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Correlation between Magnetic Resonance Imaging and Arthroscopy in Meniscal Injuries

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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].

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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.

Currrently 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 imagenology 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

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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.

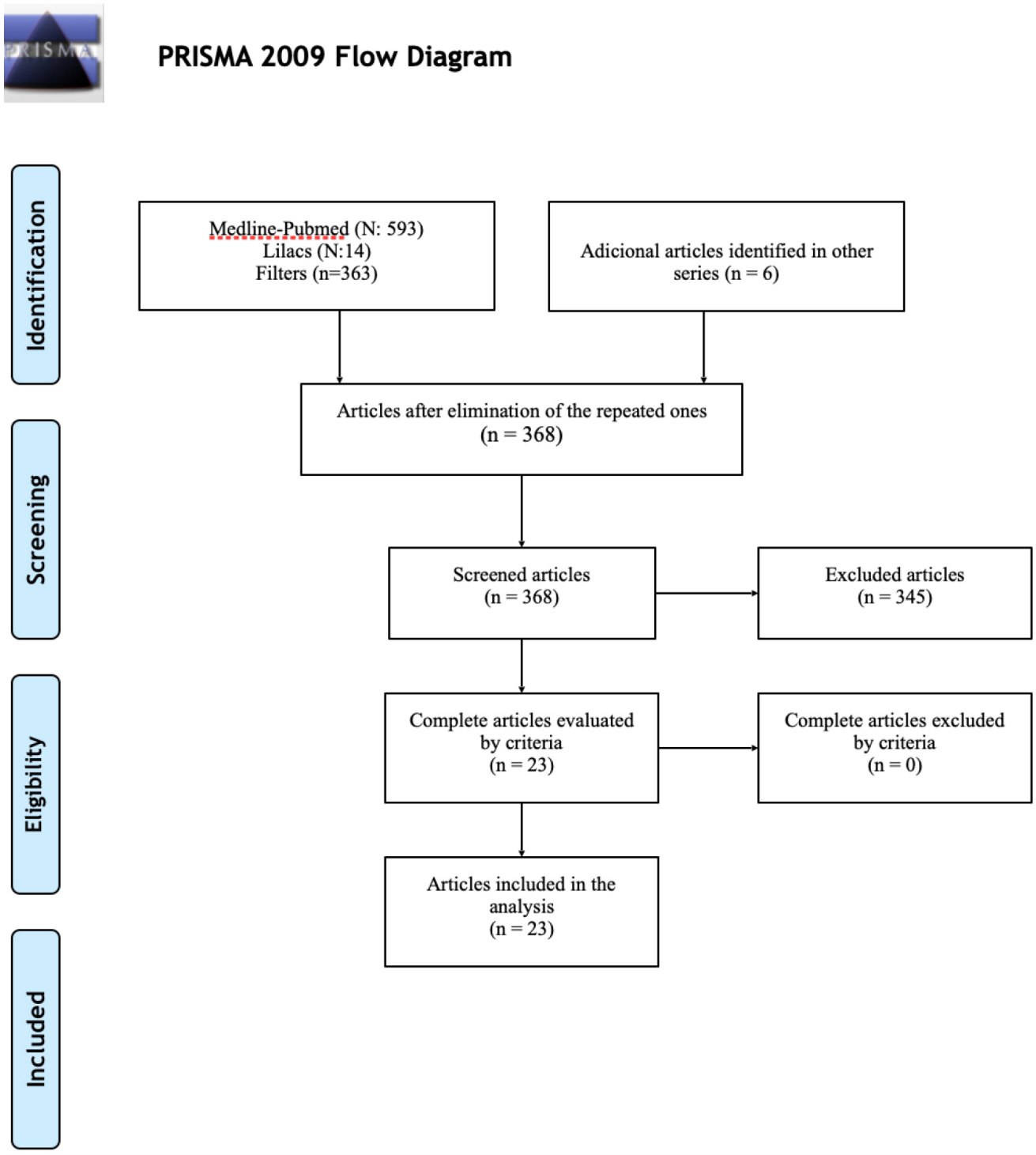

Figure 1. Systematic Review Flowchart, PRISMA Protocol, 2009.

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Table 1.

