Diagnostic guidelines for chronic ankle pain. From loose bodies to joint venture
Verhagen, R.A.W.

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Chapter 6

Prospective study on diagnostic strategies in osteochondral lesions of the talus.

Is MRI superior to helical CT?

R.A.W. Verhagen, M. Maas, M.G.W. Dijkgraaf, J.L. Tol, R. Krips, C.N. van Dijk

submitted
Abstract
The aim of this prospective study was to determine the best diagnostic modality to discriminate between patients with and without talar osteochondral lesions, with special focus on the value of MRI compared to the new multidetector helical CT. The diagnostic value of history, physical examination and standard radiography, a four centimetres heelrise view, helical CT, MRI, and diagnostic arthroscopy for simultaneous detection or exclusion of osteochondral lesion of the talus were compared. A consecutive series of 103 patients (104 ankles) with chronic ankle pain was included in this study.
Thirty-five osteochondral lesions were identified in twenty-nine patients. Twenty-seven lesions were located in the talus.
In conclusion our study shows that helical CT, MRI, and diagnostic arthroscopy are statistically significant better than history, physical examination and standard radiographs for detecting or excluding OLT. Also MRI and diagnostic arthroscopy perform better than mortise view with four centimetres heelrise. Our study did not show a statistically significant difference between helical CT and MRI. Diagnostic arthroscopy did not perform better than helical CT and MRI for detecting or excluding OLT.
Introduction

Osteochondral lesion of the talus (OLT) is one of the most important causes of residual pain after an ankle sprain. It is defined as the separation of a fragment of articular cartilage, with or without subchondral bone.\textsuperscript{1,2} The incidence of OLT after an ankle sprain is probably underestimated because these lesions often remain undetected. The incidence has been reported as high as 6.5% after ankle sprains.\textsuperscript{3,4}

Although initial symptoms may be absent, in chronic cases most patients present with intermittent pain, located deep in the ankle joint which increases on weight bearing. On physical examination signs are often lacking. A discrete limitation of range of motion with some synovitis may be present. Local tenderness on palpation with recognition is absent in most cases.

Particularly at an early stage, OLT is difficult to visualize by conventional radiography.\textsuperscript{5,6} The frequent absence of radiographic changes has led to the use of more sensitive methods for detection.\textsuperscript{7} While some authors prefer additional radiographs like mortise views with four centimetres heelrise (MX), the lack of precise localisation and extent of the lesion remains a problem.\textsuperscript{8,9} Therefore, others prefer Computed Tomography (CT),\textsuperscript{10} Magnetic Resonance Imaging (MRI),\textsuperscript{11-13} or Diagnostic Arthroscopy (DA).\textsuperscript{14}

Currently the most important non-invasive diagnostic modality in literature for identifying OLT is MRI.\textsuperscript{15,16} As is also stated in the American College of Radiology Appropriateness Criteria for chronic ankle pain.\textsuperscript{17} However, in our experience, high-resolution helical CT can accurately detect OLT. Hence, the superiority of MRI over helical CT as the instrument of choice in evaluating OLT may be questioned, when using this new CT technique. Prospective studies that compare the efficacy of these two diagnostic modalities in the evaluation of osteochondral lesions are absent.\textsuperscript{18} This led us to start a prospective study in which the various non-invasive diagnostic modalities, described in literature for detecting OLT, with special interest in cross-sectional radiology, are compared to diagnostic arthroscopy.

The aim of this prospective study is to determine the diagnostic value of history, physical exam, and standard radiographs (HPX), mortise view with four centimetres heelrise (MX), helical CT, MRI, and diagnostic arthroscopy, and to identify the best diagnostic modality to discriminate between patients with and without the disease, i.e. for simultaneous detection or exclusion of osteochondral lesions of the talus.

Based on literature data we hypothesized that:

- HPX plus any test performs better than HPX alone;
- Helical CT, and MRI performs better than MX;
- MRI performs better than helical CT; and
- Diagnostic arthroscopy performs better than any other test.
Material and Methods

Between October 1997 and May 1999 all patients with chronic ankle pain who presented at our outpatient department were consecutively included into a diagnostic protocol, approved by the Institutional Review Board (IRB) of our hospital. The study was part of a prospective study design on different diagnostic strategies in patients with chronic ankle pain. Patients were included if they failed to respond to at least 6 months of conservative treatment consisting of analgesics (NSAIDs), bracing, and/or physiotherapy. The inclusion and exclusion criteria are listed in Table 1.

