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Sport fight during alpine skiing course running – martial arts can increase the efficiency of skiers training

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Abstract

Background & Study Aim: The main questions put by the investigators were: a) what was the competitors' approach to the sport fight along the whole course in alpine skiing, and b) was the information of the runs of the previous competitors important for the next competitors. The first aim of the investigations was acquiring a knowledge on the tactical manner of skiing competitors. The second aim was a proposition of inclusion of some aspects of martial arts into training of skiers.

Material & Methods: Competitions of Alpine Ski FIS World Cup in: downhill, super-giant, giant slalom, slalom were evaluated. Altogether 798 starting applications of skiers were noted. Basic geometry of the gates was obtained. All runs were recorded with video camera. Velocities and accelerations of the runs were calculated. Two biomechanical indices were introduced.

Results: Index of skiers' level was highly correlated with the starting numbers. Index of velocity deviations was higher in technical disciplines comparing to the speedy ones. There is significant difference between better and the worse competitors taking into account tactical approach to the run. Better skiers ran specific fragments of the course with different velocity, hence they obtained shorter time of running.

Conclusions: Some gates were set in wrong manner. Skiers took into account knowledge of the tough fragment of the track and ran it in different way. It would be worthy to implement to the skiers' training elements of martial arts.

Keywords: alpine skiing • world cup • fighting • sport tactics • biomechanics • martial arts

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Introduction

Competition is deep-rooted in man's mind. It shows up in almost every kind of human activity. During peaceful time competition takes into account economy of the country or region, and also individual or group activity, including efficiency of mind and body. The latter deals especially with sport activity.

There are different kinds of sport competition (rivalry, fight): 1) direct, e.g. in fighting sports, 2) indirect – parallel in time or one by one (as in alpine skiing); 3) corresponding – on separate sport arenas. Another division of sport proposed Naglak [1]. According to him there are several sport disciplines where motor, cognitive, or perceptive characteristics are dominant: 1) games (cognitive, perceptive); 2) games with a ball or a puck, etc. (cognitive, perceptive, motor); 3) shows (motor, cognitive); 4) direct confrontation (perceptive, cognitive, motor); 5) races (motor, perceptive, cognitive). Alpine skiing can be categorized as a sport

Sport race – indirect confrontation usually on separate tracks or one after one

Sport tactics – a manner of realizing sport fight taking into account an opponent, surrounding, phase of competition

Alpine skiing – running down the hill on snow or other surface

Skiing course – geometrical surface where skier should run between gates made of poles

Velocity – distance covered in time

Acceleration – change of velocity in time

Falling exercises – acquiring manner of falling with deceleration by using muscles and activity to harden the body to the ground forces

racing activity where motor factor dominates over perception and cognition. This is a hard psychological approach to rivalry. During the run competitor depends only on his own tactical decisions, without feedback of time data, coach's advice, spectators' screams. The only knowledge competitor has before his or her run at the particular competition are configuration of gates (which is seen before the run) and time data (intermediate and the end time) of his or her predecessors in the competition.

Competitors in alpine skiing usually run individually. Time of one or two runs is taken into account. A number of runs depends on a discipline. In downhill (DH) and super-giant (SG) there is one run and in giant slalom (GS) and slalom (SL) there are two of them. Here only the first 30 skiers from the first run qualified to the second run.

A competitor at the start line possesses information only on times obtained by preceding skiers. During the run there is no possibility to have additional information on how the run is performed. There is no pressure from other competitors who accelerate their movement before the finish line as it is e.g. during athletic runs. Only at parallel slalom a competitor can observe his direct opponent. Spectators have information on the actual position of a skier based on two or three intermediate times but they do not have information what happens between measuring points. An additional specificity of alpine skiing is that every competition is situated at another course, so a skier cannot compare his own run based on time of running as it is e.g. in athletic marathon run.

Technique and tactics in competitive alpine skiing are subordinate to just one aim – obtaining the shortest time of running a course. This time is dependent directly on mean velocity and a distance covered. The competitor tries to maintain the optimal track and optimal velocity which gives safe running and the shortest time. Appropriate tactics should take into account optimal distribution of effort along the whole course. This prevents against incidents at the end of a run (running off the course, hitting a pole, falling down etc.) [2, 3].

