Original article

Is total elbow arthroplasty indicated in the treatment of traumatic sequelae? 19 cases of Coonrad-Morrey® reviewed at a mean follow-up of 5.2 years

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A B S T R A C T

Introduction: Traumatic sequelae of the elbow are difficult to manage because of bone deformities, changes in joint congruency and bone defects.

Materials and methods: Total elbow arthroplasty is a therapeutic option when the joint space has disappeared. Nineteen patients underwent semi-constrained Coonrad-Morrey® total elbow arthroplasty in 12 cases for post-traumatic elbow arthritis (group 1) and in seven cases for 7 non-union of the distal humerus (group 2). The mean age at surgery was 60 years old (56 in group 1 and 67 in group 2). The mean delay between the initial trauma and arthroplasty was 16 years (group 1) and 22 months (group 2).

Results: At a mean follow-up of 5.5 years (24–156 months) in group 1, the Quick-DASH score was 34 points with outcomes that were considered to be good to excellent in 75% of the cases according to the Mayo Elbow Performance Score (MEPS). A progressive radiolucency was identified on X-ray in 33% of the cases, and moderate wear of the polyethylene insert in 17%. There were 7 complications (58%) requiring revision in 3 cases (25%). At a mean follow-up of 4.6 years (24–108 months) in group 2, the Quick-DASH score was 39 points with good and excellent results in 86% according to the MEPS. A radiolucency was noted in 28% and moderate wear of the inserts in 14%. There were 2 complications (28%) requiring revision in 1 case (14%).

Conclusion: Semi-constrained total elbow arthroplasties provide recovery of functional range of motion with a stable and pain-free elbow for post-traumatic conditions. The age at surgery is a risk factor for complications. The indication for total elbow arthroplasty in patients under 60 should be carefully considered in relation to alternative treatment options.

Level of evidence: Level IV Retrospective study.

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1. Introduction

Post-traumatic sequelae of the elbow – non-union of the distal humerus or post-traumatic arthritis – are difficult to manage because of bone deformities, modifications of joint congruency, joint stiffness and bone defects [1–6]. Because of these elements and when the joint space has disappeared completely, total elbow arthroplasty is sometimes the only available option to restore satisfactory range of motion. In certain cases of post-traumatic arthritis, the therapeutic options include distraction with interposition arthroplasty [7,8], and arthrodesis [2,6,8,9]. In certain cases of non-union of the distal humerus in which the joint space is preserved, internal fixation with a bone graft can be proposed [10–13].

Evaluation of bone defects and of the periartricular tissue is essential for the management and preoperative planning in these cases. The use of semi-constrained total elbow arthroplasty is proposed for post-traumatic sequelae because of ligament damage and bone defects, in particular to the columns (Fig. 1). However, patients with total elbow arthroplasty must limit their activities to prevent postoperative failure [5,6,10,14–16].

Main hypothesis: semi-constrained total elbow arthroplasty is adapted for the treatment of post-traumatic sequelae of the distal humerus.

Secondary hypothesis: there is no significant difference in clinical and radiographic results following semi-constrained total elbow arthroplasty between patients with post-traumatic arthritis and those with non-union of the distal humerus.

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2. Materials and methods

This was a retrospective multicentre study performed in two university hospital centres. All patients presenting with post-traumatic sequelae from a fracture or dislocation of the distal humerus, in whom a semi-constrained total elbow arthroplasty Conornad-Morrey® (Zimmer Company, Warsaw, IN, USA was indicated, could be included in the study). Exclusion criteria included joint damage from rheumatoid arthritis, recent post-traumatic sequelae (<9 months), and patients who did not have at least 2 years of follow-up. Two groups were defined, first, patients with post-traumatic arthritis (group 1) (Fig. 2) and second, cases of non-union of the distal humerus (group 2) (Fig. 3). All patients in group 1 had global arthritis of the elbow.

