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Conservative *vs.* surgical approach for degenerative meniscal injuries: a systematic review of clinical evidence

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Abstract. – OBJECTIVE: Analyzing the available evidence by comparing the role of arthroscopic surgery and conservative treatment in the management of degenerative meniscopathy.

MATERIALS AND METHODS: A literature search was carried out on the PubMed, EMBASE, Scopus, and PEDro databases in May 2019 to identify all the randomized controlled trials (RCTs) comparing arthroscopic surgery to conservative management of painful but stable degenerated menisci. The quality of the RCTs was assessed using the Cochrane Risk of Bias Assessment.

RESULTS: A total of 10 studies, including 1525 patients and dealing with conservative treatment vs. arthroscopic surgery were included in this review. In eight studies the effectiveness of exercise therapy was compared to surgery; in one study the effectiveness of intra-articular steroid injection was compared to surgery; in one study the effectiveness of placebo surgery was compared to partial meniscectomy. In all studies, no significant inter-group difference in terms of knee pain and knee function were observed at any follow-up evaluation.

CONCLUSIONS: Degenerative meniscal tears, without symptoms of locking and catching, can be successfully managed by a proper regimen of physical therapy as a first line treatment. Surgical approach might be considered in case of poor response after conservative treatment.

Key Words:
Degenerative meniscal tears, Conservative treatment, Exercise therapy, Arthroscopy.

Introduction

The menisci are fibro-cartilaginous structures made of water (65-75%), collagen (20-25%), and 5% of non-collagenous substances, including proteoglycans, glycoproteic matrix, and elastin. Their integrity is essential for the stability of the knee, for load transmission and therefore for the prevention of early osteoarthritis (OA). The medial meniscus has a crescent-like shape and covers almost 50% of the articular surface of the medial tibia plateau. The lateral meniscus has a more circular shape and covers almost 70% of the articular surface of lateral tibia plateau. Meniscal lesions are classically distinguished in traumatic, which occurs more frequently in young patients, and degenerative. Degenerative meniscal lesions have a more complex pathogenesis than traumatic lesions: they usually occur on meniscal tissue that already has macroscopic and ultra-structural changes, that affect its resistance to load[1]. The risk factors for the onset of degenerative lesions are mal-alignment, obesity, and work activities where there is an articular overload[2,3]. Degenerative meniscal lesions occur more frequently in older patients and are usually located in the posterior horn of the medial meniscus[4]. In 85% of cases they are associated with various grades of cartilage degeneration, as a typical expression of an "early osteoarthritic" articular environment[5]. The average prevalence of asymptomatic lesions at Magnetic Resonance Imaging (MRI) examinations is 19% in women between 50 and 59 years of age, and 56% in men between 70 and 90[6]. In the last few years the gold standard for the treatment of meniscal lesions has been the arthroscopic partial meniscectomy (APM). In the United States, from 2005 to 2011, 387.833 APM have been performed[7]. Meniscectomy, even if selective, is anyway a risk factor for the progression of OA. Some studies[8,9], have shown that meniscectomy increases the incidence of cartilage lesions and OA detectable with radiographic examinations. Rongen et al[10] showed that the risk of undergoing total knee

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replacement is 3 times higher in patients who underwent previous APM. For these reasons, although there is still no consensus on the correct management of meniscal injuries, in the last years a trend reversal in the approach to degenerative meniscal damage has occurred. As the Essilfie et al[11] demonstrate, the rate of meniscectomies in patients aged 50 or more, who are more likely to have degenerative-based lesions, has gradually decreased from 2011 up to today, in favour of conservative treatment, mainly based on physiotherapy. Over time, a number of clinical trials have demonstrated the non-superiority of surgical treatment over the conservative treatment in the management of degenerative meniscal lesions. Routine clinical experience suggests that patients affected by meniscal degeneration and treated arthroscopically present a lower satisfaction rate compared to patients affected by traumatic lesions, and also symptomatic relapse is more common in the former group of patients: this could be explained by the fact that joint degeneration involves all the articular structure (i.e., menisci, ligaments, cartilage and synovium). Therefore, the treatment of the degenerated meniscal tissue alone is not enough to restore the intra-articular homeostasis, and this could determine the relapse of pain and functional limitation in a short timespan following arthroscopic treatment. Furthermore, surgery itself could be regarded as a negative stress on the joint, capable of further impairing the intra-articular environment.