There were several investigations on how skiers run the course. Taking into account tactics of running the first approaches dealt with runs through just few gates only [4, 5]. This approach could not help the coach to assess the skier during the whole performance – which fragment was wrong run, where he or she gained or where he or she lost comparing to other competitors. Further investigations of Erdmann and his group took into account running along the entire course of giant slalom [e.g. 6, 7]. This approach allowed full tactical assessment of the skiers.

The setting of gates along the course constrains acquiring specific tactics of running by the competitor which relies on accelerating and decelerating in proper fragments of the course. The specificity of these changes reflects how the competitor fought along the course. Analysis of a distribution of velocity and biomechanical indices would allow to assess objectively whether a run was active or passive, or maybe it was with too big risk leading to falling down.

Concept of the investigations

The main questions put by the investigators were: a) what was the competitors' approach to the sport fight along the whole course in alpine skiing, and also b) was the information of the runs of the previous competitors important for the next competitors. Therefore the aim of the investigations was acquiring a knowledge on the tactical manner of skiing competitors applied during their runs along the whole course.

We hypothesized: 1) there is significant difference between the better and the worse competitors in alpine skiing taking into account tactical approach to the run; 2) competitors take into account current results of previous runners before their run in the same competition, 3) competitors in technical disciplines while running the second leg take into account results of the first leg.

We put the following detailed questions: 1) What are geometric dimensions of the setting of gates? 2) What are the time data from gate to gate and of the whole course? 3) What velocities obtained skiers for all inter-gate distances, 4) How skiers run specific fragments of the course? 5) Do skiers run smoothly along the whole course? 6) Is it worthy to introduce martial arts activities into the skiers training?

Material and Methods

Alpine Skiing FIS World Cup competitions were taken into account. There were 12 competitions in four disciplines (three competitions for every discipline) of the season 2006/2007. Authors were present in Austria, Germany, Italy, Norway, Slovenia at the following locations: 1) DH – Val Gardena 15.12.2006, Garmisch-Partenkirchen 24.02.2007, Kvitfjell 10.03.2007; 2) SG – Val Gardena 16.12.2006, Hinterstoder 20.12.2006, Kvitfjell 11.03.2007; 3) GS – Alta Badia 17.12.2006, Hinterstoder 21.12.2006, Kranjska Gora 03.03.2007); 4) SL – Alta Badia 18.12.2006, Garmisch-Partenkirchen 25.02.2007, Kranjska Gora 04.03.2007.

The best skiers in the world were investigated. In different competitions mostly the same skiers participated. At every competition there were present 60-80 skiers. Altogether 798 starting applications of skiers were noted. Including two runs during technical competitions there were 978 runs taken into account. From this number 160 (16 %) runs were not finished.

Based on geodetic measurements coordinates of gates and therefore basic inter-gate distances (from pole to pole), angles of inclination (up and down) and angles of deviation (left and right) were calculated. All runs were recorded with video camera (from the monitor situated at the finish area of every competition) and then all-time data when skier passed every gate pole were obtained using AS-1 computer program (written by the second co-author). Dividing basic distance by time velocities and accelerations for all inter-gate distances were calculated.

Successive start of the first 30 competitors in downhill depends on the last training's times and in super-G is based on the actual FIS ranking. They start in opposite manner, i.e. the 30th at the training or in ranking starts the first. The next skiers (beyond the first 30) start according to FIS ranking. Within technical disciplines the succession at the start of the first 15 skiers within the FIS ranking is set by drawing and the rest runs according to FIS ranking.

The manner of a skier's run can be described using some of the following biomechanical indices [7-9]:

1) index of skiers' level (for particular geometry of a course and weather conditions skiers should obtain particular velocity):

$$W.sl = v.mean / W.geom. \quad (1)$$

where: W.sl – index of skiers' level, v.mean – mean velocity of the entire course, W.geom. – index of the course geometry (a function of inter-gate distance, angles of inclination and deviation [8]).

