FACTA UNIVERSITATIS
Series: **Physical Education and Sport** Vol. 3, N° 1, 2005, pp. 59 - 68

Scientific Paper

STANDING STABILITY OF HEMIPARETIC PATIENTS ESTIMATED IN DIFFERENT WAYS

UDC 616.8-009.11:616.88-009.18

Mónika Horváth[1], M. Fazekas[2], Tekla Tihanyi[1], József Tihanyi[1]

[1]Semmelweis University, Faculty of Physical Education and Sport Science
[2]Saint John Hospital, Budapest, Hungary
E-mail: tihany@mail.hupe.hu

Abstract. *The objective of the present study was to investigate the postural stability of hemiplegic patients as opposed to that of healthy subjects and to compare patients with right or left hemispheric lesions. Twenty hemiparetic patients (12 female and 8 male) and nine healthy subjects of the same age (8 females and 2 males) volunteered for the study. The subjects were tested under three conditions. 1. Habitual, quiet standing on both feet for 1 minute, eyes open or closed. The centre of pressure excursion was determined. 2. Measurement of body sway which determines head and shoulder movement as part of the Romberg test. 3. The Fukuda stepping test. The length of the excursion of the centre of pressure for hemiplegic subjects was longer than for the healthy subjects especially in the eyes closed condition. Body sway was significantly greater for patients with right hemisphere lesions. In the Romberg test the hemiparetic patients showed longer anteror-posterior and latero-medial head excursions compared to normal subjects. The patients with right hemisphere lesions displayed greater values than the patients with a right hemiparesis except for the neck tilt. In the Fukuda stepping test the forward, lateral and angle deviation, and rotation on the vertical axis were significantly greater for hemiparetic subjects. The left side paretic patients showed greater forward deviation, but significantly less rotation on the vertical axis. We concluded that the visual input plays a more significant role for hemiparetic patients than for healthy people. Right hemisphere lesions, compared to those of the left hemisphere, worsen standing stability. It seems that the vestibular area in the central nervous system was damaged in most of the patients studied because the side on which the hemisphere lesion was located had a greater influence on body rotation and lateral deviation than the side dominance.*

Key words: *hemiplegia, body sway, stepping test*

Received May 3, 2005

1. INTRODUCTION

The ability to maintain postural control is a critical factor for performing routine everyday activities. Numerous devices and measuring methods have been invented to help determine body sway during quiet standing, which indicate standing stability or balance ability. Such methods, known as stabilometry or posturography, record the excursion of centre mass (COM) or centre of pressure (COP). There is a significant relationship between COM and COP movement (Winter et al., 1998; Gatev et al., 1999). Since proprioceptive input from the neck muscle is an important factor in controlling posture and locomotion (Cohen, 1961; Gdowski and McCrea, 2000; Kogler et al., 2000; Schieppati, 2003) head movement and the head-shoulder angle (yaw) are often studied during quiet standing or using the stepping in place test (Fukuda, 1959; Bonanni and Newton, 1998).

Although stable control of posture and balance is automatic for healthy subjects, it is a challenging goal for hemiparetic patients due to loss of strength or joint motion limitation, and sensory organization disturbances. After a stroke, the recovery of balance is considered to be crucial for achieving autonomy in everyday activities. One of the most dangerous consequences of hemiparesis is balance loss when standing and waking, which may ultimately results in falls (Sackley, 1991) which can be fatal. The balance disorders of hemiparetic patients have, therefore, frequently been studied under different conditions (Bohannon and Larlin, 1985; Dickstein et al., 1984; Shumway-Cook et al., 1988; Mizrahi et al., 1989a, 1989b; Ring and Mizrahi, 1992; Dettman et al., 1987; Schimway et al., 1988).