The purpose of the present review is to systematically analyze the available clinical evidence concerning the treatment of degenerative meniscal lesions, to understand the correct therapeutic approach to such kind of pathology. Our hypothesis is that conservative management could provide outcomes at least comparable to those of surgery without exposing the joint to the peri and post-operative risks.

Materials and Methods

A literature search was carried out on the PubMed, EMBASE, Scopus, and PEDro databases, on May 30th, 2019, using the following key words that were combined together to achieve maximum search strategy sensitivity: "degenerative meniscus", "meniscopathy", "meniscal degeneration", "degenerative meniscal tear", "degenerative meniscal lesion", "meniscal damage", in association with: "injection", "hyaluronic acid", "platelet-rich plasma", "PRP", "platelet concentrate", "platelet- derived", "ACP", "corticosteroid" and "surgery", "arthroscopy", "debridement", "meniscectomy", "surgical", "conservative", "physiotherapy", "physical therapy", "rehabilitation program", "exercise".

First, all the retrieved articles were screened by title and abstract, using the following inclusion criteria for article selection: 1) clinical reports with randomized design (level I or II) comparing conservative management to surgery; 2) written in the English language; 3) published from 1990 to 2019; 4) dealing with treatment of patients affected by degenerative meniscal tear. "Treatment" meant both surgery and conservative management, including exercise therapy, physical therapy (e.g., lasertherapy, ultrasounds, shockwave therapy) and injective treatment as well.

Exclusion criteria were: 1) case series or comparative not randomized trials; 2) written in other languages than English; 3) not dealing with treatment of degenerative meniscal lesions. We further excluded all duplicate articles, articles from non-peer reviewed journals or articles lacking access to the full text. Conference presentations, narrative reviews, editorials and expert opinions were also excluded. A PRISMA flowchart[12] of the selection and screening method is provided in Figure 1. Two investigators extracted relevant data independently. The following data were extracted from each included study: demographics, study design and level of evidence, follow-up times, treatment groups, evaluation scores adopted, overall clinical findings. The quality of the randomized controlled trials (RCTs) included was assessed independently by two reviewers using the Cochrane Risk of Bias Assessment Tool[13]. Risk of bias was assessed as a judgment (high, low, or unclear) for individual elements from seven domains, as detailed in Table II. Discrepancies between the two reviewers were resolved by discussion and consensus, and the final results were reviewed by the senior investigators.

Results

Identification of Studies

A total of 61.103 related articles were identified through databases searching. After title and abstract screening, 378 studies were included. As shown in Figure 1, 364 articles were excluded and, ultimately, a total of 10 studies published from 2007 to October 2018 dealing with conservative treatment *vs.* arthroscopic surgery for degenerative meniscal lesions were included in this

