Original article

The role of brachioradialis release during AO type C distal radius fracture fixation

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ABSTRACT

Introduction: Open reduction and internal fixation of distal radius fractures often necessitates release of the brachioradialis from the radial styloid. However, whether this common procedure makes the reduction and fixation easier and affects the elbow function has not been fully understood.

Hypothesis: Brachioradialis (BR) release during volar plate fixation for type C distal radius fractures makes internal reduction and fixation easier, and it does not adversely affect wrist or elbow function.

Material and methods: A total of 74 patients treated with 2.4 mm volar locking compression column plate (VCP) were analyzed for type C distal radius fractures prospectively. The patients were divided into two groups, group A with BR release and group B without BR release. The two groups were compared in terms of “internal reduction and fixation time” during the operation, wrist and elbow function including the scores of Gartland and Werley (G-W), Patient-related wrist evaluation score (PRWE), Mayo Elbow Performance Score (MEPS), the Disabilities of the arm, shoulder, and hand (DASH) and a Visual analog scale (VAS) for pain at 6 and 12 months postoperatively. The radial inclination angle, palmar tilt angle and ulnar variance were also measured from the radiographs.

Results: According to the follow-up of the 74 patients, no significant differences were observed between the two groups on MEPS, DASH, G-W, PRWE, VAS and radiological outcomes at 6 and 12 months postoperatively. Mean time of reduction and internal fixation was significantly shorter in group A than that in group B.

Conclusion: Release of the BR for type C distal radius fractures facilitated the surgical procedure and did not adversely affect elbow and wrist function.

Level of evidence: II, prospective comparative study.

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1. Introduction

With an aging population, distal radius fractures (DRF) are the most common fractures and the incidence is still increasing [1]. Recent clinical studies have demonstrated that patients with unstable complex articular distal radius fractures could get rapid recovery of function with volar locking plates compared with dorsal plates, closed reduction and casting, external fixation and percutaneous pin fixation [2–4].

In type C distal radius fractures, the distal radial fragment including the radial styloid is often the biggest fragment even when the articular surface is severely comminuted [5,6]. Due to the deforming force of brachioradialis (BR) tendon, it is difficult to restore the proximal and radial displacement of the radial styloid process during reduction. To solve the problem, the traditional Henry approach for volar internal fixation was modified to include the release of BR tendon insertion during the surgical procedure in several reports [7,8]. The issues that the BR release might facilitate the reduction of the fragments was only mentioned but not specifically investigated in previous reports [7,8].

The purpose of this study was to analyze whether BR release during type C distal radius fracture fixation affects wrist or elbow function and makes the reduction and fixation easier.

2. Materials and methods

2.1. Study population

A prospective, participant-blinded, randomized, paralleled study was conducted from January 2012 to January 2015. And the
trial was addressed ethical approval by our institutional review board, complying with the 1964 Helsinki Declaration and its later amendments, and all the patients signed informed written consent. Inclusion criteria were age more than 18, type C DRF, closed fracture, lost of initial reduction, lost of palmar tilt or radial inclination > 15°, articular incongruity > 2 mm, ulnar variance > 5 mm, and operation within 14 days of injury. Exclusion criteria included systemic osteoarthrosis, local disorders (e.g., tumors), rheumatic disease, bilateral DRFs and DRF accompanied with other fractures or severe soft tissue injuries.

Seventy-four patients were admitted into this study (37 patients in group A with BR release and 37 patients in group B with BR preserved) (Fig. 1). Detailed clinical characteristics for the two groups are shown in Table 1. All patients were operated by the same senior surgeon (the first surgeon, an expert of hand surgery who has performed more than 400 surgical cases of DRFs) [9].

2.2. Surgical technique

All patients received the Henry approach [10]. The surgical procedures were standardized as reported by Wijffels et al. [11]. The pronator quadratus was released at its radial third borders with a subsequent elevation for visualization of the fracture [12]. BR tendon insertion was released in group A, but preserved in group B. Temporary fixation with K-wires was done after the preliminary reduction. Then, 2.4-mm volar locking compression column plate (VCP, Synthes, GmbH, Switzerland) was placed proximal to and without overlying the watershed line to avoid median nerve and flexor tendon injury. Intraoperative fluoroscopy was used to prevent screw penetration into the dorsal compartment and the joint. The pronator quadratus was repaired with an absorbable synthetic suture (3.0 Vicryl, Ethicon, US) for pain alleviation in the early postoperative period [12]. Reduction and internal fixation time was recorded as the time from the pronator quadratus released to the final screw implanted. A volar splint was used for postoperative immobilization for 2 weeks [13–15]. After the removal of the splint, active motion was initiated.

