The Achilles heel of adults and children
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THE POSTERIOR IMPINGEMENT-VIEW:
AN ALTERNATIVE CONVENTIONAL
PROJECTION TO DETECT BONY
POSTERIOR ANKLE IMPINGEMENT

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M. Maas, C.N. van Dijk

Arthroscopy
ABSTRACT

Purpose: The purpose of the current study was to clinically evaluate the diagnostic value of the new posterior impingement (PIM) view in the detection of an os trigonum, compared with the standard lateral view, using computed tomography (CT) as a reference standard.

Methods: Three observers, 2 experienced (orthopaedic surgeon and radiologist) and one inexperienced (resident), independently scored 142 radiographic images for the presence of an os trigonum. The diagnostic performance was assessed using the computed tomographic scan as the reference standard. Accuracy, sensitivity, specificity, positive predicted value (PPV), and negative predicted value (NPV) were calculated.

Results: The PIM view had significantly superior accuracy compared with the lateral view for each observer: orthopaedic surgeon, PIM view = 90 versus lateral view = 75 (P = .013); radiologist, PIM view = 80 versus lateral view = 64 (P = .019); resident, PIM view = 90 versus lateral view = 79 (P = .039). The mean sensitivity and specificity of the lateral view for all observers was 50% and 81%, respectively. For the PIM view, this was 78% and 89%, respectively. The PPV was 50% for the lateral view and 70% for the PIM view. The NPV was 84% for the lateral view and 93% for the PIM view.

Conclusions: The PIM view has significantly superior diagnostic accuracy compared with the conventional lateral view in the detection of an os trigonum. In cases of symptomatic posterior ankle impingement, we advise that a PIM view be used instead of or in addition to the standard lateral view for detection of posterior talar pathologic conditions.

Level of Evidence: Level II, diagnostic study
INTRODUCTION

Posterior ankle impingement is a common pathologic condition that can be divided into bony and soft tissue impingement. Bony impingement is caused by an enlarged posterior talar process (Stieda process) or an os trigonum. The os trigonum is the most common cause of symptomatic posterior ankle impingement. Surgical treatment of bony impingement is effective if the correct diagnosis is made. Frequently, however, the pathologic process causing impingement is not found on lateral radiographs. This may result in a delay in treatment or may require additional more expensive imaging studies.

The standard lateral radiograph has been used as the primary diagnostic tool in symptomatic posterior ankle impingement. Diagnosing an os trigonum based solely on clinical examination and conventional radiographs creates a challenge because of superposition of surrounding tissues (distal fibula and posterior talar ridge) in the posterior region of the talus. The current method to avoid false-negative diagnoses is additional assessment with more advanced imaging such as computed tomography (CT), magnetic resonance imaging (MRI), and technetium bone scanning. These additional techniques, although they have increased diagnostic value, do have their own set of disadvantages: increased costs and increased radiation and are more time-consuming. An alternative conventional imaging method with an altered beam

Figure 1: Conventional standard view of the ankle of a 21 year old female patient. Note how the posterior talar facet is not clearly distinguished.

Figure 2: Posterior Impingement (PIM) view of the ankle (same patient as Figure 1) The posterior talar facet is clearly distinguishable (black arrows), evidently showing an os trigonum (white arrow).
direction may provide superior diagnostic accuracy compared with the standard lateral view (Fig 1), with fewer disadvantages than with advanced imaging (CT/MRI). Based on anatomic studies and a CT-based calculation model performed at our institution, the os trigonum is expected to be best visualized with a lateral 25° external-rotation oblique view of the ankle. This posterior impingement (PIM) view (Fig 2) was designed to have the beam perpendicular to the posterior talar ridge (and possible os trigonum). The purpose of the current study was to clinically evaluate the diagnostic value of the new PIM view in the detection of an os trigonum compared with the lateral view, using CT as a reference standard. Our hypothesis was that the PIM view has higher diagnostic accuracy compared with the conventional lateral view in the detection of an os trigonum.

