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ORIGINAL ARTICLE

Foot functions in ankylosing spondylitis

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Abstract

Aim Because of the wide diversity of developmental stages in spondyloarthropathies (SpA), clinical and radiographic weak correlations are often found in the development of enthesopathies. In this study, foot functions of ankylosing spondylitis (AS) patients were analyzed with clinical and radiological features.

Method Sixty-two AS patients and 39 age-matched, gender-matched, and body mass index (BMI)–matched healthy volunteers were included in this study. Acute-phase reactant levels of participants were recorded. The disease activity and functionality were assessed using the Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) and Bath Ankylosing Spondylitis Functional Index (BASFI). Foot functional index (FFI) and timed up and go test (TUG) were performed by the same educated nurse. Radiographically, the SpA-tarsal radiographic index (TRI) and the calcaneal inclination angle (CIA) were measured by the same physician to assess midfoot and arches.

Results FFI subscores and total, TUG results, and CIA measurements were found to be significantly higher in the AS group ($p < 0.05$). FFI-pain, FFI-disability, and FFI-activity limitation subscores were significantly and positively correlated with BASDAI and BASFI scores ($p < 0.05$). Radiological changes ranging from grade 1 to grade 4 were detected in 68% of the AS paients according to TRI. Nineteen AS patients had pes planus and 26 AS patients had pes cavus deformity.

Conclusion The foot and ankle are frequently affected during the course of AS. Foot involvement and its functional impacts should be assessed regardless of the disease activity parameters in AS patients.

Keywords Ankylosing spondilitis · Enthesis · Enthesopathy · Foot

Introduction

Spondyloarthropathies (SpAs) are a group of disorders involving chronic inflammatory conditions with distinctive clinical, radiographic, and genetic features. The prototype of the group is ankylosing spondylitis (AS) and the main feature of AS is inflammatory back pain and enthesitis (inflammation of the tendon, ligament, joint capsule of bone site). It can affect both axial and peripheral joints. Entesis of the Achilles tendon and areas of the plantar fascia, such as the calcaneal insertion site and patellar tendon insersions, are clinically associated with pain and swelling around the joint [1, 2]. Enthesopathy appears to be a diagnostic and lesional element and is commonly seen in inflammatory SpA and partially, with juvenile rheumatisms. The mechanism of the formation of enthesopathic lesions is still uncertain. Tendinoperiosteal findings appear to be important in the development of the prespondilitic stage [3]. Plantar fascia is the most common chronic enthesitis area in SpA [4].

Enthesopathies, particularly with regard to pain and symptoms, can cause limitations of foot-related functions in AS [5]. Because of the wide variation in the developmental stages of the disease, enthesopathies are poorly correlated with clinical and radiographic findings [6–9]. Foot involvement is very common in SpA. Here, foot functions were evaluated using the clinical and radiological features with the light of the current literature in AS patients.

Material and Method

This is a case-control study conducted between April 2018 and August 2018. A total of 62 AS patients and 39 healthy

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volunteers similar to the case group in terms of age, gender, and body mass index (BMI) were enrolled in the study. Patients with AS met the 2010 Assessment of SpondyloArthritis International Society (ASAS) Classification Criteria [10]. AS patients with axial or peripheral involvement were included in the study.

Patients who had previous hip, knee or ankle surgery, trauma, fracture, contractures in the lower extremities, corticosteroid injection in the last 3 months, polyneuropathy/lower extremity neuropathy, severe radiculopathy, and congenital foot deformity were excluded from the study.

Data collection

Data were recorded including age, gender, body mass index (BMI), disease duration, drug use, presence of calcaneal enthesophyte, and acute-phase reactants levels. On the same day of physical examination, blood samples were obtained from all participants. C-reactive protein (CRP) and the erythrocyte sedimentation rate (ESR) were analyzed using standard laboratory techniques. Disease activity was assessed using the Bath Ankylosing Spondylitis Activity Index (BASDAI) and functionality was evaluated using the Bath Ankylosing Spondylitis Functional Index (BASFI) [11, 12]. Foot function index (FFI) and timed up and go test (TUG) were used to measure the effects of foot pathologies on disability and activity limitation. Radiologic changes were evaluated using the SpA-tarsal radiographic index (TRI) and measuring the calcaneal inclinational angle (CIA).

