

# Is Lumbo-Sacral Angle Related to Plantar Loading Patterns in Patients with Ankylosing Spondylitis?

## *Ankilozan Spondilit Hastalarında Lumbo-Sakral Açık Plantar Yüklenme Paterniyle İlişkili mi?*

Elif Aydın<sup>1</sup>, Yasemin Durum<sup>2</sup>, İmran Kurt Ömürlü<sup>3</sup>, Yasemin Turan<sup>1</sup>, Pelin Yıldırım<sup>4</sup>

<sup>1</sup>Adnan Menderes University Faculty of Medicine, Department of Physical Therapy and Rehabilitation, Aydın, Turkey

<sup>2</sup>Adnan Menderes University Faculty of Medicine, Department of Radiology, Aydın, Turkey

<sup>3</sup>Adnan Menderes University Faculty of Medicine, Department of Biostatistics, Aydın, Turkey

<sup>4</sup>Kocaeli Derince Training and Research Hospital, Clinic of Physical Therapy and Rehabilitation, Kocaeli, Turkey



### Keywords

Ankylosing spondylitis, lumbar spine, posture, pedobarography

### Anahtar Kelimeler

Ankilozan spondilit, lomber vertebra, postür, pedobarografi

Received/Geliş Tarihi : 21.03.2016

Accepted/Kabul Tarihi : 24.03.2016

doi:10.4274/meandros.2651

### Address for Correspondence/Yazışma Adresi:

Elif Aydın MD,  
Adnan Menderes University Faculty of  
Medicine, Department of Physical Therapy and  
Rehabilitation, Aydın, Turkey  
E-mail : drebulak@yahoo.com

©Meandros Medical and Dental Journal,  
published by Galenos Publishing.

©Meandros Medical and Dental Journal,  
Galenos Yayınevi tarafından basılmıştır.

### Abstract

**Objective:** Loss of lumbar lordosis is a clinical feature of ankylosing spondylitis (AS). Pedobarographic analysis assesses the interaction between the foot and the supporting surface. Postural abnormalities can reflect as pressure distribution deviations on pedobarography. The objective of the present study was to assess whether loss of lumbar lordosis detected with lumbo-sacral angle measurement is related to postural control assessed by plantar loading distribution in patients with AS.

**Materials and Methods:** Thirty-two patients (two female, 30 male, mean age: 43.06±7.8 years) with the diagnosis of AS, who already had a lateral lumbo-sacral X-ray performed within the past one year, were included in the study. Static and dynamic pedobarographic analyses of the patients were performed. The radiographic measurement of lumbo-sacral angle was done from lateral lumbo-sacral X-rays of the patients.

**Results:** The static pedobarographic measurement revealed that lumbo-sacral angle was significantly correlated with forefoot plantar pressure ( $p=0.042$ ;  $r=0.361$ ). In the dynamic assessment, the maximum pressures were lower under the first metatarsal area in patients with lower lumbo-sacral angle ( $p=0.352$ ;  $r=0.048$ ).

**Conclusion:** These findings suggest that foot joints may contribute to the compensation mechanism against the postural changes in patients with AS, statically and dynamically.

### Öz

**Amaç:** Lomber lordoz kaybı ankilozan spondilit (AS) hastalığının klinik bir özelliğidir. Pedobarografi ayak ve destek yüzey arasındaki ilişkiyi inceleyen bir yöntemdir. Postür anomalileri pedobarografik analize basınç dağılım değişiklikleri olarak yansiyabilir. Bu çalışmanın amacı, AS hastalarında lumbo-sakral açı ölçümü ile kaydedilen lomber lordoz kaybının plantar yüklenme dağılımı ile saptanan postür kontrolü üzerine etkisi olup olmadığını saptamaktır.

**Gereç ve Yöntemler:** AS tanısı olan ve son 1 yıl içerisinde çekilmiş lateral lumbosakral röntgeni olan 32 hasta (iki kadın, 30 erkek, 43,06±7,8 yaş) çalışmaya

dahil edildi. Hastaların statik ve dinamik pedobarografik analizleri yapıldı. Lumbo-sakral açı ölçümü hastaların lateral lumbo-sakral röntgen görüntülerinden yapıldı.

**Bulgular:** Statik pedobarografik ölçümde lumbo-sakral açının ön ayak plantar basıncı ile anlamlı derecede korele olduğu saptandı ( $p=0,042$ ;  $r=0,361$ ). Dinamik incelemede lumbo-sakral açısı düşük olan hastaların birinci parmak altında kalan alanda maksimum basıncının düşük olduğu bulundu ( $p=0,352$ ;  $r=0,048$ ).

**Sonuç:** Sonuçlar, AS hastalarında görülen postür değişikliklerine kompensasyonunda ayak eklemlerinin de görev aldığını düşündürmektedir.

