The comparative performance of radial head prostheses in patients younger than and older than 50 years: a systematic review

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The comparative performance of radial head prostheses in patients younger than and older than 50 years: a systematic review

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The comparative performance of radial head prostheses in patients younger than and older than 50 years: a systematic review

Abstract

Background

Patient age may play a role in the surgeon’s decision between RHA and ORIF in radial head fracture treatment. Though large sample reports have detailed outcomes of radial head replacement for a mean age younger than 50 years, the age ranges are widely distributed. Patient outcomes are not uniform across a broad age distribution. Therefore, treatment decisions should be evaluated within the confines of a narrower age bracket. An understanding of clinical outcomes for radial head replacement in younger adults will provide value for guiding treatment decisions. We performed a systematic review comparing the clinical outcomes for radial head replacement in patients younger and older than 50 years of age. Further analysis compared outcomes between radial head arthroplasty performed as a primary procedure and as a secondary procedure in patients younger and older than 50 years of age.

Methods

PubMed was queried for articles which delineated individual patient data for age, surgical treatment, and appropriate outcome metrics. Articles were grouped based on patient age of under 50 and over 50 years and within those age groups, based on the arthroplasty being performed as a primary or as a secondary procedure.

Results

There were no significant differences between the under 50 and the over 50 groups for MEPS (p=0.79) and for implant revision/removal (p=0.32). In the under 50 group, RHA done as a primary procedure had significantly higher (p=0.001) mean MEPS than RHA done as a
Age specific performance of RHA

secondary procedure. In the over 50 group, relative risk was 2.39 (95% CI 2.12 - 2.69) for implant revision/removal (p=0.11) when comparing primary and secondary procedures.

Discussion

At a mean follow-up of 48 months, radial head arthroplasty in patients under the age of 50 years had satisfactory outcomes which were comparable to outcomes in patients over the age of 50 years. Across both age groups, arthroplasty performed as a primary procedure demonstrated superior outcomes compared to arthroplasty performed as a secondary procedure. Our findings provide guidance to surgeons who face a multifaceted decision when encountering younger adult patients with radial head fracture patterns that may not be amenable to fixation. Awareness of the age-specific performance of radial head implants is an important component of the decision for surgical treatment.

Level of evidence: Level IV; Systematic Review

Keywords: radial head arthroplasty, radial head fracture, radial head ORIF, radial head revision

There has been a recent increase in the incidence of radial head fractures and as a result, the utilization of radial head arthroplasty (RHA) has also increased. Concurrent with this rise in RHA is a decline in the utilization of open reduction internal fixation (ORIF) for these fractures. Possible explanations for this trend in surgical management include prosthesis innovation, increasing favorable reports on RHA, the potential for improved surgical efficiency with RHA, and the increasing population age which may make ORIF less feasible.
Rigorous study has advanced our understanding of the radial head’s importance to the elbow and to distal articulations such as the distal radioulnar joint. Loss of the proximal radius as the secondary valgus stabilizer of the elbow may compromise elbow function. Radial head resection has a role in the treatment of certain radial head fractures however it may lead to loss of stability, altered mechanics and additional load on supporting structures.

In the majority of radial head fractures, replacement or osteosynthesis is favored in order to maintain radiocapitellar stability. The decision for radial head fixation versus arthroplasty can be straightforward in the setting of simple fractures and highly comminuted fractures. The surgical decision is more challenging in cases which fall in the middle of the spectrum of fracture complexity.

Patient age may play a role in the surgeon’s decision between RHA and ORIF in radial head fracture treatment. Though large sample reports have detailed outcomes of radial head replacement for a mean age younger than 50 years, the age ranges are widely distributed. Patient outcomes are not uniform across a broad age distribution. Therefore, treatment decisions should be evaluated within the confines of a narrower age bracket. O’Connor et al queried 150 surgeons to determine treatment preference for radial head fractures in various clinical scenarios. The authors concluded that surgeons were more likely to recommend ORIF than RHA in younger populations. Whether this partiality is validated by the literature is unknown. An understanding of clinical outcomes for radial head replacement in younger adults will provide value for guiding treatment decisions.
We had 2 specific aims: 1) To perform a review of the current literature comparing clinical outcomes for radial head replacement in patients younger and older than 50 years of age, 2) To determine if the RHA performed as a primary procedure versus as a secondary procedure had an impact on clinical outcomes, in patients younger and older than 50 years of age.

