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Review article

Clinical and radiographic results of partial versus total meniscectomy in patients with symptomatic discoid lateral meniscus: A systematic review and meta-analysis

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ABSTRACT

Purpose: Some reports have noted favorable long-term clinical results with milder postoperative arthritic changes after total meniscectomy in symptomatic patients with torn discoid lateral meniscus (DLM). This meta-analysis was conducted to compare the clinical and radiographic results between partial and total meniscectomy in patients with symptomatic DLM.
Methods: Studies were included in the meta-analysis if (1) they analysed patients who underwent arthroscopic surgeries for DLMs, (2) they directly compared clinical outcomes in patients treated with partial and total meniscectomies, (3) they analysed at least one parameter related to postoperative outcomes, including the Ikeuchi scale, and/or radiographic results including the Tapper and Hoover classification.
Results: Eight studies were finally included. The proportion of the knees with excellent or good grade appeared to be higher in partial than in total meniscectomy group, but this difference did not reach statistical significance [128/158 (81.0%) vs. 87/131 (66.4%); OR 1.62; $p = 0.10$; $I^2 = 0\%$]. The pooled results of the proportion of normal cartilage status or mild chondral wear (grade 0 or 1 of the Tapper and Hoover classification) were significantly much higher with partial than with total meniscectomy [228/261 (87.4%) vs. 94/169 (55.6%); OR 9.08; $p < 0.001$; $I^2 = 57\%$].
Conclusion: This meta-analysis showed that the radiographic outcomes of DLM were better with partial meniscectomy with or without repair than with total meniscectomy, but their clinical outcomes were similar. The findings thus suggest that meniscal preservation would be a better option than total meniscectomy for symptomatic DLM.
Level of evidence: II, Systematic review and Meta-analysis.

1. Introduction

Discoid lateral meniscus (DLM) has a prevalence ranging from 0.4% to 4.6% in Caucasians and from 13.4 to 17.9% in Asians, occurring at a higher prevalence in Asian populations [1–5]. Although asymptomatic DLM does not require treatment, DLM is frequently associated with meniscal tears and related symptoms because these menisci are larger and thicker than the normal lateral menisci and have abnormalities of the meniscal tissues [6]. If tears in a DLM are not treated appropriately, then the remnant meniscus can develop more severe tears, and preservation may not be possible [7,8]. The traditional treatment for symptomatic DLM is total meniscectomy via arthroscopic methods [9,10]. As our understanding of meniscus function has improved, meniscus-preserving procedures such as partial meniscectomy are recommended in patients with torn DLMs. However meniscus-preserving procedures are challenging and not always possible because torn DLMs are associated with different tear patterns, delays in treatment, or neglected severe tears [5,11–13]. With the advent of improved arthroscopic techniques, recent studies favour meniscal reshaping through partial meniscectomy, with or without repair [14]. Nevertheless, some reports have still noted favorable long-term clinical results with milder postoperative arthritic changes after total meniscectomy in younger patients [15,16]. Thus, the optimal treatment in symptomatic patients with torn DLMs has not been determined. Furthermore, the relations between the type of

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surgery and clinical results or postoperative arthritic progression are currently unclear.

Recently, two systematic reviews have assessed surgical outcomes of DLM without conclusive results [17,18]. However, both studies did not directly compare patients undergoing partial meniscectomy with or without repair versus total meniscectomy by analysing statistical analyses for clinical and radiographic results. Therefore, the present meta-analysis was designed to compare the clinical and radiographic results in patients undergoing partial meniscectomy and total meniscectomy for symptomatic DLM. It was hypothesized that clinical and radiographic results for the partial meniscectomy with or without repair for DLM would be better than those for total meniscectomy.

2. Methods

2.1. Literature search

The study design was based on Cochrane Review Methods. In accordance with the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement (supplementary file PRISMA checklist Appendix A), many comprehensive literature databases, including MEDLINE, EMBASE, and the Cochrane Library, were searched for studies that evaluated clinical outcomes in patients who underwent partial or total meniscectomy for DLM tear. There were no restrictions on language or year of publication. Search terms used in the title, abstract, MeSH, and keywords fields were as follows: (lateral meniscus OR lateral menisci) AND (discoid meniscus OR discoid) AND (partial meniscectomy OR total meniscectomy).

This study does not contain any studies with human participants or animals performed by any of the authors.

