EJR European Journal of Rheumatology

DOI: 10.5152/eurjrheum.2015.15104

Original Investigation

Postural deformities: potential morbidities to cause balance problems in patients with ankylosing spondylitis?

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Abstract

Objective: This study aimed to assess the impact of postural deformities caused by ankylosing spondylitis (AS) on balance problems.
Material and Methods: This study included 29 patients with AS and 21 healthy controls. For assessing exercise capacity and dynamic balance, timed up and go test, five times sit-to-stand test, gait speed, and 6-min walk test were performed. Romberg tests were used to evaluate static balance and proprioception, whereas Dynamic Gait Index (DGI), Functional Gait Assessment (FGA), Berg Balance Scale (BBS), Activity Specific Balance Confidence Scale (ABC), Dizziness Handicap Inventory (DHI), and functional reach test were used to assess dynamic balance and the risk of falling. Using Bath Ankylosing Spondylitis Metrology Index (BASMI) scores, patients with AS were divided into two groups: those with scores 0–4 were assigned to subgroup AS1, and those with scores 5–10 were assigned to subgroup AS2.
Results: In the whole group of patients with AS, five times sit-to-stand test, tandem Romberg test with eyes closed, and BBS and ABC scores were significantly worse than the healthy controls ($p<0.05$). In the AS2 subgroup having more severe and advanced disease, five additional parameters, including timed up and go test, 6-min walk test, functional reach test, FGA, and DHI scores were also significantly worse than the healthy controls ($p<0.05$). Comparing the two subgroups with each other, only BBS scores were significantly worse in the AS2 subgroup than in the AS1 subgroup.
Conclusion: Although in clinical practice, poor balance is not a common problem in AS, possibly because of compensatory mechanisms, patients with AS have poorer static and dynamic balance than healthy subjects. Significantly worse BBS scores in the AS2 subgroup than in the AS1 subgroup may suggest the presence of more dynamic balance problems in advanced disease; however, future studies comprising larger samples are necessary to confirm this assumption.
Keywords: Ankylosing spondylitis, postural balance, postural deformities

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Submitted: 10.11.2014
Accepted: 15.06.2015
Available Online Date: 21.08.2015

Introduction

Ankylosing spondylitis (AS), a chronic rheumatic disease, primarily affects the vertebral column and sacroiliac joints and is characterized by vertebral deformities and progressive decrease in the range of motion. It is commonly observed in young adults (1), and the prevalence in the general population ranges between 0.1% and 1.4% (2). Over time, vertebral fusion results in stooped posture and decreased vertebral mobility. In later stages of the disease, thoracic kyphosis is increased, rigid fusion of the whole vertebral column causes limited motion, including the cervical vertebrae, and the body's center of mass is anteriorly shifted (3). To compensate for these biomechanical changes, flexion of knees, dorsiflexion of ankles, extension of hips, and tilting of the pelvis are increased. Overall, these postural changes make it tiresome for the patient to stand erect or to walk for a long period (4). Besides, these postural changes may be expected to cause balance problems in advanced stages. In literature, there is conflicting data regarding this topic, and this may be because of the usage of different methods in previous studies, evaluating balance and postural stability in AS (2, 5-8). Therefore, we aimed to assess the impact of AS-related postural deformities on balance.

Material and Methods

In the present cross-sectional study, 29 patients with AS, fulfilling the 1984 Modified New York Criteria, and being followed up by the outpatient clinics of both Rheumatology and Physical Medicine and Rehabilitation Departments of our University Hospital, were enrolled. As the control group, 21 healthy controls from the hospital staff were also included. Study protocol was approved by the local ethics committee, and all the participants were asked to sign an informed consent form.

Table 1. Demographic characteristics of all the participants

	Healthy control group (n=21)	AS1 Group (n=18)	AS2 Group (n=11)
Male/Female (n)	16/5	14/4	11/0
Age (years) (mean±sd)	36.8±9.7	42.8±9	46.8±8.5
BMI (mean±sd)	26.2±3.9	27.1±4.6	28.1±6.4
Marital status (married %)	86.2	88.9	81.8
Occupation (n)			
Laborer	1	3	2
Office worker	10	3	0
Retired	2	2	3
Other	8	10	6

n: number of subjects; BMI: body mass index; sd: standard deviation; AS: ankylosing spondylitis