**Methods**

A systematic review was performed using the guidelines of Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA). Two study authors independently evaluated the PubMed database search returns on May 15, 2021. The search algorithm was meant to capture a wide range of results; thus, improving the generalizability of the conclusion. There was no time frame restriction on the search return. Search terminology were as follows: “radial head arthroplasty” OR “replacement” OR “prosthesis” AND “Mayo”, radial head arthroplasty” OR “replacement” OR “prosthesis” AND “terrible triad”.

**Article Selection**

Inclusion criteria specified that each article have a table with individual patient reporting of age, surgical treatment, and appropriate outcome data. Further, inclusion required individual patient reporting for one of two specific outcome metrics - a numeric Mayo Elbow Performance Score (the categorized score did not suffice) (MEPS) or specific verbiage detailing implant revision or removal. This process ensured that only implant-related reoperations were included in the
For an article to be included with zero removals or revisions, the article had to specifically state the lack of a secondary procedure. This criterion was not presumed based on the failure to mention an implant removal or revision procedure. Additionally, if removals or revisions were not detailed in a way that allowed confirmation of patient age, the article was not included.

**Article Grouping**

In keeping with the primary clinical study question, data were grouped based on patient ages of younger than 50 years and older than 50 years. Additionally, within both age groups, articles were grouped based on the radial head arthroplasty being performed as a primary procedure or as a secondary procedure.

**Data Collection**

The aggregated data included the study characteristics, the follow-up term, functional outcomes, clinical outcomes, implant type and whether revision or removal of the implant occurred. Functional outcomes were the elbow arc of motion and forearm rotation. Clinical outcomes were MEPS and Disabilities of the Arm, Shoulder and Hand score (DASH). Rates and indication for implant revision or removal were recorded.

**Statistical Analysis**
For the outcome metrics, pooled means were frequency weighted to represent the number of patients in each article. Two sample Student t tests assuming unequal variance were used to calculate the differences between groups. Relative risk ratios were calculated for the rates of implant revision/removal and for MEPS of 74 and below. For implant revision/removal and MEPS of 74 and below, a chi squared test was performed to determine if differences were statistically significant. For groups with low sample sizes, Fisher’s exact test was used. Statistical significance was set at p<0.05. All calculations were done using R (Lucent Technologies, Morris Plains, NJ, USA).

**Results**

A total of 32 articles, published from 2000-2020 were included in this review (Figure I). In the under 50 group, the mean follow-up term was 47.2 months (median 35, range 18 - 151). In the over 50 group, the mean follow-up term was 49 months (median 39.2, range 18 - 139). Comparative data for the under 50 (N=304) and the over 50 (N=225) groups is shown in Table I.

**Implant revision/removal**

In the under 50 group there were 21 (8.4%) implant revision/removal procedures. In the over 50 group there were 13 (6.7%) implant revision/removal procedures. There were no significant differences (p=0.32) when comparing implant revision/removal between the 2 age groups with a relative risk ratio of 1.24 (95% CI 1.18 - 1.31).
In the under 50 group, indications for implant revision/removal included loosening (N=6), instability (N=5), pain (N=3), implant disassembly (N=2), painful capitellar wear (N=1), stiffness (N=1), and ankylosis (N=1). In the over 50 group, indications for implant revision/removal included loosening (N=6), pain (N=2), instability (N=1), and prosthesis dislocation (N=1).

Mayo Elbow Performance Score

Categorical score distribution for the under 50 and over 50 groups are shown in Figure II and III respectively. In order to calculate relative risk between groups for MEPS, the event of note was a score of 74 and below as this denotes a finding worse than good and excellent (Table II). Comparing the under 50 and over 50 groups for patients with MEPS of 74 and below, a relative risk of 1.28 (95% CI 1.19 - 1.39) was calculated with no significance between the groups (p=0.14).

Primary and Secondary Arthroplasty

In the under 50 group, RHA done as a primary procedure had significantly higher (p=0.01) mean MEPS when compared to RHA done as a secondary procedure (Table III). Comparing primary and secondary RHA in the under 50 group, relative risk was 1.84 (95% CI 1.54 - 2.20) for a MEPS of 74 and below. The difference between primary and secondary procedures was statistically significant (p=0.02). Comparing primary and secondary RHA in the
Age specific performance of RHA

over 50 group, relative risk was 2.40 (95% CI 1.97 - 2.92) for a MEPS of 74 and below. The difference between primary and secondary procedures was statistically significant (p=0.02).

