Correlation between Magnetic Resonance Imaging and Arthroscopy in Meniscal Injuries

Andrés Gelink³*, Nicolás Casales¹, Nora Macadar², Luis Francescoli¹

¹University Clinic of Traumatology and Orthopaedics, UDELAR, INOT, Montevideo, Uruguay
²Center for Imagenology CCOU, SMI, Montevideo, Uruguay

*Corresponding author: Andrés Gelink, University Clinic of Traumatology and Orthopaedics, UDELAR, INOT, Montevideo, Uruguay; E-mail: agelink10@hotmail.com

Received: July 03 2019; Accepted: July 16, 2019; Published: July 18, 2019;

Abstract

Introduction: Meniscal injuries have a very high incidence among professional and amateur athletes. It is estimated that the incidence amounts to 24 every 100 000 each year. The different forms of imaging diagnostics play an important role in the management of knee injuries, particularly in the event of uncertain clinical diagnosis, helping to avoid unnecessary and expensive surgeries. In order to diagnose meniscal pathologies, the most commonly used imaging test is Magnetic Resonance Imaging (MRI). Health Officials from all around the world are becoming increasingly involved in the definition of surgical treatment limits, making an effort to enhance their practice and the patients’ cost-effectiveness.

Our work aims to review evidence about the correspondence between imaging tests -particularly the MRI- and knee arthroscopy as the Gold Standard for the diagnosis of meniscal injuries.

Material and Methods: We performed a systematic search that included Medline (PubMed interphase) and Lilacs databases. The search totaled 607 articles. According to filters and inclusion/exclusion criteria, 23 papers were chosen for our bibliographic review.

Results: The selected papers were prospective studies. Our results are based on data retrieval specifically linked to sensitivity and specificity of the MRI with regards to arthroscopy in meniscal injuries.

Discussion: From the analysis of this information we may consider that there is no consistency in results and opinions in English-published bibliography of a prospective profile. Nevertheless, we must acknowledge that the prevailing results are those that prioritize the relevance of MRI in terms of sensitivity and specificity. We must currently accept that MRI is a very costly study for diagnosing meniscal injuries. There are some variations in its sensitivity and specificity, but they are minor and, therefore, do not invalidate these conclusions.

Introduction

Meniscal injuries have a very high incidence among professional and amateur athletes. This injury is one of the most frequent in sports medicine: 24 in every 100 000 athletes suffer one of this each year. They show a bimodal distribution; the first incidence peak is seen among young athletes and the second is seen in middle-aged patients with degenerative joint disease [1].

Macroscopically, the menisci of the knee are two intra-articular semicircular fibrocartilaginous structure, with a wedge shaped structure, placed between the tibia and the femur, in the medial and lateral compartments. They used to be considered as vestigial remains of muscular structures in the knee. Ever since the middle of the Twentieth Century we have thoroughly known their actual functions and their anatomic, therapeutic and prognostic relevance in knee pathology. The menisci have three main functions: load transmission, cushioning and secondary stabilization [2–4].

In general, the medial meniscus is the one with less movement and therefore it gets injured more frequently than the lateral meniscus [5].

In terms of clinical diagnosis, there are over twenty specific tests described for the assessment of meniscal injuries, with sensitivity and specificity levels that fall between 64 and 97% [6–10]. The sensitivity of these tests decreases when there are other associated injuries, particularly of the anterior cruciate ligament [11–13].

The different forms of imaging diagnostic play an important role in the management of knee injuries, and particularly in the event of uncertain clinical diagnosis; they help to avoid unnecessary surgeries [14].

Since MRI was first introduced in 1984 for clinical usage, its diagnostic role in knee injuries has had a substantial impact [15–17]. MRI is the most commonly used imaging study for the diagnosis of meniscal pathologies, even though there has been an increasing amount of studies that conclude that ultrasonography might be a valid diagnostic technique for meniscal injuries [18]. Notwithstanding, MRI possesses one advantage: it assesses both hard and strong parts of the knee together with the meniscal pathology.

Some studies have shown that MRI is not better than physical examination for diagnosis of meniscal injuries [7,8,19]; other studies show that diagnostic failures range between 14 and 47% [20–22] and others showed the value of MRI as an effective and non-invasive diagnostic tool [11,23–30].
MRI and ultrasonography are the two most used screening methods for diagnosing meniscal tears and anterior cruciate ligament (ACL) tears. While there are numerous studies that show that MRI is a reliable and accurate diagnostic tool, it is very hard to establish its true sensitivity and specificity [29]. Ruwe et al. [31] claim that MRI avoids unnecessary arthroscopies, while Bridgman et al. [32] State it doesn’t.