Informed consent was obtained from all individual participants included in the study.

2.2. Study selection and data extraction

Two reviewers evaluated the titles and abstracts of the retrieved papers and selected relevant studies for full review. If the abstract did not provide sufficient data to make a decision, the entire article was reviewed. Studies were included in the meta-analysis if (1) they analysed patients who underwent in vivo arthroscopic surgeries for DLMs, (2) they directly compared clinical outcomes in patients treated with partial and total meniscectomies, (3) they analysed at least one parameter related to postoperative outcomes including the Ikeuchi scale and/or radiographic results including Tapper and Hoover (TH) classification, and (4) full reporting of parameters, including means and standard deviations and sample numbers. Two investigators independently extracted data from each study using a predefined data extraction form. A third investigator, if needed, reviewed any disagreements unresolved by discussion. The variables recorded were: (1) numbers of subjects with the Ikeuchi scale grades and Tapper and Hoover classification in each group and (2) sample size of each group, and if these variables were not mentioned in the articles, the authors of the study were contacted by email to request the data.

2.3. Assessment of methodological quality

The original Coleman methodology score uses 10 criteria to assess the methodology of a given study, with total scores between 0 and 100, and a score of 100 indicates that the study largely avoided important systemic sources of bias and other confounding factors. The quality of each included study was evaluated by two independent investigators using the modified Coleman methodology score (MCMS). Quality was also assessed using the "Strengthening the Reporting of Observational Studies in Epidemiology" (STROBE) checklist [19], which contains 22 numbered items with several multiple subitems. Differences in subsections were resolved by consensus or, if necessary, by a third senior investigator (Table 1).

2.4. Statistical Analysis

The main outcomes of the meta-analysis were the mean differences in the proportion of excellent or good grades in the Ikeuchi scale and grade ≤ 1 in TH classification between partial and total meniscectomies for DLM tears. Because the proportions of excellent or good grades in the Ikeuchi scale and grade ≤ 1 in TH classification were all binary outcomes, the results were reported as odds ratios (ORs) and 95% confidence intervals (CIs). Heterogeneity was determined by estimating the proportion of between-study inconsistencies due to actual differences between studies, rather than differences due to random error or chance, using the I^2 statistics, with values of 25%, 50%, and 75% considered low, moderate, and high heterogeneity, respectively. Analyses were performed using R statistical software version 3.4.0 (metafor package: a Meta-Analysis Package for R; R Foundation for Statistical Computing, Vienna, Austria) and RevMan version 5.2 (Copenhagen, the Nordic Cochrane Centre, The Cochrane Collaboration, 2012).

3. Results

3.1. Study identification, study characteristics, and methodological quality

An initial electronic search yielded 91 studies, and an additional two publications were identified through manual searches. After applying our inclusion and exclusion criteria, eight studies were included in this meta-analysis. Fig. 1 shows the details of the study identification, inclusion, and exclusion. The eight included studies evaluated 454 patients with DLM tears, with 211 and 243 undergoing partial and total meniscectomies, respectively. Partial meniscectomy was defined the cases that was preserved a stable and balanced peripheral rim of healthy meniscal tissue with or without meniscus repair. Total meniscectomy was included subtotal or total meniscectomy that means excision of a portion of the peripheral rim of the meniscus. Only studies directly comparing the clinical or radiological results of DLM tear between partial and total meniscectomies were included. Of these eight studies, the subjects of five studies were children or adolescents age < 15 years and the follow-up duration of the four studies was more than 5 years. Of the eight included studies, four reported the number of each grade in both the Ikeuchi scale and TH classification, two showed the proportion of each grade in the Ikeuchi scale alone, and the remaining two studies demonstrated the proportion of each grade in TH classification alone. The sample size, demographic data, number of each type in Watanabe classification, and MCMS are summarized in Table 2. The proportion of each DLM type was analysed by use of classification of Watanabe et al. [27], 238 knees (74.6%) were classified as type 1 (complete type), 71 knees (22.2%) as type 2 (incomplete type) and 10 knees (3.1%) as type 3 (Wrisberg ligament type). Postoperative clinical outcomes were analysed by use of the Ikeuchi grading system [9] and classified as excellent (full range of motion, no knee snapping, and no pain), good (infrequent pain with exertion and full range of motion), fair (slight pain, knee snapping on motion, and full range of knee motion), or poor (constant pain and/or recurrent locking of knee). Arthritic changes of the lateral compartment were evaluated based on the classification of Tapper and Hoover [28]: grade 0, normal; grade I, squaring of the tibial margin; grade II, flattening of the femoral condyle and squaring and sclerosis of the tibial plateau; grade III, narrowing of the joint space

Table 1
Quality assessment by Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist.

