



Balance Impairment Induced by Challenged Trials in HLA-B27 Carriers with Inflammatory Back Pain

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Abstract

Determine whether the postural function was impaired by comparing the performances in upright standing at ground in adult subjects with HLA-B27 carriers with Inflammatory Back Pain (IBP). Eleven subjects participated in the study, and all participants performed eight trials while standing upright on a platform with their feet on firm and foam surfaces. Tests were performed with their eyes open or closed and two-leg or one-leg supports. The postural sway was examined with a force platform that records sway indices, which were generally associated with group, firm or foam surfaces, open- or closed-eyes condition, and two-leg or one-leg standings after adjusting for age and gender. The differences of sway indices in HLA-B27 carriers with IBP were significantly increased at different trials when compared with controls. This study supports the hypothesis that HLA-B27 carriers with IBP weaken control of postural sway in varying stressful positions.

Keywords: Inflammatory back pain; HLA-B27; Sway index; Posture; Balance

Introduction

Chronic Inflammatory Back Pain (IBP) is the most prominent and frequent initial clinical feature of Ankylosing Spondylitis (AS) and other Spondyloarthritis (SpA) [1]. Patients with AS might suffer from neck injury [2], and SpA will induced peripheral joint inflammation [3]. It has been known that the tense correlation between human leukocyte antigen B27 (HLA-B27) and AS for more than 40 years [4]. A diagnosis of AS and other SpA can be predicted in one-third younger than 45 years-old-patients who having chronic low back pain (>3 months), either positive in clinical symptom of IBP, HLA B27 carries, or unilateral/bilateral sacroiliitis obtained from imaging [1,5]. Radiographs are often normal when first symptoms occur and radiological sacroiliitis always presents several years later in the course of AS. Therefore, HLA B27-posivity and IBP play the most important role in prodromal diagnosis of AS [6].

Impaired balance, unstable trunk mobility and fear of falling were related with increased threat of falls, and patients with SpA may have a larger hazard of falling due to worse control of posture and balance [7]. In a study of the balance abnormality in AS patients, Murray et al. [8] found that the AS patients with moderate type showed apparent balance abnormality in a percentage of 29% in eye open and 36% in eye closed when compared with mild and severe AS groups and concluded that the AS patients with moderate subtype have worse balance than the normal [8]. In contrast, another study of dynamic testing demonstrated neither significant differences in age, gender, body height, body weight or BMI between AS group and control group, nor a affirmative relationship between the Medial-Lateral (ML) stability index and Tragus Wall Distance (TWD) in AS patients [9]. In the meantime, the former study only described the balance abnormality, especially to moderate AS patients in terms of path length, rather than the detailed/precise parameters of sway as the popular ways [8] and the later study did not describe the balance abnormality in unstratified AS patients by dynamic testing [9].

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The simultaneous occurrence of HLA B27 carriers with Inflammatory Back Pain (IBP) is a prodromal situation far from to definite diagnosis of AS. We hypothesized that impaired control of postural sway in patients with HLA-B27 carrier either having IBP or not. In 2021, we started using a balance machine for teaching and practicing purposes. Another purpose was to teach our students/ interns how to use it for treatment of our patients and to assess balance control.

Materials and Methods

Study and control groups

Eleven subjects were included in our study. All subjects were selected based on medical records of HLA-B27 positive and inflammatory back pain. The exclusion criteria included age older than 50 years, simultaneous neurological, cardiovascular, or psychiatric disease, relentless uncorrected visual or auditory dysfunctions and habits of taking sedatives. Subjects with skeletal problems in the lower limbs owing to orthopaedic anomaly, or foot shape/formation malformations were also excluded. Another 11 healthy cases were controlled. Informed consent was obtained from each subject. The study was conducted in accordance with the principles of the Helsinki Declaration of 1975, as revised in 2004. The approval of the Institutional Review Board was waived by the human ethics committee due to the retrospective entity of the study and the fact that it was for teaching purposes only.

Study design and measurements

This cross-sectional study was conducted to evaluate sway parameters in 4 conditions as fixed set in the balance device. Postural sway was achieved using a Biodex balance system (Biodex Medical Systems, SD, 950-440, Inc., New York, USA). Patients were requested to stand motionless on a platform with firm and foam surfaces, two-leg or one-leg support, hanging arms down naturally. We tested each condition twice for 20's, eyes open and eyes closed, respectively, and took a rest for 2 min after each. Using software set up in the system, many sway indices were obtained via a data logger recording signal data from a platform. Reliable and reproducible of the platform has been affirmed as a measure of postural sway [10,11]. All subjects were tested for about 40 min. This procedure was the same as those of Després et al. [10]. Standing upright on a foam platform or one-leg support is assumed to disrupt the proprioceptive response of postural control [12,13].