Table 2. Clinical characteristics of patients with ankylosing spondylitis

	AS1 Group (n=18)	AS2 Group (n=11)
Symptom duration (mean±sd) (years)	15.4±8.1	21.7±11.8
Disease duration (mean±sd) (years)	8.2±7.6	10.2±6.4
BASMI (mean±sd)	2.4±1.5	6.7±1.7
BASDAI (mean)	3.6±1.9	3.4±1.9
BASFI (mean)	3.5±2.5	4.9±2.5
ASQoL (mean)	6.5±5.1	7.6±4.4
BDI	8.1±6.8	13.2±7.4
NSAID use (%)	94.4	90.9
Sulphasalazine use (%)	55.6	36.4
Methotrexate use (%)	11.1	0
Etanercept use (%)	0	27.4
Adalimumab use (%)	11.1	0
Infliximab use (%)	16.7	18.2

n: number of subjects; sd: standard deviation; BASMI: bath ankylosing spondylitis metrology index; BASDAI: bath ankylosing spondylitis disease activity index; BASFI: bath ankylosing spondylitis functional index; ASQoL: ankylosing spondylitis quality of life; BDI: Beck Depression Inventory; AS: ankylosing spondylitis; NSAID: nonsteroidal anti-inflammatory drug

Demographic data (age, sex, body mass index, treatment regimes, co-morbidities, symptom and disease durations, history of falls, and joint replacement operations) were recorded for all participants. Detailed physical examination, including the locomotor system, was performed on all participants. In patients with AS, disease activity and functional status were assessed using the Bath Ankylosing Spondylitis Disease Activity Index (9) and Bath Ankylosing Spondylitis Functional Index (10), respectively. Spinal mobility measurements, including lower Schober's test, hand–floor distance, tragus-to-wall distance, lumbar lateral flexion, chest expansion, and intermalleolar distance were conducted in all patients with AS as defined in Bath Ankylosing Spondylitis Metrology Index (BASMI) (11). Patients with AS were divided into two subgroups on the basis of the BASMI scores. Those with BASMI scores ranging between 0 and 4 were assigned to subgroup AS1, and those with scores between 5 and 10 were assigned to subgroup AS2.

Balance status was investigated in all of the participants using the following tests and assessment methods. For assessing exercise capacity and dynamic balance, timed up and go test (12), five times sit-to-stand test (13), gait speed (14), and 6-min walk test (15) were performed. Romberg tests (eyes open and closed, feet together, tandem, and on a soft surface) (16) were used to assess the static balance and proprioception, whereas Dynamic Gait Index (17), Functional Gait Assessment (FGA) (18), Berg Balance Scale (BBS) (19), Activity Specific Balance Confidence Scale (ABC) (20), Dizziness Handicap Inventory (DHI) (21), and functional reach test (12) were used to assess dynamic balance and risk of falling. Besides, depression was assessed using Back Depression Inventory (BDI) (22).

Two subgroups of AS, namely AS1 and AS2, were then compared with each other as well as with healthy controls. Mann–Whitney U test and Kruskal–Wallis test were used for the statistical analysis using SPSS version 20.0 (IBM software; New York, USA).

Results

The demographic data of all participants are given in Table 1, whereas clinical characteristics, scores, and the results of the measured parameters are given in Table 2. Mean symptom duration for AS1 and AS2 patients were 15.4±8.1 and 21.7±11.8 years, respectively, whereas mean disease duration (time period from the diagnosis) for the two groups were 8.2±7.6 and 10.2±6.4 years, respectively. One patient in the AS2 group had undergone a left hip replacement surgery in the past. None of the patients reported falling in the last 6 months.

Balance test scores are given in Table 3. In the whole group of patients with AS, five times sit-to-stand test, tandem Romberg test with eyes closed, BBS and ABC scores, and BDI scores reflecting depression severity were significantly worse than the healthy control subjects ($p<0.05$). When only the AS2 subgroup of patients were considered, five additional parameters, including timed up and go test, 6-min walk test, functional reach test, FGA, and DHI scores were also significantly worse than the healthy control subjects ($p<0.05$). However, those five additional balance parameters were not significantly different between AS1 and AS2 subgroups of patients. When we compared these two subgroups of patients with AS with respect to all parameters assessing balance, only BBS scores were significantly worse in patients with AS2 than in patients with AS1 ($p<0.05$). Likewise, in the whole group of patients with AS, BASMI scores were negatively correlated only with BBS scores ($p<0.05$).

