pISSN: 2093-940X, eISSN: 2233-4718
Journal of Rheumatic Diseases Vol. 24, No. 2, April, 2017
https://doi.org/10.4078/jrd.2017.24.2.93

Original Article

Does Painful Heels in Ankylosing Spondylitis Demonstrate Distinctive Features on Plain Radiographs: A Study of 104 Cases

Tae-Hwan Kim[1], Seunghun Lee[2], Il-Hoon Sung[3], Sung-Jae Kim[3], Hyo-Kyung Sung[1], Jae-Seung Hur[3]

[1]Hanyang University Hospital for Rheumatic Disease, Departments of [2]Radiology and [3]Orthopedic Surgery, Hanyang University College of Medicine, Seoul, Korea

Objective. To investigate simple radiographic findings on painful heels in ankylosing spondylitis (AS). Heel radiography in most studies was from AS patients' non-painful heel. **Methods.** Seventy AS patients (34 bilateral cases) with heel pain at the time digital radiographs were taken were studied. Standing lateral views (104 radiographs) of the heel were reviewed. Associations between radiologic abnormalities and disease duration and among various abnormal findings were analyzed. **Results.** Ninety-six (93.4%) had radiographic abnormalities (82.7% in soft tissues/61.5% in bone). Abnormalities of bone only were observed in 9.6%, of the soft tissues only in 30.8%, and of both were 51.9%. These included Kager's triangle's blurring (77.9%), posterior soft tissue swellings near the Achilles tendon insertion (65.4%), obliterations of the retrocalcaneal recess (65.4%), erosions of the superior pole of the posterior calcaneus (31.7%), subplantar irregular spurs (20.2%), posterior traction spurs (16.3%), subplantar erosions (14.4%) and cortical thickenings of the inferior calcaneal body (5.8%). There was a significant association between swelling in the posterior soft tissue and obliteration of the retrocalcaneal recess ($p < 0.001$). **Conclusion.** Digital radiography in AS is useful for observing not only bony lesions but also soft tissue abnormalities of the heel, particularly of the posterior heel. For assessing the symptomatic enthesitis of the Achilles, this simple and quick diagnostic tool is valuable when examining for soft tissues' alterations of the posterior heel. **(J Rheum Dis 2017;24:93-98)**

Key Words. Ankylosing spondylitis, Heel pain, Enthesitis of heel, Radiography

INTRODUCTION

Heel pain is a common symptom in the foot and ankle region, with many different causes that need to be distinguished by differential diagnosis [1]. Among them is ankylosing spondylitis (AS), in which enthesitis of the heel is common and occasionally is responsible for their initial symptom to seek clinics [2]. Enthesitis is defined as inflammation at the bony interfaces of ligaments, tendons, aponeurosis, annulus fibrosus and joint capsules [3]. Because many of such structures originate from, are inserted in, and also pass alongside the calcaneus, heel pain is frequent peripheral symptom in AS patients from enthesitis of inferior and posterior calcaneus [1,4,5]. Some AS patients with heel pain respond well to medication, but others need special medication such as an anti-tumor necrosis factor agent. An early diagnosis of AS or timely recognition of active enthesitis come to be relevant issue to hopefully reduce or prevent radiologic progression [6]. As well as these reasons for AS patients, getting a diagnostic clue earlier from symptomatic heels is very important in identification of causes, referral or management for patients of the heel pain. Plain radiography is primarily and commonly used to evaluate chronic inflammatory and degenerative joint diseases [7]. There are, however, few examples of radiographic studies of the heel in AS [1,4,8,9]. Previous studies employing plain radiography of the heel in AS have used conventional film

Received : February 13, 2017, **Revised :** March 12, 2017, **Accepted :** April 10, 2017

Corresponding to : Il-Hoon Sung, Department of Orthopedic Surgery, Hanyang University College of Medicine, 222-1 Wangsimni-ro, Seongdong-gu, Seoul 04763, Korea. E-mail : sungih@hanyang.ac.kr

radiography and involved mostly asymptomatic heels so that comparable findings for painful heels are, to the best of our knowledge, not available [4,8,9]. The purpose of this study was to evaluate findings obtained by digital radiography (DR) of the heel in AS patients with current heel pain, comparing those of previous studies and to observe the relationships between radiologic abnormalities and disease duration, and any correlations between different abnormal findings.