Foot function index

FFI which evaluates pain, disability, and activity restriction includes 23 items and 3 subscales. The pain subscale measures the level of foot pain in a variety of situations and the degree of difficulty in performing various functional activities depending on foot problems is determined by the disability subscale. The activity limitation due to foot problems is evaluated with the activity limitation subscale. All items are scored with the visual analogue scale (VAS), taking into account the foot conditions 1 week earlier. Higher scores indicate worsening of pain, disability, and limited activity [13].

Timed up and go test

The TUG is used to assess the risk of falling and mobility. A chair and a stopwatch are required to perform the test. The test is carried out with the patient's shoes that always used and the distance of 3 m in front of the chair is determined. The participant is asked to stand up from the chair, walk 3 m away, turn, and sit again. The elapsed time gives the result of the test [14]. The test was performed by an educated nurse.

Calcaneal inclination angle

CIA represents an angle created by a line parallel to the weight-bearing surface and a line connecting the plantar edge of the calcaneal tubercle of the posterior tuberosity and the plantar edge of the calcaneocuboid joint surface on the lateral foot view. It is drawn on a weight-bearing lateral foot radiograph between the calcaneal inclination axis and the supporting surface. It is a measurement that reflects the height of the foot framework, but is affected by abnormal pronation or supination of the foot. CIA is decreased in the flatfoot group. The measurement of CIA between 10 and 20° is indicative of pes planus and higher than 30° is indicative of pes cavus [15, 16].

Spondiloartropati-tarsal radiological index

TRI score ranges from 0 to 4 (0 = normal; 1 = osteopenia or suspicious findings; 2 = definite joint space narrowing, bony erosion(s), periosteal whiskering, or enthesophyte(s) in the plantar fascia or Achilles tendon attachments; 3 = para-articular enthesophyte(s); 4 = bony ankylosis (joint space fusion or complete bridging)). The SpA-TRI is used for an assessment of the tarsal impact in patients with SpA [17].

Ethical consideration

The ethics committee of our university approved this study (number: 2018/178).

Statistical analysis

Statistical analyses were performed using the Statistical Package for the Social Sciences 22 (IBM SPSS for Windows version 22, IBM Corporation, Armonk, NY, USA). Continuous data were presented as mean ± standard deviation and categorical variables were summarized as number and percentages. The Kolmogorov-Smirnov test was used for the evaluation of normal distribution. Comparisons of groups were performed using the chi-square tests for categorical variables. The continuous variables of the groups were compared using the independent sample t test or Mann-Whitney U test depending on the distribution of the data. Spearman's rho test is used for correlation analysis. p value < 0.05 was considered statistically significant.

Results

A total of 62 AS patients (38 males, 24 females) and 39 healthy volunteers (27 males, 12 females) were enrolled in the study. No significant differences were found between the patient and control groups in terms of age, sex, and BMI

($p > 0.05$). Calcaneal enthesophyte was detected in 34.4% ($n = 18$) of the AS patients. Of the patients, 48.3% were using biologics and 38.7% were using disease-modifying antirheumatic drugs (DMARDs). Additionally, all patients were using nonsteroidal anti-inflammatory drugs (NSAIDs). FFI subscores and total scores, TUG results, and CIA measurements were found to be significantly higher in the AS group as compared with the control group ($p < 0.05$). The descriptive and analytical data of the groups are shown in Table 1.

In AS patients; FFI-pain, FFI-disability, and FFI-activity limitation subscores were significantly and positively correlated with BASDAI and BASFI scores ($r = 0.645$, $p < 0.001$; $r = 0.601$, $p < 0.001$; $r = 0.622$, $p < 0.001$; $r = 0.728$, $p < 0.001$; $r = 0.502$, $p < 0.001$; $r = 0.629$, $p < 0.001$, respectively). FFI-disability and FFI-activity limitation subscores were significantly and positively correlated with BMI ($r = 0.352$, $p = 0.006$; $r = 0.317$, p 0.014). No significant correlations were found between FFI total scores and age, BMI, disease duration, CRP and ESR concentrations, TRI and CIA measurements, BASDAI and BASFI scores, and TUG results ($p > 0.05$). No significant correlations were found between TRI, CIA measurements and age, BMI, disease duration, CRP and ESR concentrations, BASDAI and BASFI scores, and TUG results in AS patients ($p > 0.05$).

