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Radiocapitellar Arthroplasty: Systematic Review

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Abstract

Introduction: Primary elbow osteoarthritis affects approximately 2% of the population, and has been treated with arthroplasty. However, total elbow arthroplasty (TEA) implants currently have severe weight limitations and issues with longevity. In patients with unicompartmental arthritis, unicompartmental arthroplasty may be used instead of TEA. We describe the use of Uni-Elbow Radio-Capitellum and Lateral Resurfacing Elbow for radiocapitellar arthroplasty (RCA) in this article.

Methods: Reviewers independently searched databases for keywords, such as radiocapitellar arthroplasty, RCA, uni-elbow radiocapitellum, UNI-E, and lateral resurfacing elbow, LRE. The measured outcomes of interest were the change in motion arc and patient-reported outcome scores. Studies that were not of appropriate quality determined by the Cochrane risk of bias summary tool and review studies were excluded.

Results: RCA resulted in a postoperative $38.3° \pm 28.5°$ increase in elbow flexion-extension ($P < .001$), and $35.2° \pm 28.6°$ increase in elbow pronation-supination ($P < .001$). Mayo Elbow Performance Score was significantly increased by 44.8 ± 12.6. DASH Score saw a significant reduction by 45.0 ± 14.6 points ($P < .001$), while the American Shoulder and Elbow Surgeons Score increased by 47.0 ± 10.6 points ($P < .001$). Of the 105 adult patients 16.2% experienced complications such as minor stiffness, ulnar neuropathy, component loosening, or radial head UNI-E stem failure. Reported complications were higher in the UNI-E group than in the LRE group.

Conclusion: RCA has shown promise as an option to treat radiocapitellar arthritis, particularly when excising the radial head causes lateral column instability.

Keywords

arthroplasty, radiocapitellar arthroplasty, elbow

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Introduction

Most osteoarthritis of the radiocapitellar joint has a posttraumatic or idiopathic origin.[1] Primary elbow osteoarthritis affects approximately 2% of the population and often occurs in male patients with a history of heavy lifting or athletics.[2,3] These degenerative changes can occur at the ulnohumeral, radiocapitellar (RC), or radioulnar joint and commonly cause pain, stiffness, and locking of the elbow.[4] The radiocapitellar joint, which is the articulation between the ellipsoid-shaped capitulum of the humerus and the concave surface of the radial head, has a distinct role in the stability of the elbow through the arc of forearm pronation and supination.[5,6] The capitulum and the radial head and neck are displaced from the long axis of the radius by 15° to maintain contact while undergoing 180° of pronation-supination.[7] Isolated lateral degeneration of the elbow is a very rare occurrence and tends to occur first before other compartments of the elbow are affected.[8] The options for treatment have evolved over time to attempt to alleviate pain, stabilize the lateral

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column of the elbow to prevent valgus or longitudinal instability, and restore normal kinematics.[8] These treatments are categorized in the form of debridement, arthrodesis, and arthroplasty. Arthroplasty techniques have previously focused on either interpositional material filling the space of the RC joint or total elbow arthroplasty. However, interpositional arthroplasty can potentially cause weakness or paresthesias of the operative site, donor site morbidity, and a high revision rate while total joint arthroplasty is not suitable for young, active individuals given strict postoperative activity and weight-bearing restrictions.[9]

Radiocapitellar arthroplasty (RCA) is primarily used to treat isolated radiocapitellar joint arthritis.[10] There are 2 primary means of RCA: replacement and resurfacing. The Uni-Elbow Radio-Capitellum (UNI-E) system replaces the radial head and capitulum.[11] The Lateral Resurfacing Elbow (LRE) includes reaming of the degenerative joint surfaces while preserving the original radial head and capitulum.[12] RCA has only seen widespread use recently because the long-term outcomes of this operation are poorly understood. This systematic review of the literature investigates differences in the techniques, indications, outcomes, and complications of RCA. We hypothesize that there will be a greater postoperative range of motion and lower complication rates in patients receiving the LRE than in patients undergoing the UNI-E system.

Methods

We performed this systematic review in accordance with the PRISMA extension statement for reporting and incorporating meta-analyses of healthcare interventions (citation).

Study Screening

Three reviewers independently searched PubMed, OVID Medline, EMBASE, and Cochrane online databases for studies up to April 2022, using keywords relating to Radiocapitellar Arthroplasty: radiocapitellar arthroplasty, RCA, uni-elbow radiocapitellum, UNI-E, lateral resurfacing elbow, LRE. Two other independent reviewers and the senior author verified that each study met the inclusion criteria as described below.