2) Index of velocity deviations (smaller the velocity deviations the better):

$$W.vd = ½a½ / v.mean \quad (2)$$

where: W.vd – index of velocity deviations, ½a½ – absolute value of acceleration, v.mean – mean velocity of the entire course.

The alpine ski running is a highly individual approach – some skiers run aggressively, others run more smoothly. Specific competitors were taken into account who were at different competitions within different groups and their manner of runs was analysed in details. In downhill and super-G and also in the first runs of giant slalom and slalom succeeding skiers at the start were taken into account. Here, information from the course while other skiers were running was important to assess whether the next skiers took this information into account while they were running the course. Within technical disciplines where the first 30 skiers participate in the second run, competitors were divided on those who should attack (positions 15-30 after the first run) and those who are in advantage and could run more safely (positions 1-15 after the first run).

Data were analysed using standard statistics. For all material data distribution was checked by K-S and Lillefors tests. When material was near the normal distribution mean, standard deviation, coefficients of variation, and dispersion (minimum and maximum) were calculated. For comparison of groups consistence of distribution was checked using χ^2 and ANOVA tests. If significant differences were found post-hoc and NIR tests were used to show the differences among the groups. For biomechanical indices Pearson's correlation analysis was obtained with main kinematical quantities, i.e. mean velocity of the whole run and with time obtained at the finish line. Correlation was acquired as significant when according to t-Student distribution critical value was $\alpha \geq 0.05$.

Results

Relationship of starting numbers and the positions at the finish

Significant correlations were found between final positions at the finish and the starting numbers. Figure 1 presents mean positions at the finish according to successive starting numbers within six competitions in speed disciplines (Figure 1 A) and within six competitions in technical disciplines (Figure 1 B). For the further analysis only data of the 30 first skiers at the finish line were taken into account with the assumption they represent similar sport level.

Biomechanical indices and starting numbers

Data of index of skiers' level (W.sl) were highly correlated with the starting numbers ($0.63 < r < 0.87$). This was due to the acquired system of succession at the start, i.e. within the technical disciplines the best skiers run with the first numbers (later runners have worse course surface) and

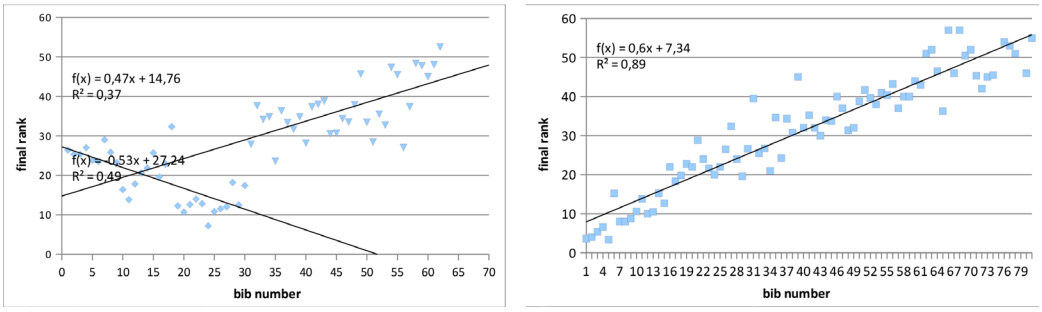

Figure 1. Relationship of starting numbers and the positions at the finish: A – speed disciplines (DH and SG) – for the first 30 skiers r = -0.612 and for the rest r = 0.702; B – technical disciplines (GS and SL) – for both disciplines r = 0.944.

within the speed disciplines starting number is not associated with the state of the course surface and a skier with the 25th or 30th number can be the first at the finish.

Values of index of velocity deviations was quite higher in technical disciplines comparing to the speedy ones. This was due to the higher values of absolute accelerations and smaller mean velocities. In slalom mean acceleration at the inter-gate distances equalled 3.49 m/s^2 and in giant slalom 1.41 m/s^2. In the speedy disciplines it equalled below 1 m/s^2. There were higher values of W.vd in technical disciplines for competitors of the better group (starting numbers 1-30) – Table 1.