In order to have an idea about the power of the present study, post-hoc power analysis was performed for some tests. Among five tests that were found to be significantly worse

Table 3. Balance scores of AS1 and AS2 subgroups of patients with ankylosing spondylitis and healthy controls

	Healthy Control (n=21)	AS Group	AS1 Subgroup (n=18)	AS2 Subgroup (n=11)	p1	p2	p3
Five times sit-to-stand test (seconds) (mean±sd)	9.5±1.4	13.5±4.1	13.1±4.4	14.1±3.7	0.001	0.001	>0.05
Romberg test (seconds)							
Feet together, eyes open	30±0	30±0	30±0	30±0	>0.05	>0.05	>0.05
Feet together, eyes closed	30±0	29.6±1.3	29.8±0.7	29.3+2.1	>0.05	>0.05	>0.05
Standing on cushion, eyes open	30±0	30±0	30±0	30±0	>0.05	>0.05	>0.05
Standing on cushion, eyes closed	30±0	29.4±2.7	30±0	28.6±4.5	>0.05	>0.05	>0.05
Feet tandem, eyes open	30±0	29.3±3.7	30±0	28.16.0	>0.05	>0.05	>0.05
Feet tandem, eyes closed	30±0	22.8±9.5	22.7±98	22.9±9.5	0.04	0.01	>0.05
DHI (mean±sd)	0.7±1.9	8.4±11.5	7.2±7.1	10.5±16.8	>0.05	<0.01	>0.05
ABC (mean±sd)	100±0	86.6±20	89.7±14.3	81.6±26.9	<0.01	<0.01	>0.05
Timed up-and-go test (seconds) (mean±sd)	6.6±1.1	10.6±16	8.6±2.4	11.1±20.5	>0.05	0.01	>0.05
6-min walk test (meters) (mean±sd)	599±98	407±142	425±135	377±153	>0.05	<0.01	>0.05
Functional reach test (centimeters) (mean±sd)	38.8±7.8	24.1±12.5	27.5±12.2	18.5±11.5	>0.05	<0.01	>0.05
FGA (mean±sd)	29.9±0.2	28.8±3,2	29.6±1.0	27.5±4.9	>0.05	0.01	>0.05
BBS (mean±sd)	55.3±1.5	54.6±3.0	55.7±0.6	52.9±4.4	<0.01	0.03	0.04
DGI (mean±sd)	23.8±0.6	23.2±2.5	23.8±0.4	22.1±4.0	>0.05	>0.05	>0.05
Gait speed (seconds/meter) (mean±sd)	0.9±0.1	0.9±0.2	0.8±0.2	1.0±0.3	>0.05	>0.05	>0.05

p1: significance level between whole AS group and healthy controls, p2: significance level between AS 2 subgroup and healthy controls, p3: significance level between AS1 and AS2 subgroups, n: number of subjects, sd: standard deviation; AS: ankylosing spondylitis; DHI: dizziness handicap inventory; ABC: activities specific balance confidence scale; FGA: functional gait analysis; BBS: Berg Balance Scale; DGI: dynamic gait index

in patients with AS than in healthy controls, two tests (BSS and tandem Romberg test) were chosen. The power of comparison of BSS among the three groups was calculated as 0.838, whereas the power of comparison of tandem Romberg test with eyes closed was calculated as 0.845. Because these figures are greater than 0.80, we believe that the power of the present study may be considered as adequate, despite sample size problems.

Discussion

In this study, we assessed the effect of postural deformities on dynamic and static balance in patients with AS and found that four parameters assessing balance, namely five times sit-to-stand test, tandem Romberg test with eyes closed, BBS, and ABC scores were significantly worse in the whole group of patients with AS than in healthy controls. Furthermore, in the subgroup of patients with AS with higher BASMI scores, i.e., in the AS2 subgroup, the number of significantly worse parameters assessing balance was increased to nine than in healthy controls. When we compared two subgroups of patients with AS, only BBS scores, which evaluate both static and dynamic balance and risk of falling, were found to be significantly worse in the AS2 subgroup.

While interpreting our findings, one should consider that "ceiling effect" may have confounded our measurements in some of these tests. "Ceiling effect" refers to the level above which variance in an independent variable can no longer be measured or estimated by a test. In fact, many tests that we used for assessing balance in our study had originally been developed and validated for patients with neurological problems. Unfortunately, there is not sufficient experience with the use of these tests in AS. This is probably the main reason of occurrence of ceiling effect in many patients. Unlike patients with neurological diseases, patients with AS may have compensated both postural instability and subtle balance problems with intact neuronal balance pathways and may have reached better scores in measurements. Probably, this is another probable reason of the "ceiling effect", which may have affected our findings. The problem of "ceiling effect" was also pointed out in a previous study by Noren et al. (23) who assessed the different applicability of clinical balance tests in patients with rheumatoid arthritis (RA). They found that although patients with better functional status performed better, BBS and "timed up-and-go test" results were also confounded by "ceiling effect."