Assessment of Study Eligibility

Initial screening involved studies on resurfacing or prosthetic replacement arthroplasty of the radiocapitellar joint. We included in our search randomized controlled trials (RCTs), case series, case reports, and prospective or retrospective comparative studies in English, Hindi, Farsi, or Arabic that reported at least one score or motion arc from the following: flexion-extension arc, pronation-supination arc, Mayo elbow performance score, DASH score (Disabilities of Arm, Shoulder, and Hand), SF-30 (Short Form – 30) score, OES (Oxford Elbow Score), or m-ASES (Pre-op Modified American Shoulder Elbow Surgeons) score. The measured outcomes of interest were the change in motion arc or patient-reported outcome scores. Secondary measured outcomes included complications seen in each study reviewed. The Cochrane risk of bias summary tool was used to assess the study quality (citation). We excluded studies that were not deemed appropriate quality as determined by the Cochrane risk of bias summary tool or those that reviewed other studies without new or primary data.

Study Population & Database Generation

A collection of individual patient demographics and outcomes was generated from the data included in each eligible study. Studies without granular data used the reported mean $\pm$ standard deviation and were assigned a weight equal to their sample size for statistical analysis purposes.

Statistical Analysis

Statistical analysis was performed with the Stata 17.0 statistical software package (StataCorp, College Station, TX). Categorical variables were reported as numbers (percentage) and were compared using the Chi-square test. Continuous variables were reported as mean $\pm$ standard deviation and were compared using the Student's *t*-test. Variables were compared first via postoperative versus preoperative values (Table 1), and a subanalysis was performed comparing the 2 major prosthesis types, LRE and UNI-E (Table 2). Differences between groups were considered statistically significant with a 2-tailed *P*-value of $< .05$.

Results

Study Information & Population

We identified and included 10 studies in our review: 7 case series and 3 individual case reports.[8,13–21] No randomized controlled trials were found in our search. Additional information regarding these studies can be found in Table 3. Our patient cohort consisted of 105 adult patients. Of these patients, 48.6% are female and 51.4% are male, with a mean age of 52.7 ± 9.0 years and a mean follow-up time of 49.8 ± 27.4 months. Summary statistics and entry completion for our cohort's characteristics and outcomes are reported in Table 1.

RCA Characteristics

The most common indication for RCA was primary degenerative arthritis (43.3%), followed by posttraumatic degenerative arthritis (37.5%), fracture (10.6%), degenerative arthritis following avascular necrosis (5.8%), and revision for loosening of the radial head prosthesis (2.9%). The

Table 1. Characteristics and Outcomes for Radiocapitellar Arthroplasty.

Characteristic	Mean ± SD/No. (%)/*P*	Entry completion
Age (years)	52.7 ± 9.0	99.0%
Female	51 (48.6%)	100.0%
Dominant elbow	7 (63.6%)	10.5%
Follow-up time (months)	49.8 ± 27.4	99.0%
Indication		
Primary degenerative arthritis	45 (43.3%)	99.0%
Posttraumatic degenerative arthritis	39 (37.5%)	
Fracture	11 (10.6%)	
Degenerative arthritis postavascular necrosis	6 (5.8%)	
Revision for radial head prosthesis loosening	3 (2.9%)	
Approach		
Kocher	45 (53.6%)	80.0%
Extensor tendon split	16 (19.0%)	
Transtricipital	15 (17.9%)	
Newcastle	8 (9.5%)	
Prosthesis		
LRE: press-fit (lateral resurfacing elbow)	68 (64.8%)	100.0%
UNI-E: radial head excision with replacement	37 (35.2%)	
Fixation type		
Cemented	20 (35.7%)	53.3%
Uncemented	36 (64.3%)	
Outcome		
Flexion-extension arc degrees		
Pre-op	76.1 ± 27.5	96.2%
Post-op	113.9 ± 15.1	96.2%
Δ	**+ 38.3° ± 28.5° (*P* < .001)**	95.2%
Pronation-supination arc degrees		
Pre-op	100.7 ± 41.1	81.0%
Post-op	136.5 ± 22.2	81.9%
Δ	**+ 35.2° ± 28.6° (*P* < .001)**	81.0%
Mayo Elbow Performance Score		
Pre-op	45.1 ± 9.3	95.2%
Post-op	90.0 ± 7.3	98.1%
Δ	**+ 44.8 ± 12.6 (*P* < .001)**	94.3%
DASH Score		
Pre-op	61.9 ± 9.4	55.2%
Post-op	17.6 ± 8.8	61.0%
Δ	**−45.0 ± 14.6 (*P* < .001)**	55.2%
ASES Score		
Pre-op	40.2 ± 7.2	48.6%
Post-op	87.3 ± 3.5	48.6%
Δ	**+ 47.0 ± 10.6 (*P* < .001)**	48.6%
Post-op:		
Complication reported	17 (16.2%)	
SF-36 Physical	43.3 ± 9.3	5.7%
SF-36 Mental	58.4 ± 8.7	5.7%
OES Pain	51.9 ± 20.6	24.8%
OES Functional	84.3 ± 7.7	23.8%
OES Psycho-Social	66.7 ± 21.2	5.7%