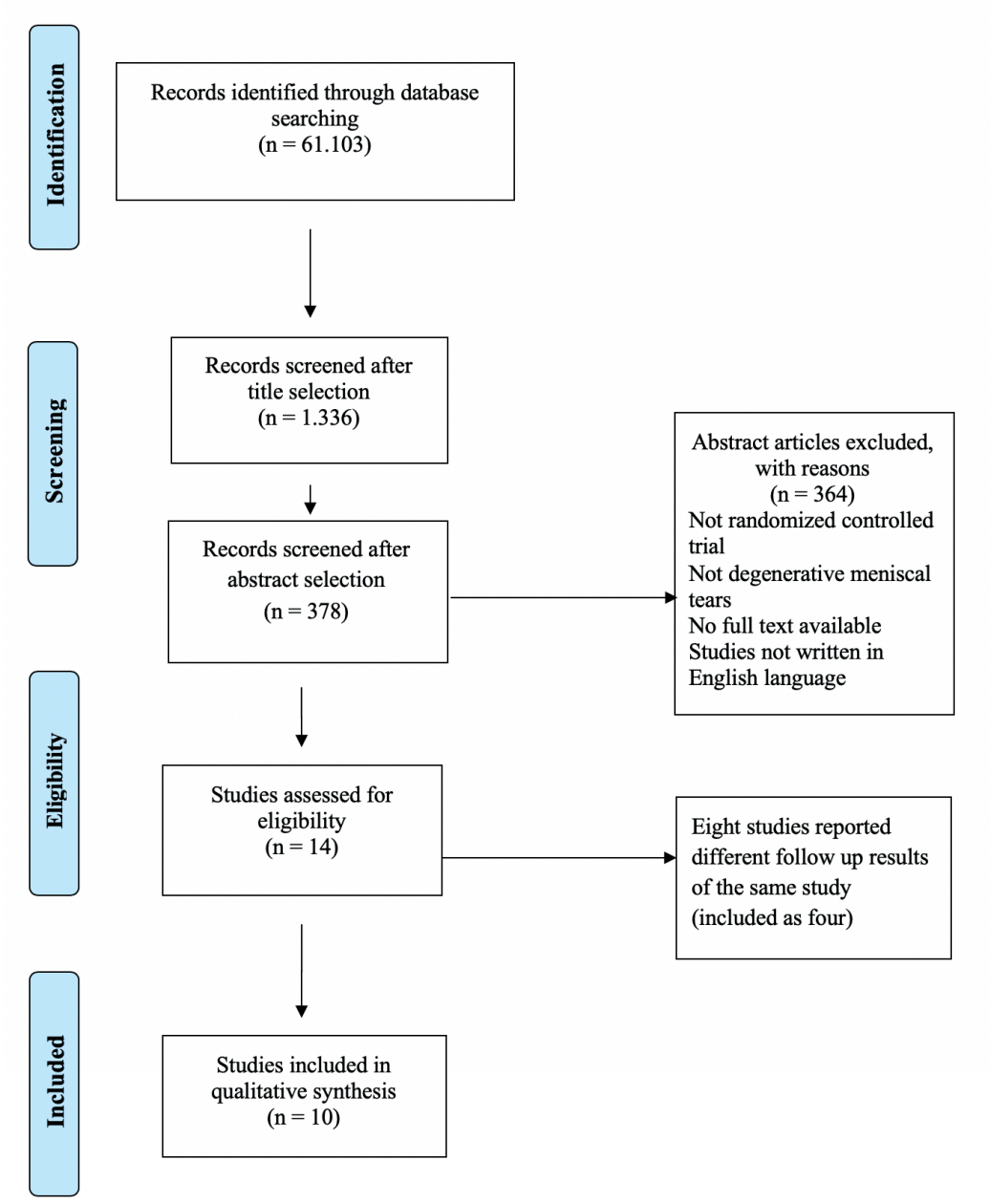

Figure 1. PRISMA Flowchart resuming the papers' inclusion process.

review[14-23]. A synopsis of all the randomized trials included in the present systematic review is shown in Table I.

Study Design and Quality

The results of the analysis performed with the Cochrane Risk of Bias tool for RCTs are detailed in Table II. In three papers[15,17,18] there were not enough details on the way the randomization was carried out. Only in four studies[14,19-21] the method used for concealment was described with enough details. Apart from the work from Shinoven et al[14], participants involved had not been blinded to treatment allocation. Only in five papers[14,15,19-21] the outcome assessment was evaluated by a third person blinded to treatment. Regarding incom-

Table I. Synopsis of all the randomized trials included in the present systematic review.

