Technische Universität München

Improving ski jumping performance: optimization of ski angles in the flight phase

J. Petrat, M. Stanglmeier (Head: Prof. Dr. A. Schwirtz)
Department of Biomechanics in Sports, Technical University of Munich, Germany

Introduction & Goal

From the Olympic Winter Games in 2010, when the Swiss ski jumper Simon Ammann won double gold due to a new innovative binding system, there is done a plenty of applied research about optimal ski angles in the flight phase of the ski jump (3). Particularly the skis´ roll angle is to be kept preferably small in order to reach a plain ski position (1). In dependence of the skis´ pitch angle an optimal lifting effect should be achieved and therefore jumping performance improved (2). This can be implemented by physical but mainly technological approaches during training periods.
The aim of the study is in the first instance to I) capture and report flight kinematics of the skis (roll/ pitch angle), II) investigate (a) lateral and (b) intraindividual differences of ski angels, c) verify influence of different binding systems and III) examine correlation to jumping performance.

Methods

Participants & protocol:
Ski jumps of German juvenile elite athletes (ski jumping/ Nordic combined; n= 25; age= 17,4± 1,4) were analyzed in several training sessions on normal (HS 106) and large (HS 137) jumping hills during summer season.

Data collection & analysis:
Each ski was equipped with an IMU (gyroscope) installed behind the rear part of the ski binding system (s. Fig. 1). Ski angels (roll, pitch) were recorded (sampling rate 100 Hz) via Bluetooth connection and stored by data logger. Its chronological sequence was processed and displayed by LabView-software immediately after each training session (s. Fig. 2). Additionally a 2d-video analysis at dorsal view was done to inspect jumper´s symmetry/ balance during flight (s. Fig. 2b). Furthermore data of in run speed, weather conditions, used skis and binding systems was collected and factored.

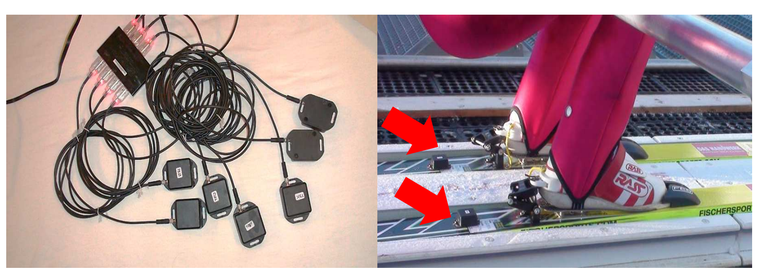


Fig. 1: Data logger connected to USB for charging (left). IMU installed on skis (right).

Results

I) Report of ski kinematics

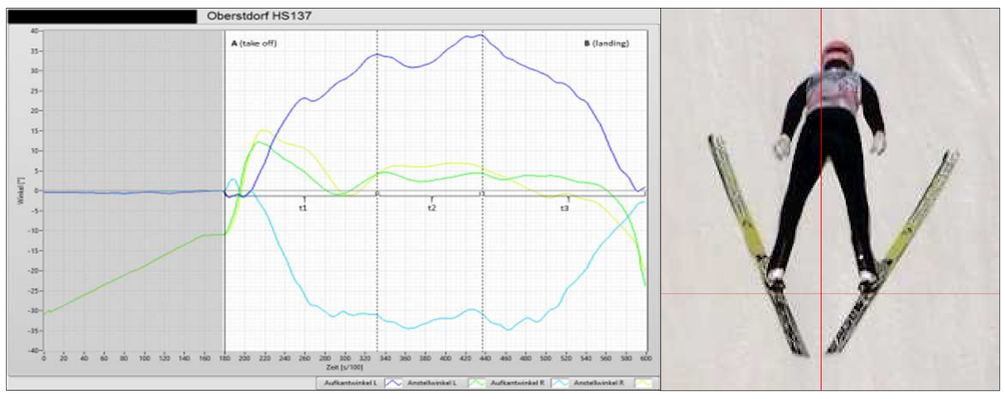
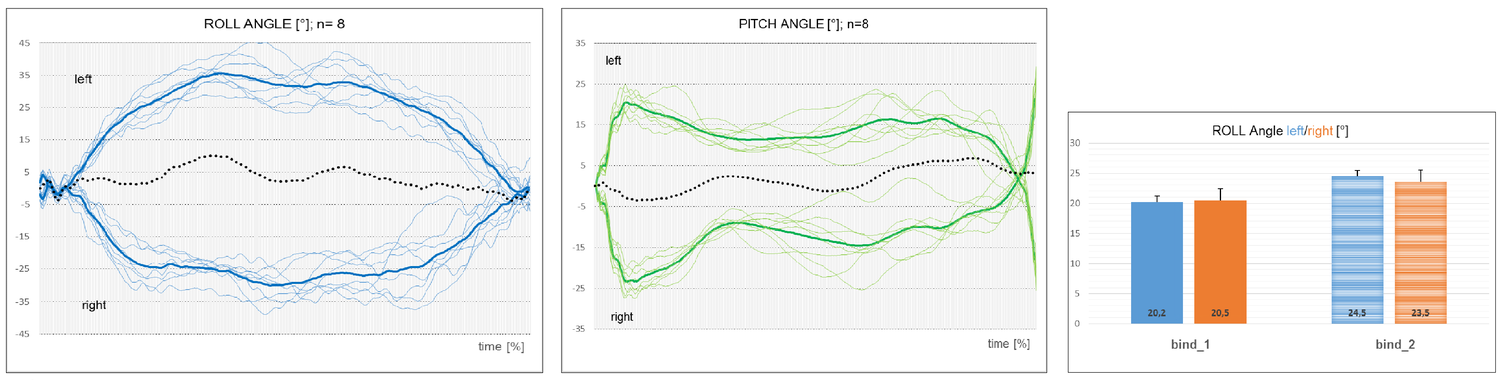


Fig. 2:
L: roll (blue) and pitch (green) angle for left and right ski.
R: 2d video analysis at dorsal view.

II) Variation of ski angels



a) b) c)

Fig. 3: roll (a) and pitch (b) angle with lateral deviation (black dotted). Roll angle in comparison to different binding systems (c).

III) Correlation to jumping performance

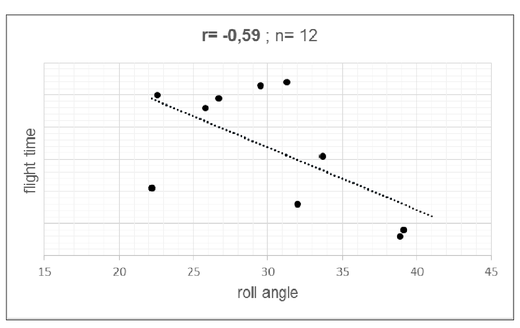


Fig. 4: Roll angle correlated to flying time. Relevant influencing factors (pitch angle, in run speed, outer conditions) are assumed to be nearly constant.

Discussion

Displaying ski kinematics can be implemented by IMUs accurately. Results show conspicuous differences in resulting ski angles and its influence on jumping performance. Ski´s roll angle is affected by different binding systems and is to be considered separately due to symmetric characteristics.

Conclusion

Analyzing ski angles in flight phase particularly in junior athletes is indispensable for both choosing individual´s binding system in an optimal way and therefore optimizing ski jumping technique respectively jumping performance. Further research should implicate additional factors like the skis´ yaw angle, in run speed 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

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Contact: Johannes Petrat, Dipl.-Sportwiss. (Univ.), PhD student, johannes.petrat@tum.de
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