MECHANICAL LOAD AND MUSCULAR EXPENDITURE IN ALPINE SKIRACING

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KEY WORDS: alpine ski racing, strength, diagnostics.

INTRODUCTION: High external forces acting in alpine ski racing have been published in several studies (Babiel et al. 1997, Mueller et al. 2002). As a consequence alpine skiing athletes spend great efforts on increasing their muscular strength in conditioning training accompanied by different methods of performance diagnostics (Mueller et al. 2002). The presented study tries to compare individually the muscular abilities in lab with the demand on strength during competitive skiing.

METHOD: Seven male athletes of the German National Ski Team participated in the measurements. The mechanical load in alpine skiing (SL, GS, SG) was measured by pressure soles (Parotec, Paromed, Germany) in each boot and both knee angles by goniometers (Penny&Giles, UK). Data have been stored in a data logger (Parotec, Paromed, Germany) and all runs recorded by video. Diagnostics on maximal isometric strength have been done in different knee angles (90°, 120°) on a leg press (Desmotronic, Schnell, Germany). Additionally, using the same device, concentric and eccentric strength abilities were measured at knee angular velocities of 45°/s, 90 °/s and 180°/s. The absolute isometric strength abilities ($F_{iso}(\omega)$) at different knee angles were extrapolated by a custom built model. The dynamic abilities were determined by a factor ($dsV(\dot{\omega})$) relating the concentric and eccentric forces at different angular velocities to the maximum isometric strength. Finally the muscular expenditure of individual force production in skiing was calculated by: $F_{\exp} = \frac{F_{ski}}{(F_{iso} \bullet dsV)}$.

RESULTS and DISCUSSION: First results show that in all measured cases the intensity of muscular expenditure in turns is higher than 50% of maximum 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.
In all disciplines the measured distribution of force between inside and outside leg in skiing (approx. 30%/70%) was higher than of the muscular expenditure (approx. 50%/50%). Concerning training advice this gives evidence that the athlete's muscular sensitivity is different to the measured load at boot sole. Possible reason for this may be the different knee angle of inside and outside leg and thus the changing ability of muscular force production.

CONCLUSION: In technique training it has to be concerned that the muscular sensitivity of load distribution is different to the one at ground because of the changing knee angles. Depending on the varying aims, e.g. minimizing friction or optimizing energy consumption, the load distribution should be regulated appropriately. Further the well known importance of strength endurance abilities become obvious and should be considered in training.

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