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Original article

Functional and anatomical outcomes of single-stage arthroscopic bimeniscal replacement

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ABSTRACT

Background: Meniscal replacement by an allograft or scaffold has been proven effective in patients with post-meniscectomy pain syndrome. Replacement of both menisci is a rarely performed procedure about which little is known. The primary objective of this work was to assess the functional outcomes of arthroscopic bimeniscal replacement. The secondary objectives were to evaluate meniscal healing and the time-course of cartilage lesions.
Hypothesis: Single-stage arthroscopic bimeniscal replacement provides good functional and anatomical outcomes, similar to those seen after replacement of a single meniscus, in adults with post-meniscectomy pain syndrome.
Material and methods: Five patients received regular follow-up after single-stage arthroscopic bimeniscal replacement by an allograft and/or substitute, with or without concomitant anterior cruciate ligament reconstruction. Median follow-up was 30 months (range, 24–68 months). Radiographs and magnetic resonance imaging scans of the knee obtained before surgery and at last follow-up were evaluated. The following parameters were recorded: KOOS and IKDC score, knee osteoarthritis, knee alignment, condition of the cartilage, healing of the meniscal replacement material, meniscal extrusion, and other complications.
Results: Allografts were used to replace both menisci in 3 patients, whereas 2 patients received a lateral allograft and a medial scaffold. The median subjective IKDC score was 83.9 (range, 55.1–94.3) and the median objective IKDC score was B (range, A–C). The median global KOOS was 85.7 (range, 65.7–92.3). Extrusion occurred for one medial and two lateral menisci.
Conclusion: Bimeniscal replacement by an allograft and/or substitute provides good short-term functional and anatomical outcomes. Nevertheless, this procedure is warranted only in highly selected patients.
Level of evidence: IV, retrospective study.

1. Introduction

The menisci play a pivotal role in load distribution, shock absorption, lubrification, stability, and proprioception of the knee. Even when partial, meniscectomy carries a 10-year risk of osteoarthritis of 40% at the lateral compartment and 22% at the medial compartment [1]. Despite the current emphasis on meniscal preservation (via meniscal repair or sparing excision) [2], extensive meniscectomy is performed in some patients.

Among patients with anterior cruciate ligament (ACL) tears, 10% to 20% have damage to both menisci [3], which are removed in 1.8% of cases [4].

Meniscal reconstruction procedures are available for young patients who have post-meniscectomy knee pain without advanced osteoarthritis. Meniscal allograft transplantation after total or subtotal meniscectomy has been found effective in relieving the pain and providing good long-term functional outcomes [5,6]. Meniscal scaffolds can be used instead in patients with persistence of a meniscal wall and intact anterior and posterior horns [7]. Meniscal replacement probably has a favourable cost/benefit ratio when used in properly selected patients [8].

Replacement of both menisci can be considered in young patients with pain after the excision of both menisci but no significant osteoarthritis. However, only very few data on this procedure are available and, to our knowledge, no separate evaluation of outcomes has been performed to date [9,10]. The primary objective of this work was to assess the functional outcomes of arthroscopic bimeniscal replacement. The secondary objectives were to evaluate

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meniscal healing and the time-course of the cartilage lesions. The working hypothesis was that single-stage arthroscopic bimeniscal replacement provides good functional and anatomical outcomes, similar to those seen after replacement of a single meniscus, in adults with post-meniscectomy pain syndrome.

2. Material and methods

Patients who underwent bimeniscal replacement between January 2015 and January 2017 were included in a retrospective study. All patients received follow-up according to the standard protocol for their diagnosis. A physical examination and investigations were performed 45 days, 3 months, 6 months, and 2 years after surgery. Patients were informed by letter that their anonymised data would be used for this retrospective study; none declined study participation.

Patients were selected for bimeniscal reconstruction based on the following criteria: age 18 to 50 years, pain after bimeniscal excision, failure of non-operative treatment followed for at least 1 year, lower limb axis between 175° and 185° or realignment osteotomy performed during the same stage, and absence of ligament laxity or same-stage correction by ligament reconstruction. Thus, bimeniscal reconstruction was considered in young patients who had chronic significant pain in both tibio-femoral compartments after bimeniscectomy despite appropriate non-operative treatment, without major cartilage damage and with normal lower limb alignment. Patients were not eligible for bimeniscal reconstruction if the schuss radiograph showed Ahlbäck grade III or higher osteoarthritis and/or the pre-operative magnetic resonance imaging (MRI) scan showed focal cartilage lesions grade 3a or higher in the International Cartilage Repair Society (ICRS) classification.

