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Arthroscopic and open debridement in primary elbow osteoarthritis: a systematic review and meta-analysis

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- Primary osteoarthritis (OA) of the elbow can cause disabling symptoms of pain, locking, stiffness, and a limitation in the range of motion. There is no consensus regarding the role of open and arthroscopic debridement in the treatment of symptomatic primary elbow OA. The aim of this study is to systematically review the outcome of surgical debridement. A preoperative/postoperative comparison will be made between the two surgical procedures.
- All studies reporting on debridement as treatment for primary elbow OA with a minimum of one-year follow-up were included. Outcome parameters were functional results, complications, and performance scores.
- Data were extracted from 21 articles. The arthroscopic group consisted of 286 elbows with a weighted mean follow-up of 40 ± 17 months (range, 16–75). The open group consisted of 300 elbows with a weighted mean follow-up of 55 ± 20 months (range, 19–85). Both procedures showed improvement in Mayo Elbow Performance Score (MEPS), range of motion (ROM) flexion-extension, and ROM pronation-supination. Only in ROM flexion was a statistically significant difference in improvement seen between the groups in favour of the open group. The arthroscopic group showed improvement in pain visual analogue scale (VAS) scores. Nothing could be stated about pain VAS scores in the open group due to a lack of data. In the arthroscopic group 18 complications (6%) were described, in the open group 29 complications (12%).
- Surgical debridement is an effective treatment for the disabling symptoms of primary elbow OA with an acceptable complication rate.

Keywords: arthroscopic debridement; open debridement; primary elbow osteoarthritis

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Introduction

Degenerative joint disease of the elbow is less common compared to the hip and knee. The prevalence of primary elbow osteoarthritis (OA) is 2–3%.[1,2] OA of the elbow can cause severe disabling symptoms of pain, locking, stiffness, and a limitation in the range of motion (ROM).[3] According to the literature, the elbow joint is more affected by OA in men who perform strenuous manual work.[1,2] Essential parts of non-operative treatment are rest, anti-inflammatory medication, and long-term activity modification.[1] Literature describes many different surgical procedures for elbow OA, both arthroscopic and open, including arthroscopic debridement with or without radial head resection,[4–20] open debridement,[6,21–23] interposition arthroplasty,[24] the Outerbridge-Kashiwagi procedure,[25–29] radiocapitellar replacement,[30] and total elbow arthroplasty (TEA).[31] The results of TEA and radiocapitellar arthroplasty as treatment modality for severe elbow OA have been reviewed recently.[31–34] Open and arthroscopic debridement have gained popularity and became important treatment options to diminish pain and gain ROM.[23] Arthroscopic debridement may be appropriate for young, active patients with OA of the elbow and may be more suitable to treat pain, whereas open debridement more reliably improves the ROM.[6,35] The aim of this study is to systematically review the literature concerning elbow functional, performance scores and complications for arthroscopic and open debridement as treatment for elbow OA. If possible, a meta-analysis to compare both groups will be performed.

Materials and methods

This systematic review and meta-analysis were performed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[36] The review was registered in an international prospective register of systematic reviews (PROSPERO). The protocol is registered under the following number: CRD42018084378, and can be accessed electronically at: http://www.crd.york.ac.uk/prospero.

Literature search and study selection

Three online medical databases (PubMed, Embase, and the Cochrane Central Register of Controlled Trials) were searched on 28 October 2019 using the keywords "elbow osteoarthritis", "surgery", "open", "arthroscopic", "outcome", "complications", and their synonyms, each fitted for the specific databases. Full search details are available in Appendix I. Title, abstract and full-text screening was performed by four independent reviewers (each article was screened by two reviewers) to identify potentially relevant articles. Additionally, the reference lists of the included articles were manually checked to avoid missing relevant articles. The authors independently selected articles. Studies were not blinded for author, affiliation, or source. Any disagreement was resolved by discussion and consensus by either the first two (CW and AS) or the second two (LV and HK) authors.

Inclusion and exclusion criteria

All included articles presented original data on patients who had undergone arthroscopic or open debridement in primary elbow OA. Studies were included if they were written in English or Dutch, had at least 12 months of mean follow-up, and reported on a minimum of five patients. Studies had to contain at least one of the outcome parameters to be included. Reviews, expert opinions and surgical technique articles were excluded. Articles that did not provide separate data for the primary OA group were excluded.

Data extraction

The following parameters were recorded when available: numbers of patients and elbows, sex, age, and type of debridement (arthroscopic or open). Relevant outcome parameters included the months of follow-up, pain score measured using the visual analogue scale (VAS), ROM of the elbow in terms of flexion-extension and pronation-supination, Mayo Elbow Performance Score (MEPS), complications, and information about revision surgery. The MEPS is an elbow outcome score used to test the limitations in the elbow during activities of daily living (ADL). Scores ranged from 0 to 100, with a higher score indicating a better outcome. Some studies compared different groups; therefore, when possible, the different groups were collected separately. The ROM flexion-extension arc was determined by subtracting the values of the ROM extension from the values of the ROM flexion. The deltas represent the difference in preoperative and postoperative ROM values. The mean deltas were calculated for each ROM by taking the mean average of the differences between preoperative and postoperative values described in the used studies.

Methodological quality

The methodological quality of included studies was assessed by assigning levels of evidence as previously defined by the Centre for Evidence-Based Medicine (http://www.cebm.net). Levels of evidence were performed by four independent reviewers (each article was screened by two reviewers). Any scoring differences were discussed until consensus was reached.

