CHARACTERISTICS OF THE FORCE APPLICATION POINT - A METHOD TO IDENTIFY LEARNING PROCESSES IN ALPINE SKIING?

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Since many years teaching concepts in alpine skiing are based on practice experiences and scientific research. Different tools are available to improve specific deficits. One of these tools is the so called "Alpine Basic Position" (ABP), which describes a particular body position. If one is trained in this, he is able to react on balance fluctuations, immediately. Furthermore it is possible to control movements in a harmonic and precise way, which is very important for steering skies exact and controlled. The determination of the force application point (FAP) is an important parameter to analyze body movements. In this study a fully qualified ski instructor (A) and an intermediate skier (B) were asked to fulfil five different exercises, which were developed for training the ABP. While A was skiing in a constant way, B was responding differently. Some exercises occurred a similar characteristic – in accordance to A -, some not.

KEY WORDS: teaching concepts, skiing, force application point, motor learning.

INTRODUCTION: To learn skiing in a comfortable and safe way is one of the most important intentions of teaching concepts. Therefore a skier has to be in a balanced situation, which is interfered by surrounding circumstances, like moguls, ice and so on, constantly. One basic feature of the Austrian Ski Teaching Concept is the so called "Alpine Basic Position" (ABP), which describes a specific body position on skis (ankle, knee, hip and arms are bended and the slope is compensated (WÖRNDLE 2003). The ABP can be seen as a tool to learn new techniques, to stabilize them and to use skills under difficult conditions. One who is able to realize the ABP at a very high level, is able to fulfil movements in a harmonic and precise way. Experts are identified by having a stabile technique, which can be seen on i.e. characteristics of knee angle and force-time characteristics. [SCHIEFERMÜLLER (2001), STADLER (2006)]. Each steering of skis is an interaction between athlete and slope. Thereby the skis can be seen as an interface. Unfortunately, ski instructors do not have the possibility to "see" this interaction in detail. They can interpret visual body movements, only. The determination of ground reaction forces, especially the trajectory of the force application point can give accurate information about steering mechanism. For example: Body movements and balance regulations can be identified. In which way this parameter is affected by using specific exercises was analyzed in this study.

METHODS: 55 high qualified experts (trainer c-level, fully qualified ski instructors and sport scientists) were asked regarding their specific teaching methods by using a questionnaire. Afterwards 23 selected experts (member of instruction teams) had to respond questions about the importance of the parameters, which are describing the ABP, in detail. Relating to these results the following five exercises (Fig. 1) were chosen [SCHEIBER (2004)]. They were analysed regarding to characteristics of knee ankle, ground reaction forces and force application point, as well as a video analysis. The kinetic parameters were measured with NOVEL Insoles (NOVEL Inc.) and Video with a digital camcorder (50 Hz). Thereby one High Level Skier = A (fully qualified ski instructor) and an Intermediate Skier = B, with no experiences in doing specific exercises in skiing, took part in a case study. Certainly, test person A was familiar with the exercises. Subject B was instructed by verbal instruction and visual demonstration. Only information concerning movement execution was given. So he was not informed about the results of the expert rating, as well as the intended purpose of the exercises in detail, to avoid concentration distractions (AMESBERGER 1999).

(1) without exercise (2) „Swallow“ (3) one-sided hip grab (4) Lift upper Ski (5) Draw a line

Fig. 1 – Selected Exercises

RESULTS AND DISCUSSION: Teaching concepts consider the movement of the FAP from the toe to the heel area as optimum, during steering a turn. In Fig.2 this can be seen at the FAP characteristic from subject A. The short time variation of the FAP is given, but in a medium specification. Test person B shows a high variability, as well as not existing backward movement of the FAP, in fact the characteristic is unsystematic.