The following were recorded before surgery then at each follow-up visit: body mass index, occupation, sports activities, and knee symptoms (pain, effusion, locking, instability). At the same time points, the patients were examined for knee range of motion and objective IKDC score items and were invited to complete the subjective KOOS and IKDC score questionnaires. The following standing radiographs were obtained: antero-posterior and lateral views, skyline view at 30° of flexion, schuss view of both knees, and long-leg radiograph. These radiographs were used to determine knee alignment and to look for tibio-femoral osteoarthritis (graded according to Ahlbäck) and/or patello-femoral osteoarthritis and/or other bone abnormalities.

MRI of the knee was performed before surgery and 2 years after surgery. The pre-operative MRI scan served to quantify the meniscal defects and to assess the feasibility of replacement of each meniscus (substitute in the event of partial meniscectomy with persistent meniscal wall and roots, according to standard indications for meniscal replacement [11]; allograft in the event of either subtotal medial meniscectomy or extensive lateral meniscectomy [12] leaving no bridging meniscal substance at the hiatus). The following were assessed on the MRI scan obtained 2 years post-operatively: meniscal healing (complete, partial, absent [5]), status of the cartilage (ICRS classification), measurement of meniscal extrusion, and status of the ACL transplant if ACL reconstruction was performed.

2.1. Operative technique

Arthroscopic meniscal replacement was performed by a single operator. The patient was supine, with the knee secured to a post and a pneumatic tourniquet inflated at the root of the limb. An antero-lateral portal and an antero-medial portal were created. The meniscal remnants were freshened partially to receive a substitute or completely to receive an allograft.

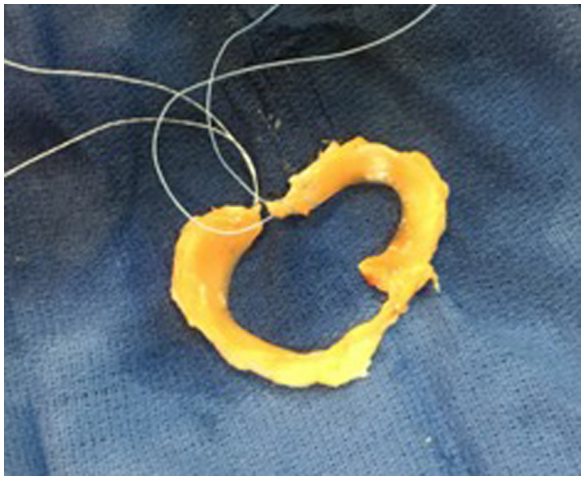

Fig. 1. Monobloc bimeniscal allograft.

2.1.1. Meniscal allograft

Allograft size was determined using the pre-operative MRI scan [13]. Frozen allografts were used. The posterior meniscal horns were fixed using trans-osseous tunnels, and the body of the meniscus was sutured to the capsule using the all-inside technique. The anterior horn and inter-meniscal ligament were secured on anchors. When an allograft was implanted on both sides, the two menisci were left connected via the inter-meniscal ligament (Fig. 1).

2.1.2. Meniscal substitute

During arthroscopy, an appropriate flexible ruler was used to measure the length of the meniscal defect. The Actifit® polymer scaffold (Orteq, London, UK) was prepared, implanted, and fixed using all-inside sutures.

If ACL reconstruction with patellar tendon was performed concomitantly, the sequence was as follows: patellar tendon transplant harvesting, preparation of the meniscal bed for the substitute or allograft, preparation of the notch and creation of the femoral and tibial tunnels, implantation of the meniscal substitutes and/or allografts, and insertion and fixation of the ligament transplant.

The same post-operative rehabilitation programme was used in all patients. Weight-bearing was eliminated for 45 days, during which immediate passive flexion to 90° was allowed. After 45 days, passive flexion was unlimited. Patients were allowed to return to sports after 6 months.

3. Results

The study included 4 males and 1 female with a median age at surgery of 30 years (range, 25–36 years) and a median follow-up of 30 months (range, 24–68 months). No patient was lost to follow-up. Table 1 reports the main pre-operative data. An allograft was used to replace both menisci in 3 patients. In the other 2 patients, an allograft was implanted laterally and a scaffold medially.

Functional knee instability was present in 3 patients, who underwent ACL reconstruction using the bone-patellar tendon-bone technique. Among them, 2 had old ACL tears that had not been treated surgically and 1 had had previous ACL reconstruction.