To assess the risk of bias, the Methodological Index for Non-Randomized Studies (MINORS)[37] was used. The MINORS is a validated and established index for evaluating the methodological quality of non-randomized studies. The index involves 12 criteria for comparative studies, of which eight criteria have been designed for non-comparative studies. These items were scored according to the set criteria: 0 (not reported), 1 (reported but inadequate), or 2 (reported and adequate). The maximum score for comparative studies was 24 and 16 for the eight-item index. Two reviewers independently evaluated each study according to the MINORS index and scoring differences were discussed until consensus was reached. This was done for the included studies by four independent reviewers (each article was screened by two reviewers). The given MINORS are presented in Table 1. Randomized controlled trials (RCTs) were evaluated using the Cochrane tool.[38]

Data and statistical analysis

The primary outcome measures are pain, elbow function, MEPS, and complications. The outcome measures will be calculated for each study by dividing them by the total number of elbows. Due to the different size of the study populations the average is expressed in a weighted mean. Larger study populations will weigh more than smaller study populations and each patient will contribute equally to the final mean. When able and relevant, weighted mean values will also be calculated according to type of debridement. Only studies reporting the standard deviation (*SD*) associated with the mean average were included in the meta-analysis. If the *SD* was not reported, it was estimated according to the method of Walter and Yao using the sample size and range.[39] Studies presenting both sample size and range were therefore also included. Studies reporting preoperative and postoperative data

Table 1. Given methodological items for non-randomized studies

Study (first author)	Methodological items for non-randomized studies*							
	Clearly stated aim	Inclusion of consecutive patients	Prospective data collection	Endpoint appropriate to the aim of the study	Unbiased assessment of the study endpoint	Follow-up period appropriate to the aim of the study	Loss to follow-up less than 5%	Prospective calculation of the study size
Morrey[3]	1 2	1 2	2 0	2 2	0 1	2 2	1 0	0 0
Adams[4]	1 1	2 2	2 0	2 0	0 0	2 2	1 0	0 0
Galle[7]	2 2	2 2	2 0	2 2	1 0	2 2	0 0	0 0
Kim[9]	2 2	2 2	2 0	2 2	0 2	2 2	1 2	0 0
Kim[10]	2 2	2 2	2 0	2 2	0 1	2 2	1 1	0 0
Krishnan[11]	2 2	2 2	2 0	2 2	0 1	2 2	2 2	0 0
Lim[12]	2 2	2 2	2 0	2 2	0 1	2 2	1 1	0 0
MacLean[13]	2 2	2 2	2 0	1 2	0 1	2 2	1 2	0 0
Redden[18]	1 1	0 1	2 0	1 2	0 1	2 2	2 0	0 0
Tsuge[21]	2 2	0 1	2 0	2 2	0 1	2 2	0 1	0 0
Hattori[22]	2 2	2 2	2 0	2 2	0 1	2 2	1 2	0 0
Cha[26]	2 2	2 1	2 0	2 2	2 2	2 2	2 0	2 0
Allen[42]	1 1	2 2	2 1	2 2	0 1	2 2	1 2	0 0
Antuña[43]	2 2	2 2	2 0	2 2	0 2	2 2	1 2	0 0
Oka[44]	2 2	2 2	2 1	2 2	0 1	2 2	2 1	0 0
Rettig[45]	2 2	2 2	2 0	2 2	0 1	2 2	1 1	0 0
Sarris[46]	2 2	1 2	1 0	1 2	0 1	2 2	2 1	0 0
Tashijan[47]	2 2	2 2	1 0	2 2	2 1	2 2	1 2	0 0
Lubiatowski[48]	2 2	2 2	2 1	2 2	0 0	2 2	0 0	0 0
Miyake[49]	2 2	2 2	2 0	2 2	0 1	2 2	2 0	0 0
Phillips[50]	1 2	1 2	2 0	2 2	0 1	2 2	2 2	0 0

*Scoring was simplified to a three-point scale from 0 to 2.

were compared with a group analysis by use of X^2 tests. A difference was considered as statistically significant when the p-value was less than 0.05.[40] Heterogeneity between studies was assessed by use of X^2 and I^2 statistic. $I^2 > 50\%$ was considered as substantial heterogeneity.[41] Review Manager version 5.3 (the Nordic Cochrane Center, Copenhagen, Denmark) was used to calculate mean differences with 95% confidence interval (CI).

Results

Selection process

The search yielded a total of 1325 articles, including 485 PubMed hits, 634 Embase hits, and 206 Cochrane database hits. The cross-reference check of the included studies did result in two additional relevant articles. Duplicates were removed (*n* = 307) and 1020 articles were screened by title and abstract. A total of 60 studies were selected for full-text screening and a total of 21 articles were included for data extraction. For a total of 12 articles the *SD* was reported or could be estimated. These articles were included to perform the meta-analysis. A flowchart is presented in Fig. 1 and an overview of the included articles and baseline characteristics is presented in Appendix II.

Methodological quality and risk of bias

The level of evidence of 19 articles was level IV and for two articles was level III. The MINORS index was applied to all selected articles and scores ranged from 9 to 22. The major limitations of the methodologies of the selected studies were non-calculated or small sample size, retrospective design, and no unbiased assessment of endpoints.

Patients

Overall, 286 elbows of 284 patients were included in the arthroscopic group with a weighted mean follow-up of 40 ± 17 months (range, 16–75). Three hundred elbows of 292 patients were included in the open group with a weighted mean follow-up of 55 ± 20 months (range, 19–85). The baseline characteristics are described in Table 2. Ten articles described open debridement,[3,21,22,26,42–47] and 11 articles evaluated an arthroscopic procedure.[4,7,9–13,18,48–50]

Pain

Pain was evaluated for the arthroscopic group with a VAS score in six articles (182 elbows).[4,7,9,11,12,18] The overall mean weighted preoperative VAS score was 5.4 ± 2.3 (range, 3.5–9.2) and the overall mean weighted postoperative VAS score was 1.8 ± 1.8 (range, 0.8–2.9). The pre- and postoperative VAS scores are shown in Table 3. Due to a lack of data for the open group, no comparison could be made between the two groups (Supplementary data 1).