Bold values indicate a significant difference pre-op versus post-op at $P < .05$. SF-36, Short-Form questionnaire; OES, Oxford Elbow Score.

Kocher approach (interval between the anconeus and extensor carpi ulnaris tendon) was used most frequently (53.6%), followed by an extensor tendon split approach (19.0%), trans-tricipital approach (17.9%), and the Newcastle approach (triceps preserving approach) (9.5%) (Table 1). 64.8% of patients received the Lateral Resurfacing Elbow resurfacing prosthesis, while the other 35.2% underwent UNI-E radial and capitellar arthroplasty. Of the UNI-E

Table 2. Characteristics and Outcomes by Prosthesis Type.

Characteristic	LRE (n = 68)	UNI-E (n = 37)	*P*
Age (years)	53.7 ± 8.5	50.6 ± 9.6	.103
Follow-up time (months)	46.5 ± 28.3	56.1 ± 24.6	.090
Indication			
Primary degenerative arthritis	**39 (58.2%)**	**6 (16.2%)**	**< .001**
Posttraumatic degenerative arthritis	22 (32.8%)	17 (45.9%)	.816
Fracture	**4 (6.0%)**	**7 (18.9%)**	**.040**
Degenerative arthritis post avascular necrosis	2 (3.0%)	4 (10.8%)	.101
Revision for radial head prosthesis loosening	**0 (0.0%)**	**3 (8.1%)**	**.018**
Approach			
Kocher	28 (54.9%)	17 (51.5%)	.761
Extensor tendon split	**0 (0.0%)**	**16 (48.5%)**	**< .001**
Trans-tricipital	**15 (29.4%)**	**0 (0.0%)**	**< .001**
Newcastle	**8 (15.7%)**	**0 (0.0%)**	**.017**
Fixation type			
Cemented	**1 (2.9%)**	**19 (90.5%)**	**< .001**
Uncemented	**34 (97.1%)**	**2 (9.5%)**	**< .001**
Outcome			
Complication reported	**7 (10.3%)**	**10 (27.0%)**	**.026**
Flexion-extension arc degrees			
Pre-op	**71.0° ± 24.2°**	**85.8 ± 31.1°**	**.010**
Post-op	**110.1° ± 12.2°**	**121.4 ± 17.4°**	**< .001**
Δ	+ 39.2° ± 27.4°	+ 36.6 ± 30.8°	.672
Pronation-supination arc degrees			
Pre-op	**109.0° ± 38.3°**	**72.1° ± 38.0°**	**< .001**
Post-op	**139.1° ± 22.2°**	**127.2° ± 20.0°**	**.038**
Δ	**+ 29.5° ± 28.6°**	**+ 55.1° ± 18.0°**	**< .001**
Mayo Elbow Performance Score			
Pre-op	**43.6 ± 6.9**	**47.9 ± 12.4**	**.031**
Post-op	90.2 ± 5.3	89.7 ± 10.4	.729
Δ	+ 46.3 ± 10.9	+ 42.0 ± 15.3	.114

Bold values indicate a significant difference between prostheses at $P < .05$.

devices used, 35.7% underwent cemented fixation and 64.3% underwent press-fit fixation (Table 1).