MATERIALS AND METHODS

From January 2006 to December 2009, 808 AS patients were selected at our outpatient clinics for Rheumatic Disease. AS patients satisfying the modified New York criteria [10] and having heel pain on their visit to our hospital were included in the study. All the medical records were reviewed. Patients with no radiographs of weight-bearing lateral views of the heel were excluded. Eventually 70 of the 808 patients (8.7%) were enrolled. Bilateral heel pain was identified in 34 of these patients, so the total number of lateral digital radiographs available for evaluation was 104. A review of patient records identified their age and gender, and disease duration. Radiographic images were visualized with a picture archiving and communications system (PACS) (PiViewSTAR, 5.0.9.98 version; Infinitt Corporation, Seoul, Korea). Bony abnormalities such as spurs of the plantar and posterior calcaneus (traction or irregular), proliferation, and erosion were assessed as previously described [8,9]. Changes in the shadows of soft tissues comprising the retrocalcaneal recess, and in the vicinity of the insertion of the Achilles tendon and Kager's triangle, were also observed [11]. An experienced orthopedic foot and ankle surgeon (IHS) and a musculoskeletal radiologist (SL) independently evaluated all abnormal findings of bone and soft tissues in plain radiographs twice weekly. This study was approved by the Institutional Review Board on Human Subjects Research and Ethics Committees, Hanyang University Hospital (HYUH 2011-11-010).

Statistical analysis was performed with an SPSS software package (PASW Statistics for Windows, Release 18.0; IBM Co., Armonk, NY, USA). Inter and intraobserver reliabilities were assessed using weighted Cohen's kappa values. Values of k below 0.4 reflect poor, between 0.4 and 0.75 fair to good, and above 0.75 excellent agreements [12]. Correlations between radiographic abnormalities of bone and soft tissues and disease duration were tested with Spearman's correlation coefficient. Correlations between different findings were tested using the chi-square and Fisher's exact tests.

RESULTS

Clinical characteristics of the patients were in Table 1. The mean time from diagnosis over which radiographs of the heel were taken was 8.3±3.5 (range, 4.3～21.1) years.

Inter-and intraobserver reliabilities were more than good to excellent for all abnormalities except for blurred Kager's triangle, which showed fair, and the abnormal findings agreed by the two observers are listed in Table 2. One or more radiographic abnormality was detected in 96 of the 104 feet (92.3%). There were abnormal findings of soft tissues and bone in 86 (82.7%) and 64 (61.5%) radiographs, respectively (Figure 1). There were 10 (9.6%), 32 (30.8%), and 54 (51.9%), abnormalities, of bone only, soft tissues only, and both, respectively, and 8 (7.7%) patients had no abnormalities. Overall and soft tissue abnormalities of the posterior heel were more marked than those of the plantar heel. The frequencies of both plantar and posterior bony spurs were correlated with disease duration, but the correlation for other abnormalities was not significant (Table 3). The association between posterior soft tissue swelling near the insertion of the Achilles and obliteration of the retrocalcaneal recess was statistically significant ($p < 0.001$). And, erosion in the superior pole of the posterior calcaneus was the only bone lesion commonly associated with soft tissue abnormalities ($p=0.001$).