MEPS

In seven articles[4,7,9,11,12,48,49] the MEPS was reported for the arthroscopic group. The mean weighted MEPS in this group were pre- and postoperatively 61 ± 13 and 88 ± 11 respectively, after a mean weighted follow-up of 40 ± 15

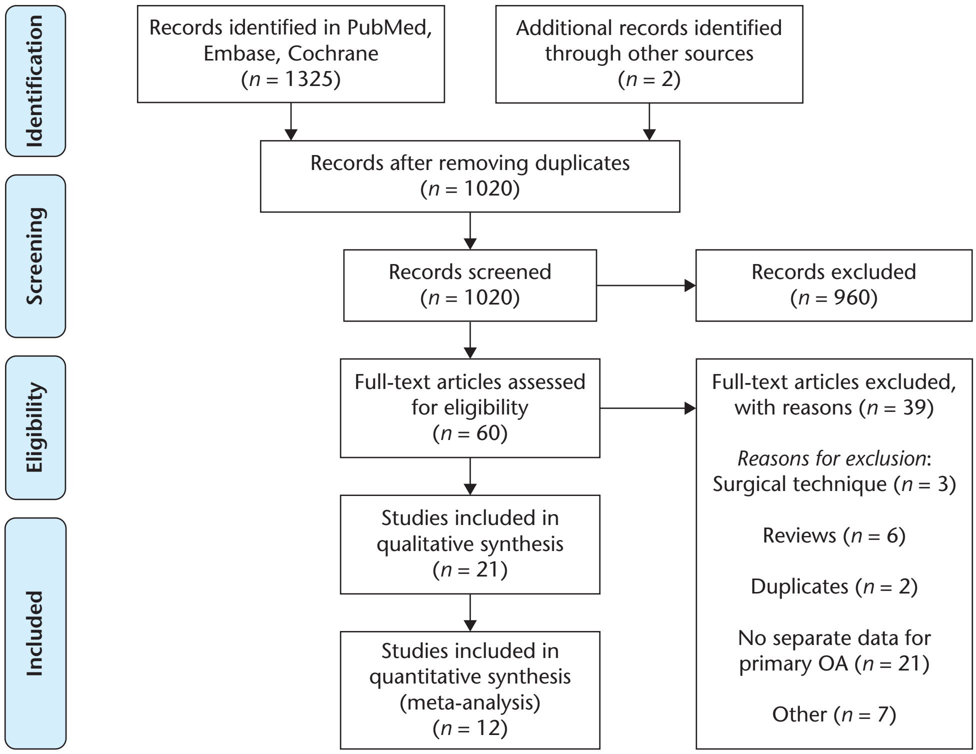

Fig 1. Selection progress flowchart.

Table 2. Baseline characteristics

	Open debridement	Arthroscopic debridement	Total
Patients *(n)*	292	284	576
Elbows *(n)*	300	286	586
Male *(%)*	81.2	82.0	81.6
Weighted mean age *(yr)*	49.9 ± 9.3	44.2 ± 12.1	47.1 ± 10.6
Weighted mean follow-up *(mo)*	55.4 ± 20.3	40.2 ± 17.2	48.1 ± 17.9

Note. n, number; *yr*, years; *mo*, months.

Table 3. Weighted pain scores in the arthroscopic debridement group

	n	Weighted pain score
VAS preoperative *(range)*	182	5.4 ± 2.3 (3.5–9.2)
VAS postoperative *(range)*	182	1.8 ± 1.8 (0.8–2.9)

Note. VAS, visual analogue scale; *n*, number of elbows.

months (range, 24–62). In three articles[22,26,43] the MEPS was reported for the open group. The mean weighted MEPS in this group were pre- and postoperatively 57 ± 7 and 86 ± 5 respectively, after a mean weighted follow-up of 53 ± 17 months (range, 19–80). An overview of the data for MEPS is presented in Table 4. There was an increase in MEPS from pre- to postoperative measurement for both the arthroscopic and open group; however, a difference between the groups could not be observed (Supplementary data 2; P = 0.95).

ROM

Eleven articles reported on the ROM[4,7,9–13,18,48–50] in the arthroscopic group. After a weighted mean follow-up of 40 ± 17 months (range, 24–75) the mean weighted preoperative flexion was 115 ± 15 degrees and extension was 22 ± 9 degrees. The overall mean weighted preoperative pronation and supination were respectively 76 ± 7 and 74 ± 8 degrees. The overall weighted postoperative flexion was 127 ± 10 degrees and extension was 9 ± 5 degrees. The overall weighted postoperative pronation was 80 ± 7 degrees and supination was 79 ± 6 degrees.

Eight articles reported on the ROM[21,22,26,42–45,47] in the open group. After a weighted mean follow-up of 58 ± 20 months (range, 19–85) the mean weighted preoperative flexion was 108 ± 12 degrees and extension was 29 ± 9 degrees. The overall mean weighted preoperative pronation and supination were respectively 70 ± 9 and 68 ± 12 degrees. The overall weighted postoperative flexion was 126 ± 8 degrees and extension was 19 ± 11 degrees. The overall weighted postoperative pronation was 72 ± 9 degrees and supination was 72 ± 11 degrees.