There was negative correlation of index of velocity deviation and starting number in technical disciplines (r = –0.33 in the first leg and –0.28 in the second leg), however in downhill and super-giant there were no significant differences of the index of velocity deviation between the first 30 competitors and the rest of them. Different tactics was necessary within speed and technical running. Within downhill there was important to maintain high velocity at the long inter-gate distances with small velocity deviations and within slalom active run was necessary with change of velocity at every possible fragment of the course.

Changes in manner of running after situations of running off the track by previous competitors

No significant difference was found between manner of running for a group before an incident and for a group after an incident taking into account indices for the whole track. However, when the track's fragment just before the incident was concerned significant lowering of velocity and lowering of the index of velocity deviations were found.

At one of the tracks there was difficult set of gates number 20-21. Seven competitors ran off the track in this place. Runners with lower numbers had high

Table 1. Index of velocity deviations (three runs in each discipline).

Competitors		SL	GS	SG	DH
All at the Finish (n = 3´30)	min	0.110	0.033	0.021	0.010
	max	0.590	0.154	0.070	0.078
	x	0.262	0.071	0.038	0.031
	SD	0.066	0.017	0.008	0.009
	V	25.1	24.3	22.4	29.5
Finish places 1-15 (n = 3´15)	x	0.266*	0.072*	0.037	0.031
	SD	0.062	0.018	0.005	0.007
	V	23.3	25.9	12.5	22.0
Finish places 16-30 (n = 3´15)	x	0.255*	0.070*	0.039	0.031
	SD	0.068	0.016	0.005	0.007
	V	26.9	22.7	17.5	23.3

*significant differences p<0.05

velocity at the gate numbers 20 and 21 hence they had problems and velocity at the gate number 23 was smaller. Next competitors just before the start have the possibility to watch at the television screen runs of preceding competitors. They could also have information from the coaches and other members of the team situated along the track on the manner other skiers ran the course. So, it was very probable that competitors who possessed knowledge on difficult fragment of the track at gates 21 and 22 after gate number 19 they ran slower and due to this after quiet running of the gate number 21 at gate 23 they had higher velocity. An example of such a situation was shown in the Figure 2.

Changes of values of indices in the case when competitor had time advantage within the second leg

Within the technical disciplines at the second run competitors had higher values of investigated indices. No relations were found between values of indices and advantage after the first leg.

Discussion

Based on the analysis of kinematics indices one can see the influence of succession of start on the end results. The information on the situation at the course reaching a competitor before the start can influence the decision he or she would make according to his or her running. The assessment of the run was based, among other quantities, on velocity deviations. These deviations are important from the energetic point of view because accelerations and decelerations engage significantly the muscle system. They are also important from the tactical point of view since a fight for a victory needs active run.

When a competitor stays at the starting gate he or she is there alone. If there is a shorter course the only success would be to run at maximum of his or her possibilities almost from the very beginning. When a course is long and tough optimal velocity tactics should be applied. At the beginning a bit slower velocity could be used with a gain of smaller load. In addition some sets of gates are of such configuration that there is better to run previous inter-gate distances with lower velocity and the next set of distances with higher velocity. In this way the whole set of gates would be run with shorter time. A competitor planning tactics of running needs to take into account possible risk and to estimate what risk can acquire other competitors. Often there are risk decisions but in order to win they need to risk. Unfortunately, not rarely it ends with incidents or injuries.