Comparing primary and secondary RHA in the under 50 group, relative risk was 1.37 (95% CI 1.24 - 1.50) for implant revision/removal (p=0.33).Comparing primary and secondary RHA in the over 50 group, relative risk was 2.39 (95% CI 2.12 - 2.69) for implant revision/removal (p=0.11) (Table IV & V).

**Implant type**

Of the 32 included articles, 23 (72%) reported radial head implant manufacturer. There was substantial heterogeneity with 12 different implants being reported. Thus, comparing outcomes for specific implants was not feasible due to sampling variability. Outcome comparisons were possible based on implant polarity in both age groups. There was no significant difference between MEPS when comparing monopolar and bipolar implants in the younger than 50 group (p=0.18) and the older than 50 group (p=0.07). There was no significant difference in implant revision/removal when comparing monopolar and bipolar implants in the younger than 50 group (p=0.75) and the older than 50 group (p=0.25).

**Discussion**

Given the increasing rates of arthroplasty for radial head fracture, a clear comprehension of age-specific outcomes in these cases is needed. Following RHA, patients under 50 years of age had
Age specific performance of RHA

satisfactory clinical outcomes which were comparable to RHA outcomes in patients over 50 years of age. These aggregated age-specific results provide an important contribution to determining the appropriate treatment for radial head fractures.

We chose an age delineation of 50 years for several reasons. The age of 50 has been previously identified as the demarcation for a change in the radial head fracture demographic.\textsuperscript{19, 27} Population studies have used this age to define a young adult population when characterizing fracture incidence.\textsuperscript{9, 17} Reviews on RHA commonly report a mean patient age younger than 50 years and this is the age delineation for young adult patients in arthroplasty reports for other upper extremity joints.\textsuperscript{1, 21, 22, 38}

The literature has demonstrated that patient age is an important determinant when surgeons are deciding whether to perform a joint arthroplasty in younger adult patients.\textsuperscript{26, 34} Surgeon hesitancy to replace the radial head in younger adult patients may be due to the potential for long term complications leading to recurrence of pain and the ultimate need for revision surgery. However, recent findings of higher rates of revision surgery and lower patient satisfaction in ORIF patients compared to RHA patients challenges this dogma.\textsuperscript{6, 25} While each case should be individually assessed, the present study suggests that RHA in patients under the age of 50 provides satisfactory outcomes across a short term follow-up with mean follow-up of 48 months. Importantly, these outcomes are comparable to outcomes for patients over 50 years old.

Arthroplasty may be performed as the index operation or for revision of a prior intervention. In the acute setting, the extent of articular comminution drives the decision to perform primary
Age specific performance of RHA

arthroplasty. In the chronic setting, pain and dysfunction due to failed fixation or resection may lead to the decision to perform arthroplasty as a secondary procedure. Patients in the under 50 age group who received RHA as a primary procedure had significantly higher MEPS (p=0.02) compared to patients who received RHA as a secondary procedure. Additionally, in the under 50 group there were significantly (p=0.02) more patients with a poor MEPS when RHA was performed as a secondary procedure compared to RHA as a primary procedure. The knowledge of superior performance in primary arthroplasties provides important clarity to the surgeon’s evaluation of treatment options. When the most appropriate surgical option is unclear, primary arthroplasty may give patients the best opportunity of a satisfactory outcome.

