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Ramp Lesions: Revisão Sistemática da Performance Diagnóstica da RM e da Eficácia do Tratamento

Ramp Lesions: a Systematic Review of MRI Diagnostic Accuracy and Treatment Efficacy

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FMUP

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TÍTULO DISSERTAÇÃO

Ramp Lesions: a Systematic Review of MRI Diagnostic Accuracy and Treatment Efficacy

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Manuel António Pereira Gutierres

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ASSINALE APENAS UMA DAS OPÇÕES:

É AUTORIZADA A REPRODUÇÃO INTEGRAL DESTE TRABALHO APENAS PARA EFEITOS DE INVESTIGAÇÃO, MEDIANTE DECLARAÇÃO ESCRITA DO INTERESSADO, QUE A TAL SE COMPROMETE.	☐
É AUTORIZADA A REPRODUÇÃO PARCIAL DESTE TRABALHO (INDICAR, CASO TAL SEJA NECESSÁRIO, Nº MÁXIMO DE PÁGINAS, ILUSTRAÇÕES, GRÁFICOS, ETC.) APENAS PARA EFEITOS DE INVESTIGAÇÃO, MEDIANTE DECLARAÇÃO ESCRITA DO INTERESSADO, QUE A TAL SE COMPROMETE.	☐
DE ACORDO COM A LEGISLAÇÃO EM VIGOR, (INDICAR, CASO TAL SEJA NECESSÁRIO, Nº MÁXIMO DE PÁGINAS, ILUSTRAÇÕES, GRÁFICOS, ETC.) NÃO É PERMITIDA A REPRODUÇÃO DE QUALQUER PARTE DESTE TRABALHO.	X

Faculdade de Medicina da Universidade do Porto, 23/ 03 / 2020

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Dedicatória

Dedico este trabalho ao meu irmão que me compeliu a ingressar nesta área e aos meus pais que me deram a oportunidade de o fazer.

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Ramp Lesions: A Systematic Review of MRI Diagnostic Accuracy and Treatment Efficacy

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Abstract

Purpose: We conducted a systematic review of the published literature with regard to the diagnosis and treatment of ramp lesions (RLs) in Anterior Cruciate Ligament (ACL) deficient knees aiming to assess the accuracy of Magnetic Resonance Imaging (MRI), compared to arthroscopy, in establishing the presence of a RL and the clinical efficacy of surgical repair of RLs.

Methods: A comprehensive search of the MEDLINE, Web of Science and Scopus databases was performed according to PRISMA guidelines. Studies assessing MRI diagnostic accuracy for RLs or the clinical effect of RL repair in participants with acute or chronic ACL injuries were included. Diagnostic accuracy measures were pooled, analysed and plotted in forest plots. Preoperative and at last follow-up treatment efficacy outcome measures were extracted and plotted in forest plots, for graphical comprehension.

Results: Sixteen studies met the criteria and were included. The diagnostic analysis showed a pooled sensitivity, specificity, positive and negative likelihood ratios of 65.1% (95% CI, 59.73 to 70.42), 91.6% (95% CI, 89.14 to 94.05), 2.91 (95% CI, 2.38-3.55) and 0.53 (95% CI, 0.44-0.64), respectively, with high heterogeneity (I^2 above 80%) for all measures. Treatment analysis showed improved clinical scores (Lysholm Knee Score, IKDC score and laxity difference between the knees) in all studies after meniscal suture repair. A separate analysis showed no differences between repair of smaller, stable, ramp lesions with meniscal sutures and repair with abrasion and trephination only.

Conclusion: Although the results present considerable heterogeneity and quality could be improved, MRI seems to demonstrate moderate accuracy in the diagnosis of RLs in patients presenting with acute or chronic ACL tear and the surgical repair of RLs can be associated with improved overall outcomes. A continued interest in the development of knowledge of this condition is essential.

Level of Evidence: III, Systematic review of Level-III studies.

Introduction

Primarily described in 1988 by Strobel[1], and again in 2010 by Bollen[2], injury to the peripheral attachment of the posterior horn of the medial meniscus (termed "Ramp Lesion") after Anterior Cruciate Ligament (ACL) lesion still remains an understudied topic.

The coexistence of ACL rupture and other knee injuries has been described in many studies. ACL rupture is associated with a meniscal injury in over 50% (16-82%, in different studies) of acute ACL ruptures undergoing ACL repair and over 80% of chronic ACL ruptures.[3-9]

The medial meniscus is firmly attached to the tibia and femur, allowing it to act as a knee stabilizer, behaving as a wedge against the tibia and preventing anterior translation, especially in the ACL-deficient knee.[10-16] For these reasons the medial meniscus is especially susceptible to injuries after ACL lesion.

Besides being named ramp lesions (RL), these injuries are often described as meniscocapsular separations and meniscosynovial tears.[11] Originally, the term referred to a longitudinal tear of the peripheral attachment of the posterior horn of the medial meniscus (PHMM) at the meniscocapsular junction. However, recent literature has extended the definition to include injury of the meniscotibial ligament and peripheral longitudinal tears in the Red-Red zone of the PHMM.[11, 17-21] For the purposes of this review, all these descriptions will be considered as RLs.

Thaunat et al[19] proposed a classification system based on possible arthroscopic findings (tear location and pattern, degree of mobility at probing and visibility), dividing RLs into five subtypes, type 1 – meniscocapsular lesions (very peripheral, located in the synovial sheath, with very little mobility at probing), type 2 – partial superior lesion (stable lesions, only diagnosed by a trans-notch view, with little mobility at probing), type 3 – partial inferior or hidden lesion (not visible, suspected when there is significant mobility at probing), type 4 – complete tear in the red-red zone, and type 5 – double tear in the red-red zone of the PHMM.

Seil et al[22] proposed a different classification, based on criteria important for the decision of further therapy: the mediolateral extent of the lesion, distinguishing complete lesions (across the entire base of the ramp) form partial lesions (only medial or central), and the behaviour of the capsule-ligament complex during flexion of the knee joint, differentiating adherent lesions, with self-healing potential, from dehiscent lesions, requiring repair.

The epidemiology of RLs is still incompletely defined. Incidence ranges from 9% to 40% in many small populations studies, becoming higher with chronicity of ACL deficiency.[2, 13, 23, 24] Shelbourne et al[25] found an incidence of 12.5% in 3385 patients who underwent ACL reconstruction between 1997 and 2010.[25] Male sex, younger age, chronic (> 6 weeks) ACL injury, increased time from injury, and presence of a lateral meniscal tear are all significant risk factors for ramp lesions.[26, 27] Contact sports have been appointed as risk factors by some authors, but the results are discordant across different studies.[27, 28] Song et al[23] found an association between an increased Medial Meniscal Slope (MMS) in MR imaging and the presence of a RL.[28]

When a RL is present in an ACL-deficient knee, anterior and external rotational laxities are significantly increased, compared to isolated ACL injury. In such cases, repair of the ACL alone does not fully correct this abnormality, suggesting the importance of diagnosing and repairing the meniscal injury during ACL reconstruction surgery.[12, 29, 30] However, clinical identification can be a troublesome situation. There are no specific clinical tests for the diagnosis of RLs and common tests for meniscal tears are not accurate in diagnosing RLs.[31]

In spite of its rare usage, the diagnostic accuracy of ultrasound for meniscal tears is relatively high but its accuracy in the specific detection of RLs is still widely unexplored.[32, 33] As for Magnetic Resonance Imaging (mri), whilst a reliable diagnostic modality for most meniscal pathologies,[34] its sensitivity and specificity for the diagnosis of RL have been questioned by some authors, marking the need for further research, especially for a quantitative analysis of data from the existing studies. [2, 31, 35]

The general consensus is that arthroscopic evaluation, with direct visualization of the posteromedial meniscus and capsule, is necessary to reliably assess the occurrence of a RL after ACL injury.[11] Nonetheless, standard anterolateral arthroscopy portals, even with the addition of probing, have limited accuracy, requiring insertion of the arthroscope in the posteromedial recess.[21, 36, 37] Multiple techniques have been described to that effect, the most commonly used being the Gillquist, or Intercondilar, view, which consists in the insertion of the arthroscope through a narrow triangular space, bordered by the posterior cruciate ligament, medial femoral condyle, and the tibial spine.[38-42] Another option is the posteromedial portal, performed when a "hidden lesion" is suspected or for meniscal tear repair, which consists on a portal close to the joint line, just above the meniscus and immediately posterior to the longitudinal portion of the medial collateral ligament.[36, 37, 43-48] In spite of the minimal disruption of soft tissue before reaching the capsule, this portal provides limited field of vision and space to establish a second (surgical) portal.[45] Many authors suggest a systematic diagnostic approach to the diagnosis, relying in the initial arthroscopic evaluation through a standard anterolateral portal, followed by the intercondylar view and finally the posteromedial portal for patients with instability at probing of the PHMM without a clear diagnosis using the other portals.[21, 48]

What to do when a ramp lesion is identified is not consensual and may depend on whether ACL injury is acute or chronic. In chronic ACL injuries, the repair of RL is consensual.[11] However, in the acute setting, once they are located in a vascularized region of the meniscus, several authors have stated that shorter or more stable tears may be managed with conservative treatment following ACL reconstruction.[49, 50] Conversely, some authors state that acute repair is necessary since the hypermobility of the detached meniscocapsular structure delays, or even impedes, spontaneous healing.[13, 51, 52]

Repair options may include open repair, termed posteromedial arthrotomy,[53, 54] now widely replaced by other techniques, as the inside-out and the all-inside repair techniques, both providing similar results.[1, 20, 55] The inside-out repair technique offers versatility in the number and placement of sutures, potentially creating a stronger construct, appropriate for tears extending anteriorly through the meniscus.[56] All-inside suture repair technique is associated with less neurovascular risks, but is associated with implant breakage/migration, nerve irritation, and chondral damage.[11, 57, 58] For small and stable subacute or chronic injuries, stimulation of a healing response with abrasion and trephination may be recommended.[20]

The existing literature lacks a comprehensive analysis of data from the existing treatment studies, in order to clearly understand the added benefit of repairing the meniscal tear.

