JOINTS 2023; 1: e728

Category: Original Article

MENISCAL ALLOGRAFT TRANSPLANTATION IN PATIENTS WITH DISCOID MENISCUS: A SYSTEMATIC REVIEW

A. PAGANO[1], M. ESPINOSA[2], G. DAL FABBRO[1], P. AGOSTINONE[1], G.A. LUCIDI[1], A. GRASSI[1,3], S. ZAFFAGNINI[1,3]

[1]2nd Orthopaedic and Traumatologic Clinic, IRCCS Istituto Ortopedico Rizzoli, Bologna, Italy
[2]Department of Traumatology, Clinical School of Medicine, University of Desarrollo, Santiago, Chile
[3]Department of Biomedical and Neuromotor Sciences, University of Bologna, Bologna, Italy

Corresponding Author
Anna Pagano, MD; e-mail: anna.pagano@ior.it

ABSTRACT – *Objective:* Meniscal allograft transplantation (MAT) has been proven to produce satisfactory clinical and functional results in the general population. However, it is unclear if the same results can be expected in patients with post-meniscectomy syndrome after discoid meniscus. The purpose of the present study was to perform a systematic review of clinical and radiological outcomes of MAT in patients with discoid meniscus.

Materials and Methods: A systematic literature review of the MEDLINE/PubMed, EMBASE, and Cochrane databases was performed to identify studies which assessed clinical and radiological outcomes in patients with discoid meniscus treated with MAT. Clinical outcomes evaluated were Lysholm, Tegner, and subjective IKDC scores. MRI-related outcomes were measures of allograft healing and extrusion >3 mm. PRISMA (Preferred Reporting for Systematic Reviews and Meta-Analyses) guidelines were followed with a PRISMA checklist.

Results: A total of 12 studies evaluating 116 knees were included in the systematic review. The mean follow-up was 52.8±51.7 months, and the mean clinical outcomes at this point were: Lysholm 83.2±9.8, Tegner activity scale 5.4±1.5, IKDC 78.2±7.2. Regarding the MRI-related outcomes, complete healing was reported in 21/39 knees and allograft extrusion >3 mm in two of 116 knees. Based on this systematic review of the literature, patients with discoid meniscus who underwent meniscal allograft transplantation demonstrated good clinical and radiological outcomes.

Conclusions: MAT is a valid option for the treatment of post-meniscectomy syndrome after total/subtotal meniscectomy in the setting of discoid meniscus.

KEYWORDS: Discoid meniscus, Meniscal allograft transplantation, Clinical outcomes, Meniscal allograft healing, Meniscal allograft extrusion.

INTRODUCTION

The discoid meniscus is a congenital anatomical variant characterized by an alteration in the shape (width and thickness), stability, and structure of the meniscus[1,2]. It usually occurs in the lateral meniscus, and its incidence is difficult to determine due to the large number of asymptomatic cases. In the USA, an incidence of 3-5% has been calculated; however, in Asian populations, it is described as up to 17%[3,4].

The discoid meniscus is susceptible to injuries even with low-energy mechanisms. In some cases, it is necessary to resect a large part of the meniscus, given the complexity and extension of the tears, leaving a meniscus that lacks a normal function[5]. It is known that the long-term results of a total or subtotal meniscectomy are poor since they are associated with early development of osteoarthritis of the knee. In children, substantial meniscal loss is of more concern than in adults because they need a functional knee for a longer lifespan, and early degenerative joint changes should be limited. Discoid meniscus, being a congenital condition, can lead to meniscectomy surgery at a younger age than patients without discoid meniscus, and thus can lead to early osteoarthritis. This is particularly relevant in the lateral compartment since it is more vulnerable to the meniscal deficit than the medial compartment[6,7].

