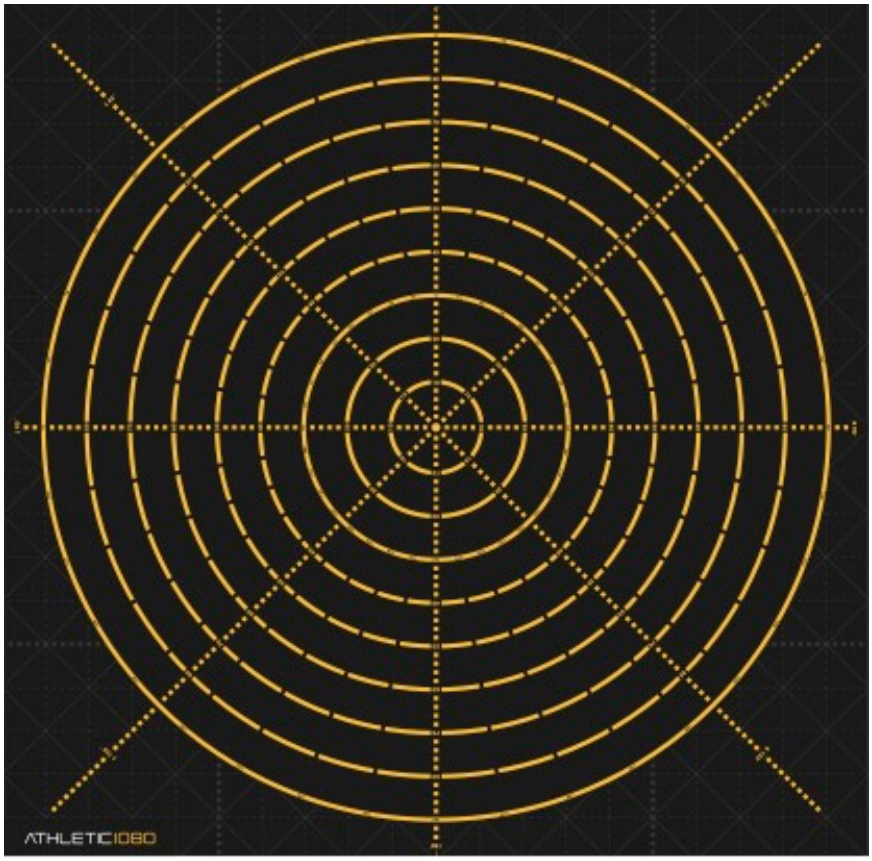

Figure 1: 1080 testing mat

Hand reach profiles standing on the left and right foot is presented in Figure 2 below. A total 1080 MAP movement score of 5.4, with a score of 5.6 and 5.2 for the left and right foot respectively.

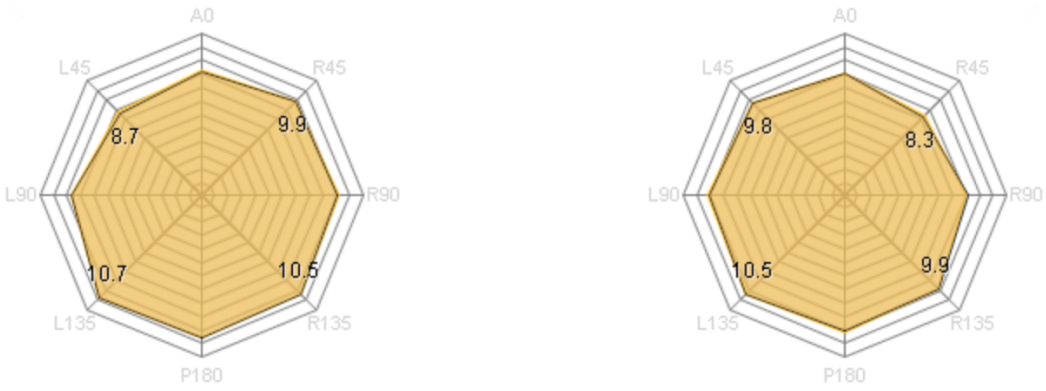

Figure 2: 1080 MAP hand reaches initial visit

Foot reach profiles standing on the left and right foot is presented in Figure 3 below. A total 1080 MAP movement score of 6.3, with a score of 6.9 and 5.7 for the left and right foot respectively.

