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PREDOMINANCE OF POSTURAL IMBALANCE IN LEFT HEMIPARETIC PATIENTS

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ABSTRACT. Postural sway characteristics in a group of 15 left hemiparetic patients were compared with those in a group of 15 right hemiparetic patients using a statokinesimetric platform. The results in the two patient groups were also compared with those derived from a group of 15 age-matched healthy control subjects. Three postural sway parameters were used: the total sway area, the anteroposterior sway and the lateral sway. Hemiparetic patients showed a larger sway area and a lateral displacement of the center of pressure toward the side of the lesion compared to normal subjects. Furthermore, left hemiparetic patients showed greater sway area and lateral displacement compared to right hemiparetic patients. We suggest that the predominance of postural imbalance in left hemiparetic patients could be due to a displacement of postural reference toward the lesion's side.

Key words: posture, hemiplegia, posturography, egocentric reference, spatial behaviour.

INTRODUCTION

Asymmetry in posture and movement is the most common locomotor deficit identified in patients with hemiparesis resulting from cerebral vascular events (26, 29). This asymmetry is closely related to the changes in static posture as shown with postural measurements in hemiparetic patients, demonstrating a shift of body weight towards the non-paretic limb (1, 8, 18). These results can perhaps be explained by the relative importance of proximal and axial motor deficiency as well as by somesthetic deafferentation processes, hemianopia or vestibular disturbances.

Many cerebral structures are involved in postural recovery after cerebral vascular events: the cerebellum, mainly the archeo- and paleocerebellum; basal ganglia; and the cortex, mainly the posterior parietal area on both sides. The right posterior parietal cortex seems to be predominantly involved in the spatial integration, as shown by the prevalence of visuospatial disorders with lesions to this side (9, 11). Visuospatial information might be crucial for recovery of posture.

Therefore, it could be suggested that patients with right hemispheric lesions may have different postural recovery than patients with left hemipheric lesions. We thus performed a pilot study, the aim of which was to quantify and compare postural sway characteristics of a group of left and right hemiparetic patients with those of a group of normal age-matched subjects.

MATERIAL AND METHODS

Subjects

Thirty right-handed hemiparetic patients participated in this study (see Table I for a description of subjects). Fifteen subjects had a right hemiplegia and 15 had a left hemiplegia. Hemiplegia was secondary to an ischemic stroke in the acute phase of recovery (with four months of onset). Patients were selected for this study if they (1) were medially stable without prevailing complications, (2) had potential for functional locomotion with rehabilitation, (3) showed ability to stand up without external support for at least 30 seconds. In addition, 15 healthy volunteers (with no history of vestibular dysfunction) were tested (6 females and 9 males). Control subjects had an average age of 46 years (range: 28–72 years) and an average weight of 63.2 kg (range: 56–82 kg).

Methods

Posturographic evaluation was performed using a Sereme + Spectral statokinesimeter. It consisted of a statokinesimetric platform measuring 45 × 55 cm with four strain gauges placed on the diagonals of the platform. The strain gauges transformed pressure variations into variations in the current's intensity. The accuracy of measurement on each detector was ± 0.5 kg. Information obtained from the strain gauges was transmitted to the central unit of a computer (See Calmels et al. (5)).

During the test, subjects stood barefoot in the upright position with their arms alongside their bodies and with their feet 10 cm apart, centered in relation to the antero-posterior axis. Subjects kept their eyes open and remained silent.