Allogeneic meniscal transplants have been used in the last decades for the treatment of post-meniscectomy syndrome, with good functional results in the short and medium term[8-10]. However, most of the series reported in literature, in which the results are indistinctly achieved in patients with and without a history of discoid meniscus, are heterogeneous. Conversely, also due to the younger age of patients treated with total or subtotal meniscectomy for complex discoid meniscus tears, and to a different meniscal anatomy, the results in these patients could be impaired. For these reasons, it is relevant to know the clinical course of a patient who presented a total/subtotal meniscectomy due to a torn discoid meniscus and who underwent MAT.

There are two main fixation methods used to fix a MAT: suture-only fixation (soft tissue) and bone-plugs fixation. The first one consists of fixing a completely soft tissue graft only using sutures through the body and meniscal horns, while the meniscal roots are fixed using a transtibial suture technique. In the bone-plug technique, the graft is prepared with a bone plug attached to each root, securing a bone-to-bone fixation in the meniscal roots, the rest of the meniscus being fixed with sutures. Also, there is a keyhole technique, which is a subgroup of bone plugs: a 10-mm wide and high bone bridge is prepared from the anterior to the posterior root of the meniscus.

To date, the literature is scarce on reports evaluating MATs in the setting of discoid meniscus patients, especially in the long term; moreover, there is no systematic review that analyzes the functional and imaging results of MATs in the discoid meniscus population. Therefore, the purpose of the present study was to perform a systematic review of clinical and radiological outcomes of MATs in patients with discoid meniscus.

The hypothesis is that MAT is a valid option for the treatment of post-meniscectomy syndrome after total/subtotal meniscectomy in the setting of discoid meniscus.

MATERIALS AND METHODS

A literature review of the MEDLINE, EMBASE, and Cochrane databases was performed from the date of inception to June 2023 for studies that assessed clinical and MRI-related outcomes in patients with discoid meniscus who underwent MAT. Search terms used were “meniscal allograft transplantation” OR “meniscus transplantation” OR “meniscus allograft” OR “meniscal allograft” AND “discoid meniscus”. The study quality was assessed using the modified Coleman Methodology Score (mCMS) for all studies (Table 1). Inclusion criteria in this review were: studies that reported clinical or MRI-related outcomes of MAsT in the discoid meniscus, studies that reported clinical or MRI-related outcomes of MATs in young population in which patients with discoid meniscus could be analyzed separately, and clinical reports of any level of evidence. Exclusion criteria included: non-English language articles, nonhuman studies, review or surgical technique articles, editorials, and conference abstracts. Two authors (AG and ME) independently screened titles and abstracts of the searched articles and selected all relevant literature for a full-text review. We used a predefined data extraction electronic form as follows: first author, year of publication, study design, sample size (patients/knees), gender, medial or lateral discoid meniscus, mean age at the time of MAT, time between first surgery and MAT, allograft type and storage method mean follow up, values of Lysholm, Tegner activity scale and subjective IKDC scores, healing and extrusion assessed in MRI at final follow up. The outcomes were defined as follows: (1) Clinical outcomes at final follow-up: Lysholm, Tegner activity scale, and subjective IKDC scores and (2) MRI-related outcomes at final follow-up: allograft healing (percentage of MATs healed) and extrusion (percentage of MATs with extrusion >3 mm).

Due to the low level of evidence of the included studies and to the heterogenous data available, it was not possible to perform further quantitative analysis of the abstracted data.

Table 1. Description of articles included in the study, including data on number of cases, age at the time of MAT, surgical technique, associated procedures, sizing method, graft type, and mCMS (modified Coleman Methodology Score).

