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Conversion to knee arthroplasty is more common after meniscectomy than meniscus repair in patients older than age 40

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Abstract

Purpose: To describe rates of conversion to unicompartmental or total knee arthroplasty (KA) in patients over the age of 40 years (at initial surgery) after partial meniscectomy (ME) or meniscal repair (MR).

Methods: Patients over the age of 40 undergoing isolated ME or MR between 2016 and 2018 were extracted from a single healthcare provider database. Data on patient characteristics, type of initial surgery, number of returns to the operating room, as well as performed procedures, including conversion to KA, were recorded. Comparative group statistics as well as a Kaplan–Meier survival rate analysis were performed.

Results: A total of 3638 patients (47.8% female) were included, with 3520 (96.8%) undergoing ME and 118 (3.2%) MR. Overall, 378 (10.4%) patients returned to the OR at an average of 22.7 ± 17.3 months postoperatively. Conversion to KA was performed more frequently in patients after primary ME ($n = 270$, 7.7%) compared to those with MR (2.5%, $n = 3$, odds ratio [OR]: 3.2, $p = 0.03$). Compared to ME (2.3%, $n = 82$), two times as many patients undergoing MR returned for subsequent meniscus surgery (MR: 5.9%, $n = 7$, OR: 2.6, $p = 0.02$). Time from primary surgery to KA (ME: 22 ± 17 months, MR: 25 ± 15 months, $p = 0.96$) did not differ between the treatment groups. Survivorship was 95% for ME and 98.2% for MR after 24 months ($p = 0.76$) and 92.5% and 98.2% after 60 months ($p = 0.07$), respectively.

Conclusion: The overall reoperation rate after meniscal surgery was 10.4% in patients over the age of 40 years. Patients treated with primary ME have over three times higher odds to undergo subsequent KA compared to those treated with MR. However, patients with primary MR have a higher rate of subsequent meniscus surgery compared to those undergoing primary ME. This information is important when considering and treating a patient over the age of 40 and meniscal injury.

Abbreviations: BMI, body mass index; CPT, current procedural terminology; KA, knee arthroplasty; ME, meniscectomy; MR, meniscal repair; MRI, magnetic resonance imaging; TKA, total knee arthroplasty.

Level of Evidence: Level III study.

KEYWORDS
knee arthroplasty, meniscal repair, meniscectomy, meniscus, total knee joint

INTRODUCTION

The meniscus plays a major role in providing load transfer and stability to the knee joint, yet is frequently injured [18]. Total meniscectomy (ME) results in a 75% increase in tibiofemoral contact pressures and influences anteroposterior and rotatory stability of the knee, thereby accelerating the progression of osteoarthritis [28, 32]. Preserving the meniscus is therefore recommended whenever possible in the treatment of meniscal injury [3, 20, 32]. Non-operative management is the first line in the treatment of degenerative meniscal tears in patients older than 40 years, while surgical treatment is reserved for cases in which satisfactory results cannot be obtained nonoperatively [10, 14]. When surgery is performed, there remains debate regarding the superiority of meniscus repair (MR) versus ME, as satisfactory functional results and low failure rates have also been reported following MR in older patients [7, 8, 11, 17, 21, 23]. Advanced age is no longer considered a contraindication to meniscus repair; the decision of whether to repair or resect the meniscus is rather based on the patient's activity level and biological age, as well as the tissue quality of the meniscus [2, 7, 8, 26].

The aim of the present study was to retrospectively compare mid-term conversion rates to unicompartmental or total knee arthroplasty (KA) in patients older than 40 years following primary arthroscopic MR or ME. It was hypothesized that conversion to KA would be more common, and occur in a shorter time frame, in patients who underwent ME compared to MR.

MATERIALS AND METHODS

This retrospective study was granted Institutional Review Board approval at the University of Pittsburgh (No: STUDY19030196). All patients undergoing meniscus surgery between 1 January 2016 and 31 December 2018 at a single large healthcare system (University of Pittsburgh Medical Center Healthcare) were identified in a database and analysed for inclusion. Exclusion criteria included a follow-up of less than 5 years, age younger than 40 years old and any additional ligamentous, osseous, or cartilage procedures (Figure 1).