Currently we need the highest levels of evidence in order to support the use of diagnostic tests, especially when these are an important part of the definition of therapeutic limits, such as knee arthroscopy, for anterior cruciate ligament and meniscus injuries. In the future, the technological and clinical advances shall, undoubtedly, change the way we use MRI [33].

**Objective**

This paper aims to review evidence about the correlation between MRI and knee arthroscopy as the Gold Standard for the diagnosis of meniscal injuries.

**Material and Methods**

In May 2018, we performed a systematic search that included Medline (PubMed interphase) and Lilacs databases. We used similar search methods in both databases, employing the term MESH for Medline-PubMed.

We combined the results using Boolean operators; the synthetic results for said search were (=“Menisci, Tibial”[Mesh]) AND “Magnetic Resonance Imaging”[Mesh] AND “Arthroscopy”[Mesh].

In Lilacs we applied the same search method. The filters we used were articles published between 2004 and 2018, articles written in English and articles about human beings.

**Inclusion Criteria**

The inclusion criteria were:

- Human, adults, and published in English.
- Prospective cohort studies
- Evaluation of MRI for the diagnosis of meniscal injuries
- Arthroscopy as a diagnostic reference (Gold Standard)
- Results with sensitivity and specificity (Se. & Sp.)

**Exclusion Criteria**

Exclusion criteria were: retrospective articles, systematic reviews, children injuries, kinds of meniscal injuries.

Thereafter, we selected the title, made an overview (or full review in case of doubts) and used each work’s bibliography as an additional method.

Even though there are differences among the meniscal injury diagnosis criteria in MRIs, it is widely accepted that the presence of an intra-meniscal signal extending to an articular surface and/or a distortion of the regular shape represent a clinically significant injury [34].

**Search Strategies**

For the bibliographic selection we used, as a guide, the flow chart from the PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) protocols (Figure 1).

In Medline-PubMed we obtained 593 results as a total, using MESH terms and Boolean operators. After applying the aforementioned filters, the results were the following:

- Since 2004 to 2018: 396
- In humans: 390
- In English: 360

In the Lilacs platform we found 14 studies, and applying the same filters we found 3 papers, one of which also turned up in the Medline-PubMed search.

From both searches, and excluding the repeated article, we obtained 362 articles that, added to 6 other papers found in the bibliography, gave us a total of 368 studies.

When we applied the aforementioned inclusion and exclusion criteria in both platforms with regards to title and overview, we selected 23 articles in total (this excluded 345 studies); so far the search was conducted by only one author.

Afterwards, these 23 studies were read in full and included in our bibliographic review by 2 authors.

When applicable, we extracted the following data from each work: Author, Year of Publishing, Hospital, Study Design, Amount of Patients, Patients’ Age, Study Period, 1 or both menisci studied, Se. & Sp. (Table 1).

**Results**

All 23 articles were diagnostic prospective studies with Arthroscopy as Gold Standard as diagnostic reference (Table 1).

Among these studies we found 22 that analyzed the correlation between imaging studies and arthroscopy (Se. & Sp.) in both menisci [35–56] and one paper in a single meniscus [18]. About the correlation between imagerology and arthroscopy in ACL we found 13 papers, [35–37,39,41–43,46–48,52,54,55] and 8 studies regarding the correlation between clinical examination and arthroscopy in meniscal injuries [18,35,43–46,52,53].

We found one work that compared the intensity of the MRI scanner’s field (1.5 T vs. 3T) for the assessment of meniscal and ligamentary disorders in the knee [47]. There were three studies that compared the diagnostic power of different sequences of the MRI scanner for meniscal injuries [38,51,55].

Finally, we found three papers that compared ultrasonography with MRI for the detection of meniscal injuries [18,50,56].

Regarding the description of the studies, we found the following:

- a) 14 [35,36,39,40,43–48,51–53,55] that showed a higher level of sensitivity than specificity in the medial meniscus and a higher level of specificity than sensitivity in the lateral meniscus; b) five [37,38,41,54,56] that showed a higher level of specificity than of
sensitivity in the medial and lateral menisci; c) two [42,49] that showed a higher level of specificity than sensitivity in the medial meniscus and a higher level of sensitivity than specificity in the lateral meniscus (it is relevant to highlight that low-intensity scanners were used in said works); d) one [18] showing a higher level of specificity than sensitivity in the medial meniscus in acute and chronic injuries; and finally e) one study [50] that showed a higher level of sensitivity than of specificity globally in both menisci.

Figure 1. Systematic Review Flowchart, PRISMA Protocol, 2009.
Table 1.