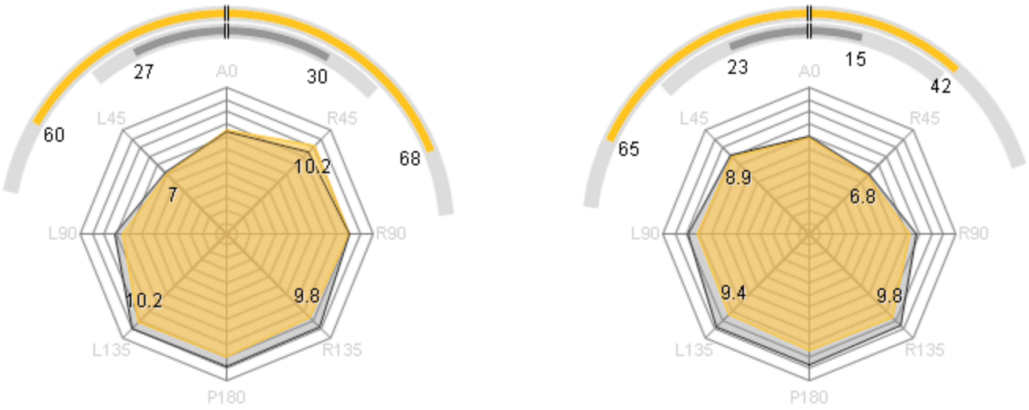

Figure 3: 1080 MAP foot reaches initial visit

These profiles were analyzed. Based upon reference data (national team female alpine skiers, n=4), and comparisons to other sports, the athlete performed well with all hand reaches. However there was a notable excessive lumbar spine extension with the posterior overhead diagonal reaches (L135 and R135). The right side foot reaches was markedly less stable and mobile, thus a lower score. Based upon three-dimensional analysis of the SEBT (Delahunt et al., 2013; Doherty et al., 2015), and kinematic analysis of own data (manuscript in preparation), there is a decreased ability to perform hip internal and external rotation, which is also evident when hip flexion, knee flexion and dorsiflexion is introduced. The same pattern is evident on the left side, but to a lesser degree.

Intervention

Hip internal and external rotation with varying degrees of hip flexion was introduced as a part of her general training program. Focus was on the right side, but the exercises were also done the left side. Specifically the exercises, described for the right side, were; 1) half kneeling with anterior, anterolateral (L45) and anteromedial (R45) lunges with left foot, 2) Standing on right foot while pivoting into internal and external rotation with left foot with progressively decreased support/touch left foot, 3) same pivot exercise as above with increasing hip flexion and 4) same exercises as above with anterolateral distraction through elastic band. Exercises were done 5x30 dynamic repetitions 5-7 days per week for 7 weeks.

Outcome

The same 1080 MAP profile was then performed after 7 weeks (Figure 4). Now the 1080 MAP score was 7.9 with a score of 8.1 and 7.7 left and right respectively. This is an overall increase of 25.4%, with an increased of 17.4 and 35.1% on the left and right side respectively.

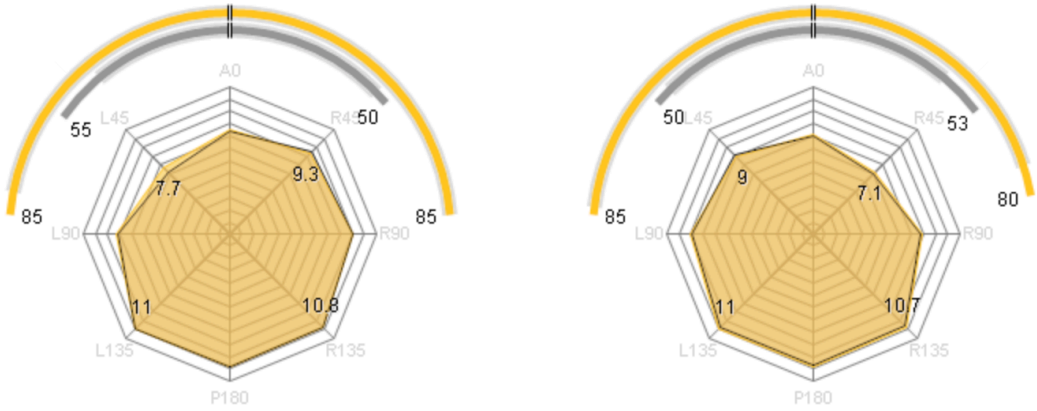

Figure 4: 1080 MAP foot reaches after 7 weeks

Discussion

There was a marked increase in foot reach performance after 7 weeks of dynamic mobility training. The profiles are more symmetrical in area, and hip internal and external rotation is now slightly above reference values for the group. When comparing to male international alpine skier reference data (n=7) she is now above the average of this group, while before the intervention she was below.

