

## ANALYSIS OF THE DISTRIBUTION OF PRESSURES UNDER THE FEET OF ELITE ALPINE SKI INSTRUCTORS

Dany Lafontaine, M.Sc.<sup>1,2,3</sup>, Mario Lamontagne, Ph.D.<sup>1,2,3</sup>, Daniel Dupuis, M.Sc.<sup>1,2</sup>, Binta Diallo, B.Sc.<sup>1,2,3</sup>, Faculty of Health Sciences<sup>1</sup>, School of Human Kinetics<sup>2</sup>, Department of Cellular and Molecular Medicine, Anatomy program<sup>3</sup>, University of Ottawa, Ottawa, Ontario, Canada.

**Keywords:** Alpine skiing, instructors, pressure measurements, turns, on-site

### **Introduction:**

Alpine skiing is a very popular recreational sport in many parts of the world. The sport has evolved greatly in the past 30 years, thanks in large part, to technological advances in the equipment being used by skiers. Thanks also to technological advances, previous research has been able to determine the forces and pressures involved in skiing in laboratory and/or static situations. However, due to the environment where the sport is performed, traditional biomechanical research equipment is not very well suited to skiing studies. The focus of the on-site research done to this point has been aimed towards ski racers. However, most recreational skiers are not racers. Thanks to recent developments in biomechanical instrumentation, research on alpine skiing can now be performed in on-piste situations. Therefore it would be of interest to determine what is happening under the feet of high level non-racers, such as ski instructors.

### **Methods:**

Three highly skilled ski instructors (CSIA level IV) consented to serve as subjects for this study. Their usual ski boots were fitted with pressure sensitive insoles linked to the PEDAR mobile system which they wore on their backs (Novel corporation, Munich). With their boots so equipped, the subjects performed a variety of turns of controlled radii on a groomed piste. The turn radii were controlled by markers on the snow surface, and were consistent with the guidelines of the Fédération Internationale de Ski, for turn size. Subjects skied on a groomed piste, while the PEDAR system recorded pressure data (sampling rate 50 Hz) onto a memory card. A video (60 Hz) recording of their ski runs was also made to facilitate analysis.

### **Results:**

What has come out of the results at this point of the study, is that the pressure recorded under the feet can be quite high. The highest pressures are measured on the medial parts of the heel, as well as the medial parts of the forefoot (under first metatarsal). The centre of pressure travels from under the first metatarsal joint down to under the medial part of the heel of the skiers, as they make their way through the turn. These highest pressures reach up to 30 newtons per square centimetre. Force-time histories reveal that forces of up to 3 times body weight can be attained during high performance recreational skiing.

### **Conclusions/Discussion :**

It is quite likely that the type of equipment (skis and boots) worn by the subjects had an effect on the values obtained. The individual technical adjustments of the skiers may have also had an effect on the measurements. One thing is certain, the centre of pressure moves from the front medial part of the foot, back towards the medial side of the heel as the skiers progress through the turns.

### **Acknowledgements :**

The authors would like to thank all members of LeGap ski school for their valued cooperation.

### **References :**

- Hall, B.L., *Dynamic Displacement and Pressure Distribution in Alpine Ski Boots*, Microform Publications, College of Human Development and Performance, University of Oregon, 1991.
- Müller, E., *Analysis of the biomechanical characteristics of different swinging techniques in alpine skiing*, J. of Sports Sciences, 1994, 12, 261-278.
- Nigg, B.M, van den Bogert, A.J., Read, L. and Reinschmidt, C. , *Load on the locomotor system during skiing. A biomechanical perspective*, in Müller et al., *Skiing and Science*, London, E & FN Spon, 1997, 27-35.
- Schaff, P., Senner, V. and Kaiser, F., *Pressure distribution measurement for the alpine skier-from the biomechanical high tech measurement to its application as Swingbeep-feedback system*, in Müller et al., *Skiing and Science*, London, E & FN Spon, 1997, 159-172.
- van Bergen, B., *Different possibilities of measuring forces transmission between ski and binding*, in Müller et al., *Skiing and Science*, London, E & FN Spon, 1997, 189-199.
- Wimmer, M.A. and Holzner, R., *Constraint forces may influence the measurement of vertical ground reaction forces during slalom skiing*, in Müller et al., *Skiing and Science*, London, E & FN Spon, 1997, 208-215.