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Original article

Meniscal-wall ultrasound-guided steroid infiltration for degenerative meniscal lesions (DML) shows low rate of conversion to surgery

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ABSTRACT

Introduction: Degenerative meniscal lesions (DML) are frequent in the general population. However, the management of stable DML is always a challenge due to the lack of universal consensus and evidence.
Hypothesis: We assessed ultrasound-guided corticosteroids medial meniscal-wall infiltration as a conservative therapy for symptomatic DML and we searched for associated factors of very good response. Our hypothesis is that these injections will contribute to avoid the surgical treatment and improve clinical and functional scores.
Material and methods: An observational retrospective study included patients with DML of medial meniscus without mechanical symptoms of catching or locking, and without radiological signs of osteoarthritis, who underwent meniscal-wall corticoid infiltration under ultrasound between 2020 and 2021. Evaluations were carried-out at 24 months minimum after infiltration to determine any surgical intervention performed and assess clinical and functional outcome by a standard questionnaire to evaluate pain score using VAS at rest and on walking, SKV and TEGNER. Patient characteristics at the time of the infiltration were collected to determine the factors associated with very good response (SKV $>$ 90).
Results: 187 patients were included. Surgery-free survival was 95% (90–97) (33,17 (SD, 6,40) months), mean VAS pain score at rest of 1.47 (SD, 2.51), mean VAS on walking of 2.47 (SD, 2.91), mean SKV score of 71.32 (SD, 22.75) and mean Tegner score of 6.75 (SD, 1.67) at a minimum of 24 months follow-up. BMI was significantly lower in the very good responders (SKV $>$ 90) with a p = 0,017 (24.04 (SD, 3.82) in patients with SKV $>$ 90 versus 26,23 (SD, 4.93) in patients with SVK $\leq$ 90).
Conclusion: US-guided meniscal wall infiltration is able to provide lasting symptom relief and functional recovery over time, in addition to low rate of conversion to surgery for patients suffering from DML without radiological signs of osteoarthritis.
Level of proof: IV; retrospective study.

1. Introduction

Degenerative meniscal lesions (DML) are frequent in the general population and are often incidental findings on knee Magnetic Resonance Imaging (MRI) [1]. They usually develop slowly on meniscal tissue that already has ultra-structural changes that affect its resistance to load [2]. The risk factors are mal-alignment, obesity, and work activities where there is an articular overload [3].

The management of DML has been always a challenge in orthopedic practice. Data provided by the European Society of Sports Traumatology, Knee Surgery and Arthroscopy [4] or the guidelines published in the British Medical Journal [5] showed no or poor clinical benefit of arthroscopy in the case of painful but stable DML. In fact, arthroscopy is the first line treatment for meniscus-related mechanical symptoms such as catching and locking, associated with the presence of large flaps or bucket handle tears [4], but "the last resort" of treatment in case of DML [6,7]. Therefore, conservative management is advocated as the first line approach and it includes analgesics, anti-inflammatory drugs, physical

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therapy and weight loss [8]. Intra-articular injections of various substances ranging from corticosteroids, to hyaluronic acid (HA), or platelet rich plasma (PRP) could represent a therapeutic option to increase the outcome of conservative management [9]. Bouvard and Juret are the first authors to describe an infiltration technique in the juxta meniscal zone with encouraging results [10]. However, they didn't differentiate between traumatic and degenerative tears, and they included patients with advanced knee OA.

In this study, we assessed ultrasound (US) guided corticoids medial meniscal-wall injection as a conservative therapy for symptomatic medial DML without signs of knee OA at 24 months minimum follow-up (F/U). The primary objective is to determine the surgery-free survival rate. The secondary objectives are to describe clinical and functional outcomes (Pain visual analogue scale (VAS) at rest and on walking, Self Knee Value (SKV) score, TEGNER) and to assess the factors associated with a very good response (SVK > 90) based on the age, body mass index (BMI), job type, smoking, and the sport practiced in order to better identify indications for this procedure.

Our hypothesis is that these injections will contribute to low rate of surgical treatment, and obtain good clinical and functional scores in patients with DML.