In most of the studies researchers reported increased body sway during quiet standing for hemiparetic patients after a stroke compared to people without central nervous system disorders (Mizrahi et al., 1989a, 1989b; Ring and Mizrahi, 1992; Dettman et al., 1987; Schimway et al., 1988; Bonan et al., 2004). The weight bearing capacity was found to be asymmetric (Dickstein, 1984; Bohannon, 1985; Sackley, 1990; Sackley, 1991). Pai et al. (1994) reported a greater COP excursion at the paretic side.

Several reports indicated a trend toward postural imbalance among patients with right hemisphere lesions (Bonan et al., 2004; Hesse et al., 1994; Rode et al., 1997). Rode et al. (1997) reported a greater COP movement area for patients with a right hemiparesis and a COP excursion dominance on the side of the affected leg compared to those of the subjects with left hemisphere lesions. Proprioceptive input from the neck muscles plays an important role in the definition of the reference system for the control of posture and locomotion. In humans, neck afferent input plays a significant role in the control of posture (Brandt, 1996). DiFabio and Anderson (1993) reported a neural connection between ankle and head movement. Namely, a sudden instability beneath the foot leads to the ankle's reaction to adapt to the altered situation. This is followed by a head movement independent of visual control. Sakaguchi et al. (1995) found a significant correlation between the movement of the centre of pressure and head excursion in a healthy population. Muscle spasms and weakness in the affected side of hemiparetic people leads to the assumption that head movement and the neck tilt (yaw) would be greater for them compared to normal subjects.

It is known that healthy subjects stepping in place with eyes closed walk forward and deviate toward the non-dominant side whilst spinning around their longitudinal axis. In most of the cases researchers found that right handed people drift left and rotate to the left around their longitudinal axis, too (Nonanni and Newton, 1998). It is believed that this phenomenon can be attributed to lower limb strength and coordination of the non-dominant leg. The greater body sway of the hemiparetic patients and the shift of the centre of pressure toward the unaffected leg during a quiet stance, can lead to the assumption that hemiparetic patients would deviate toward the effected leg in stepping test (Fukuda test). Also, we can expect that the displacement angle would be greater for hemiparetic patients than for healthy people depending upon the dominant /non-dominant and affected and unaffected side variations.

Therefore the aim of the present study was to compare the balance ability of paretic and healthy people of the same age, tested in three different experimental conditions, as well as the relationship between the selected variables.

2. METHODS

Subjects. Twenty female (n=12) and male (n=8) hemiparetic subjects were recruited for the purpose of this study (age: 65.0 ± 14.2 years), selected at random from a sample of 86 patients. Also, ten healthy female (n= 8) and male (n=2) subjects (age: 56.2±3.4 years) volunteered for the study, serving as a control group. The recruited subjects were informed of the purpose of the study in written form. The subjects voluntarily participated and signed a consent form approved by the Regional Ethics Committee of St. John Hospital, Budapest (3988/2003). The patients have suffered from right (n=11) and left (n=9) residual hemiparesis for 2, 3 years in average.

The procedure.

Experimental condition 1. Body sway was measured using a force platform (PDM Multifunction Force Measuring Plate). The subjects stood comfortably on the platform, barefoot, in a quiet stance position. The distance between their parallel feet was approximately 20 cm. First, the subjects were tested with their eyes open and then with them closed. The duration of the measurement was 60 s. During the quiet stance the total centre of pressure excursion (COP) was recorded.

Experimental condition 2. For measurement of body sway an ultrasound-based device (the Zebris, CMS20S Measuring System) was used. To detect head movement, a helmet with two miniature transmitters was placed on the subject's head. One of the markers was fixed on the top of the helmet and the other was attached at the level of the first cervical vertebra. Another two transmitters were attached to the shoulders, allowing for the calculation of the neck tilt in relation to the head (yaw). Three ultrasound receivers (microphones) arranged in triangle form in the same plane were situated 0.5 meters from the subject. The receiver's plane had a tilt angle of 80 degrees in relation to the horizontal plane. The measuring procedure is based on the measurement of the travel time of ultrasonic pulses that are emitted by miniature transmitters (markers) to the three microphones built into the compact device.

