THE EFFECT OF MOVING VISUAL SCENE ON POSTURE STABILITY IN THE ELDERLY AND SUBJECTS WITH MILD COGNITIVE IMPAIRMENT.

Martin Kucharik[1], Kosutzka Zuzana[2], Marian Šaling [2]

[1] Department of behavioural neuroscience, Slovak Academy of Sciences.
[2] 2nd Neurological Departments, Faculty of Medicine, Comenius University in Bratislava, Slovakia

ABSTRACT

The ability to maintain balance in upright stance is gradually worsening with aging and even more obvious it is associated with dementia. The reasons of disequilibrium are not fully understood. The purpose of our study was to investigate posture stability of elderly and patients with mild cognitive impairment (MCI) to a moving visual scene. Visual scene moved in frontal (towards or from a subject) or sagittal plane (rotation to right or left). Postural responses were recorded by posturography. Measurement consists from 10 s quiet standing, followed by dynamic visual stimulation for 20 s and post stimulation period for 20 s. Total path of center of pressure (COP), mean sway velocity and mean sway amplitude were analyzed separately for every measured period. Results showed that patients with MCI were less stable than healthy elderly subjects, when experiencing a moving visual scene. The difference between patients and elderly subjects were even greater after visual stimulation. The patient posture balance did not reach the same level than before stimulation. Total path of COP and sway velocity mostly reflect balance differences between groups. The findings showed that posture stability in patients was more influenced by dynamic visual scene than in the elderly. Patients with MCI appear to have problem with solving sensory conflict. They are less capable to re-weighting sensory information and have to exert more effort to keep balance of upright posture.

METHODS

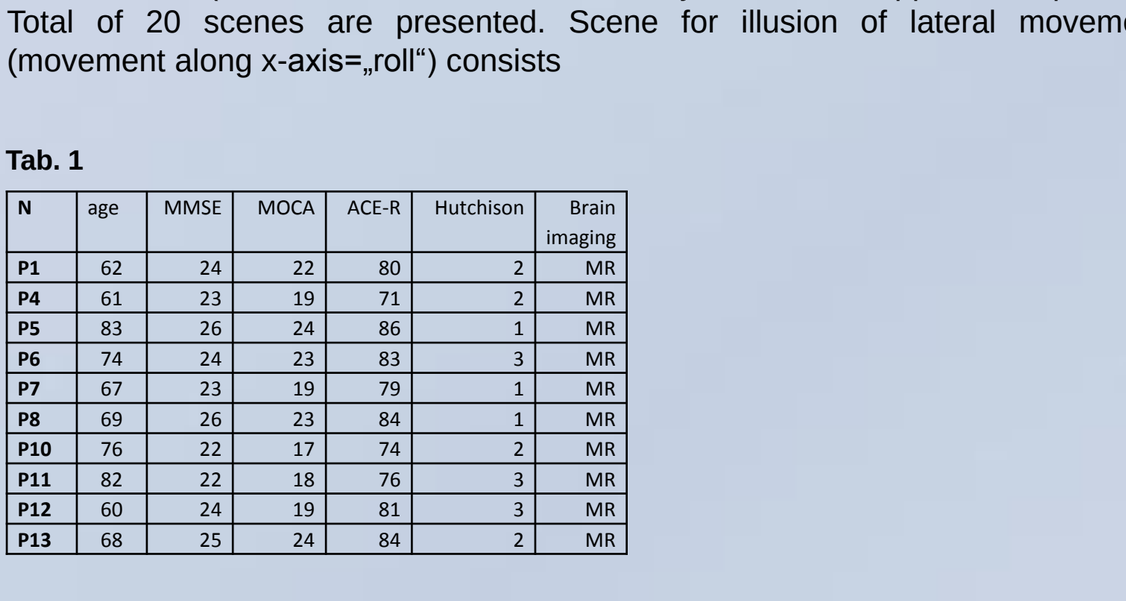
10 persons with MCI were enrolled to study group (5 male, 5 female), average age was 74,2 years (SD=7,2). Study group subjects underwent clinical neurologic examination, brain imaging (contrast CT or MRI), cognitive testing (see **Tab. 1**). Control group consisted of 10 elderly (8 male, 2 female) without known somatic or psychiatric morbidities. Their average age was 72,2 years (SD=4,2). Each participant underwent the same measurement protocol, which consists of measurements of responses to scenes in 4 directions (right and left, from and toward subject). Measured subject stands barefoot on force platform, in front of the projection screen. Distance between eyes and screen is set to 0,75 m (see **Fig. 1A**). Single measurement has duration of 50 s. It consists of 10s pre-stimulus period (static scene), followed by 20 s stimulation period (moving scene) and 20 s 20 s post-stimulus period (static scene). Each scene is presented 5 times in random order (directions of scenes are randomly shuffled to suppress adaptation). Total of 20 scenes are presented. Scene for illusion of lateral movement (movement along x-axis=„roll“) consists