The surgical technique was the same regardless of the indication for total elbow arthroplasty. The Bryan-Morrey surgical approach was used in all cases [3–5]. Prostheses were cemented with antibiotic cement and a bone graft was placed behind the anterior flange of the humeral component. The triceps was then reinserted onto the olecranon by trans osseous sutures with non-absorbable (16 cases) or absorbable (3 cases) sutures. The elbow was immobilized in extension for 48 h in a sling, and then the patient was authorized to begin active movement of the elbow depending on the pain. Rehabilitation was begun in 10 patients. Surgery lasted a mean 92 min (52–190 min), and the patient was hospitalized for a mean 6 days (4–10 days).

Thirteen patients (68%) had at least one operation of the elbow before arthroplasty. Arthroplasty was performed on an elbow with no existing internal fixation material except in one case (case n°18). Two patients presented with neurological complications – confirmed by electromyogram – before arthroplasty. Simple neurysis was performed in two cases (case n°1 and n°19). According to the Morrey et al. classification, there were bone defects in 9 cases [3] (Fig. 1).

The preoperative and postoperative clinical evaluation was based on the Mayo Clinic score for elbows or the Mayo Elbow Performance Score (MEPS) [14] and the Quick-DASH score [17]. A radiographic assessment, including an AP and lateral X-ray of the elbow, was used to assess peri-prosthetic radiolucencies at the final follow-up, as well as the presence of wear of the polyethylene bushes near the hinges of the prosthesis (Fig. 4) [6].

The means and distribution of continuous variables were calculated and the number and percentages of the variables were determined by class. The Student t-test was used to compare means and the chi² test to compare nominal variables. P < 0.05 was considered to be significant.

3. Results

Nineteen patients met the inclusion criteria. There were 14 women and 5 men. In 12 cases, the indication for arthroplasty was post-traumatic arthritis (group 1) (Table 1) and in 7 cases Non-union of the distal humerus (group 2) (Table 2). The mean age of patients at surgery was 60 years old (56 years old in group 1 and 67 in group 2). The mean delay between the initial trauma and arthroplasty was 16 years in group 1 and 22 months in group 2. The number of prior interventions per patient was 1.2 in group 1 and 2.4 in group 2. Results were expressed as means with minimum and maximum values.

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After a follow-up of 5.1 years (2–13), the MEPS for the entire series was 86 points (45–100) and the quick-DASH score was 35.7 points (5.8–73.3). Pain and active flexion were significantly improved compared to preoperative scores ($P < 0.0001$ and $P < 0.0001$, respectively). There was a significant difference between the patient’s age and the development of complications ($P = 0.039$). The mean age at arthroplasty in patients with complications was 54 years old (65 in patients without complications). There was no significant difference in the following preoperative values: number of prior interventions, deformities, bone deficits or gender; and the following postoperative results: complications, surgical revisions, wear of the polyethylene bushings and radiolucencies.

After a follow-up of 5.5 years (2–13), the MEPS in the post-traumatic arthritis group was 86 points (45–100) and the quick-DASH score was 34 points (5.8–73.3). Results were considered to be good to excellent in nine cases (75%) according to the MEPS. The pain score went from 6 (0–30) preoperatively to 36 points (5–45) postoperatively and 10 patients (83%) improved. The stability score reached 9 points (0–10). There was instability of the elbow in 2 cases due to bipolar septic loosening of the

arthroplasty and in one case aseptic loosening of the humeral component occurred. The range of motion score was 16 points (5–20). The mean range of motion was: 41° extension deficit and 129° flexion deficit, 45° pronation and 35° supination. Five patients (41%) presented with a functional range of motion of at least 100° flexion–extension. We did not find any significant difference between pronation–supination ranges of motion and resection or not of the radial head. All patients presented with normal function on the MEPS. (Table 3).