Two tests (Romberg and Fukuda or Unterberger test) were carried out in this experimental situation. During the Romberg test the blindfolded subjects stood in a Romberg position with their back to the receiver. The subjects had to stand in quiet stance during the one minute measurement. Head excursion was recorded in the latero-medial (LM) and anterior-posterior (AP) direction. The head movement area (HA) was also determined. The area contained 95 percent of the total head movement. The neck tilt angle was estimated using two straight lines connecting the two head markers or the shoulder transmitters, respectively.

Experimental condition 3. In the Fukuda Stepping test (FST) subjects marched in place with arms outstretched and at their own preferred pace for one minute while blindfolded in an evenly lighted, quiet room. Four measures were taken: (1) displacement from origin (cm) or forward movement, (2) angle of displacement (degrees), (3) lateral displacement (cm) or lateral deviation and (4) angle of rotation on their vertical axis (degrees) or self spin (Figure 1). Before the actual testing, the subjects were familiarized with the procedure. Each subject was tested twice.

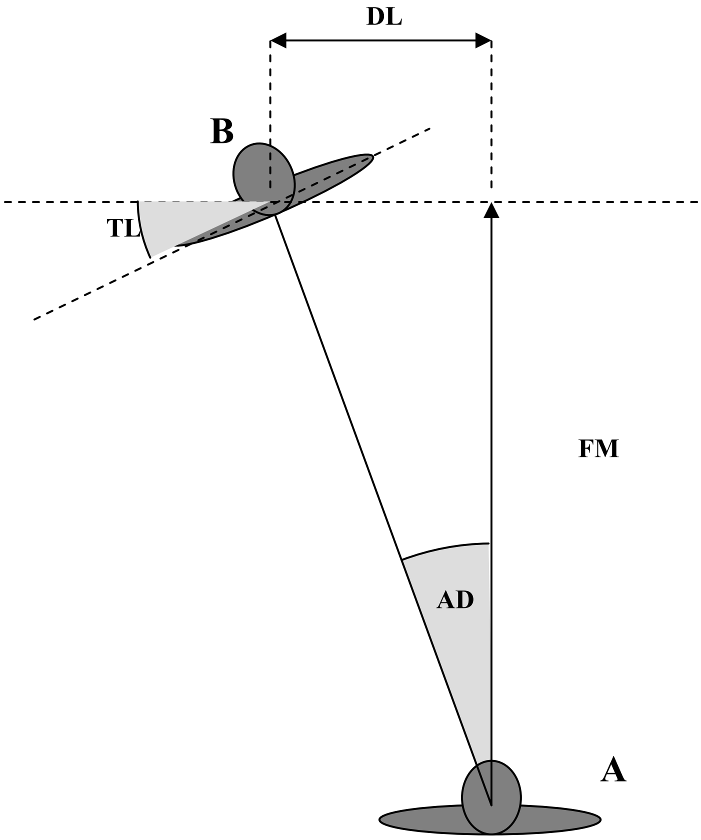

Fig. 1. Variables determined during Unterberger test. "A" and "B" indicate the initial and end position of the subject, respectively. FM - length of the forward motion, LD - lateral deviation from the straight line, AD - angle deviation and TL – rotation on the longitudinal axis

Statistical analysis

All values are expressed as means (SD). The statistical significance of the differences between the hemiparetic and healthy group, and the groups with right or left hemispheric lesions were evaluated by the variance analysis (ANOVA) and the unpaired t-test. The Pearson product-moment correlation was applied to reveal a significant relationship between the selected variables. The level of statistical significance was set at P <0.05.

3. Results

Excursion of centre of pressure. The total length of the excursion (TLE) was significantly longer for paretic subjects compared to healthy subjects in both the eyes open and closed conditions. No significant difference was, however, found between the eyes open and closed conditions in the case of healthy subjects. The paretic patients displayed greater body sway in the eyes closed than in the eyes open condition. Patients with both left and right hemiparesis displayed a longer TLE when tested in the eyes closed condition than in the eyes open condition. The means of the TLE was almost identical for both groups when tested in the eyes closed condition. In contrast, patients with right hemisphere lesions (left side paretic, LSP) had a significantly longer TLE than patients with left hemisphere lesions (RSP) tested in the eyes open condition (Table 1).