## Introduction

Ankylosing spondylitis (AS) is a chronic, inflammatory rheumatic disease which predominantly affects the axial spine (1). Alterations in spinal posture are considered a classical feature of the disease. The most common postural changes seen in AS are limitation of spinal mobility, loss of lumbar lordosis, increased dorsal kyphosis, head protraction, hip flexion contracture, and consequent knee flexion (2,3). Spinal kyphosis has been associated with a forward and downward shift of the centre of mass of the trunk in the sagittal plane. It was also reported that hyperkyphosis leads to a stooped position in these patients, which limits them to see the horizon. Body balance was shown to be maintained by excessive knee and ankle flexion (4). However, contribution of lumbar lordosis loss to postural control has not been identified before. Pedobarography assesses interaction of the foot and supporting surface, which can be used for biomechanical analysis of gait and posture (5). A review by Rosario drew the conclusion that pedobarographic assessment has the potential to supply excellent research in the postural field and related areas (6). The objective of the present study was to assess whether loss of lumbar lordosis detected with lumbo-sacral angle measurement is related to postural control assessed by plantar loading distribution in patients with AS.

## Materials and Methods

Thirty-two patients with AS (two female, 30 male, mean age:  $43.06 \pm 7.8$  years), who attended the physical medicine and rehabilitation outpatient clinic, were included in the study. Local ethics committee approved the study. Patients, who satisfied the Modified New York Criteria for AS and who already had a lateral lumbo-sacral X-ray performed within the past one year, were included in the study. Further inclusion criteria were independent ambulation ability, no orthopaedic impairment in the lower

extremity, no neurologic disease with influence on gait, and no previous orthopaedic surgery. A written consent was obtained from all participants. At baseline, demographic characteristics of the patients were recorded. Assessment of the patients with AS were done at least four hours after they woke up to minimize the effect of morning stiffness. For dynamic measurement, the participants were asked to walk across a capacitive pressure distribution platform (RSscan International, Olen, Belgium) mounted in the middle of the walkway and level with the surface. The patients were asked to walk with normal steps at a customary walking speed. For static measurement, the participants were asked to stand on the platform with the arms at both sides. Maximum pressure distributions and contact areas under the forefoot, midfoot and rearfoot areas were recorded. For detailed analysis of dynamic plantar foot loading, foot prints were subdivided into ten anatomical zones: lateral heel, medial heel, midfoot, five metatarsals, toe 2-5 and hallux and maximum pressures were recorded for these regions. The radiographic measurement of lumbo-sacral angle was done from lateral lumbo-sacral X-rays of the patients. A line is placed at the upper end-plate of the S1 vertebrae and another line was placed horizontally to the vertical axis of the lumbar vertebra (Figure 1). The angle between these two lines was measured as lumbo-sacral angle. The mean values of the two measurements were taken as a final score and included in the analysis. The Kolmogorov-Smirnov test was used to assess the normality of numeric variables. The Pearson correlation analysis was used to determine the correlation between the numeric variables. Descriptive statistics are presented as mean  $\pm$  standard deviation. A p value of less than 0.05 was considered statistically significant.

## Results

Radiographic evaluation revealed that the mean lumbo-sacral angle in the patients with AS was

32.84±11.24 degrees. The mean symptom duration was 17.24±7.19 years and symptom duration was not correlated with lumbo-sacral angle.

The static pedobarographic measurement revealed that lumbo-sacral angle was significantly correlated with forefoot plantar pressure ( $p=0.042$ ,  $r=0.361$ ). In the dynamic assessment, the maximum pressures were lower under first metatarsal area in patients with lower lumbo-sacral angle ( $p=0.352$ ,  $r=0.048$ ). There was no significant correlation between contact areas of the foot and lumbo-sacral angle. Comparison of lumbo-sacral angle with pedobarographic data are demonstrated in Table 1.

## Discussion

Postural control is described as the ability to maintain appropriate relationship between entire body and the environment, modifying the body to gravity and the activity done, as well as to ability to control the center of mass in relationship with the base of support. The findings of the present study revealed that static plantar pressure under the forefoot area diminishes with decreasing lumbo-sacral angle. This

result may indicate that together with excessive knee and ankle flexion (4), the foot joints are also involved in order to compensate postural imbalance in patients with AS. Previous trials have ended up reporting conflicting results regarding the postural control in patients with AS (7-9). In contrast with our findings, Aydog et al. (8) have reported that there were no correlations between stability indices and spinal limitations in AS patients. They only found a positive correlation between medio-lateral sway and tragus-to-wall distance. In another study, Murray et al. (10) described altered balance with magnometry. They suggested that balance deficit was not related to postural deviations. In contrast, Vergara et al. (7) linked postural control impairment to spinal deviations in patients with AS. In addition, Souza et al. (9) also demonstrated impaired postural control in individuals with AS. On the other hand, the authors did not analyze the patients' spinal limitations. In dynamic assessment, pressure under the first metatarsal area decreased with decreasing lumbar lordosis. This may interrupt gait characteristics in these patients. Del Din et al. (11) described impaired gait parameters in patients with AS. The authors reported absence of the heel rocker which they suggested that it could have



