

Oculographic, Clinical Test of Sensory Integration and Balance and Computerized Dynamic Posturography Findings in Patients with Psoriatic Arthritis

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Objective: To assess the frequency and characteristics of the oculographic findings and the usefulness of the clinical test of sensory integration and balance (CTSIB) for the evaluation of balance in patients with psoriatic arthritis (PsA) by comparing this test with the computerized dynamic posturography (CDP).

Study Design: A series of consecutive patients that fulfilled the Moll and Wright criteria for PsA and matched controls were studied.

Setting: The study was performed at the Otolaryngology Division of a tertiary reference center.

Intervention: Vestibular evaluation including CTSIB followed by CDP was performed to all patients and age, sex, and ethnically frequency-matched controls.

Main Outcome Measure: Patterns of CTSIB and CDP (gold standard) were assessed and compared.

Patients: Sixty PsA patients (63.3% women) and 60 matched controls.

Results: PsA patients had higher frequency of abnormal oculocephalic response (13.3%) and abnormal caloric test

(26.7%) than controls (0% in both cases) ($p=0.006$ and $p<0.001$, respectively). Benign paroxysmal positional vertigo (BPPV) was diagnosed in two (3.4%) patients and none of the controls ($p=1$). Significantly increased frequency of abnormal CTSIB test with vestibular loss pattern (33.3%) in patients compared with controls (6%) was observed ($p=0.002$). Significantly increased frequency of abnormal CDP was also observed in PsA patients (14 [23.3%] versus 0 [0%] of controls) ($p<0.001$). CTSIB yielded 100% sensitivity, 73% specificity, 48% positive predictive value, and 100% negative predictive value.

Conclusions: This study indicates that oculographic findings are common in PsA. CTSIB is useful for assessing balance disorder screening in the routine clinical practice in these patients. **Key Words:** BPPV—Computerized dynamic posturography—CTSIB—Nystagmus.

Otol Neurotol 38:448–453, 2017.

Psoriatic arthritis (PsA) is a chronic inflammatory rheumatic disease that involves people with psoriasis. It is characterized by synovial and enthesal inflammation (1,2).

PsA belongs to a group of rheumatic diseases called spondyloarthritis. Our group demonstrated a strong evidence for inner ear compromise in patients with PsA (3) and ankylosing spondylitis (AS) (4), which is also a condition included within the group

of spondyloarthritis. As observed in patients with scleroderma (5), we also disclosed an increased frequency of benign paroxysmal positional vertigo (BPPV) and abnormal postural control of vestibular origin in patients with AS compared with matched controls (6).

In the present study we aimed to determine if patients with PsA present some kind of postural abnormalities in the clinical test of sensory integration and balance (CTSIB). We also intended to assess the usefulness of CTSIB in the routine clinical practice for the evaluation of balance by comparing this test with the gold standard test, the computerized dynamic posturography (CDP), which is a more expensive and complex test. Also, the specific oculographic findings and BPPV observed in patients with PsA were analyzed.

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The authors disclose no conflicts of interest.

DOI: 10.1097/MAO.0000000000001296

MATERIALS AND METHODS

Patients

Cross-sectional study that included consecutive patients attending hospital outpatient rheumatology clinics (March through October 2008) that fulfilled the Moll and Wright criteria for PsA: 1) presence of an inflammatory arthritis—peripheral arthritis and/or sacroiliitis or spondylitis, 2) presence of psoriasis, and 3) absence of serological tests for rheumatoid factor (7). They were treated by the same group of rheumatologists and were recruited from the University Hospital Lucus Augusti, Lugo, Spain. As reported elsewhere (3–6), this hospital is the single referral center for rheumatic diseases for a well defined and ethnically homogenous, mixed rural and urban, white population living in the region of Lugo, central Galicia (Northwestern Spain).