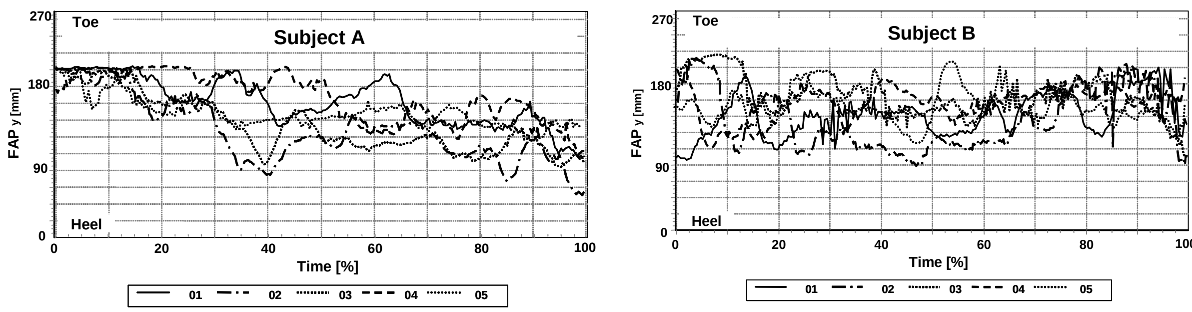


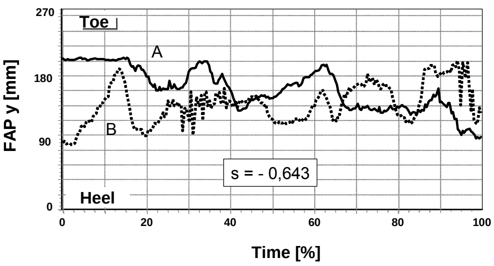
Fig.2 Position of FAP in anterior-posterior direction, Subject A and B, 1 turn, 5 exercises

To prove this theory an analysis regarding the similarity was done and the results can be seen in Tab. 1. The given coefficients were calculated by using a specific MAT-Lab routine on the base of ten Taylor polynomial [BIRKLBAUER 2006 (referring to SCHÖLLHORN)]. Equal to correlation coefficients is given: $-1 \le s \le 1$, in which 0 means no similarity and 1 shows a high similarity [e.g. Sinus vs. Cosinus = 0; Sinus (φ=0) vs. Sinus (φ=0) = +1; Sinus (φ=0) vs. Sinus (φ=180) = -1]

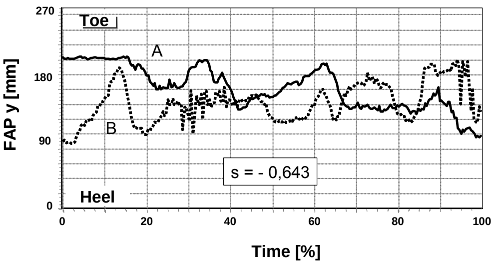
Tab. 1 – coefficients of similarity (reference = 1 turn without exercise)

Proband A	s = 1	s = + 0,917	s = + 0,900	s = + 0,768	s = + 0,825
Proband B	s = 1	s = + 0,170	s = - 0,268	s = + 0,066	s = - 0,440
Exercise No.	(1)	(2)	(3)	(4)	(5)

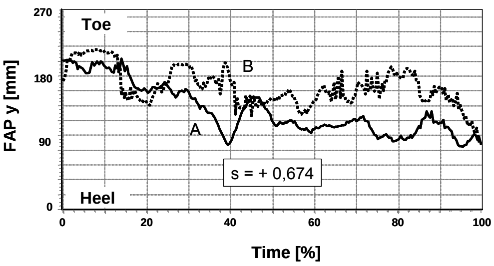
The coefficients of subject A are very high for all exercises, by using (1) as reference, while B shows a clearly lower similarity till to negative values. This means that movements of A are constant, as well as goal oriented. In contrast, B is still in a learning phase and his regulation processes are not fully developed.