Patients registered in the database were divided based on Current Procedural Terminology (CPT) codes into two groups: ME ('CPT-29880' and 'CPT-29881') and meniscus repair ('CPT-29882' and 'CPT-29883'). Data regarding patient age, sex, body mass index (BMI), race, and surgical history were recorded. In addition, CPT codes were used to collect information regarding date, type and number of returns to the operating room (OR), including those for conversion to KA. The primary endpoint was ipsilateral knee arthroplasty (CPT—27440–27447), including total knee arthroplasty (TKA), as well as medial or lateral unicompartmental knee arthroplasty.

Statistical analysis

Statistical analysis was performed using Microsoft Excel (Microsoft Version 16.69) and SPSS Statistics (IBM 28.0). Normal distribution was determined using the Kolmogorov–Smirnov test. Independent-sample *t* tests (continuous variables and normally distributed) or Mann–Whitney *U* tests (ordinal or non-normally distributed data) were used to determine group differences. Chi-square tests were performed to compare dichotomous variables. Additionally, a Kaplan–Meier survival analysis was performed. Survivorship was defined as not having undergone KA at the final follow-up. odds ratios (ORs) and 95% confidence intervals (95% CI) were calculated for significant results. Statistical significance was set to $p < 0.05$ (two-sided).

RESULTS

Between 2016 and 2018, a total of 3638 patients older than 40 years of age were treated for isolated meniscal injuries by 164 different surgeons in 17 different hospitals. Of these, 3520 ME and 118 MR were performed (Figure 1). The average follow-up (=surgical intervention until extraction of database) was 64.4 ± 6.3 months. Patients with ME were on average 2.3 years older and had a 1 month longer follow-up. In case of meniscal repair (MR), 44% ($n = 52$) a root repair were performed, 4.2% (4.2) bucket handle repair, 5.9% ($n = 5$) repair of longitudinal tear and 3.4% ($n = 4$) and 1.4% ($n = 2$) radial- and horizontal tear, respectively. In 40.8% ($n = 48$), the exact type of repair could not be determined based on the operation report. Detailed patient characteristics are displayed in Table 1.

Return to the OR

Overall, 378 (10.4%) patients returned to the OR, of which 58 (1.6%) returned two or more times (Figure 1).