Inclusion and Exclusion Criteria

To reduce the risk of misdiagnosis, only patients with PsA who had been diagnosed and treated for at least 1 year at the outpatient Rheumatology clinic at the time of the assessment were included. To minimize the potential influence of atherosclerosis in the development of vestibular abnormalities, all PsA patients seen during the period of recruitment with cardiovascular events, including ischemic heart disease (angina or myocardial infarction electrocardiographically confirmed), heart failure, cerebrovascular accidents (transient ischemic attacks or strokes confirmed by magnetic resonance imaging and/or computerized tomography brain scan), or peripheral arterial disease (confirmed by Doppler and/or arteriography) or chronic kidney disease were excluded (3).

PsA patients and controls were questioned regarding any history of previous vestibular disturbances: vertigo, dizziness and disequilibrium, cranial trauma, ear infection, metabolic disease, renal failure, and ototoxic drug use. Those with a known cause, such as trauma, Menière disease and other vestibular disorders, ear surgery, previous history of cerebrovascular complications, infections involving the inner ear, syphilis, acoustic schwannoma, and those in treatment with vestibulotoxic drugs were excluded. Moreover, as established in a former study (3), patients seen during the period of recruitment that had severe cervical involvement or neck pain that caused severe limitation in the range of movements of the neck were also excluded.

At the time of the study 60 patients with PsA fulfilled the inclusion criteria described above. However, based on the exclusion criteria described above, another 14 patients with PsA seen during the period of recruitment were excluded.

Controls

Sixty community based controls were included. They were recruited from family physicians from health centers of the Lugo region. They were age ± 2 years and sex and ethnically matched controls without family history of spondyloarthritis, psoriasis, PsA, rheumatoid arthritis, connective tissue diseases, or any other inflammatory rheumatic diseases. Exclusion criteria were the same as those used for PsA patients.

Informed consent was obtained from all cases and controls. The local institutional committee approved the study.

Vestibular Study

Eye movements were studied with videonystagmoscopy and videonystagmography to quantify these results (Ulmer VNG, Ver 3.3 SYNOPSIS, Marseille, France). The equipment

consisted of a modified diving mask (goggles) in which the eye was illuminated by infrared light emitting diodes placed on each side of the camera lens. The light-sealed mask carried one infrared-sensitive video camera allowing observation of one eye in a monitor while the other was closed (8).

Positional and Positioning Tests

Positional nystagmus was assessed in several positions to establish gravity's effect on vestibular receptors of the inner ear. Horizontal and vertical eye movements were monitored using videonystagmoscopy and videonystagmography with open eyes without fixation during 60 seconds in four different positions: supine lying, right lateral lying, left lateral lying, and head hanging position. For this evaluation, only the last 30 seconds of the study were registered and the presence of positional nystagmus in any direction in at least one of the four positions mentioned above were considered abnormal; the presence of positional nystagmus in any direction in at least one of the four positions was considered abnormal and if nystagmus was present; visual fixation test was performed for confirming a reduction in at least a 50% in slow phase velocity of nystagmus, typically found in peripheral vestibular lesions. Then, Dix–Hallpike test (9) and the roll test were performed in all patients and controls (10). In all cases, eye movements were recorded with goggles for at least 30 seconds. Since normal subjects can also develop positional nystagmus on positioning testing when visual fixation is removed (11), a diagnosis of BPPV was based on both a clinical history of definitive episodes of positional spells of vertigo and physical examination showing specific signs and symptoms after performing the provocative maneuver. In PsA patients with moderate limited cervical spine movements and a negative Dix–Hallpike test, Semont diagnostic maneuver were performed for assessing posterior semicircular canal function (12). The presence of BPPV in PsA patients was assessed as previously reported (6,13).

Oculocephalic response (OCR) also called “head thrust test” or Halmagyi test was assessed. The test was performed as previously reported (14). A normal response was recorded when the subject was able to maintain visual fixation without ocular drift during the head rotation. An abnormal response was recorded when the eyes drifted in the same direction as the head and clinically evident compensatory refixation saccades were necessary to reset gaze on the stationary target.