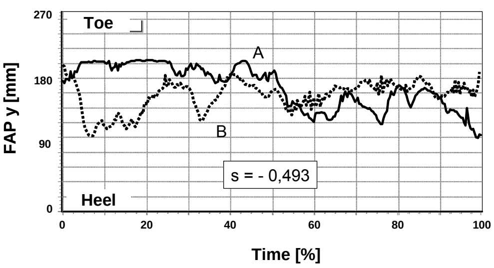
(1) without exercise



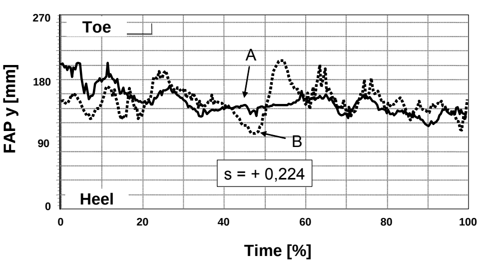
(2) „swallow“



3) one-sided hip grab



(4) lift uphill ski



(5) draw a line

Fig. 3 Characteristic and Similarity of FAP by using specific exercises

If one is orientated on the theory of model learning, it is of interest to analyse the exercises in detail. Therefore all exercises of subject A and B were compared, by using A as reference. Fig.4 shows the results (time normalized; 0/100%=edge changing). As described before subject A is represented by a harmonic backward movement of the FAP during one turn. Regarding to the task which is given to subject B, he shows a similarity which is high and positive (E3 = +0,674) to high and negative (E4 = -0,493), (E2 = + 0,273) and (E5 = +0,224) are also positive but less similar.

Related to the model learning theory E3 makes it possible for subject B to fulfil the exercise in a similar way to subject A, which is representing the reference. Maybe E4 was too difficult for B and so he was not able to steer the ski in a correct way. Similar to E3, E2 and E5 show a learning supported behaviour. It is an eye catching that all given instructions result in a higher similarity of the characteristic of FAP as skiing without one of these tasks.

The big differences in the results of subject B should be seen in combination with the distinctive short term variability (Fig.2), which may represent the uncompleted learning phase.

Actual learning theories, like Differential Learning Processes (e.g. SCHÖLLHORN) would interpret these variations as interferences, which include many learning relevant information. Of course both theories have their acceptation and validity and can be noticed in practice.

The high fluctuations in other measured parameters, such as knee ankle and ground reaction force, as well as steering deficits (video) are typical for this skiing level and make the results speculative, but these results could also be found at them as a tendency (SCHEIBER, 2004). For example: laterality was lower at exercise 3 than skiing without exercises – identified by force distribution (left leg to right leg) and video.

CONCLUSION: Two expert ratings (n=55, n=23) were accomplished to get detailed information about using teaching methods in practice. Based on these results two skier (A=very high level; B=low/intermediate level) were asked to perform selected exercises while skiing a turn. These specific exercises are part of the methodical concept of the Austrian Skiing Tutorial to train the so called Alpine Basic Position (ABP), which describes a specific body position on skis (ankle, knee, hip and arms are bended and the slope is compensated (WÖRNDLE 2003). One who is able to realize the ABP at a very high level, is able to perform movements in a harmonic and precise way. The determination of ground reaction forces, especially the trajectory of the force application point (FAP) can give accurate information about steering mechanism. How the FAP is affected by using specific exercises was analyzed in this study. While subject A performs harmonic and goal oriented movements during one turn (backward shift of FAP ~ 90 mm; and similar time characteristic + 0,768 < s < + 0,917; reference = skiing without exercise), B shows unsystematically FAP movements, as well as non-similar curves (-0,440 < s < + 0,170; reference = skiing without reference). This fact reveals an uncompleted learning process of subject B, while A has already developed a constant technique. Specifically exercise (3) showed a high positive similarity (s = + 0,674) between A and B, while exercise (4) produced a relatively high negative similarity (s = - 0,493). The level of complexity of this task could be one reason for this result. Exercise (2) and (5) could be identified by lower, but also positive similarity coefficients (+ 0,273 and + 0,224). Of course these exercises have an influence on the whole body. So the force application point is only one parameter, which may differ. Nevertheless by having a view on the knee ankle characteristic exercise (3) showed a natural position, while the force distribution was well balanced (70:30% - downhill ski to uphill ski). Furthermore the laterality, which was typical for subject B (regarding to steering behaviour) was lower in this case, which could be identified by video and force distribution (left/right) (SCHEIBER, 2004).

It seems that the similarity of FAP-characteristics is an indicator, which is able to describe learning processes in Alpine Skiing. Further studies have to be done, but it might be able to use this tool to analyse exercises regarding to difficulty and effectiveness. For the development of teaching concepts these informations are of high value.

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