Table 1. Means and SD of total length of COP excursion (TLE) in centimetres for healthy (HS), paretic (PS), right (RSP) and left side paretic subjects (LSP). Asterisks indicate significant difference between HS and PS, or RPS and LPS groups. Crosses indicate significant difference between eyes closed and open conditions within groups.

	HS	PS	RSP	LSP
Eyes open	77.50 ± 15.45	96.85∗ ± 20.54	91.10 ± 21.08	104.05∗ ± 17.34
Eyes closed	81.62 ± 25.59	126.23∗†± 38.44	127.54† ± 40.01	124.49† ± 36.12

The mean of the AE for hemiparetic patients and for healthy subjects differed significantly in both eyes closed or open conditions. The healthy subjects showed no significant difference in AE when being tested in the eyes closed and eyes open conditions, but the AE for the patients increased significantly in the eyes closed condition. When comparing LSP and RSP groups, the LSP patients demonstrated a significantly larger AE (Table 2).

Table 2. Means and SD of the area (cm^2) of an ellipsis containing 95 % of COP excursion (AE) for healthy (HS), paretic (PS), right (RSP) and left side paretic subjects (LSP). Asterisks indicate significant difference between HS and PS, or RPS and LPS groups. Crosses indicate significant difference between eyes closed and open conditions within groups.

	HS	PS	RSP	LSP
Eyes open	4.74 ± 2.22	6.95∗ ± 4.57	6.04 ± 2.8	8.08∗ ± 6.9
Eyes closed	6.41 ± 2.77	17.87† ± 14.33	13.24† ± 6.11	23.64†∗ ± 18.4

Head and shoulder excursion during the Romberg test. The mean of the excursion of the head represented, by the area in which the head moved, was significantly greater for paretic people than for the healthy subjects. Also, the body sway was considerably greater for paretic patients than for the healthy subjects in both the A-P and M-L directions. The left side paretic people showed a greater head excursion area and neck tilt than the patients belonging to group patients with right hemiparesis (Table 3).

Table 3. Romberg test variables

	HS	PS	RSP	LSP
A – P (cm)	4.26 ± 1.01	6.06 ± 2.56*	4.8 ± 1.17	7.6 ± 2.93*
M – L (cm)	2.63 ± 0.83	4.10 ± 2.38*	3.13 ± 1.33	5.27 ± 2.82*
HA (cm^2)	10.58 ± 3.92	23.12 ± 16.01*	15.67 ± 8.9	32.23 ± 17.9*
NT (degr)	9.19 ± 7.02	14.43 ± 7.14*	15.49 ± 9.03	13.15 ± 3.24*

Legend: Means and SD of body sway in anterior-posterior direction (A - P), in medial-lateral direction (M - L), head excursion area (HA) and neck tilt (NT) for healthy (HS), paretic (PS), right (RSP) and left side paretic subjects (LSP). Asterisks indicate significant difference between HS and PS, or RPS and LPS groups

Fukuda (Unterberger) test. During the test both healthy and paretic subjects moved forward and rotated on their longitudinal axis. There was no significant difference between the groups in regards to these variables. The lateral deviation was significantly greater for the paretic group compared to the group of healthy subjects. Nine of the eleven right sided paretic subjects deviated towards the right side whilst seven of the nine left side paretic subjects deviated towards the left side. In regards to the healthy subjects, all the right handed subjects deviated and turned to the left. One of the left handed healthy subjects deviated and turned to the right and the other deviated slightly to the left.