An overview of the data for ROM is provided in Table 5. A meta-analysis comparing pre- and postoperative data

Table 4. Weighted MEPS according to procedure

	Open debridement		Arthroscopic debridement		Total	
	n		*n*		*n*	
MEPS preoperative *(range)*	140	57.0 ± 7.2 (55–60)	213	61.2 ± 13.3 (55.8–73.0)	353	59.6 ± 11.5 (55–73)
MEPS postoperative *(range)*	140	85.7 ± 4.9 (83–94)	213	87.6 ± 11.1 (81.3–95.0)	353	86.8 ± 11.2 (81.3–95.0)

Note. MEPS, Mayo Elbow Performance Score; *n*, number of elbows.

Table 5. Weighted ROM in open and arthroscopic procedures*

	Open debridement						Arthroscopic debridement						Total					
	Preoperative		Postoperative		Δ		Preoperative		Postoperative		Δ		Preoperative		Postoperative		Δ	
	n	*degrees*	*n*	*degrees*	*n*	*degrees*	*n*	*degrees*	*n*	*degrees*	*n*	*degrees*	*n*	*degrees*	*n*	*degrees*	*n*	*degrees*
Flexion *(range)*	268	108.1 ± 11.6 (95–122)	250	126.4 ± 8.0 (120–133)	250	19.2 ± 6.2 (11–29)	286	114.9 ± 14.9 (100–136)	286	127.4 ± 9.9 (115–140)	286	12.5 ± 7.7 (–1–40)	554	111.6 ± 14.4 (95–136)	536	126.9 ± 9.6 (115–140)	536	15.7 ± 7.8 (–1–40)
Extension *(range)*	268	28.5 ± 9.0 (17–38)	250	18.7 ± 11.2 (12–23)	250	10.2 ± 5.9 (0–23)	286	21.5 ± 8.6 (11–40)	286	9.1 ± 4.7 (7–16)	286	11.2 ± 6.7 (–0.8–33)	554	24.9 ± 9.6 (11–40)	536	13.6 ± 9.3 (7–23)	536	10.7 ± 6.3 (–0.8–33.0)
Flexion-extension arc *(range)*	268	79.5 ± 11.4 (66–100)	250	107.6 ± 5.6 (99–121)	250	29.4 ± 9.7 (17–45)	286	93.4 ± 12.7 (60–125)	286	117.1 ± 9.7 (103–133)	286	23.7 ± 13.9 (0–73)	554	86.7 ± 13.9 (60–125)	536	112.7 ± 9.4 (101–133)	536	26.4 ± 12.5 (0–73)
Pronation *(range)*	156	70.0 ± 8.7 (62–77)	138	72.3 ± 8.5 (65–77)	138	1.3 ± 2.8 (–2–6)	73	75.8 ± 7.3 (73–80)	73	80.1 ± 7.4 (80.0–80.1)	73	4.3 ± 3.7 (0–7.4)	229	71.8 ± 10.5 (62–80)	211	75.0 ± 10.1 (65.0–80.1)	211	2.3 ± 3.4 (–2.0–7.4)
Supination *(range)*	156	68.1 ± 12.0 (61–77)	138	72.3 ± 11.3 (64–83)	138	3.3 ± 1.5 (2–6)	73	73.7 ± 8.4 (71–78)	73	78.8 ± 6.3 (78–79)	73	5.0 ± 3.5 (1–8)	229	70.0 ± 13.5 (61–78)	211	74.5 ± 11.4 (64–83)	211	3.9 ± 2.5 (1–8)

Note. ROM, range of motion; *n*, number of elbows.
*Only articles presenting results of flexion-extension and pronation-supination were analysed.

showed an overall decrease in extension deficit in the arthroscopic and open surgery groups; however, there was no difference between these groups (Supplementary data 3; P = 0.56). Meta-analyses comparing preoperative and postoperative data showed an overall increase in ROM flexion, pronation, and supination in both groups. A difference between both groups was not observed for pronation (Supplementary data 4; P = 0.49) and supination (Supplementary data 5; P = 0.75). However, there was a statistically significant difference of flexion in favour of the open group (Supplementary 6; P = 0.03). Substantial statistical heterogeneity was seen at the analysis for flexion.

Complications

Eleven articles[4,7,9–13,18,48–50] described a total of 18 complications (6%) following 286 procedures in the arthroscopic group. Nine articles[3,21,22,26,42,43,45–47] described a total of 29 complications (12%) following 249 procedures in the open group. In the arthroscopic group seven nerve palsies occurred, of which three were transient. In the arthroscopic group both ulnar neuropathies (*n* = 4) and median neuropathies (*n* = 3) occurred. In the open group 20 nerve palsies occurred, of which 16 were transient. In the open group the nerve palsies were only ulnar neuropathies (*n* = 20). The risk of postoperative neurologic complications in the open group was 8%, whereas the incidence in the arthroscopic group was 2%. In three patients (1%) a hematoma was described, which only occurred in the open group. In each group two wound infections were reported in two patients (1%). Other postoperative complications were heterotopic ossification, bursitis, and no improvement in ROM. In eight cases a triceps tendon avulsion was described in the arthroscopic group and in five cases in the open group.

A total of 27 reoperations (5%) were performed, of which 13 (5%) and 14 (4%) reoperations were respectively performed in the open and arthroscopic groups. Ulnar nerve compression (*n* = 9) and persistent pain and limitation of motion (*n* = 2) were the most common indications for reoperation in the open group. In the arthroscopic group the most common indications were persistent pain and limitation of motion (*n* = 7) and heterotopic ossifications (*n* = 3). An overview of the complication rates is presented in Table 6.

