THE INFLUENCE OF HEAD POSITION ON POSTURAL STABILITY

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The influence of head position on the stance stability was studied in a set of 51 healthy university students (men, n = 21; women, n = 30) in a bipedal stance and the stance on left and right leg respectively. The head position was standardised by observation of a fixed point through dominant and nondominant eye. Two AMTI force plates and 3D kinematic analysis (APAS system) were used for the evaluation of posture stability. No significant differences were found in the bipedal stance in all test procedures. The differences in the head positions have statistically and significantly influenced only the posture stability by stance on the left leg in both groups (dominant eye right and left) in contrast to the stance on the right leg where the differences were not statistically significant.

KEY WORDS: postural stability, postural control, head position, eye dominance, 3D videography method, force plates

INTRODUCTION: Maintenance and renewal of stability in static and kinetic motor situations is one of the basic motor tasks in daily and general sport motorics. The quality of posture stability plays a key role in obtaining good results in a variety of sport branches (e.g. shooting, gymnastics, archery etc.). There are very complicated systems influencing the quality of posture and the afferent information, since input information towards control of posture correction vary greatly (Winter, 1990).

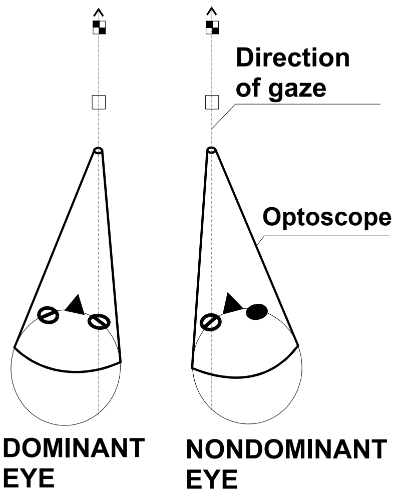
Postural control is dependent on the vestibular, optic and proprioceptive information which initiate the central motor programme (Horak, 1997; Enoka, 1994). The predeterminants in the selection of posture control programme is based only on a part of sensory information rather than the total information from all sensory sources. The eye subsystem is probably the dominant source of information for posture control (Nashner, & McCollum, 1985; Grigg, 1994; Dietz, Horstmann, & Berger, 1989).

The head position is a very significant factor in movement realisation, and for that reason, influences the information received coming from the eye and the vestibular systems. The vestibular system in man is less developed than the eye system and due this reason, maintaining of posture stability during daily motor activity is dominantly provided for all by visual afference (Trew, & Everett, 1997). In comparison with the vestibular sensors, the eye system has a lower threshold of excitability and visual information could be more precise for posture control.

The position of the head is mostly influenced by a unilateral dominance of the eye. The dominant eye determines the natural and most optimal basic position of the head and the strategy for posture control would probably result from this long term adapted movement status. A change in the head position could create a less usual situation – a little stress influencing a set of afferent information (eye, vestibular) for posture control.

It can be expected that the quality of posture stability could be affected by changes in head position.

METHODS: Fifty one healthy university students (average age 22.6 years, 21 men, 30 women) participated in the experiments. Based on the test of eye dominance (Greenman, 1996) the set of participants was divided into two groups (dominant eye right – DER, n = 34; dominant eye left – DEL, n = 17). The mechanical tool named ”optoscope” (see Figure 1) made of paper and adapted to the face was used for standardisation of the head position. An optoscope enables us to watch a defined point through one eye only. The position of the head was standardised in two variants. The first head position was the ”natural” position in which the participants observed the point through the dominant eye (DOE) and in the second position through the nondominant eye (NDE) – dominant eye was blinded (see Figure 1).



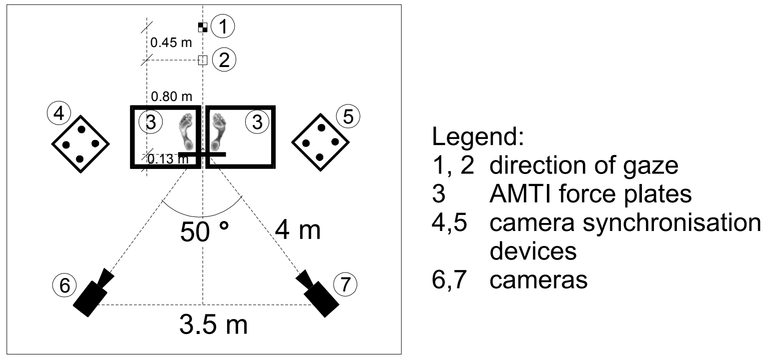


Figure 1 - Standardisation of head changes by using the ”optoscope”.

Figure 2 - Diagram of the experiment.

The quality of posture stability was tested in the bipedal stance, stance on the right, and left leg (Trendelenburg’s test). In all positions, the vertical component of the reaction force was recorded during a 15 sec. stance and the final result computed from the first 5 second stance. The tests for posture stability in all three positions (bipedal, right leg, left leg stance) were conducted in two different head positions: watch the point with the dominant eye (DOE) and nondominant eye (NDE). Two AMTI force plates (sampling 1 kHz) and 3D kinematic analyses (50 Hz) based on the APAS system were used for evaluation of the postural quality. The scheme of the measurement organisation is drawn in Figure 2. Measured variables for the changes in centre of pressure (COP) were derived based on 95% prediction confident ellipse: AREA, SDx, SDy (see Figure 3). Statgraphics 5.0 was used for the statistical elaboration (nonparametric signs test and Mann-Whitney test).