Table 1 Inclusion and exclusion criteria

<table>
<thead>
<tr>
<th>Inclusion criteria</th>
<th>Exclusion criteria</th>
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<tbody>
<tr>
<td>• residual complaints of the ankle more than six months</td>
<td>• suspected extra-articular cause</td>
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<tr>
<td>• suspected articular cause (ankle joint)</td>
<td>• systemic disease (rheumatoid arthritis, systemic lupus erythematoses, malignancy, etc.)</td>
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<td>• age of patient over 18 years</td>
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</table>

Non-invasive diagnostic procedures

All patients underwent a diagnostic protocol, consisting of routine physical exam, standard AP and lateral weight bearing radiographs of both ankles (HPX). After informed consent all patients were scheduled for arthroscopy. In the mean time additional diagnostics were performed. Additional examination consisted of an AP mortise view (weight bearing) of both ankles with four centimetres heelrise (MX),CT scan with multiplanar reconstructions (MPR) in the sagittal and coronal plane, and MRI.

High-resolution multidetector helical CT was performed using a dual helix CT (Twin Flash, Elscint, Israel or MX Twin Flash, Picker, USA). Axial data acquisition was performed with 0.5 mm slices 3D data set. Both, semi-coronal and sagittal reformatted images of 2 mm were reconstructed.

MRI without intravenous or intra-articular contrast was performed with a 1.5-Tesla Vision system (Siemens, Erlangen, Germany), with the ankle joint placed in a Circularly Polarized head coil. Although a flexible extremity coil was available, the CP head coil was chosen since it provided the best signal to noise ratio. The imaging protocol consisted of sagittal TSTIR, T1-weighted SE, sagittal, coronal, and axial FSE dual echo sequences (3mm), DESS 3D with reformatted images in coronal and axial plane (2mm).

All CT and MRI scans were separately evaluated by an experienced musculoskeletal radiologist without knowledge of patients' history and outcome of the standard radiographs. The radiologist was blinded to the CT results when evaluating MRI, and vice versa.
In contrast to the plain radiographs, the results of CT and MRI were kept undisclosed to the surgeon who performed the arthroscopy. A second orthopaedic surgeon was knowledgeable about the outcome of the diagnostic tests and informed the patient as to what type of operative procedure would be done to correct the lesion(s) in the talus.

**Arthroscopic procedure**

The arthroscopic procedure was performed within twelve weeks after inclusion into the study. All arthroscopic procedures were performed by the senior author in an outpatient setting under general or regional anaesthesia with tourniquet at thigh level. A 2.7-mm and 4.0-mm 30° angle arthroscopes were used. Standard anteromedial and anterolateral portals were made routinely. Ankles were distracted using a non-invasive distraction system. After completion of the diagnostic arthroscopy with HPX (history, physical exam, and standard radiographs), and MX data (heelrise view), the results were noted on a standardised form. Subsequently, the results of the other additional radiographic examinations were disclosed to the surgeon and the arthroscopic examination was continued using the same anaesthesia to confirm and subsequently treat a lesion.

In this paper we present the data of the patients with OLT. Treatment of OLT included removal of the involved osteochondral segment, curettage and multiple drilling of the base with a K-wire (1.6 mm). All OLTs in this study could be treated by arthroscopic means. The more posterior located lesions were treated with the ankle in maximum plantar flexion.

**Final diagnosis**

After the diagnostic arthroscopy the results of the additional (non-invasive and invasive) diagnostics were evaluated by arthroscopic examination using the same anaesthesia. The outcome of this ‘second’ procedure, including previous test information, was regarded to represent the final diagnosis. All these procedures (diagnostic arthroscopy, ‘final diagnosis’ arthroscopy, and arthroscopic treatment) were done in concert during one arthroscopic procedure.

Postoperative care consisted of rehabilitative exercises and progressive weight bearing up to 6 weeks.

The one and two years follow-up examinations were used to verify this final diagnosis.