2.3. Postoperative examinations and radiological views

The examinations included: range of motion of wrist and elbow with the same goniometer, grip strength of the hand with a Jamar dynamometer, postoperative anteroposterior and lateral view, pain using a visual analog scale (VAS) in which 0 represents “no pain” and 10 indicates “the worst possible pain”, the scores of Garland and Werley (G-W), Patient-related Wrist evaluation score (PRWE), Mayo elbow performance score (MEPS), the Disabilities of the arm, shoulder, and hand (DASH) [16–19]. Reduction and internal fixation time was compared between the two groups to identify whether BR insertion release facilitated the reduction. G-W, PRWE, MEPS, DASH and VAS at 6 and 12 months were analyzed to identify whether BR insertion release affected wrist or elbow function. Postoperative standard anteroposterior and lateral radiographs of the wrist were obtained at each follow up. Palmar tilt angle was measured on lateral radiographs while radial inclination angle and ulnar variance were assessed on posteroanterior radiographs as described by Medoff [20].

In the present study, for precise evaluation, two independent experts performed the evaluations, and the data were averaged from the two evaluations. The inter-observer reliability was accessed by calculating the intraclass correlation coefficient (ICC).

2.4. Statistical analysis

Based on the study of Griffin [21] and Kim et al. [22], the power analysis showed that the required sample size of the present study was 34 cases (n1 = 17, n2 = 17) with a power of 80% at the 0.05 probability.

Continuous data were presented as means ± standard deviation (SD), and any differences between the two groups were analyzed by independent t test. Categorical data were presented as number (n) or percentage, and any differences between the two groups were analyzed by Chi² test or Fisher’s exact test as appropriate. All of the statistical tests and P value were two-tailed and P-values < 0.05 were considered statistically significant.

3. Results

3.1. Functional outcomes

Based on the detailed clinical characteristics of the 74 patients, no significant differences were found between the two groups regarding age, gender, AO classification [23], the time from injury to surgery, dominant hand rate and injury mechanism (Table 1).

The measurements included “Reduction and internal fixation time”, follow-up examinations and radiological views. Mean time of reduction and internal fixation was significantly shorter in group A than that in group B (25.0 ± 4.8 min vs. 31.1 ± 6.6 min, P = 0.000). None of the patients in the two groups had the plates removed until the 12-month follow-up [24]. At 6- and 12-month follow-up, we found no significant differences in VAS, G-W, PRWE, MEPS, and DASH scores (Table 2). The mean range of motion and grip strength were measured more than 80% of that of the contralateral side at 6 and 12 months of follow-up. Loss of elbow motion was negligible at 6 and 12 months of follow-up (less than 3%). And at 12-month follow-up, the rate for group A categorized as good or excellent was 91.9% (34/37) compared with 89.2% (33/37) for group B according to Garland and Werley scores. Elbow function evaluation of all the patients in both groups were categorized as excellent according to MEPS at 6- and 12-month follow-up (Table 2).

3.2. Radiological outcomes

No significant differences were observed between the two groups in palmar tilt, radial inclination and ulnar variance at 6- and 12-month postoperatively (Table 3). The average ICC value which represented interobserver variability was 0.900.

3.3. Complications

Two patients in each group experienced wound-healing disturbances. Complex regional pain syndrome (CRPS) was observed in one patient in group A. At 12-month follow-up, articular step-offs were found in two patients in group A and one patient in group B, which was 2, 1, 2 mm, respectively. The overall complication rate was 10.8% (8 out of 74). Volar subluxation of the first dorsal compartment tendons and BR tendinitis which might be related with BR release were not observed in both groups. The complication rates for group A and group B were 16.2% and 8.1% with no significant differences between the two groups (P = 0.708, Table 4).