Magnetic resonance imaging was performed in all patients with horizontal direction-changing positional nystagmus in positioning testing and when a vertical nystagmus was observed in patients or controls.

Clinical Test for Sensory Integration and Balance (CTSIB)

For assessing static equilibrium and before performing CDP and bithermal water caloric test, the CTSIB (“foam and dome test”) was conducted in all patients. CTSIB was performed as described by Horak (15) and Shumway-Cook and Horak (16). CTSIB is an inexpensive test useful in differentiating between individuals with and without vestibular disorders. The technique uses combinations of three visual and two support-surface conditions. Visual conditions include the use of a blindfold for eliminating visual and visual-conflict dome for producing inaccurate input. The six test conditions of the sensory organization were performed in a manner that attempted to simulate the six conditions of dynamic posturography. All of them were carried as described in a former study of our group (6).

Normal young adults are able to maintain balance for 30 seconds under all six conditions with minimal amounts of body sway. Furthermore, the examiner uses the first condition (condition 1) as a baseline for comparing sway under the other five conditions. In conditions 5 and 6, normal adults sway 40% more than they do in condition 1. For this reason, for each specific condition individuals were considered to have abnormal CTSIB when they were not able to maintain the position for more than 50% of the time (16). The patterns of postural disorientation are classified as “visually dependent” when conditions 3 and 6 fulfill criteria of abnormality, and conditions 2 and 5 may or not show abnormality; “surface dependent” if conditions 4, 5 and 6 are abnormal; “vestibular loss” when abnormality is found in conditions 5 and 6; and “sensory selection” when the abnormal conditions are 3, 4, 5 and 6.

Computerized Dynamic Posturography (CDP)

CDP is considered the gold standard test to study balance. Dynamic postural study was performed with standard sensorial organization test (SOT) protocol that was performed by the NeuroCom SMART Equitest system, version 8.4.0 (NeuroCom, A Division of Natus, Clackamas, OR). The Equitest consists of an expensive movable dual platform with load cells that can rotate/translate in the anteroposterior direction. The system also includes a movable visual screen/surround that can rotate in the anteroposterior (AP) direction. The movable platforms and screen collectively allow for the manipulation of input from the visual, vestibular, and somatosensory systems and quantifies their relative influence on balance performance through the measurement of spontaneous sway. The CDP assesses both the balance system as a whole (composite) and its individual components, i.e., the vestibular, visual, and somatosensory systems, in their own right. An abnormal CDP was considered to be present if patients showed a composite less than 70%.

SOT protocol consists of three 20-second trials under six different sensory testing conditions that were performed as previously described (3). The system includes a database on healthy age and weight and height matched subjects for each patient of the study. However, for the purpose of the present study a control group matched by sex and age was also studied.

Findings were classified into patterns from the combination of results for the different test conditions (17) (Table 1). To compare CTSIB and CDP only the patterns yielded by using both tests were included.

Caloric Test

A bithermal water caloric test was also performed. Each ear was irrigated alternatively with a constant flow of water, at temperatures of 30 and 44 °C, for a constant period of time of 40 seconds. Details were explained in previous studies (4).

Statistical Analysis

Continuous data were expressed as mean \pm standard deviation (SD) and categorical variables as percentages. Continuous variables were compared using Student's *t* test. Proportions were compared using contingency tables by either χ^2 or two-tailed Fisher's exact test.

Sensitivity and specificity of CTSIB was also calculated using CDP as the gold standard test. Statistical significance was defined as $p \leq 0.05$. Calculations were performed with the statistical package Stata, release 10.0/SE (Stata Corporation, College Station, TX).

RESULTS

Clinical and Vestibular Findings in Patients with PsA and Controls

Sixty-three percent of PsA patients were women (mean age of 53 years). Vestibular symptoms were more common in PsA patients than in controls ($p < 0.001$) (Table 2). Abnormal OCR was also more commonly found in patients with PsA (13.3%) than controls (0%) ($p = 0.006$). Patients also showed a higher frequency of abnormal caloric test (26.7%) than controls (0%) ($p < 0.001$) (Table 3). Hypofunction in caloric test (canal paresis) was recorded in 16 of the 25 (64%) PsA patients with abnormal CTSIB and in all PsA patients ($n = 12$) with abnormal CDP.

