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DYNAMIC POSTURAL STABILITY TESTING OF ELITE
SKI AND SNOWBOARD ATHLETES

by

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ABSTRACT

Dynamic postural stability (DPS) is the ability to regain postural control after landing,¹ and is important for success at the elite level of ski and snowboard competitions. Numerous studies have identified different landing protocols for the assessment of DPS. The purpose of this series of investigations was to determine the effectiveness of using a vertical landing protocol versus a horizontal landing protocol to measure ground reaction forces (GRFs) and time to stabilisation (TTS) as a measure of DPS within the elite athlete environment.

In the first investigation, ten healthy recreational athletes and seven elite ski and snowboard athletes volunteered to participate. Athletes completed single leg right (SLR), single leg left (SLL) and double leg (DL) landings from a 0.40 m vertical drop. Both athlete groups observed similar within-subject variation with a coefficient of variation (CV%) ranging from 9.1% to 28.2% for all landings. Test re-test reliability scores indicated good reliability for all outcome measures between day 1 and day 2 of testing for all measured outcomes: vertical TTS (TTS_v), force peak (F_{peak}), time to force peak (TF_{peak}), rate of force development (RFD) and impulse. A significant difference was observed between elite skiers and recreational athletes in single leg (SL: combined SLR and SLL) and DL landing tasks with effect sizes of, SL: $d = 2.63$, DL: $d = 0.07$ and SL: $d = 0.02$, DL: $d = 0.07$, for TF_{peak} and RFD, respectively. It was found that TTS measures did not have the sensitivity to discriminate between healthy non-injured recreational athletes and elite ski and snowboard athletes, with no significant differences being observed. Furthermore, it was observed that minimal discrepancies were seen between left and right leg landings and it is proposed that if no pre-injury DPS measures are taken, that the non-injured limb be used as a benchmark measure of DPS.

The second study investigated whether a strength and power focused training program could improve TTS measures in elite ski athletes. Using the same vertical drop-landing protocol as the first study, seven elite mogul and ski-cross athletes participated in a six-week strength and power focused training program. Pre- and post-training TTS measures in the vertical, medial/lateral and anterior/posterior directions were determined to assess DPS. It was found that a six-week strength and power training intervention had no effect ($d \leq 0.42$) on TTS scores in the three measured planes for elite mogul and ski-cross athletes. Changes in post-training intervention GRF measures for the SLL and SLR landings ranged from -2.0% to 9.0% and DL landings from 0.2% to 2.0% . However, this does not preclude the relevance of the testing measures and it is suggested that these measures be used as a post-injury rehabilitation progress assessment tool for return to training and competition.

In the third study, a multidirectional landing protocol was used to investigate the relationship between vertical and horizontal landing protocols. Ten elite ski and snowboard athletes participated in the study. It was hypothesised that a multidirectional landing protocol would be better at identifying DPS demands in the anterior/posterior and medial/lateral directions compared to only using a vertical drop-landing protocol. The multidirectional landing protocol involved a 0.40 m vertical drop, a 100% leg length forward step, a 50% leg length lateral hop and a 50% leg length medial hop landing task. The GRF measure of vertical peak force and TTS measures in all three planes were recorded. A Spearman's Rank Order correlation was used to assess the athletes' performance in a vertical drop landing compared to horizontal landing task. Results indicated no systematic relationship between landing directions, suggesting consideration be given to the landing protocol used and the specific GRF and DPS outcome measures being tested. Using the longest stabilisation times as a discriminator for placing the highest demand on

DPS, it is recommended that a lateral hop protocol be used for assessment of TTS in the medial/lateral direction, a forward step protocol for TTS in the anterior/posterior direction and using a vertical drop or forward step protocol for TTS measures in the vertical direction and force peak (F_{peak}).

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LIST OF ABBREVIATIONS

ACL	Anterior cruciate ligament
A/P	Anterior/ Posterior
BW	Body weight
CNS	Central nervous system
COM	Centre of mass
CV	Coefficient of variation
DL	Double leg
DPS	Dynamic postural stability
Elite	Elite athletes
FAI	Functional ankle instability
FIS	Federation de ski
F _{peak}	Force peak
GRF	Ground reaction force
HP	Halfpipe
Hz	Hertz
IC	Initial contact
M/L	Medial/ Lateral
N	Newtons
Rec	Recreational athletes
RFD	Rate of force development
RM	Repetition max
SBX	Snowboard-cross

SEBT	Star excursion balance test
SL	Single leg
SLL	Single leg left
SLR	Single leg right
SWC	Smallest worthwhile change
SX	Ski-cross
TFpeak	Time to Force peak
TTS	Time to stabilisation
V	Vertical