2. Materials and methods

2.1. Participants

After approval from the institutional review board of our university hospital, 198 patients with DML of the medial meniscus (Fig. 1) who underwent meniscal-wall corticoid infiltration under U/S (Fig. 2a and b) between 2020 and 2021 were reviewed retrospectively. This technique targeted the meniscal wall which is located between the articular capsule and the periphery of the meniscus where there is the free nerve endings acting as nociceptors in meniscal pain, and therefore treats the "trigger" tissue rather than the whole joint (Fig. 3).

The inclusion criteria were patients with DML on MRI who presented with medial joint line pain and tenderness during a consultation with a single experienced senior orthopedic surgeon.

Patients with history of mechanical symptoms of an unstable meniscus lesion type locking/catching or blocking, unstable signs of meniscal lesion on MRI (bucket handle tear, flap, large radial fissure, meniscal extrusion), ligamentous injuries, instability, mechanical axis deviation of more than 5 degres, osteoarthritic changes with Kellgren-Lawrence scale ≥2 on x-rays, chondral defects above International Cartilage Repair Society scale (ICRS) II on MRI, and patients who underwent prior surgery or infiltration or with a history of knee trauma in the last year were excluded from the study.

2.2. Data collection and follow up

Patient characteristics at the time of the infiltration were collected to determine the factors associated with very good response (SKV > 90 versus SVK ≤ 90) : height (m), weight (kg) with BMI calculation, side of infiltrated knee (R/L), duration of symptoms before the infiltration calculated in months, smoking, age, job type (physical or not physical), sports type (contact pivot, non-contact pivot, non-pivot).

Evaluations were carried-out at 24 months minimum after infiltration during a follow-up visit or via a telephone interview using a standard questionnaire to determine if any surgical intervention was performed (arthroscopy, osteotomy, arthroplasty), and to evaluate clinical and functional outcome. It includes pain score using the visual analogue scale (VAS) [11] at rest and on walking, functional scores using SKV [12] and TEGNER [13]. Before analyses, verification of missing or aberrant or inconsistent data was conducted. After corrections, the database was locked. Analysis was performed on the locked database.

2.3. Statistical analysis

The group studied includes 198 patients (exhaustive recruitment). This sample size allows to highlight a rate of avoiding surgical treatment at 24 months expected at 80% with a 95% confidence interval (95%CI) with a width of ± 6% (which requires the analysis of 186 patients).

We first described characteristics of patients using the appropriate descriptive statistics according to the type of variables. Descriptive statistics included the number of non-missing observation, mean with standard deviation (SD), median with interquartile range (IQR) and range (minimum-maximum), for continuous variables, and number of non-missing observation with frequency (%) for categorical variables. For the analysis of the primary endpoint, Kaplan–Meier survival curves were drawn and described using surgery free survival (since infiltration) together with 95%CI. Functional scores were described using mean with SD, median with IQR and range. For the analysis of the factors associated with good response (SVK > 90 versus SVK ≤ 90), categorical variables were compared between groups using the χ^2-test (or Fisher's exact test when necessary). Student's t-test was used to compare the distribution of continuous variables (or Mann Whitney's test when distribution

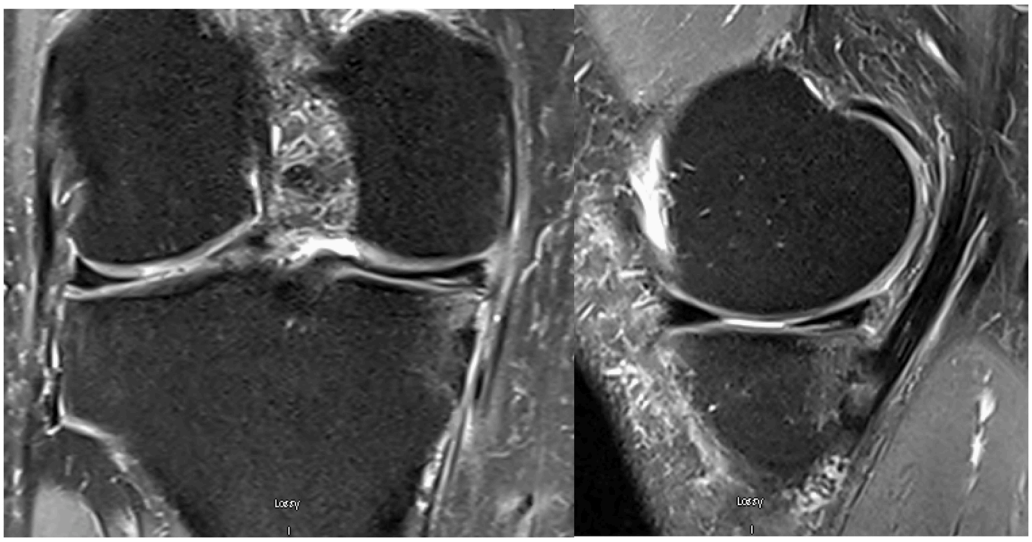

Fig. 1. Degenerative medial meniscal lesion of the right knee in a 57 years old man.