The SEBT is known as postural control/dynamic balance test that have certain joint movements predicting reach distance (Delahunt et al., 2013; Doherty et al., 2015). Thus, one might argue that it is a test of both mobility and stability. Based upon these notions, a hand reach tests, can also be considered a tests of mobility and stability. Task specific tests in standing, such as the ones described above, where the excursion of each reach is quantified might offer more meaningful information about both magnitude and interaction of different joint movements in the absence of traditional goniometric measurements. Furthermore, compiling information about how elite athletes in their respective sports, such as alpine skiing, perform on different reach tests might provide us with important information about mobility and stability and their influence on performance.

No performance or strength and power measures were done pre and post intervention in this case. The effect of the change in the profile on other physical factors or performance would have been good, since that could have allowed to determine the effect of mobility and stability on measures such as strength and power. Performance measures, such as race time in different disciplines, were not possible to obtain in this part of the season.

In conclusion, dynamic mobility training had a positive effect on mobility and stability as described by the 1080 MAP foot reach profile. However, the influence of these profile changes on other physical factors such as strength and power has to be determined. Furthermore, there is a need to determine profiles of different physical factors in elite athletes in order to determine their importance on performance.

References

Bere, T., Mok, K. M., Koga, H., Krosshaug, T., Nordsletten, L., & Bahr, R. (2013). Kinematics of anterior cruciate ligament ruptures in World Cup alpine

skiing: 2 case reports of the slip-catch mechanism. *The American journal of sports medicine, 41*(5), 1067-1073. doi: 10.1177/0363546513479341

Delahunt, E., Chawke, M., Kelleher, J., Murphy, K., Prendiville, A., Sweeny, L., & Patterson, M. (2013). Lower limb kinematics and dynamic postural stability in anterior cruciate ligament-reconstructed female athletes. *Journal of athletic training, 48*(2), 172-185. doi: 10.4085/1062-6050-48.2.05

Doherty, C., Bleakley, C. M., Hertel, J., Caulfield, B., Ryan, J., & Delahunt, E. (2015). Laboratory Measures of Postural Control During the Star Excursion Balance Test After Acute First-Time Lateral Ankle Sprain. *Journal of athletic training, 50*(6), 651-664. doi: 10.4085/1062-6050-50.1.09

Eriksrud, O. A., P. Andreassen, E.H. Litsos, S. Sæland, F.O. Federolf, P. Cabri, J. (2013). *Challenges and opportunities in developing a test battery for joint mobility using reach tasks starting from upright standing positions.* Paper presented at the IcSports 2013, Vilamoura, Portugal.

Gorski, T., Rosser, T., Hoppeler, H., & Vogt, M. (2014). An anthropometric and physical profile of young Swiss alpine skiers between 2004 and 2011. *International journal of sports physiology and performance, 9*(1), 108-116. doi: 10.1123/ijspp.2013-0223

Gribble, P. A., Hertel, J., & Plisky, P. (2012). Using the Star Excursion Balance Test to assess dynamic postural-control deficits and outcomes in lower extremity injury: a literature and systematic review. *Journal of athletic training, 47*(3), 339-357. doi: 10.4085/1062-6050-47.3.08

Neumayr, G., Hoertnagl, H., Pfister, R., Koller, A., Eibl, G., & Raas, E. (2003). Physical and physiological factors associated with success in professional alpine skiing. *Int J Sports Med, 24*(8), 571-575. doi: 10.1055/s-2003-43270

Raschner, C., Platzer, H. P., Patterson, C., Werner, I., Huber, R., & Hildebrandt, C. (2012). The relationship between ACL injuries and physical fitness in young competitive ski racers: a 10-year longitudinal study. *British journal of sports medicine, 46*(15), 1065-1071. doi: 10.1136/bjsports-2012-091050

Sporri, J., Kroll, J., Haid, C., Fasel, B., & Muller, E. (2015). Potential Mechanisms Leading to Overuse Injuries of the Back in Alpine Ski Racing: A Descriptive Biomechanical Study. *The American journal of sports medicine*. doi: 10.1177/0363546515588178