Dynamics of carved and skidded ski- and snowboard turns

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Introduction
Alpine skiing and snowboarding are the most popular winter sports in the Alps and are practiced by an increasing number of people. With the increased number of skiers and snowboarders also the number of injuries increased. This is one of the reasons to focus on the dynamics of the ski-skier system and the snowboard-snowboarder system. Several studies have already been carried out regarding dynamics in skiing and snowboarding (Quinn & Mote 1992, Schwameder et al. 2001, Knünz et al. 2001). Knünz et al. (2001) compared the dynamics of the snowboard-snowboarder system on an alpine with a freestyle board. Schwameder et al. (2001) determined the effect of the binding position on dynamic variables in skiing. Quinn and Mote (1992) measured the forces acting on the ski-skier system to calculate the loading on the knee joint. The purpose of this study was to compare the ground reactions forces in carved and skidded turns, both in skiing and snowboarding. It was hypothesized that the forces in carved turns are higher than in skidded turns in both skiing and snowboarding.

Methods
Dynamic data were collected with a mobile force plate (KISTLER). This device was placed between the binding plate of the ski and the binding in skiing and between the board and the binding in snowboarding. Five subjects, three skiers and two snowboarders, participated in the study. In skiing only a left turn was performed assuming left and right turns were similar. In snowboarding, both a front side and a backside turn were performed. From each dataset the analysed turn was separated and triggered by the moment about the longitudinal axis of the skis/snowboard. Therefore each turn was defined as the phase from one edge change to the next (Schwameder et al. 2001). For each subject a carved and a skidded turn were analysed. The average force for each leg was one of the parameters to compare the dynamics of carved and skidded turns. Forces were normalized to body weight (BW).

Results
Figure 1 shows the average forces on the inside and outside boot for a carved and skidded turn in skiing. Figure 2 shows the average forces on the front and rear boot for a carved and skidded backside turn in snowboarding.

![Fig. 1: Average forces normalized to body weight on the outside boot (white) and inside boot (black) in a carved and skidded ski turn](image)

![Fig. 2: Average forces normalized to body weight on the front boot (white) and rear boot (black) in a carved and skidded backside turn in snowboarding](image)

The results in skiing show that the average forces in carved turns are higher than in skidded turns, both on the outside and on the inside boot. In snowboarding the average forces on both boots are higher in a backside carved turn than in a backside skidded turn. Furthermore, a more equal force distribution between the boots was observed in snowboarding.

Discussion/Conclusion
The results confirm the hypothesis that higher forces have to be produced to keep the ski and snowboard on the edges in carving turns. Furthermore, also Knünz et al. (2001) found that the rear boot was loaded higher than the front boot in carved backside turns in snowboarding. It can be concluded that carved turns in skiing and snowboarding require a certain amount of force. If this required amount of force cannot be produced, turns cannot be carved anymore and inevitably result in skidding. In competitive skiing and snowboarding, carved turns are required to minimize the snow friction and consequently reduce running time. Consequently, specific strength training programs have to be optimized to allow athletes to produce sufficient force in the leg extensors. Furthermore, technically clean ski and snowboard turns require a sufficient amount of leg muscle force to sustain the high ground reaction forces. This is important, both for competitive and recreational skiers.

References