Systematics and correction of skiing technique errors in beginners based on biomechanical analysis

Giovanis V.
University of Athens, Department of Physical Education and Sport Science

Annotation:

The result of the training is mastering the skiing technique by the students. It is subject to the instructors' subjective evaluation. The video analysis and calculation of biomechanical coefficients may supply objective evaluation and specify the errors committed.

Гіованіс В. Систематизація і корекція горнолижної техніки у процесі навчання методами біомеханічного аналізу. У статті дається аналіз змісту навчального процесу групи студентів в умовах семиденного навчально-тренувального згрупування у горах. Індивідуальний аналіз техніки спуску на лижах відбувався за допомогою двох синхронізованих відеокамер. Було використано метод порівняння біомеханічних параметрів техніки учнів з біомеханічною моделлю як метою навчання.

Гиованис В. Систематизация и коррекция горнолыжной техники в процессе обучения методами биомеханического анализа. В статье анализируется содержание учебного процесса группы студентов в условиях семидневного учебно-тренировочного сбора в горах. Индивидуальный анализ техники спуска на лыжах проводился с помощью двух синхронизированных видеокамер. Использовался метод сравнения биомеханических параметров техники обучаемых с биомеханической моделью как целью обучения.

Keywords:

3D analysis, skiing technique, errors, centre of gravity, movement analysis

аналіз, техніка, лижі, навчання, пересування маса тіла.

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Methodology

The research involved 70 students of Teacher Training College of Revalidation, Resocialization and Physical Education in Bialystok, Poland, and 5 instructors (the control group, the standard group) who participated in the winter camp in Jańskie Łaźnie, the Czech Republic, in January 2007. the training in the winter camps lasted 7 days. Practical classes were held on the slopes and they were complemented with theoretical knowledge in the form of lectures.

The basic evolutions taught and assessed included the following:

- snowplow turns,
- half-plow turn,
- traverse parallel side-slip

The classes took place in 12-person groups with an instructor. At the beginning of the camp, the participants were divided into groups based on their skiing abilities (2, 4).

The first stage of the research involved collecting the material at the beginning of the camp (2nd day) and at its end (7th day). Two video cameras (Hi-8) recorded the passing of the slope's fragment following the arc marked by the instructor. During the slide there was a requirement of the half-plow turn technique. The students were to present the most correct technique at the level of their current skills. The camera was placed still on the tripod, and the recording frequency was f=25 Hz.

The data regarding the height and body mass of the people under examination was collected along with their skis' length.

The material collected was subject to a biomechanical analysis. The video recording was converted into AVI files with a multimedia card. Then, by means of Aschenbrenner's programme (5), the centre of gravity of a skier and their equipment was determined (CoG) and the angles of the respective body parts were measured. The skier's centre of gravity and the angles were defined in the medium sequence of the turn. The achieved coordinates (CoG) were converted in percentage values in proportion to the length of the lower extremities (l) for further comparison. The forward binding was assumed to be the centre of the reference system. The values obtained at the beginning were compared with the ones obtained at the end of the camp (1, 3).

The position of the centre of mass was assumed to be the correctness criterion. The examined persons were divided into 5 groups, according to the shifts in CoG in the sagittal plane (type of error)

Group A – CoG too much forwards,

Group B – CoG too much backwards

Group C – CoG in the forward-backward axis but too high,

Group D – CoG as above, but too low,

Group E – CoG correct

The force of the error will be evidenced by the CoG distance from the medium standard group in the coordinates system normalized by the standard deviations of the standard group.

The correct position was assumed to the average of the instructors' group with range 2 standard deviations. Subsequently, the results were correlated with the point-based assessment given by the instructors. The data obtained were subject to the standard statistical and comparative analysis.

Results

The first stage of research described the skiers' positions by means of measuring the angles and CoG position based on the video recording analysis. Fig. 1 presents the distribution of the results of the skier's centre of mass coordinates.