Discussion

The mean improvement in ROM was 34 degrees (35 for open surgery and 34 for arthroscopic surgery) and the mean improvement in MEPS was 27 (29 for open 26 for arthroscopy) in patients with primary OA. The mean improvement in pain VAS was 4 in the arthroscopic group. A meta-analysis showed only in ROM flexion a statistically

Table 6. Complications in open and arthroscopic procedures

	Open debridement (*n* = 249)	Arthroscopic debridement (*n* = 286)	Total (*n* = 535)
Complication rate (%)	29 (12)	18 (6)	47 (9)
Neurologic (%)	20 (8)	7 (2)	27 (5)
Hematoma (%)	3 (1)	0 (0)	3 (1)
Wound infection (%)	2 (1)	2 (1)	4 (1)
Other (%)	5 (2)	8 (3)	13 (2)

Note. n, number of elbows.

significant difference in improvement between the groups in favour of the open group. For flexion, substantial heterogeneity was observed. The overall complication rate was 9% (6% after arthroscopic debridement and 12% after open debridement). However, it has to be noted that most complications were transient with long-term consequences occurring in 3% of cases for both groups. The most frequent long-term complications were heterotopic ossifications ($n = 3$) and lack of ROM improvement ($n = 3$) in the arthroscopic group, and persistent ulnar neuropathies ($n = 2$), ectopic ossifications ($n = 2$), and persisting symptoms ($n = 2$) in the open group.

A strength of this review is that this systematic review summarizes the data from the included articles in a structured manner. Other reviews have been written about the comparison of arthroscopic and open debridement. A narrative review by Poonit et al[51] described 21 articles about arthroscopic and open debridement on elbow OA. Due to the use of a meta-analysis, this systematic review will provide a more elaborated comparison between the arthroscopic and open groups. In addition to this, the studies included in the analysis by Poonit et al did not use the same scoring system and as a result direct comparison was not always possible. The studies used in this current systematic review always included one of the predetermined parameters to be included, often allowing comparison. Another recent review by Sochacki et al[52] only described arthroscopic debridement for primary OA patients. They analysed 213 elbows from nine articles. In the current review 286 elbows with primary OA treated with arthroscopic debridement from 11 articles were analysed, providing a more extensive overview compared to the review by Sochacki et al. Besides this, the present systematic review included not only the arthroscopic but also the open procedure for treatment of primary OA. These results can aid to determine the indication for surgery but also which types of approaches may be most optimal.

Unfortunately, there are some weak points in the current review. The data used in the group analyses were clinically heterogenous, but in one group statistical heterogeneity occurred. A meta-analysis comparing data concerning complication and reoperation rates between the arthroscopic and open groups was not possible due to the small number ($n = 1$) of studies presenting the complication and reoperation rates for both groups.

Both groups showed ROM improvement in all directions. Only in the ROM flexion was a significant difference seen in favour of the open group regarding ROM improvements. Statistical heterogeneity was seen for ROM flexion. Fletcher stated that reasons for heterogeneity could include clinical or methodological differences.[53] No clear reason has been found for the heterogeneity in this review. Thus, a random effects model, which accounts for unexplained heterogeneity, is suitable for this review.[54,55] This random effects model is presented in Supplementary data 6.

With regard to the ROM flexion-extension arc, both approaches showed an improvement (arthroscopic 23.7 ± 13.9 degrees and open 29.4 ± 9.7 degrees). A review by Carlier et al[56] showed an improvement in ROM flexion-extension arc of 28.5 degrees for the arthroscopic debridement in the secondary OA group. The ROM flexion-extension arc mean average of this current review was also similar to the improvement in ROM flexion-extension arc of 26.4 degrees in a review by Merolla et al,[15] reporting patients with primary and post-traumatic elbow arthritis managed using arthroscopic debridement. These similarities may indicate that patients with primary OA achieve the same level of improvement as patients with secondary OA of the elbow following arthroscopic debridement.

Both open and arthroscopic debridement improve ROM to functional values. Morrey et al state that most activities of daily living are possible within a ROM of 100 degrees (between 30 and 130 degrees flexion).[57] The data in this review show an average postoperative flexion of 127 degrees and an extension of 14 degrees. This would suggest that the average patient has a ROM of 113 degrees with the operated elbow, making ADL after the debridement for the average patient possible again. A study by Sardelli et al[58] found that the functional elbow ROM necessary for ADL may be greater than the study by Morrey et al described: a flexion of 27 to 149 degrees. This difference in maximal flexion may be explained by the different movements included in the more recent study, such as using a cellular telephone.

Lindenhovius et al concluded that in patients with contracture release of a stiff elbow, pain was the strongest predictor of the final general health status.[59] Therefore, pain could be the most important factor for the patient in choosing arthroscopic debridement, open debridement, or no surgery at all. In the literature, the minimum clinically important difference of the VAS varied from 1.2 to 3.0.[60–62] The arthroscopic group in this current review showed an improvement of 3.5 on the VAS and was therefore clinically relevant. Due to a lack of data no conclusions can be drawn for the open group.