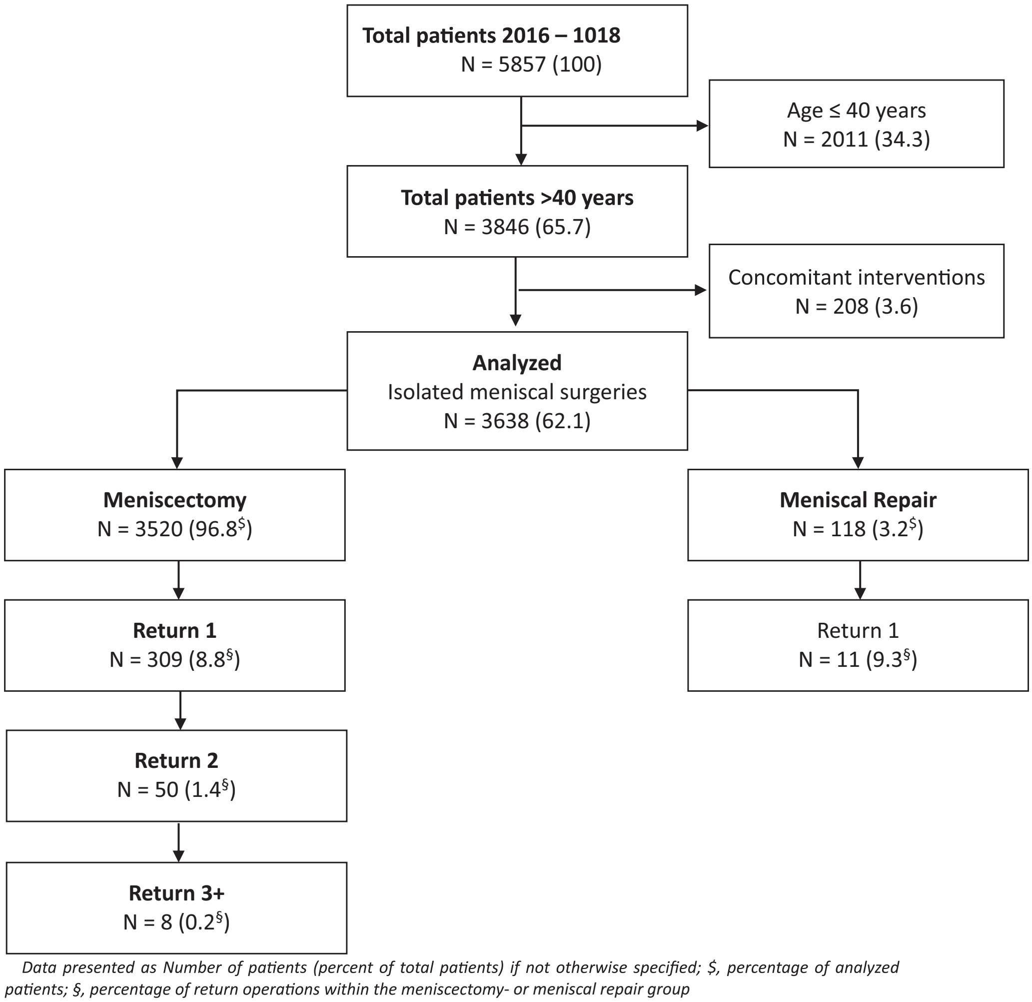

FIGURE 1 Flow chart showing patient inclusion and exclusion. Data presented as Number of patients (per cent of total patients) if not otherwise specified; $, percentage of analysed patients; §, percentage of return operations within the meniscectomy- or meniscal repair group.

The average time from primary surgery to return surgery was 22.7 ± 17.3 months. There were no statistically significant differences in time from primary surgery to return operation between ME (22.6 ± 17.2 months) and MR (23.7 ± 18.6 months, $p = 0.96$) groups. Of patients undergoing primary MR, two times as many returned for subsequent meniscus surgery (5.9%, $n = 7$) compared to those undergoing primary ME (2.3%, $n = 83$, $p = 0.02$, OR: 2.6, 95% CI: 1.2–5.8).

Conversion to knee arthroplasty

Out of all patients, a total of 273 (7.5%) underwent subsequent KA. In those patients undergoing primary ME, conversion to KA ($n = 270$, 7.7%) was significantly higher compared to those undergoing primary MR ($n = 3$, 2.5%, OR: 3.2, 95% CI: 1.0–10.1, $p = 0.03$). None of the primary MR patients required KA at their second return procedure compared to seven (2.3%) of the primary ME patients. Time from primary surgery to KA (ME: 22 ± 17 months, MR: 25 ± 15 months, $p = 0.95$) did not differ between both treatment groups. No statistically significant difference in the number of any other return operations was observed between both

TABLE 1 Patient characteristics.

	Total patients ($n = 3638$)	Meniscectomy ($n = 3520$)	Meniscal repair ($n = 118$)	p
Gender (female[a])	1739 (47.8)	1664 (47.3)	75 (63.6)	0.001
Age (years)	57.2 ± 9.0	57.2 ± 9.0	54.9 ± 7.9	0.001
BMI	31.5 ± 6.4	31.6 ± 6.4	30.6 ± 5.5	0.29
Bilateral	48 (1.3)	44 (1.3)	4 (3.4)	0.06
Average follow-up (month)	64.4 ± 6.3	64.4 ± 6.3	63.1 ± 11.0	0.001

Abbreviation: BMI, body mass index.
[a]Data presented as number (percent of totally included patients per group).

TABLE 2 Number and type of return interventions.[a]

	Return 1			Return 2+			Total				
	ME (*n* = 3520)	MR (*n* = 118)	*p*	ME (*n* = 3520)	MR (*n* = 118)	*p*	ME (*n* = 3520)	MR (*n* = 118)	*p*	OR	95% CI
Knee arthroplasty	241 (6.8)	3 (2.5)	0.08	29 (0.8)	0 (0)	1	270 (7.7)	3 (2.5)	**0.03**	3.2	1.0–10.1
Meniscectomy	74 (2.1)	7 (5.9)	**0.01**	8 (0.1)	0 (0)	1	82 (2.3)	7 (5.9)	**0.02**	2.6	1.2–5.8
Meniscus repair	4 (0.1)	0 (0)	1	1 (0)	0 (0)	1	5 (0.1)	0 (0)	1		
Cruciate ligaments	4 (0.1)	1 (0.8)	0.15	0 (0)	0 (0)	1	4 (0.1)	1 (0.8)	0.15		
Other procedures	10 (0.3)	0 (0)	1	3 (0.1)	0 (0)	1	21 (0.6)	0 (0)	1		
Total	309 (8.8)	11 (9.3)	0.86	58 (1.6)	0 (0)	1	367 (10.4)	11 (9.3)	0.88		