First Author	Level of Evidence	No. of MAT procedures	Age at MAT (years)	Surgical	Associated procedures	Sizing Method	Graft Type	mCMS
Bulgheroni[11]	V	1	33	ND	2, PLC reconstruction + opening-wedge valgus osteotomy	ND	ND	60
Chang[12]	IV	2	22	ND	No	X-ray	Cryopreserved	64
Kim[13]	IV	14	27.9	Keyhole	3, OAT for OCD	X-ray	2 cryopreserved, 12 fresh frozen	54
Kocher[14]	IV	2	11	Keyhole	1, chondroplasty	X-ray	ND	57
Lee[15]	V	1	15	Keyhole	1, drilling + autologous osteoperiostal graft for OCD	ND	ND	57
Smith[16]	V	1	14	ND	2, opening wedge valgus osteotomy, osteochondral allograft	ND	ND	28
Wang[17]	IV	3	23	Bone-plugs	No	X-ray	Fresh frozen	38
Yoon[18]	IV	16	35.8	Keyhole	6, microfractures	MRI	Fresh frozen	68
Zaffagnini[19]	V	1	15	Soft tissue	1, opening wedge valgus osteotomy	X-ray	Fresh frozen	48
Kimura[21]	IV	8	18.1	Soft Tissue	3, distal femoral osteotomy	X-ray	Fresh frozen	60
Wang[22]	III	8	26.9	Bone-plugs	1, ACL reconstruction	X-ray + MRI	Fresh frozen	60
Ren[23]	III	59	30.9	22 Bone bridge technique; 37 Modified bone plug technique	No	MRI	ND	65

ND: not determined.

RESULTS

The database search identified a total of 19 studies (Figure 1) whose abstracts were screened and selected according to predefined inclusion and exclusion criteria. After duplicates were removed, a total of 12 studies were included for the final analysis[11-19]. No studies in this review were randomized or controlled. Two studies were case series with 14 and 16 knees, respectively, a study reported outcomes for 3 knees, two studies for 2 knees, and 4 were singular case reports.

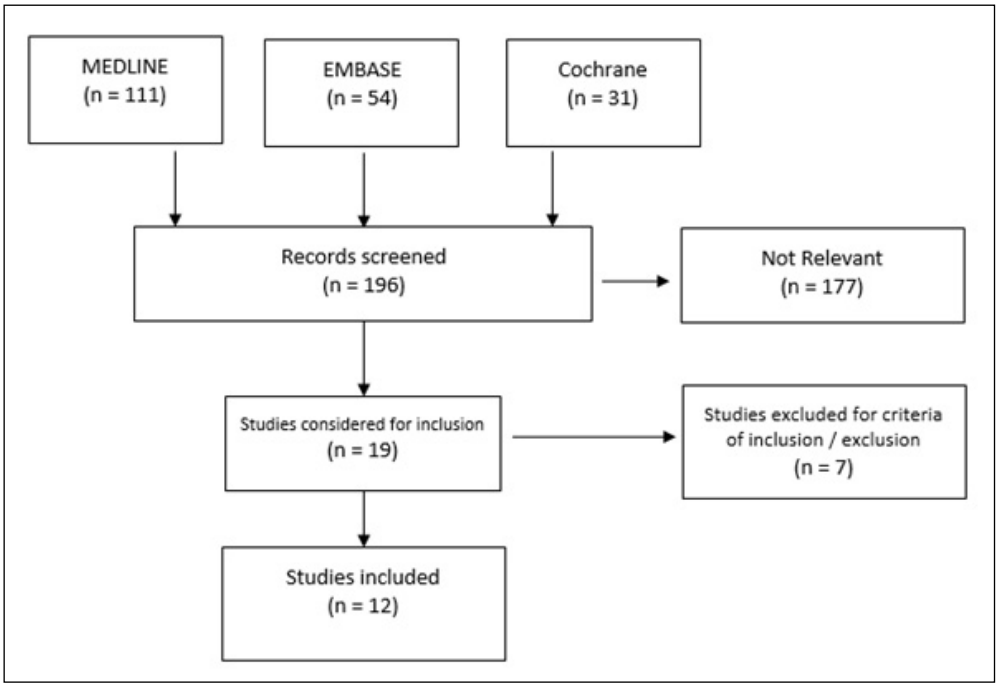

Figure 1. Flowchart of the inclusion process.