	Author	Year	Hospital	Type of study	N	Age (years)	Period	1 or both menisci	Sensitivity and Specificity (%) - MI: internal menisci, ME: external menisci
1	**Muresan et al**	2017	University of Medicine and Pharmacy of Tîrgu Mureş, Tîrgu Mureş, România	Prospective	45	29,4	May 2014 – July 2015	Both menisci	**+ S y E: MI: 69,4/76,6 ME: 75,0/80,0**
2	**Chagas-Neto et al**	2016	Division of Radiology, Internal Medicine Department, Faculdade de Medicina de Ribeirão Preto da Universidade de São Paulo (FMRPUSP), Ribeirão Preto, SP, Brazil	Prospective	38	33,5	–	Both menisci	**+ S y E: MI: 83/71 ME: 54/92**
3	**Nilton Orlando Júnior et al**	2015	Fundacão Hospital Adriano Jorge, Manaus, AM, Brazil	Prospective	72	33,54	June 2012 – December 2013	Both menisci	**+ S y E: MI: 92,50/74,19 ME: 65/88,46**
4	**Khan et al**	2015	Department of Orthopedics of the Holy Family Hospital, New Delhi, India	Prospective	26	13–50	March 2011- May 2012	Both menisci	**+ S y E: MI: 100/50 ME: 50/86**
5	**James L. Cook et al**	2014	Missouri Orthopaedic Institute, Department of Orthopaedic Surgery, University of Missouri.	Prospective	71	37.2	–	Both menisci	**+ S y E: 91, 7/66,7**
6	**H.N Chen et al**	2014	The Second Affiliated Hospital of Soochow University, China.	Prospective	171	45.8	October 2009 – December 2011	Both menisci	**+ S y E: MI: 95.60/96.25 ME: 96.47/95.25**
7	**Wei Chen et al**	2014	Department of Radiology, Southwest Hospital, The Third Military Medical University, Chongqing 400038, China	Prospective	94	40,5	December 2011 - October 2012	Both menisci	**+ S y E: MI: 93,5/66,7 ME: 92,2/100**
8	**Bari et al**	2014	Department of Radiodiagnosis, JNMC, DMIMS, Sawangi (Meghe) Wardha, Maharashtra, India	Prospective	71	–	June 2012 – July 2014	Both menisci	**+ S y E: MI: 93,54/87,50 ME: 77,77/81,81**
9	**Timotijevic Sladjan et al**	2014	Hospital - KBC	Prospective	107	29.7	****	External menisci	**+ S y E: 68/87 (acute) S y E: 75/95 (cronic)**
10	**Navali et al**	2013	The Orthopedic Ward at Tabriz Shohada Hospital,Tabriz, Iran	Prospective	120	29,13	October 2008 – October 2009	Both menisci	**+ S y E: MI: 84,2/71.4 ME: 56,5/92,8**
11	**Roza Dzoleva-Tolevska et al**	2013	University Orthopaedic Surgery Clinic, Ss. Cyril and Methodius University, Skopje, R. Macedonia	Prospective	70	–	–	Both menisci	**+ S y E: MI: 79,5/38,1 ME: 40/92,7**
12	**Sharifah et al**	2013	Department of Radiology, University Kebangsaan Malaysia, Kuala Lumpur, Malaysia	Prospective	65	28	2009 – 2012	Both menisci	**+ S y E: MI: 82/92 ME: 83/97**
13	**Pieter Van Dyck et al**	2013	University Hospital and the University of Antwerp, Antwerp (Edegem), Belgium	Prospective	200	45	2010 – 2012	Both menisci	**+ S y E: MI: 93/90 ME: 77/99 (1,5 T) MI: 96/88 ME: 82/98 (3 T)**
14	**Ersin Eercin et al**	2011	Ankara Mevki Military Hospital,Orthopedics and Traumatology Clinic,Istanbul, Turkey	Prospective	30	38	5 months	Both menisci	**+ S y E: MI: 95/60 ME: 67/88**
15	**F. Rayan et al**	2009	Kettering General hospital	Prospective	131	–	36 months	Both menisci	**+ S y E: MI: 76/52 ME: 61/92**

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	Author	Year	Hospital	Type of study	N	Age (years)	Period	1 or both menisci	Sensitivity and Specificity (%) - MI: internal menisci, ME: external menisci
16	**Gul-e-khanda et al**	2008	Radiology Department, Aga Khan University Hospital, Karachi	Prospective	50	–	2006–2007	Both menisci	**+ S y E: MI: 100/69.27 ME: 87.5/88.23**
17	**M.J. Sampson et al**	2008	Departments of Radiology and Orthopaedics, Sports Surgery Clinic, Santry Demesne, Dublin.	Prospective	61	29,6	–	Both menisci	**+ S y E: MI: 91/93 ME: 77/93**
18	**Naranje et al**	2008	Departments of OrthopaedicsAll India Institute of Medical Sciences, New Delhi, India	Prospective	50	27	–	Both menisci	**+ S y E: MI: 96/89 ME: 84/90**
19	**Noha H. Behairy et al**	2008	Cairo University, Cairo, Egypt	Prospective	70	22–59	–	Both menisci	**+ S y E: MI: 47/95 ME: 100/75**
20	**F.K.W Schafer et al**	2006	Department of Diagnostic Radiology, Christian-Albrechts-Universitaet Kiel, Kiel, Germany	Prospective	31	40.5	18 months	Both menisci	**+ S y E: MI: 88,6/98,3 ME: 90/95,9**
21	**Keith Winters et al**	2005	Wellington Public Hospital	Prospective	67	37	1999 -2003	Both menisci	**+ S y E: MI: 87/92 ME: 46/ 91**
22	**Sanchez Vaz et al**	2005	Orthopaedics and Traumatology Department, Hospital Regional do Paraná, State University of Londrina – Londrina/PA, Brazil.	Prospective	300	–	August 1998 – March 2002	Both menisci	**+ S y E: MI: 97,5/92,9 ME: 91,9/93,6**
23	**Kocabey et al**	2004	Division of Orthopedics (D.L.J.), Section of Sports Medicine (Y.K., W.M.I., Ö.A.A.), University of Kentucky, Lexington, Kentucky, U.S.A	Prospective	50	22	August 2001 – December 2001	Both menisci	**+ S y E: MI: 80/79 ME: 85/97**

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 meniscus 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, thusly 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 be the consequence of including anterior cruciate ligament injuries, which would decrease the sensitivity of the medial meniscus [11].

Other authors like Magee et. al., said that the MRI scanner's power might be another element that modifies results [62]. The magnetic field's intensity is a commonly reported study variable that might have

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some impact over the precision in meniscal injury cases. However, after analyzing different studies, we found no significant difference among different magnetic fields' 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.

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