After RL repair, there are no evidence-based rehabilitation protocols described in the literature. In the setting of ACL reconstruction, the standard protocol for ACL reconstruction rehabilitation is recommended, and is the option most authors use.[11, 52] Preventing excessive weightbearing and joint compressive forces, that lead to disruption of meniscal healing has proved beneficial for the medial meniscus.[31, 52, 59, 60]. Thus, it is recommended to restrict passive flexion to 90º and all active flexion for, at least, the first two weeks postoperatively, while full weight bearing should not be allowed for, at least, three to four weeks postoperatively.[52, 59, 60] Also, knee rotation should be avoided in the first 3 weeks, as knee rotation increases medial meniscus mobility.[11] Pivot or contact activities and squatting and lifting exercises, should be restricted for at least 4 to 6 months, at which full activity can be allowed.[11, 52, 59, 60]

We conducted a systematic review of the published literature with regard to the diagnosis and treatment of RLs in ACL deficient knees aiming to assess the accuracy of MRI (compared to arthroscopy) in establishing the presence of a ramp lesion and the clinical efficacy of the surgical repair of RLs, by evaluating the difference between preoperative and postoperative knee scores. Our hypothesis was that MRI can adequately diagnose or exclude ramp lesions and surgical repair of ramp lesion leads to improved clinical outcomes at final follow-up.

Methods

The present study was conducted according to the PRISMA guidelines.[61] A protocol for the conduction of the review was written before the start of the study and followed until the end of the review.

Study Eligibility

Types of studies: all study designs, except for case reports, ex vivo studies, reviews and technical notes, were included, without publication date, status or language restrictions

Participants: Studies were considered when they examined participants, of any age, with acute or chronic ACL rupture undergoing (or who underwent) reconstruction and at risk for or diagnosed with a concomitant ramp lesion.

Interventions and Comparisons: studies were included if they compared the diagnostic accuracy of Magnetic Resonance Imaging (MRI) with arthroscopy (gold standard) or if they assessed the long-term clinical effect of ramp lesion repair (through any method of repair).

Outcomes: primary outcomes considered were sensitivity, specificity and likelihood ratios for the diagnostic studies and Lysholm Knee Score, International Knee Documentation Committee (IKDC) Score and Laxity Difference between the affected and the non-affected knees, for the treatment analysis. Articles not presenting any of the aforementioned outcomes or without a pre-treatment analysis of patients were excluded.

Literature Search

Included databases were MEDLINE, Web of Science and Scopus. The last search was run on 12/01/2020 and search clauses can be found in appendix. The search terms cover a broad spectrum of meniscus and associated knee injuries, to avoid missing relevant literature. As a result of the different designations of RLs, keywords such as “ramp”, “hidden”, “meniscocapsular”, “meniscosynovial” and “posteromedial” were included in the search clause. The use of additional limiters and filters was restricted, in order to avoid missing potentially relevant studies. The reference lists of the selected articles were also checked for relevancy.

Study Selection and Data Abstraction

Two researchers independently screened the titles and abstracts yielded by the database searches against the inclusion criteria. Disagreements were solved by consensus. Full reports for all titles and abstracts that appeared to have met the inclusion criteria or where there was some uncertainty were sought. Full text reports were then screened and included if they met the inclusion criteria. Reasons for excluding papers were recorded. None of the researchers was blinded to the journal titles, authors or institutions.

Data regarding the study sample and methodology, intervention details (MRI and surgical techniques), and all reported important outcomes were systematically extracted from the included studies, following the predefined protocol.

Risk of Bias Assessment

The QUADAS-2 instrument was used to assess possible risk of bias in diagnostic studies, according to the Cochrane Collaboration recommendation.[62] Each of the 11 recommended quality items was judged as 'yes' or 'no', according to whether that characteristic was present. When there was insufficient detail reported in the study, that item was judged 'unclear'.

For the treatment studies, we evaluated the quality of the included articles using the MINORS[63] validated instrument, designed for non-randomized surgical studies and based on 12 items, the last four specific for comparative studies. Each item was scored as "0", "1" or "2", if the item was not reported, reported but inadequate or reported and adequate, respectively.

Quality assessment was accomplished by one of the authors. Results are presented for each item, independently.

Data Analysis

Sensitivity, specificity and positive and negative likelihood ratios (LR), with corresponding 95% confidence intervals (CI), were extracted whenever provided in the original reports, or computed with the available information. The diagnostic accuracy measures were pooled and analysed using a random effects model and plotted in forest plots. Statistical heterogeneity was tested using the I^2 statistic.

Preoperative and at last follow-up treatment efficacy outcome measures were extracted and plotted in forest plots for graphical comprehension of the results. No meta-analysis of these results was attempted, since no measures of association were provided in most studies. A separate analysis with two studies[64, 65] was performed to compare the efficacy of meniscal suture to abrasion and trephination only, in small (< 1.5 cm) and stable Ramp Lesions.

Unless otherwise noted, continuous variables were expressed as means and 95% confidence intervals (CI) and categorical variables were expressed as frequencies. Standard deviations were used to estimate 95% confidence intervals, when CI were not provided.

Stata software (version 15.1) was used for the meta-analysis and to produce forest plots. A $P < 0.05$ was considered statistically significant.

Results

Literature Search

The systematic review flow chart is presented as Figure 1. Initial search through the databases retrieved 1102 articles. A total of 16 original research articles were included in the systematic review, eight studies were included in the diagnostic analysis and nine studies were included in the treatment analysis, with one study[66] being included in both portions.

Characteristics of the Included Studies

The study and patient characteristics from the included studies are summarized in Table 1. All studies were conducted in a single center and evaluated a total of 1959 patients. Populations depicted in the studies presented a predominance of males (except in one study by Furumatsu et al[67]) and young adults.

The MRI characteristics of the diagnostic studies included are summarized in Table 2. Hatayama et al [41] used two cohorts in their study to compare different magnet strengths in the diagnosis of RL (3.0-Tesla versus 1.5-Tesla). MRI diagnostic criteria are similar in all but one study by Kumar et al[68], where they used oedema of the tibial plateau as a marker of RLs. Sagittal fat-suppressed proton density-weighted image and fat-suppressed T2-weighted image were the preferred sequences. Only two studies[69, 70] reported the interpretation of the MR images simultaneously by a musculoskeletal radiologist and an orthopaedic surgeon, the remaining reported MRI interpretation by either a radiologist or a surgeon only. The estimated time from injury to the diagnostic MRI was not mentioned in any of the studies.

Table 3 compiles the treatment approaches from the studies included in the review. ACL reconstruction was performed in all patients, either by a hamstring autograft (640 patients), a patellar bone-tendon-patellar bone autograft (98 patients) and a quadriceps tendon graft (two patients). The ACL reconstruction strategy was absent in three studies.[66, 71, 72] Sonnery-Cottet et al[73] added anterolateral ligament repair to the intervention in 189 patients. All studies present different postoperative rehabilitation protocols, with many common key points. All patients were followed for a minimum of 12 months, except in the study by Gulenc et al[66] (33 weeks).

Risk of Bias Assessment

Regarding risk of bias in the diagnostic studies, portrayed in Figure 2, all studies satisfied at least six of the 11 items recommended by the Quality Assessment of Diagnostic Accuracy Studies 2 (QUADAS-

2) tool. Three studies were considered of low quality concerning the representativeness of the spectrum of patients, as a result of the study of a paediatric population[74] or the study of patients already diagnosed with Ramp Lesions.[66, 69] The interval between MRI and the reference standard was absent in three studies.[35, 68, 74] Blinding of the two tests results was only reported in three studies[68, 69, 75] and only one study[76] reported on the clinical information available at the time of interpretation of test results. All other topics were considered of high quality for every study.

Table 4 summarizes risk of bias in the treatment studies according to the MINORS tool. Liu et al[64] was not included in the quality assessment, as it was designed as a randomized controlled trial. This study was assessed to have a low overall risk of bias, according to the randomization process, blinding of the allocated intervention and unbiased outcome measurements. Blinding of the interventions to the investigators assessing the outcomes was only performed in one study, by Sonnery-Cottet et al[73], as was the case for prospective calculation of the study sample, performed only in the study by Keyhani et al[71].

