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Static and dynamic posturography in patients with asymptomatic HIV-1 infection and AIDS

Posturografia statica e dinamica in soggetti HIV sieropositivi asintomatici e in soggetti affetti da AIDS

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Key words

Vestibular system • HIV • AIDS • Diagnosis • Posturography

Parole chiave

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Summary

Alterations of the vestibulo-ocular reflex, optokinetic nystagmus, and visuo-vestibular-ocular reflex, have already been described in patients with AIDS and HIV-1 positive asymptomatic subjects. The introduction to the clinical practice of posturographic techniques allows us to study, with precision, postural perturbation that may be present when performing Romberg's test and to study the vestibulo-spinal reflex as a component of the vestibular system. The relative lack of studies on posturography and AIDS, encouraged us to continue our research on the vestibular system both in asymptomatic HIV-1 seropositive patients and in patients with AIDS (IV stage according to the classification proposed by the Centre for Disease Control). Recordings were made in group 1 (control group, 55 normal subjects), in group 2 (15 asymptomatic HIV-positive subjects), and in group 3 (15 patients with AIDS stage IV). Static and dynamic posturography were carried out using Tonnies platform system (Tonnies GmbH & Co., Wurzburg, Germany) and the data were analysed with Tonnies Posturographic Tübingen (TPOST) software vers. 5.19. In asymptomatic HIV+ subjects, we observed an increase in RW, RA and M3 reflex latency. AIDS patients (stage IV) exhibited significant alterations in almost all the posturographic parameters and the electromyographic potentials. Our results validate static and dynamic posturography as a method for otoneurological investigation and appear to confirm that the entire vestibular system is involved since the earliest stages of the HIV infection. In the HIV+ subjects, a variable dysfunction in the reflex control to long latency was observed, which is correlated with the alteration of the central dopaminergic system; in AIDS patients, the central nervous system damage appears more important, globally distributed and correlated also with immunosuppression.

Riassunto

Le alterazioni del riflesso vestibolo-oculare (VOR), del nistagmo otticocinetico e del riflesso visuo-vestibolo-oculare (VVOR) sono già state descritte sia in pazienti affetti da AIDS che in soggetti HIV-1 sieropositivi asintomatici. La relativa scarsità in letteratura di indagini posturografiche in soggetti affetti da AIDS e le già descritte alterazioni del sistema visuo-vestibolare negli stessi, ci hanno indotto ad ampliare le nostre ricerche sulle possibili alterazioni del sistema vestibolare sia in pazienti HIV-1 sieropositivi asintomatici che in pazienti con AIDS conclamata (IV stadio). L'indagine è stata condotta su tre gruppi di soggetti: il primo gruppo (controllo) costituito da 55 soggetti adulti sani, il secondo gruppo costituito da 15 soggetti siero-positivi asintomatici (HIV+), il terzo gruppo costituito da 15 pazienti affetti da AIDS conclamata (gruppo IV secondo la classificazione CDC). Per quel che riguarda l'indagine stabilometrica, i soggetti sono stati posti in posizione di Romberg, sulla piattaforma stabilometrica modello Tönnies (Tönnies GmbH & Co., Wurzburg, Germany) interfacciata con PC IBM XT 286T e software TPOST versione 5.19 per l'elaborazione dei dati. L'indagine stabilometrica nei pazienti sieropositivi ha dimostrato, alla prova statica, un significativo aumento di entrambi gli indici di Romberg (RW e RA), mentre alle prove posturografiche dinamiche, per il riflesso a lunga latenza M3 si è rilevato un significativo aumento della latenza. Nei pazienti con AIDS IV stadio si è osservato un aumento significativo di quasi tutti i parametri posturografici statici e dinamici. I nostri risultati evidenziano l'importanza della posturografia statica e dinamica nell'indagine otoneurologica e confermano l'interessamento dell'intero sistema vestibolare già dai primi stadi dell'infezione da HIV: nei soggetti HIV sieropositivi la precocità delle alterazioni elettromiografiche suggerirebbe l'ipotesi di un'azione diretta e precoce del virus HIV sul sistema nervoso, pur in assenza di altre manifestazioni cliniche; nei soggetti con AIDS IV stadio, l'aumento di quasi tutti i parametri posturografici e le alterazioni dei potenziali elettromiografici sembrano confermare una diffusa compromissione del sistema dell'equilibrio e dei riflessi vestibolo-spinali.