Based on the measurements from the camp's beginning, the study group was divided according to the errors made in keeping the correct position. The most numerous group included people with CoG moped backwards (36%), and then forwards (24%); too high and too low positions (18% and 11% respectively) were also noticed; 11% of

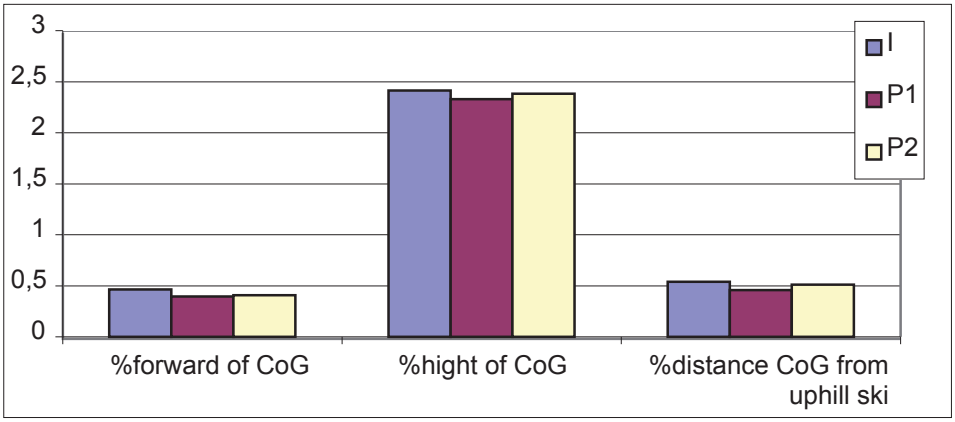

Fig. 1. Comparison of the average CoG position (groups: I-instructors, P1 – students at beginning, P2 – students at the end of camp)

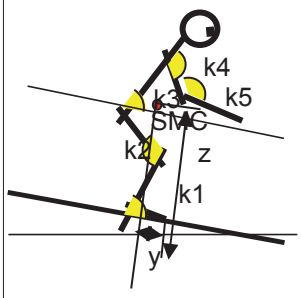

Fig. 2. Examined geometrical values (see below)

the students presented the correct position at the very beginning of the classes.

The instructors' group obtained the following geometrical values that determine the position of the body:

- the angle of the shins bending relative to the skis (k1): 77°
- the angle in the knee joint (k2): 133°
- the angle of the trunk bending relative to the skis (k3): 68°
- the angle of the arms' bending relative to the trunk (k4): 149°
- the angle of the forearms raised relative the arms (k5): 136°
- the height (from) the whole body mass against the length of the lower extremities (l): 2.41
- the distance (y) between the projection of the centre of the body mass in the sagittal plate (y) in relation to the length of the lower extremities (l): 0.46

Moreover, it was stated that the position of the extremities should be symmetrical. The position of the values examined is illustrated in Fig. 2.

The detailed data that describe the position in the sagittal and frontal plates obtained on the basis of the video recording analysis are included in table 1.

The results describing the students' positions at the beginning are included in Table 2, and at the end of the camp in table 3.

The most conspicuous difference was the position of the centre of the body mass. N beginners, it was moved backwards to the skis against the standard group. The relation of the centre projection to the extremities' length (y/l) amounted to –0.06, and at the end of the camp its value increased to 0. The angle in the knee joints (k2) did not change during the training and was 140° for both groups. The angle of the trunk bending (k3) was smaller than in the standard group and amounted to 72° at the beginning and to 74° at the end. There was a big angle variety in the position of the extremities.

The most frequent errors included:

- too small bending of the shins forwards, by 8° at the beginning and by 6 at the end of the camp° on average, maximally by 20°
- excessive bending in the knee joint, maximally by 23° more than instructors'
- insufficient bending in the knee joint, maximally by 25° less.
- bending the trunk excessively forwards by about 30°
- bending the trunk backwards, in some case even by 19°
- holding the arms too high or too low

Discussion

The errors resulted in shirting the projection of the centre of the body mass to the back of the skis. The vertical coordinate of the centre of the body mass (z) does not differ much, yet, the horizontal one (y) aims at the standards values along with the increased level of training in the study group.

The material collected allowed for conducting the biomechanical analysis of the turning technique at different stages of the basic training. There were changes observed to the skier's position when measuring the angles of the respective body parts and the position of the centre of the body mass.