Demographic Data

A total of 116 MATs in 115 patients were included, with a mean final follow-up of 52.8±51.7 months (range 19-180, Table 1). Gender was reported in all cases, with 54 males (47%) and 61 females (53%). Lateral discoid meniscus was present in 113 of the 116 knees (97.4%), while medial discoid meniscus was only present in 3 knees (2.6%). The mean age at MAT was 22.7±8.2 years, while the mean time between the first meniscectomy and MAT was reported in 10 of the 12 studies and was 53.4±18.0 months (range 5.5-9.6 y). The associated procedures were reported in 9 of the 12 studies and were present in 21 of the 116 MATs (18.1%), including osteotomies (6 tot), cartilage procedures (4 osteochondral autograft techniques for osteochondritis dissecans, 1 osteochondral allograft, 6 microfractures, 1 chondroplasty), 2 posterolateral corner reconstructions, 1 anterior cruciate ligament reconstruction. Regarding the meniscal graft features, the size determination was reported in 113 of the 116 MATs (97.4%), in 38 cases were described by X-ray, and in 83 cases by MRI. The type of MAT was reported in 52 cases, being fresh frozen in 48 of the cases and cryopreserved in 4 patients. The selected technique was reported in 112/116 MATs: the keyhole procedure was used in 33 cases, the bone plug in 11 knees, the modified bone-plug technique in 37 cases, the bone bridge technique in 22 knees, and the trans-tibial tunnel for the posterior horn and soft tissue fixation for the remaining meniscus in two cases.

Clinical Outcomes

Regarding clinical outcomes, 6 of the 12 studies[12,13,18,20,21] reviewed (107 MATs) found a statistically significant difference between the outcomes analyzed in the pre-operative and final follow-up. Overall, 10 studies[12-15,17-22] (114 MATs) reported the Lysholm score, and at the final follow-up, the mean was 83.2±9.8 (range 62-97). 8 studies[12,14,15,17-22] (99 MATs) reported the Tegner activity scale being 5.4±1.5 (range 4-8)

at the final follow-up. Regarding subjective IKDC score, it was reported by 6 studies[12,15,18-20,22] (101 MATs); at the final follow-up, the mean subjective IKDC score was 78.2±7.2. In one study[14] that included 2 patients with discoid meniscus, it was reported the pedi-IKDC that was 70.5 (Table 2).

Table 2. Clinical and MRI outcomes described in the studies included in the systematic review.

First Author	Mean Follow-up (months)	Clinical and MRI outcomes at final follow-up				
		Lysholm	Tegner	IKDC	MRI complete healing (No)	Graft Extrusion > 3 mm (No)
Bulgheroni[11]	28	ND	ND	ND	ND	ND
Chang[12]	19	97*	4*	87.9*	ND	ND
Kim[13]	58.1	91.4*	ND	ND	14	0
Kocher[14]	24	62	7	ND	2	0
Lee[15]	24	85	8	75	1	0
Smith[16]	12	ND	ND	ND	ND	ND
Wang[17]	24	76.6	5	ND	3	0
Yoon[18]	37	78.8*	4.5*	70*	ND	2
Zaffagnini[19]	180	82.5	ND	72.5	1	0
Kimura[21]	62.4	92.8*	4*	ND	ND	ND
Wang[22]	133.2	84.5*	4.5*	85.5*	ND	ND
Ren[23]	31.3	81.1*	6*	78.2*	ND	ND

ND: not determined; *: significant statistical differences.

In a total of 114 MATs studied, there are 5 cases of re-operations (4.39%): 1 partial meniscectomy for MAT injury, 1 stem cell treatment, 1 total meniscectomy of meniscus graft for recurrent synovitis with chronic swelling and effusion, 1 arthrolysis, 2 repairs with suture. In addition, unspecified conservative treatment was performed in only one case.