Note: $p = 0.05$; bolded *p* values represent statistically significant group differences.
Abbreviations: CI, confidence interval; ME, meniscectomy; MR, meniscal repair; NNT, number needed to treat; OR, odds ratio.
[a]Data presented as number (per cent of totally included patients per group).

groups (Table 2). Survivorship was 95% for ME and 98.2% for MR after 24 months ($p = 0.76$) and 92.5% and 98.2% after 60 months ($p = 0.07$), respectively.

Survivorship after 24 months of the primary meniscal intervention was 95% for ME and 98.6% for MR ($p = 0.76$). Survivorship dropped to 92.5% in the ME group and 97.2% in the MR group after 60 months ($p = 0.07$) (Figure 2).

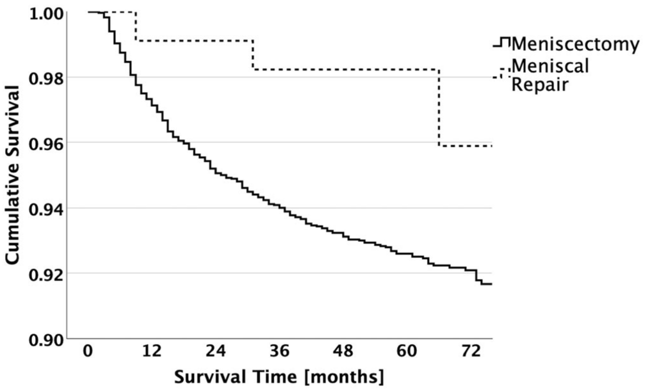

FIGURE 2 Kaplan–Meier survival analysis showing survivorship of 95% for ME and 98.6% for MR after 24 months, and 92.5% in the ME group and 97.2% in the MR group after 60 months.

Influence of age and BMI

Patients who returned to the OR after ME did not statistically differ in age (ME: 58.4 ± 8.5 years, MR: 55.0 ± 7.7 years, $p = 0.19$) and average BMI (ME: 31.8 ± 6.1, MR: 30.8 ± 5.3, $p = 0.59$) compared to those treated with MR. Age (ME: 60.9 ± 8.1 years, MR: 59.3 ± 6.4 years, $p = 0.51$) and BMI (ME: 32.2 ± 6.4, MR: 34.3 ± 2.5, $p = 0.28$) did not differ between MR and ME groups that were converted to KA.

In the primary ME group, patients who ultimately underwent KA were slightly older compared to those who did not undergo KA (60.9 ± 8.1 years vs. 57.0 ± 9.0, $p \le 0.001$, 95% CI: 2.87–4.93). There was no difference in BMI between both groups (KA: 32.2 ± 6.4, no KA: 31.5 ± 6.4, $p = 0.08$). In the primary MR group, patients undergoing KA did not differ in age (KA: 59.3 ± 6.4 years, no KA: 56.0 ± 8.5 years, $p = 0.03$) but had a significantly lower BMI (KA: 34.3 ± 2.5, no KA: 30.9 ± 5.4, $p = 0.0$, 95% CI: 0.79–6.00) compared to those not undergoing KA.

DISCUSSION

The main finding of the present study was that patients over age 40 were 3.2 times more likely to undergo knee arthroplasty after primary ME versus meniscus repair. In contrast, patients with primary MR had a higher rate of subsequent meniscus surgery compared to those undergoing primary ME (5.9% vs. 2.3%).