RCA Outcomes

RCA resulted in a postoperative 38.3° ± 28.5° increase in elbow flexion-extension ($P < .001$), as well as a 35.2° ± 28.6° increase in elbow pronation-supination ($P < .001$) (Table 1). Mayo Elbow Performance Score was significantly increased by 44.8 ± 12.6 points from a preoperative average classification as "poor" to a postoperative average classification as "excellent" ($P < .001$). The DASH Score saw a significant reduction by 45.0 ± 14.6 points ($P < .001$), while the American Shoulder and Elbow Surgeons Score increased by 47.0 ± 10.6 points ($P < .001$) (Table 1).

Complications were reported in 16.2% of cases, which included minor stiffness ($n = 3$), stiffness with arthrolysis ($n = 2$), ulnar neuropathy ($n = 2$), radial head component loosening ($n = 1$), heterotopic ossification ($n = 1$), capitellar component displacement ($n = 1$), radial head or neck resorption ($n = 3$), or radial head UNI-E stem failure ($n = 4$). Postoperative scores for SF-30 Physical and Mental, as well as OES Pain, Functional, and Psycho-Social assessments, can be found in Table 1.

LRE Versus UNI-E

A subanalysis comparing the LRE and UNI-E prostheses can be found in Table 2. While mean patient age and follow-up time were consistent between groups, LRE was more commonly utilized for primary degenerative arthritis ($P < .001$). In contrast, UNI-E was performed more often for indications such as fracture and revision following radial head prosthesis loosening. While the Kocher approach was equally common, studies including the UNI-E system tended to use the extensor tendon split approach, while LRE was more likely to be performed by the trans-tricipital or Newcastle approaches. 97.1% of LRE elbows were uncemented, while 90.5% of UNI-E elbows were cemented (Table 2).

Reported complications were higher in the UNI-E group (27.0% vs 10.3%, $P = .026$). While the UNI-E group demonstrated higher flexion-extension arc measurements both pre-op and post-op, there was no significant difference in the overall increase in arc degrees between groups ($P = .672$). In contrast, the LRE cohort demonstrated higher pronation-supination arc measurements both pre-op and post-op. However, the overall increase in motion was more substantial for the UNI-E group (55.1° ± 18.0° vs 29.5° ± 28.6°, $P < .001$). Finally, neither the postoperative Mayo Elbow Performance Score ($P = .729$) nor the change in score ($P = .114$) were significantly different between groups (Table 2).

Discussion

Our systematic review of 105 patients across 10 studies found that following RCA (1) there was a significant increase in both the flexion-extension and pronation-supination arc ($P < .001$); (2) there was no significant difference in the Mayo Elbow Performance Score following UNI-E and LRE based arthroplasties; (3) there was a significantly higher rate of complications in UNI-E compared to LRE ($P = .026$); and (4) there was a significantly greater increase in a pronation-supination arc following UNI-E compared to LRE.

Table 3. Characteristics of Included Radiocapitellar Arthroplasty Studies.

Reference	Study	Country	Design	N	Prosthesis type
Heijink et al[13]	Heijink (2008)	USA	Case series	3	LRE & UNI-E
Giannicola et al[14]	Giannicola (2010)	Italy	Case report	1	LRE
Kepler et al[15]	Kepler (2010)	USA	Case report	1	UNI-E
Giannicola et al[16]	Giannicola (2012)	Italy	Case series	20	LRE
Heijink et al[17]	Heijink (2014)	Netherlands	Case series	6	LRE
Bigazzi et al[18]	Bigazzi (2016)	Italy	Case series	7	LRE
Schmidt[19]	Schmidt (2017)	Germany	Case report	1	LRE
Kachooei et al[8]	Kachooei (2018)	Iran	Case series	19	LRE & UNI-E
Spross et al[20]	Spross (2019)	Switzerland	Case series	16	UNI-E
Giannicola et al[21]	Giannicola (2019)	Italy	Case series	31	LRE & UNI-E

Abbreviations: UNI-E, uni-elbow radiocapitellum, LRE, lateral resurfacing elbow.

Studies dating back to 1967 identified that the lateral elbow compartment is the first to show degenerative changes and pain refractory to medical treatment in patients younger than 50.[22] In younger, more active patients who do not have significant ulnohumeral degeneration, total elbow arthroplasty may be unnecessary, and RCA should be considered.[23] Our study found that there was a significant increase in both the flexion-extension and pronation-supination arc ($P < .001$) following either method of RCA, suggesting that this operation is an effective means to improve elbow joint mobility.