MRI-related Outcomes

Of the 12 studies, 5 of them[13-15,17,19] (including 21 MATs, 18.4%) reported the healing of the graft in MRI at final follow-up which was complete in all cases. Regarding to extrusion, it was reported in others 6 studies[13-15,17-19] (including 37 MATs, 32.5%) and only 2 patients (1.8%) presented a graft extrusion bigger than 3 mm.

DISCUSSION

The main finding of this systematic review was that MAT is a safe and successful procedure to treat patients with meniscal deficiency due to discoid meniscus, presenting good clinical and MRI-related outcomes.

In the past decades, the treatment of discoid meniscus consisted of total or subtotal meniscectomy, but degenerative changes have developed with time[23-25]. Räber et al[26] reviewed 17 total meniscectomies in 14 patients with discoid meniscus. At a mean of 19.8 years (range, 12.5-26.0 years), 10 of 17 knees had clinical and radiological signs of osteoarthritis. Currently, the treatment of choice is arthroscopic saucerization with preservation of the meniscal rim. A recent systematic review[27] that included 422 discoid lateral menisci treated surgically reported good clinical results and a low rate of moderate/advanced degenerative changes with long-term follow-up. However, Kim et al[28], in the largest series on discoid meniscus, showed a statistical difference in the radiological changes over 5 years of follow-up between patients treated with total and partial meniscectomies. For this reason, patients who previously have

undergone total or subtotal meniscectomy for discoid meniscus may be candidates for MAT. The indications of MATs in this population are, in fact, the same as in the general population, that is, patients with meniscal deficit secondary to total or subtotal meniscectomies, and that present pain in the affected compartment of the knee without signs of advanced joint degeneration. The role of prophylactic MAT in the acute setting of discoid meniscus lesions is still debated, and no strong evidence is available on MAT chondroprotection. Therefore, considering the possible morbidity of MAT, especially in young patients with open physis, MAT should be reserved for symptomatic patients after meniscal removal.

During the preoperative study and planning, it is important to know the skeletal maturity of these patients, since the surgical technique of the MAT must respect the physis, if it is still open[14]. On the other hand, it is important to recognize and treat other factors that may be present in these patients, such as instability, the state of the cartilage, and the axis of the lower extremities.

A relevant point when performing a MAT is the size match of the graft. Although different methods have been described to measure the size of the graft, there is no method that is clearly superior to the others. Pollard et al[29] described the size measurement in the AP and lateral X-ray and is one of the most used. Approximately in half of the cases reviewed[11,15,16,19-22] in this work, the measurement was done by X-ray and in the other half by MRI.

In a recent cadaveric study by Rohde et al[30], the authors described the typical meniscal widths along the rim, indicating that all axial widths increase with age, and medial and lateral menisci varied at linearly proportional rates. Therefore, age and stage of development are important considerations for surgeons in selecting appropriate MAT in pediatric patients with discoid menisci.

Despite the lack of high-quality evidence, MAT can be considered as a chondroprotective procedure in young people with meniscal deficiency[31,32]. At short and intermediate follow-up, clinical results are demonstrated[33] to be good to excellent in terms of pain and function levels. In fact, in a recent pilot randomized controlled trial[34], the authors demonstrated that MATs provided superior patient-reported outcomes than personalized physiotherapy. Smith et al[33], in a systematic review evaluating clinical outcomes of 1,374 MATs in the general population, showed an average Lysholm score of 81.3 points, a subjective IKDC of 70 points, and Tegner activity score of 4.7 points at a mean final follow-up of 5.1 years. However, it is not clear if MATs have the same results in patients with a history of discoid meniscus. In this regard, Yoon et al[18] reviewed retrospectively a series of 36 patients who underwent MATs with a previous meniscectomy, comparing the clinical results of 16 with discoid meniscus *vs.* 20 with nondiscoid meniscus. They did not report significant differences in the Lysholm, VAS, and subjective IKDC scales; they only observed a small decrease in the postoperative range of motion in patients with discoid meniscus (132.8±15.7 *vs.* 140.0±6.6, $p<.05$). Similarly, no differences in terms of extrusion at the MRI evaluation were observed between groups.