Although ME was historically the most commonly performed surgery for symptomatic meniscal injuries regardless of tear type and patient age, advanced knowledge of the function and importance of the meniscus has led to a shift from ME towards MR in both traumatic and degenerative cases [4, 6, 12, 13]. Today, MR is encouraged whenever possible both in younger and older patients, as long-term outcomes and rates of osteoarthritis progression favour MR over ME [2, 4, 10, 11, 15, 22, 25, 30]. While many of the studies comparing ME and MR include young patients, similar postoperative results with comparable failure rates are obtained in patients aged 40 years and older [7, 8, 11, 29, 33]. Concern has been noted for meniscal reinjury after MR in older patients, yet current evidence does not confirm whether failure rates are higher, lower, or similar to younger patients [8]. A recent systematic review analysing outcomes after MR in patients aged 40 and older revealed a failure rate of 10% overall, ranging from 0% to 23% [8]. Furthermore, a comparative analysis including 339 patients over and under the age of 40 reported no significant difference in terms of failure (5.5% vs. 5.3%) [29].

When comparing ME to MR, a large cross-sectional cohort study including over 1.3 million patients reported that patients who initially underwent ME were less likely to undergo revision meniscal surgery (5.1% vs. 10.6%) but had a higher conversion to arthroplasty (4.7% vs. 1.2%) [6]. The observed 10% revision rate after MR, excluding arthroplasty, is in line with previous studies [16, 19, 27], with younger and more active patients having higher reoperation rates compared to those who are older [6]. In the present study, the overall reoperation rate after meniscal surgery (10.4%) is comparable to previous literature. Patients undergoing initial MR had two times the rate of subsequent meniscus interventions (5.9% vs. 2.3%), but a significantly lower rate of conversion to KA (7.7% vs. 2.5%).

Rates of conversion to TKA following MR and ME vary throughout the literature and are influenced by patient age and length of follow-up. For MR, a 1.2% conversion rate to TKA among all age groups at 2-year follow-up has been recently reported [6]. When including only patients older than 50, this incidence of conversion to TKA rises to 10.1% at 1 year, 13.7% at 2 years, and 15.6% at 3 years [5]. At long-term follow-up following MR, a conversion rate to TKA of 6.6% among patients older than 40 years has been reported [29].

A comparative study reported a significantly higher conversion rate to TKA within 2 years for ME (4.7%) compared with MR (1.2%) [6]. For patients aged 50 and older, conversion rates to TKA following ME range between 4.5% and 21.5% [1, 5, 6, 9, 24, 31]. Like previous literature, the present results show a significantly higher conversion rate to KA after initial ME (7.7%) compared to MR (2.8%) at mid-term follow-up. These study results are in line with previous study results but have to be critically discussed in light of the study's limitations.

First and foremost, it is imperative to recognize that large database studies, such as this one, inherently have limitations pertaining to the limited information depth of patient details, including but not limited to the preoperative articular status of the patient, meniscal tissue quality and limp alignment. Potential coding errors are an additional well-known drawback of these studies and may affect the accuracy of the present results. Additionally, all interventions were performed by various surgeons using slightly different indications, techniques, instruments and postoperative rehabilitation protocols, which may limit the specific applicability of the present results. Large database studies also have advantages. Thanks to the large number of included patients and surgeons, a real-world healthcare scenario of a single healthcare network is represented. Additionally, from a statistical perspective, the extensive patient cohort diminishes the likelihood of selection bias. This large number and heterogeneity of patients may enhance the external validity of the present, thereby presenting a comprehensive reflection of the prevailing clinical landscape.

Based on the present data, it can be concluded that meniscus repair seems to be an adequate treatment option in patients over 40 years of age, provided that the current recommendations for meniscus suturing are followed. Rather than age, the indication of whether a meniscus injury is to be repaired or resected should be based on the overall articular status and the meniscal tissue quality, taking into account also limp alignment, previous surgeries and the patient's expectations. Irrespective of these multifactorial considerations, the main goal remains the preservation of the meniscus whenever clinically viable to avoid further knee degeneration and the need for knee reconstructive surgery.

CONCLUSION

Overall return to the OR after meniscal surgery was 10.4% in patients over the age of 40 years. Patients undergoing primary ME exhibit three times higher odds to undergo knee arthroplasty compared to those after MR. Conversely, those with MR have a high rate of subsequent meniscal surgery. The meniscus should be preserved whenever possible to avoid further knee degeneration and the need for knee reconstructive surgery. Patients can be informed that the risk of KA decreases after MR, but the chance of a follow-up arthroscopic procedure increases.