In contrast, the heterogeneity and overlapping features of balance tests together with the lack of sufficient literature experience in patients with rheumatic diseases made it difficult to choose which tests to be used in the present study. Because none of the tests were specifically designed for or validated in patients with AS, we utilized various, sometimes overlapping tests for assessing both dynamic and static balance, to prevent any missing finding.

In literature, there is limited number of previous studies investigating balance problems in patients with AS. The relatively conflicting results reported in those studies were possibly because of different methods used. Among those studies, Aydoğ et al. (6) found no significant negative effect of AS on pos-

tural stability; however, they pointed out that tragus-wall distance may correlate with dynamic postural instability, particularly in patients with AS with advanced disease stage. According to these authors, increased knee flexion, ankle dorsiflexion, and hip extension in AS may help to compensate for the vertebral deformities by means of shifting the body's center of mass. Aydoğ et al. (6) also speculated that enthesopathy occurring in AS may damage the afferent nerve fibers in ligaments, tendons, and joint capsule, thereby disturbing proprioception. Supporting this speculation, we also found that tandem Romberg test performed with closed eyes, which evaluated proprioception, was significantly worse in the patients with AS than in healthy controls. However, Swinkles et al. (24) suggested that proprioceptive deficiencies occurring in AS were compensated by other systems and caused no balance problems.

Vergara et al. (5) found that static postural control of patients with AS, particularly in the frontal plane, was significantly worse than the control group and suggested that these biomechanical alterations were compensated with neuromuscular strategies. Durmus et al. (7) also reported the presence of postural instability in AS that became more apparent in patients with a longer tragus-wall distance as a sign of more advanced disease. Murray et al. (3) investigated whether patients with AS had poorer balance than normal subjects using sway magnetometry in 30 subjects with AS. They made quantitative measurements of movement at the hips with eyes open and eyes closed and compared the results with the data from 58 normal subjects. Moreover, they investigated whether there was any relationship between balance and posture in AS. They reported that the numbers of patients with poor balance were significantly greater than expected. However, they could find no significant relationship between balance and any of the quantitative descriptions of posture.

Although balance problems may occur in AS, as suggested in the limited number of previous studies and confirmed in the present study, one may wonder why poor balance is not a common problem in patients with AS in clinical practice. The chronic nature of the disease, slow progression of postural deformities, and possibly compensatory mechanisms against postural instability may explain this paradox. Because hip extension is generally limited due to disease involvement in late stage AS, compensation for the increased thoracic kyphosis is mainly performed by ankle dorsiflexion and knee flexion as suggested by Bot et al. (8). These authors also emphasized the importance of early surgical hip interventions as a way to combat increased workload on the knees and ankles.

None of the previous studies concentrating on balance problems in patient population with AS touched upon the incidence of falls in those patients, contributed and/or caused by balance disturbances. In the present study, we found that ABC scores provided an idea regarding risk of falls were significantly worse in the whole group of patients with AS than in healthy controls.

The most important limitation of this study is small numbers in each subgroup of patients. Unfortunately, we could not recruit additional patients to this study for technical reasons. We admit that the sample size problems may have affected our results, particularly creating a tendency for type two errors. In contrast, as pointed out in the "Results" section, the power of the present study may be considered as adequate, despite sample size problems. Because post-hoc power analysis for BSS and tandem Romberg test with eyes closed revealed power of 0.838 and 0.845, respectively.

In conclusion, the present findings support the concept that patients with AS have poorer static and dynamic balance than healthy subjects. Balance problems may be even more severe in advanced disease as suggested by significantly worse BBS scores in the AS2 subgroup than in the AS1 subgroup. In clinical practice, poor balance is not a common problem in patients with AS possibly because of compensatory mechanisms. Because patients with AS have fracture risk factors, such as osteoporosis and immobilization, subclinical balance problems may facilitate consequential falls, thereby increasing morbidity. We believe that the presence of subclinical balance problems should be considered particularly in patients with advanced disease, and relevant precautions should be taken if present. Future studies including larger number of patients will be necessary to confirm the presence of balance problems in AS as well as to find out whether advanced disease in AS would cause more severe balance problems.

Ethics Committee Approval: Ethics Committee approval was received for this study from the ethics committee of Ege University School of Medicine.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - Y.A., H.K., E.C.; Design - Y.A., H.K., E.C.; Supervision - Y.A., H.K., G.K.; Materials - E.C., G.K.; Data Collection and/or Processing - E.C., R.D.; Analysis and/or Interpretation - E.C., G.K., R.D.; Literature Review - E.C., G.K.; Writer - E.C., G.K., Y.A., H.K.; Critical Review - G.K., R.D.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The author declared that this study has received no financial support.

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