Author(Year)	Item 5 Setting	Item 6 Participants	Item 7 Variables	Item 8 Data sources/measurement	Item 12 Statistical methods	Item 14 Descriptive data	Item 15 Outcome data	Item 16 Main results
Ahn (2015) [20]	+	+	+	+	+	+	+	+
Aglietti (1999) [21]	+	±	+	+	±	+	+	±
Aichroth (1991) [22]	+	+	+	–	±	+	+	±
Davidson (2003) [23]	+	+	+	+	±	+	+	+
Kim (2007) [15]	+	+	+	+	+	+	+	+
LeeDH (2009)[24]	+	+	+	+	+	+	+	+
LeeSW (2016) [25]	+	+	+	+	+	+	+	+
Pellacci (1992) [27]	+	+	+	+	+	+	+	+

(+) = well described; (±) = partly described; (–) = poorly/not described.

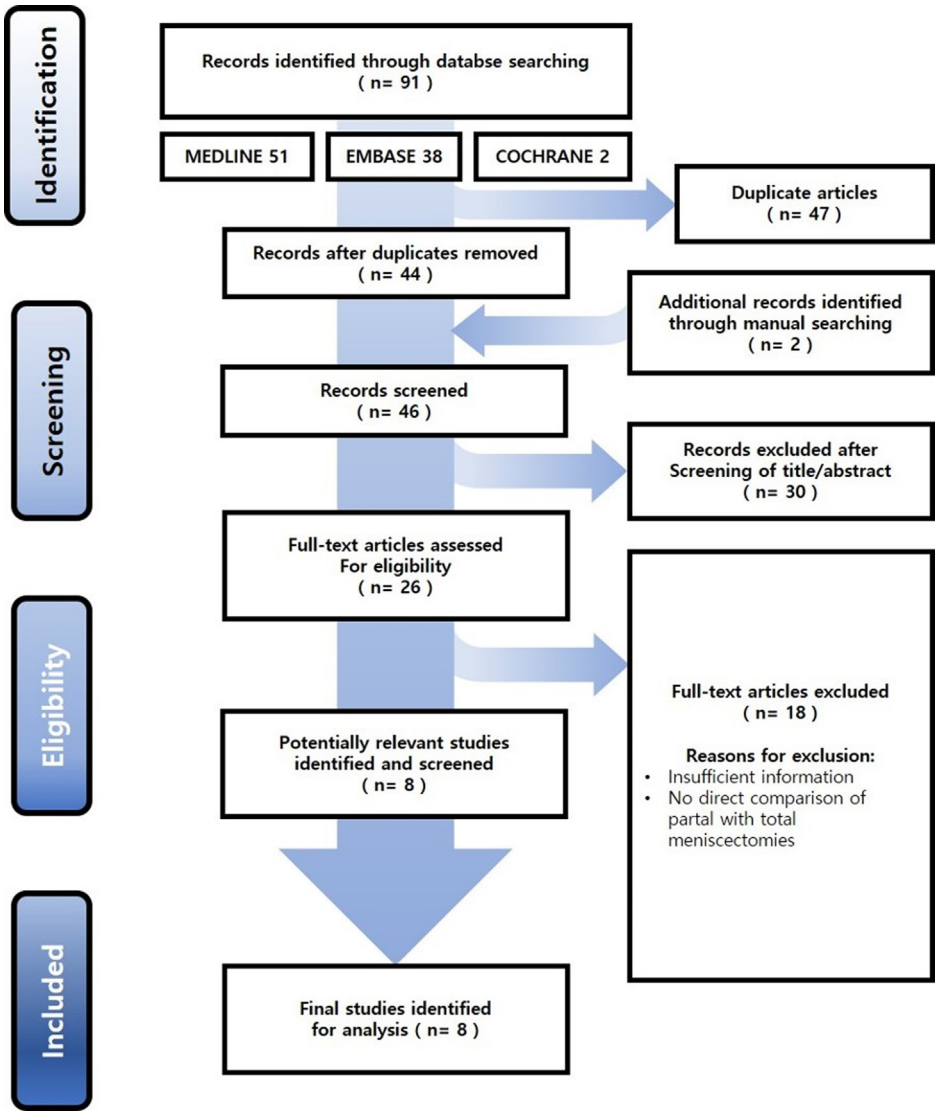

Fig. 1. Preferred Reporting Items for Systematic reviews and Meta-analyses flow diagram of the identification and selection of the studies included in the meta-analysis.