**Statistical evaluation**

Based on the final diagnosis the sensitivity, specificity, positive and negative predictive values were calculated for each diagnostic test: history, physical examination and standard radiographs (HPX), mortise view with four centimetres heelrise (MX), helical CT, MRI, and diagnostic arthroscopy, respectively. Furthermore the diagnostic odds ratio (DOR) was calculated. Although the DOR is not yet a commonly applied statistical measure in the radiological or orthopaedic literature, it is very applicable, since it is independent of the underlying prevalence
Prospective study on diagnostic strategies in osteochondral lesions of the talus

of the diagnosis under investigation.\textsuperscript{24,25} This DOR is calculated as the likelihood ratio of a positive test result divided by the likelihood ratio of a negative test result and measures the discriminatory capacity of a test.\textsuperscript{24} Its value ranges from 0 to infinity. Higher values indicate better test performance; unity indicates no discrimination between diseased and non-diseased persons.\textsuperscript{25}

The relative diagnostic odds ratio (RDOR) and its confidence interval adjusted for test covariance were calculated to compare the discriminatory capacity of different tests in this patient group. If the RDOR does not include unity, the tests differ. The width of the confidence interval was determined by:\textsuperscript{26}

- the number of multiple comparisons made (n=4), and
- the common correlations among pairs of tests (all between 0.55 and 0.9).

For analysing statistical significant differences between the various diagnostic modalities, the RDORs with 98.75% one-tailed confidence intervals were calculated (a=0.0125, one-tailed).

Results
Population
One hundred and three patients with a mean age of 33 years (range 18 – 68) were enrolled in the study. Eighty-two patients (79%) had a history of ankle trauma, thirty-two (31%) had undergone previous ankle surgery. All patients, but one, had unilateral involvement. Patients' demographics and baseline characteristics are listed in Table 2.

Table 2  Patients' demographics and ankle characteristics

<table>
<thead>
<tr>
<th></th>
<th>Whole group</th>
<th>Osteochondral lesion group</th>
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<tr>
<td>number of patients</td>
<td>103</td>
<td>29</td>
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<tr>
<td>male – female ratio</td>
<td>71 males – 32 females</td>
<td>17 males – 12 females</td>
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<tr>
<td>mean age (range)</td>
<td>33.1 yrs (18.3 – 67.7)</td>
<td>35.1 yrs (20.3 – 56.9)</td>
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<td>number of ankles involved</td>
<td>104</td>
<td>29</td>
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<tr>
<td>right – left ankle ratio</td>
<td>51 – 53</td>
<td>15 – 14</td>
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<tr>
<td>number of osteochondral lesions</td>
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<td>- talar and tibial</td>
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<td>history of trauma</td>
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<td>previous operations</td>
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<td>- &gt; 24 months</td>
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Thirty-five osteochondral lesions were identified in twenty-nine patients. Among them, twenty-five (86%) had a history of ankle trauma (twenty-three cases with inversion trauma, two cases with an ankle fracture). Assessment of the history revealed that all patients with OLT had weight bearing related pain located deep in the ankle joint. Preoperative radiological findings showed that sixteen ankles had grade 0 osteoarthritic changes, nine grade I and four grade II.

Final diagnosis

In Table 3 the data on all patients with OLT according to the final diagnosis are listed. Twenty-one patients had a talar osteochondral lesion, two a tibial osteochondral lesion, and six patients

Table 3  Data on all patients with osteochondral lesion(s) according to final diagnosis

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<thead>
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<th>Case</th>
<th>M/F*</th>
<th>HPX^</th>
<th>MX^^</th>
<th>CT TAL.</th>
<th>TIB.</th>
<th>MRI TAL.</th>
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<th>Arthroscopy TAL.</th>
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* Male / Female;
+ positive for OLT
- negative for OLT
^ History, physical examination, and plain radiographs
^^ Mortise view with four centimetres heelrise
= not MRI-compatible

AM anteromedial, AL anterolateral, CM centromedial, CL centrolateral, PM posteromedial, PL posterolateral, A anterior, P posterior.
Prospective study on diagnostic strategies in osteochondral lesions of the talus

had combined talar and tibial osteochondral lesions. Seven osteochondral lesions were located anterolaterally in the talar dome, four anteromedially, two centrolaterally, three centromedially, nine posteromedially and two were located posterolaterally. Of the tibial osteochondral lesions seven lesions were located anteriorly and one posteriorly.