Table4. Result of the Fukuda (Unterberger) test

	HS	PS	RSP	LSP
FM (cm)	61.9 ± 23.1*	77.1 ± 46.9	73.6 ± 45.3*	81.5 ± 48.3
LD (cm)	10.3 ± 2.8*	16.4 ± 5.1	16.2 ± 5.8	16.5 ± 4.2
AD (degrees)	18.0 ± 12.6*	27.7 ± 16.6	25.5 ± 15.0	30.3 ± 18.1
TL (degrees)	27.9 ± 18.8*	32.7 ± 29.1	39.1 ± 34.9*	24.9 ± 16.9

Legend: Means and SD of length of the forward motion (FM), lateral deviation (LD) from the straight line, angle deviation (AD) and turning around the longitudinal axes (TL). Asterisks indicate significant difference between HS and PS, or RPS and LPS groups

Relationship between the variables. There was a significant relationship found between the area of head excursion and the area of centre of pressure in both left and right-sided paretic groups in both the eyes open or closed conditions. In the left sided paretic group the length of the COP excursion showed a significant correlation with the area of head movement. The medio-lateral movement of the head and the COP had a significant relationship in the left sided paretic group during either the eyes open or eyes closed conditions, but no significant relationship was found between variables related to the right sided paretic group. The variables of head and COP movement did not relate to each other.

4. DISCUSSION

It is known that humans use three basic mechanisms to obtain a sense of balance in daily life. The three mechanisms (visual, vestibular, and proprioceptive) interact to maintain posture and impart a conscious sense of orientation. There are measurable reflexes associated with these stimulus modalities. Reflexes generally serve to maintain stability in posture, or in maintaining stability in the visual field. A defect in one of these systems, or incongruous inputs amongst the systems can be compensated for by reliance on the other two systems. Visual inputs aid in the maintenance of an upright posture and in orientation. Conscious and unconscious correction of posture is possible through processing visual inputs.

The vestibular system can affect posture via vestibulospinal pathways. These pathways, in conjunction with visual-postural and proprioceptive-postural pathways, serve to maintain the patient's center of gravity which is the base of support. For instance a quick head tilt to the right causes the extension of the right sided leg extensors to counteract a change in the perceived center of gravity. A perceived forward motion causes a sway forward to maintain the support base.

Proprioceptive inputs aid in static and dynamic postural control primarily through two reflex arcs. The first is the myototic reflex, where a stretch in a muscle causes the contraction of the muscle. The myototic reflex serves to maintain stability across a joint. The second proprioceptive reflex arc that aids in posture control is the functional stretch response, which utilizes multiple somatosensory inputs to provide for coordinated limb and trunk movements across joints. Both of these reflex arcs have lower latencies than visual-postural reflexes and vestibular-postural reflexes.

It is assumed, however not yet proven entirely, that the three factors interact and commonly control postural sway in quiet standing. Loss of one of these factors or its perturbation increases body sway, namely, the movement of the center of gravity or center of pressure which was measured in our test. Our study proved that stroke disturbed proprioceptive reflexes are indicated by the significantly greater total COP excursion in the eyes open condition. In fact, for the hemiparetic patients, the COP excursion was 25 % longer than for the healthy subjects. When the visual system feedback mechanism was switched off the difference between paretic and healthy subjects in regards to body sway was more pronounced (54.6 %), indicating that the interaction between visual and proprioceptive inputs plays a more significant role in generating balance corrections for stroke victims than for healthy subjects. Our result is in accordance with the recent study of Corriveau et al. (2004) who reported an increased COP amplitude in the eyes closed condition for elderly stroke victims. However, not only proprioceptive impairment, but the possible impairment of vestibular function due to stroke can be connected to postural instability of hemiparetic patients.

Several studies (Fridberg et al., 1970; Coles et al., 1985; Faugier-Grimaud and Vntre, 1989) have supported the existence of cortical control of vestibular functions in animals and humans. The inability to use vestibular input because of lesions involving the vestibular cortex has been observed, (Miyai et al., 1997) and the effect of vestibular stimulation on postural control in patients with hemiparesis was shown to reduce postural asymmetry (Rode et al., 1998).