AUTHOR CONTRIBUTIONS

Armin Runer: Conception or design; data acquisition; data analysis; interpretation of data; drafting manuscript; final approval. **Anil Özbek**: Data acquisition; data analysis; drafting manuscript; critical manuscript revision; final approval. **Sahil Dadoo**: Data acquisition; data analysis; drafting manuscript; critical manuscript revision; final approval. **Laura Keeling**: Data acquisition; drafting manuscript; critical manuscript revision; final approval. **Camila Grandberg**: Data acquisition; data analysis; drafting manuscript, critical manuscript revision; final approval. **Ian Engler**: Conception or design; data analysis; interpretation of data; critical manuscript revision; final approval. **James J. Irrgang**: Conception or design; data acquisition; interpretation of data; critical manuscript revision; final approval. **Jonathan D. Hughes**: Conception or design; interpretation of data; critical manuscript revision; final approval. **Volker Musahl**: Conception or design; interpretation of data; critical manuscript revision; final approval.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data are available upon request from the corresponding author.

ETHICS STATEMENT

The study was granted Institutional Review Board approval at the University of Pittsburgh (No: STUDY19030196). All patients provide informed consent for data usage.

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REFERENCES

1. Barnds, B., Morris, B., Mullen, S., Schroeppel, J.P., Tarakemeh, A. & Vopat, B.G. (2019) Increased rates of knee arthroplasty and cost of patients with meniscal tears treated with arthroscopic partial meniscectomy versus non-operative management. *Knee Surgery, Sports Traumatology, Arthroscopy*, 27(7), 2316–2321. Available from: https://doi.org/10.1007/s00167-019-05481-8
2. Beaufils, P., Becker, R., Kopf, S., Englund, M., Verdonk, R., Ollivier, M. et al. (2017) Surgical management of degenerative meniscus lesions: the 2016 ESSKA meniscus consensus. *Knee Surgery, Sports Traumatology, Arthroscopy*, 25(2), 335–346. Available from: https://doi.org/10.1007/s00167-016-4407-4
3. Becker, R., Kopf, S., Seil, R., Hirschmann, M.T., Beaufils, P. & Karlsson, J. (2020) From meniscal resection to meniscal repair: a journey of the last decade. *Knee Surgery, Sports Traumatology, Arthroscopy*, 28(11), 3401–3404. Available from: https://doi.org/10.1007/s00167-020-06316-7
4. Billières, J., Pujol, N., & the U45 Committee of ESSKA. (2019) Meniscal repair associated with a partial meniscectomy for treating complex horizontal cleavage tears in young patients may lead to excellent long-term outcomes. *Knee Surgery, Sports Traumatology, Arthroscopy*, 27(2), 343–348. Available from: https://doi.org/10.1007/s00167-018-5219-5
5. Boyd, J.A. & Gradisar, I.M. (2016) Total knee arthroplasty after knee arthroscopy in patients older than 50 years. *Orthopedics*, 39(6), e1041–e1044. Available from: https://doi.org/10.3928/01477447-20160719-01
6. Bradley, K.E., Cevallos, N., Jansson, H.L., Lansdown, D.A., Pandya, N.K., Feeley, B.T. et al. (2022) Younger patients are more likely to undergo arthroscopic meniscal repair and revision meniscal surgery in a large cross-sectional cohort. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, 38(10), 2875–2883.e1. Available from: https://doi.org/10.1016/j.arthro.2022.04.020
7. Engler, I.D., Moradian, J.R., Pockros, B.M., Schirmeister, C.M., Richmond, J.C. & Salzler, M.J. (2021) Patient-reported outcomes of meniscal repair and meniscectomy in patients 40 years of age and older show similar good results. *Knee Surgery, Sports Traumatology, Arthroscopy*, 29(9), 2911–2917. Available from: https://doi.org/10.1007/s00167-020-06299-5