Diagnostics

In Table 3 also the results of the different diagnostic modalities are presented for each patient with an osteochondral lesion. For the different diagnostic modalities for OLT, sensitivity, specificity, positive and negative predictive value, and DOR are listed in Table 4. Intertest

<table>
<thead>
<tr>
<th>Table 4</th>
<th>The calculated sensitivity, specificity, positive and negative predictive value, and diagnostic odds ratio of the different diagnostic modalities for talar OLT.</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
</tr>
<tr>
<td>HPX^</td>
<td>104</td>
</tr>
<tr>
<td>MX^&amp;</td>
<td>104</td>
</tr>
<tr>
<td>MDCT</td>
<td>104</td>
</tr>
<tr>
<td>MRI*</td>
<td>102</td>
</tr>
<tr>
<td>DA**</td>
<td>104</td>
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</table>

^ History, physical examination, and standard radiographs
&^ Mortise views with four centimetres heelrise
^ N = 102; two lesions were not MRI-compatible due to screws in the talus and metallic clips in the brain
** Diagnostic Arthroscopy; comparisons with DA were corrected for continuity

comparisons, based on the RDOR and its confidence interval, are listed in Table 5.

On history, physical examination, and standard radiographic examination (HPX) OLT was suspected in twenty-three patients. This was correct in sixteen patients. In addition, HPX suspected no lesion in eighty-one patients, of which eleven did have an OLT (false negative). The DOR equalled 14.5. Compared to HPX (Table 5), all other tests performed significantly better, except MX.

On the mortise views with four centimetres heelrise (MX), OLT was suspected in twenty-four patients. This was diagnosed correctly in nineteen out of twenty-seven talar lesions. Based on MX, five lesions were suspected in seventy-seven patients who did not have an OLT (false positive), with a DOR of 34.2. In twelve out of these nineteen cases (63%) the lesion was located centrally or posteriorly. Compared to MX (Table 5), MRI and DA are statistically better, while helical CT is not (p-values are 0.009, 0.003, and 0.03 respectively).

Helical CT identified twenty-two OLTs correctly. CT was false negative in five patients. Two of them (case 2 and 4) were classified according to Anderson for MRI as grade I lesion, and also two (case 17 and 20) as a grade II-A lesion. The other CT false negative case (case 18) was also false negative on MRI. This lesion was classified stage D (flap present) according to
Table 5  Relative Diagnostic Odds Ratio (RDOR) - with corresponding 98.75% confidence interval - for the comparison of the discriminatory capacity of the diagnostic modalities for talar OLTs.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>RDOR</th>
<th>lower CI</th>
<th>exact p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MX&lt;sup&gt;^A&lt;/sup&gt; – HPX&lt;sup&gt;^A&lt;/sup&gt;</td>
<td>104</td>
<td>2.35</td>
<td>0.851</td>
<td>0.03</td>
</tr>
<tr>
<td>MDCT – HPX</td>
<td>104</td>
<td>23.0</td>
<td>1.55</td>
<td>0.005*</td>
</tr>
<tr>
<td>MDCT – MX</td>
<td>104</td>
<td>9.78</td>
<td>0.653</td>
<td>0.03</td>
</tr>
<tr>
<td>MRI&lt;sup&gt;^A&lt;/sup&gt; – HPX</td>
<td>102</td>
<td>38.6</td>
<td>2.67</td>
<td>0.001*</td>
</tr>
<tr>
<td>MRI – MX</td>
<td>102</td>
<td>15.8</td>
<td>1.13</td>
<td>0.009*</td>
</tr>
<tr>
<td>MRI – MDCT</td>
<td>102</td>
<td>1.93</td>
<td>0.0665</td>
<td>0.3</td>
</tr>
<tr>
<td>DA** – HPX</td>
<td>104</td>
<td>56.4</td>
<td>3.88</td>
<td>0.0004*</td>
</tr>
<tr>
<td>DA – MX</td>
<td>104</td>
<td>26.2</td>
<td>1.89</td>
<td>0.003*</td>
</tr>
<tr>
<td>DA – MDCT</td>
<td>104</td>
<td>4.81</td>
<td>0.232</td>
<td>0.1</td>
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<tr>
<td>DA – MRI</td>
<td>102</td>
<td>2.81</td>
<td>0.187</td>
<td>0.2</td>
</tr>
</tbody>
</table>