Table I. *Right and left hemiparetic group characteristics*

	RH group ($n = 15$)	LH group ($n = 15$)
Age	53.6	53.4
Range	(31–69)	(21–70)
Time from onset (months)	3.4	4
Female	7	1
Male	8	14
Weight (kg)	65.8	67.3
	(54–83)	(52–90)
Paretic limb control		
Isolated[1]	5	4
Partial synergy[2]	5	6
Full synergy[3]	5	5
Orthesis use	8	10
Sensory deficits		
Deep	13	14
Superficial	13	14
Visual field defects	3	4
Neuropsychological disorders		
Aphasia	12	0
Unilateral neglect	0	11
Anosognosia	0	0
CT-Scan findings		
Cortico–subcortical hypodense lesion parieto-temporo-occipital carrefour	7	7
	5	4
Cortical hypodense lesion	0	1
Subcortical hypodense lesion	8	7
Capsulo-thalamic region	1	2
Capsulo-lenticular region	3	4
Capsular lacuna	3	2

Standard error of the mean in parentheses.
[1] Ability to perform completely independent movements at the hip, knee and ankle.
[2] Ability to perform some independent joint movements while some were performed only in synergy with other joint movements.

Statokinesimetric measurements recorded the weight supported by the right-anterior, left-anterior, right-posterior and left-posterior strain gauges for 30 seconds standing sampled at 100 Hz. For each measurement, the center of gravity and the distribution of body weight in the antero-posterior and lateral axes were determined in kilograms. The mean distribution of body weight in the antero-posterior and lateral axes are called antero-posterior and lateral differences (Fig. 1). The parameter "surface" area, expressed in kilograms, reflects the various changes of the center of gravity position, as compared to the mean center of gravity; it corresponds to the surface area of the quadrilateral of variance.

Three parameters were obtained in patients and control subjects: the total sway area, the antero-posterior difference and the lateral difference. For each parameter, mean and standard deviations in each group (control subjects, right hemiparetic patients (RH) and left hemiparetic patient (LH)) were compared using a two-sided Student's t-test.

RESULTS

Total sway area

The group of LH patients showed a larger value tha the group of control subjects ($t = 5.1$; $p < 0.0005$ and also than the group of RH patients ($t = 2.9$ $p < 0.005$). The group of RH patients also showed significant increase compared to the group of contro subjects ($t = 1.9$; $p < 0.05$) (see Fig. 2).

Antero-posterior difference

The group of LH patients showed no significan difference, as compared with the group of contro subjects ($t = 0.1$; $p > 0.05$) and with the group o RH patients $t = 0.11$; $p > 0.05$). The group of RH patients showed no significant difference as compared with the group of control subjects ($t = 0.02$; $p > 0.05$) (see Fig. 2).

Lateral difference

The left hemiparetic patients group and the right hemiparetic patients group showed a greater value than the control subjects group (LH: $t = 5.7$; $p < 0.0005$; RH: $t = 6$; $p < 0.0005$). The absolute value of the LH patients group showed greater values than the absolute values of the RH patients group ($t = 3.4$; $p < 0.005$).

The results revealed that in the hemiparetic patients there was a significant shift of the center of pressure towards the side of the lesion. That shift predominated clearly in the group of left hemiparetic patients (see Fig. 2).

DISCUSSION

Hemiparetic patients showed modifications of postural sway with a widening of the surface area and a lateral displacement of the center of pressure toward the side of the lesion, suggesting decreased postural stability, as already described (1, 8, 18). Furthermore, we showed that postural imbalance predominated in patients with right hemispheric lesions compared to patients with left hemispheric lesions. Similar findings have been reported by Hesse et al. (13) in a small group of hemiparetic patients (12 right and 8 left). In