We found significant differences between the LSP and RSP groups in the total length of body sway during the eyes open condition. The right hemisphere lesions resulted in greater body sway and a larger excursion of the COP than those of the left hemisphere lesions. However, the two groups have not shown significant difference in the eyes closed condition. This result can be explained as follows. General damage to the sensory cortex is referred to as agnosia. Agnosia can affect any sensory modality including vision, touch, sound, taste and proprioception. Damage to the right parietal lobe may cause a disorder called contralateral neglect in which the person is unaware of the opposite side of the body and unaware of objects in the left half of the visual field. In other words, it seems that parietal lobe damage in the right hemisphere may disturb the normally well-coordinated interaction between visual and proprioceptive in-, and output, resulting in a longer COP excursion associated with a larger area of COP movement. Namely, the COP movement amplitude increased significantly, which supports our hypothesis. This result is supported by the report of Rode et al. (1997).

Characterising postural stability by means of head movement, we found similar results to those of the COP movement test. The anterior-posterior and lateral movements of the head were significantly longer for patients than for healthy subjects, but the difference in head excursion was considerably greater than the COP excursion. The movement amplitude was 2.2 times greater in the hemiparetic group than in the control group, indicating that there is a neural mechanism linking ankle somatosensory input and head control (Di Fabio and Anderson, 1993). The left sided paretic patients displayed a significantly longer anterior-posterior, lateral head excursion and head movement area. This result is in accordance with the findings related to COP movement and support the theory described above. The hemiparetic subjects in this study displayed significantly greater neck tilt than the healthy subjects, which is in accordance with the finding of Sakaguchi et al. (1995). The neck tilt was less in the case of the LSP subjects than for the RSP subjects, which may explain the smaller rotation for this group around the longitudinal axis in Fukuda test. The significant relationship between the COP and head excursion indicates that both influence the postural stability of healthy subjects and patients with central nervous system dysfunction.

Although the Fukuda stepping test is commonly used to assess individuals with peripheral vestibular dysfunction or balance instability, there are few studies published dealing with hemiparetic patients. The reason for this fact can be found in that opinion that the amount of rotation and direction deviation in the Fukuda stepping test is a poor indicator of the side of the lesion. This standpoint can be accepted if side dominance is not to be taken into consideration. In the present study the hypothesis was that lesion location and side dominance commonly determine the amount of rotation and the direction of the forward and lateral deviation. Indeed, the healthy subjects produced significantly lower values than the hemiparetic subjects. The greatest difference was found in angle deviation (AD), which was 1.4 times greater for the PS group on average. This result may indicate that stability of stance is influenced not only by weaker proprioception and reduced strength of the muscles on the paretic side. Namely, it is very probable that the lesion in the given hemisphere includes the centre of the vestibular system, too. One can expect that one of the reasons for greater lateral and angle deviation in the case of the PS subjects can be attributed to the coincidence of side dominance and lesion location. However, we found that seven of the right side dominant patients with left hemisphere lesions deviated and turned slightly to the right. This configuration decreased the deviation which could be attributed to the lesion side. There were seven paretic subjects with right side dominance and right hemisphere lesions who deviated and turned considerably to the left, due to the overall sum of the influencing factors. Similarly we found pronounced lateral and angle deviation for two left handed subjects with right hemisphere lesions. These nine subjects displayed much greater deviation than those having no coincidence of side dominance and lesion side effect.

The means for the RSP and LSP group did not show great difference in the measured variables. The difference between the two groups in lateral deviation was negligible. Although the LSP subjects had 18.9 percent greater angular deviation than the RSP subjects, the difference is not statistically significant. The means of forward deviation and rotation on the longitudinal axis differed significantly, but interestingly the amount of rotation was less in the case of the LSP people. This result can be explained by a smaller neck tilt angle which was observed in the case of the LPS group during the Romberg test. It seems that the neck reflex plays a more significant role in postural stability in this respect than the hemisphere where the lesion is located.