Training of competitors at the highest level is performed with the best coach's knowledge, all needed facilities, high financial support. But still new ways of improvement could be added. One of those is implementing to the skiers' training elements of fighting sports (martial arts). Similar approach described Foretić et al. [10] who presented implementation of wrestling to the handball players. Through frequent contact with the body of an opponent in wrestling they had less fear in contacting opponent's body

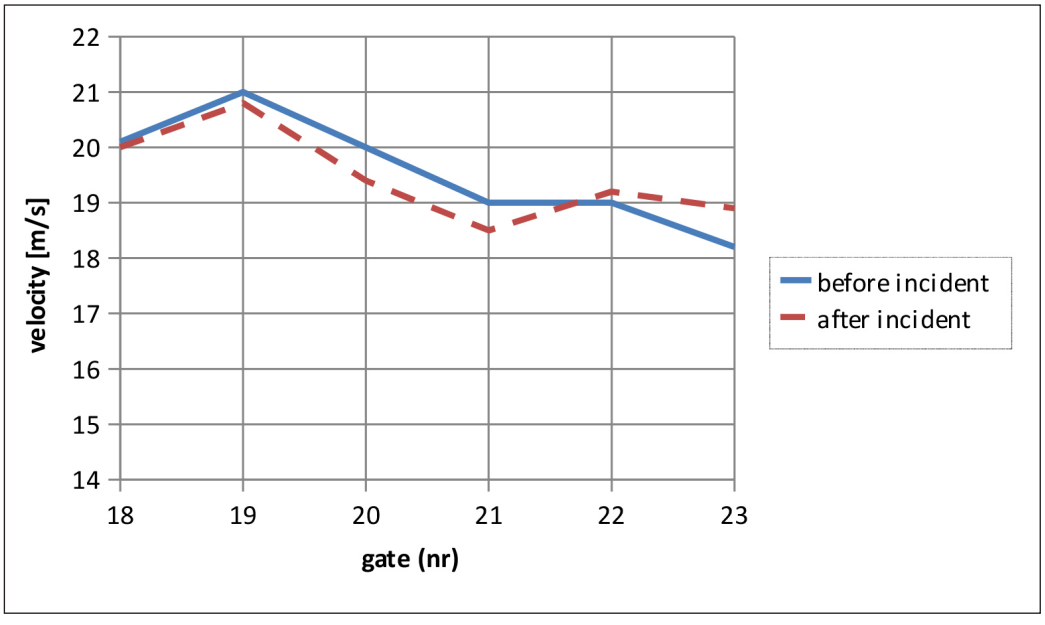

Figure 2. Mean velocity data at the intergate distances 20-23 for competitors who ran before and after incidents (SG track in Kvitfjel, NOR).

in handball. It is very important to acquire knowledge and skills on falling in skiing competitors. The knowledge of falling acquired through participation in fighting art like judo should give less fear while falling on snow during high speed at the competition. More over the body accustomed to the falls should be more resistant to forces acting during contact with the ground.

Training of fighting arts should improve very important psychological approach to the competition. A competitor should have great motivation to the activity he or she is performing. Martial arts have long tradition of implementing to the mind of a competitor such an approach. High level of combination of motivation to achieve success and motivation to avoid failure provide better psychophysiological states [11].

In order to improve mentality of alpine skiers, i.e. perception and cognition of his or her own body and circumstances of activity it would be worthy to train some aspects of martial arts. In this way a competitor will be more confident in his or her abilities and will better cope with defeat.

Martial arts give also an example of a good relation 'master-pupil'. Coach like a good master should educate a novice in a sense of self-esteem through club discipline [12].

Proposed method of analysis of kinematics of running gives a possibility of assessment of tactics and would show real process of competition along the course. It would show a sport fight which is not seen during television coverage. Another possibility is application of obtained results for better pageantry of skiers' performance. This can be done through visualization of comparison of a run of particular skier with the best one up to now using computer animation [13].

Conclusions

Competitors take into account the manner previous skiers ran the course, especially when some incident occurred, and change their manner of running

Within technical disciplines while running the second leg it seams competitors take into account the results of the first leg in such a way that if there is a large difference in time results those from further places need to risk faster running in order to be closer to the winning positions. Probably this is a cause of incidents at the course. Nevertheless this shows a fight along the course without direct contact with opponents.

Since setting of gates sometimes is wrong it would be worthy to check this setting before running of skiers, e.g. by a team of sport analysts. All fragments that could be too tough for skiers could be re-set.

The authors would like to give an advice to the skiers' coaches to introduce to the training some activities of sports of direct fighting, e.g. discipline manner of conduct, mental activities, and falling exercises.

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