Study	Study design	Treatment groups	Outcome measures	Follow-up	Rehabilitation program	Main results	Comments on results
Østeras et al[18]	Randomized Pilot Study	Arthroscopic partial meniscectomy (n=8) *vs.* Exercise therapy (n=9)	VAS KOOS HAD Dynamic quadriceps muscle strength (5RM)	Baseline, 3 months	12 weeks (3 times per week)	No significant differences between the two groups regarding pain and function. Significant difference between groups with less depression and anxiety in the exercise group	The results from this study demonstrate that conservative therapy is just as effective as surgery. Furthermore, anxiety and depression are a major factor for persistent pain, decreased function, social isolation and early death. Symptoms of depression decrease with an appropriate dosage of endurance exercise therapy.
Yim et al[16]	Randomized Controlled Trial	Arthroscopic partial meniscectomy (n=54) *vs.* Exercise therapy (n=54)	VAS LKSS TAS	Pre-operative, 3, 6, 12, and 24 months	3 weeks supervised (3 times per week); 8 weeks unsupervised (daily)	No significant differences between groups after 2 years	Arthroscopic meniscectomy did not provide any significant advantage relative to strenghtening exercises in terms of the relief of knee pain, improved knee function, or increased satisfaction of patients after 2 years.
Herrlin et al[23]	Prospective randomized trial	Arthroscopic partial meniscectomy (n=47) *vs.* Exercise therapy (n=43)	KOOS LKSS TAS VAS	Baseline, 8 weeks, 6, 24 and 60 months	8 weeks (twice a week)	No significant differences between groups after 2 and 5 years	Arthroscopic surgery followed by exercise therapy did not result in better patient-reported outcomes than exercise therapy alone. However, one third of the patients from the exercise group still had disabling knee symptoms after the exercise therapy but improved to the same level as the rest of the patients after arthroscopic surgery.
Katz et al[22]	Multicenter randomized controlled trial	Arthroscopic partial meniscectomy (n=174) *vs.* Exercise therapy (n=177)	WOMAC KOOS SF-36	Baseline, 3, 6 and 12 months	6 weeks	No significant differences between groups after 6 months	No significant differences between the study groups in functional improvement 6 months after randomization; however, 30% of the patients who were assigned to physical therapy alone underwent surgery within 6 months.

Table continued

Table I (Continued). Synopsis of all the randomized trials included in the present systematic review.

Study	Study design	Treatment groups	Outcome measures	Follow-up	Rehabilitation program	Main results	Comments on results
Vermesan et al[17]	Randomized controlled trial	Steroid injection (n=60) *vs.* Arthroscopic debridement (n=60)	OKS	Baseline, 1 and 12 months	/	No significant differences between groups after 1 year	Degenerative medial meniscal tears, in the presence of osteoarthritis, can only marginally benefit from arthroscopic debridement over intra-articular steroid injections in short term follow-up.
Stensrud et al[19]	Randomized controlled trial	Arthroscopic partial meniscectomy (n=42) *vs.* Exercise therapy (n=40)	Isokinetic knee muscle strength LEFT GRC	3 months	12 weeks (2-3 times per week)	Significant differences between groups regarding isokinetic knee muscle strength in favor of exercise therapy group	Surgery was not associated with changes in muscle strength at 3 months postoperatively, so a 12-weeks supervised exercise therapy program seems necessary to improve muscle strength in patients with degenerative meniscal tears.
Kise et al[21]	Randomized controlled trial	Arthroscopic partial meniscectomy (n=70) *vs.* Exercise therapy (n=70)	KOOS SF-36 LEFT Isokinetic knee muscle strength	Baseline, 3, 12 and 24 months	12 weeks (2-3 times per week)	No significant differences between groups after 2 years	Exercise therapy showed positive effects over surgery in improving thigh muscle strength, at least in the short term. Results should encourage clinicians and middle aged patients with degenerative meniscal tear and no definitive radiographic evidence of osteoarthritis to consider supervised exercise therapy as a treatment option.
Gauffin et al[15]	Prospective, randomized, single-blinded study	Arthroscopic partial meniscectomy (n=75) *vs.* Exercise therapy (n=75)	KOOS EQ5D PAS	Baseline, 3, 12 and 36 months	12 weeks (twice a week)	Better results in favor of surgery group after 1 year, no significant differences between groups after 3 years	Knee arthroscopic surgery may be beneficial for middle-aged patients with meniscal symptoms in addition to an exercise program. Older age and absence of mechanical symptoms should not be contraindications to surgery.

Table continued

Table I (Continued). Synopsis of all the randomized trials included in the present systematic review.

Study	Study design	Treatment groups	Outcome measures	Follow-up	Rehabilitation program	Main results	Comments on results
Sihvonen et al[14]	Multicenter, randomized, double-blind, sham-controlled trial	Arthroscopic partial meniscectomy (n=70) *vs.* Sham surgery (n=76)	LKSS WOMET Knee Pain after Exercise	Baseline, 2, 6, 12 and 24 months	/	No significant differences between groups after 2 years	Arthroscopic partial meniscectomy was not superior to sham surgery, with regard to outcomes assessed during a 24-month follow-up period. These results argue against the current practice of performing arthroscopic partial meniscectomy in patients with a degenerative meniscal tear.
van De Graaf et al[20]	Multicenter, randomized clinical trial	Arthroscopic partial meniscectomy (n=159) *vs.* Exercise therapy (n=162)	IKDC VAS RAND-36 TAS	Baseline, 3, 6, 12, and 24 months	8 weeks (twice a week)	No significant differences between groups after 2 years	Among patients with non-obstructive meniscal tears, physiotherapy was non-inferior to arthroscopic partial meniscectomy for improving patient-reported knee function over a 24-month follow-up period. Based on these results, physiotherapy may be considered as an alternative to surgery for patients with non-obstructive meniscal tears.