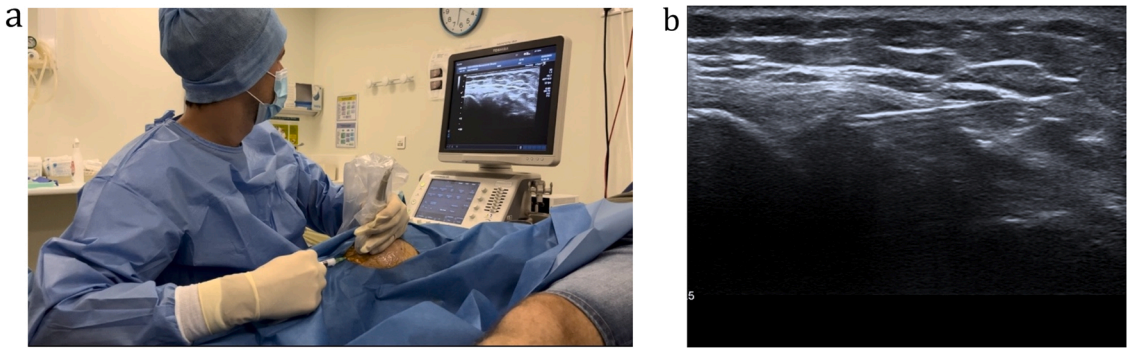

Fig. 2. (a) Corticosteroid injection procedure. (b) Simultaneous ultrasound image.

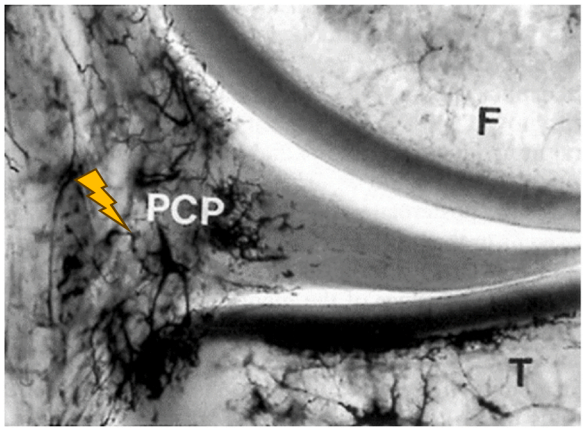

Fig. 3. The ultrasound guided injection is targeted on the trigger area (yellow flash) which is located near the perimeniscal capillary plexus. Reprinted from Arnoczky SP and Warren RF (25). PCP = perimeniscal capillary plexus, F = femur, T = tibia.

departed from normality or when homoscedasticity is rejected). All reported p-values were two-sided and the significance threshold was <0.05. Statistical analyses were performed using STATA software 17.0 (STATA Corp., College Station, TX, USA).

3. Results

A total of 187 patients were included in the study after excluding 11 patients for the following reasons: history of infiltration (3), history of meniscal surgery (3), history of osteotomy (3), history of unspecified knee surgery (2). Five patients (5/187; 2.6%) reported transient post-procedural pain during the 24 h that followed the meniscal-wall injection.

3.1. Population characteristics

Patients had a mean age of 50.96 (SD, 14.19) years. A Kellgren–Lawrence scale 0 was found in 71 patients (37.9%) and scale 1 in 116 patients (62.1%) on radiographs. 94 patients (50.3%) had their right knee affected. The mean duration of meniscal symptoms before infiltration was 19.07 (SD, 18.24) months. 37 patients were active smokers (19.8%). Mean BMI was 25.84 (SD, 4.81) Kg/m^2. 64 patients (34.2%) were not working (unemployment or at age of retirement), 25 (13.4%) had a physical job and 98 (52.4%) had not physical job. 55 patients (29.4%) do not participate in any type of sport, 12 patients (6.4%) in pivot contact sport, 24 (12.8%) participate in pivot non-contact sport and 96 (51.3%) participate in non-pivot sports. The Population characteristics is described in Table 1.