4. Discussion

A biomechanical study conducted by Tirrell et al. implied that release of the BR tendon during open reduction for DRFs could be performed without adverse effects to elbow function [25]. But
to the author’s knowledge, there was no previous clinical study focused on elbow or wrist function impairment and reduction facilitation for type C DRFs when BR release was carried out. This prospective study demonstrated that the patients with BR insertion released or not yielded similar outcomes of elbow and wrist function, which provided overall satisfactory outcomes at 6- and 12-month follow-up. The wrist function of each group was comparable with previous reports on internal plate fixation for intra-articular distal radius fractures [26,27] while with no elbow function impairment.

The lateral and intermediate columns are always involved in type C distal radius fractures according to Rikli’s column theory [28]. The distal radial fragment including the radial styloid was an important part which participates in radial height of the lateral column. The reduction of the distal radial fragment was crucial during the operation because it was usually an indispensable reference for surgeons to restore other fragments. For the deforming force of the BR tendon, it is difficult to restore the fragment during open reduction [8,11]. After BR release, it was comparative easier to restore the radial height which may simplify “reduction and internal fixation” [7]. According to the present study, significant differences were found in reduction and internal fixation time between group A and group B, which was consistent with the results of Orbay et al. [7,8]. The mean time for group A and group B were 25.0 and 31.1 minutes, respectively (P = 0.000). Only the time from the pronator quadratus released to the final screw implanted was recorded to avoid confounding bias brought by other steps during the operation.

It was demonstrated that the BR release technique seemed non-inferior to the BR preserved treatment in terms of functional and radiographic outcomes. In addition, it took shorter time to accomplish “open reduction and internal fixation”, although the difference between the two groups (about 6 minutes) did not seem to be of clinical significance. Based on the comparative easier manipulation and the shorter time, the BR tendon release facilitates reduction and internal fixation for type C distal radius fractures.

The BR originates from the lateral supracondyly ridge of the humerus and the contiguous intermuscular septum, and its distal part inserted at the base of the first dorsal compartment which lies
Table 2
Clinical outcomes between the two groups.

<table>
<thead>
<tr>
<th></th>
<th>6 months</th>
<th>12 months</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Groups (mean, SD)</td>
<td>Groups (mean, SD)</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Patellar flexion of the wrist (°)</td>
<td>56.1 (10.7)</td>
<td>57.3 (10.8)</td>
</tr>
<tr>
<td>Dorsal extension of the wrist (°)</td>
<td>55.1 (10.6)</td>
<td>57.6 (9.3)</td>
</tr>
<tr>
<td>Grip strength of the hand (kg)</td>
<td>27.1 (7.2)</td>
<td>28.4 (7.8)</td>
</tr>
<tr>
<td>VAS</td>
<td>0.7 (0.7)</td>
<td>0.8 (0.9)</td>
</tr>
<tr>
<td>G&amp;T and Werley score</td>
<td>3.7 (3.8)</td>
<td>3.7 (4.3)</td>
</tr>
<tr>
<td>PRWE</td>
<td>16.4 (8.1)</td>
<td>17.5 (8.9)</td>
</tr>
<tr>
<td>Mayo elbow performance score</td>
<td>99.8 (2.2)</td>
<td>99.1 (2.0)</td>
</tr>
<tr>
<td>Elbow flexion (°)</td>
<td>136.6 (6.9)</td>
<td>137.7 (5.5)</td>
</tr>
<tr>
<td>Elbow extension (°)</td>
<td>136.6 (6.0)</td>
<td>137.0 (5.4)</td>
</tr>
<tr>
<td>DASH</td>
<td>15.9 (15.4)</td>
<td>14.0 (15.4)</td>
</tr>
</tbody>
</table>

VAS: a visual analog scale (VAS) for pain using a 10-point scale; DASH: the Disabilities of the arm, shoulder, and hand; PRWE: patient-related wrist evaluation score; SD: standard deviation.

Table 3
Radiological outcomes.