Apart from the previously mentioned parameters, other factors can also influence the choice between the two approaches. Arthroscopic procedures require a small incision and are minimally invasive; this requires a more experienced surgeon who has performed at least 100 procedures.[63,64] A review by Poonit et al stated that patients undergoing open surgery have a higher rate of postoperative infections compared with those undergoing arthroscopic debridement.[51] This review shows a 1% risk of infection for both arthroscopic and open debridement. The low rate of (infectious) complications from Poonit et al in arthroscopic debridement could be explained by the smaller size of the incision and thus, a lower risk of soft tissue injury.[65] Therefore, the arthroscopic approach may be preferred in patients with a higher infection risk, such as obesity, older age, diabetes mellitus, and low serum albumin concentration.[65] Arthroscopic release of the posterior band of the medial collateral ligament provides greater flexion in the short term (six months), but it is not beneficial in the long run (longer than two years) regarding postoperative range of motion.[66]

Open debridement requires a larger incision, with more soft tissue injury with a possible risk of soft tissue contraction and a higher risk of infection and haematoma.[51] This could be the reason why in the current review there are double the number of complications in the open group compared to the arthroscopic group. Especially more neurologic complications and haematomas occurred in the open group, possibly due to this larger incision. The most common reasons for revision surgery were the nine ulnar nerve compressions in the open group, whereas in the arthroscopic group only three reoperations were related to neuropathies. Most of the neuropathies were transient in the open group. Nevertheless, the open approach can be preferred to remove large osteophytes or loose bodies more easily and quickly. Due to the little available working space and risk of ulnar nerve injury, the medial gutter may be difficult to access with the arthroscope. Therefore, the choice to approach the primary OA openly may indicate a more complicated case which might contribute to a higher complication rate. Furthermore, the open group was preoperatively more impeded in ROM flexion than the other group, possibly due to the more complicated cases associated with ROM-limiting osteophytes that are preferably treated in an open manner.[67] This greater impediment in the open group could explain why the ROM flexion improvement was greater in this group than the arthroscopic group, resulting in equal postoperative ROM flexion outcomes for both groups. In conclusion, the optimal surgical treatment of symptomatic primary elbow OA should be determined depending on the patients' and surgeons' characteristics.

This review can help surgeons to inform patients, to address patient questions and aid in shared decision making when surgeons and patients face operative treatment and have to decide if surgery is indicated and whether it will be performed using an open or an arthroscopic approach. Future studies should focus on recovery time for the open compared to the arthroscopic approach. The time unable to use the operated elbow for driving and working could have an effect on the decision about whether open or arthroscopic debridement is preferred. A randomized controlled trial with validated patient-reported outcome measures (PROMS) can be performed to get a better insight into the differences in outcome between arthroscopic and open debridement. Because pain is a strong predictor of final general health status in patients with contracture release of a stiff elbow,[64] future studies should focus on whether open debridement meets the minimum clinically important difference of the VAS for patients with primary OA in order to make a clinically relevant difference.

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SUPPLEMENTAL MATERIAL

Supplemental material is available for this paper at https://online.boneandjoint.org.uk/doi/suppl/10.1302/2058-5241.5.190095

REFERENCES

1. **Gramstad GD, Galatz LM.** Management of elbow osteoarthritis. *J Bone Joint Surg Am* 2006;88:421–430.

2. **Stanley D.** Prevalence and etiology of symptomatic elbow osteoarthritis. *J Shoulder Elbow Surg* 1994;3:386–389.

3. **Morrey BF.** Primary degenerative arthritis of the elbow: treatment by ulnohumeral arthroplasty. *J Bone Joint Surg Br* 1992;74:409–413.

4. **Adams JE, Wolff LH III, Merten SM, Steinmann SP.** Osteoarthritis of the elbow: results of arthroscopic osteophyte resection and capsulectomy. *J Shoulder Elbow Surg* 2008;17:126–131.

5. **Bornu BC, Clément X, Kempf JF, Clavert P.** Arthroscopic elbow joint release with radial head resection arthroplasty: 12 cases. *Orthop Traumatol Surg Res* 2015;101:735–739.

6. **Cohen AP, Redden JF, Stanley D.** Treatment of osteoarthritis of the elbow: a comparison of open and arthroscopic debridement. *Arthroscopy* 2000;16:701–706.

7. **Galle SE, Beck JD, Burchette RJ, Harness NG.** Outcomes of elbow arthroscopic osteocapsular arthroplasty. *J Hand Surg Am* 2016;41:184–191.

8. **Kelly EW, Bryce R, Coghlan J, Bell S.** Arthroscopic debridement without radial head excision of the osteoarthritic elbow. *Arthroscopy* 2007;23:151–156.

9. **Kim SJ, Kim JW, Lee SH, Choi JW.** Retrospective comparative analysis of elbow arthroscopy used to treat primary osteoarthritis with and without release of the posterior band of the medial collateral ligament. *Arthroscopy* 2017;33:1506–1511.

10. **Kim SJ, Shin SJ.** Arthroscopic treatment for limitation of motion of the elbow. *Clin Orthop Relat Res* 2000;375:140–148.

11. **Krishnan SG, Harkins DC, Pennington SD, Harrison DK, Burkhead WZ.** Arthroscopic ulnohumeral arthroplasty for degenerative arthritis of the elbow in patients under fifty years of age. *J Shoulder Elbow Surg* 2007;16:443–448.

12. **Lim TK, Koh KH, Lee HI, Shim JW, Park MJ.** Arthroscopic débridement for primary osteoarthritis of the elbow: analysis of preoperative factors affecting outcome. *J Shoulder Elbow Surg* 2014;23:1381–1387.

13. **MacLean SB, Oni T, Crawford LA, Deshmukh SC.** Medium-term results of arthroscopic debridement and capsulectomy for the treatment of elbow osteoarthritis. *J Shoulder Elbow Surg* 2013;22:653–657.

14. **McLaughlin RE II, Savoie FH III, Field LD, Ramsey JR.** Arthroscopic treatment of the arthritic elbow due to primary radiocapitellar arthritis. *Arthroscopy* 2006;22:63–69.