DISCUSSION

Few reports have investigated the heel conditions of AS patients by plain radiography, and these mainly focused on asymptomatic heels [4,8,9]. In those studies, it was

Table 1. Clinical characteristics of the patients (n = 70)

Variable	Data
Gender (male:female)	60:10
Age (yr)	30.7 ± 10.9 (range, 15～59)
ESR (mm/h)	45 ± 37.3 (range, 2～140)
CRP (mg/dL)	2.7 ± 3 (range, 0～11.3)
HLA-B27 positivity (%)	97.1

ESR: erythrocyte sedimentation rate, CRP: C-reactive protein, HLA: human leukocyte antigen.

Table 2. Number of abnormalities in ankylosing spondylitis and the inter-and intra-observer reliability in 104 lateral foot X-rays

Variable	Location	Lesion	Incidence	Inter-observer reliability	Intra-observer reliability
Bony abnormalities	Inferior calcaneal tuberosity	Spur	21 (20.2)	0.92	0.86
		Erosion	15 (14.4)	0.76	0.78
	Calcaneal body	Proliferation	6 (5.8)	0.92	0.76
	Posterior calcaneal tuberosity	Spur	17 (16.3)	0.92	0.93
		Erosion	33 (31.7)	0.85	0.85
Soft tissue changes	Retrocalcaneal recess	Obliteration	68 (65.4)	0.88	0.91
	Posterior soft tissue	Swelling	68 (65.4)	0.76	0.92
	Kager's triangle	Blurring	81 (77.9)	0.63	0.72
Others	Talonavicular joint	Arthritis	2 (1.9)	NA	NA
	Calcaneonavicular joint	Arthritis	1 (1)	NA	NA
		Coalition	2 (1.9)	NA	NA

Values are presented as number (%). NA: not available.

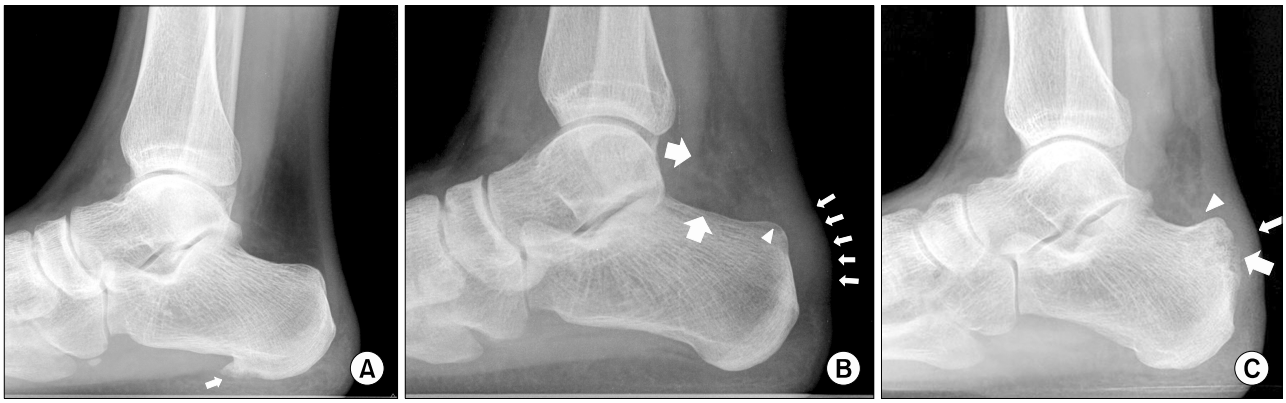

Figure 1. Lateral plain foot radiographs. (A) Subplantar erosion with an irregular spur (small arrow) in the inferior calcaneal tuberosity without any involvement soft tissue and bone of the posterior heel. (B) Focal involvement of soft tissues of the posterior heel such as blurred Kager's triangle (large arrows), swelling of the posterior soft tissue shadow (small arrows) and obliteration of the retrocalcaneal recess (arrowhead), which are distinctively comparable to posterior heel of (A). (C) Concomitant involvement of bone and soft tissue of the posterior heel such as blurred Kager's triangle, erosion of the posterior calcaneal tuberosity (large arrow), swelling of the posterior soft tissue shadow (small arrow) and obliteration of the retrocalcaneal recess (arrowhead).