Though the literature has demonstrated that a majority of implant failures occur in the first 48 months postoperatively, a primary concern with RHA in younger patients is the long-term sequelae of capitellar erosion and ulnohumeral arthritis. Recent reports on RHA across follow-ups of 100-145 months concluded that the concerning radiographic findings of stem lucency and articular degeneration did not routinely translate into negative clinical outcomes. Jung et al reported on recreational athletes at a mean age of 49 years and mean follow-up of 8.4 years. In spite of 25% of patients having radiographic evidence of severe lucency and severe degenerative changes, the rate of return to sport in these patients was not affected. In summary, radiographic findings such as stem lucency and articular degeneration may not be associated with negative clinical outcomes at mid to long terms of follow-up. These long-term findings in addition to the current findings suggest a trend in improved outcomes for RHA.
As with all systematic reviews which intend to investigate specific topics from a wide range of contexts, the current outcomes are limited by the methodology of the included articles. The current results represent a wide spectrum of injury, from isolated radial head fracture to more complex injuries with concomitant bony and ligamentous lesions. This wide range of injury scenarios contributes to the generalizability of the results. While the Mayo Elbow Performance Score is widely reported and provides a conducive metric for aggregating outcome data, it may not adequately illustrate the complete clinical presentation of the patient’s outcome. The current results include many implant designs and thus, may not be representative of a specific implant’s performance. Further, we did not stratify results based on stem fixation nor stem length. The strengths of this review are the wide search parameters, the narrow inclusion criteria and the further grouping of arthroplasty cases into those performed as primary and as secondary procedures. These study characteristics contribute to a reliable conclusion that is based on the available literature.

**Conclusion**

At a mean follow-up of 48 months, radial head arthroplasty in patients under the age of 50 years have satisfactory outcomes which are comparable to outcomes in patients over the age of 50 years. In both age groups, when the arthroplasty is performed as a primary procedure, outcomes were superior to the arthroplasty being performed as a secondary procedure. Our findings provide guidance to surgeons who face a multifaceted decision when encountering younger adult patients with radial head fractures that may not be amenable to fixation. Awareness of the age-
specific performance of radial head implants is an important component of the decision for surgical treatment.

References


Figure and table legends:

Figure I: Flowchart depicting literature search and article selection process with exclusion criteria

Figure II: Categorical Mayo Elbow Performance Score for radial head arthroplasty patients under 50 years of age

Figure III: Categorical Mayo Elbow Performance Score for radial head arthroplasty patients over 50 years of age

Table I: Comparative analysis of the study characteristics, patient characteristics, and outcome metrics between the under 50 and the over 50 age groups

Table II: Comparative analysis between groups for a Mayo Elbow Performance Score of 74 and below

Table III: Comparative analysis of the outcome metrics in patients under 50 years between radial head arthroplasty performed as a primary and a secondary procedure

Table IV: Comparative analysis between groups for implant revision or removal

Table V: Comparative analysis of the outcome metrics in patients over 50 years between radial head arthroplasty performed as a primary and as a secondary procedure
# Outcomes of radial head arthroplasty comparing patients under and over 50 years

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Age</th>
<th>Gender, m</th>
<th>F/U, m†</th>
<th>F/E arc†</th>
<th>P/S arc†</th>
<th>MEPS†</th>
<th>DASH†</th>
<th>Rem/Rev*</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;50y</td>
<td>304</td>
<td>37.4</td>
<td>68%</td>
<td>47.2</td>
<td>116</td>
<td>137</td>
<td>87.6</td>
<td>16.2</td>
<td>8.1%</td>
</tr>
<tr>
<td>&gt;50y</td>
<td>225</td>
<td>60.1</td>
<td>46%</td>
<td>49</td>
<td>120</td>
<td>140</td>
<td>89.1</td>
<td>15.8</td>
<td>9%</td>
</tr>
<tr>
<td>p value</td>
<td>0.14</td>
<td>N/A</td>
<td><strong>0.002</strong></td>
<td>0.75</td>
<td>0.19</td>
<td>0.59</td>
<td>0.79</td>
<td>0.92</td>
<td>0.89</td>
</tr>
</tbody>
</table>

- All values reported as means
- †Follow-up in months, elbow flexion extension arc, forearm pronosupination arc, Mayo Elbow Performance Score, Disabilities of the Arm, Shoulder, and Hand Score
- *Implant removal or revision

"€"
<table>
<thead>
<tr>
<th>Comparison (Group)</th>
<th>Risk ratio</th>
<th>95% CI</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comparison between RHA† in patients under 50 and patients over 50 years</td>
<td>1.28</td>
<td>1.19 - 1.39</td>
<td>0.14</td>
</tr>
<tr>
<td>In the under 50 group, comparison between RHA† as a primary and secondary procedure</td>
<td>1.84</td>
<td>1.54 - 2.20</td>
<td><strong>0.02</strong></td>
</tr>
<tr>
<td>In the over 50 group, comparison between RHA† as a primary and secondary procedure</td>
<td>2.40</td>
<td>1.97 - 2.92</td>
<td><strong>0.02</strong></td>
</tr>
</tbody>
</table>