<sup>A</sup> History, physical examination, and standard radiographs
<sup>^A</sup> Mortise view with four centimetres heelrise
#  N = 102; two lesions were not MRI-compatible due to screws in the talus and metallic clips in the brain
## Diagnostic Arthroscopy; comparisons with DA were corrected for continuity
* Statistically significant (p< 0.0125, one-tailed confidence interval)

the arthroscopic classification for OLTs (Cheng).<sup>28</sup> CT was false positive in one patient. Previously this patient had an ankle fracture with local osteoarthritic cysts and interruption of the cartilage. The sensitivity and specificity for helical CT was 0.81 and 0.99 respectively, with a DOR of 334. Compared to helical CT (Table 5), MRI and DA are not statistically better, with p-values of 0.33 and 0.12 respectively.

One patient was not MRI-evaluable due to presence of screws in the talus, and one due to metallic clips in the brain. One of them had an OLT. MRI identified twenty-eight OLTs. In three cases MRI was false positive. All three cases had osteoarthritic cartilage damage of the talus. Thus twenty-five out of twenty-six OLTs were identified correctly. The sensitivity and specificity for MRI was 0.96 and 0.96 respectively, with a DOR of 608. There was no statistical difference between MRI and DA, with a p-value of 0.2.

Diagnostic arthroscopy diagnosed twenty-nine OLTs of which twenty-seven were correct. Two cases were false positive. In one false positive case there were osteoarthritic changes of the talus, and in the other local softening of the talar cartilage was present without any signs of OLT on helical CT and/or MRI. Therefore, this lesion was classified as no OLT. The sensitivity and specificity for DA was 1.0 and 0.97 respectively, with a DOR of 709.

Eight tibial osteochondral lesions were identified at the final diagnosis. In six of them also a talar lesion was present, of which five were kissing lesions.<sup>29,30</sup> No isolated tibial osteochondral lesion was identified on HPX. Helical CT identified five tibial lesions correctly. No false positive lesions were scored according to the final diagnosis. MRI identified seven out of eight tibial lesions. Also no false positive lesions were scored. Diagnostic arthroscopy missed four out of eight tibial lesions. In three of these four missed lesions (case 3, 12, and 15) also a talar lesion was present. No false positive lesions were scored according to the final diagnosis.
Sensitivity and specificity of tibial osteochondral lesions were 0.63 and 1.0 for helical CT, for MRI 0.88 and 1.0, and for diagnostic arthroscopy 0.50 and 1.0 respectively.

Follow-up
At the two years follow-up the treatment results of OLTs were excellent/good in twenty-four of twenty-nine patients (83%). At the one and two years follow-up there were no changes in the osteoarthritic grade on the radiographs of all patients.

Discussion
Which of the non-invasive diagnostic modalities available is sensitive and specific enough for detecting or excluding OLTs, i.e. discriminate between patients with and without the disease? Plain radiographs are useful in the initial evaluation of patients with acute or chronic ankle pain. These initial examinations, however, may not detect or exclude all osteochondral lesions of the talus. In this prospective study routine radiographic examination missed 41% of the OLTs. This is comparable with the literature.\(^\text{43}\) Compared to HPX alone the DOR will more than double by adding mortise views with four centimetres heelrise (MX) to the standard radiographic work-up for OLT of the ankle. Of the non-invasive diagnostic modalities MR imaging has the highest sensitivity (0.96), but helical CT scanning is more specific (0.99). Both are superior to HPX alone, whereas MX is not.

In this study, to our knowledge the first prospective evaluation of various diagnostic modalities described for detecting or excluding OLT, some remarkable results were derived. According to the experimental and clinical experience of Thompson and Loomer (1984) a heelrise view was developed since a significant number of osteochondral lesions are located posteriorly.\(^\text{83}\) Unlike expected, only one of the three extra diagnosed osteochondral lesions by MX was located posteriorly. In our opinion this may be explained by the simple fact of an additional radiograph in a different position (plantar flexion) of the talus alone.