8. Everhart, J.S., Higgins, J.D., Poland, S.G., Abouljoud, M.M. & Flanigan, D.C. (2018) Meniscal repair in patients age 40 years and older: a systematic review of 11 studies and 148 patients. *Knee*, 25, 1142–1150. Available from: https://doi.org/10.1016/j.knee.2018.09.009
9. Harris, I.A., Madan, N.S., Naylor, J.M., Chong, S., Mittal, R. & Jalaludin, B.B. (2013) Trends in knee arthroscopy and subsequent arthroplasty in an Australian population: a retrospective cohort study. *BMC Musculoskeletal Disorders*, 14(1), 143. Available from: https://doi.org/10.1186/1471-2474-14-143
10. Hohmann, E., Angelo, R., Arciero, R., Bach, B.R., Cole, B., Cote, M. et al. (2020) Degenerative meniscus lesions: an expert consensus statement using the modified Delphi technique. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, 36(2), 501–512. Available from: https://doi.org/10.1016/j.arthro.2019.08.014
11. Husen, M., Kennedy, N.I., Till, S., Reinholz, A., Stuart, M.J., Krych, A.J. et al. (2022) Benefits of meniscal repair in selected patients aged 60 years and older. *Orthopaedic Journal of Sports Medicine*, 10(9), 232596712211174. Available from: https://doi.org/10.1177/23259671221117491
12. Jacquet, C., Pujol, N., Pauly, V., Beaufils, P. & Ollivier, M. (2019) Analysis of the trends in arthroscopic meniscectomy and meniscus repair procedures in France from 2005 to 2017. *Orthopaedics & Traumatology: Surgery & Research*, 105(4), 677–682. Available from: https://doi.org/10.1016/j.otsr.2019.01.024
13. Katano, H., Koga, H., Ozeki, N., Otabe, K., Mizuno, M., Tomita, M. et al. (2018) Trends in isolated meniscus repair and meniscectomy in Japan, 2011-2016. *Journal of Orthopaedic Science*, 23(4), 676–681. Available from: https://doi.org/10.1016/j.jos.2018.04.003
14. Lee, D.Y., Park, Y.J., Kim, H.J., Nam, D.C., Park, J.S., Song, S.Y. et al. (2018) Arthroscopic meniscal surgery versus conservative management in patients aged 40 years and older: a meta-analysis. *Archives of Orthopaedic and Trauma Surgery*, 138(12), 1731–1739. Available from: https://doi.org/10.1007/s00402-018-2991-0
15. Lee, W.Q., Gan, J.Z.W. & Lie, D.T.T. (2019) Save the meniscus—clinical outcomes of meniscectomy versus meniscal repair. *Journal of Orthopaedic Surgery*, 27(2), 230949901984981. Available from: https://doi.org/10.1177/2309499019849813
16. Lyman, S., Hidaka, C., Valdez, A.S., Hetsroni, I., Pan, T.J., Do, H. et al. (2013) Risk factors for meniscectomy after meniscal repair. *The American Journal of Sports Medicine*, 41(12), 2772–2778. Available from: https://doi.org/10.1177/0363546513503444
17. Matsusue, Y. & Thomson, N.L. (1996) Arthroscopic partial medial meniscectomy in patients over 40 years old: a 5- to 11-year follow-up study. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, 12(1), 39–44. Available from: https://doi.org/10.1016/S0749-8063(96)90217-0
18. Musahl, V., Citak, M., O'Loughlin, P.F., Choi, D., Bedi, A. & Pearle, A.D. (2010) The effect of medial versus lateral meniscectomy on the stability of the anterior cruciate ligament-deficient knee. *The American Journal of Sports Medicine*, 38(8), 1591–1597. Available from: https://doi.org/10.1177/0363546510364402
19. Nakayama, H., Kanto, R., Kambara, S., Kurosaka, K., Onishi, S., Yoshiya, S. et al. (2017) Clinical outcome of meniscus repair for isolated meniscus tear in athletes. *Asia-Pacific Journal of Sports Medicine, Arthroscopy, Rehabilitation and Technology*, 10, 4–7. Available from: https://doi.org/10.1016/j.asmart.2017.05.299
20. Nepple, J.J., Block, A.M., Eisenberg, M.T., Palumbo, N.E. & Wright, R.W. (2022) Meniscal repair outcomes at greater than 5 years: a systematic review and meta-analysis. *Journal of Bone and Joint Surgery*, 104(14), 1311–1320. Available from: https://doi.org/10.2106/JBJS.21.01303