Oculographic Features in Patients with PsA in Positional and Positioning Tests

Unlike matched controls, six patients experienced nystagmus in positional and positioning tests but only two of them fulfilled diagnostic criteria of BPPV. One was diagnosed with benign paroxysmal positional vertigo-horizontal semicircular canal (BPPV-HSC), associated to abnormal caloric test, while the other was diagnosed with benign paroxysmal positional vertigo-

TABLE 1. Patterns observed from the combination of results for the different CDP test conditions

Patterns	Combination of Conditions	Functional Relevance
Somatosensory system or sensory selection	Quotient	Patient's ability to use input from the somatosensory system to maintain balance
	SOT2/SOT1	
Visually dependent	Quotient	Patient's ability to use input from the visual system to maintain balance
	SOT4/SOT1	
Vestibular loss	Quotient	Patient's ability to use input from the vestibular system to maintain balance
	SOT5/SOT1	
Visual preference	Quotient	Even when visual information is incorrect, patients trust it to maintain balance
	SOT3+SOT6/SOT2+SOT5	

CDP indicates computerized dynamic posturography; SOT, sensorial organization test.

TABLE 2. Main clinical and vestibular findings in 60 patients with PsA and 60 controls

	PsA Patients (%) ^a N=60	Controls (%) ^a N=60	P
Age (years ± SD) (yr) ^b	52.9 ± 10.7	53.0 ± 10.7	0.96
Sex (female/male)	38/22	38/22	1
Patients with abnormal vestibular symptoms:			
Vertigo	12 (20)	0 (0)	<0.001
Dizziness	15 (25)	1 (1.7)	<0.001
Dysequilibrium	17 (28)	0 (0)	<0.001
Abnormal OCR ^c	8 (13.3)	0 (0)	0.003
Head shaking nystagmus	2 (3.3)	0 (0)	0.15
Patients with positional nystagmus with			
≥1 abnormal position	4 (6.7)	0 (0)	0.04
Dix–Hallpike	1 (1.7)	0 (0)	1
Abnormal cephalic roll test	1 (1.7)	0 (0)	1
Abnormal caloric test	16 (26.7)	0 (0)	<0.001

^aNumber in parenthesis indicates the total proportion of patients with a particular variable.

^bAt the time of the study.

^cAbnormal OCR was considered present when the eyes drifted in the same direction as the head and clinically evident compensatory refixation saccades were necessary to reset gaze on the stationary target.

PsA indicates Psoriatic Arthritis; SD, standard deviation.

Head shaking nystagmus: presence of nystagmus post head shaking for 20 seconds.

Abnormal caloric test was considered if canal paresis was more than 25% in bithermal caloric test.

Positional nystagmus: more than one position with presence of nystagmus.

posterior semicircular canal (BPPV-PSC). The remaining four patients showed pure horizontal positional nystagmus in absence of visual fixation without symptoms of vertigo when the positional test was performed. None of them fulfilled criteria for the diagnosis of BPPV. However, 2 of 4 (50%) also showed abnormal caloric test (Table 3).

CTSIB and CDP Findings in Patients with PsA and Controls

Abnormal CTSIB was registered in 25 of the 60 PsA patients (41.7%). The vestibular loss was the most frequent pattern in the patients (20 of 25). In contrast, only six controls (10%) had abnormal CTSIB, which was due to a vestibular loss pattern ($p=0.002$) (Table 4). An increased frequency of abnormal CDP was also observed in patients when compared with controls (14 [23.3%] of the patients versus 0 [0%] of controls) ($p<0.001$). Vestibular loss was also the most common CDP pattern in PsA patients since it was observed in nine of the 14

patients with abnormal CDP. When results between CTSIB and CDP were compared, two patients with PsA who presented a visually dependent pattern in CDP were considered as being normal because the composite SOT score was within normal values (>70%) (Table 5).