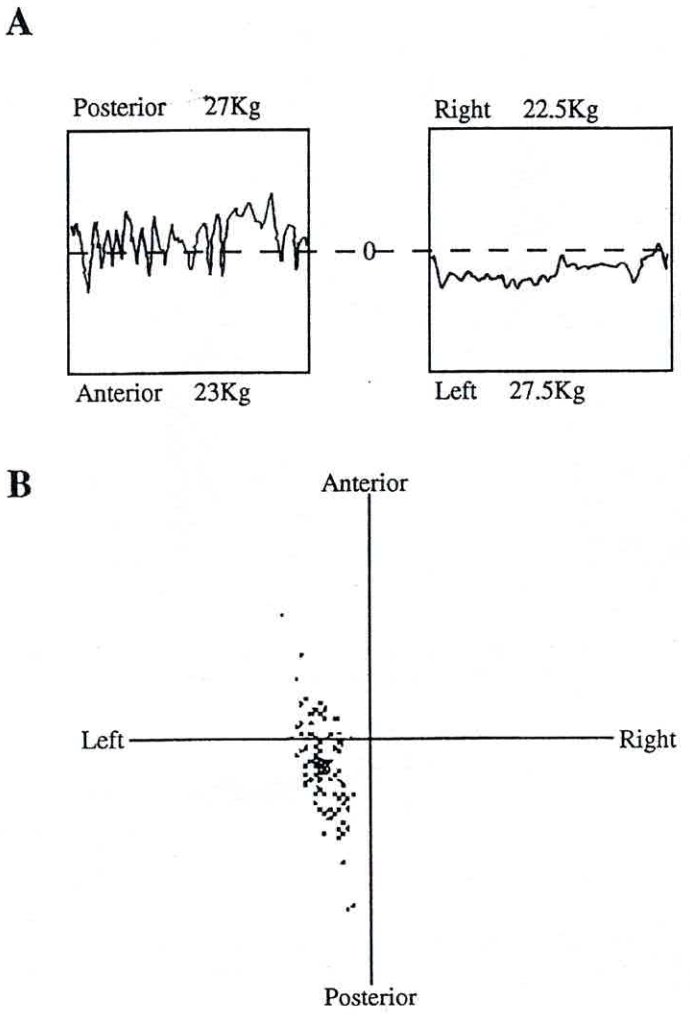

Fig. 1. Statokinesimetric measurements in a right hemiparetic patient during 30 seconds standing: A – Representation of the weight distribution in antero-posterior axis (left part) and in lateral axis (right part) as a function of time. If antero-posterior difference (posterior–anterior) is positive, weight distribution is more posterior than anterior and inversely. If lateral difference (right–left) is positive, weight distribution is more to the right than to the left and inversely; B – Representation of the weight distribution along both the antero-posterior and lateral axes to obtain the different positions of the center of gravity (in kilograms). Surface area represents the various changes of the center of gravity position (small squares) as compared to the mean of the center of gravity (large empty square).

our two groups of hemiparetic patients, clinical characteristics such as age, weight, lower limb power, sensory disturbances and visual field defects were comparable and cannot explain this difference. (The sex distribution was different in the two patient groups with a predominance of males in the left hemiparetic group. However, sex distribution does not affect the lateral sway obtained in similar conditions (2, 17)). Then the predominance of postural imbalance in left hemiparetic patients seems then to be related to damage of the right hemisphere.

Following damage of the right hemisphere, particularly the post-rolandic regions, specific disorders are observed as visuospatial neglect, constructive apraxia, disturbances of the spatial imagery, anosognosia and somatoparaphrenia (4, 10). All of these clinical manifestations suggest an implication of the right hemisphere in the spatially oriented behaviour (4, 9, 11).

Eleven out of 15 left hemiparetic patients showed initially manifestations of visuospatial neglect as indicated by their behaviour and by neuropsychological assessment, but those manifestations had disappeared