Introduction

The static posturographic tests, with eyes open and closed, are used to study the body sway shown in the Romberg test. Other cognitive elements are obtained with dynamic posturographic tests [1 2]. These procedures determine, by a sudden shift (tilt) of the platform and consequent movement of the feet, on the legs, around the ankle malleolar-malleolar axle, a segmental short latency reflex (M1) in the triceps sural muscles. The mean duration of the electromyographic response is 50-60 ms, at a velocity and amplitude, respectively, of 40°/sec. and 4°, while a more elevated tilt determines a middle latency reflex (M2) with a mean duration of 115-120 msec. The two reflexes occur simultaneously with the passive movement of the head induced by the inclination of the platform. The reaction to platform tilting is guaranteed by the contraction of the anterior tibial muscle mainly by a non-voluntary long latency reflex (M3) with a duration of 120 to 130 msec [3 4]. Static and dynamic posturography, therefore, allows the use also of the vestibulo-spinal reflex. in the study of the equilibrium system.

In AIDS and HIV+ patients, alterations in the vestibular-ocular reflex (VOR), optokinetic reflex (OKN) and visuo-vestibular-reflex (VVOR) have been documented [5-7].

There are, moreover, few studies on posturography and AIDS [8 9].

Aim of the current study was to investigate whether the posturographic procedure could detect the presence of possible disorders of the vestibulo-spinal reflex (VSR). Positive results could indicate that posturography might be useful as a clinical tool or in the follow-up of these patients.

Material and methods

The study population consisted of three different groups:

1. 55 healthy adult subjects (35 male, 20 female) aged between 25 and 50 years (mean 35) with no clinical evidence of disease;
2. 15 asymptomatic HIV+ patients (7 male, 8 female) aged between 25 and 30 years (mean 28);
3. 15 HIV+ patients (5 male, 10 female); aged between 24 and 42 years (mean 32.8) classified as AIDS group IV according to the CDC classification. One of these patients presented alcoholic cirrhosis, but none showed neurological or otoneurological symptoms.

The patients stood in Romberg's position on the stabilometric platform, in a normally illuminated and aereated environment. Patients were examined in two static conditions for 20 sec. and in two alternate dynamic conditions of 5 minutes. The first was with open eyes and the second with closed eyes. A Tonnies' platform was used with modular extension to allow a dynamic integration with the Personal Computer IBM XT 2861 and software T-POST vers. 5.19 for the analysis of data.

Static measurements

The stabilometric platform uses two force circumferentors in four angles which measure the spontaneous oscillations of the body. The movements are recorded in an anterior-posterior and in a lateral direction. The following parameters are considered: Way (average velocity of movement); Area (total surface of movement for unity of time); AP (average velocity in anterior-posterior direction); L (average velocity in lateral direction); AP/L (coefficient of the preferential direction of movement); RW (Romberg index open/closed eyes reported to Way); RA index (Romberg index closed/open eyes reported to Area). The prevailing direction of oscillation is clearly represented in a histogram of direction that shapes the respective vectors of movement from the point of support and allows the prevailing direction of movement to be identified.

Dynamic measurements

Following a sudden movement (tilt) of the stabilometric base, an EMG recording of three responses (M1, M2, M3) has been observed, derived bilaterally from the triceps sural and anterior tibial muscle by four channels. The constant velocity was 50°/sec and the amplitude 4°. The frequency of sampling was 1000 Hz and 500 ms of the recording time with onset 100 msec after stimulation. Analysis of the EMG signals was automatically performed as the average of 8 tests. The purpose was to identify the relative peak of muscular potentials, in the low and middle latency (SL, SM) and in the long latency (LL), derived from the triceps sural muscle and from the anterior tibial muscle, respectively. Latency (L), duration (D), amplitude (To) and Area of single electromyographic potential were computed in the left and in the right leg. The T test of Bonferroni was used in the statistical analysis.

Results

Static posturography

Results of static posturography are shown in Table I. In the group of the HIV+ patients, compared with the controls, there was a significant decrease of L in open eyes ($p < 0.05$) and an increase of AP in closed eyes ($p < 0.05$). In the group of AIDS patients, we observed a significant increase (p 0.05) both in open and in closed eyes for all the parameters; by contrast, L in open eyes was not significant (Table I).

Table I. Static posturography: results and statistical analysis.

Open eyes					
Group	Way	Area	AP	L	AP/L
Normal	1.32 ± 0.41	0.26 ± 0.19	0.12 ± 0.07	0.24 ± 0.01	0.60 ± 0.35
HIV+	1.23 ± 0.32	0.23 ± 0.13	0.14 ± 0.08	0.18 ± 0.07	0.88 ± 0.50
AIDS	1.79 ± 0.96	0.55 ± 0.47	0.22 ± 0.07	0.22 ± 0.13	1.13 ± 0.41
p < 0.05	3 vs. 1	3 vs. 1	3 vs. 1	2 vs. 1	3 vs. 1
Closed eyes					
Normal	1.93 ± 0.59	0.47 ± 0.32	0.16 ± 0.09	0.37 ± 0.15	0.55 ± 0.41
HIV+	2.41 ± 0.90	0.56 ± 0.30	0.35 ± 0.30	0.32 ± 0.14	0.55 ± 0.14
AIDS	3.21 ± 1.92	1.54 ± 2.08	0.39 ± 0.23	0.46 ± 0.39	1.38 ± 1.35
p < 0.05			2 Vs 1		2 vs. 1
	3 vs. 1	3 vs. 1	3 vs. 1	3 vs. 1	3 vs. 1