Although nowadays MRI is the most appropriate modality to use,\(^\text{15,17}\) our results do not support that presumed superiority in case of discriminating patients with or without OLT. MRI showed a high sensitivity and specificity, but these results were not statistically significant better than the results provided by the use of helical CT with multiplanar reconstructions. This has not been stated in literature before.

Helical CT and MRI have improved the sensitivity and specificity for detection, exclusion, and characterization of osteochondral injuries.\(^\text{9}\) MRI identified four chondral lesions, which helical CT did not found. Consequently, MRI provides more certainty than CT, that OLT is indeed absent if MRI turns out negative. MR imaging allows visualisation of the extent of bony involvement and of overlying cartilage abnormalities, although MRI may not be as useful in showing cortical outlines in comparison with helical CT.\(^\text{33}\) However the true extent
of the OLT may be obscured by the concomitant bone marrow edema. It is known that the
diameter of the lesions measured on MRI can exceed conventional radiographic findings.\textsuperscript{34}
This is important for preoperative planning of drilling, because sufficient perforation of the
sclerotic bone is essential.

CT scanning can accurately identify and localize a lesion while defining its extent.\textsuperscript{35,36} In the
past CT was regarded as the reference test by which the final diagnosis was established.\textsuperscript{37,38}
The use of helical technology with multiplanar reconstructions has improved diagnostic quality
and surgical implementation of helical CT. In the present study 81% of the OLTs were
identified on CT scan correctly. Only five false negative cases were present in this study. In
four cases these were purely chondral lesions without subchondral abnormalities; these might
be detected when intraarticular contrast was used. Chondral lesions can be missed, since
helical CT without intra-articular contrast cannot assess the overlying cartilage.\textsuperscript{39} Our results
show that, given a positive test result, helical CT provides more certainty than MRI that an
OLT is actually present. Furthermore, CT has the advantage of a wider availability and a
shorter acquisition time compared with MR imaging.

Pritsch and others first suggested the role of arthroscopy in the treatment of osteochondral
lesions of the ankle in 1984.\textsuperscript{40} An advantage of diagnostic arthroscopy over radiological tools
is that not only inspection of the cartilage is possible, but by palpation with a probe it is
possible to determine if there are soft spots or delaminated areas to pinpoint an OLT.\textsuperscript{34}
Furthermore, once the OLT is detected it can be treated subsequently during the same
procedure. In the present study all OLTs were identified by arthroscopy, but four out of eight
tibial lesions were missed. In three cases also a talar lesion was found. The tibial lesions most
likely were overlooked due to the presence of these talar lesions. Since the surgeon was
comfortable with the idea that the cause of the patients' complaints was detected no systematic
inspection of the tibial plafond was performed. This phenomena is known as 'satisfaction of
search'.\textsuperscript{41,42} It is therefore important to inspect the tibial plafond routinely and systematically
even in patients with a talar lesion, for so called mirror images or kissing lesions.\textsuperscript{29,30,43} We
found five kissing lesions in 104 ankles (5%), which is comparable with other studies.\textsuperscript{44}
Diagnostic arthroscopy was statistically significant better than HPX and MX. However,
diagnostic arthroscopy did not show better results than helical CT or MRI in detecting or
excluding OLT.

**Drawbacks**

There are some drawbacks to our study design. Ideally, the scoring of the index test and the
reference test should be blinded. In our study the reference test consists of the combination of
the index tests and, as a consequence, has not been scored blindly. We strongly argue that this
is reasonable, because, in practice, information from the combination of tests is the best proxy
of a gold standard. Neither test available on the market can serve as a gold standard on its own.
Conclusion

In conclusion our study shows that there is no statistically significant difference for discriminating patients with or without OLT between helical CT, MRI, and diagnostic arthroscopy. Also MRI and diagnostic arthroscopy perform better than mortise view with four centimetres heelrise. Helical CT and MRI are statistically significant better than history, physical examination and standard radiographs for detecting or excluding talar osteochondral lesions, while MX is not. Both tests perform very similar. Helical CT provides more certainty than MRI that an OLT is present, and MRI provides more certainty in case of a negative test result. Contrary to our hypotheses, conventional MRI did not prove better than high-resolution multidetector helical CT for simultaneous detection or exclusion of osteochondral lesions.

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References


Prospective study on diagnostic strategies in osteochondral lesions of the talus