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Hospital</th>
<th>Type of study</th>
<th>N</th>
<th>Age (years)</th>
<th>Period</th>
<th>I or both menisci</th>
<th>Sensitivity and Specificity (%)</th>
<th>Sensitivity and Specificity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muresan et al</td>
<td>2017</td>
<td>University of Medicine and Pharmacy of Tîrgu Mureș, Tîrgu Mureș, România</td>
<td>Prospective</td>
<td>45</td>
<td>29.4</td>
<td>May 2014 – July 2015</td>
<td>Both menisci</td>
<td>+ S x E: MI: 69.4/76.6 ME: 75.0/80.0</td>
<td></td>
</tr>
<tr>
<td>Chagas-Neto et al</td>
<td>2016</td>
<td>Division of Radiology, Internal Medicine Department, Faculdade de Medicina de Ribeirão Preto da Universidade de São Paulo (FMRPUSP), Ribeirão Preto, SP, Brazil</td>
<td>Prospective</td>
<td>38</td>
<td>33.5</td>
<td>–</td>
<td>Both menisci</td>
<td>+ S x E: MI: 83/71 ME: 54/92</td>
<td></td>
</tr>
<tr>
<td>Nilton Orlando Júnior et al</td>
<td>2015</td>
<td>Fundácio Hospital Adriano Jorge, Manaus, AM, Brazil</td>
<td>Prospective</td>
<td>72</td>
<td>33.54</td>
<td>June 2012 – December 2013</td>
<td>Both menisci</td>
<td>+ S x E: MI: 92.50/74.19 ME: 65/88.46</td>
<td></td>
</tr>
<tr>
<td>Khan et al</td>
<td>2015</td>
<td>Department of Orthopedics of the Holy Family Hospital, New Delhi, India</td>
<td>Prospective</td>
<td>26</td>
<td>13-50</td>
<td>March 2011– May 2012</td>
<td>Both menisci</td>
<td>+ S x E: MI: 100/50 ME: 50/86</td>
<td></td>
</tr>
<tr>
<td>James L. Cook et al</td>
<td>2014</td>
<td>Missouri Orthopaedic Institute, Department of Orthopaedic Surgery, University of Missouri.</td>
<td>Prospective</td>
<td>71</td>
<td>37.2</td>
<td>–</td>
<td>Both menisci</td>
<td>+ S x E: MI: 91, 7/66.7</td>
<td></td>
</tr>
<tr>
<td>H.N Chen et al</td>
<td>2014</td>
<td>The Second Affiliated Hospital of Soochow University, China.</td>
<td>Prospective</td>
<td>171</td>
<td>45.8</td>
<td>October 2009 – December 2011</td>
<td>Both menisci</td>
<td>+ S x E: MI: 95.60/96.25 ME: 96.47/95.25</td>
<td></td>
</tr>
<tr>
<td>Wei Chen et al</td>
<td>2014</td>
<td>Department of Radiology, Southwest Hospital, The Third Military Medical University, Chongqing 400038, China</td>
<td>Prospective</td>
<td>94</td>
<td>40.5</td>
<td>December 2011 - October 2012</td>
<td>Both menisci</td>
<td>+ S x E: MI: 93.5/66.7 ME: 92.2/100</td>
<td></td>
</tr>
<tr>
<td>Bari et al</td>
<td>2014</td>
<td>Department of Radiodiagnosis, JNMC, DMIMS, Sawangi (Meghe) Wardha, Maharashtra, India</td>
<td>Prospective</td>
<td>71</td>
<td>–</td>
<td>June 2012 – July 2014</td>
<td>Both menisci</td>
<td>+ S x E: MI: 93,54/87,50 ME: 77,78/81,81</td>
<td></td>
</tr>
<tr>
<td>Timotijevic Sladjan et al</td>
<td>2014</td>
<td>Hospital - KBC</td>
<td>Prospective</td>
<td>107</td>
<td>29.7</td>
<td>****</td>
<td>External menisci</td>
<td>+ S x E: MI: 68/87 (acute) S x E: 75/95 (chronic)</td>
<td></td>
</tr>
<tr>
<td>Navali et al</td>
<td>2013</td>
<td>The Orthopedic Ward at Tabriz Shohada Hospital,Tabriz, Iran</td>
<td>Prospective</td>
<td>120</td>
<td>29,13</td>
<td>October 2008 – October 2009</td>
<td>Both menisci</td>
<td>+ S x E: MI: 84.2/71.4 ME: 56.5/92.8</td>
<td></td>
</tr>
<tr>
<td>Roza Dzoleva-Tolevska et al</td>
<td>2013</td>
<td>University Orthopaedic Surgery Clinic, Ss. Cyril and Methodius University, Skopje, R. Macedonia</td>
<td>Prospective</td>
<td>70</td>
<td>–</td>
<td>–</td>
<td>Both menisci</td>
<td>+ S x E: MI: 79.5/38.1 ME: 40/92.7</td>
<td></td>
</tr>
<tr>
<td>Sharifah et al</td>
<td>2013</td>
<td>Department of Radiology, University Kebangsaan Malaysia, Kuala Lumpur, Malaysia</td>
<td>Prospective</td>
<td>65</td>
<td>28</td>
<td>2009 – 2012</td>
<td>Both menisci</td>
<td>+ S x E: MI: 82/92 ME: 83/97</td>
<td></td>
</tr>
<tr>
<td>Pieter Van Dyck et al</td>
<td>2013</td>
<td>University Hospital and the University of Antwerp, Antwerp (Edegem), Belgium</td>
<td>Prospective</td>
<td>200</td>
<td>45</td>
<td>2010 – 2012</td>
<td>Both menisci</td>
<td>+ S x E: MI: 93/90 ME: 77/99 (1.5 T) MI: 96/88 ME: 82/98 (3 T)</td>
<td></td>
</tr>
<tr>
<td>Ersin Eercin et al</td>
<td>2011</td>
<td>Ankara Mevki Military Hospital,Orthopedics and Traumatology Clinic,istanbul, Turkey</td>
<td>Prospective</td>
<td>30</td>
<td>38</td>
<td>5 months</td>
<td>Both menisci</td>
<td>+ S x E: MI: 95/60 ME: 67/88</td>
<td></td>
</tr>
<tr>
<td>F. Rayan et al</td>
<td>2009</td>
<td>Kettering General hospital</td>
<td>Prospective</td>
<td>131</td>
<td>–</td>
<td>36 months</td>
<td>Both menisci</td>
<td>+ S x E: MI: 76/52 ME: 61/92</td>
<td></td>
</tr>
</tbody>
</table>
Discussion