Table 1
Population characteristics.

	Total N = 187
Side n (%)	
Right	94 (50.3)
Left	93 (49.7)
Duration of symptoms (M)	
Mean (SD)	19.07 (18.24)
Active smoker n (%)	
No	150 (80.2)
Yes	37 (19.7)
Age (years) n (%)	
<35	25 (13.4)
≥35	162 (86.6)
BMI	
Mean (SD)	25.84 (4.81)
Job type n (%)	
Not working	64 (34.32)
Physical job	25 (13.4)
Not physical job	98 (52.4)
Sport type n (%)	
No sport	55 (29.4)
Pivot-contact	12 (6.4)
Pivot non-contact	24 (12.8)
Non-pivot	96 (51.3)

M: month; n: number; SD: Standard deviation; IQR: interquartile range; Min, Max: minimum, maximum.

3.2. Surgery-free survival rate

The mean follow-up for surgery lasted for 33,17 (SD, 6,40) months (between 14 and 44 months; with a minimum follow-up of 24 months in patients without surgery). 12 patients (6.4%) underwent subsequent surgery following the infiltration in another institution (7 underwent arthroscopic meniscectomy and 5 underwent high tibial osteotomy) at last follow-up for reasons that we do not know. At 24 months, the surgery-free survival was 95% (95%CI: 90-97) (Table 2 and Fig. 4).

3.3. Clinical and functional scores

The mean follow-up lasted for 32,04 (SD, 5,89) months (between 17 and 41 months). Assessment of pain through VAS showed a mean VAS at

Table 2
Surgery-free survival rate at two years follow-up.

Time (month)	Survivor function	95% conf.int.
12	1	
18	0.98	0.95; 0.99
24	0.95	0.90; 0.97
30	0.95	0.90; 0.97
36	0.94	0.90; 0.97
42	0.94	0.90; 0.97

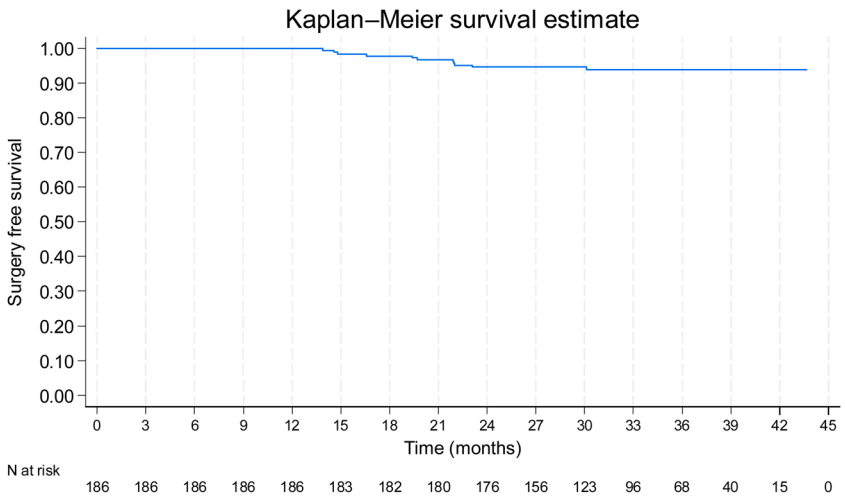

Fig. 4. Surgery-free survival rate.

rest of 1.47 (SD, 2.51), while 2.47 (SD, 2.91) on walking. In functional assessment, the mean SKV score was 71.32 (SD, 22.75), and the mean Tegner score was 6,75 (SD, 1.67) (Table 3).

3.4. Factors associated with a very good response (SVK > 90)

There was no association between either age, side of knee pain, smoking, duration of symptoms before infiltration, job type, sports type and response to infiltration. However, BMI was significantly lower in very good responders (SKV > 90) with a p = 0.017 (mean BMI = 24.04 [SD, 3.82] vs. 26.23 [SD, 4.93]) (Table 4).

4. Discussion

Meniscal-wall corticosteroid injection showed an excellent surgery-free survival with 95% [95%CI: 90–97] of patients free of any surgical intervention at 24 months minimum follow up, and provided long term symptom relief and functional success. Lower BMI is associated with very good response (SKV > 90).