5. Conclusion

We concluded that visual input plays a more significant role for hemiparetic patients than for healthy people. A right hemisphere lesion worsens standing stability to a greater extent than a left hemisphere lesion. It seems that the vestibular area in the central nervous system was damaged in most of the patients studied because the hemisphere where the lesion was located had a greater influence on body rotation and lateral deviation than side dominance.

References

1. Bohannon, R.W., & Larlin, P.A. (1985). Lower extremity weight bearing under various standing conditions in independently ambulatory patients with hemiparesis. *Phys. Ther.,* 65, 1323-5.
2. Bonan, I.V., Colle, F.M., Guichard, J.P., Vicaut Eisenfisz, M., Tran Ba Huy, P., Yelnik, A.P. (2004). Reliance on visual information after stroke. Part I: Balance on dynamic posturography. *Arch. Phys. Med. Rehabil.,* 85, 268-73.
3. Bonanni, M., & Newton, R. (1998). Test–retest reliability of the Fukuda Stepping Test. *Physiother. Res. Int.,* 3, 58–68.
4. Brandt, T. (1996). Cervical vertigo—reality or fiction? (Review). *Audiol. Neurootol.,* 1, 187–96.
5. Cohen, L.A. (1961). Role of eye and neck proprioceptive mechanisms in body orientationand motor coordination. *J. Neurophysiol.,* 24, 1–11.
6. Coles, M.G., Gratton, G., Bashore, T.R., Eriksen, C.W., & Donchin, E. (1985). A psychophysiological investigation of the continuous flow model of human processing. *J. Exp. Psychol.,* 11, 529-53.
7. Corriveau, H., Hebert, R., Raiche, M., & Prince, F. (2004). Evaluation of postural stability in the elderly with stroke. *Arch. Phy.s Med. Rehabil.,* 85(7), 1095-101.
8. Dickstein, R., Nissan, M., Pillar, T., & Sheer, D. (1984). Foot-ground pressure pattern of standing hemiplegic patients: major characteristics and patterns of improvement. *Phys. Ther.,* 64, 19-23.
9. DiFabio, R.P., & Badke, M.B. (1990). Extraneous movement associated with postural sway during dynamic goal-directed weight redistribution. *Arch. Phys. Med. Rehabil.,* 71, 365-71.
10. DiFabio, R.P., & Anderson, J.H. (1993). Effect of sway-referenced visual and somatosensory inputs on human head movement and postural patterns during stance. *J. Vestib. Res.*, 3(4), 409-17.
11. Faugier-Grimaud, S., & Ventre, J. (1989). Anatomic connections of inferior parietal cortex (area 7) with subcortical structures related to vestibule-ocular function in a monkey. *J. Comp. Neurol.,* 280, 1-14.
12. Fridberg, L., Olsen, T.S., Roland, P.E., Paulson, O.B., & Lassen, N.A. (1970). Focal increase of blood flow in the cerebral cortex of man during vestibular stimulation. *Brain*., 93, 313
13. Fukuda, T. (1959). The stepping test. Two phases of the labyrinthine reflex. *Acta Otolaryngol.,* 50, 95–108.