15. **Merolla G, Buononato C, Chillemi C, Paladini P, Porcellini G.** Arthroscopic joint debridement and capsular release in primary and post-traumatic elbow osteoarthritis: a retrospective blinded cohort study with minimum 24-month follow-up. *Musculoskelet Surg* 2015;99:S83–S90.

16. **Ogilvie-Harris DJ, Gordon R, MacKay M.** Arthroscopic treatment for posterior impingement in degenerative arthritis of the elbow. *Arthroscopy* 1995;11:437–443.

17. **Pederzini LA, Nicoletta F, Tosi M, Prandini M, Tripoli E, Cossio A.** Elbow arthroscopy in stiff elbow. *Knee Surg Sports Traumatol Arthrosc* 2014;22:467–473.

18. **Redden JF, Stanley D.** Arthroscopic fenestration of the olecranon fossa in the treatment of osteoarthritis of the elbow. *Arthroscopy* 1993;9:14–16.

19. **Savoie FH III, Nunley PD, Field LD.** Arthroscopic management of the arthritic elbow: indications, technique, and results. *J Shoulder Elbow Surg* 1999;8:214–219.

20. **Willinger L, Siebenlist S, Lenich A, Liska F, Imhoff AB, Achtnich A.** Arthroscopic arthrolysis provides good clinical outcome in post-traumatic and degenerative elbow stiffness. *Knee Surg Sports Traumatol Arthrosc* 2018;26:312–317.

21. **Tsuge K, Mizuseki T.** Debridement arthroplasty for advanced primary osteoarthritis of the elbow: results of a new technique used for 29 elbows. *J Bone Joint Surg Br* 1994;76:641–646.

22. **Hattori Y, Doi K, Sakamoto S, Hoshino S, Dodakundi C.** Capsulectomy and debridement for primary osteoarthritis of the elbow through a medial trans-flexor approach. *J Hand Surg Am* 2011;36:1652–1658.

23. **Raval P, Ellanti P, Harrington P.** Ulnohumeral debridement arthroplasty: a retrospective study and midterm outcome results. *Eur J Orthop Surg Traumatol* 2015;25:847–850.

24. **Baghdadi YM, Morrey BF, Sanchez-Sotelo J.** Anconeus interposition arthroplasty: mid- to long-term results. *Clin Orthop Relat Res* 2014;472:2151–2161.

25. **Al Hussainy H, Hekal W, Farhan M.** The Outerbridge-Kashiwagi procedure for osteoarthritis of the elbow: do site and number of loose bodies matter to the outcome? *Eur J Orthop Surg Traumatol* 2005;15:129–134.

26. **Cha SM, Shin HD, Kim KC, Park IY.** Outcomes of the mini-open Outerbridge-Kashiwagi procedure according to preoperative radiocapitellar joint status. *J Hand Surg Am* 2014;39:209–218.

27. **DeGreef I, Samorjai N, De Smet L.** The Outerbridge-Kashiwaghi procedure in elbow arthroscopy. *Acta Orthop Belg* 2010;76:468–471.

28. **Forster MC, Clark DI, Lunn PG.** Elbow osteoarthritis: prognostic indicators in ulnohumeral debridement: the Outerbridge-Kashiwagi procedure. *J Shoulder Elbow Surg* 2001;10:557–560.

29. **Vingerhoeds B, Degreef I, De Smet L.** Debridement arthroplasty for osteoarthritis of the elbow (Outerbridge-Kashiwagi procedure). *Acta Orthop Belg* 2004;70:306–310.

30. **Giannicola G, Angeloni R, Mantovani A, et al.** Open debridement and radiocapitellar replacement in primary and post-traumatic arthritis of the elbow: a multicenter study. *J Shoulder Elbow Surg* 2012;21:456–463.

31. **Welsink CL, Lambers KTA, van Deurzen DFP, Eygendaal D, van den Bekerom MPJ.** Total elbow arthroplasty: a systematic review. *JBJS Rev* 2017;5:e4.

32. **Prkic A, Welsink C, The B, van den Bekerom MPJ, Eygendaal D.** Why does total elbow arthroplasty fail today? A systematic review of recent literature. *Arch Orthop Trauma Surg* 2017;137:761–769.

33. **Heijink A, Morrey BF, Eygendaal D.** Radiocapitellar prosthetic arthroplasty: a report of 6 cases and review of the literature. *J Shoulder Elbow Surg* 2014;23:843–849.

34. **Giannicola G, Sacchetti FM, Antonietti G, Piccioli A, Postacchini R, Cinotti G.** Radial head, radiocapitellar and total elbow arthroplasties: a review of recent literature. *Injury* 2014;45:428–436.

35. **Pitta M, Davis W III, Argintar EH.** Arthroscopic management of osteoarthritis. *J Am Acad Orthop Surg* 2016;24:74–82.

36. **Moher D, Shamseer L, Clarke M, et al; PRISMA-P Group.** Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Syst Rev* 2015;4:1.

37. **Slim K, Nini E, Forestier D, Kwiatkowski F, Panis Y, Chipponi J.** Methodological Index for Non-Randomized Studies (MINORS): development and validation of a new instrument. *ANZ J Surg* 2003;73:712–716.

38. **Higgins JP, Altman DG, Gøtzsche PC, et al; Cochrane Bias Methods Group; Cochrane Statistical Methods Group.** The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *BMJ* 2011;343:d5928.

39. **Walter SD, Yao X.** Effect sizes can be calculated for studies reporting ranges for outcome variables in systematic reviews. *J Clin Epidemiol* 2007;60:849–852.

40. **Bhattacharya B, Habtzghi D.** Median of the p value under the alternative hypothesis. *Am Stat* 2002;56:202–206.

