ANALYSIS OF ATHLETES' STATIC-DYNAMIC STABILITY

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INTRODUCTION: The ability to maintain balance and static-kinetic stability is particularly important for athletes. The balance function realizes a stable connection between the individual and the environment, resulting in "spatial" stabilization. This means that the environment is perceived as "stable," that man lives, moves or stays in a stable surrounding. That is why this fact is of particular importance in the training process of figure skaters, gymnasts and other athletes. Different tests are made for their selection and for assessment of the training process.

This paper presents a method for computer processing of results from craniocorporographic examinations (CCG) of athletes at standard and sensitized Romberg's standing test and Unterberger-Fukuda stepping test. The aim is to compare the sensitivity and reliability of those tests.

METHODS AND PROCEDURES: The method described by Claussen (1978) is used for CCG examinations. CCG, as defined by Gurtu, is a quantitative and qualitative record of the structure of a persons' movement when performing stepping and Romberg's test. Static posturography (SPG) records the posture swaying in standing position for 1 min., and kinetic posturography (DPG) is a photographic record of the stepping test (80 steps/min.). The photo of SPG shows 4 spots representing the swaying of the athlete's head (shoulders).

The ability to maintain one's balance is realized via impulses coming from the visual and vestibular analyzer and from the proprioreceptors. In order to test this sensor interaction, and thus the ability to maintain stable balance, the following modifications of SPG are suggested:

- Closed eyes, arms stretched forward, feet close together (R);
- Feet one in front of the other in a straight line (R1);
- Legs slightly bent at the knee and ankle joints (R2);
- One straight leg and the other crossed on the calf of the former leg (R3).

DPG considers:

- Walking on one spot with closed eyes and arms stretched forward (U);
- Head in left flexion at 45° (U1);
- Head in right flexion at 45° (U2);
- Head in retroflexion at 45° (U3);

The evaluation of the results is performed with computer methods developed by the authors with the following parameters:

For SPG:

- forward-backward deviation (mm);
- lateral deviation (mm);
- surface (mm^2).

For DPG:
- width of lateral swaying (cm);
- linear shifting (cm);
- body rotation (°);
- perimeter (cm);
- surface (cm^2).

The test involving 5 athletes aged 20 - 25 is performed in a dark and noise-insulated chamber.

For the purposes of computer processing, the image is scanned and entered in the computer. The evaluation is made with the software products CorelDraw and AutoCad.

Thus, for SPG, the photographic image is "outlined" by a circumference or other best fitting geometric figure (the end points of the image are connected with lines forming a polygon). After that it is possible to calculate the perimeter and surface of this figure.

The procedure is similar for DPG.

RESULTS AND DISCUSSION: The study shows that for SPG the greatest disturbance in statokinetics is observed in the case of one leg crossed on the calf of the standing straight leg. The imbalance is greater in the lateral direction than in the forward-backward direction. The balance is easier in the test with squatting, the imbalance being greater laterally than forward-backward.

Table 1. Results from Romberg's test

Person	GK				JI			
Test	X (mm)	Y (mm)	P (mm)	S (mm^2)	X (mm)	Y (mm)	P (mm)	S (mm^2)
R1	3	4	25.20	37.31	4	4	25.20	37.31
R1	3	2	29.11	51.59	4	4	22.98	33.61
R2	3	2	32.71	70.23	6	4	23.93	35.43
R3	9	7	49.03	115.05	7	5	56.97	171.99

A significant number of the tested persons show a certain greater stability at R1 as compared to the standard R.

With the Unterberger-Fukuda test (DPG) the statokinetics is disturbed in the case where the head is in left and right flexion. What is more, the linear shifting at right flexion is smaller than that at U1 and U. The same could be seen for U3 but here the width of lateral swaying is smaller.

The posture is considered in terms of a balancing function. The latter aims at stabilization of the visual field and keeping the straight position of the body in balance. This is realized by constant forward/backward movement from the center of gravity around the balance point. This movement is called "posture swaying" and is realized via the vestibular-spinal reflexes. The dysfunction of the balancing mechanisms causes the appearance of incorrect reflexes, provoking a feeling of vertigo. Those reflexes are best checked with the discussed tests.

Table 2. Results from Unterberger-Fukuda test

Person Test	Lateral deviation (cm)	Linear shifting (cm)	Angular deviation (°)	P	S
GK					
U	10	55	20	98.53	125.45
U1	10	55	20	353.98	833.43
U2	10	35	15	256.97	171.99
U3	15	30	5	152.85	332.22
JI					
U	10	50	60	97.49	115.42
U1	15	50	15	157.23	360.47
U2	20	35	0	102.14	327.48
U3	10	25	0	214.82	475.39

On the other hand, for the purposes of testing sensor interaction, the visual signals can be eliminated by closing the eyes and, even better, by conducting the test in a dark chamber. The auditory signals are eliminated by noise insulation. These conditions are observed in this case. The proprioceptive signals can be modified by changes in the standing posture (in this case R, R1, R2, R3). The examined person loses contact with the earth while "walking," thus cutting off the impulses from the proprioreceptors. In this way the athlete keeps the balance mainly via impulses received only from both vestibular systems.

The participation of the particular sensor systems in providing the balance is as follows:

- The visual system provides information by tracing and optokinetic mechanisms. The main signal is the retinal skid. Additional information is provided by the proprioreceptors of the eye muscles;
- The vestibular system informs about every change in the position of the head towards the environment. It provides spatial information;
- The proprioreceptor mechanisms give information from the sensor formations in muscles, joints and skin. In this case, the principal role belongs to the cervical and knee-joint proprioreceptors.

For DPG the vestibular signals are modified at the position of the head in left, right or retroflexion (U, U1, U2, U3). This test is among the best ones for assessment of the state of the vestibular-spinal system.

The above-mentioned considerations support the selection of modifications of SPG and DPG.

The obtained results prove the greater sensitivity of certain tests, guaranteeing the more precise selection of a particular group of athletes, and for assessment of the effectiveness of the training process.

Nor should one neglect the fact that posture swaying is affected by:

- Physical conditions - weight force, location of the center of gravity, body mass, etc.;
- Physiological compensatory mechanisms, neuro-muscular reflector mechanisms, etc.
- Psychological components, attention, psychic conditions, emotions, etc.

Nevertheless, it should be considered that the proposed method enables the more precise and objective assessment of the athlete's training at particular stages.

CONCLUSIONS:
1. The test is adequate for screening athletes.
2. It can be used for assessment of the functional state and effectiveness of the training process.
3. The most sensitive tests are R3 and R2 of SPG, and U3 and U2 of DPG.

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