Table 3. Correlations between radiographic abnormalities of bone and soft tissues and disease duration

Variable	Location	Lesion	Correlation coefficient	p-value
Bony abnormality	Inferior calcaneal tuberosity	Spur	0.231	0.018
		Erosion	0.073	0.461
	Calcaneal body	Proliferation	0.084	0.397
	Posterior calcaneal tuberosity	Spur	0.281	0.004
		Erosion	−0.028	0.776
	Total		0.265	0.007
Soft tissue abnormality	Retrocalcaneal recess	Obliteration	−0.123	0.773
	Posterior soft tissue	Swelling	−0.029	0.13
	Kager's triangle	Blurring	−0.149	0.215
	Total		−0.124	0.210
Total number of abnormalities			0.714	0.036

noted that 17% to 58% of patients with AS had radiographic changes in their heels [1,9] and some radiographic alterations were seen in the absence of local symptoms [8,11]. However, there is no information about the incidence and pattern of abnormal findings in symptomatic heels in AS patients. We observed a considerably higher incidence of plain radiographic changes in painful heels: 92.3% of the symptomatic patients had pathologic changes in either or both bone and/or soft tissue. This higher incidence is presumably due to the condition that we specifically enrolled patients with symptomatic heel pain, even though our patients were younger and their disease was of shorter duration than those in previous studies [1,8,9].

In previous studies, AS patients were found to have radiographic changes in their heel bones, such as erosion, spurs and periostitis [1,4,13]. Such lesions, which develop as a result of inflammatory processes on entheses, may not be disease-specific but rather late consequences of enthesitis in advanced AS [13,14]. In the present work, we observed similar varieties of bony pathology in the calcaneus except for an apparently higher incidence of bony erosion on plantar and posterior tuberosities. The frequencies of bony erosion in the previous and present results were comparable (8.5% [1] and 21% [4] previously vs. 46.1% in our patients) and bony erosion was not correlated with disease duration. These findings would support that the erosive changes may not be just late lesions in symptomatic cases but rather a sign of a relatively earlier stage [9,15], or marker of acute on chronic stages of the disease when it is associated with soft tissue changes.

The incidence of bony spurs on plantar and posterior tuberosities was similar in previous reports and our results (29% [4] and 31.2% [1] vs. 36.5%). Bony spurs in the present study were correlated with disease duration as in previous studies on patients without local symptoms [1,8,9]. Those suggest that such spurs represent chronic or quiescent lesions from various reasons [8,9]. Authors of this sutudy believe that radiographic alterations in lacking local symptoms would have not any clinical significances and heel spur alone may not show disease-related specificity.

The prevalence of soft tissue lesions of the heel was much higher than that of bony changes in our symptomatic AS patients. Many of the patients had soft tissue swelling in the posterior heel portion. We believe that the standing radiographic evaluation of plantar soft is not proper due to the thicker plantar soft tissue and weight-bearing pressure on the soft tissues. On the other hand, the lateral view provides plenty of information about the condition of the soft tissues of the posterior heel because of the thinner soft tissue coverage and superficial location of enthesial structures, especially at the insertion point of the Achilles tendon. We found a markedly higher incidence of obliterated retrocalcaneal recesses than previous studies (2.8% [1] and 16.3% [9] vs. 65.4%). The soft tissue changes, such as obliterated retrocalcaneal recesses and associated soft tissue swelling in the posterior heel near the Achilles' insertion, are key findings of our study. The concomitant presence of these soft tissue abnormalities strongly suggests that they are the result of current enthesitis of the posterior heel. They have been designated retrocalcaneal bursitis due to the inflammatory changes at the insertion of the Achilles tendon [11,16], which is the prime example of an 'enthesis organ' [17]. Since such soft tissue lesions were not correlated with disease duration, the radiographic changes of soft tissue shadowing may be more relevant to the concurrent state of the heel than the bony changes, and may represent acute lesions, especially in those cases where only soft tissues are affected (30.8%).