After a follow-up of 4.6 years (2–9), the MEPS score in the non-union of the distal humerus group was 86 points (45–100) and the quick-DASH score was 40 points (19.2–68.3). The results were considered to be good and excellent in six cases (86%) according to the MEPS. The preoperative pain score went from 6 points (0–30) to 33 points (5–45) after surgery and 6 patients (86%) improved. The stability score was 10 points. No instability was reported. The mobility score was 18 points (15–20). The mean extension–flexion was: 29° extension deficit and 133° flexion deficit, 56° pronation and 52° supination. Four patients (57%) presented with a flexion–extension functional range of motion of at least 100°. We did not find any significant difference between pronation–supination range of motion and resection or not of the radial head. Function was found to be normal on the MEPS score in all patients. (Table 4).

There was a significant difference in age between “post-traumatic osteoarthritis” group 1 (mean age 56 years old) and the “Non-union” group 2 (mean age 67 years old) (P = 0.037). There was no significant difference in the delay to surgery between the post-traumatic arthritis group (mean delay 16 years, standard deviation 19.3 years) and the “Non-union” group 2 (mean delay 22 months, standard deviation 12.3 months) (P = 0.067) (Table 5). A progressive radiolucency was identified on X-ray in four cases (33%), and moderate wear of the polyethylene bushings in two cases (17%) in group 1. A progressive radiolucency was identified in two cases (28%), and moderate wear of the polyethylene bushings in one case (14%) in group 2 (Figs 2 and 3). Union was obtained in the autologous bone graft behind the anterior flange. We did not find any significant difference between the development of radiolucencies on X-ray on the humeral or ulnar side, wear of the bushings or the severity of the initial bone defect. There was no significant difference between the patient with aseptic loosening (Morrey grades [3]) and the length of the humeral stem component.

There were 7 complications in group 1 (58%) in 6 patients, requiring surgical revision in 3 cases (25%) in 3 patients. In one case, this was due to septic loosening which was repaired in one operation 18 months after the initial arthroplasty (case n° 2, Table 3).

Eight months after revision surgery extension–flexion range of motion was –50/120 and the MEPS score was 45 points. In one case, there was bipolar loosening with a peri-prosthetic humeral fracture 2 years after the initial arthroplasty (case n° 12, Table 3). One case of revision surgery with a sleeve allograft and revision arthroplasty was performed. Twenty-five months after revision the extension–flexion range of motion was –20/140 and the MEPS score was 100 points. Finally, in one case revision with articular lave was performed for a deep infection 6 months after the initial surgery (case n° 6, Table 3). Forty months after revision, the extension–flexion range of motion was –50/120 and the MEPS score was 95 points. The rate of complications was 71% (5 complications/7 patients) in patients under the age of 60 compared to 40% (2 complications/5 patients) in patients over 60.

There were 2 complications in group 2 (28%) in 2 patients requiring revision surgery in 1 case (14%). This was due to complete wear of the bushings requiring surgical revision to change the axis and the polyethylene bushings 8 years after the original arthroplasty (Fig. 5) (case n° 13, Table 4). Sixteen months after revision, the extension–flexion range of motion was –55/130 and the MEPS score was 80 points. All patients were at least 60 years old when arthroplasty was performed.

There was no significant difference between the two groups for the development of complications, surgical revisions, wear of the polyethylene inlay, or radiolucencies (Table 5).

4. Discussion

The choice of therapeutic options depends on the age of the patient, osteoarticular and periarticular lesions and functional needs. Arthrodesis only seems to be indicated to treat post-traumatic sequelae in severe cases, in particular, those with a history of infection. The functional difficulties caused by this surgery and the absence of possible compensation of the sub and supra adjacent joints makes this therapeutic option a poor functional choice. Union can be difficult to obtain in case of bone defects (4 cases of non-union in 9 patients in the study by Hahn et al. [18]).