METHODS

This trial was designed and conducted according to the STARD guidelines (STAndards for the Reporting of Diagnostic accuracy studies) and was approved by the Medical Ethical Committee of our institute(30).

Patients
All consecutive patients, 18 years and older, who visited our outpatient clinic between December 2010 and September 2011 with clinically suspected soft tissue or bony posterior ankle impingement also known as the os trigonum syndrome, were eligible for participation (all patients at risk). Suspicion of the os trigonum syndrome by our senior staff, experienced foot and ankle surgeons, is based on the following: among other clinical tests, it is standard to evaluate whether the posterior impingement test (sudden passive hyperplantar flexion of the ankle) is positive; furthermore, patient complaints are evaluated (pain on hyperplantar flexion) consisting of retrocalcaneal pain aggravated on walking, running, and forced hyperplantar flexion.6,12,20,32

The required imaging for inclusion consisted of a lateral view, a PIM view, and CT of the affected ankle. Data were collected prospectively, creating a database with all images of included patients. The study was conducted retrospectively, and images were independently scored for the presence of an os trigonum. An os trigonum was defined as an osseous structure located posterior to and separate from the lateral tubercle of the posterior talar process and in the same sagittal plane as the lateral tubercle of the posterior talar process. If any osseous structure was identified on CT as bridging, this was defined as an enlarged posterior talar process instead of an os trigonum. One experienced orthopaedic surgeon (C.N.v.D), one experienced musculoskeletal radiologist (M.M.), and one orthopaedic resident (J.I.W.) individually performed the analyses. Images were analyzed anonymously to avoid recognition of patients and accompanying complaints. Observers
were given the choice of os trigonum “yes” or “no” when scoring the images. Observers were allowed to enlarge the image and adjust brightness and contrast. Images were excluded from analysis if individual observers decided that the quality of a radiograph, either lateral view or PIM view, was considered too low for daily clinical practice, and thus too low to score properly, and if there was a consensus regarding the individual decision at analysis. Computed tomographic images, assessed separately by independent radiologists, were used as the gold standard reference for the evaluation of the presence of an os trigonum. After scoring the radiographic images, the results were matched with the gold standard reference. All patients in whom it could not be clearly determined whether or not an os trigonum was present on CT were excluded from the analysis.

Imaging techniques

Standard Lateral Ankle View. This weight-bearing radiograph is made according to a standardized protocol with the lower leg parallel to the detector. The lower leg is internally rotated until an imaginary line can be made with both malleoli perpendicular to the detector. The focus is on the joint line between the distal tibia and talar bone (Fig 1 and Video 1). (Video 1 available at www.arthroscopyjournal.org).

PIM View. The PIM view radiograph is also obtained according to a standardized protocol and a weight-bearing image; the medial side of the ankle is placed directly against the detector. This position provides a 25° external rotation compared with the lateral view, which allows for a perpendicular view of the posterior part of the talus. The 25° external rotation is calculated from the internal rotation necessary for the lateral view; this was based on anatomic studies of the os trigonum and a CT-based calculation model performed at our institution.4,32 The beam is perpendicular to the detector and is focused on the ankle joint (Fig 2 and Video 1) (Video 1 available at www.arthroscopyjournal.org).

Computed Tomography. Computed tomographic scans (0.55 mm couples, 0.27 mm inclination) were made according to the hospital's standard CT ankle protocol. For the gold standard references, all planes were reviewed and a bone setting was used. Patients were placed in the prone position with both ankles strapped at 90°.