It has been empirically observed that intra-articular injections do not appropriately alleviate pain in patients with DML [14,15]. Since soluble agents, such as corticosteroids, are rapidly cleared from joints via synovial capillaries and lymphatic drainage, without reaching the target area, this translates into a major barrier to successful treatment [15,16]. Indeed, with intra-articular injection, no influence should be expected on the quality of the meniscal tissue, in addition that long term treatment with intra-articular corticosteroid injection could promote joint destruction and tissue atrophy [17]. Because the menisci innervation follows the blood supply, nerve fibers are found primarily in the peripheral vascular zone covering the outer third of the meniscus, whereas the inner two-thirds of the menisci contain no nerves [18]. Owing to the peripheral location of the free nerve endings acting as nociceptors in meniscal pain, a meniscus-targeted injection with corticosteroid treat the "trigger" tissue rather than the whole joint [18]. With its anti-inflammatory, fibrotic and analgesic effects, it can provide a timely and lasting clinical improvement by interrupting the inflammatory cascade and reducing vascular permeability at the peripheral border of the menisci [18].

In recent years, there has been increased interest in the use of ultrasound (US) guidance for therapeutic injections, with the advantages of real-time imaging, absence of radiation exposure, and convenience of performing the procedure portably [19]. In particular, at the knee, US offers high spatial resolution and exquisite soft tissue delineation,

Table 3
Clinical and functional scores at two years follow-up.

	Total 187 (100)
SKV	
Mean (SD)	71.32 (22.75)
TEGNER	
Mean (SD)	6.75 (1.67)
VAS for pain at rest	
Mean (SD)	1.47 (2.51)
VAS on walking	
Mean (SD)	2.47 (2.91)

n: number; SD: Standard deviation; IQR: inter-quartile range; Min, Max: minimum, maximum; SKV: self knee value; VAS: visual analogic scale.

Table 4
Factors associated with a very good response.

	SKV		
	≤90 (good responders) N = 154 (82.4%)	>90 (very good responders) N = 33 (17.6%)	P value
Side n (%)			.874
Right	77 (50.0)	17 (51.5)	
Left	77 (50.0)	16 (48.5)	
Duration of symptoms (M)			.961
Mean (SD)	19.54 (19.17)	16.86 (13.05)	
Active smoker n (%)			.798
No	123 (79.9)	27 (81.8)	
Yes	31 (20.1)	6 (18.2)	
Age (years)			.678
Mean (SD)	51.16 (14.08)	50.03 (14.92)	
Age (years) n (%)			.778
<35	20 (13.0)	5 (15.2)	
≥35	134 (87.0)	28 (84.8)	
BMI			**.017**
Mean (SD)	**26.23 (4.93)**	**24.04 (3.82)**	
Job type n (%)			.395
Not working	53 (34.4)	11 (33.3)	
Physical job	23 (14.9)	2 (6.1)	
Not physical job	78 (50.6)	20 (60.6)	
Sport type n (%)			.221
No sport	47 (30.5)	8 (24.2)	
Pivot-contact	10 (6.5)	2 (6.1)	
Pivot non-contact	16 (10.4)	8 (24.2)	
Non-pivot	81 (52.6)	15 (45.5)	

M: month; n: number; SD: Standard deviation; IQR: inter-quartile range; Min, Max: minimum, maximum.