and/or hypertrophic change; and grade IV, a combination of grade I, II, and III changes to a more severe degree. The overall mean of MCMS of the included studies was 68 (SD, 5.5; range, 60–74) of 100, indicating good quality. Of the eight studies, 4 had a mean CMS > 70 (good or excellent quality), and no studies had a mean score < 55 (poor quality).

3.2. Clinical Outcomes

Of the eight studies, six reported the number of knees graded using the Ikeuchi scale such as excellent, good, fair, and poor after surgery (15–19; 20–21; 23–24; 26–28). The proportion of the knees with excellent or good grade appeared to be higher in partial than

Table 2
Characteristics of included studies.

Study	Year	Sample size		Age (range, years)	Sex (M/F)	Mean follow-up (range, years)	Watanabe classification (C/IC/W)	Ikeuchi rating (E/G/F/P)		Classification of Tapper & Hoover (0/I/II/III/IV)		MCMS
		Partial M	Total M					Partial M	Total M	Partial M	Total M	
Ahn[20]	2015	40†	8	9.9 (4–15)	23/15	10.1(8–14)	47/1/0	27/11/2/0	4/3/1/0	28/0/12/0/0	1/0/6/1/0	74
Aglietti[21]	1999	11	6	13.6(5–18)	4/13	10(5–15)	10/4/3	8/2/1/0	4/2/0/0	0/1/4/3/1	0/1/2/2/0	62
Aichroth[22]	1991	6	48	10.5(4–18)	28/24	5.5(2–18)	NR	NR	NR	6/0/0/0/0	3/0/3/0/0	72
Davidson[23]	2003	19	13	11.4(6–18)	12/22	3(0–22)	33/3/3	9/4/6/0	4/5/4/0	NR	NR	63
Kim[15]	2007	53	72	26.1(15–40)	62/59	5.5(3.2–10.2)	74/51/0	16/21/14/2	15/24/28/5	13/30/7/3/0	7/29/28/8/0	72
Lee DH[24]	2009	23	20	9.5(5–14)	20/23	4.3(2.1–9.4)	36/7/0	13/7/3/0	9/7/3/1	5/15/3/0/0	7/18/11/7/0	66
Lee SW[25]	2016	87	58	21.5(18–74)	75/70	4(2–6.8)	NR	NR	NR	72/14/1/0/0	28/19/10/1/0	72
Pellacci[26]	1992	12	18	32.4(5–58)	16/14	2.3(1–7)	38/5/4	13/4/1/0	9/1/2/0	NR	NR	60

C = complete type; F = female; E = excellent; G = good; F = fair; IC = incomplete type; M = meniscectomy; M = male; MCMS = modified Coleman methodology score; P = poor; NR = not reported; W = Wrisberg type. †This number included 18 cases with partial meniscectomy and repair group.