Interposition arthroplasty is a therapeutic option that can be proposed in young patients to recover the joint space alone. However, in case of bone defects, the risk of instability is highly high with this treatment (30% in 7 patients in the study by Larson et al. [8]) and functional results vary (50% improvement in 7 patients on the MEPS in the study by Larson et al. [8]).

In certain cases, humeral non-union can be treated by combining a bone graft and stable internal fixation if the joint space is intact.

Table 3
Postoperative data in group 1 “post-traumatic arthritis”.

<table>
<thead>
<tr>
<th>Case</th>
<th>Follow-up (months)</th>
<th>Range of motion extension–flexion (active)</th>
<th>MEPS</th>
<th>DASH</th>
<th>Complications</th>
<th>Surgical revisions</th>
<th>Wear of PE bushings (X-ray follow-up)</th>
<th>Progressive radiolucency (X-ray follow-up)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>48</td>
<td>–40/140</td>
<td>100</td>
<td>34.2</td>
<td>No Septic loosening</td>
<td>No</td>
<td>Moderate</td>
<td>No (since revision)</td>
</tr>
<tr>
<td>2</td>
<td>26</td>
<td>–50/120</td>
<td>45</td>
<td>73.3</td>
<td>No</td>
<td>Yes: 1 (one-step revision + 18 months)</td>
<td>Absence (since revision)</td>
<td>No (since revision)</td>
</tr>
<tr>
<td>3</td>
<td>24</td>
<td>–40/120</td>
<td>90</td>
<td>48.3</td>
<td>No</td>
<td>No</td>
<td>Absence</td>
<td>Yes (humeral)</td>
</tr>
<tr>
<td>4</td>
<td>24</td>
<td>–30/130</td>
<td>100</td>
<td>35</td>
<td>Ulnar nerve injury</td>
<td>No</td>
<td>Absence</td>
<td>Yes (humeral)</td>
</tr>
<tr>
<td>5</td>
<td>33</td>
<td>–15/135</td>
<td>100</td>
<td>5.8</td>
<td>No</td>
<td>No</td>
<td>Absence</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td>46</td>
<td>–50/120</td>
<td>95</td>
<td>7.5</td>
<td>Sepsis (+ 6 months)</td>
<td>Yes: 1 intraarticular lavege</td>
<td>Moderate</td>
<td>No</td>
</tr>
<tr>
<td>7</td>
<td>33</td>
<td>–10/110</td>
<td>65</td>
<td>27.5</td>
<td>No</td>
<td>No</td>
<td>Absence</td>
<td>Yes (humeral)</td>
</tr>
<tr>
<td>8</td>
<td>156</td>
<td>0/140</td>
<td>100</td>
<td>17.5</td>
<td>No</td>
<td>No</td>
<td>Absence</td>
<td>No</td>
</tr>
<tr>
<td>9</td>
<td>120</td>
<td>–75/135</td>
<td>70</td>
<td>17.5</td>
<td>Radial nerve injury</td>
<td>No</td>
<td>Absence</td>
<td>Yes (ulnar)</td>
</tr>
<tr>
<td>10</td>
<td>90</td>
<td>–60/135</td>
<td>80</td>
<td>27.5</td>
<td>No</td>
<td>No</td>
<td>Absence</td>
<td>No</td>
</tr>
<tr>
<td>11</td>
<td>59</td>
<td>–80/125</td>
<td>85</td>
<td>67.5</td>
<td>Ulnar nerve injury</td>
<td>No</td>
<td>Absence</td>
<td>No</td>
</tr>
<tr>
<td>12</td>
<td>127</td>
<td>–20/140</td>
<td>100</td>
<td>46</td>
<td>Bipolar loosen- ing + humeral fracture (+ 9 years)</td>
<td>Yes: 1 Allograft</td>
<td>Absence</td>
<td>No</td>
</tr>
</tbody>
</table>
Table 4
Postoperative data in group 2 “non-union”.