Diagnostic Accuracy of MRI

Figure 3 depicts the forest plots summarizing the accuracy of magnetic resonance imaging in the detection of ramp lesions. The pooled results showed a sensitivity of 65.08% (95% CI, 59.73 to 70.42), a specificity of 91.59% (95% CI, 89.14 to 94.05), a positive likelihood ratio of 2.91 (95% CI, 2.38 to 3.55) and a negative likelihood ratio of 0.53 (95% CI, 0.44 to 0.64). Heterogeneity was high, with I^2 statistics above 80% for all outcomes evaluated.

Treatment Efficacy of Ramp Lesion Repair

Figure 4 shows the forest plots describing the results from studies that evaluated the effects of treatment. Mean preoperative and final Lysholm Knee Scores ranged from 56.8 to 68.6 and 84.5 to 94.4, respectively. Mean preoperative and final IKDC scores ranged from 52.7 to 64.3 and 82.1 to 90.6, respectively. Mean preoperative and final laxity differences between the affected and the unaffected knees ranged from 6.1 mm to 7.2 mm and 0.4 mm to 1.6 mm, respectively. The improved final outcomes are statistically significant in all studies ($P < 0.05$), using tests for paired samples.

Figure 5 presents the comparison of the all-inside suture technique of the medial meniscus versus abrasion and trephination for the repair of small and stable Ramp Lesions (< 1.5 cm), in the two studies that evaluated both techniques. Lysholm Knee Scores, IKDC scores and laxity differences between the affected and the unaffected knees in both groups increased significantly postoperatively ($P < 0.05$), but no significant differences were observed between the two groups before or after the surgery ($P > 0.05$) in both studies.

Discussion

The results of this review demonstrated that MRI has a moderate sensitivity (65%) and a high specificity (92%) in the diagnosis of Ramp Lesions. The positive and negative likelihood ratios (2.91 and 0.53, respectively) indicate a questionable clinical significance of the MRI, as the pre-test probability will only suffer slight (around 15%) modifications after MRI interpretation.

MRI has been appointed as a reliable diagnostic modality for most medial meniscal pathologies, with sensitivities of over 90% and specificities of over 80%, in two systematic reviews with meta-analysis.[34, 77, 78] This accuracy for the diagnosis of medial meniscus injury is said to be lower in the presence of an ACL tear,[79, 80] which may explain the lower sensitivity of MRI for the diagnosis of RLs found in this review. DePhillipo et al[38] inquired 36 directors of orthopaedic sports medicine through an electronic questionnaire and found that despite 89% of surgeons stated that they routinely use MRI for the diagnosis, 50% believed that they are rarely or only sometimes accurate in the diagnosis.[38] In fact, our results suggest that MRI may have a good accuracy in the diagnosis of RLs, but arthroscopy remains the reference standard and should not be replaced by MRI, as stated in the literature for other cartilage damages in the knee.[77, 78, 81]

Our results showed that Lysholm Knee Scores, IKDC scores and laxity differences between the affected and the unaffected knees significantly improve after ramp lesion repair with sutures. In small and stable ramp lesions (< 1.5 cm) no significant differences were found between all-inside sutures and abrasion and trephination of the meniscus, suggesting that in these cases, abrasion and trephination may be a viable option for the management of RLs.

Repair of the medial meniscus in the context of ACL reconstruction has been associated with high success rates, when evaluated by second-look arthroscopy (complete healing ranging from 82.1 to 97.4%), with little complications and satisfactory clinical results.[51, 82, 83] Results from this review showed that the surgical repair of ramp lesions leads to improved clinical results compared to preoperative scores. Despite the absence of a meta-analysis of these results, because no effect measures for direct comparisons between the pre and post treatment periods were provided in the original reports, the visual presentation of the results in forest plots provides a good picture of the benefit of surgery and differs from previous reviews.[17, 84]

It is generally accepted that extensive medial meniscal injuries require surgical repair (with inside-out or all-inside sutures) and 92% of surgeons report surgical repair of meniscal RLs in their clinical practice.[38] On the other hand, there is some controversy in the management of small and stable meniscal tears.[49, 85, 86] In the two studies included in this review, comparing all-inside sutures to abrasion and trephination of the meniscus, the overall outcomes were similar.

Limitations

The present systematic review has a few limitations that should be discussed. This review analyses data of a relatively small number of studies. Regardless of the comprehensiveness of the search expressions, the use of multiple databases and the inclusion of articles in several languages, the available literature on this topic is scarce and some of the articles failed to report important outcomes (such as, sensitivity and specificity for diagnostic studies [2, 21, 24, 87, 88] and preoperative plus postoperative clinical outcomes [27, 89-91] for treatment studies) and had to be excluded.

Both the diagnostic and treatment studies included are heterogeneous regarding the methods used. Different magnet strengths, different knee position and differences in the diagnostic criteria could be responsible for the differences in sensitivity and specificity and for the heterogeneity encountered. In the treatment studies, differences between the surgery and postoperative protocols could also be responsible for some variability in the results. The evidence regarding the accuracy of different magnet strengths in the diagnosis of meniscal injuries is conflicting[92-95], but a recent meta-analysis[96] showed no statistically significant difference between the 1.5-T and 3-T groups in sensitivity and specificity. There are no defined criteria to diagnose RLs on MRI, but irregular posterior meniscal outline and fluid separating the meniscus and capsule, are considered to correlate best with the diagnosis of RLs[34, 97] and may explain the conflicting results found by Kumar et al[68]. Considering patient position, Bollen[2] hypothesized that when the knee is in near full extension, meniscocapsular separation is reduced, making the diagnosis harder and affecting the sensitivity of MRIs. To our knowledge, no study has compared the efficacy of all-inside suture using a device with all-inside suture using a hook. Visual inspection of the forest plot conveys the impression that outcomes between the two methods are similar, but a more objective approach is important and missing in the literature. Sonnery-Cottet et al[73] performed anterolateral ligament reconstruction in 189 patients, but no significant differences were found between the two groups. Also, we found variability between the postoperative rehabilitation protocols adopted by each article and, even though most share the same basic principles, a standardization of the postoperative protocol is needed for future research.

The studies included in this review were also heterogeneous regarding the amount of information provided. Mean time from injury to the diagnostic MRI was absent in all the diagnostic studies and time from MRI to arthroscopy was missing in three[35, 68, 74]. RLs may heal spontaneously, causing a mismatch between the MRI and arthroscopic findings if there is substantial delay between the two methods. The amount of clinical information available to the radiologist at the time of MRI interpretation was omitted in most articles. Combination of clinical and MRI findings provides the most accurate non-invasive method currently available for diagnosing injuries of the menisci.[77] Time from injury to surgery (and distinction between acute or chronic injuries) was also absent in many treatment studies. As chronicity of the lesion can be a factor in the decision of treatment, this information is valuable and should be reported by the studies. Further radiological studies are warranted using standardized optimal conditions (as knee positioning and MRI sequences evaluated) and the inclusion of clinical findings in the evaluation of the images, possibly leading to the development of preoperative diagnostic algorithms.

The studies that addressed the effects of treatment present many quality issues. Most studies[18, 66, 71, 72, 98] were uncontrolled before-after studies with a single preoperative outcome measurement, presenting a serious risk of bias, as we cannot be sure that the observed improvements are due to the intervention, instead of other factors. The absence of blinding was also common across the reviewed studies and contributes to an increased risk of bias. Further studies comparing different surgical options and the non-surgical management of these injuries are warranted to make assertions regarding the correct approach in the management of these conditions.

Conclusion

Notwithstanding the longevity of recognition of ramp lesions, risk factors for developing this type of injury, the incidence, diagnosis and the outcomes of treatment remain incompletely defined. Although the results present considerable heterogeneity and the quality could be improved, MRI seems to demonstrate moderate accuracy in the diagnosis of ramp lesions in patients presenting with acute or chronic ACL tear and the surgical repair of ramp lesions can be associated with improved overall outcomes. A continued interest in the development of knowledge of this condition is essential.

Appendix

Database query string for PubMed: (tibial meniscus injuries[Mesh] AND ("ramp" OR "hidden" OR "meniscocapsular" OR "meniscosynovial" OR "posteromedial" OR ("medial" AND "peripheral"))) OR (("Anterior Cruciate Ligament Injuries"[Mesh] OR "meniscus"[Tiab] OR "meniscal"[Tiab]) AND ("ramp"[Tiab] OR "hidden"[Tiab]) AND "lesion"[Tiab]) OR ("meniscocapsular"[Tiab] OR "meniscosynovial"[Tiab] OR (("meniscus"[Tiab] OR "meniscal"[Tiab]) AND (("peripheral"[Tiab] AND "medial"[Tiab]) OR "posteromedial"[Tiab])) AND (lesion[Tiab] OR "tear"[Tiab] OR "separation"[Tiab])).

Database query string for Scopus and Web of Science: TITLE-ABS-KEY ((ramp AND lesion) OR (hidden AND lesion) AND (meniscus OR meniscal OR (Anterior AND Cruciate AND Ligament))) OR (meniscocapsular OR meniscosynovial OR ((meniscus OR meniscal) AND posteromedial) AND (separation OR tear OR lesion OR injury)).