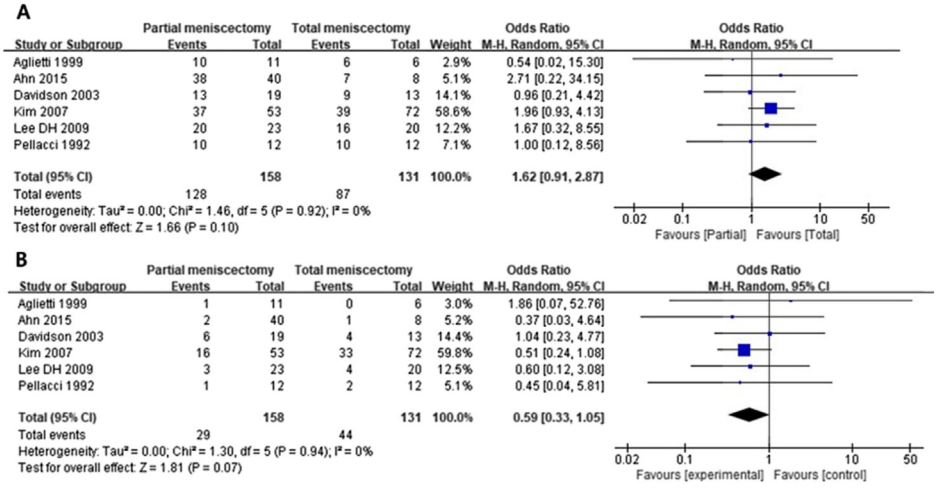

Fig. 2. Forest plot comparing the clinical outcomes between partial and total meniscectomies for knees with discoid lateral meniscus tear. A: The proportion of the knees that belong to excellent or good grade appears to be higher in the partial than in the total meniscectomy group, but this difference does not reach statistical significance (81.0% vs. 66.4%; OR 1.62; 95% CI, 0.91 to 2.87; $p = 0.10$); B: The proportion of the knees of fair or poor grade is lower in the partial than in the total meniscectomy group. This difference is also not statistically significant (18.3% vs. 33.5%; OR 0.59; 95% CI, 0.33 to 1.05; $p = 0.07$).

in total meniscectomy group, but this difference did not reach statistical significance [128/158 (81.0%) vs. 87/131 (66.4%); OR 1.62; 95% CI, 0.91 to 2.87; $p = 0.10$; $I^2 = 0\%$] Fig. 2A. In addition, the proportion of the knees with fair or poor grade was lower in the partial than in the total meniscectomy group; this difference was also not statistically significant [29/158 (18.3%) vs. 44/131 (33.5%); OR 0.59; 95% CI, 0.33 to 1.05; $p = 0.07$; $I^2 = 0\%$] Fig. 2B.

3.3. Radiologic Outcomes

Of the eight studies, six mentioned the proportion of knees graded in the TH classification after partial or total meniscectomy [15–28]. The pooled results of the proportion of normal cartilage status or mild chondral wear (TH grade 0 or 1) were significantly much higher in the partial than in the total meniscectomy group [228/261 (87.4%) vs. 94/169 (55.6%); OR 9.08; 95% CI, 2.94 to 28.09; $p < 0.001$; $I^2 = 57\%$] Fig. 3A. In contrast, the pooled result in terms of the proportion of knees with more advanced arthritic change (TH grade 3 or 4) was far lower with partial than total meniscectomy group [7/214 (3.3%) vs. 19/164 (11.6%); OR 0.31; 95% CI, 0.10 to 0.96; $p = 0.04$; $I^2 = 18\%$] Fig. 3B. There were no knees with grade 4 arthritic changes in both groups, except one knee in the partial meniscectomy group.

3.4. Sensitivity and meta-regression analyses

Sensitivity analysis showed that the subgroup analysis for age > 25 years and follow-up duration of > 5 years also showed no difference in the proportion of excellent or good grade based on the Ikeuchi scale between the partial and total meniscectomy groups, which was similar to the original analysis. This finding indicated that even older age and longer follow-up duration did not affect the results of the original analysis, that is, comparable clinical outcomes between two approaches. Sensitivity analysis also found that the subgroup analysis on age < 15 years and follow-up duration of < 5 years did not substantially change the original results, that is, compared with partial meniscectomy, total meniscectomy showed lower proportion of normal or mild radiologic arthritis in TH grade after surgery (Table 3). In the current study, this finding meant that more severe chondral wear in total than in partial meniscectomy was shown even in studies with young patients and short-term follow-up duration.

The results of the meta-regression analyses are reported in Table 4. Demographic data, including patients' sex, age, and length of follow-up period, were not significantly associated with the difference in the proportion of excellent or good grade in the Ikeuchi scale and proportion of normal or mild radiologic arthritis in the TH grade between the two surgical approaches.