Using CPD as the gold standard test, the sensitivity of CTSIB was 100% because in our study 12 patients with PsA had abnormal CTSIB results (true positive results) with no false negative results. Specificity (true negative results) was 73% because 13 PsA patients showed false positive results by CTSIB (Table 6). The positive predictive value for detecting balance disorders in PsA patients was 48% and the negative predictive value was 100%.

DISCUSSION

We previously disclosed a marginally significant association of laboratory markers of inflammation (C-reactive protein and erythrocyte sedimentation rate)

TABLE 3. Summary of oculographic features in PsA patients with had nystagmus following positional and positioning tests

Pt/C no.	Ear (R/L)	SPVmax (°/s)	Latency (s)	Nystagmus Characteristics	BPPV Type	Caloric Test (%/side) ^a
1	R	3	15	H	No	35/R (abnormal)
2	R	5	23	H	No	15/L
3	L	7	14	H	No	30/L (abnormal)
4	R	3	16	H	No	10/L
5	L	6	7	L-R	PSC	Normal
6	R	25.5	0	HDCh (G)	HSC	36/R (abnormal)

^aCanal paresis in caloric test measured in percentage of deficit / ear side. Abnormal caloric test if more than 25%.

BPPV indicates benign paroxysmal positional vertigo; (G), geotropic; H, pure horizontal positional nystagmus without symptoms of vertigo; HDCh, horizontal direction changing; HSC, horizontal semicircular canal; L, left; L-R, linear-rotatory; No, absence of criteria for BPPV; No, absence of BPPV; PsA, psoriatic arthritis; PSC, posterior semicircular canal; Pt/C, patient/case.; R, right; SPVmax, maximal slow phase velocity in degrees per second (s). It shows the ear with a pathological condition.

TABLE 4. Patterns of abnormal CTSIB in patients with PsA and controls

Variable	PsA (n = 60) (%) ^a		Controls (n = 60) (%) ^a	P
	Abnormal CTSIB			
VD	0 (0)	0 (0)		–
SD	4 (6.7)	0 (0)		0.04
VL	20 (33.3)	6 (10)		0.002
SS	1 (1.7)	0 (0)		0.32

^aIndicates the total proportion of individuals with a particular variable.

CTSIB indicates clinical test of sensory integration and balance; PsA, psoriatic arthritis; SD, surface dependent; SS, sensory selection; VD, visually dependent; VL: vestibular loss.

Individuals were considered to have abnormal CTSIB when they were not able to maintain the position for more than 50% of the time.

n = indicates the total number of individuals in each subgroup.

with abnormal audiovestibular symptoms in patients with PsA (3). The present study constitutes the first attempt to assess the frequency of static postural abnormalities using both CTSIB and CDP tests in patients with PsA. The study examined the deficits of randomly chosen PsA patients and compared them to age-matched control subjects. Because of that, the study provides information on the disease-specific impact of PsA on balance. The results indicate an increased frequency of abnormal postural control of vestibular origin in patients with PsA. CTSIB was a useful method for assessing balance impairment in the routine clinical practice in these patients. BPPV was also found more frequently in PsA patients than in controls.

The etiology of the vestibular disorder in PsA is unknown. It may be of ischemic origin. Alternatively, it may be the result of an intralabyrinthine autoimmune process in these patients. Taking together, the results of our study support a peripheral vestibular abnormality in PsA patients. In this regard, 26.7% of PsA patients

TABLE 5. Comparison between patterns of abnormal CTSIB versus abnormal CDP in patients with PsA

Variable	PsA (n = 60) (%) ^a		P
	Abnormal CTSIB	Abnormal CDP	
VD	0 (0)	2 (3.3) ^b	0.50
SD	4 (6.7)	–	1.00
VL	20 (33.3)	9 (15)	0.004
SS	1 (1.7)	–	–
VP	–	3 (5)	–
Total	25 (41.7)	14 (23)	0.02

^aIndicates the total proportion of individuals with a particular variable.