Data and statistical analyses

We adopted Generalized Estimating Equations (GEEs) to judge the relationship of the interests and to adjust the correlations from measurements acquired under distinct conditions (eyes open vs. closed, firm vs foam surface, and two-leg vs one-leg standing), adjusted for potential confounders (age and gender) as well. A P value of 0.05 or less indicated a statistically significant difference. Contrast estimates were also performed after the final GEE models of sway indices. All feasible data was analyzed by PROC GENMOD (SAS, 9.13, Carry, NC, USA).

Results

Ten (91%) of the 11 subjects were male. The mean \pm standard deviation (SD) of age was 35.4 \pm 10.7 years. Sway indices were associated with group, firm or foam surfaces, open- or closed-eyes, and two-leg or one-leg standing (Table 1). Comparing the sway intensities group differences at different trials, the HLA-B27 carriers with IBP group versus control were 2.57 significantly increased (P<0.0001, Table 2); nevertheless, the differences between two groups were significant (all P < 0.0001, Table 2).

Table 1: Sway indices of balance testing detected from challenging trials and the combination of all trials in study group.

 Source: Model was assessed using generalized estimating equations, as well adjusted for age, and gender.

Conditions of Trial	Sway Indices (Two-Leg Standing)	Sway Indices (One-Leg Standing)	Mean of Sway Indices (Fixed Set in Biodex)
Eyes Open in Firm Surface	0.35±0.15	0.56±0.13	0.44
Eyes Closed in Firm Surface	0.78±0.18	3.82±0.19	0.8
Eyes Open in Foam Surface	1.19±0.29	2.92±0.29	0.79
Eyes Closed in Foam Surface	3.36±0.31	5.88±0.36	2.41
Composite Score	1.09±0.16	2.13±0.21	1.11

Table 2: Sway indices at different trials in AS patients.

Source: Model was assessed using generalized estimating equations, as well adjusted for age, and gender.

Parameter		Estimate	S.E.	Z	p-value
Intercept		4.45	0.11	28.87	< 0.0001
Group	AS vs. control	2.57	0.67	2.32	< 0.0001
Group	2 vs. 3	4.61	0.98	6.94	< 0.0001
Eyes	Open vs. Close	-2.16	0.79	-7.18	< 0.0001
Firm surface	Open vs. Close	-1.34	0.71	-7.43	< 0.0001
Foam surface	Open vs. Close	-2.54	0.36	-3.87	< 0.0001
Position	Two-leg vs. One-leg standing	-0.49	0.14	-4.86	0.0032

Discussion

In this study, we investigated into changes in postural sway examined on the ground and in stress in the HLA-B27 carriers with IBP while they kept an upright posture in eight trials aimed at challenging the accountability of vision (eyes open vs. closed) and proprioception (firm or foam surfaces, and two-leg vs. one-leg standing). The results demonstrated that sway indices were related with group, proprioception, and open- or closed-eyes, condition individually (Tables 1&2). This fact means proprioception may collectively revise the postural sway. Also, the sway indices of HLA-B27 carriers with IBP were significantly larger than controls during the upright standing tests.

Postural sway profiles owing to intended experimental conditions depend on multiple variables. The somatosensory systems, including vestibular, proprioceptive and visual inputs play an important role in postural control and stabilization at low frequencies of sway. Posture control systems usually need adjustment to maintain stance when orientation inputs from various senses are not enough. Consequently, to maintain postural steadiness, a higher postural stiffness should be combined with a corresponding elevation in damping [14,15]. Perpetuation of upright posture depends on integrity of the skeleton and related soft tissues of trunk and limbs (e.g., discs, joint capsules, and ligaments) that provoke reflex contraction of lumbar muscle groups and participated in the spinal-stabilizing system [16]. The somatosensory neuromusculoskeletal system of human body is crucial in feedback control when healthy persons place on a platform [17], which system is mainly attributed with proprioceptive receptors in the trunk and lower extremities [18-20]. Therefore, all of those information work together to establish the point of the protrusion of the center of a suprapedal mass relative to the feet and comparison of triggering postural corrections, the proprioceptive inputs from the trunk or hip are more essential than the lower legs [21]. A prior study found that patients with chronic low back pain have delayed the average trunk onset time during unstable sitting tests and concluded that the disturbed proprioception in lumbar spine and delayed lumbar muscle response times in chronic low back pain were associated with impaired posture control [22]. Coronal-planned positioning of the lumbar spine is a vital component for postural control while upright standing [23]. Endurance times of core muscle are highly related to fatigue and worse balance, because the ability of upholding the activity of trunk muscles (core muscle endurance) is inferior in those AS [24].