With the available data obtained from this review, the clinical outcomes of patients who underwent MAT in the setting of the discoid meniscus can be considered similar to the reported series of MAT in the general population. The pooled clinical outcomes obtained in the present systematic review (Lysholm 83.2±9.8, subjective IKDC 78.2±7.2, Tegner activity 5.4±1.5), are comparable to those reported by Smith et al[33] for general population (Lysholm 81.3, subjective IKDC 70, Tegner 4.7). Only a slight difference can be noted in the Tegner score, with higher values in patients with discoid meniscus. However, this finding could be influenced by the younger age of patients with discoid meniscus, which are, therefore, more likely to be involved in sports activities. In fact, the average age at surgery of MATs performed in the general population has been reported[35] to be 33.7 years, with a range between 19.8 and 48 years, while the mean age at surgery of MAT for discoid meniscus reported in this systematic review was 22.7±8.2 years, ranging between 11 and 35.8 years.

Limitations

The present study had several limitations, which were mostly inherent to the systematic review study design and the quality of the data of the included studies. The inclusion of studies with lower levels of evidence with respect to the RCT reduced the global level of evidence of the systematic review; however, we wanted to have the most comprehensive view on this specific topic, and we believe that this compromise was necessary. The modified Coleman methodology score highlighted shortcomings in the quality of the studies, especially regarding the type of study, sample size, and description of postoperative rehabilitation. Moreover, the heterogeneity in patient characteristics and surgical technique did not allow a sophisticated statistical analysis. In addition, a second look and a pre- or postoperative MRI check were not performed in all studies. Finally, the relatively short follow-up in some of the included studies leaves concerns regarding the effectiveness of the MATs.

CONCLUSIONS

This systematic review showed that MAT is an effective and safe procedure to treat patients with pain and functional limitation after total or subtotal meniscectomy for a torn discoid meniscus. Good clinical and MRI-related outcomes can be expected at short and intermediate follow-up.

Conflict of Interest:
Nothing to declare.

Funding:
None.

ORCID ID:
Anna Pagano: 0009-0001-3402-7530
Maximiliano Espinosa: 0000-0003-3155-4009
Giacomo Dal Fabbro: 0000-0002-8258-6425
Piero Agostinone: 0000-0002-5024-6944
Gian Andrea Lucidi: 0000-0003-3065-9212
Alberto Grassi: 0000-0003-4236-1798
Stefano Zaffagnini: 0000-0002-2941-1407

Data Availability:
Data are available from the corresponding author.

Ethics Approval:
Not applicable.

Informed Consent:
Not applicable.