KOOS=Knee Injury and Osteoarthritis Outcome Score; **HAD**=Hospital Anxiety and Depression Scale; **LKSS**=Lysholm Knee Scoring Scale; **TAS**=Tegner Activity Scale; **WOMAC**=Western Ontario and McMaster Universities Osteoarthritis Index; **SF-36**=Short Form-36 Health Survey; **OKS**=Oxford Knee Score; **LEFT**=Lower Extremity Functional-performance Tests; **GRC**=Global Rating Scale of Change; **EQ5D**=EuroQol; **PAS**=Physical Activity Scale; **WOMET**=Western Ontario Meniscal Evaluation Tool; **IKDC**=International Knee Documentation Committee.

Table II. Cochrane Risk of Bias assessment for all the included studies. + Low risk of bias; - High risk of bias; ? Unclear risk of bias.

	Selection bias Random sequence generation	Selection bias Allocation concealment	Reporting bias Selective reporting	Performance bias Blinding (participants and personnel)	Detection bias Blinding (outcome assessment)	Attrition bias Incomplete outcome data	Other bias
Gauffin et al[15]	?	?	+	-	+	-	+
Herrlin et al[23]	+	-	+	-	-	+	+
Katz et al[22]	+	-	+	-	-	+	+
Kise et al[21]	+	+	+	-	+	+	+
Østeras et al [18]	?	?	+	-	-	+	-
Sihvonen et al[14]	+	+	+	+	+	+	+
Stensrud et al[19]	+	+	+	-	+	+	+
Van de Graaf et al[20]	+	+	+	-	+	+	+
Vermesan et al[17]	?	?	+	-	-	+	+
Yim et al [16]	+	-	+	-	-	+	+

plete data, only Gauffin et al[15] showed a loss at follow-up rate greater than 20%. Furthermore, in the work from Østeras et al[18] the number of patients enrolled was very small and therefore the results must be interpreted with caution.

Patients and Evaluation Methods

Ten studies involving a total of 1525 patients with degenerative meniscal lesions were included in this review. The mean age was 54 years. Of the 10 trials, eight were conducted in Europe[14,15,17-21,23], one in the US[22], and one in South Korea[16]. Seven of the included trials[15-19,21,23] were single-center trials and three were multi-center trials[14,20,22].

In eight studies the effectiveness of exercise therapy was compared to APM[15,16,18-23]. In one study the effectiveness of intra-articular steroid injection was compared to APM[17]. In one study the effectiveness of placebo surgery was compared to arthroscopic surgery[14]. In the RCTs included in our review, patients enrolled were middle-aged with degenerative meniscal tears, documented by MRI or arthroscopy.

In all studies, except the one from Vermesan et al[17], patients underwent radiographic evaluation and were classified according to Kellgren-Lawrence (K-L) grading system or Ahlbäck classification. In two papers, patients with K-L grade 0-1 were included[14,15], in other three papers patients with K-L grade 0-2 were included[18,19,21]; in two papers patients with radiographic K-L grade 0-3 were included[20,22]; in one paper patients with Ahlback grade 0-1 were included[23]; in one paper patients with Ahlback grade 0 were included[15]. Baseline and follow-up assessments were based on different clinical scores. Knee pain was evaluated using the Knee injury and Osteoarthritis Outcome Score pain (KOOS pain) and Visual Analog Scale (VAS).

Knee function was evaluated using the following items: Knee injury and Osteoarthritis Outcome Score Activity of Daily Living (KOOS ADL), Tegner activity scale, Western Ontario and McMaster Universities (WOMAC) knee function score, Lysholm knee function score, Oxford knee score, Short Form-36 Health Survey (SF-36) the EuroQol (EQ5D), Isokinetic knee extension peak torque, the International Knee Documentation Committee (IKDC), Western Ontario Meniscal Evaluation Tool (WOMET) and Hospital Anxiety and Depression Scale (HAD).