Romberg index		
Group	RW	RA
Normal	1.39 ± 0.39	1.94 ± 0.91
HIV+	2.04 ± 0.83	2.98 ± 1.81
AIDS	1.78 ± 0.38	2.43 ± 1.17
p < 0.05	2 vs. 1	2 vs. 1
	3 vs. 1	

RW and RA indexes increased both in the HIV+ and AIDS patients in comparison to the control group ($p < 0.05$).

Dynamic posturography

EMG results (M1, M2, M3) in the normal group, HIV+ and AIDS patients, in open and closed eyes, are shown in the Tables II, III, IV and V. In both conditions, the HIV+ and AIDS patients showed an increase of M1 latency compared to the control group ($p < 0.05$). A non-statistical decrease in the M1 value to the right was observed ($p < 0.05$) with open eyes, only in the HIV+ subjects. With open eyes, M2 latency showed an increase in the AIDS patients, both on the left and right side, only on the left side in the HIV+ group ($p < 0.05$). M3 latency was increased ($p < 0.05$) only in the AIDS group with closed eyes.
There was no significant difference in the duration of M1 and M2 in the HIV+ and AIDS patients with open eyes. With closed eyes, we observed a reduction ($p < 0.05$) of M1 to the left in the AIDS group and of M2 bilaterally both in the HIV+ and AIDS groups. With closed eyes, no significant differences in M2 latency were observed in HIV+ and AIDS patients. Furthermore, the M3 duration was increased with open eyes and reduced with closed eyes ($p < 0.05$).
No significant differences were found, regardless of the amplitude and the area, in M1, M2, M3.

Discussion

This study revealed an impairment in postural balance in the HIV+ patients as demonstrated by static and dynamic posturography. A particularly important finding is the increase in the Romberg indexes and the duration of M3 latency. This may indicate early improvement of the equilibrium system, both peripheral and central, in accordance with our previous study on optic-vestibular interactions in AIDS [7]. The early EMG abnormalities suggest an involvement of the CNS, also in absence of other clinical symptoms [7 10 11]. It has been suggested that, in these subjects, a dysfunction of the dopaminergic striati pathways occurs, especially in the connections between the frontal association cortex and the caudatus nucleus [9].
AIDS subjects (IV stage) exhibited significant alterations in almost all the posturographic parameters and the electromyographic potentials. These findings suggest a marked involvement of the balance system and of the vestibular-spinal reflexes. In AIDS patients, evidence of CNS alterations, in the basal ganglia, has been demonstrated, consisting in giant polynucleate cells, dendritic vacuolar degeneration and glial micronodules [12].
Analogous lesions have been described in the caudatus nucleus, in the putamen and in the nigra sub-

Table II. Dynamic posturography: results and statistical analysis.

Open eyes - latency

Group	M1		M2		M3	
	right	left	right	left	right	left
Normal	39.3 ± 3.0	39.4 ± 3.2	61.9 ± 3.7	63.2 ± 5.1	120. ± 0.13	121.7 ± 21.0
HIV+	37.2 ± 12.0	46.7 ± 6.0	60.0 ± 11.8	70.0 ± 6.2	123.0 ± 15.9	124.2 ± 10.8
AIDS	45.6 ± 7.5	55.8 ± 24.0	67.2 ± 3.9	70.6 ± 18.0	128.4 ± 10.4	127.4 ± 10.7
p < 0.05		2 *vs.* 1		2 *vs.* 1		
	3 *vs.* 1	3 *vs.* 1	3 *vs.* 1	3 *vs.* 1		

Closed eyes - latency

Group	M1		M2		M3	
	right	left	right	left	right	left
Normal	39.5 ± 3.1	40.8 ± 3.5	63.3 ± 6.8	63.0 ± 4.9	113. ± 19.4	118.0 ± 18.7
HIV+	43.6 ± 3.7	47.3 ± 8.3	65.3 ± 11.8	68.6 ± 5.5	122.6 ± 13.4	114.3 ± 10.2
AIDS	42.2 ± 0.5	46.5 ± 1.1	70.7 ± 6.1	55.6 ± 4.2	144.2 ± 70.7	143.2 ± 58.7
p < 0.05	2 *vs.* 1	2 *vs.* 1				
	3 *vs.* 1	3 *vs.* 1			3 *vs.* 1	3 *vs.* 1

Table III. Dynamic posturography: results and statistical analysis.