<table>
<thead>
<tr>
<th>Cases</th>
<th>Follow-up (months)</th>
<th>Extension–flexion Range of motion (active)</th>
<th>MEPS</th>
<th>DASH</th>
<th>Complications</th>
<th>Surgical revisions</th>
<th>Wear PE bushings (on X-ray)</th>
<th>Progressive radiolucencies (on X-ray)</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>108</td>
<td>-55/130</td>
<td>80</td>
<td>30</td>
<td>Complete wear bushings + broken axis (+ 8 years)</td>
<td>Yes: 1 change axis + bushings</td>
<td>Absence (since revision)</td>
<td>No</td>
</tr>
<tr>
<td>14</td>
<td>48</td>
<td>0/140</td>
<td>100</td>
<td>43.3</td>
<td>No</td>
<td>No</td>
<td>Absence</td>
<td>Yes (ulnar)</td>
</tr>
<tr>
<td>15</td>
<td>46</td>
<td>-30/130</td>
<td>45</td>
<td>68.3</td>
<td>No</td>
<td>No</td>
<td>Absence</td>
<td>No</td>
</tr>
<tr>
<td>16</td>
<td>29</td>
<td>-55/133</td>
<td>85</td>
<td>19.2</td>
<td>Ulnar nerve injury</td>
<td>No</td>
<td>Moderate</td>
<td>No</td>
</tr>
<tr>
<td>17</td>
<td>24</td>
<td>-40/130</td>
<td>95</td>
<td>32.5</td>
<td>No</td>
<td>No</td>
<td>Absence</td>
<td>No</td>
</tr>
<tr>
<td>18</td>
<td>72</td>
<td>-20/130</td>
<td>100</td>
<td>33</td>
<td>No</td>
<td>No</td>
<td>Absence</td>
<td>Yes (humeral)</td>
</tr>
<tr>
<td>19</td>
<td>62</td>
<td>-5/140</td>
<td>95</td>
<td>45</td>
<td>No</td>
<td>No</td>
<td>Absence</td>
<td>No</td>
</tr>
</tbody>
</table>

Table 5
Statistical data for comparative analysis of group 1 “post-traumatic osteoarthritis” and group 2 “non-union”.

<table>
<thead>
<tr>
<th></th>
<th>Group 1 “post-traumatic osteoarthritis”</th>
<th>Group 2 “non-union”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age</td>
<td>56 years old</td>
<td>67</td>
</tr>
<tr>
<td>Delay to surgery</td>
<td>16 years</td>
<td>21 months</td>
</tr>
<tr>
<td>Complications</td>
<td>7 complications in 6 patients (58%)</td>
<td>2 complications in 2 patients (28%)</td>
</tr>
<tr>
<td>Surgical revision</td>
<td>n = 3 patients</td>
<td>n = 1 patient</td>
</tr>
<tr>
<td>Wear of polyethylene bushings (on X-ray)</td>
<td>n = 2 patients</td>
<td>n = 1 patient</td>
</tr>
<tr>
<td>Progressive radiolucency (X-ray)</td>
<td>n = 5 patients</td>
<td>n = 2 patients</td>
</tr>
</tbody>
</table>

P = *; not practicable test due to the lack of cases.

Fig. 5. Change of axis and the polyethylene bushings after 8 years. Absence of columns (non-union) results in severe instability and significant stress on the axis of the prosthesis.

Good quality bone is essential in these cases because otherwise internal fixation may not be stable (two revisions in ten patients for Niu et al. [13]).

An osteoarticular allograft can be considered in case of severe bone defects [19–21]. This technique is rarely used. There is a risk of graft absorption and chondrolysis and the rate of complications is usually high (50% in the study by Breen et al. [19]), and allograft resorption was present at the final radiographic follow-up in 5/6 cases in the study by Allieu et al. [20].