The distributions of foot arc abnormalities of the groups are shown in Table 2; the distribution of the TRI in the AS group is shown in Table 3.

Discussion

Foot joints damage which can be caused by inflammatory, metabolic, or degenerative diseases which leads to functional insufficiency and disability. The foot involvement in SpA differs from rheumatoid arthritis (RA) and has characteristic features in joints, periarticular structures, and surfaces. Besides the axial involvement, enthesitis and inflammation in the midfoot and tarsus are accompanied by the disease. Midfoot involvement or tarsitis causes diffuse and persistent swelling extending from the ankle to metatarsophalangeal joints. In acute stage, it leads to temporary disability and discomfort. In chronic stage, tarsitis causes structural damage and impairment which permanently worsening the functional status [17]. Therefore, we aimed to evaluate foot function using the clinical and radiologic tools in AS patients.

In our study, FFI scores and TUG results were significantly higher in AS patients. Walking abnormalities due to involvement of the foot and lower extremities can occur in inflammatory rheumatic diseases [18, 19]. Arthritis, enthesitis, metatarsal synovitis, and deformations affect the functional capacity and walking performance of AS patients. Sahlı et al. [20] reported that 52% of SPA patients had foot involvement and 35% of the cases were symptomatic. Consistent with this study, foot involvements may have affected the FFI scores and TUG results of the AS patients in our study. Although no significant correlations were found between FFI total scores and disease activity parameters, FFI-pain, FFI-

Table 1 The descriptive and analytic data of the groups

	AS ($n = 62$)	Control ($n = 39$)	p
Age (year)	40.5 ± 10.3	41.6 ± 13.5	0.67
Gender (male/female)	38/24	27/ 12	0.14
BMI (kg/m^2)	28.1 ± 4.5	27.8 ± 4.3	0.68
Disease duration (year)	8 (1–28)[a]	–	
CRP (mg/dL)*	10.5 ± 16.3	5.2 ± 3.1	0.049
ESR (mm/h)	14.2 ± 12.2	13 ± 6.4	0.56
TRI (0–4)	2.1 ± 0.8	–	
Calcaneal enthesophyte	18/34.4%	–	
TUG (s)*	10.5 ± 3.2	6.7 ± 1.6	0.000
CIA (degree)*	32.4 ± 6.1	28 ± 4.6	0.001
FFI, total*	129.8 ± 52.5	83.8 ± 59.9	< 0.001
FFI, pain subscale*	44.9 ± 22.8	31 ± 22.9	0.004
FFI, disability subscale*	52.4 ± 28.3	35.7 ± 25.1	0.003
FFI, activity limitation subscale	32.4 ± 13.8	17 ± 15.7	< 0.001
BASDAI	3.7 ± 1.8	–	
BASFI	2.9 ± 2.2	–	

BMI, body mass index; *ESR*, erythrocytes sedimentation rate; *CRP*, C-reactive protein; *BASDAI*, Bath Ankylosing Spondylitis Disease Activity Index; *FFI*, foot functional index; *TRI*, tarsal radiological index; *BASFI*, Bath Ankylosing Spondylitis Functional Index; *CIA*, calcaneal inclination angle; *TUG*, time up to go test. *Statistically significance. $p < 0.05$. [a] Median (min–max)

Table 2 The distribution of foot types according to CIA

	AS ($n = 62$)	Control ($n = 39$)	p
Pes planus (10–20°)	19	6	1.000
Medium (20–30°)	17	21	
Pes cavus (> 30°)	26	12	

*Statistically significance. $p < 0.05$. *CIA*, calcaneal inclination angle; *AS*, ankylosing spondylitis; *n*, number

disability, and FFI-activity limitation subscores were significantly and positively correlated with BASDAI and BASFI scores in AS patients. Laatiris et al. [21] found that enthesitis indexes were significantly and positively correlated with BASDAI and BASFI. Additionally, enthesitis scores were significantly correlated with deterioration of quality of life. Based on these results, increased rates of enthesitis and foot involvements parallel to disease activity may have negatively affected the functional capacity of our patients.