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Tables

TABLE 1. Study and Patient Characteristics*

Author (Year)	Study Period	Design		*N*	Age, y†	Male, %	Focus
Arner (2017)[75]	2013 to 2015	P/NC		90	28 ± 10 (14-45)	50.0	D
Chen (2018)[98]	Aug/2010 to Dec/2014	R/C		46	26 (18–41)	73.9	T
DePhillipo (2017)[69]	April/2010 to July/2016	P/C		301	29.6 ± 12.5 (14-61)	66.0	D
Furumatsu (2014)[67]	July/2009 to Dec/2011	P/C		20	19 (15-38)	40.0	T
Gulenc (2019)[66]	2017	P/NC		15	26.8 (18-35)	53.3	D/T
Hatayama (2018)[70]	April/2013 to Aug/2017	P/C		155	25.3 (13-60)	51.0	D
Keyhani (2017)[71]	2011 to 2014	P/C		128	24 (18-48)	83.6	T
Kim (2018)[35]	June/2011 to April/2015	P/C		195	31.7 ± 11.7	88.2	D
Kumar (2018)[68]	Jan/2006 to June/2016	R/C		178	NR.	NR.	D
Li (2015)[72]	Aug/2011 to Feb/2014	P/C		23	NR.	NR.	T
Liu‡ (2017)[64]	Aug/2008 to April/2012	P/C	(SG)	50	35.6 ± 8.5	76	T
			(AG)	41	34.8 ± 9.1	73.2	
Malatray (2018)[74]	Oct/2014 to May/2016	P/C		56	14.0 ± 1.3 (12-17)	76.8	D
Sonnery-Cottet (2018)[73]	Jan/2013 and Aug/2015	R/C		383	27.4 ± 9.2 (14-60)	76.5	T
Thaunat (2016)[18]	Oct/2012 to March/2013	P/C		132	26.4 (12-57)	83.3	T
Yang‡ (2017)[65]	Jan/2010 to Jan/2014	R/C	(SG)	37	35.7 ± 8.5	75.7	T
			(AG)	31	34.8 ± 8.1	74.2	
Yeo (2018)[76]	Jan/2015 to Sep/2017	R/C		78	37.3 (19-52)	82.1	D

*AG, abrasion and trephination group; Aug, August; D, diagnosis; Dec, December; Feb, February; Jan, January; NR, not reported; Oct, October; P, prospective; R, retrospective; Sep, September; SG, meniscal suture group; T, treatment; Y, years

†Age is expressed as mean ± SD (Range), when available.

‡Liu et al[64] and Yang et al[65] used 2 different cohorts to compare different treatment approaches.

TABLE 2. MRI characteristics of the Studies included in this review*

Author (Year)	Knee Position	Magnet Strength, T	Slice Thickness & MRI Sequence	RLs, %	Diagnostic Criteria
Arner (2017)[75]	Near full extension.	1.5	3 mm; Sequences NR.	14.4	High SI or separation between the posterior capsule and the PHMM.
DePhillipo (2017)[69]	NR.	3.0 or 1.5	NR; Sag. PDFS and T2FS.	16.6	High SI or separation between the posterior capsule and the PHMM.
Gulenc (2019)[66]	NR.	NR.	NR; Sagittal T2FS.	NR.	Separation between the capsule and the PHMM or tibial oedema.
Hatayama† (2018)[70]	Near full extension.	3.0 $(N = 59)$	2 mm; Sag. PDFS.	20.3	High SI or separation between the posterior capsule and the PHMM.
		1.5 $(N = 96)$	NR.	37.8	
Kim (2018)[35]	NR.	NR.	NR; Sag. PDFS.	25.6	Peripheral LT ≤ 4 mm of the meniscocapsular junction of the PHMM.
Kumar (2018)[68]	NR.	NR.	NR; Sag. PDFS and T2FS.	14.9	Oedema of the posterior medial tibial plateau.
Malatray (2018)[74]	Near full extension.	NR.	NR.	23.2	Peripheral LT of the meniscocapsular junction of the PHMM.
Yeo (2018)[76]	Neutral	3.0 or 1.5	3 - 4 mm; Sag. PDFS and T2FS.	9.0	High SI or separation between the posterior capsule and the PHMM.

*LT, longitudinal tear; MRI, Magnetic Resonance Imaging; NR, not reported; PDFS, Fat-suppressed Proton Density-weighted image; PHMM, posterior horn of the Medial Meniscus; RLs, proportion of ramp lesions; Sag, Sagittal; SI, fluid-like Signal Intensity; TFI, time from injury; T2FS, fat-suppressed T2-weighted image; T, Tesla.

†Hatayama et al[70] used 2 cohorts to compare different magnet strengths in the diagnosis of ramp lesions.

TABLE 3. Treatment Methods from the Studies included in this review*

Author (Year)	Surgery Details & ACL Graft	Postoperative Protocol	TFI to Repair	Follow-up Time	Adverse Events
Chen (2018)[98]	All-inside suture device (*FasT-Fix*). HT.	0º-90º at 4 wks; full WB/ROM in 6 wk; full activity at 6 mo.	NR.	32 mo.	2 femoral condyle injuries.
Furumatsu (2014)[67]	All-inside suture device (*FasT-Fix*). BPTB, HT.	Partial WB in 2 wk; full WB in 4-6 wk; full activity in 5-8 mo.	6 mo.	24 mo.	5% secondary interventions.
Gulenc (2019)[66]	All-inside suture technique. NR.	0-90° by the 3rd wk; full activity in 4-6 mo.	NR.	33.1 ± 12.7 wk.	NR.
Keyhani (2017)[71]	All-inside suture with hook. NR.	0°-90° and partial WB after 2-4 wk; full WB and ROM at 6 wk.	NR.	> 24 mo.	Residual joint pain in 3 pts.
Li (2015)[72]	All-inside suture device (*FasT-Fix*). NR.	0º-90º by the 4th wk; full WB in 6 wk; full activity after 6 mo.	NR.	14 mo.	NR.
Liu (2017)[64]	All-inside suture with hook. HT.	0º-90º by the 4th wk; full WB at 4 wk; full activity at 9-12 mo.	NR.	37.9 ± 15.9 mo.	NR.
Sonnery-Cottet (2018)[73]	All-inside suture with hook. BPTB, HT.	0º-90º by the 4th wk; WB as tolerated; full activity at 8-9 mo.	13.5 ± 32 mo.	37.4 ± 9 mo.	NR.
Thaunat (2016)[18]	All-inside suture with hook. HT, BPTB, QT.	0º-90º by the 6th wk; full WB in 3 wk; full activity at 9 mo.	NR	27 mo.	2 hematomas needing lavage
Yang (2017)[65]	All-inside suture device (*FasT-Fix*). HT.	Partial WB at 8 wks; full WB at 12 wk; full activity after 6 mo.	45.2 ± 28.1 d	> 24 mo.	Residual joint pain in 3 pts.
Liu (2017)[64]	Abrasion and trephination. HT.	0º-90º by the 4th wk; full WB at 4 wk; full activity at 9-12 mo.	NR.	40.3 ± 16.5 mo.	NR.
Yang (2017)[65]	Abrasion and trephination. HT.	Partial WB at 8 wks; full WB at 12 wk; full activity after 6 mo.	42.8 ± 25.4 d	> 24 mo.	Residual joint pain in 2 pts.

*ACL, Anterior Cruciate Ligament; BTB, bone-tendon-bone autograft; d, days; mo, months; HT, hamstring tendon autograft; NR, not reported; pts, patients; QT, quadriceps tendon autograft; ROM, range of motion; TFI, time from injury; WB, weight-bearing; wk, weeks.

TABLE 4. Risk of bias for treatment studies using the MINORS tool.

Studies	Aim	Consecutivene Patients	Prospective Collection	Appropriate Endpoints	Endpoint Assessment	Follow-up Period	Loss to Follow-up	Study Size Calculation	Control Group	Contemporary groups	Baseline Equivalence	Statistical Analysis
Chen et al[98]	1	2	0	2	0	2	2	0	-	-	-	-
Furumatsu et al[67]	2	2	1	2	0	2	2	0	-	-	-	-
Gulenc et al[66]	1	1	0	2	0	1	2	0	-	-	-	-
Keyhani et al[71]	2	2	0	2	0	2	2	2	-	-	-	-
Li et al[72]	0	2	0	1	0	2	2	0	-	-	-	-
Sonnery-Cottet et al[73]	2	2	2	2	2	2	1	0	2	2	1	2
Thaunat et al[18]	2	2	0	2	0	2	2	0	-	-	-	-
Yang et al[65]	2	2	1	2	0	2	2	0	2	2	2	2

Aim: clearly stated aim; **Consecutive Patients:** all patients fit for inclusion have been included; **Prospective Collection:** data collected according to a pre-established protocol; **Appropriate Endpoints:** endpoints appropriate to the aim of the study; **Endpoint Assessment:** unbiased blinded assessment; **Follow-up Period:** appropriate to the aim of the study**; Loss to follow up:** less than 5%; **Study Size Calculation:** prospective calculation of the study size. Additional criteria for comparative studies: **Control Group:** adequate control group; **Contemporary groups:** both groups managed in the same time period; **Baseline Equivalence**: similar groups; **Statistical Analyses:** in accordance with the type of study.