Reported Clinical Outcome

Pain

In all studies no significant difference in knee pain was observed between conservative group and APM group at any follow-up evaluation.

Function

In eight studies[14-17,20-23] no significant difference in knee function was observed between conservative group and APM group. In the study from Stensrud et al[19] a mean difference of 16% in isokinetic knee extension peak torque was found in favor of the exercise therapy group: patients in the exercise group improved isokinetic knee extension peak by a mean of 25 Nm from baseline to follow-up. In the study from Østeras et al[18] patients in the "high-dosage" medical exercise therapy group recorded better scores on Hospital Anxiety and Depression Scale (HAD) at follow-up.

Cross-Over Rate (i.e., Conversion From Conservative Treatment to Surgery)

Concerning cross-over rate, in the study from Yim et al[16] only one patient from the conservative group crossed-over to the surgery group. In two studies[17,18] no cross-over between the 2 groups has occurred. In the other seven studies[14,19-23] the cross-over rate was between 19% to 33%.

Treatment

In 8 studies patients in the conservative group were assigned to the following exercise therapy:

- Gauffin et al[15]: exercise program aimed at increasing muscle function and postural control for 3 months.
- Herrlin et al[23]: exercise therapy for 2 months.
- Katz et al[22]: exercise therapy for 6 weeks.
- Kise et al[21]: progressive neuromuscular and strength exercises over 12 weeks.
- Østerås et al[18]: "high-dosage" medical exercise therapy (MET) over 12 weeks.
- Stensrud et al[19]: progressive neuromuscular and strength exercises over 12 weeks.
- van De Graaf et al[20]: exercise protocol over 8 weeks.
- Yim et al[16]: scheduled physical exercise to improve muscle strength, endurance, and flexibility under the supervision of a physical therapist for 3 weeks.

In one study[17] patients in the conservative treatment group underwent intra-articular steroid injection (1 ml of betamethasone + 4ml of 1% lidocaine).

In one study[14] patients underwent placebo-surgery, i.e., diagnostic knee arthroscopy only.

In seven studies patients in the treatment group underwent surgery, consisting in APM[14,16-21]. Among these, in one trial articular debridement was also performed to treat cartilage wear [17].

In two studies[22,23] patients in the treatment group were subjected to surgery followed by exercise therapy. In one study[15] patients in the treatment group underwent also exercise therapy before surgery (i.e., pre-habilitation).

Complications

Three trials reported on adverse events. In the study by Sihvonen et al[14] one infection in the arthroscopic partial meniscectomy group was reported. In the paper by Katz et al[22] three serious adverse events in the APM group and two in the physical therapy group were indicated. Van de Graaf et al[20] reported nine serious adverse events in the APM group and eight in the physiotherapy group (in all cases not related to the execution of the exercise protocol).

Rehabilitation Protocols

Different rehabilitation regimens have been proposed for the management of symptomatic degenerative meniscal lesions. Stensrud et al[19] proposed a 12-week exercise therapy consisting of progressive exercises performed for a minimum of 2 and a maximum of 3 sessions per week. The program included neuromuscular exercises, such as single-leg squats, plyometric, and strength exercises. To ensure progressive overload for each patient, they used the "plus-two rule", previously adopted by Eitzen et al[24] which stipulates that the last set should be performed with as many repetitions as possible, and if the patient is able to add at least 2 extra repetitions to the set, the load has to be increased during the next training session. Strength training aims at improving muscle force output. Neuromuscular exercise aims at improving dynamic function, alignment, and control[25]. Restoring neuromuscular function and improving muscular strength, particularly of the quadriceps, is crucial because muscles act as shock absorber for the body and thus dampen the knee load rates during activity[26].

Yim et al[16] included also non-steroidal anti-inflammatory drugs (NSAIDs) in addition to physiotherapy, to reduce pain, restore full range of motion (ROM) and improve knee function. It consisted of exercises for muscle strength, endurance and flexibility. The treatment provided advantages in terms of relief of pain and knee functionality.