Table 2 reports the functional outcomes in each patient with comparisons of the data collected pre-operatively and at last follow-up. The occupation changes in 2 patients had no connection to the knee pathology. A single patient returned to sports at the same level (departmental football competitions). The other 4 patients either discontinued all sports activities or switched to a different type of sport.

Table 1
Pre- and intra-operative data.

#	Patient data							Characteristics of the surgical procedure			Radiographs		
	Sex	Age (years)	Follow-up (months)	Side	BMI (kg/m^2)	Occupation	Main sports	Medial meniscus	Lateral meniscus	Other procedures	MTF	LTF	Axis (°)
1	F	33	32	L	20	Civil servant	Dance	Allogr.	Allogr.	ACL	1	1	177
2	M	25	43	R	29	Engineer	Football	Scaffold	Allogr.	ACL	0	0	178
3	M	27	32	L	24	Warehouse worker	Football	Allogr.	Allogr.	–	1	0	177
4	M	30	19	L	24	Taxi driver	Weight-lifting	Allogr.	Allogr.	ACL	0	0	179
5	M	36	68	R	25	Executive	Rugby	Scaffold	Allogr.	–	0	0	177

BMI: body mass index; MTF: medial tibio-femoral compartment (Ahlbäck); LTF: lateral tibio-femoral compartment (Ahlbäck); F: female; M: male; Allogr.: allograft; Subst.: substitute; ACL: anterior cruciate ligament.

Table 2
Functional scores before surgery and at last follow-up.

Patient #	Pre-op. IKDC		Post-op. IKDC		KOOS					
	Objective IKDC	Subjective IKDC	Objective IKDC	Subjective IKDC	KOOS symptoms and stiffness	KOOS pain	KOOS function	KOOS sport	KOOS quality of life	KOOS global
1	D	47.1	B	83.9	46.4	94.4	91.7	60	43.8	67.3
2	D	51.5	A	94.3	75	94.4	98.6	90	100	91.6
3	C	58.5	A	93.1	92.8	100	100	100	68.8	92.3
4	D	48.6	B	87.4	85.7	88.9	100	85	68.8	85.7
5	D	41.2	C	55.2	64.3	77.8	91.7	70	25	65.8

Table 3
Anatomical outcomes at last follow-up.

Patient #	Radiographs			MRI					
	MTF (Ahlbäck)	LTF (Ahlbäck)	Axis (°)	Extrusion MM (mm)	Extrusion LM (mm)	Appearance of MM	Appearance of LM	Cartilage TF ICRS)	Cartilage TF ICRS)
1	1	1	179	2	4	Fully healed	Fully healed	2	3
2	0	0	177	0	2	Partially healed	Fully healed	1	2
3	1	2	179	1.5	0	Fully healed	Fully healed	1	4
4	0	2	177	4	3	Partially healed	Partially healed	1	4
5	1	1	179	0	2	Fully healed	Fully healed	2	3

MTF: medial tibio-femoral compartment; LTF: lateral tibio-femoral compartment; MM: medial meniscus; LM: lateral meniscus.

Table 3 shows the imaging study findings in each patient. Extrusion occurred for 3 of the 10 treated menisci (2 lateral and 1 medial) (Figs. 2–4). Of the 10 menisci, 3 were partially healed (Figs. 5 and 6).

There was a single complication, which occurred 6 months postoperatively and consisted in discomfort due to extrusion into the joint of the anchor used for fixation of the anterior horn of the medial meniscus (patient #5). Revision arthroscopic surgery was performed to remove the anchor. The meniscal allograft and substitute were healed.

4. Discussion

The main finding from this study is that bimeniscal replacement provides good short-term functional outcomes when used to treat chronic post-bimeniscectomy pain syndrome. Nevertheless, neither the KOOS nor the IKDC scores seemed correlated to the anatomical outcomes. Thus, poorer values of these parameters did not always coincide with meniscal extrusion or severe cartilage lesions.

Our findings are consistent with the literature. In a meta-analysis of meniscal allograft outcomes, De Bruycker et al. [14] found that the mean increases at last follow-up versus baseline were 24 points for the IKDC score and 23.1 points for the KOOS. Functional improvements have been reported consistently, regardless of follow-up duration, although the scores declined over time. In a study of meniscal substitutes, Leroy et al. [11] observed significant functional score improvements that remained stable over the 5-year follow-up. Outcomes may differ depending on whether the lateral or the medial meniscus is replaced [15]. A return to sports at a high level seems difficult, as the functional outcomes are then poorer. In contrast, the practice of low-impact sports such as swimming and cycling is easily achieved, with a 76% return-to-sports rate in a study by Noyes [16].