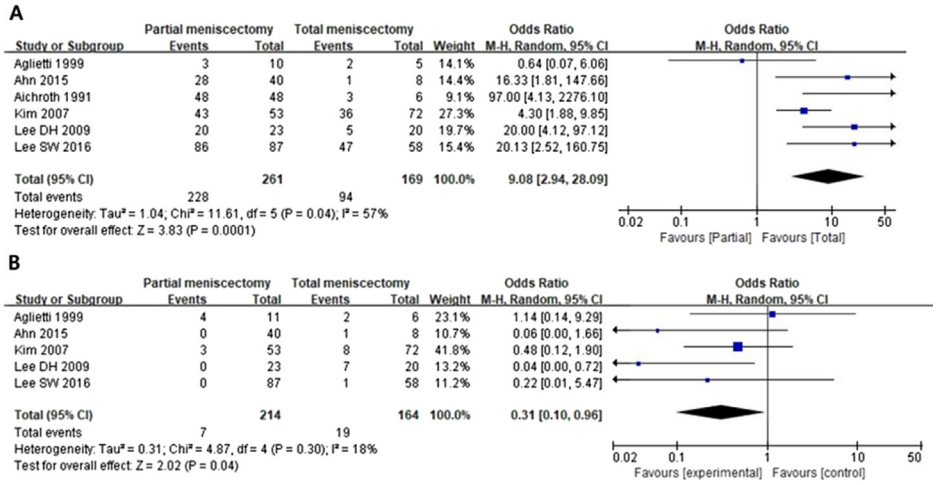

Fig. 3. Forest plot comparing the radiologic outcomes between partial and total meniscectomy for knees with discoid lateral meniscus tear. A: The proportion of normal cartilage status or mild chondral wear (grade 0 or 1 of the Tapper and Hoover classification) is significantly much higher with partial than with total meniscectomy (87.4% vs. 55.6%; OR 9.08; 95% CI, 2.94 to 28.09; $p < 0.001$); B: The pooled result in terms of the proportion of knees with more advanced arthritic change (grade 3 or 4 of the Tapper and Hoover classification) is far lower with partial than total meniscectomies (3.3% vs.11.6%; OR 0.31; 95% CI, 0.10 to 0.96; $p = 0.04$).

Table 3
Summary of odds ratio for outcomes of subgroup analysis between partial and total meniscectomies of discoid lateral meniscus.

Outcome or subgroup	Number of studies	Participants (Partial/Total)	ES (95% CI)	I^2 (%)	*p* value
Ikeuchi scale			Odds ratio		
All	6	158/131	1.62 (0.92–2.87)	0	0.098
Subgroup analysis					
Age > 25 yr	2	65/84	1.82 (0.90–3.69)	0	0.096
FU > 5 yr	3	104/86	1.90 (0.94–3.82)	0	0.074
Tapper–Hoover grade			Odds ratio		
All	6	261/169	7.05 (3.90–12.72)	57	< 0.001
Subgroup analysis					
Age < 15 yr	4	121/39	10.74 (1.63–70.84)	66	< 0.001
FU < 5 yr	3	163/150	9.43 (2.93–30.37)	51	< 0.001

CI = confidence interval; ES = effect size; FU = follow-up.

Table 4
Meta-regression analyses comparing associations of age and follow-up duration with the proportion of excellent or good grade in the Ikeuch scale and grade 0 or 1 in the Tapper and Hoover classification after surgery in patients who underwent partial or total meniscectomy for discoid lateral meniscus tear.

Variable	Coefficient	Standard error	*p* value	95% confidence interval
Proportion of Excellent or Good Grades in the Ikeuch scale				
Age	0.014	0.037	0.705	– 0.059 to 0.087
Follow-up period	0.084	0.160	0.601	– 0.230 to 0.399
Proportion of Grade 0 or 1 in the Tapper and Hoover classification				
Age	– 0.082	0.119	0.488	– 0.316 to 0.151
Follow-up period	– 0.077	0.256	0.762	– 0.578 to 0.424

4. Discussion

The most important finding of the study is that total meniscectomy had worse radiologic results than partial meniscectomy for torn DLMs, although there was no significant difference in the clinical outcomes between the two surgical approaches. Sensitivity analysis also found that the subgroup analysis on age > 25 years and follow-up duration of > 5 years did not substantially change, which was similar to the original analysis.

Contrary to our hypothesis, the results of the current study showed no significant difference in the clinical outcome measured by the Ikeuchi scale between partial meniscectomy and total meniscectomy for patients with DLM tear, despite more severe lateral compartment arthritic change in total meniscectomy than in partial meniscectomy groups. Although it is unclear why there was no difference in clinical outcomes between two groups, some possible reasons could be assumed. One of the most plausible causes was the relatively young mean age of patients in the included studies. These relatively young patients were more tolerable to pain than old patients because of their better muscular protection around the knee [29,30]. Therefore, functional impairment could not occur until chondral wear progressed to some extent. Furthermore, all chondral wear of the patients in the included studies of this meta-analysis showed only mild arthritis of less than TH grade 2. This relatively mild chondral wear may be likely to be asymptomatic [31]. A recent study [32] comparing the motion characteristics of knees with DLM tear and lateral meniscus tear using a motion capture system also showed the hint of the possible reason for similar clinical outcomes between two groups. That study showed that the maximum lateral tibial translation and maximum internal tibial rotation in the knees with DLM tear were significantly decreased compared to those in knees with lateral meniscus tear. Those reductions in translation and rotation of the tibia may be maintained after partial or total meniscectomy and may delay subsequent articular cartilage degeneration compared with general lateral meniscus tear, thus