Herrlin et al[23] indicate that exercise therapy can be recommended as initial treatment for non-traumatic, degenerative medial meniscal tears. Exercises were structured to improve muscle strength and endurance, muscle flexibility, as well as balance and proprioception.

One multicenter RCT[22] designed a three-stage (acute, subacute and advanced activity phase) structured program over 6 weeks to address inflammation, ROM, concentric and eccentric muscle strength, muscle length restrictions, aerobic conditioning (e.g., with the use of a bicycle, elliptical machine, or treadmill), functional mobility, and proprioception and balance. Criteria for advancing from stage I to II and from stage II to III included the level of self-reported pain, observed strength, range of knee motion, knee effusion, and functional mobility. Interesting data emerged from the report of Østeras et al[18], in which a high-repetition, high-dosage medical exercise therapy (MET) were pragmatically adjusted for individual differences due to performance and progression. A combination of global aerobic, semi-global, and local exercises led to less depression and anxiety, compared with APM. The authors hypothesized that the global exercises are important to stimulate the body's own pain modulating system through the gate control mechanism in the posterior horn of the spinal cord and the release of endogenous neuropeptides in the central nervous system.

Discussion

The main finding of the present systematic review is that arthroscopic surgery for meniscal degeneration does not provide superior outcome with respect to exercise therapy up to middle term evaluation.

The management of degenerative meniscal tears has been always a challenge in orthopedic practice and no treatment algorithm exists due to the lack of universal consensus. Despite surgical treatment may be acceptable in case of meniscus-related mechanical symptoms, such as knee catching and locking, traditionally associated with the presence of large flaps or bucket handle tears[27], current evidence suggests that the "painful" but stable meniscus is not candidate to surgery as a first-line treatment. In fact, meniscal degeneration rarely walks alone within a symptomatic knee: in most cases chondral damage or osteoarthritis are already present, together with alterations of the synovial homeostasis. In the majority of the trials included in the present review, patients were affected by a certain degree of joint degeneration, usually mild to moderate as assessed before surgery by radiographic scores and then confirmed by arthroscopic assessment. The joint micro-environment is therefore impaired as a whole system and this could explain the non-superior results obtained after surgically addressing meniscal degenerative tears[28]. Indeed, concurrent cartilage treatments, such as debridement have no real therapeutic potential and do not prevent further degeneration over time, thus contributing only to a temporary pain relief in the early months surgery: as shown by two papers, better pain relief was obtained with surgical approach just at the first, short-term evaluation. In light of these considerations, the conservative management of painful degenerative meniscal lesions is currently being advocated as the first line approach. Looking at the available data, despite a documented increase in clinical outcomes following surgery, the lack of significance compared to exercise therapy endorse the conservative approach as the first therapeutic option to manage this particular kind of patients, also considering: 1) the potentially deleterious effect of arthroscopy on the joint environment (post-surgical inflammatory response), and on the psychological status of the patient[18]; 2) the risks related to the surgical procedure itself (post-op infection, deep venous thrombosis, arthrofibrosis etc.); 3) the influence of even minimal partial meniscectomy on the progression of cartilage injury over time or the onset of post-meniscectomy osteonecrosis, as shown by a number of trials published over the last decades[29]. Another relevant aspect is that many studies evaluated patients at minimum 12 months, with the longest follow-up being 60 months[23]: this confirms that the exercise therapy is able to provide stable and lasting results over time, with a low rate of conversion to surgery, which should be therefore reserved to patients who fail conservative treatment or are not satisfied with the achieved outcomes. The failure of conservative treatment is also a crucial point, since it is strictly related to the compliance of the patient to the rehabilitation protocol proposed: in a "real world setting", which often implies a less rigorous follow-up of the patient, the lack of adherence to the physiotherapy, mainly due to social and working habits, could be regarded as the principal cause of failure of conservative management. Patients often quit physiotherapy prematurely and are pushed to surgery in the wrong belief that they could obtain positive outcome in shorter times. Therefore, the present review further highlights the need of a proper compliance to exercise therapy, even if it is impossible

to establish an ideal duration of exercise therapy: based on the data emerged from the systematic review, the duration ranged from 3 to 12 weeks, with the majority of trials adopting the longest regimen (12 weeks). The efficacy of rehabilitation has been proved by many trials and reflects the fact that joint degeneration is a disease affecting not only the intra-articular tissues, such as menisci and cartilage, but also extra-articular structures, such as ligaments, muscles and tendons. To this purpose, physical therapy is the only approach able to target the joint in its entirety: regular and gradual muscular strengthening, posterior kinetic chain stretching, proprioceptive exercises are fundamental strategies to avoid the loss of strength and the onset of flexion contracture, both of which play a relevant role in worsening knee function and increase pain due to a "mechanical impairment" in a degenerated joint where the shock absorbing tissues (i.e., meniscus and cartilage) are biochemically and functionally weakened.