Open eyes - duration

Group	M1		M2		M3	
	right	left	right	left	right	left
Normal	19.7 ± 2.9	20.8 ± 3.7	21.6 ± 4.9	21.0 ± 4.5	128.8 ± 48.2	130.2 ± 42.7
HIV+	19.7 ± 0.9	20.5 ± 2.8	29.5 ± 24.0	18.5 ± 7.0	182.0 ± 34.0	180.0 ± 44.4
AIDS	19.6 ± 5.0	17.4 ± 5.4	18.6 ± 4.4	20.0 ± 8.4	183.5 ± 22.5	190.4 ± 46.1
p < 0.05					2 *vs.* 1	2 *vs.* 1
					3 *vs.* 1	3 *vs.* 1

Closed eyes - duration

Group	M1		M2		M3	
	right	left	right	left	right	left
Normal	21.6 ± 3.6	20.7 ± 3.7	26.9 ± 5.4	27.5 ± 6.4	175.2 ± 54.9	167.3 ± 53.0
HIV+	20.0 ± 3.0	19.3 ± 3.0	19.6 ± 1.5	14.6 ± 3.2	136.6 ± 18.9	168.3 ± 17.6
AIDS	22.7 ± 5.8	16.7 ± 2.8	13.0 ± 6.7	12.6 ± 6.5	135.4 ± 21.1	119.0 ± 30.1
p < 0.05			2 *vs.* 1	2 *vs.* 1	2 *vs.* 1	2 *vs.* 1
		3 *vs.* 1	3 *vs.* 1	3 *vs.* 1	3 *vs.* 1	3 *vs.* 1

stance of HIV patients with dementia [13]. These disorders could be correlated with the action of the HIV virus itself on the Nervous System or with infections induced by immunosuppression [14-16].

Conclusions

The present results validate static and dynamic posturography as a reliable method for otoneurological

Table IV. Dynamic posturography: results and statistical analysis.

Open eyes - area

Group	M1		M2		M3	
	right	left	right	left	right	left
Normal	4.3 ± 2.3	4.8 ± 2.8	3.9 ± 2.3	3.6 ± 1.9	51.4 ± 29.2	44.6 ± 21.5
HIV+	2.8 ± 0.6	2.1 ± 1.0	3.9 ± 2.9	4.3 ± 3.1	43.7 ± 7.4	58.7 ± 9.5
AIDS	4.5 ± 1.8	4.6 ± 1.9	3.0 ± 1.2	4.6 ± 3.1	45.2 ± 12.7	40.9 ± 16.9

$p < 0.05$

Closed eyes - area

Group	M1		M2		M3	
	right	left	right	left	right	left
Normal	5.2 ± 2.0	4.4 ± 2.8	4.8 ± 0.3	4.5 ± 2.3	57.4 ± 50.5	48.9 ± 34.4
HIV+	4.8 ± 1.8	6.5 ± 1.8	3.9 ± 0.5	4.0 ± 1.6	30.4 ± 13.9	44.1 ± 5.0
AIDS	5.4 ± 0.4	5.8 ± 1.1	5.0 ± 3.5	5.1 ± 3.2	29.8 ± 9.0	30.1 ± 19.8

$p < 0.05$

Table V. Dynamic posturography: results and statistical analysis.

Open eyes - amplitude

Group	M1		M2		M3	
	right	left	right	left	right	left
Normal	406 ± 264	469 ± 238	338 ± 239	317 ± 211	732 ± 236	666 ± 201
HIV+	361 ± 276	361 ± 279	234 ± 125	290 ± 232	590 ± 158	785 ± 200
AIDS	398 ± 152	464 ± 171	280 ± 100	374 ± 165	587 ± 160	610 ± 205

$p < 0.05$

Closed eyes - amplitude

Group	M1		M2		M3	
	right	left	right	left	right	left
Normal	452 ± 196	384 ± 247	339 ± 172	319 ± 195	689 ± 145	674 ± 398
HIV+	446 ± 169	568 ± 154	204 ± 157	400 ± 277	655 ± 180	670 ± 144
AIDS	480 ± 65	563 ± 73	332 ± 164	363 ± 208	609 ± 261	479 ± 184

$p < 0.05$

investigation and suggest, furthermore, early involvement of the equilibrium system in clinically asymptomatic HIV infection, as well as in patients with AIDS [5-7 17]. In HIV+ patients, a variable dysfunction in the reflex control system to long latency can be observed, which appears to be correlated with alterations in the central dopaminergic system (basal ganglia, caudatus nucleus, nigro-striatus system) [8 9]. In AIDS patients, alterations in the dopaminergic system and CNS damage appear to be more important, globally distributed and probably correlated also with immunosuppression induced by the virus.

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