REFERENCES

1. Clark CR, Ogden JA. Development of the menisci of the human knee joint. Morphological changes and their potential role in childhood meniscal injury. J Bone Joint Surg Am 1983; 65: 538-547.
2. Kocher MS, Logan CA, Kramer DE. Discoid Lateral Meniscus in Children: Diagnosis, Management, and Outcomes. J Am Acad Orthop Surg 2017; 25: 736-743.
3. Ikeuchi H. Arthroscopic treatment of the discoid lateral meniscus. Technique and long-term results. Clin Orthop Relat Res 1982; 167: 19-28.
4. Kim JG, Han SW, Lee DH. Diagnosis and Treatment of Discoid Meniscus. Knee Surg Relat Res 2016; 28: 255-262.
5. Bin SI, Kim JC, Kim JM, Park SS, Han YK. Correlation between type of discoid lateral menisci and tear pattern. Knee Surg Sports Traumatol Arthrosc 2002; 10: 218-222.
6. Baratz ME, Fu FH, Mengato R. Meniscal tears: the effect of meniscectomy and of repair on intraarticular contact areas and stress in the human knee. A preliminary report. Am J Sports Med 1986; 14: 270-275.
7. McDermott ID, Lie DTT, Edwards A, Bull AMJ, Amis AA. The effects of lateral meniscal allograft transplantation techniques on tibio-femoral contact pressures. Knee Surg Sports Traumatol Arthrosc 2008; 16: 553-560.
8. McCormick F, Harris JD, Abrams GD, Hussey KE, Wilson H, Frank R, Gupta AK, Bach BR, Cole BJ. Survival and reoperation rates after meniscal allograft transplantation: analysis of failures for 172 consecutive transplants at a minimum 2-year follow-up. Am J Sports Med 2014; 42: 892-897.
9. Verdonk PCM, Verstraete KL, Almqvist KF, De Cuyper K, Veys EM, Verbruggen G, Verdonk R. Meniscal allograft transplantation: long-term clinical results with radiological and magnetic resonance imaging correlations. Knee Surg Sports Traumatol Arthrosc 2006; 14: 694-706.
10. Zaffagnini S, Grassi A, Marcheggiani Muccioli GM, Benzi A, Serra M, Rotini M, Bragonzoni L, Marcacci M. Survivorship and clinical outcomes of 147 consecutive isolated or combined arthroscopic bone plug free meniscal allograft transplantation. Knee Surg Sports Traumatol Arthrosc 2016; 24: 1432-1439.
11. Bulgheroni E, Bulgheroni P. Posterolateral rotatory instability of the knee after arthroscopic subtotal lateral meniscectomy: a case report. Joints 2014; 2: 93-96.
12. Chang HC, Teh KL, Leong KL, Mak SL, Karim SA. Clinical evaluation of arthroscopic-assisted allograft meniscal transplantation. Ann Acad Med Singap 2008; 37: 266-272.
13. Kim JM, Bin SI. Meniscal allograft transplantation after total meniscectomy of torn discoid lateral meniscus. Arthroscopy 2006; 22: 1344-1350.
14. Kocher MS, Tepolt FA, Vavken P. Meniscus transplantation in skeletally immature patients. J Pediatr Orthop B 2016; 25: 343-348.