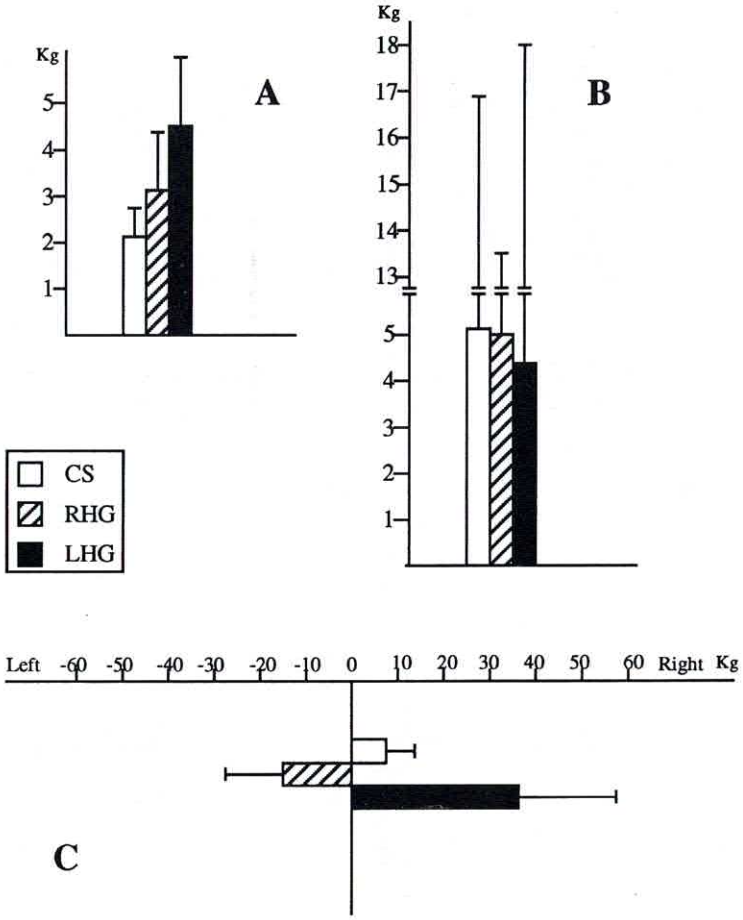

Fig. 2. Mean values and standard deviation of total sway area (A), antero-posterior (B), and lateral difference (C) in two groups of right and left hemiparetic patients (RH and LH) and a group of control subjects (CS), measured with a statokinesimetric platform.

at the time of the examination. Nevertheless, the persistence of a predominant postural imbalance in our LH patients could be interpreted as another specific right hemisphere manifestation, reflecting a disturbance of the spatially oriented posture. Right hemiparetic patients showed a better recovery of posture than LH patients, because the intact right hemisphere can compensate more readily for the postural deficit related to hemiplegia than the left hemisphere. In left hemiparetic patients, the lesser degree of independence and social adjustment and the poorer recovery of motor function as compared to right hemiparetic patients lend support to this explanation (7, 12).

We thus suggest that the recovery of posture in hemiparetic patients implies not only recovery of motor, somatosensory and visual deficits, but also spatial cognition. Spatial cognition requires the integration of visual, proprioceptive and vestibular information about the position of eyes, head and body. All this information is used by the brain to produce multiple higher-order (e.g. egocentric) representations of space, subserving accurate spatial behaviour. Such spatial representations could be disrupted by unilateral cerebral damage in the controlateral side of the space, particularly following a right hemisphere lesion. For example, the displacement of the mid-saggital plane representation, which is appreciated by pointing in straight-ahead position in the dark, is shifted towards the side of the lesion in patients with right parietal lobe damage (19, 22). Distortion of geographic space representation is also displayed in

patients with visuospatial neglect asked to evoke mentally a geographical map or a city place (3, 24). Rather than a concept of a unitary representation of space or egocentric reference (14, 28), the concept of multiple representations in spatial cognition has recently been debated, especially to account for the many manifestations of neglect (27). This interpretation is supported by the observation that direction-specific vestibular (6, 23, 25, 27), proprioceptive (15, 16) and visual stimulations (20), contributing to the building-up and updating of spatial representations, may temporarily improve or worsen hemineglect. Furthermore, manipulation of gravitational-otolithic information, as obtained by supine position, significantly reduced the rightward directional error in the line bissection task in hemineglect patients (21). One can then hypothesize that the lesser recovery of posture (i.e. the greater lateral displacement of the center of pressure towards the side of the lesion) of our left hemiparetic patients could reflect a persistent distortion of a "spatial postural representation", whereas other representational disorders usually related to neglect manifestations had regressed.

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