21. Noyes, F.R. & Barber-Westin, S.D. (2000) Arthroscopic repair of meniscus tears extending into the avascular zone with or without anterior cruciate ligament reconstruction in patients 40 years of age and older. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, 16(8), 822–829. Available from: https://doi.org/10.1053/jars.2000.19434
22. Paxton, E.S., Stock, M.V. & Brophy, R.H. (2011) Meniscal repair versus partial meniscectomy: a systematic review comparing reoperation rates and clinical outcomes. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, 27(9), 1275–1288. Available from: https://doi.org/10.1016/j.arthro.2011.03.088
23. Poland, S., Everhart, J.S., Kim, W., Axcell, K., Magnussen, R.A. & Flanigan, D.C. (2019) Age of 40 years or older does not affect meniscal repair failure risk at 5 years. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, 35(5), 1527–1532. Available from: https://doi.org/10.1016/j.arthro.2018.11.061
24. Raaijmaakers, M., Vanlauwe, J., Vandenneucker, H., Dujardin, J. & Bellemans, J. (2010) Arthroscopy of the knee in elderly patients: cartilage lesions and their influence on short term outcome. A retrospective follow-up of 183 patients. *Acta Orthopaedica Belgica*, 76(1), 79–85.
25. Ro, K.H., Kim, J.H., Heo, J.W. & Lee, D.H. (2020) Clinical and radiological outcomes of meniscal repair versus partial meniscectomy for medial meniscus root tears: a systematic review and meta-analysis. *Orthopaedic Journal of Sports Medicine*, 8(11), 232596712096207. Available from: https://doi.org/10.1177/2325967120962078
26. Rothermel, S.D., Smuin, D. & Dhawan, A. (2018) Are outcomes after meniscal repair age dependent? A systematic review. *Arthroscopy*, 34, 979–987. Available from: https://doi.org/10.1016/j.arthro.2017.08.287
27. Shelbourne, K.D. & Carr, D.R. (2003) Meniscal repair compared with meniscectomy for bucket-handle medial meniscal tears in anterior cruciate ligament-reconstructed knees. *The American Journal of Sports Medicine*, 31(5), 718–723. Available from: https://doi.org/10.1177/03635465030310051401
28. Spang, J.T., Dang, A.B.C., Mazzocca, A., Rincon, L., Obopilwe, E., Beynnon, B. et al. (2010) The effect of medial meniscectomy and meniscal allograft transplantation on knee and anterior cruciate ligament biomechanics. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, 26(2), 192–201. Available from: https://doi.org/10.1016/j.arthro.2009.11.008
29. Steadman, J.R., Matheny, L.M., Singleton, S.B., Johnson, N.S., Rodkey, W.G., Crespo, B. et al. (2015) Meniscus suture repair: minimum 10-year outcomes in patients younger than 40 years compared with patients 40 and older. *The American Journal of Sports Medicine*, 43(9), 2222–2227. Available from: https://doi.org/10.1177/0363546515591260
30. Stein, T., Mehling, A.P., Welsch, F., von Eisenhart-Rothe, R. & Jäger, A. (2010) Long-term outcome after arthroscopic meniscal repair versus arthroscopic partial meniscectomy for traumatic meniscal tears. *The American Journal of Sports Medicine*, 38(8), 1542–1548. Available from: https://doi.org/10.1177/0363546510364052
31. Wai, E.K., Kreder, H.J. & Williams, J.I. (2002) Arthroscopic débridement of the knee for osteoarthritis in patients fifty years of age or older: utilization and outcomes in the Province of Ontario. *The Journal of Bone and Joint Surgery-American Volume*, 84(1), 17–22. Available from: https://doi.org/10.2106/00004623-200201000-00003
32. Woodmass, J.M., LaPrade, R.F., Sgaglione, N.A., Nakamura, N. & Krych, A.J. (2017) Meniscal repair: reconsidering indications, techniques, and biologic augmentation. *Journal of Bone and Joint Surgery*, 99(14), 1222–1231. Available from: https://doi.org/10.2106/JBJS.17.00297
33. Zhu, S., Li, X., Lu, Z., Koh, J.L., Wang, C., Wang, P. et al. (2023) Arthroscopic repair of degenerative medial meniscus tears in patients aged over 45 years resulted in favorable clinical outcomes and low clinical failure rates at a minimum 2-year follow-up. *Knee Surgery, Sports Traumatology, Arthroscopy*, 31(5), 1815–1823. Available from: https://doi.org/10.1007/s00167-022-07133-w

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