Verdonk et al. [5] reported a decline in the cartilage degradation rate as assessed by MRI and radiography in 41% to 52% of patients after meniscal allograft replacement. Zaffagnini [17] found better cartilage preservation after substitute replacement compared to partial meniscectomy. Three instances of meniscal extrusion were recorded, 2 laterally and 1 medially, in our population. Meniscal extrusion decreases the functional surface area and impairs the mechanical function of the allograft or substitute. Fixation techniques that rely solely on suturing were associated with higher

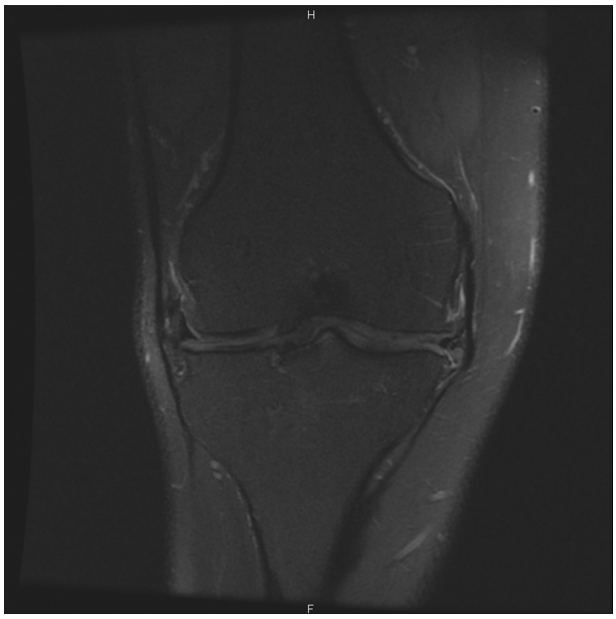

Fig. 2. MRI, coronal view showing no evidence of meniscal extrusion after 2 years (patient #5).

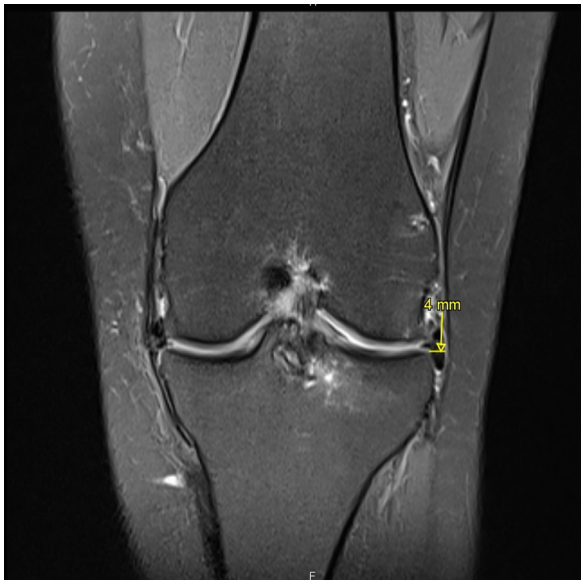

Fig. 3. MRI, coronal view showing lateral meniscal extrusion after 2 years (patient #1).

extrusion rates in several studies, although there was no correlation with the clinical outcomes [18,19]. Koh et al. [18] reported significantly greater extrusion at the lateral meniscus than at the medial meniscus (4.7 mm and 2.9 mm, respectively).

No failures were recorded in our study. Nevertheless, caution is required when interpreting this finding given the 3-year follow-up and small number of patients. Failure, defined as total or subtotal removal of the allograft and/or conversion to arthroplasty occurred in 12.2% of patients after a follow-up of over 12 years in one study [20]. In studies of meniscal substitutes with follow-up durations of 2 to 10 years, the rate of failure defined as partial or complete substitute removal ranged from 8% to 17.3% [11,20].

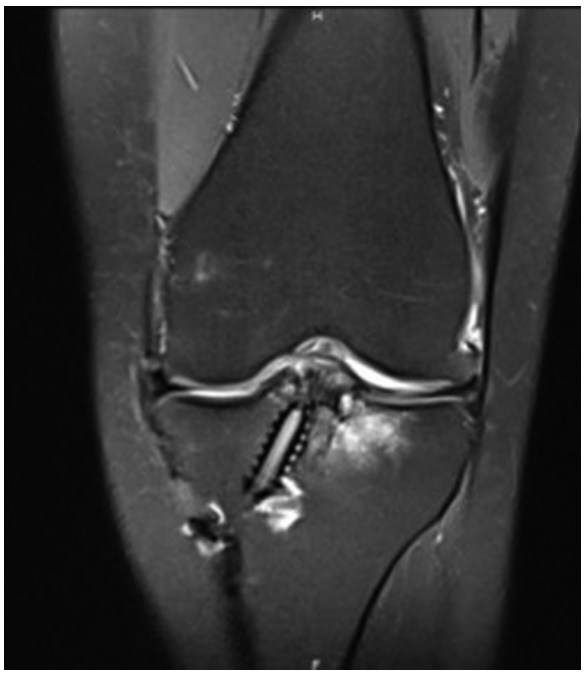

Fig. 4. MRI, sagittal view showing complete healing of both meniscal implants (patient #3).