Tab. 1

N	age	MMSE	MOCA	ACE-R	Hutchison	Brain imaging
P1	62	24	22	80	2	MR
P4	61	23	19	71	2	MR
P5	83	26	24	86	1	MR
P6	74	24	23	83	3	MR
P7	67	23	19	79	1	MR
P8	69	26	23	84	1	MR
P10	76	22	17	74	2	MR
P11	82	22	18	76	3	MR
P12	60	24	19	81	3	MR
P13	68	25	24	84	2	MR

of checkered board which rotates around axis aligned with the approximate center of body mass of measured subject (see **Fig. 1B**). Checkered pattern of surfaces was chosen to eliminate “cuing” of vision on any solid object in the visual field. For illusion of forward and backward motion (along y-axis) we chose scene with transition of endless tube (see **Fig.1C**)

Fig .1



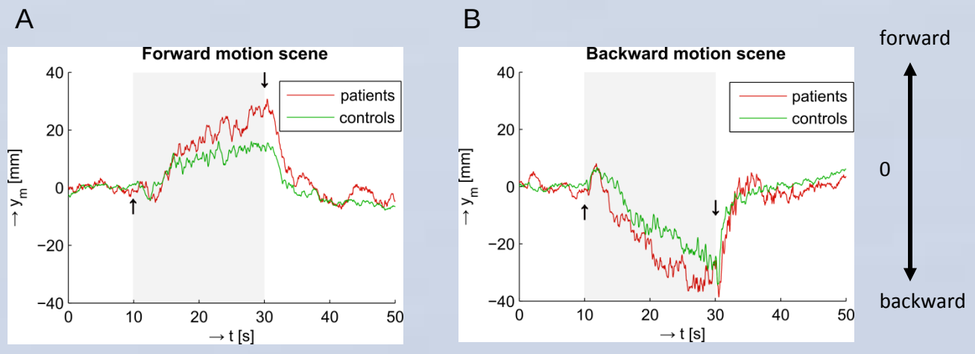
Measured CoP positions were used to calculate total path of CoP sway velocities and for calculation (see references 1 , 2). Each of 5 time periods (10 s pre-stimulus, 20 s stimulus and 20 s post-stimulus) were analyzed separately.

Statistical analysis
Measured data were checked for normal distribution (Shapiro-Wilk test). However, normal distribution was confirmed only in control group. Therefore non-parametrical statistical methods were used (Mann-Whitney U test). Values were compared between groups (95% CI, p-value=0,05). Statistical significance is stated in **Tab. 1** for total path of COP, **Tab. 2** for sway velocities.

RESULTS

Visual stimulation towards person induced body sway backwards. Opposite stimulation (from person) induced body sway in forward direction **Fig. 2A,B**. These responses had same direction in both patients and control group. Visual stimulation in lateral direction to the left induced body movement towards right, and in similar way stimulation to the right side evoked body movement towards left .

Fig.2



During **stimulus** period, both groups produced larger total sway path of COP, than in pre-stimulus period. However, there was significant difference between groups only for visual moving scene from subject (details in **Tab. 2**). During post-stimulus period, patient group retained larger total sway path of COP than control group in frontal and sagital axis except for situation, when scene was moving towards subject (see **Tab. 2**). After analysis of total path, which showed significant differences between groups, we analyzed sway velocities and amplitudes separately in AP and ML direction. During pre-stimulus period, there were no significant differences between groups in

Tab. 2

			Total Path of COP (mm)			
		Visual scene movement direction	left	right	from	towards
stimulus	study group	AVG (SD)	874,6 (529,5)	726,6 (333,5)	703,8 (302,9)	836,9 (425,5)
	control group	AVG (SD)	551,0 (237,9)	455,0 (118,5)	428,2 (205,5)	684,0 (378,5)
		p-value	p=0,243	p=0,123	**p=0,043**	P=0.352
post-stimulus	study group	AVG (SD)	559,1 (260,8)	532,9 (245,1)	547,5 (286,5)	798,7 (642,3)
	control group	AVG (SD)	292,3 (79,7)	274,9 (47,0)	277,0 (62,7)	406,1 (151,1)
		p-value	**p=0,003**	**p=0,001**	**p=0.002**	**p=0.113**

any direction . In **Tab. 2** we stated group averages, SD and p-values for velocities in medio-lateral axis – that means that stimulation was performed in medio-lateral axis (separately for left and right direction of scene). Similarly, average velocities, SD and p-values are stated for antero-posterior axis (for scene direction from and towards person). During stimulation period, we did not find significant differences in medio-lateral axis of stimulation and also for moving visual scene from and towards subject. (see details **Tab. 3**). We observed most pronounced differences of sway velocities in post-stimulation phase. When subjects were exposed to scene in ML direction, we observed significantly higher sway velocities in study group than in control group In similar manner, we observed higher