Blurring of Kager's fat pad and soft tissue swelling near the Achilles insertion have not been reported previously in plain radiographic studies of the heel in AS. Therefore, it is not possible to compare these radiographic features such as soft tissues swelling of heel with earlier studies. Blurring of Kager's fat pad was observed in 81 feet (77.9%). Its anterior, posterior and inferior borders are completed by the flexor hallucis longus, the Achilles tendon and the upper surface of the calcaneus, respectively [18]. The ankle and subtalar joint also lie at the anteroinferior corner of the triangle. When observing the lateral plain radiographs of the heel, as well as focusing enthesitis related area of the calcaneus, a blurred margin of this triangle itself deserves attention since it is a well-known radiographic reference in evaluating problems with such bordered structures [17,19]. All the local structures can be affected by inflammation in AS including bursitis, synovitis, tenosynovitis, and tendonitis. When patients complain of pain in the posterior heel, the structures at the blurred borders of Kager's triangle, if present, need to be carefully examined and further evaluated in clinical situations.

Ultrasonography and magnetic resonance imaging are considered more suitable methods of work-up for assessing such soft tissue conditions. They are, however, rela-

tively expensive and difficult to use as first line diagnostic tools because of the need for well-trained specialists, sophisticated equipment and etc. For musculoskeletal problems, radiologic study beginning with plain radiographs is accepted as the standard screening method. Compared with the other specialized modalities, plain radiography is very cost-efficient, simple to use, and quick generated. On the other hand, conventional radiography has been considered ineffective in detecting soft-tissue inflammation [18]. However, digitalized images provide more detailed information than conventional plain radiographs [16,19]. The main advantages of DR are its relatively high resolution, adjustable contrast and brightness, and the ability to reprocess images to obtain additional information; they thus provide sharper and more detailed images of soft tissue than conventional film radiographs [18,20]. The simple radiographic findings of the heel, even with digital images, could not be comparable to ultrasonography or magnetic resonance imaging to detect enthesitis. But its primary and fundamental value of simple radiography seems to be important topic to any primary physician or even musculoskeletal specialist particularly when heel pain is the initial symptom of patients to visit clinics. With those features from this simple and quick diagnostic tool, physician could be able to have clue for proper approach to evaluate enthesitis so that unnecessarily delaying diagnosis or inappropriate treatment could be avoided.

There are limitations to our study. First, it is a retrospective study of digitalized images. Second, it has no normal standardized control group. Third, there were no data from clinical assessment, ultrasonography or magnetic resonance imaging for comparison. A well-designed prospective study including thorough physical findings would provide more precise information on the specific conditions causing heel pain. Despite these limitations, large information from the DR including newly observed features should be available in AS patients with heel pain. Supplementary systematic review of patient and thorough physical examination, allied with the findings of DR would enhance a diagnostic value. Especially with observing evident alterations in soft tissue of the posterior heel, it could help clinician to understand particularly the sources of heel pain from the ongoing inflammation from enthesitis of the Achilles.

CONCLUSION

The plain radiography in AS is useful when observing bony lesions as well as soft tissue abnormalities of the heel, particularly of the posterior part. It would help for locating the source of heel pain, and also for offering clues for identifying the cause of the heel pain via special diagnostic modalities. Soft tissue changes seen by DR, such as obliterated retrocalcaneal recesses and swellings where the Achilles inserts, were efficiently detected, independent of the duration of AS, and would be helpful for diagnosing enthesitis of the Achilles associated with retrocalcaneal bursitis.

CONFLICT OF INTEREST

No potential conflicts of interest relevant to this article were reported.