foam surface disrupted proprioceptive signals for control of posture and proprioceptive system may reimburse in the absence of visual and vestibular feedback while individuals stand closing their eyes or experiencing varying experiments. However, some obtained measurements of postural sway were still significantly different in HLA-B27 carriers with IBP while comparing controls. All of the rheumatic signs of SpA, including IBP could be explained by a primary inflammatory enthesitis over spines or other peripheral joints. We hypothesized that IBP might disturb performance of the proprioceptive signals and lumbopelvic stabilizing musculature via enthesitis. There are many musculatures in vertebral column, iliac crest and sacrum, and we believe that the coordination of the multifidus and lower parts of lumbar erector spinae [25] were disturbed by IBP when simultaneous contraction. That's why the main reason causing so different between groups of IBP in HLA-B27 positivity and controls.

Our remarkable findings were linked with the inspection that sway index is the most sensitive and reliable indicator for placing stability [26], better than the sway parameters of mean, area, velocity, and intensity used in the past [21,23,27,28]. Posture has been demonstrated to be affected in chronic lower back pain; hence, postural sway quantifies a subject's capacity to maintain center of steadiness. The sway index is an objective parameter of postural sway, which endows with a universal assessment of how well an individual may integrate various senses in consideration of balance and compensate while one or more of those senses are compromised. A high value of sway index designates a reduction in the one's ability to carry on upright posture during challenges. The lower the sway index the less unsteady the subject was under balance trials [26]. Sway index can reflect the performance of the postural sway from our results obtained in the control group. Therefore, standing upright might be a reproducible approach of determining postural sway, irrespective of placing on foam plane.

Opposing studies showed patients with mild AS do not have clinical deficits in spinal position sense [29] and no balance abnormality in dynamic testing in patients with AS [9]. We assumed that poor postural sway after plausible loss of proprioception and chronic back pain caused by IBP could be a main reason while the individual was in a challenging situation. The symptoms of IBP are persistent in early AS and then become intermittent, aggravating, or quiescent. We suggest that IBP and the loss of proprioception in the lumbopelvic musculature are more severe in HLA-B27 carriers with IBP and this resulted in a significant difference in sway parameters between IBP with HLA-B27 positivity. A comparison between previous reports was shown in Table 3.

Investigating the underlying reason regards our results, the

Table 3: Comparisons of the postural balance characteristics between two previous studies and our study.

Author	Chang ST (2021) [1]	Murray et al. [8]	Aydog et al. [9]
No. of subjects	11	30	70
Purpose and investigation	Static and dynamic balance function in AS	Static balance function in AS and the relationship between balance and posture.	Dynamic balance function in AS and the relationship between balance and posture.
Measurement of posture	None	Macrae's modification of Shober's test, tragus to the wall distance (TWD) and chest expansion	Bath Ankylosing Spondylitis Metrology Index (BASMI)

Stratifying AS subjects	No	Yes	No
Struttlying no subjects		105	
Balance device	Biodex Medical Systems, SD, 950-440, Inc., New York, USA	Sway magnetometry	Biodex, Inc., Shirley, NY, USA)
Tested mode	Challenging trials as set in device	Eyes open and eyes close	Eyes open only
Relationship between balance and posture.	Significant	No statistically significant differences may be due to insufficient subjects	Significant association between dynamic postural balance and TWD.
AS on balance	Yes. Negative for static trials and positive for dynamic ones.	Yes, Negative effect on postural stability, especially to moderate AS subjects	No negative effect on postural stability due to compensation from other unaffected structures (joints)

One of limitations of our study was the small sample size. The second was the role of Fat-suppressed MRI of the spine we did not consider, which defines the severity of enthesitis by excluding the higher signal of fat in the soft tissue and bone marrow and perpetuation of the higher signal from extra water in exact locations of inflammation. This suggests a potential direction for us to explore HLA-B27 carriers with IBP.

Conclusion

In conclusion, the observed postural stability of HLA-B27 carriers with IBP when upright standing at various challenging trials was poorer than control. Significant differences in sway indices in HLA-B27 carriers with IBP appeared when compared to controls. This study carries out the hypothesis that IBP in IBP with HLA-B27 positivity majorly weakens control of postural function in stressful upright postures, which mechanism might be attributed by IBP and poorer control of posture.

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