0: not reported; 1: reported but inadequate; 2: reported and adequate.

Figures

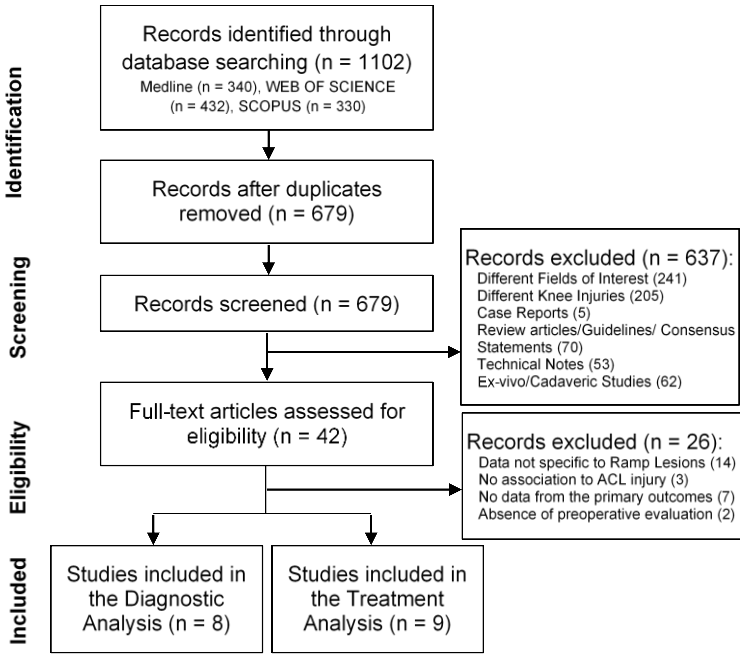

FIGURE 1. Study selection process for the Systematic Review using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. Gulenc et al[66] was included in both portions of the analysis.

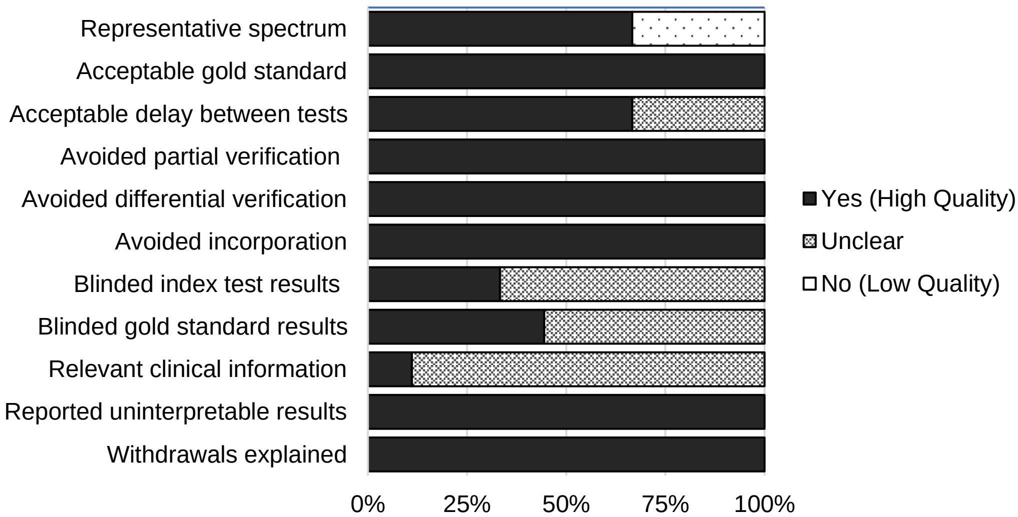

FIGURE 2. Risk of bias of the diagnostic studies, using the QUADAS-2 tool.

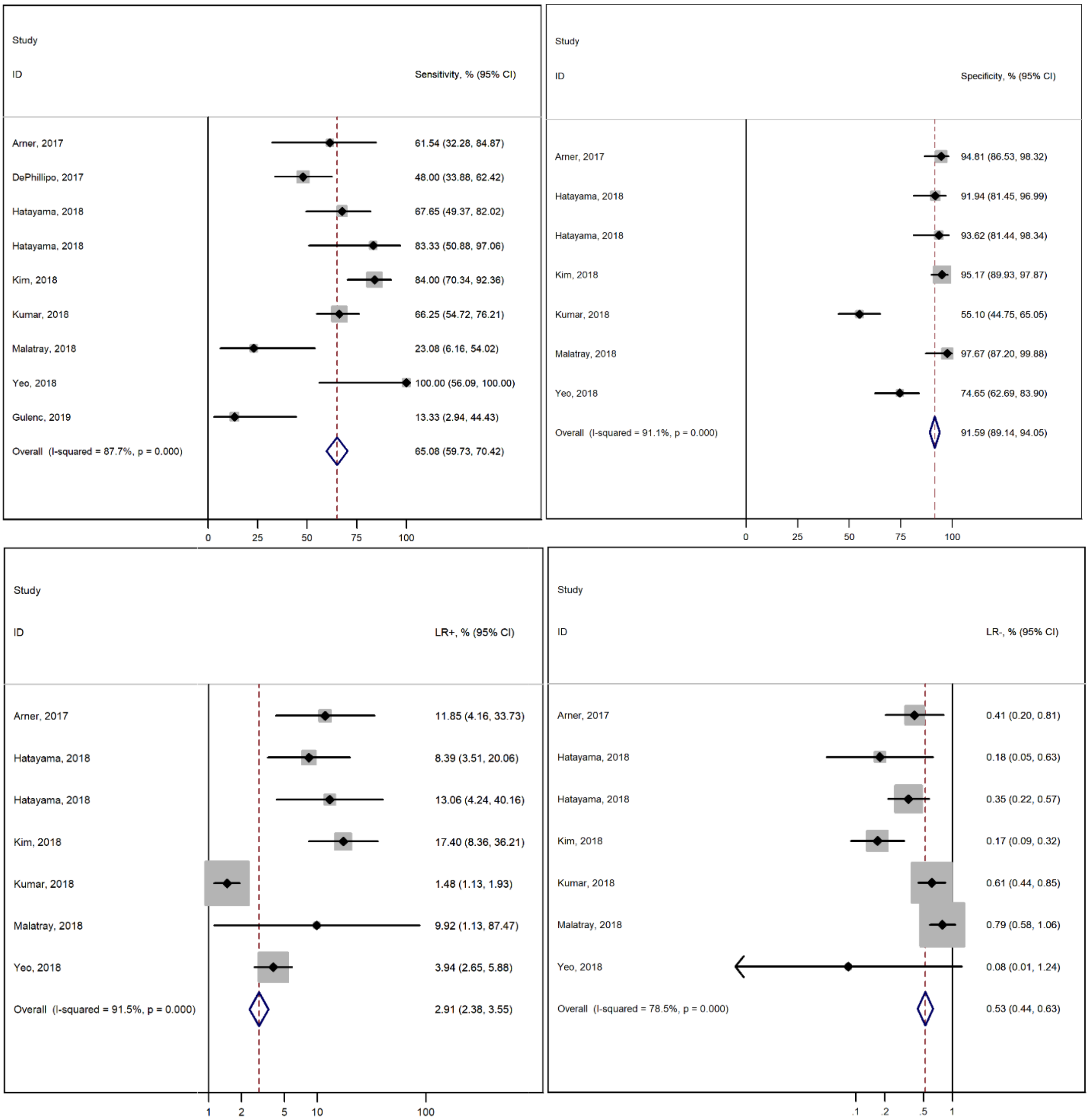

FIGURE 3. Forest plots summarizing MRI accuracy in the detection of ramp lesions.

Dots in squares represent the estimated measures while the horizontal lines represent the 95% CI. The diamond shape represents the combined estimate. I^2 with 95% CI and the result of the using the chi-squared test are also provided.

Hatayama et al[70] used 2 different cohorts to compare different magnet strengths, 3-Tesla (upper) and 1,5-Tesla (lower).