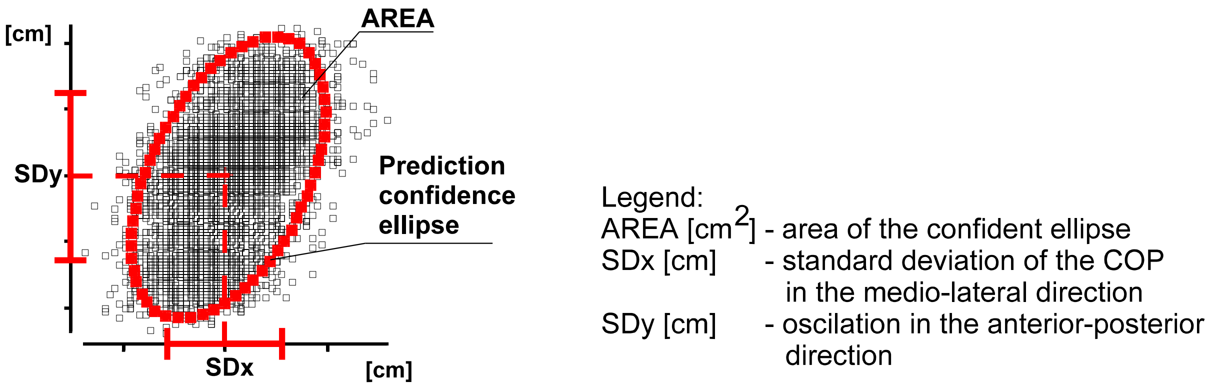


Figure 3 - Evaluation of the posture quality due changes in COP.

RESULTS: The kinematic analysis of head position confirmed different and very stable two variants of the head. The change in head position by gazing at the point with NDE resulted in rotation and tilt to the left in the set of participants with the dominant right eye and similar for the dominant eye left. The statistical analysis of differences in the bipedal stance between postural correction with DOE and NDE has brought nonsignificant differences in all observed cases. The quality of postural stability in one leg stance with DOE and NDE correction has been analysed on the right and left limbs (Table 1).

Table 1 Differences in Postural Stability in Single Limb Stance between DOE and NDE Correction for the Group DER and DEL (Nonparametric Signs Test)

Variable	Measured position	Group DEL p	Group DER p
AREA	Stance on the left leg	0.013*	0.017*
	Stance on the right leg	0.095	0.186
SDy	Stance on the left leg	0.023*	0.024*
	Stance on the right leg	0.225	0.551
SDx	Stance on the left leg	0.017*	0.223
	Stance on the right leg	0.058	0.045*

* $p < 0.05$, ** $p < 0.01$

The significant differences in postural stability by correction with DOE and NDE have been found in the group DEL as well as DER. With stance on the left leg, the postural stability has differed in correction with DOE and NDE for both groups in all measured variables. No differences were elaborated with the right leg stance (except variables SDx – mediolateral perturbations in both groups). Better quality of postural stability was confirmed by stance correction with NDE.

Table 2 Differences in postural stability in single limb stance with DOE and NDE correction between groups DER and DEL (Mann-Whitney test)

Variable	Measured position	DOE correction p	NDE correction p
AREA	Stance on the left leg	0.740	0.019*
	Stance on the right leg	0.486	0.092
SDy	Stance on the left leg	0.947	0.039*
	Stance on the right leg	0.941	0.284
SDx	Stance on the left leg	0.567	0.089
	Stance on the right leg	0.777	0.476

* $p < 0.05$, ** $p < 0.01$

Statistical significant differences between groups with DER and DEL have been found only for stance on the left leg by NDE correction ($p < 0.05$ for AREA, SDy and the SDx is approaching significant level). Higher posture stability was produced in the DEL group during stance on the left leg in comparison with the group DER. Better results in posture stability was confirmed in the group DEL in all measured tests.

DISCUSSION: The results of experiments have brought to light some interesting findings. The differences in the posture stability by the dominant and nondominant eye correction were approved in the stance on the left leg. The hypothesis about low level stability in situation with the correction of posture by nondominant eye has not been confirmed. One possible explanation of this fact results from the principle of initiating voluntary movement (Enoka, 1994; Vele, 1995 and others). The limbic system is the main initiatior of voluntary movement. Nontypical head position (gaze at the point with nondominant eye) could be significant stimulus for an individual which advocates higher level of voluntary control for posture corrections. The other possible explanation is the fact that the test procedures started in the stance on the left leg with the dominant eye correction. It can be considered that the training in the process of testing may be a factor influencing measured results. Another factor affecting the results could be a laterality of lower extremities. It is known that the right leg dominance in general population reaches to about 80-90%. Differences in the quality of postural stability were mostly higher by stance on the left leg in comparison with the stance on the right leg.

CONCLUSION:

The quality of postural stability in bipedal stance has not been influenced in all tested situations.

Changes in head positions due to the dominant and nondominant eye corrections for postural stability were statistically significant with stance on the left leg for both groups (DER and DEL). The higher level of postural stability was found in stance with the correction in nondominant eye.

No differences were found between the groups DER and DEL by correction of stance with the dominant eye. In the stance with correction in the nondominant eye, significant differences were found in stance on the left leg.

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