IMPROVING PERFORMANCE IN JUVENILE SKI JUMPING: OPTIMIZATION OF SKI ANGLES IN THE FLIGHT PHASE

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The purpose of this study was to analyse and optimize ski angles in the flight phase of juvenile ski jumpers focusing on flying technique and equipment. Inertial measurement units (IMU) installed on jumper´s skis and 2d motion analysis were used to display kinematics in the flight phase. Results show deficits in flying technique and individual´s adjustment of the binding system. Guidelines for coaches and athletes could be derived and implemented.

KEY WORDS: high performance sports, kinematics, inertial measurement units.

INTRODUCTION: Swiss ski jumper Simon Ammann won double gold in the 2010 Olympic Games using an innovative binding system with positive effects on ski angles respectively jumping performance. This has influenced applied biomechanics researchers to study optimal ski angles in the flight phase of the ski jump. In particular the skis´ roll angle is to be kept preferably small in order to reach a plain ski position (Seo, Murakami & Yoshida, 2004). In dependence of the pitch and yaw angle an optimal lifting effect with minimal loss of speed is to be achieved and therefore jumping performance improved (Schwameder, 2008). This can be implemented by physical but mainly technological approaches (Virmavirta, 2016). As a matter of fact juvenile ski jumpers show deficits in flying techniques and individual´s equipment compared to elite athletes (Kreibich, 2003). Therefore ski kinematics has to be optimized in order to improve jumping performance.
The aim of the study is to report ski angles (roll/ pitch/ yaw) during flight to investigate quality characteristics of jumper´s flying technique. Furthermore the influence of different binding systems should be verified correlated to jumping performance. Finally results should help coaches and athletes to analyze flying technique more precisely to optimize performance and equipment.

METHODS: During summer season 2016 ski jumps of German juvenile national teams (Ski Jumping/ Nordic Combined; n=20; age= 17,4± 1,4) were analysed. Skis were equipped with an inertial measurement unit (IMU) including a gyroscope installed behind the rear part of the ski´s binding system. Ski angles (roll, pitch, yaw) were recorded (sampling rate 100 Hz) via Bluetooth connection and stored by data logger. Data was processed and displayed by Matlab-software (Fig. 1a). Additionally a 2d video analysis at dorsal view was done to inspect jumper´s balance during flight (Fig. 1b). Furthermore data of wind, in run speed and binding systems was collected and factored.

RESULTS: Data shows individual differences in resulting ski angles connected to individual jumping technique and equipment. Video analysis at the dorsal view investigates jumper´s body-ski-relation referring to aspects of symmetry and balance (Fig. 1b). Ski´s roll angle is affected by different binding systems and correlated to flying time (Fig. 3). It is to be considered laterally due to symmetric characteristics the same as pitch and yaw angle.

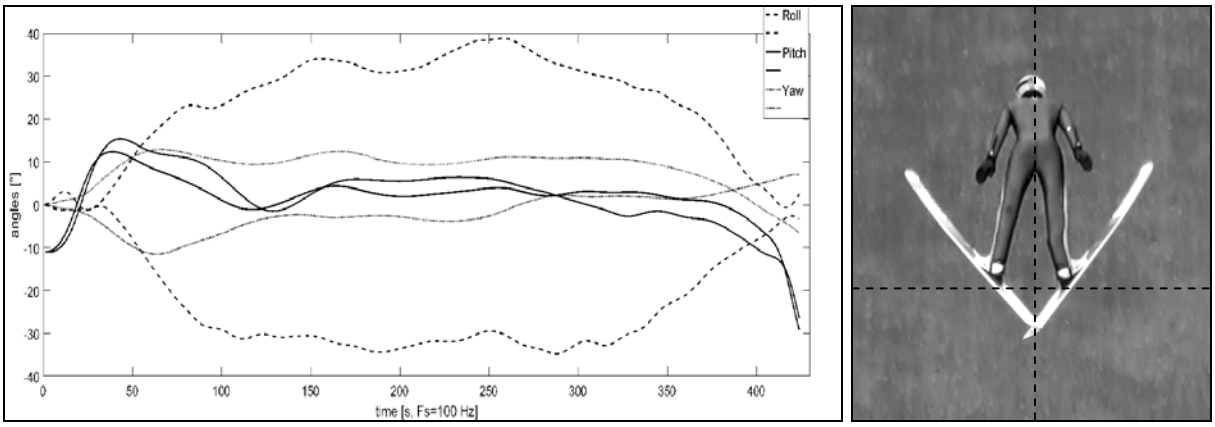

Figure 1: a) ski angles (roll, pitch, yaw) of left and right ski during flight. b) 2d video analysis at dorsal view.

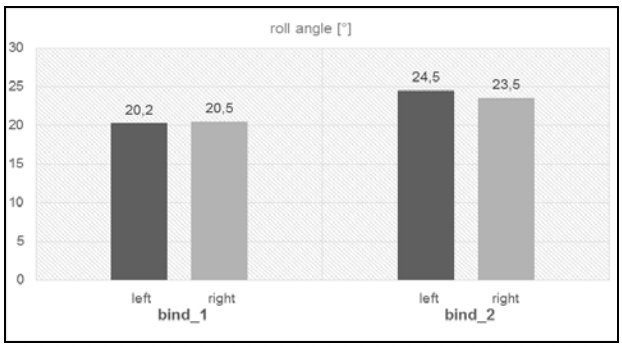

Figure 2: roll angle of left and right ski by contrast with two different binding systems.

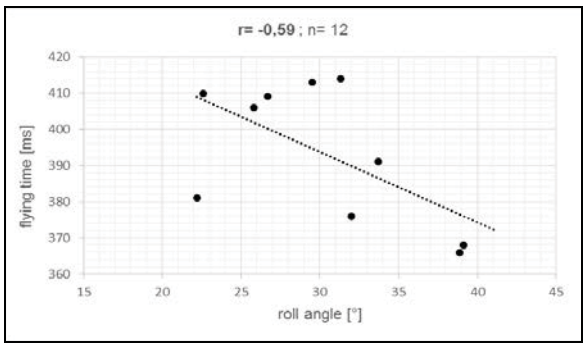

Figure 3: Roll angle correlated to flying time.

DISCUSSION: Displaying ski kinematics can be implemented by IMUs accurately and complements the 2d video analysis for quantifying ski kinematics of the flight phase. Since the application of measurement devices in ski jumping still is complicated, the use of IMUs allows flight analysis in an easy but efficient way. Nevertheless there are several factors influencing jumping performance which have to be determined and factored for precise statistics. Further data collection and processing are in progress.

CONCLUSION: Analyzing ski angles in flight phase particularly in junior athletes is indispensable for both choosing individual´s equipment in an optimal way and therefore optimizing ski jumping technique respectively jumping performance. Further research should implicate additional factors like kinematics of the jumper´s body as well as its vertical and horizontal speed. For a more precise analysis a bigger amount of individual jumps as well different phases of the flight have to be considered.

REFERENCES:

Kreibich, S. (2003). Untersuchungen zur Optimierung der Bindungseinstellung und Materialanpassung im Skispringen. *Leipziger sportwissenschaftliche Beiträge*, 44 (2), 111-126.

Schwameder H. (2008). Biomechanics research in ski jumping, 1991-2006. *Sports Biomech*, Jan 7(1), 114-36.

Seo, K., Murakami, M. & Yoshida, K. (2004). Optimal flight technique for V-style ski jumping. *Sports Engineer*, 7 (1), 97-104.

Virmavirta, M. (2016). *Aerodynamics of ski jumping*. The engineering approach to winter sports (pp 153-181). New York: Springer..