<table>
<thead>
<tr>
<th></th>
<th>Groups (mean, SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Volar tilt (°)</td>
<td></td>
</tr>
<tr>
<td>6 months</td>
<td>12.3 (3.4)</td>
</tr>
<tr>
<td>12 months</td>
<td>11.1 (3.1)</td>
</tr>
<tr>
<td>Radial inclination (°)</td>
<td></td>
</tr>
<tr>
<td>6 months</td>
<td>23.1 (3.1)</td>
</tr>
<tr>
<td>12 months</td>
<td>24.6 (2.4)</td>
</tr>
<tr>
<td>Ulnar variance (mm)</td>
<td></td>
</tr>
<tr>
<td>6 months</td>
<td>1.2 (2.8)</td>
</tr>
<tr>
<td>12 months</td>
<td>1.6 (2.6)</td>
</tr>
</tbody>
</table>

SD: standard deviation.

Table 4
Complications.

<table>
<thead>
<tr>
<th></th>
<th>Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Wound healing disturbances</td>
<td>2</td>
</tr>
<tr>
<td>Complex regional pain syndrome</td>
<td>1</td>
</tr>
<tr>
<td>Articular step-offs</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>5</td>
</tr>
</tbody>
</table>

in the distal radius [5]. According to Tirrell et al., even at long release distances, loss of elbow flexion torque after BR release was expected to be less than 5% [25]. And Tirrell et al. thought that elbow flexion impairment would be negligible after the BR release. However, their results were based on biomechanical investigation of 5 extremity cadaveric specimens. To determine whether BR release procedure has the potential to decrease elbow flexion strength in patients of DRFs, we assessed the clinical outcomes for 12-month follow-up, and we also found similar results in consist with Tirrell et al.’s. Additionally, the BR tendon is not part of wrist which involves in flexion or extension of wrist function. And it may be the reason why the BR release makes no effects on wrist and hand function.

There were various options after the BR was released. Orbay suggested that the BR should be sutured back in place to retain the bone graft [7]. Z-lengthened cut was applied if possible according to Wijffels et al. [11]. However, the effect of BR release or preserved was not addressed. In a prospective study conducted by Kim et al. [22], it was showed that wrist function and elbow flexion strength were not affected when the BR was released. But there was no randomization in group allocation in his study. In our study, the patients of group A with BR released and group B with BR preserved got comparable elbow and wrist function. The BR retraction was restricted by limited distance of BR release, connections between the BR and antebrachial fascia [5]. Additionally, scarring of the transected tendon and post-surgical healing may retain part of its ability to transmit force distally [25]. Therefore, we thought it was not necessary to repair the BR when it was released for distal radius fractures.

Previous studies showed different complication rates which may be related with various definition of complication. Arora et al. noted complications in 31 of 114 (27%) patients with a palmar locking plate for unstable distal radius fracture [29]. Fowler et al.
noted complications in 2 of 37 (5.4%) patients with a variable-angle volar locking plate for unstable distal radius fracture [30]. Additionally, the internal implants also affected the complication rate [31]. According to the study conducted by Von et al. [32], the complication rate for complex articular distal radius fractures with a 2.4-mm and 3.5-mm locking compression plate was 18% and 11%, respectively. In our study, the complication rate for group A and group B was 16.2% and 8.1%, respectively. The complications included wound healing disturbances, CRPS and articular step-offs. However, complications which might be related to BR release such as volar subluxation of the first dorsal compartment tendon and tendinitis of the BR were not detected in group A. It was thought that the limited distance of release (less than 2 cm) and post-surgical healing should be responsible for the phenomenon.

5. Limitations

Limitations of the study should be addressed. The present study was conducted at single-center level. A multi-center cohort study would be improved to perform the power and validity of the findings in this regard. And the outcomes of a long-term follow-up were not included in the present study. Kreder et al. indicated that potential midterm complications such as carpal tunnel syndrome and irritation of the flexor pollicis longus may become apparent 12 months later after the operation [33]. However, it was demonstrated that outcome scores and functional results appear stable after 1 year and the follow-up more than 12 months could not affect the results [34,35]. Thus, we thought the follow-up interval was deemed adequate for detecting the differences between the two groups.

6. Conclusion

Brachioradialis (BR) release could save time and simplify the surgical procedure for type C distal radius fractures, and show no adverse effects on wrist and elbow function simultaneously.

Disclosure of interest

The authors declare that they have no competing interest.

Acknowledgments

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References