Total elbow arthroplasty is proposed as an alternative to these surgical procedures for the treatment of post-traumatic sequelae. The most frequently used prosthesis is semi-constrained to obtain satisfactory joint stability despite bone defects, poor quality bone or ligament injury [14,22–26]. In isolated cases, with central bone defects of the humeral epiphysis (grade 1 or 2 on the Morrey scale [31] with intact ligaments (Fig. 1), modular components with a closed trochlea are being evaluated. No firm conclusions can be drawn for the moment, because there is not enough follow-up.

The biases of our study are its retrospective design, the multi-centre assessment with a limited number of patients and in some cases short follow-up (two years follow-up in cases n° 3, 4 and 17). Results of cases of post-traumatic arthritis in the literature are satisfactory in 64–83% of the cases according to the MEPS [3,6,16]. In our series, satisfactory results were obtained in 75% of cases with recovery of flexion–extension range of motion of at least 100°. The rate of complications in the literature ranged from 27 to 38% [3,6,16]. The study by Schneeberger et al. [6] reported a rate of complications of 37% in 41 patients after 5.8 years follow-up. Wear of
the polyethylene bushings has been correlated to the severity of the preoperative deformity. In a series of 85 cases evaluated after a follow-up of 9 years, Throckmorton et al. [16] reported complications in 30%. The rate of complications was 58% in our series of post-traumatic arthritis. In the case of severe deformities of the distal humerus, the humeral cut can be adapted during the procedure to correct the extension deficit. Because of the readjustment of the columns, a long stem may be chosen to ensure stability. (Case n°5 Tables 1 and 3, Fig. 2).

The results in our series are comparable to those in the literature for non-union of the distal humerus with satisfactory results obtained in between 57 and 86% on the MEPS [1,10,15,21–23,25]. A satisfactory result was obtained in 86% of the cases in our series and in 57% of the cases recovery of flexion–extension range of motion of at least 100° was obtained. The rate of complications can range from 43 to 50% depending on the series [22,23,25]. In our series, the rate of complications was 28%.

In our series, age at arthroplasty was associated with an increased risk of complications (P = 0.039). The mean age at arthroplasty of patients presenting with a complication was 54 years old. The number of prior operations, the level of activity and functional need have frequently been reported to be risk factors for complications in the literature, although no significant difference has been confirmed [3,6,14,15,24]. We did not perform systematic transposition of the ulnar nerve. We performed neurolysis in two cases due to injury confirmed on preoperative electromyogram (cases n°1 and n°19). We identified three cases of ulnar nerve injury after arthroplasty (cases n°4, 11, and 16), or a rate of 6.3%. According to Throckmorton et al. [16] – who performs systematic transposition – 4/85 patients presented with an ulnar nerve complication, or 4.7% of cases.

Despite this high rate of complications, the results obtained in this series after a mean follow-up of 5.1 years (2–13) were good with a mean MEPS score of 86 points (45–100) and a mean quick-DASH score of 35.7 points (5.8–73.3). Pain and active flexion were significantly improved compared to preoperative scores (P < 0.0001 and P < 0.0001, respectively). Semi-constrained elbow arthroplasty is a therapeutic option in the treatment of post-traumatic sequelae of the distal humerus.

Despite the two very different populations – differences in age and mean delay to surgery (Table 5), we did not find any significant difference in clinical and radiographic results between the two etiologies. This can be explained in part by the small size of the groups, and the marked difference in the delay to surgery in the “non-union” group.

5. Conclusion

In post-traumatic sequelae of the elbow, semi-constrained total elbow arthroplasties make it possible for most patients to recover functional range of motion with a stable, pain-free elbow. It is often the only therapeutic option because of severe lesions of the elbow in these cases. The functional results as well as the development of complications depend on the patient’s age, level of activity, functional needs, and initial quality of bone and periarticular tissue of the elbow.

The rate of complications is higher according to the age at arthroplasty as well as in the post-traumatic arthritis group. The indication for total elbow arthroplasty in patients under 60 should be carefully considered in relation to alternative treatment options.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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