The group showed much deviation from the values assumed as standard at the beginning; the differences were both excessive and negative. The most frequent terror was bending the shins insufficiently forwards, which accompanied by an excessive bending in the knee joint caused the centre of the body mass shift considerably backwards relative to the skis. The students attempted to compensate for this terror bending their trunks more forwards. As a result their position lost balance and optically deviated from the standard position. Persons whose ankle joint was bent not enough while bending their shins insufficiently forwards had to straighten their trunks in order not to weigh down their skis, and some even bent backwards. Furthermore, many cases of asymmetry in the position of the extremities were noted. The average position of the centre of the body mass in the projection on the skis' plane appeared much further back from the frontal binding than in case of the standard group.

T the end of the camp there was a visible improvement in the position and skiing technique. The angle of bending the shins forwards, angles in the knee joints and the position of the arms got closer to the standard values. The body symmetry also improved. The trunk is still insufficiently bent, which makes the centre of the body mass shift backwards against the skis. In comparison to the results from the very beginning of the camp, it is closer to the correct value. In the amounts under research

Table 1.

Values describing the position of the body on the slope Data for the standard group - in the sagittal plate

I	x	S	V	min	max
k1	77	6.35	0.08	69	85
k2	133	5.15	0.04	127	141
k4	149	10.64	0.07	131	157
k5	134	15.34	0.11	120	156
k3	68	9.31	0.14	55	77
y/l	0.46	0.04	0.08	0.41	0.51
z/l	2.41	0.11	0.04	2.27	2.54

Table 2.

Values describing the position of the body on the slope Data for the students' group at the beginning of the camp.

P1	x	min	max	S	V
k1	77	66	89	10.4	0.135
k2	140	101	159	19.69	0.141
k3	72	50	99	17.33	0.241
k4	145	122	173	18.57	0.128
k5	145	113	178	20.59	0.142
y/l	-0.06	-0.12	0	0.01	-0.167
z/l	0.97	0.83	1.01	0.18	0.186

Table 3.

Values describing the position of the body on the slope Data for the students' group at the end of the camp.

P2	x	min	max	S	V
k1	75	71	85	5.94	0.079
k2	140	111	151	13.41	0.096
k3	74	50	82	13.57	0.183
k4	157	139	178	15.31	0.098
k5	128	96	141	14.1	0.110
y/l	0	-0.1	0.1	0.1	
z/l	0.97	0.9	0.99	0.11	0.113

the differences in the values are much smaller than at the beginning, which proves the level of the group getting equal.

T can be said that the downhill skiing technique has improved during the training. The results obtained at the end of the camp were gained under more difficult weather conditions, which still shows the more advanced level of the students and at the same time proves the training to be effective.

The above method of research may be useful in instructing skiing. The instructor, having the standard and student's error description based on the video analysis at their disposal, can offer the very student unequivocal and precise instructions. T can also be applied for auto-correction when improving one's own skiing technique.

At the camp one could also additionally notice the positive effects in the form of an increased motivation while being recorded and a greater awareness of one's own mistakes when watching the recording. Video camera should be one of the fundamental didactic aids during the training process.

Bibliography

1. Bober T. Biomechaniczne kryteria skuteczności techniki sportowej / T. Bober. - Sport wyczynowy, 1979. - nr.9-10.
2. Giovanis V. Kinematyka przejazdów torów slalomowych w narciarstwie alpejskim a problem urazowości. Dysertacja doktorska / V. Giovanis. Kraków. - 1998.
3. Perlak J. Biomechaniczne podstawy narciarstwa / J. Perlak. Kraków. - 1986.
4. Vyšata K. Metodyka nauczania narciarstwa zjazdowego. Skrypt Zakładu Sportów Wodnych i Zimowych / K. Vyšata. AWF, Warszawa. - 1998.
5. Baka R. Biomechanical Aspects of Skiing Technique Evaluation with the Use of Picture Methods. (Biomechaniczne aspekty oceny techniki narciarskiej przy pomocy metod obrazowych) / R. Baka, P. Aschenbrenner. //Międzynarodowy Kongres Naukowy: „Góry, Sport i Zdrowie", Roverto, Włochy. - 2007.

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Giovanis Vassilis
boraczynski@osw.olsztyn.pl