14. Gatev, P., Thomas, S., Kepple, T., & Hallett, M. (1999). Feedforward ankle strategy of balance during quiet stance in adults. *J Physiol.*, 514, 915-928.
15. Gdowski, G.T., & McCrea, R.A. (2000). Neck proprioceptive inputs to primate vestibular nucleus neurons. *Exp. Brain. Res.*, 135, 511–26.
16. Hesse, S., Schauer, M., Melzic, M., Jahnke, M., & Mauritz, K. (1994.) Quantitative analysis of rising from a chair in healthy and hemiparetic subjects. *Scand. J. Rehabil. Med.*, 26, 1-6.
17. Kogler, A., Lindfors, J., Odkvist, L.M., & Ledin, T. (2000). Postural stability using different neck positions in normal subjects and patients with neck trauma. *Acta Otolaryngol.,* 120, 151–5.
18. Miyai, I., Mauricio, R.L., & Reding, M.J. (1997). Parietal-insular strokes are associated with impaired standing balance as assessed by computerized dynamic posturography. *J. Neurol. Rehabil.,* 11, 35-40.
19. Rode, G., Tiliket, C., & Boisson, D. (1997). Predominance of postural imbalance in left hemiparetic patients. *Scand. J. Rehabil. Med.,* 29, 11-6.
20. Rode, G., Tiliket, C., Harlopain, P., & Boisson, D. (1998). Postural asymmetry reduction by vestibular caloric stimulation in left hemiparetic patients. *Scand. J. Rehabil. Med.*, 30, 9-14.
21. Sackley, C.M.. (1991). Falls, sway and symmetry of weight bearing after stroke. *Int. Disabil. Stud.,* 13, 1-4.
22. Schieppati, M., Nardone, A., & Schmid, M. (2003). Neck muscle fatigue affects postural control in man. *Neuroscience*, 121, 277–85.
23. Shumway-Cook, A., Anson, D., & Haller, S. (1988). Postural sway biofeedback: its effect on reestablishing stance stability in hemiplegic patients. *Arch. Phys. Med. Rehabil.,* 69, 395-400.
24. Winter, D.A, Patla, A.E., Prince, F., Ishac, M., & Gielo-Perczak, K. (1998). Stiffness control of balance in quiet standing. *J. Neurophysiol.*, 80, 1211-1221.

TELESNA STABILNOST HEMIPARETIČNIH PACIJENATA SA RAZLIČITIM PROCENAMA

Mónika Horváth, M. Fazekas, Tekla Tihanyi, József Tihanyi

Cilj ove studije je bio da se ispita posturalna stabilnost hemiplegičnih pacijenata u odnosu na zdrave osobe kao i uporedjenje stanja pacijenata sa lezijom leve ili desne hemisfere. Uzorak je činilo 20 hemiparetičnih pacijenata (12 žena i 8 muškaraca) i 10 zdravih osoba iste starosne dobi (osam žena i dva muškarca). Ispitanici su testirani na tri različita načina. 1. Uobičajeno, mirno stajanje na obe noge u roku od jedne minute sa otvorenim ili zatvorenim očima. Tako se odredjivao centar pritiska. 2. Merio se otklon tela odnosno kretanje glave i ramena putem Rombergovog testa. 3. Radjen je Fukuda steping test. Dužina izmeštanja centra pritiska kod hemiplegičnih pacijenata je bila veća u odnosu na zdrave osobe naročito kada su im oči bile zatvorene. Otklon tela je bio značajno veći kod pacijenata sa lezijom desne hemisfere. Kada je radjen Rombergov test hemiparetični pacijenti su pokazali duže anteriorno-posteriorno i lateralno-medijalno okretanje glave u poredjenju sa zdravim ispitanicima. Pacijenti sa lezijom desne hemisfere su pokazali veće vrednosti u odnosu na paretične pacijente na desnoj strani tela, osim dužine okreta vrata.

Prilikom primene Fukuda steping testa lateralna, ugaona i devijacija unapred kao i rotacija oko vertikalne ose su bile znatno veće kod hemipareticnih ispitanika. Pacijenti sa parezom na levoj strani su pokazali vežu devijaciju u kretanju napred ali su zato imali značajno manju rotaciju oko vertikalne ose. Mi smo, stoga zaključili da vizuelni input ima mnogo veću ulogu kod hemiparetičnih pacijenata nego li kod zdravih osoba. Lezija desne hemisfere u mnogome pogoršava telesnu stabilnost pacijenata nego li kada je u pitanju lezija leve hemisfere. Čini se da je vestibularna oblast u centralnom nervnom sistemu bila oštećena kod većine ispitanih pacijenata zato što je strana lezije hemisfere imala veći uticaj na rotaciju tela i lateralnu devijaciju nego li dominantnost strane oštećenja.

Ključne reči: *hemiplegija, otklon tela, steping test*