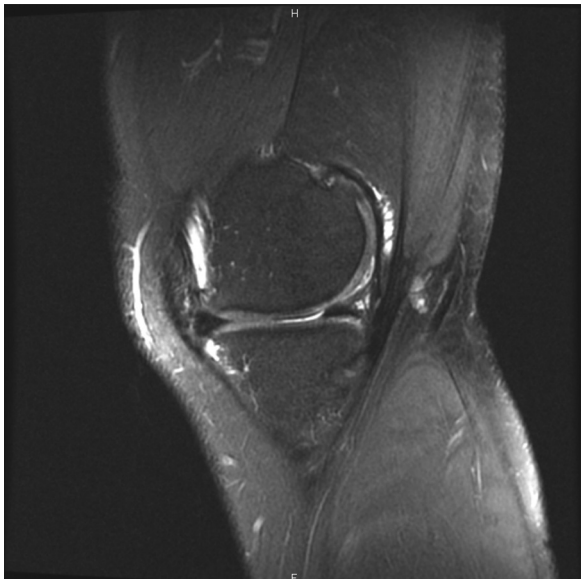

Fig. 5. MRI, sagittal view showing uniform healing of a meniscal substitute (patient #5).

Ours is the first cohort study of bimeniscal replacement [21]. McCormick found no differences in allograft replacement survival according to whether the medial, lateral, or both menisci were replaced, but they did not perform a specific analysis of their results [9,22]. In other studies [10,14,22], the cohorts included 2 to 6 patients with bimeniscal replacement, but no sub-group analyses were performed. There have been no reports of combined bimeniscal replacement (allograft on one side and substitute on the other).

The limitations of our study include the retrospective design. In addition, the number of patients is small, reflecting the low incidence of this pathology.

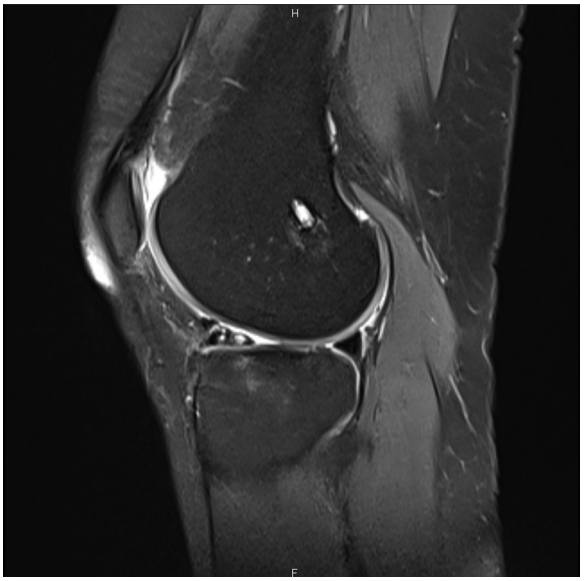

Fig. 6. MRI, sagittal view showing heterogeneous healing of a meniscal allograft (patient #5).

5. Conclusion

Arthroscopic bimeniscal replacement using allografts and/or meniscal scaffolds is feasible. However, this procedure is technically challenging and should be reserved for highly selected patients. It provides good short-term functional and anatomical outcomes in young patients who have post-bimeniscectomy pain without osteoarthritis. These outcomes seem similar to those of single meniscus replacement, for which the available data are more abundant. Slight degradation of the cartilage was noted, as well as cases of extrusion predominating on the lateral side, which did not correlate with the functional outcomes. Outcome data over longer follow-up durations are needed.

Disclosure of interest

N.P.: occasional educational consultant for Zimmer Biomet, Smith & Nephew, and Lima.

F.B. and C.T. declare that they have no competing interest.

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Contributions of each author

F.B. re-evaluated the patients and drafted the manuscript.

C.T. contributed to draft the manuscript.

N.P. coordinated the study and revised the manuscript for important intellectual content.

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