^bTwo patients with PsA showed a visually dependent (VD) pattern in CDP test but they were included in the normal group because CDP they showed normal results in the composite SOT score (>70%).

CDP indicates computerized dynamic posturography; CTSIB, clinical test of sensory integration and balance; PsA, psoriatic arthritis; SD, surface dependent; SS, sensory selection; VD, visually dependent; VL, vestibular loss; VP, visually preference.

n = indicates the total number of individuals in each subgroup.

TABLE 6. Sensitivity and specificity of CTSIB for assessing postural abnormalities in patients with PsA

CTSIB Result	Abnormal CDP	Normal CDP	Total (n)
Abnormal	12 ^a (sensitivity = 100%)	13	25
Normal	0	35 (specificity = 73%)	35
Total (n)	12	48	60

^aTwo patients with PsA were included in the normal group because CDP in both cases showed normal results in the composite SOT score (>70%).

CDP indicates computerized dynamic posturography; CTSIB, clinical test of sensory interaction and balance; PsA, psoriatic arthritis.

n = indicates the total number of individuals in each subgroup.

presented abnormal caloric test results and 13.3% abnormal oculoccephalic response or head thrust test. Moreover, in the group of patients with abnormal CTSIB, up to 64% (16 of 24) had associated canal paresis (hypofunction) when caloric testing was performed. Therefore, we think that the combination of caloric and head thrust tests with CTSIB could be useful to determine the presence of balance impairment in patients with PsA.

Although normal individuals can also develop positional nystagmus when visual fixation is removed (11), none of the controls had horizontal positional nystagmus of peripheral vestibular characteristics in positional study. This finding was observed in four of the 60 patients with PsA. The presence of this finding in our patients may be the result of a vestibular damage, probably located at the peripheral level, which occurs slowly and gradually since none of the PsA patients suffered an acute vestibular syndrome and none of them recalled to have suffered vertigo before our assessment.

Although CDP is the gold standard test for balance studies (17), El-Kashlan et al. (18) reported that CTSIB can reliably distinguish patients with vestibular disorders from normal subjects and it may be a useful screening tool. Formal CDP is more exact in defining the specific pattern of dysfunction. Nevertheless, CTSIB results were found to have a good correlation with the dynamic posturography (19).

In our series, CTSIB and CDP abnormalities were common among PsA patients. Specifically, a vestibular pattern was found in around 20 and 40% of patients studied by CDP and CTSIB, respectively. When both tests were compared, sensitivity of CTSIB reached 100% whereas specificity only yielded 48%. Consequently, we support its potential use as a routine screening test for the assessment of vestibular involvement in patients with spondyloarthritis.

In the general population individuals with BPPV often experience postural instability without vestibular loss function in caloric test (11). In keeping with this finding, vestibular loss was the main pattern of abnormal CTSIB and CDP in two PsA patients who fulfilled BPPV criteria.

Regarding BPPV in PsA patients, its low frequency was similar to that found in patients with AS (6). This is in contrast with the higher frequency observed in vasculitic process such as giant cell arteritis and scleroderma (5,20). We think that the different pathogenesis of spondyloarthritis when compared with that of vasculitis syndromes may account for these differences.

A vestibular pattern observed in CTSIB is not always due to a peripheral vestibular lesion. In this regard, in our series, hypofunction in caloric test (canal paresis) was recorded in 64% of the patients with abnormal CTSIB while it was found in all patients who had abnormal CDP. Nevertheless, none of the controls with abnormal CTSIB had hypofunction in caloric test. Because of that, we think that in patients with PsA the presence of canal paresis may be an additional finding supporting the potential peripheral origin of the vestibular hypofunction, which was well correlated with CDP results.

CONCLUSION

The present study indicates that oculographic findings are common in PsA. CTSIB may be useful for balance disorder screening in the routine clinical practice in these patients.

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