BIOMECHANICS IN WINTER SPORTS

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INTRODUCTION: Biomechanics in sport is distinguished as a research field by two central investigational goals: first, the avoidance of injuries and, second, the improvement of the level of performance. This contribution will predominantly concern itself with possibilities of utilizing sport biomechanics in the direct training process of top class winter sports. The areas in which biomechanics can be applied in the training and teaching process are very diverse. First to be ascertained via biomechanical methods are those characteristics which essentially influence performance. The second area lies in determining individual, current performance levels and in examining performance progress and in the third area feedback systems should be provided during the training session in order to minimize intervention times. The quality of the training process can also be improved by the use of specific training devices and exercises. And, last but not least, biomechanical investigations should also assist the athlete's efforts of optimising the equipment.

PERFORMANCE DIAGNOSTICS: Biomechanical technique analysis and performance diagnostics are essential measures to enhance the quality of training and the performance of the athletes. Scientifically secured knowledge concerning performance-determining characteristics is hardly present in complex outdoor sports like ski racing or ski jumping. Descriptive biomechanical analyses attempt to quantitatively characterize athletes' movement techniques using kinematic, kinetic and electromyographic methods. The results of such investigations lead to a better understanding of movements used and provide coaches and athletes valuable support in directing training goals.

SPECIFIC TRAINING DEVICES AND EXERCISES: Trying to optimise the quality of training it is also important to direct one's attention to the development of highly specific means of training. For the development of specific training exercises the principle of kinematic and kinetic correspondence has to be taken into consideration. This principle states that the special exercises must be in harmony with those parameters of movement which characterise the structure of competition technique. In close cooperation with the Austrian skiing association our working group has done many research studies in order to develop the training devices and exercises which are necessary to follow the principles of specificity and individuality in the training process of top class skiing and ski jumping athletes. Examples from these investigations will be presented during this presentation.

SPECIFIC TEST BATTERIES AND NORM PROFILES: The efficiency of the training also depends on the quality of performance tests available. If possible, valid and standardised tests should be built into the training process for all performance-relevant features of the sport in question. The training plan must be organised as corresponds to the results of these tests. Within the framework of long-term cooperation with the Austrian Skiing Association, we have developed sport-specific test systems for alpine and Nordic ski racers and ski jumpers.

FEEDBACK SYSTEMS: Numerous investigations in the area of motor learning and technical training have indicated in concert that suitable feedback systems can significantly contribute to shortening acquisition time according to the principle of objectively supplementing rapid and immediate information. These systems, on the one hand, should measure as exactly as possible the characteristics which are to be improved in training and, on the other, make the measurement results available to the athlete in an easily understandable form and within the most effective Prae-KR Interval.

EQUIPMENT IMPROVEMENT: Ski racers are convinced to be able to race faster using so called risers. So in a further project we had to prove this hypothesis and to try to find the mechanism which might increase the racer's performance. In a field test three different riser heights (0 cm, 1 cm, 2 cm) were used. The course was standardized by gates. 12 runs, using the different ski systems alternatively were performed by a world cup racer. The following parameters were measured: running time, ground reaction forces normal to the ski, anterior/posterior moments or lateral moments respectively. There was a significant decrease of the running time in dependence on the riser height. No significant differences for forces and moments could be found between the different riser heights analysing the whole turn. But if the turn is divided into a steering phase and a very short edge changing phase, the values of the steering phase remain nearly constant, whereas the values of the edge changing phase decrease significantly using higher risers. Therefore risers help to reduce running time as the edge changing can be managed in a shorter time period.