In SpA, Achilles tendinitis produces thickening of the tendon, and retrocalcaneal bursitis obliterates the normal radiolucency [22]. Lopez-Bote JP et al. [23] reported the formation of calcaneal erosive lesions in the early stages of AS and sclerotic and proliferative lesions in the late stages of AS. We evaluated the tarsal impact of the AS patients using the SPA-TRI. Radiographs were detected as normal in 32% of the patients. Radiological changes ranging from grade 1 to grade 4 were detected in the remaining patients. Additionally, no significant correlations were found between TRI scores and age, BMI, disease duration, and clinical and laboratory disease activity parameters in our study. Sahlı et al. [20] compared SPA patients with and without foot involvement and no significant differences were found between the groups in terms of gender, BMI, marital status, working status, morning stiffness, VAS, ESR, BASDAI, and BASFI. Hamdi et al. [24] evaluated the radiographs of the knee and foot in AS patients and significant correlations were found between radiographic changes and BASDAI and BASFI scores. However, no significant correlations were detected between radiologic changes and Ankylosing Spondylitis Quality of Life scores in their study. In our study, we used direct radiographs to investigate the foot involvement in AS patients. Although direct radiography is the first choice, its sensitivity is limited compared to ultrasonography and magnetic resonance imaging. The occurrence of radiographic changes takes time to develop, resulting in diagnostic delays. Radiographs generally demonstrate chronic inflammation, enthesitis, and tarsitis, which are less painful than acute forms. For the reasons mentioned above, the clinical and laboratory course of AS may have failed to correlate with the course of the radiographic structural foot changes in our study.

Foot arches are formed by tarsal and metatarsal bones and strengthened by ligaments and muscles. Relatively high (cavus foot, talipes foot, or pes cavus) or low (flatfoot or pes planus) medial longitudinal arches (MLAs) can result in musculoskeletal disorders affecting the lower limb and foot functions [25]. In our study, CIA which shows foot arch abnormalities was significantly higher in the AS group. Of 62 AS patients, 19 had pes planus and 26 had pes cavus deformity. The presence of foot arch abnormalities was similar to controls. Sahlı et al. [20] evaluated the foot prints of the SPA patients using a podoscopic examination. Twenty-three of 60 patients had abnormal foot prints, pes cavus deformity was detected in 14 patients and pes planus deformity was detected in 9 patients. Erdem et al. [26] reported that the most commonly affected anatomical regions were the hindfoot (83%), midfoot (69%), and ankle (22%) according to magnetic resonance images of AS patients. Midfoot involvement, tarsitis, and inflammation of transverse tarsal joint may contribute to the occurrence of MLA deformities in AS patients. In our study, no significant correlations were found between CIA and FFI scores and laboratory and clinical disease activity parameters. Decrease (pes planus) or increase (pes cavus) in CIA measurements can be detected in AS patient. Since both deformities adversely affect foot functions and functionality, significant correlations may not be found.

Limitation of the study

This study has some limitations. Sample size is small. We evaluated foot involvements using the direct radiographs. Ultrasonography or magnetic resonance imaging was not used in our study. We did not evaluate an enthesitis score. As a result of small sample size, we could not compare axial and

Table 3 The distribution of TRI of the AS group

Grade	*n*/%
0 (normal)	20/32.2
1 (suspicious findings, osteopenia)	10/16.1
2 (joint narrowing, bony erosions, periostal whiskering, or enthesophytes	18/29
3 (para-articular enthesophyte)	13/20.9
4 (bony ankylosis)	1/1.6

AS, ankylosing spondylitis; *TRI*, tarsal radiological index; *n*, number; %, percentage

peripheral AS patients. Presence of Achilles tendinitis, plantar fasciitis, lower extremity arthritis, and postural abnormalities was not recorded.

Conclusion

Although the foot and ankle are frequently affected during the course of rheumatic diseases, they are poorly evaluated and treated. Foot involvement including enthesitis, tarsitis, and deformities is an important cause of disability and functional impairment in AS patients. Foot involvement and its impact on functional status should be assessed regardless of the disease activity parameters in AS patients.

Compliance with ethical standards

The study was approved by the local ethics committee.

Disclosures None.

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