Scoring and Analysis

The primary outcome measure was accuracy, defined as the proportion of patients who are correctly classified on radiographs. The following additional diagnostic performance characteristics were also calculated according to the standard formulas: sensitivity, specificity, positive predicted value (PPV) and negative predicted value (NPV). The latter 4 values were calculated with 95% confidence intervals (CIs). Comparison of the accuracy, sensitivity, and specificity between the lateral and PIM views was performed by using McNemar tests for
paired binary data. Comparisons were considered statistically significant at a probability of \( P < .05 \). Additionally, multirater kappa values were calculated with 95% CIs to estimate the paired interobserver agreement for both the lateral and PIM views separately. The kappa statistic was interpreted as almost perfect (0.81 to 1.00), substantial (0.61 to 0.80), moderate (0.41 to 0.60), fair (0.21 to 0.40), and slight (0.00 to 0.20).32 Data were entered into IBM SPSS Statistics, version 20 (SPSS, Chicago, IL).

RESULTS

The 3 observers independently evaluated the files, consisting of 154 radiographic images, for the presence of an os trigonum in 77 patients who were clinically symptomatic for posterior ankle impingement. Six cases (12 images) were excluded from analysis because the quality of the PIM view or the lateral view radiographs was considered too low to properly score the posterior talar process; exclusion was because of an inadequate lateral view in 4 cases, and 3 cases were excluded because of an inadequate PIM view (in one case, both images were inadequate). This resulted in the inclusion and analysis of 71 patient files and a total of 426 evaluated images. In 17 of 71 patients, an os trigonum was present on CT, resulting in a prevalence of 24% (95% CI, 15% to 36%). The range in sensitivity of the lateral view for all observers was 41% (95% CI, 19 to 67) to 71% (95% CI, 44 to 87); the specificity ranged from 63% (95% CI, 49 to 75) to 91% (95% CI, 79 to 97). For the PIM view, the sensitivity ranged between 76% (95% CI, 50 to 92) and 88% (95% CI, 62 to 98); the specificity ranged from 78% (95% CI, 64 to 86) to 94% (95% CI, 84 to 99) for all observers. The PPV ranged from 38% (95% CI, 22 to 56) to 58% (95% CI, 29 to 83) for the lateral view and 56% (95% CI, 36 to 74) to 81% (95% CI, 54 to 95) for the PIM view. The NPV ranged from 83% (95% CI, 70 to 92) to 87% (95% CI, 72 to 95) for the lateral view and 93% (95% CI, 82 to 98) to 95% (95% CI, 83 to 99) for the PIM view. The orthopaedic surgeon had significantly better diagnostic results using the PIM view regarding accuracy (\( P = .01 \)). The radiologist also had significantly superior diagnostic results in accuracy using the PIM view (\( P = .02 \)). The inexperienced observer had significantly better results with the PIM view in accuracy (\( P = .04 \) and sensitivity (\( P = .03 \)) (Table 1). Kappa values for interobserver agreement were 0.35 (95% CI, 0.00 to 0.71) and 0.71 (0.42 to 0.99) for the lateral and PIM views, respectively.

DISCUSSION

This study shows the significant diagnostic superiority of the PIM view compared with the lateral view for the radiographic diagnosis of os trigonum, regardless of the specialty
The Posterior Impingement-view and experience of the observer. Although no statistically significant difference was found regarding sensitivity and specificity for each individual observer, clinically relevant differences were evident; the increase in sensitivity ranged from 17% to 35% and the increase in specificity ranged from 3% to 15%. The increase in PPV and NPV ranged from 18% to 27% and from 8% to 11%, respectively. Finally, the interobserver agreement was superior for the PIM view. The increased detection rate with the PIM view is attributable to its 25° external rotation, ensuring a superior position of the tibia and fibula and preventing substantial overprojection of the posterior talar ridge and a superior beam direction perpendicular to the posterior talar process. Previous studies evaluated altered conventional beam directions for ankle and hindfoot pathologic conditions.29,33-38 An oblique 45° and 70° externally rotated ankle view was developed to study posteromedial talar process fractures.33-36,38 The anteromedial impingement view was designed to detect bony anteromedial ankle impingement.29,37 Both have changed the diagnostic path and resulted in less extensive use of alternative (CT) imaging.29,33-38 Hitherto, no study was performed to focus on the common pathologic condition of osseous posterior ankle impingement. This study focused on the os trigonum; even though it is the most common cause of posterior ankle impingement, an enlarged posterior talar process may also cause symptomatic posterior ankle impingement. Because the anatomic location is identical, the same beam direction should be as effective for a posterior talar process. The results of this study simplify the diagnostic path for patients with symptomatic posterior ankle impingement. Previously, a lateral view was used, ideally showing a cause for the posterior impingement symptoms; however, the pathologic process often was unclear and additional imaging (CT/MRI) would be planned.5,6,11,13,19,22,24,26-28 The higher