Tab. 3

Sway velocities			velocity in x-axis (medio-lateral)		velocity in y-axis (antero-posterior)	
		Scene direction	left	right	forward	Backward
stimulus	study group	AVG (SD)	49,7 (36,1)	39,6 (20,43)	51,5 (18,7)	68,9 (41,9)
	control group	AVG (SD)	29,4 (13,3)	21,8 (3,62)	41,1 (21,1)	60,6 (37,9)
		p-value	0,243	0,063	0,143	0,579
post-stimulus	study group	AVG (SD)	27,7 (13,7)	26,5 (11,6)	36.4 (13,1)	58.1 (53,9)
	control group	AVG (SD)	14,3 (3,24)	13.2 (1,97)	21.6 (6,66)	33,1 (14,8)
		p-value	**0,035**	**0,000**	**0,003**	**0,143**

sway velocities in AP axis after stimulation in AP direction (after forward scene p=0,003) but not in backward scene (p=0,143). The duration of stimulation post effect is presented in **Fig. 3** for the total path of sway in stimulus and post-stimulus period within each group (every scene direction separately). In study group, total path of sway of COP did not decrease significantly.

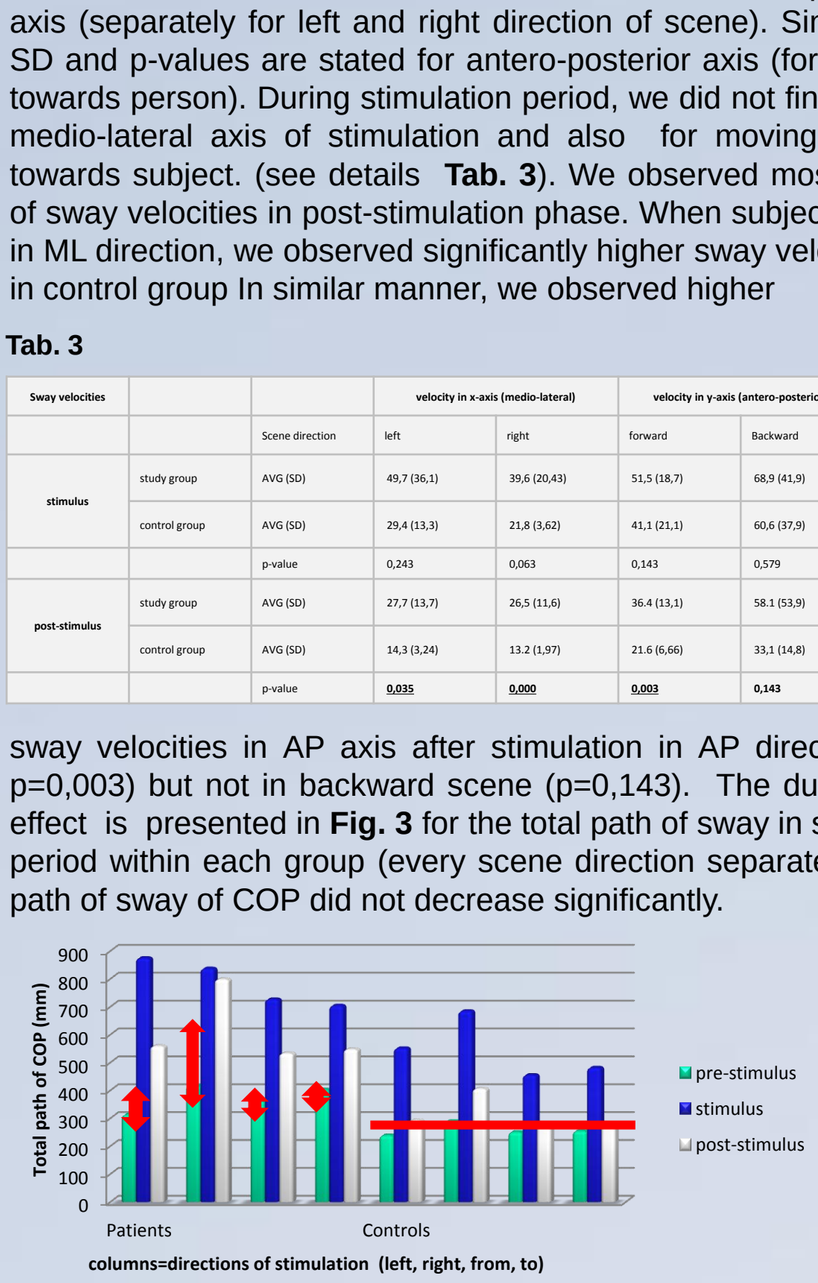


Fig. 3 Comparison of sway pattern in total path of COP Patients did not return to pre-stimulus values during the whole post-stimulus period – see arrows).

However, in control group, total path of sway decreased in post-stimulus period almost to the pre-stimulus values. See **Fig. 2**.

CONCLUSIONS

Patients with MCI were more destabilized by dynamic visual illusion than control group. However, there are not significant differences for total path of COP and sway velocity between groups during visual moving scene. Significant differences occur in post-stimulus periods. Patients with MCI experienced prolonged destabilization even after the visual stimulation stopped (post-stimulus period). This findings suggests that patients with MCI were less effective to cope with erroneous information and posture instability persisted longer time. This suggest that sensory integration and sensory reweighted is altered in demented patients. Persisted posture instability increases risk of fall long after visual illusion disappeared.

REFERENCES

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