41. **Higgins JP, Thompson SG.** Quantifying heterogeneity in a meta-analysis. *Stat Med* 2002;21:1539–1558.

42. **Allen DM, Devries JP, Nunley JA.** Ulnohumeral arthroplasty. *Iowa Orthop J* 2004;24:49–52.

43. **Antuña SA, Morrey BF, Adams RA, O'Driscoll SW.** Ulnohumeral arthroplasty for primary degenerative arthritis of the elbow: long-term outcome and complications. *J Bone Joint Surg Am* 2002;84:2168–2173.

44. **Oka Y.** Debridement arthroplasty for osteoarthrosis of the elbow: 50 patients followed mean 5 years. *Acta Orthop Scand* 2000;71:185–190.

45. **Rettig LA, Hastings H II, Feinberg JR.** Primary osteoarthritis of the elbow: lack of radiographic evidence for morphologic predisposition, results of operative debridement at intermediate follow-up, and basis for a new radiographic classification system. *J Shoulder Elbow Surg* 2008;17:97–105.

46. **Sarris I, Riano FA, Goebel F, Goitz RJ, Sotereanos DG.** Ulnohumeral arthroplasty: results in primary degenerative arthritis of the elbow. *Clin Orthop Relat Res* 2004;420:190–193.

47. **Tashjian RZ, Wolf JM, Ritter M, Weiss AP, Green A.** Functional outcomes and general health status after ulnohumeral arthroplasty for primary degenerative arthritis of the elbow. *J Shoulder Elbow Surg* 2006;15:357–366.

48. **Lubiatowski P, Ślęzak M, Wałecka J, Bręborowicz M, Romanowski L.** Prospective outcome assessment of arthroscopic arthrolysis for traumatic and degenerative elbow contracture. *J Shoulder Elbow Surg* 2018;27:e269–e278.

49. **Miyake J, Shimada K, Moritomo H, Kataoka T, Murase T, Sugamoto K.** Kinematic changes in elbow osteoarthritis: in vivo and 3-dimensional analysis using computed tomographic data. *J Hand Surg Am* 2013;38:957–964.

50. **Phillips NJ, Ali A, Stanley D.** Treatment of primary degenerative arthritis of the elbow by ulnohumeral arthroplasty: a long-term follow-up. *J Bone Joint Surg Br* 2003;85:347–350.

51. **Poonit K, Zhou X, Zhao B, et al.** Treatment of osteoarthritis of the elbow with open or arthroscopic debridement: a narrative review. *BMC Musculoskelet Disord* 2018;19:394.

52. **Sochacki KR, Jack RA II, Hirase T, et al.** Arthroscopic debridement for primary degenerative osteoarthritis of the elbow leads to significant improvement in range of motion and clinical outcomes: a systematic review. *Arthroscopy* 2017;33:2255–2262.

53. **Fletcher J.** What is heterogeneity and is it important? *BMJ* 2007;334:94–96.

54. **Barili F, Parolari A, Kappetein PA, Freemantle N.** Statistical primer: heterogeneity, random- or fixed-effects model analyses? *Interact Cardiovasc Thorac Surg* 2018;27:317–321.

55. **Riley RD, Higgins JP, Deeks JJ.** Interpretation of random effects meta-analyses. *BMJ* 2011;342:d549.

56. **Carlier Y, Desmoineaux P, Lenoir H, Vidil A; French Arthroscopic Society.** Prospective comparative analysis of arthroscopic debridement for primary and post-traumatic elbow osteoarthritis. *Orthop Traumatol Surg Res* 2019;105:S217–S220.

57. **Morrey BF, Askew LJ, Chao EY.** A biomechanical study of normal functional elbow motion. *J Bone Joint Surg Am* 1981;63:872–877.

58. **Sardelli M, Tashjian RZ, MacWilliams BA.** Functional elbow range of motion for contemporary tasks. *J Bone Joint Surg Am* 2011;93:471–477.

59. **Lindenhovius AL, Doornberg JN, Ring D, Jupiter JB.** Health status after open elbow contracture release. *J Bone Joint Surg Am* 2010;92:2187–2195.

60. **Lee JS, Hobden E, Stiell IG, Wells GA.** Clinically important change in the visual analog scale after adequate pain control. *Acad Emerg Med* 2003;10:1128–1130.

61. **Kelly AM.** The minimum clinically significant difference in visual analogue scale pain score does not differ with severity of pain. *Emerg Med J* 2001;18:205–207.

62. **Danoff JR, Goel R, Sutton R, Maltenfort MG, Austin MS.** How much pain is significant? Defining the minimal clinically important difference for the visual analog scale for pain after total joint arthroplasty. *J Arthroplasty* 2018;33:S71–S75.e2.

63. **Kautzner J, Zeman P, Stančák A, Havlas V.** Hip arthroscopy learning curve: a prospective single-surgeon study. *Int Orthop* 2018;42:777–782.

64. **Galatz LM.** Editorial commentary: open versus arthroscopic elbow osteocapsular arthroplasty. *Arthroscopy* 2019;35:1090–1091.

65. **Cheadle WG.** Risk factors for surgical site infection. *Surg Infect (Larchmt)* 2006;7:S7–S11.

66. **Kim SJ, Kim JW, Lee SH, Choi JW.** Retrospective comparative analysis of elbow arthroscopy used to treat primary osteoarthritis with and without release of the posterior band of the medial collateral ligament. *Arthroscopy* 2017;33:1506–1511.

67. **Wong SH, Chiu KY, Yan CH.** Review article: osteophytes. *J Orthop Surg (Hong Kong)* 2016;24:403–410.