Dynamics of Freestyle Skiing –Equipment Development and Implications for Injury Prevention Strategies

PhD Proposal

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Introduction / Background

With freestyle skiing disciplines, namely *moguls* and *aerials,* now being permanent components of Olympic Winter Games an increased interest of recreational skiers in snow sports was noticed. It can be speculated that broadcasted reports on international competitions may provide advanced skiers with new model figures or that simply an increased skill level of recreational skiers supports this trend. In addition to requiring diverse technical skills beyond those involved in traditional alpine skiing, it is likely these disciplines produce different loading patterns. Skiing and snowboarding in New Zealand resulted in 11,633 new snowsport injury claims in the 2006-2007 period, leading to a total cost of approximately $12 million for the Accident Compensation Corporation (ACC) [1]. It has been noted that the knee is involved in a majority of freestyle skiing injuries [2-7]. These statistics support the health and fiscal importance of preventive identification of potential risk factors and the development of injury prevention strategies in freestyle skiing.

No quantitative research has been published on the mechanics of freestyle skiing. Being an outdoor sporting activity there are major technical challenges encountered. Therefore, the development of a suitable methodology for data collection is required. Once this has been established a systematic analysis of loading conditions in freestyle specific movements will allow for setting up a database on mechanical principles and loading conditions experienced.

For the proposed project we will initially validate innovative measurement technology which allows for data collection in the skiing environment. This method includes the collection of ground reaction force data as well as motion analyses in order to allow for model calculations of joint loading in freestyle skiing. This methodology will be applied to collect data on typical freestyle skiing movements and assess the effects of changes in equipment or technique.

It is hypothesized that remarkable strain beyond acceptable limits occurs in the knee joint in typical freestyle skiing manoeuvres and is likely to cause serious injuries. Harmful body postures can be avoided through appropriate adjustment of equipment design and/ or riding technique and thus lead to a more advantageous position of the body’s centre of mass. Hence the proposed project has the potential to reveal invaluable insights in the mechanics of a popular kind of snow sport in order to reduce the prevailing high incidence of knee injuries.

Outline

This PhD project will be developed in three subsequent phases:

- In Phase I an innovative methodology to measure ski-boot contact forces will be validated. Force sensors are integrated in an existing portable high-speed video system. Data reliability and accuracy will be established via comparisons to laboratory-based equipment. The Influence of the force plate on the athlete’s performance will be estimated in initial tests.

- Phase II will entail the collection of data on selected freestyle specific movements in order to investigate loading ranges as they are found in a skiing environment.
- In Phase III we plan to assess the effect of specific interventions in equipment (ski boots) on loading patterns in freestyle skiing. Subsequently a mathematical knee model will be employed so as to calculate tissue loading on the knee.

Studies in phase II and III are intended to be conducted in Switzerland due to more stable climatic conditions and easier access to high profile athletes as well as sophisticated force measurement devices to be used in order to gain the most reliable results.

Timeline

March – August 2007:	Literature review on methodology and initial testing of prototype force plate in terms of the influence of the skier's performance
Sept. – December 2007:	Publication of results of initial testing in a peer reviewed journal and oral presentation at the 4th International Congress on Science and Skiing (14-20/12/2007 St. Christoph/ Arlberg, Austria)
Febr. 2008	Enrolment conversion from MSc to PhD in Biomechanics
March 2008	Start recruitment of subjects and organization of testing sessions overseas
March - June 2008	Validation of measurement methodology by comparison to laboratory measurements
May 2008:	Submission of extensive research proposal to postgraduate committee – oral presentation of proposal
Oct. 2008:	On-snow data collection (Switzerland) – base line data & interventions
End 2008 – End 2009:	Final data analysis, publications and thesis write-up

References

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