‡Categorical scoring matrix rates a fair or poor result with a score of 74 or below
†Radial head arthroplasty
¤Risk ratio of 1 suggests no difference in level of risk between groups
*Confidence interval
## Outcomes of primary and secondary radial head arthroplasty patients under 50 years

<table>
<thead>
<tr>
<th></th>
<th>F/U, m†</th>
<th>F/E arc†</th>
<th>P/S arc†</th>
<th>MEPS†</th>
<th>DASH†</th>
<th>Rem/Rev**</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary</strong></td>
<td>51.1</td>
<td>118</td>
<td>138</td>
<td>87.7</td>
<td>14.3</td>
<td>6%</td>
</tr>
<tr>
<td><strong>Secondary</strong></td>
<td>45.9</td>
<td>113</td>
<td>139</td>
<td>81.4</td>
<td>23.3</td>
<td>8%</td>
</tr>
</tbody>
</table>

*All values reported as means
†Follow-up in months, elbow flexion extension arc, forearm pronosupination arc, Mayo Elbow Performance Score, Disabilities of the Arm, Shoulder and Hand Score
**Implant removal or revision
<table>
<thead>
<tr>
<th>Comparison</th>
<th>Risk ratio‡</th>
<th>95% CI*</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comparison between RHA† in patients under 50 and patients over 50 years</td>
<td>0.983</td>
<td>0.93 - 1.04</td>
<td>0.89</td>
</tr>
<tr>
<td>In the under 50 group, comparison between RHA† as a primary and secondary procedure</td>
<td>0.971</td>
<td>0.88 - 1.07</td>
<td>0.93</td>
</tr>
<tr>
<td>In the over 50 group, comparison between RHA† as a primary and secondary procedure</td>
<td>0.93</td>
<td>0.82 - 1.04</td>
<td>0.17</td>
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†Radial head arthroplasty  
‡Risk ratio of 1 suggests no difference in level of risk  
*Confidence interval
## Outcomes of primary and secondary radial head arthroplasty patients over 50 years

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<th>MEPS†</th>
<th>DASH†</th>
<th>Rem/Rev**</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary</strong>*</td>
<td>55</td>
<td>122</td>
<td>143</td>
<td>90.3</td>
<td>15.2</td>
<td>4%</td>
</tr>
<tr>
<td><strong>Secondary</strong>*</td>
<td>48</td>
<td>117</td>
<td>143</td>
<td>85.4</td>
<td>24.4</td>
<td>21%</td>
</tr>
<tr>
<td><strong>p value</strong></td>
<td>0.526</td>
<td>0.362</td>
<td>0.87</td>
<td>0.221</td>
<td>0.11</td>
<td>0.11</td>
</tr>
</tbody>
</table>

*All values reported as means
†Follow-up in months, elbow flexion extension arc, forearm pronosupination arc, Mayo Elbow Performance Score, Disabilities of the Arm, Shoulder and Hand Score
**Implant removal or revision
PubMed query return (n = 798)

Duplicate articles excluded (n = 419)

Articles screened by abstract and title (n = 379)

Irrelevant articles excluded (n = 86)

Full-text articles assessed for inclusion (n = 293)

Full-text articles excluded:
- Lack of individual patient results (n = 181)
- Lack of Mayo scores (n = 37)
- Review articles (n = 25)
- ORIF reports (n = 12)
- Cadaveric research (n = 6)

Articles which met the inclusion criteria for review (n = 32)

Analysis based on patient age:
- <50 years old (n = 32)
- >50 years old (n = 29)

Analysis based on arthroplasty as a primary procedure:
- <50 years old (n = 26)
- >50 years old (n = 23)

Analysis based on arthroplasty as a secondary procedure:
- <50 years old (n = 13)
- >50 years old (n = 10)
Mayo Elbow Performance Score for patients under 50 years of age

- Excellent: 47%
- Good: 34%
- Fair: 14%
- Poor: 5%
Mayo Elbow Performance Score for patients over 50 years of age

- Excellent: 57%
- Good: 27%
- Fair: 12%
- Poor: 4%
Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐ The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

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