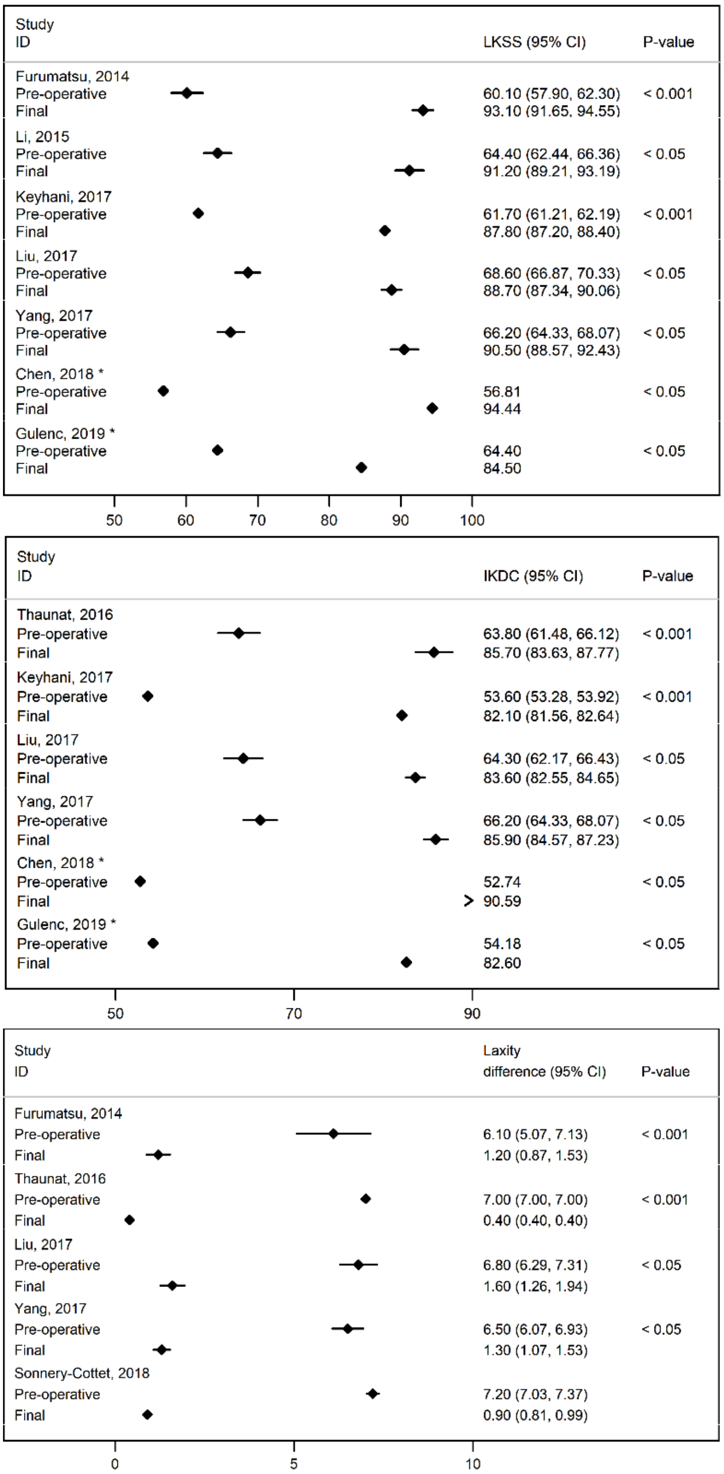

FIGURE 4. Forest plots grouping the mean Pre-operative and Final (at final follow-up) Lysholm Knee Scores, International Knee Documentation Committee scores and laxity differences between the affected and the unaffected knee.

Dots in squares represent the estimated measures while the horizontal lines represent the 95% CI.

*only point estimates are presented because no confidence intervals or information to compute them were available from these studies.

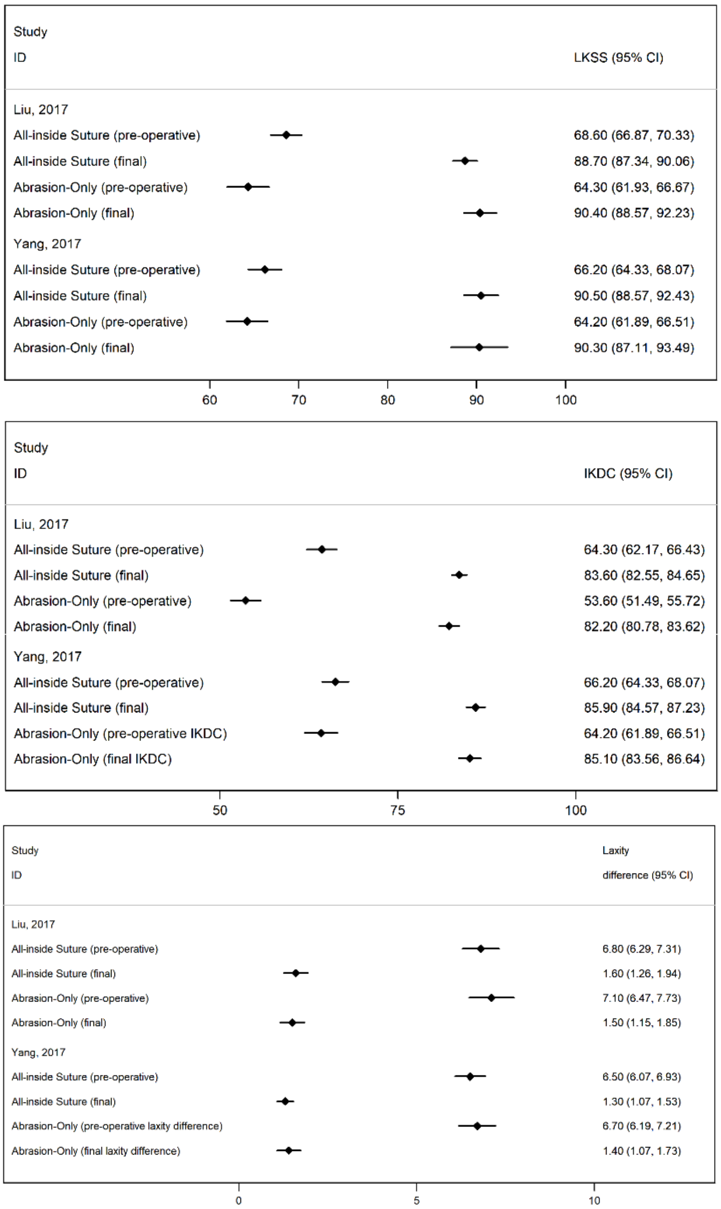

FIGURE 5. Forest plots comparing the mean Preoperative and Final (at final follow-up) outcomes between all-inside suture of the medial meniscus versus abrasion and trephination for the repair of small and stable Ramp Lesions (< 1.5 cm), in the two studies that evaluated both techniques.

Dots in squares represent the estimated measures while the horizontal lines represent the 95% CI.

Anexos

Instructions for Authors

INTRODUCTION

All submissions to *Arthroscopy: The Journal of Arthroscopic and Related Surgery* must comply with these Instructions for Authors. Studies should be in compliance with human studies committees and animal welfare regulations at the authors' institutions and also in compliance with Food and Drug Administration guidelines. All manuscripts will be subject to peer review. Letters to the Editor and comments on the Journal's content or policies are always welcome and encouraged.

All manuscripts are to be submitted electronically through the *Arthroscopy* online submission and review system website https://ees.elsevier.com/arth (details in Submission section below).

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Submission of a manuscript to Arthroscopy for peer review implies that:

- It is original work, has been written by the stated authors, and has not been published elsewhere, including electronically, in the same form, in any language. Likewise, a similar manuscript has not been submitted to or published by any other journal, by any of the authors
- Any manuscript submitted to Arthroscopy is not currently being considered for publication by any other journal and will not be submitted for such review while under review by this Journal.
- If the submission is accepted, it will not be published elsewhere, including electronically in the same form, in any language, without the written consent of the copyright holder.

BEFORE YOU BEGIN

Disclosure of Potential Conflict of Interest

Arthroscopy uses the ICMJE disclosure for authors. Each author of a manuscript must complete the form and save it using his or her name. The corresponding author will upload all the authors' completed forms at the time of submission. Download the *Arthroscopy* Journal ICMJE form here: ICMJE Form.

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An easy method to combine files is to select all of the disclosure forms to be combined in the folder where they are stored, right-click, and select "Combine supported files in Acrobat."

Authorship

Arthroscopy generally limits the number of authors to 7. If there are more than 7 authors, we ask the corresponding author to justify each author's participation using the ICMJE criteria for authorship:

1. Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND
2. Drafting the work or revising it critically for important intellectual content; AND
3. Final approval of the version to be published; AND
4. Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Clinical trial registration (prospective publication of clinical research study authors, title, purpose, hypothesis, methods including statistical methods, and confirmation of Institutional Review Board approval) mitigates against bias resulting from selective reporting of results. Clinical trials beginning patient enrollment after January 1, 2012, will not be accepted for publication in *Arthroscopy* without prospective registration of the trial (i.e., before enrollment of the first patient). Trials may be registered in any national or international registry. Include details on the separate title page *only*.

Except in rare circumstances where the temporal effect of the outcome being measured is brief, clinical trials will not be accepted for publication in *Arthroscopy* without 24 months' minimum follow-up for all subjects who are enrolled and reported. The Journal strongly encourages the use of the CONSORT (Consolidated Standards of Reporting Trials) guidelines when designing and reporting randomized controlled trials (RCTs). The criteria outlined by the CONSORT group are meant to assist in improving the overall quality of RCTs and provides a minimum set of recommendations for reporting on RCTs. There is a 25-item checklist designed to facilitate study setup, reporting, and interpretation. The overall goal of using the CONSORT criteria is to facilitate the study design from the outset, and provide for a high-quality and prudently conceived RCT. The guidelines can be found at http://www.consort-statement.org/Media/Default/Downloads/CONSORT%202010%20Checklist.doc.

SUBMISSION

After registering as an author through the Arthroscopy online submission and review system website (https://ees.elsevier.com/arth), you will be guided step by step through the uploading of your own files and approving of the single PDF that will be created from them. You can track the progress of your manuscript through our website. Communications about a manuscript will be handled through e-mail. Please access the website for more specifics about online submission, including a tutorial for authors, artwork guidelines, and a link to author support by e-mail that is monitored around the clock.