**Figure 1.** Measurement of lumbo-sacral angle

**Table 1. Comparison of lumbo-sacral angle with pedobarographic data**

	r	p
Right forefoot relative pressure	0.044	0.810
Right rearfoot relative pressure	-0.190	0.298
Left forefoot relative pressure	0.361	<b>0.042</b>
Left rearfoot relative pressure	-0.139	0.448
1 <sup>st</sup> toe peak pressure	-0.052	0.779
2-5 toe peak pressure	-0.014	0.939
1 <sup>st</sup> metatarsal peak pressure	0.352	<b>0.048</b>
2 <sup>nd</sup> metatarsal peak pressure	0.233	0.199
3 <sup>rd</sup> metatarsal peak pressure	0.178	0.328
4 <sup>th</sup> metatarsal peak pressure	0.060	0.744
5 <sup>th</sup> metatarsal peak pressure	0.017	0.927
Midfoot peak pressure	0.144	0.432
Medial heel peak pressure	0.118	0.521
Lateral heel peak pressure	0.162	0.377
Rear foot contact area	-0.263	0.146
Midfoot contact area	0.308	0.086
Forefoot contact area	-0.074	0.688

been a result of difficulties in accomplishing the shock absorption due to biomechanical alterations in sagittal plane. Our result concurs with the data reported in the literature. The results of the present study must be considered in the light of several limitations. Firstly, the number of patients included was small. Secondly, patients who have foot involvement were not included in the study in order to avoid interference with calcaneal enthesitis points.

### Conclusion

In conclusion, loss of lumbar lordosis affects postural control in patients with AS. The foot joints are involved in establishing postural control which may interrupt gait parameters in patients with AS.

### Ethics

Ethics Committee Approval: The study were approved by the Local Ethics Committee of Adnan Menderes University, Informed Consent: Consent form was filled out by all participants.

Peer-review: External and internal peer-reviewed.

### Authorship Contributions

Surgical and Medical Practices: Elif Aydın, Yasemin Durum, Concept: Pelin Yıldırım, Elif Aydın, Yasemin Durum, Design: Elif Aydın, Yasemin Turan, Data Collection or Processing: İmran Kurt Ömürlü, Analysis or Interpretation: İmran Kurt Ömürlü, Literature Search: Yasemin Turan, Writing: Elif Aydın, Yasemin Durum.

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

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

### References

1. Arnett FC. Seronegative spondyloarthropathies. *Bull Rheum Dis* 1987; 37: 1-12.
2. Sawacha Z, Carraro E, Del Din S, Guiotto A, Bonaldo L, Punzi L, et al. Biomechanical assessment of balance and posture in subjects with ankylosing spondylitis. *J Neuroeng Rehabil* 2012; 9: 63.
3. Swinkels A, Dolan P. Spinal position sense and disease progression in ankylosing spondylitis: a longitudinal study. *Spine (Phila Pa 1976)* 2004; 29: 1240-5.
4. Bot SD, Caspers M, Van Royen BJ, Toussaint HM, Kingma I. Biomechanical analysis of posture in patients with spinal kyphosis due to ankylosing spondylitis: a pilot study. *Rheumatology (Oxford)* 1999; 38: 441-3.
5. Orlin MN, McPoil TG. Plantar pressure assessment. *Phys Ther* 2000; 80: 399-409.
6. Rosário JL. A review of the utilization of baropodometry in postural assessment. *J Bodyw Mov Ther* 2014; 18: 215-9.
7. Vergara ME, O'Shea FD, Inman RD, Gage WH. Postural control is altered in patients with ankylosing spondylitis. *Clin Biomech (Bristol, Avon)* 2012; 27: 334-40.
8. Aydog E, Depedibi R, Bal A, Eksioğlu E, Unlü E, Cakci A. Dynamic postural balance in ankylosing spondylitis patients. *Rheumatology* 2006; 45: 445-8.
9. Souza MC, Tutiya GC, Jones A, Júnior IL, Natour J. Assessment of functional balance and quality of life among patients with ankylosing spondylitis. *Rev Bras Reumatol* 2008; 48: 274-7.
10. Murray HC, Elliott C, Barton SE, Murray A. Do patients with ankylosing spondylitis have poorer balance than normal subjects? *Rheumatology (Oxford)*. 2000; 39: 497-500.
11. Del Din S, Carraro E, Sawacha Z, Guiotto A, Bonaldo L, Masiero S, et al. Impaired gait in ankylosing spondylitis. *Med Biol Eng Comput* 2011; 49: 801-9.