REFERENCES

1. Gerster JC, Vischer TL, Bennani A, Fallet GH. The painful heel. Comparative study in rheumatoid arthritis, ankylosing spondylitis, Reiter's syndrome, and generalized osteoarthrosis. Ann Rheum Dis 1977;36:343-8.
2. Dougados M, van der Linden S, Juhlin R, Huitfeldt B, Amor B, Calin A, et al. The European Spondylarthropathy Study Group preliminary criteria for the classification of spondylarthropathy. Arthritis Rheum 1991;34:1218-27.
3. Spadaro A, Iagnocco A, Perrotta FM, Modesti M, Scarno A, Valesini G. Clinical and ultrasonography assessment of peripheral enthesitis in ankylosing spondylitis. Rheumatology (Oxford) 2011;50:2080-6.
4. Mason RM, Murray RS, Oates JK, Young AC. A comparative radiological study of Reiter's disease, rheumatoid arthritis and ankylosing spondylitis. J Bone Joint Surg Br 1959; 41-B:137-48.
5. Gibbon WW, Cassar-Pullicino VN. Heel pain. Ann Rheum Dis 1994;53:344-8.
6. Rudwaleit M, Khan MA, Sieper J. The challenge of diagnosis and classification in early ankylosing spondylitis: do we need new criteria? Arthritis Rheum 2005;52:1000-8.
7. Ory PA. Radiography in the assessment of musculoskeletal conditions. Best Pract Res Clin Rheumatol 2003;17:495-512.
8. Resnick D, Feingold ML, Curd J, Niwayama G, Goergen TG. Calcaneal abnormalities in articular disorders. Rheumatoid arthritis, ankylosing spondylitis, psoriatic arthritis, and Reiter syndrome. Radiology 1977;125:355-66.
9. López-Bote JP, Humbria-Mendiola A, Ossorio-Castellanos C, Padrón-Pérez M, Sabando-Suárez P. The calcaneus in ankylosing spondylitis. A radiographic study of 43 patients. Scand J Rheumatol 1989;18:143-8.
10. van der Linden S, Valkenburg HA, Cats A. Evaluation of diagnostic criteria for ankylosing spondylitis. A proposal for

modification of the New York criteria. Arthritis Rheum 1984;27:361-8.
11. van Sterkenburg MN, Muller B, Maas M, Sierevelt IN, van Dijk CN. Appearance of the weight-bearing lateral radiograph in retrocalcaneal bursitis. Acta Orthop 2010;81: 387-90.
12. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics 1977;33:159-74.
13. Riley MJ, Ansell BM, Bywaters EG. Radiological manifestations of ankylosing spondylitis according to age at onset. Ann Rheum Dis 1971;30:138-48.
14. Genc H, Cakit BD, Tuncbilek I, Erdem HR. Ultrasonographic evaluation of tendons and enthesal sites in rheumatoid arthritis: comparison with ankylosing spondylitis and healthy subjects. Clin Rheumatol 2005;24:272-7.
15. Fernández del Vallado P, Gálvez Failde JM, Gijón Baños J, Beltrán Gutiérrez J. Erosive calcaneitis as an early diagnostic sign in ankylosing spondylitis. Rev Clin Esp 1967;105: 367-72.
16. Bansal GJ. Digital radiography. A comparison with modern conventional imaging. Postgrad Med J 2006;82:425-8.
17. D'Agostino MA, Olivieri I. Enthesitis. Best Pract Res Clin Rheumatol 2006;20:473-86.
18. Murphey MD. Computed radiography in musculoskeletal imaging. Semin Roentgenol 1997;32:64-76.
19. Freedman M, Steller D. Digital radiography of the musculoskeletal system: the optimal image. J Digit Imaging 1995; 8(1 Suppl 1):37-42.
20. Goodman LR, Shanser JD. The pre-Achilles fat pad: An aid to early diagnosis of local or systemic disease. Skeletal Radiology 1977;2:81-6.