15. Lee DW, Kim JG, Ha JK, Kim WJ. Simultaneous Osteoperiosteal Autologous Iliac Crest Graft and Lateral Meniscus Allograft Transplantation for Osteochondral Lesion with Bony Defect and Lateral Discoid Meniscus Tear. Knee Surg Relat Res 2016; 28: 165-171.
16. Lee YS, Teo SH, Ahn JH, Lee OS, Lee SH, Lee JH. Systematic Review of the Long-term Surgical Outcomes of Discoid Lateral Meniscus. Arthroscopy 2017; 33: 1884-1895.
17. Wang SI. Meniscal allograft transplantation for symptomatic knee after meniscectomy of torn discoid medial meniscus: Report of three cases. Acta Orthop Traumatol Turc 2018; 52: 70-74.
18. Yoon KH, Lee SH, Park SY, Jung GY, Chung KY. Meniscus allograft transplantation for discoid lateral meniscus: clinical comparison between discoid lateral meniscus and nondiscoid lateral meniscus. Arthroscopy 2014; 30: 724-730.
19. Zaffagnini S, Espinosa M, Neri MP, Marcacci M, Grassi A. Treatment of meniscal deficiency with meniscal allograft transplantation and femoral osteotomy in a patient with history of lateral discoid meniscus. 15-year Follow-up Case Report. JBJS Case Connect 2020; 10: 0079.
20. Ren S, Zhou R, Zhang X, Bai L, Jiang C, Ren Y, You T, Zhang W. Anatomical knee variables result in worse outcomes of lateral meniscal allograft transplantation with discoid lateral menisci than with nondiscoid lateral menisci. Knee Surg Sports Traumatol Arthrosc 2021; 29: 4146-4153.
21. Kimura Y, Yamamoto Y, Sasaki S, Sasaki E, Sasaki T, Tsuda E, Ishibashi Y. Meniscus Allograft Transplantation Obtained From Adult Patients Undergoing Total Knee Arthroplasty May be Used for Younger Patients After Lateral Discoid Meniscus Meniscectomy. Arthrosc Sports Med Rehabil 2021; 3: 1679-1685.
22. Wang DY, Meng XY, Gong X, Yu JK, Jiang D. Meniscal allograft transplantation in discoid meniscus patients achieves good clinical outcomes and superior chondroprotection compared to meniscectomy in the long term. Knee Surg Sports Traumatol Arthrosc 2022; 31: 2877-2887.
23. Hashimoto Y, Nishino K, Yamasaki S, Nishida Y, Tomihara T, Nakamura H. Posterior subtotal meniscectomy revealed the worst scenario for the progression of osteocartilaginous damage in cases of juvenile discoid lateral meniscus with peripheral tear. Arch Orthop Trauma 2023; 143: 5157-5165.
24. Haskel JD, Uppstrom TJ, Dare DM, Rodeo SA, Green DW. Decline in clinical scores at long-term follow-up of arthroscopically treated discoid lateral meniscus in children. Knee Surg Sports Traumatol Arthrosc 2018; 26: 2906-2911.
25. Manzione M, Pizzutillo PD, Peoples AB, Schweizer PA. Meniscectomy in children: a long-term follow-up study. Am J Sports Med 1983; 11: 111-115.
26. Räber DA, Friederich NF, Hefti F. Discoid lateral meniscus in children. Long-term follow-up after total meniscectomy. J Bone Joint Surg Am 1998; 80: 1579-1586.
27. Smith RA, Vandenberg CD, Pace JL. Management of Long-Term Complications in the Setting of Lateral Meniscal Deficiency After Saucerization of a Discoid Lateral Meniscus in an Adolescent Patient: A Case Report and Review of the Literature. JBJS Case Connect 2018; 8: 102.
28. Kim SJ, Chun YM, Jeong JH, Ryu SW, Oh KS, Lubis AMT. Effects of arthroscopic meniscectomy on the long-term prognosis for the discoid lateral meniscus. Knee Surg Sports Traumatol Arthrosc 2007; 15: 1315-1320.
29. Pollard ME, Kang Q, Berg EE. Radiographic sizing for meniscal transplantation. Arthroscopy 1995; 11: 684-687.
30. Rohde MS, Trivedi S, Randhawa S, Wright CE, Vuong BB, Pham N, Stavinoha T, Ellis HB, Ganley TJ, Green DW, Fabricant PD, Tompkins M, Shea KG. Pediatric meniscus morphology varies with age: a cadaveric study. Knee Surg Sports Traumatol Arthrosc 2023; 31: 4179-4186.
31. Smith NA, Parkinson B, Hutchinson CE, Costa ML, Spalding T. Is meniscal allograft transplantation chondroprotective? A systematic review of radiological outcomes. Knee Surg Sports Traumatol Arthrosc 2016; 24: 2923-2935.
32. Verdonk R, Volpi P, Verdonk P, Van der Bracht H, Van Laer M, Almqvist KF, Vander Eecken S, Prospero E, Quaglia A. Indications and limits of meniscal allografts. Injury 2013; 44: 21-27.
33. Smith NA, MacKay N, Costa M, Spalding T. Meniscal allograft transplantation in a symptomatic meniscal deficient knee: a systematic review. Knee Surg Sports Traumatol Arthrosc 2015; 23: 270-279.
34. Smith NA, Parsons N, Wright D, Hutchinson C, Metcalfe A, Thompson P, Costa ML, Spalding T. A pilot randomized trial of meniscal allograft transplantation versus personalized physiotherapy for patients with a symptomatic meniscal deficient knee compartment. Bone Joint J 2018; 100: 56-63.
35. Myers P, Tudor F. Meniscal allograft transplantation: how should we be doing it? A systematic review. Arthroscopy 2005; 31: 911-925.