The results of our review are shown within the context of other two previous reviews related to meniscal injuries [29,57]. Unlike the previous reviews, our investigation only included prospective studies with the aim of finding the most accurate results.

It is worth highlighting that, even though it is not the main focus of our work, the clinical examination is of utmost relevance with regards to the diagnosis of meniscal injuries. Several studies show that a correct and thorough clinical examination, preferably performed by an expert surgeon, is more sensitive and specific than MRI in order to diagnose medial meniscus injuries but has similar results in lateral menisci issues [8,43–45,58].

Conceptually, it is customary to request an MRI in the event of diagnostic doubts [35,43,46,52] or when another therapeutic procedure is to be performed, e.g.: anterior cruciate ligament (ACL) surgery [42,45,59].

Another diagnostic element with good results, comparable with MRI, is ultrasonography [50,56]. Cook et al. state that in their series they found the same level of sensitivity but a better level of specificity than MRI for the diagnosis of meniscal injuries, thus encouraging its usage, firstly due to its efficacy and secondly due to its low cost and quickness regarding the performance logistics [50].

Focusing on MRI, there are studies that substantially support its usage for diagnosing injuries within the context of a traumatic knee and, specifically, for meniscal injuries [60,61]. The vast majority of the studies analyzed in this review affirm that this test has great potential in comparison with other diagnostic tools (such as the clinical examination or the ultrasonography). They show that MRI has a better sensitivity level for the medial meniscus and a better specificity level for the lateral meniscus [35,36,39, 40, 43–48,51–53,55], and, also as previously stated, we compared similar results with other reviews contemporary to ours.[29,57] There were studies in our review that did not show what most of the bibliography affirms [38,42,49]. Some, such as the one published by Behairy et al., showed opposite results: a higher sensitivity level for the lateral meniscus and a higher specificity level for the medial meniscus. Said authors say that this result might not show what most of the bibliography affirms [38,42,49]. Some, such as the one published by Behairy et al., showed opposite results: a higher sensitivity level for the lateral meniscus and a higher specificity level for the medial meniscus. Said authors say that this result might be the consequence of including anterior cruciate ligament injuries,