Both LRE and UNI-E are used when performing RCA, but each of these has different methods of implantation, which may impact the rates of complications for each system. One difference is that the UNI-E implant requires the use of bone cement, a space-filling substance that expands to fill the space between implants and bone.[24] Bone cement has potential side effects, including cement fragmentation, and expansion over time.[24] We identified 1 case of LRE that was performed with cementing, and 2 cases of UNI-E that were performed without cementing across 105 cases, which supports the traditional application of each implant.

When comparing the outcomes of UNI-E and LRE, our study identified a significantly greater increase in pronation-supination following UNI-E when compared to LRE, but also identified a higher rate of complications following UNI-E when compared to LRE. Our study also found that patients undergoing UNI-E had significantly worse preoperative pronation-supination arc degrees than patients undergoing LRE ($P < .001$), which could be the reason that there was a significantly greater increase in the range of motion (ROM) following operation with UNI-E. The UNI-E implant requires the removal of the radial head and capitellum, while LRE simply resurfaces the joint and preserves these bony structures.[25,26] These differences allow the UNI-E implant to be used in situations where bone resection is required, or there is inadequate bone to simply resurface the joint.[21] Additionally, joint replacement without bone preservation as seen in the UNI-E may contribute to the relatively greater increase in ROM, and the higher rates of complications seen in this system. Despite these differences in the motion of pronation-supination possible postoperatively, our study also identified that there was no difference in the Mayo Elbow Performance Score following operation with either of the 2 procedures, meaning that there may not be a meaningful difference in the quality of life following an operation that can be attributed to the use of either system. This supports the idea that the relative increase in ROM following UNI-E compared to LRE may be due to preoperative differences determining which system surgeons utilize, and postoperative outcomes are very similar. Surgeons should choose whether to use the UNI-E or LRE system on a case-by-case basis based on the injuries and conditions of each patient.

One potential complication of performing RCA is potential damage to the posterior interosseous nerve (PIN), which innervates the supinator muscles, and the extensor muscles of the wrist and digits.[27] This nerve originates in close proximity to the radiocapitellar joint, with one cadaver study finding it on average 1.2 mm from the joint.[28] In this systematic review of RCA no instances of this complication were identified, but surgeons should remain vigilant of this potential complication due to the anatomical proximity of this nerve to the joint site.

Although over 50% of both UNI-E and LRE procedures were conducted using the Kocher approach, 29.4% and 15.7% of UNI-E operations were performed with the trans-tricipital and Newcastle approaches, respectively. 48.5% of LRE operations were performed with the extensor tendon split approach. LRE using the extensor tendon split approach was only reported by Spross et al,[10] suggesting that the results of very few surgeons were reported from this approach. Additionally, operations using the trans-tricipital approach were only reported by Giannicola et al[14,16] and were not reported in any of the more recent studies. The Newcastle approach was only reported by Giannicola et al,[21] suggesting that the surgeon transitioned from the trans-tricipital approach to the Newcastle approach. One potential reason for the difference in rates of each approach

may be the amount of exposure. Desloges et al[29] conducted a cadaver study of 16 upper extremities and found that the extensor tendon split approach provided more reliable visualization of the anterior radial head. Additionally, further studies should be conducted to determine the relative efficacy of each of these surgical approaches.

Limitations

The retrospective nature of this study introduces certain unavoidable biases. Furthermore, although this is a systematic review of the literature, the patients included in this review are solely from case reports and case series which limits the scope of our findings. Additional studies about the relative efficacy of the 2 commonly used implants in this procedure must be conducted to improve the quality of the literature on this topic. Additionally, the collected studies did not report on the same outcomes. This further limits our ability to compare the outcomes reported in these studies.

Conclusion

Whether choosing LRE or UNI-E for lateral elbow degeneration, RCA has shown promise as an option for radiocapitellar arthritis, particularly when excising the radial head causes lateral column instability.[17] While radial head resections have traditionally been used to treat radiocapitellar arthritis, the proximal migration of the radius and long-term acceleration of ulnohumeral arthritis are reasons to favor RCA.[30,31] RCA is a relatively new technique with a growing body of literature. We hope that our systematic review of the literature can inform surgeons about the risks and benefits of each of the methods used to perform RCA. To our knowledge, this is one of the first studies to conduct a systematic review for RCA. Future studies should aim to investigate the relative benefit of RCA versus total elbow arthroplasty to determine if there is a benefit to unicompartmental arthroplasty.

Declaration of Conflicting Interests

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