reducing knee joint pain. These decreased kinematic characteristics could be also a potential cause of the absence of difference between the two surgical approaches for DLM tear. Another possible reason could be found in the alignment change of knees with DLM tear after surgery. Kim et al. [33] showed that varus deformity was more common in the DLM tear group than in the normally shaped lateral meniscus tear group and that the DLM tear group had slightly less varus alignment postoperatively than preoperatively. Partial or total meniscectomy of DLM tear to some degree might have changed the knee alignment from varus to neutral alignment. This neutralizing alignment effect of partial or total meniscectomy may reduce or offset the worsening clinical outcomes due to the chondral wear of the lateral compartment, which could explain partially the absence of significant difference of clinical outcomes between partial and total meniscectomies for DLM tear. Finally, the Ikeuchi scale may be relatively insensitive to detecting difference in functional outcomes between the two techniques because it is not a scoring system but a grading system with only four different levels depending on the pain, mechanical symptom, and range of motion in the knee joint. The lower power of discrimination in the Ikeuchi scale due to potentially high ceiling effect [34] could be the assumed reason for the no difference in the clinical outcomes between the two techniques.

Previous studies have reported contradicting results of whether total meniscectomy could lead to worse articular cartilage degeneration than did partial meniscectomy. Aglietti et al. [22] compared the long-term radiological outcomes of partial meniscectomy and total meniscectomy for torn DLM with average 10 years of follow-up. Their result showed no difference in radiographic osteoarthritis between the partial and total meniscectomy groups. However, Lee et al. [25] demonstrated that radiographic arthritic changes at mean 4.3 years of follow-up were significantly more severe in the subtotal/total meniscectomy group than in the partial meniscectomy group. More recently, Ahn et al. [23] demonstrated that the subtotal/total meniscectomy group showed significantly greater progression of degenerative changes than the partial meniscectomy with or without repair group at a mean 10.1 years of follow-up. Similarly, the current meta-analysis also showed that subtotal/total meniscectomy led to greater progression of degenerative changes than partial meniscectomy. Subgroup analysis that only included studies with patients with age < 15 years and follow-up duration < 5 years also demonstrated more advanced chondral wear in total than in partial meniscectomy, indicating that total meniscectomy could lead to more severe articular arthritis even in young age and short-term follow-up duration than partial meniscectomy. Therefore, these results suggested that the preservation of meniscal tissue should be considered for patients with symptomatic DLM, given the relatively young age of the patient population and its vulnerability to fast chondral wear after total meniscectomy.

This study had several limitations. One of the most important limitations was that the tear pattern and magnitude of tear extension were different between the included studies. Therefore, the indication of partial and total meniscectomies was also different between studies; the wide range from 16.6% to 88.8% of the proportion of the total meniscectomy group in the included studies of the current study supported this point. In addition, the time interval from tear occurrence and arthroscopic surgery as well as postoperative follow-up period also differs between studies, which might affect the severity of chondral wear after surgery. However, preoperative symptom duration was not reported, and the results of the meta-regression analysis in our study showed that the follow-up period did not influence the clinical outcome and severity of chondral wear between the two approaches.

5. Conclusion

In conclusion, the radiographic outcomes of DLM are better with partial meniscectomy with or without repair than with total meniscectomy, but their clinical outcomes are similar. The findings thus suggest that compared to total meniscectomy, meniscal preservation would be a better option for symptomatic DLM.

Disclosure of interest

The authors declare that they have no competing interest.

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Contributions

Study conception and design: S.H. Lee.
Acquisition of data: S.H. Lee, D.H. Lee.
Analysis and interpretation of data: D.H. Lee.
Drafting of manuscript: S.H. Lee, D.H. Lee.
Critical revision: D. Lima, D.H. Lee.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.otsr.2019.02.023.

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