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Hospital</th>
<th>Type of study</th>
<th>N</th>
<th>Age (years)</th>
<th>Period</th>
<th>I or both menisci</th>
<th>Sensitivity and Specificity (%)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gui-e-khanda et al</td>
<td>2008</td>
<td>Radiology Department, Aga Khan University Hospital, Karachi</td>
<td>Prospective</td>
<td>50</td>
<td></td>
<td>2006–2007</td>
<td>Both menisci</td>
<td>+ S y E: MI: 100/69.27 ME:</td>
<td>87.5/88.23</td>
</tr>
<tr>
<td>M.J. Sampson et al</td>
<td>2008</td>
<td>Departments of Radiology and Orthopedics, Sports Surgery Clinic, Santry Demeene, Dublin.</td>
<td>Prospective</td>
<td>61</td>
<td>29.6</td>
<td>–</td>
<td>Both menisci</td>
<td>+ S y E: MI: 91/93 ME:</td>
<td>77/93</td>
</tr>
<tr>
<td>Naranje et al</td>
<td>2008</td>
<td>Departments of OrthopedicsAll India Institute of Medical Sciences, New Delhi, India</td>
<td>Prospective</td>
<td>50</td>
<td>27</td>
<td>–</td>
<td>Both menisci</td>
<td>+ S y E: MI: 96/89 ME:</td>
<td>84/90</td>
</tr>
<tr>
<td>Noha H. Behairy et al</td>
<td>2008</td>
<td>Cairo University, Cairo, Egypt</td>
<td>Prospective</td>
<td>70</td>
<td>22–59</td>
<td>–</td>
<td>Both menisci</td>
<td>+ S y E: MI: 47/95 ME:</td>
<td>100/75</td>
</tr>
<tr>
<td>F.K.W Schaefer et al</td>
<td>2006</td>
<td>Department of Diagnostic Radiology, Christian-Albrechts-Universitaet Kiel, Kiel, Germany</td>
<td>Prospective</td>
<td>31</td>
<td>40.5</td>
<td>18 months</td>
<td>Both menisci</td>
<td>+ S y E: MI: 88,6/98,3 ME:</td>
<td>90/95,9</td>
</tr>
<tr>
<td>Sanchez Vaz et al</td>
<td>2005</td>
<td>Orthopaedics and Traumatology Department, Hospital Regional do Paraná, State University of Londrina – Londrina/PA, Brazil.</td>
<td>Prospective</td>
<td>300</td>
<td></td>
<td>August 1998 – March 2002</td>
<td>Both menisci</td>
<td>+ S y E: MI: 97,5/92,9 ME:</td>
<td>91/93,6</td>
</tr>
</tbody>
</table>
some impact over the precision in meniscal injury cases. However, after analyzing different studies, we found no significant difference among different magnetic field's intensities, higher or lower (3.0 T and 1.5 T) [18,41,47,63]. Moreover, there are descriptions stating that 0.2 T scanners are equally effective and have lower costs than the conventional ones used nowadays [64,65]. Furthermore, given the current technological progress, it is necessary to develop new studies.

Some authors limited their revisions to the most current studies; they wanted to use those with modern technology and more experienced imagenology specialists [29]. This isn't the case of other authors who disagree with the aforesaid, who claim that the previous studies have a higher quality and better methodology and that there might be a selection mistake [57]. In other words, all studies should be included regardless of its publishing year. This also avoids the bias that may happen when authors select a specific year for exclusion.

From the analysis of the collected information, and as a consequence of the preceding discussion, we may consider that there is no consistency of results and opinions in English-published bibliography of a prospective profile. Nevertheless, we must acknowledge that the prevailing results are those that prioritize the relevance of MRI in terms of sensitivity and specificity. We must currently accept that MRI is a very costly study for diagnosing meniscal injuries. There are some variations in its sensitivity and specificity, but they are minor and, therefore, do not invalidate these conclusions. There is no doubt that, in future years, technological progress shall provide more accurate devices that will allow us to reach safer diagnostic levels.

Likewise we shouldn’t forget that clinical examination, when combined with MRI, offers the most accurate non-invasive method to obtain the available information about meniscal pathological findings [53, 66].

A thorough search throughout medical literature, including PubMed and Lilacs databases, provided us with 23 studies that informed about the correlation between imaging screening and arthroscopy in both menisci and only one work about the lateral meniscus, all of them published between 2004 and 2018, and they constitute the strength of our study. The limitations are the reduced amount of cases in some studies and the inability of access to final conclusions due to the lack of uniformity in the results of the analyzed studies.

References


42. Behairy NH, Dorgham MA, Khaled SA (2009) Accuracy of routine magnetic resonance imaging in meniscal and ligamentous injuries of the knee: comparison with arthroscopy. *Int Orthop* 33: 961–967. [Crossref]


60. Kersting-Sommerhof B, Gerhardt P, Golder W, Hof N, Riel KA, Helmberger H, et al. (1995) [MRI of the knee joint: first results of a comparison of 0.2-T specialized system and 1.5-T high field strength magnet]. *Rofo* 162: 390–5. [Crossref]


Citation: