BIOMECHANICS IN ALPINE SKIING - APPLICATION AND SCIENTIFIC SUPPORT IN ELITE SPORT

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Modern alpine ski racing is characterized by high acting forces in combination with the challenge of keeping the balance and the ideal loading of the ski. Therefore biomechanical diagnostics on the one hand is focused on those acting forces and the corresponding strength abilities of the athletes, on the other hand is trying to measure, evaluate and improve movement abilities during skiing. This paper tries to show the application of different biomechanical methods and results in the concept of the scientific support of the German Ski Team in cooperation with the Olympiastuetzpunkt Bayern and the Technische Universitaet Muenchen.

To measure the acting forces during skiing two general systems are used: The first consists of a force plate mounted between ski and binding collecting data of forces (fz) and moments (mx, my). The raw data are transmitted wireless, evaluated in real time and synchronized to the video recording. Right after the run, information about the loading position and posture can be given to racers and coaches. The second measurement system is a pressure insoles device (Parotec, Paromed, Germany) which is inserted into the ski boots. Data are stored in a data logger and the runs are video recorded. The evaluations can be presented in breaks of the training session or after the training. For certain analyses additionally knee angles are measured by goniometry.

To assess the individual strength abilities of the racers maximal isometric (knee angles: 90°, 120°) and concentric/eccentric tests in different angular velocities (45°/s, 90 °/s, 180°/s) on a leg press (Desmotronic, Schnell, Germany) are performed. Additionally speed strength is measured by common jumping tests as squat jumps and counter movement jumps on a force plate.

Results of the measurements in skiing approved the amount of acting forces known from literature in different disciplines in a range of 1500 up to 3500 N. Model based calculations also showed, that the racer has to sustain average maximum forces up to 2.5 g in GS and SG. Concerning the movement behaviour, the trainability of ideal positions in straight gliding could be shown as well as the importance of certain movement patterns during turns. Relating the individual strength abilities to the measured acting forces in skiing by using different custom built models, the muscular expenditure of individual force production in skiing was estimated. Results show that in all measured cases the intensity of the estimated muscular expenditure in turns is higher than 50% of maximum tested in lab. The highest expenditure was recorded in SL with maximal intensities up to 100% depending on very low knee angles in some situations. However, the time of this maximum force production in SL is comparatively low. Averaging the values over 20s, the mean expenditure in all disciplines is about 40%. This indicates the high energy demands and needs of specific strength endurance abilities in alpine ski racing.