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diagnostic value of the PIM view may justify the replacement of the lateral view in selected patients with symptomatic posterior ankle impingement. Furthermore, additional imaging may become less necessary, depending on the clinical and radiographic findings. Although the current advancements in CT/MRI imaging techniques are very important and provide new insights, the disadvantages should not be overlooked, i.e., the radiation exposure and the financial burden. As proved previously, these techniques may not be necessary to provide proper care to our patients. In addition, these new techniques are often more time-consuming because high-resolution (MR) imaging requires long scan duration and, as proved previously, are less patient friendly. The advantage of these new altered beam direction conventional imaging techniques is low cost, time efficiency, easy performance in a physician office setting, and lower radiation levels. An interesting result in this study was the difference between the observers (Table 1). It is a well-documented problem with imaging studies. Previous studies have shown the variability of radiographic interpretation between radiologists and other observers, as well as the influence of computerized images and the timing at which the observations took place. Substantial intraobserver differences are also well documented and are an accepted interpretation limitation of radiographic diagnostic accuracy. Regarding the current study, the orthopaedic observers scored a substantially higher sensitivity with the PIM view compared with the lateral view, whereas the radiologist had a substantially higher specificity with the PIM view compared with the lateral view (Table 1). Focusing on the comparison between observers, the lateral view provides an explanation: the sensitivity for orthopaedic observers is relatively low (41% to 47%) compared with the radiologist (71%). This may be a result of the observational technique that is used by the individual observer. Does one view the image to exclude pathologic processes or does one view to trace pathologic processes? It appears as if the radiologist generally assumed that there was a certain pathologic process, resulting in more false-positive results, whereas the orthopaedic observers assumed there was no pathologic process, resulting in more false-negative results. This leads to a possible weakness of any imaging study: the clinical inquiry to be answered by radiographic evaluation may influence the actual outcome of the evaluation. This is the first report, to our knowledge, on the clinical use of the PIM view. Although the current PIM view is a significant improvement for os trigonum detection, future studies should focus on the optimization of the PIM view. The variables that require further analysis are the shape of the synchondrosis, its relation to the lateral malleolus, the bimalleolar axis, and the syndesmotic line. A limitation of the study is that it was not powered to detect differences between the observers with respect to the primary outcome measure. Although the prevalence of os trigonum, based on the patient at risk calculation, is comparable to previous studies, the absolute number of os trigoni is relatively small in this study. This results in a relatively insufficient power to show significant differences regarding outcomes specified per
observer. Although the interobserver variability proved to be superior for the PIM view, this study did not report on intraobserver variability; previous research has elaborated on this meticulously studied and accepted interpretation limitation of all radiographic diagnostic accuracy studies. Furthermore, because of the number of analyzed images, the variability is corrected because of the stochastic deviation of the entire group. The variability in the execution of the scan protocol is important in imaging studies. Although the execution of both imaging techniques is straightforward, and a clear imaging protocol is issued at our institute to account for reproducibility bias, there might be subtle execution differences between technicians. The exclusion of 3 PIM views and 4 lateral views shows possible reproducibility bias, which was corrected for in this study. The PIM view has significantly superior diagnostic accuracy compared with the conventional lateral view in the detection of an os trigonum. In the case of symptomatic posterior ankle impingement, we advise the use of a PIM view instead of or in addition to the standard lateral view for detection of posterior talar pathologic conditions.
REFERENCES