PREPARATION

Peer Review

This journal operates a double blind review process, which means the identities of the authors are concealed from the reviewers, and vice versa. All contributions are typically sent to a minimum of two independent expert reviewers to assess the scientific quality of the paper. The Editor is responsible for the final decision regarding acceptance or rejection of articles. The Editor's decision is final. More information on types of peer review.

General

Manuscripts should be typed double-spaced with continuous line numbering. Submit in this order; see details in the following sections: Separate (unblinded) title page, blinded title page, blinded text, references, figure and video legends, tables, figures, and conflict of interest forms. *Arthroscopy* follows style points for text and references of the *AMA Manual of Style*.

Recommended Maximums for Articles Submitted to *Arthroscopy*

Type of Article	**Number of Words***	**Figures (Figure Parts)**	**Tables**
Original Article	4,000	7 (15)	4
Level V Evidence†	1,600	0	0
Systematic Review	4,500	7 (15)	4
Meta-analysis	4,000	7 (15)	4
Technical Note‡	1,500‡	no limit‡	4
Case Report (rarely accepted)	—	—	—
Letter to Editor & Reply	500	2 (2)	0

* Maximum number of words is exclusive of the title page, blind title page, references, and figure legends. † *Level V Evidence* articles are submitted at the invitation of the Editor-in-Chief or Assistant Editor-in-Chief. ‡ **Technical Notes** are now published **only** in *Arthroscopy Techniques*. Video is required for submission. The video must be narrated and list disclosures on an opening slide. Submit as for *Arthroscopy* at http://ees.elsevier.com/arth

Separate Title Page

A separate (unblinded) title page of each manuscript should include the following essential information:

1. ***Title.*** Concise and informative. Titles are often used in information-retrieval systems. Avoid abbreviations and formulae where possible.
2. ***All Authors' full names, degrees, and affiliations.*** Where the family name may be ambiguous (e.g., a double name), please indicate this clearly. Present each author's affiliation and address below the names.
3. ***Corresponding Author.*** Clearly indicate who will handle correspondence at all stages of reviewing and publication, and after publication. Ensure that telephone numbers (with country and area code) are provided in addition to the e-mail address and the complete postal address. Contact details must be kept up to date by the corresponding author.
4. ***In addition,*** include IRB and RCT information, as well as a short running title (maximum of 45 characters and spaces). Include any acknowledgment of persons who provided help during the research/writing (e.g., language help, writing assistance, or proof reading the manuscript, etc.).

Blinding the Manuscript

Because all manuscripts are blinded to reviewers, the first page of the blinded manuscript must be a blinded title page that lists *only the title*. Likewise, in the text, do not include any identifying information, such as an author's initials or the names of institutions where the study was done, or a phrase such as "our study" that, when followed by a citation, reveals authorship of the present manuscript in the reference list.

Manuscript Structure

1. Abstract

Original Articles, abstracts should be a *maximum of 300 words* and structured to include the following sections: *Purpose:* One or 2 sentences that simply state the purpose with no background information or hypothesis. *Methods:* Provide, with sufficient detail, the methods of the study including selection criteria. *Results:* Provide results, with data, P values, and standard deviation of mean or 95% confidence intervals. Present most important findings first. Please provide exact P values (not *P* <) and numbers to support your methods findings. *Conclusions:* State only what your study found; do not include extraneous information not backed up by the results. *Level of Evidence* (for human studies) or *Clinical Relevance* (basic science or in vitro study: why is this study important from a clinical standpoint?).

Systematic Reviews and **Meta-analyses,** the abstract and text should be structured as an Original Article.

Technical Notes for *Arthroscopy Techniques,* the abstract should be an unstructured summary (maximum length, 200 words). The body of these manuscripts should consist of unstructured summary abstract, Introduction, Technique, and Discussion, plus references and figure legends and video legend.

Case Reports, the text should consist of unstructured summary abstract, Introduction, Case Report, and Discussion, plus references and figure legends.

Level V Evidence articles, the abstract should be an unstructured summary (maximum length, 300 words). See the Levels of Evidence table.

2. Introduction

The introduction of an Original Article should succinctly state the problem or controversy that led you to undertake the study, including a concise review of only the most relevant literature. Conclude the introduction by stating the *purpose* of the study and your *hypothesis*. The purpose in the Introduction should match that of the Abstract.

3. Methods

Describe the study design (prospective or retrospective, inclusion and exclusion criteria, duration). If prospective or a cadaver study, the number of enrolled subjects is reported in Methods. If retrospective, the study population (numbers, demographics, length of follow-up) should be in Results.

Include IRB and animal studies information. IRB approval is required for all human studies except retrospective and cadaver studies (unless the institution where the study was performed requires it).

The statistics that you have used to analyze the data should be described in detail. You cannot make the statement, "We found no significant difference between the two groups" unless a power study was done and you include in the text the value of alpha, beta, and standard deviation. Use of the word *significant* requires your reporting an exact *P* value. Confidence intervals of 95% are required whenever the results of survivorship analysis are given in the text, tables, or figures. Use of the word *correlation* requires you to report the correlation coefficient.

Arthroscopy encourages the use of validated outcome instruments. The use of both a general health outcome measure and a joint-specific, limb-specific, or condition-specific measure is encouraged. If an outcome instrument leads to a categorical ranking (e.g., excellent or good or poor), the aggregate outcome score for each patient should be provided.

4. Results

Describe in detail the data obtained during the study following the order of the Methods to include final number of subjects, demographics, length of follow-up (mean and range). The overall final patient follow-up should be 80% or greater (less than 20% drop-out) in order to minimize follow-up bias. In general, scientific studies will not be accepted for publication without meeting this criterion. ***Results obtained with less than two years of follow-up are rarely accepted for publication by the Journal.*** All data in the text must be consistent with the rest of the manuscript, including data in tables, figures, and legends. Present comparison data in tables and present as mean ± standard error of the mean with confidence intervals.

5. Discussion

Be concise. The Discussion should start with the most important findings of your study. Is your hypothesis affirmed or refuted? Compare and contrast your study with others in the most relevant world literature, particularly the recent literature. A complete literature review is unnecessary. At the end of the Discussion, under the subheading "Limitations," review the limitations of your study.

6. Conclusions

Briefly state your new (or verified) view of the problem you outlined in the Introduction. Take special care to draw your conclusions only from your results and verify that your conclusions are firmly supported by your data. Most importantly, do not make concluding statements that are not supported by your data, lie beyond the scope of your study, or are unnecessary (e.g., "further studies are warranted"). ***The conclusions in the text must match those in the abstract.***

7. References

The Journal follows the reference style in "Uniform Requirements for Manuscripts Submitted to Biomedical Journals" (see http://www.icmje.org/recommendations/browse/manuscript-preparation/preparing-for-submission.html#g). Provide all authors' names when 6 or fewer; when 7 or more, list the first 3 and add et al. Provide article titles and inclusive page numbers (321-328, not 321-8). References to online-only material must list author, title, the URL, and the date accessed by the author. For abbreviations of journal names, refer to PubMed. Please ensure that every reference cited in the text is present in the reference list (and vice versa). ***The accuracy of reference data is the responsibility of all authors.***

Data Reference

This journal encourages you to cite underlying or relevant datasets in your manuscript by citing them in your text and including a data reference in your Reference List. Data references should include the following elements: author name(s), dataset title, data repository, version (where available), year, and global persistent identifier. Add [dataset] immediately before the reference so we can properly identify it as a data reference. This identifier will not appear in your published article.

Reference style

In text: Number references in the order in which they appear in the text. Unpublished results and personal communications (only if essential to your message) should be mentioned in the body of the text at the end the statement with the appropriate information in parentheses. For example: (J. Karlsson, M.D., personal communication, [month and year of communication]).

Formatting Examples

Periodical

Jackson TJ, Lindner D, El-Bitar YF, Domb BG. Effect of femoral anteversion on clinical outcomes after hip arthroscopy. *Arthroscopy* 2015;31:35-41.

Chapter in a book

Ruch DS, Poehling GG. Operative arthroscopy of the wrist. In: Andrews JR, Timmerman LA, eds. *Diagnostic and operative arthroscopy*. Philadelphia: WB Saunders, 1997;199-205.

Book

Burkhart SS, Lo IKY, Brady PC, Denard PJ. *The cowboy's companion: A trail guide for the arthroscopic shoulder surgeon.* Philadelphia: Lippincott Williams & Williams, 2012.

Article in Press

Note: Citation of an 'in press' article is permitted only if it has been accepted for publication. Rosso F, Bisicchia S, Bonasia DE, Amendola A. Meniscal allograft transplantation: A systematic review. *Am J Sports Med* in press, available online 13 June, 2014. doi:10.1177/0363546514536021.

Dataset

[dataset] Oguro, M, Imahiro, S, Saito, S, Nakashizuka, T. Mortality data for Japanese oak wilt disease and surrounding forest compositions, Mendeley Data, v1; 2015. https://doi.org/10.17632/xwj98nb39r.1.