Despite the focus of the present analysis was on physical therapy *vs.* surgery, we also included one trial where arthroscopy was compared to intra-articular steroid injection[17], which is also a "conservative" approach commonly used in clinical practice: even in this trial, no superior results were reported for the arthroscopic approach up to one year, with a similar rate of symptomatic relapse. Anyway, intra-articular injections of various substances ranging from corticosteroids[30] to hyaluronic acid[31] or platelet derived growth factors[32] could represent a further therapeutic option to increase the outcome of conservative management and their beneficial potential has been consistently demonstrated in literature. These products have various biologic actions and could modulate the intra-articular environment reducing inflammation and articular swelling, therefore decreasing pain, allowing patients to start sooner their rehabilitation protocol and be more compliant to it, with higher chance of maximizing the clinical benefit after this combined management. Future randomized studies are needed to understand whether and how the injective approach could improve the results of physical therapy.

The analysis of the methodological quality of the trials included has revealed overall good results as shown in Table II. The main limitation emerged is correlated to the difficulty in performing double blinded trials due to ethical reasons: in fact it is very hard to receive approval to perform sham surgery (i.e., diagnostic arthroscopy or just skin portals), which is the necessary condition to blind the patient but would expose her/him to the risks of anesthesia and minimal joint manipulation. To date, only one trial reported results of patients treated by sham surgery[14]. Other limitations have emerged in the blinding of evaluators and randomization and group concealment strategies, thus fostering higher quality trials to be performed to confirm the currently available evidence.

Coming back to the role of surgery, it should not be neglected anyway since it could be reasonable to consider an arthroscopic treatment in case of failure of a properly conducted physical therapy program (with or without an attempt to use intra-articular injection). What deserves further attention is the role of rehabilitation and its timing with respect to the planned surgery. Adequate post-operative rehabilitation contributes to a faster and longer lasting outcome: surgery represents a stressful event on the joint and on the entire body, so that physical therapy should always follow in order to minimize muscular loss and walking impairment that could lead to prolonged recovery times and ultimately affect the full healing of the patient[33]. Furthermore, in the last years, pre-operative rehabilitation (the so-called pre-habilitation) has gained increasing interest: in fact, it has been shown that, in the setting of joint replacement surgery, a pre-op physical therapy protocol contributes to improve the post-op. results[34], and similar findings can be expected even for arthroscopic surgery.

The present analysis suffers some relevant limitations anyway. First of all, due to the heterogeneity of outcome measurements (different clinical questionnaires adopted), it was impossible to perform an adequate meta-analysis among the randomized trials. Clustering as low as two or three trials would not have added significance to the findings of the systematic review.

Furthermore, the wide range of rehabilitation protocols adopted in terms of exercises and duration does not allow the identification of the best therapeutic approach, which is a relevant clinical issue at the present moment. This uncertainty therefore fosters further studies to compare different protocols with the aim of determining whether an ideal conservative approach exists to manage painful knees affected by meniscal degenerative lesions.

Lastly, based on data available, it was not possible to enquire the role of physical therapy (e.g., laser therapy, ultrasounds, shockwave therapy) in the management of meniscopathy.

Conclusions

Degenerative meniscal tears, without symptoms of locking and catching, can be successfully managed by a proper regimen of exercise therapy as a first line treatment since arthroscopic surgery is not able to provide better outcomes up to middle term evaluation. Surgical approach might be considered in case of poor response after conservative treatment and the patient should be anyway informed of the early and delayed risks linked to surgery and meniscal resection, especially in case of concurrent presence of cartilage damage.

Conflict of Interests

The Authors declare that they have no conflict of interests.

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