making it an ideal guidance modality for both intra and extra articular injection [20,21]. Three articles on cadaveric specimens validated the feasibility and safety peri-meniscal injection under U/S guidance [7,19,2]. However, experience with meniscus-targeted corticoids injections under U/S is still limited with only six articles were found in literature [10,19,22–25]. The limited articles, the heterogeneity in inclusion/exclusion criteria and indication, in follow-up timing and in outcomes measures make the comparison between these variables and our results impossible. Bouvard et al. [10] showed that these infiltrations constitute an effective treatment in 214 patients. 20% of patients were operated by arthroscopy at Day 60 and 33% at Day 90. However, they didn't differentiate between traumatic and degenerative tears, and they included patients with advanced knee OA, in addition to patients with signs of locking on physical exam. Wilderman et al. [22] found that these injections produced 5.68 weeks of pain relief on average, with a decrease in pain from initial to follow-up visits of 2.14 as per the VAS score in 135 patients. Similarly, they included patients with traumatic or degenerative fraying lesions and patients with knee OA. Di Sante et al. [23] evaluate a small case series of 32 patients with knee OA stages II and III of Kellgren–Lawrence (K–L) associated with meniscal extrusion. All participants showed a significant reduction in VAS pain score over time at 1- and 4-week follow-up. Nakase et al. [24] showed that US-guided MCL bursa injection is effective for symptomatic DML but ineffective for flap tears and posterior root tears, with nine patients (18%) underwent surgery within the first year. Marion et al. [25] studied 41 patients with traumatic and DML treated by meniscal-wall injection, associated with an additional treatment of HA injection in connection with chondral lesions in 68%. 3 patients (7.3%) were then operated by an arthroscopic meniscectomy respectively, 2, 7 and 12 months after meniscal-wall infiltration. Coll et al. [19] study was the sole in literature similar to our study regarding the inclusion/exclusion criteria. They demonstrate a significant mid-term symptom relief and functional recovery at 6 weeks in 35 patients, with 71% (25/35) reporting full return to daily activities. They found that four patients (4/35; 11.4%) underwent arthroscopic surgery or knee replacement surgery during the year that followed procedure, which is less good than our results (2%–6% depending on the time after infiltration). Louis et al. [26] show that medial meniscus suturing in stable knees represents a small part of annual arthoscopic activity and it occurs less frequently than during ACL reconstruction surgery [27]. Moreover there is no consensus regarding rehabilitation procotocols [28]. Our study is the biggest series of patients who evaluate meniscal-wall infiltration of corticosteroids. We differentiated ourselves from the vast majority of studies on the subject by strictly excluding traumatic lesions and osteoarthritis in order to offer with a very precise protocol, a targeted injection adapted to DML. The injection is carried out by a radiologist trained in osteoarticular pathology and following a standardized protocol.

Bouvard et al. [10] was the only article that evaluated the clinical and paraclinical profile of the good responder to this technique. The responder patients in the retrospective study were younger (mean = 40 years old) than the non-responders (mean = 46 years old) but there were no functional, clinical or radiological signs predicting the success or failure of the meniscal-wall infiltration apart from the occurrence of a blocked knee or lock, which appeared to be a poor indication for injections [10]. In aiming to identify the pattern of a "very good responder" to treatment, we divided the SKV score between $\leq$90 (good responders) and >90 (very good responders) and we studied the possible predictive factors. No significant difference was observed regarding age, side, smoking, job type, sports type and the duration of symptoms before injection. However, the very good responder's patients had a significantly lower BMI.

The strength of our study is first the number of patients included and the mid-term follow-up. Second, the inclusion/exclusion criteria that we put in order to eliminate any other pathologies that could bias our results. Careful clinical evaluation was required in our study at patients' inclusion to determine if the DML was likely to directly impact the patient's symptoms. Other processes related to traumatic meniscal tear or knee osteoarthritis that may be contributing to the pain were excluded.

We are aware that this is a study of a modest level of evidence. First, lack of baseline pain and functional score for comparison between baseline data and last follow-up. Second, the retrospective character of the study and lack of randomized control group analysis. In fact, the first patients treated were so satisfied with the results that we could not leave patients without any treatment. Third, lack of comparison to intra-articular joint injection which is theoretically quicker and less technically challenging.

5. Conclusion

US-guided meniscal wall infiltration is able to provide lasting symptom relief and functional recovery over time, in addition to low rate of conversion to surgery for patients suffering from DML without radiological signs of osteoarthritis.

CRediT authorship contribution statement

François Duprat: First author (conception of the work, drafting the article, data collection, data analysis, critical revision, final approval of the article).

Dany Mouarbes: drafting the article, critical revision.

Emilie Berard: data analysis and interpretation.

Samy Saoudi: data collection.

Jean Baptiste Lions: data collection.

Pierre Thomas: critical revision of the article.

Marie Faruch Bilfeld: critical revision of the article, drafting the article.

Etienne Cavaignac: Drafting the article, critical revision of the article, final approve of the version to be published, conception/design of the work.

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Declaration of Generative AI and AI-assisted technologies in the writing process

No use of any generative AI or AI-assisted technologies to write this manuscript.

Declaration of competing interest

Etienne Cavaignac: consultant for Arthrex and Amplitude with no link to this study.

The other authors have nothing to declare.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.otsr.2024.104026.

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