For further detail and examples, you are referred to the *AMA* Manual of Style.

8. Figure and Video Legends

Ensure that each illustration and each part of a multipart illustration has a legend (caption). Supply legends separately, not attached to the figure. Figure legends must be robust and "stand alone" (i.e., contain a complete, take-home, educational message, as if a reader viewed only that Figure without looking at any other Figure or without reading the text). Orient the reader to the image by mentioning patient position, side, and viewing portal or MRI orientation as appropriate. Keep text in the illustrations themselves to a minimum but explain in the legend all symbols and abbreviations used.

9. Tables

Number tables consecutively in accordance with their appearance in the text. Include a short descriptive title with the table number. Place footnotes to tables below the table body and indicate them according to the symbol hierarchy (i.e., asterisk, dagger, double dagger, etc.). Define all abbreviations. Avoid vertical rules. Do not give the same information in tables that you give in the text or in figures.

10. Figures

Number figures consecutively in accordance with their appearance in the text. Figures must be submitted separately from the text. Arrows and labels should be added to figures as appropriate to orient the reader to the arthroscopic images. Previously published figures may be used if permission has been received from the source publisher.

11. Disclosure

After the figures, you will upload each author's completed *Arthroscopy* ICMJE form. These forms must be completed, signed, and submitted with the manuscript.

SYSTEMATIC REVIEWS (WITH AND WITHOUT META-ANALYSIS)

Refer to Harris JD, Brand JC, Cote MP, Dhawan A; *Research Pearls: The Significance of Statistics of Perils of Pooling: Pearls and Pitfalls of Meta-analyses and Systematic reviews;* Arthroscopy 2017; E-published April 27, 2017 for guidance in design, conduct, reporting, and publishing SR/MA in Arthroscopy.

General

Review authors are encouraged, but not required, to register the systematic review (SR) on PROSPERO (https://www.crd.york.ac.uk/PROSPERO/) after the review topic is conceived, but before the conduct of the review begins. Submission of a SR should follow the 27-item PRISMA checklist (http://www.prisma-statement.org/). The following guidelines incorporate key elements of the PRISMA checklist and are intended to improve the quality of SR submissions:

Introduction

- Rationale for why a SR is needed should be clearly described. What is already known about the topic, current gaps in knowledge, and why a SR is likely to produce evidence that will serve to address these gaps should be clearly stated. If a similar or identical SR/MA has been published in last 5 to 10 years, then the submitted SR/MA must show that the evidence has changed.

- Define the specific research question, preferably in PICO format (Participants, Interventions, Comparisons, and Outcomes).
    - *Example: In collision athletes, does open Bankart repair, in comparison to arthroscopic Bankart repair, result in lower rates of recurrent instability?*

Methods

Study Eligibility (Inclusion and Exclusion Criteria)

- Eligibility criteria should follow the PICO question defined in the Introduction.
o Example:*Studies that included collision athletes with a Bankart lesion undergoing primary repair, compared open to arthroscopic treatment, and reported recurrent instability rates at two years or greater follow up were eligible for inclusion.*
- Other pertinent criteria for determining eligibility including type of studies (Level of Evidence, study design, etc.) that was reviewed.
    - Example:*Case series (Level IV evidence) or studies that did not specifically compare open to arthroscopic treatment were excluded.*
    - *Consult CEBM (http://www.cebm.net/ocebm-levels-of-evidence/) for thorough descriptions of level of evidence in therapeutic, diagnostic, prognostic, and economic studies.*

Literature Search

- The search strategy (terms, string) should be described with enough detail that it could be reproduced.
- Indicate which databases were searched. Two or more databases should be used (the combination of MEDLINE, EMBASE, and Cochrane will capture 97% of all relevant studies in Orthopedic Surgery SR/MA).
- The search should be performed independently by two or more study authors to ensure no omission of potentially relevant subjects and resolution of disagreement in the setting of possible study inclusion.

Study Selection and Data Abstraction

- The process for selecting studies, indicating who screened the studies and how were disagreements managed should be clearly described.
- The specific data that were extracted from each study and information on who abstracted the data, what tools (data collections forms, etc.) were used to facilitate abstraction, and how were disagreements managed should be described.

Risk of Bias Assessment

- The process used to appraise the methodological quality or risk of bias including the tools use for appraisal should be clearly described.
- The tools used to evaluate the studies should be appropriate for the design of the included studies. Common tools include Cochrane's Risk of Bias for randomized clinical trials, Coleman, Modified Coleman, CONSORT, Newcastle-Ottawa or MINORS for observational non-randomized studies.
- Multiple, independent raters for the risk of bias assessment are recommended. Rater statistics (kappa, ICC) should be reported to quantify the degree agreement between the raters and a description of how disagreements were handled, i.e. how the final score was arrived at, should be included.

Data Analysis

- The primary outcome measure(s) should be clearly stated.
o Example: *The primary outcome measure was the rate of recurrent instability. Risk ratios (rate in open group divided by the rate in arthroscopic) were calculated for each study.*
- If a meta-analysis is performed, the rationale or criteria used for determining that pooling data was appropriate should be provided.
- In nearly all situations, meta-analysis should only be performed with level I or II evidence studies.

- The methods used to analyze the data (fixed versus random effects) and measures of heterogeneity or consistency (I^2) should be clearly described.
- For a meta-analysis using a random effect model, prediction intervals are strongly recommended.
- Plans for exploring heterogeneity or inconsistency between studies, including subgroup analyses and meta-regressions should be clearly described.
- Any additional analyses (sensitivity, publication bias) should also be clearly described.

Results

- Presentation of the results should follow the Methods section.
- The study selection process should be depicted in a PRISMA flow chart.
- Risk of Bias scores should be presented for each item on the selected tools. Reporting aggregate scores is OK however scores for each item are needed to determine the specific areas where studies were at risk for bias.
- For SR without a meta-analysis, forest plots with the summary estimate suppressed are recommend as they allow the effects of the individual studies and their relative size and weight to be displayed together in the same figure.

Discussion and Conclusion should follow the Journal's guidelines for original research.

Common Errors

- ***Including studies with duplicate patient populations***. In some instances a SR turns up studies on the same patient group. Including these studies in any statistical analysis artificially inflates the number of patients and should be avoided.
- ***Pooling diverse, heterogeneous studies with different designs.***Combining non-randomized studies with randomized trials is typically not appropriate as these designs carry different risks of bias and are apt to distort the results. If a SR includes studies with different designs (randomize trials, cohort studies, etc.) these should be pooled separately. Typically, these are level III or IV evidence studies.
- ***No rationale for provided for pooling non-randomized studies.*** If the available literature is limited to observational studies, a rationale for why a meta-analysis will produce valid results that contribute to the understanding of the problem under question is needed. If one can not be reached, a meta-analysis should be avoided.
- ***Quantifying heterogeneity but not failing to explore or discuss it.*** Reporting of the I^2 statistic has become more frequent however it's important to discuss its impact on the results. If the results are heterogeneous efforts should be undertaken to explore this inconsistency. Techniques like subgroup analysis can be used to determine if I^2 values change when grouped according to co-variants. For example, I^2 values may change when the studies are analyzed according to a clinical characteristic (those that included patients with bone loss vs. those that did not) or a risk of bias item (those that adequately randomized patients versus those that did not). Lastly, I^2 is a relative measure. As recommended above, providing a prediction interval will assist in interpreting the effect of heterogeneity. A prediction interval provides a range of probable effects that reflects the variation in the different studies and settings, including what would be expected in future patients.

SUBMISSION CHECKLIST

The following checklist will be useful before sending a manuscript to the journal for review. Ensure that the following items are present:

One author has been designated as the corresponding author with the following contact details:

- E-mail address

- Full postal address
- Telephone numbers

All necessary files have been uploaded, and contain:

- All figure legends
- All tables (including title, description, footnotes)
- Separate files for figures
- ICMJE forms for all authors

Further considerations:

- Manuscript has been spell-checked and grammar-checked
- References are in the correct format for *Arthroscopy*
- All references included in the reference list are cited in the text, and vice versa
- Permission has been obtained for use of copyrighted material from other sources, including the Web

RESEARCH DATA

This journal encourages and enables you to share data that supports your research publication where appropriate and enables you to interlink the data with your published articles. Research data refers to the results of observations or experimentation that validate research findings. To facilitate reproducibility and data reuse, this journal also encourages you to share your software, code, models, algorithms, protocols, methods and other useful materials related to the project.

Data linking

If you have made your research data available in a data repository, you can link your article directly to the dataset. Elsevier collaborates with a number of repositories to link articles on ScienceDirect with relevant repositories, giving readers access to underlying data that gives them a better understanding of the research described.

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In addition, you can link to relevant data or entities through identifiers within the text of your manuscript, using the following format: Database: xxxx (e.g., TAIR: AT1G01020; CCDC: 734053; PDB: 1XFN).

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To foster transparency, we encourage you to state the availability of your data in your submission. This may be a requirement of your funding body or institution.

If your data is unavailable to access or unsuitable to post, you will have the opportunity to indicate why during the submission process. The statement will appear with your published article on ScienceDirect. For more information, visit the Data statement page.

Updated February 2018