3D imaging in corrective osteotomy of the distal radius
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Citation for published version (APA):
Vroemen, J. (2013). 3D imaging in corrective osteotomy of the distal radius

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CHAPTER 2

CORRECTIVE OSTEOTOMY OF THE DISTAL RADIUS. INVENTORY OF HARDWARE REMOVAL AND RE-OPERATION RATES

Vroemen JC, Dobbe JGG, Tempelman CVRM, Strackee SD, Streekstra GJ

Nederlands Tijdschrift voor Plastische Chirurgie, April 2013. Volume 4, number 2, 51-54
INTRODUCTION

A symptomatic malunion is a complication that sometimes occurs after a distal radius fracture. (1-3) A corrective osteotomy is a surgical treatment option for these malunions of the distal radius. The goal of a corrective osteotomy is to restore the malpositioned distal radius segment to its original position. (4-6) The procedure is relatively uncommon and technically challenging. If the result of a corrective osteotomy is not satisfactory, for example by undercorrection of the malunited radius, a re-operation is sometimes needed to restore the anatomical alignment of osseous structures in the wrist joint.

The conventional surgical procedure uses two-dimensional plain radiographs for planning and evaluation. There are many studies on the clinical results of a conventional corrective osteotomy of the malunited distal radius. (7-9) However, most studies are single-center, use data from a small patient group and have a short follow-up period. The aims of our study were to identify the long-term results of the conventional radial corrective osteotomy procedure in a multicenter retrospective study and to characterize the patients with post-operative complications.

We provide an overview of surgery data of corrective osteotomy procedures. Recorded complications and re-operation rates of the conventional technique can serve as reference data in comparing new and improved techniques with the conventional technique, and can help to assess possible improvements. We investigated the number of hardware removals and the total re-operation rate of a corrective osteotomy of the distal radius. Our hypothesis is that these rates are higher in our long-term follow-up than in previous short-term follow-up studies. Furthermore, we recorded differences in surgical techniques between practitioners, such as different approaches and graft types.

PATIENTS AND METHODS

We collected medical files from existing databases. Four of the seven investigated hospitals perform corrective osteotomies of the malunited distal radius. These were two university hospitals (A1 and A2) and two district hospitals (B1 and B2). In these hospitals, fifteen different surgeons perform this operation, working in three departments: plastic reconstructive and hand surgery, orthopaedic surgery and the department of traumatology.

We made an inventory of all operation reports and patient charts of the corrective osteotomy procedures of the distal radius performed in the years 2006-2010. We included the following parameters in our investigation: patients sex and age, type of hospital where the procedure is performed (academic or district), department of treatment, initial treatment of the fracture, type of surgical approach, type of inserted bone wedge. We investigated if patients underwent a re-operation and registered post-operative hardware removal.
Furthermore, we searched patient records for complications other than hardware related. The medical ethical committee approved this multicenter study. The procedures followed were in accordance with the Helsinki Declaration of 1975, as revised in 2000.

RESULTS

We found that 75 patients (14 males, 61 females) had a corrective osteotomy of a mal-united distal radius in the years 2006-2010. All procedures of a corrective osteotomy of the distal radius were performed using conventional plain radiographs for planning and evaluation. Mean follow-up was 37 months (range 6-66). The average time between the distal radius fracture and the first corrective osteotomy was 41 months (range 2-276). In 48% of the patients the initial treatment of the fracture was a plaster cast, 20% was treated operatively and in 32% of the patients the initial treatment type was unknown. The average age of the patients at the primary corrective osteotomy of the distal radius was 49 years (range 11-78).

Fifty-eight of the patients (78%) had been operated in an academic hospital, 17 patients (22%) in a district hospital. (Table I) The greater part of the corrective osteotomies is performed by the department of plastic surgery (74%). The orthopaedic department performed 12% and the department of traumatology 14% of the corrective osteotomies. The surgical approach was either volar (76%), dorsal (16%) or both (2%). In 6% the surgical approach was unknown. (Table II) Several types of bone grafts were used for support

<table>
<thead>
<tr>
<th>Hospital</th>
<th>Primary</th>
<th>Re-correction</th>
<th>Hardware removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>45 (60%)</td>
<td>5 (11%)</td>
<td>15 (33%)</td>
</tr>
<tr>
<td>A2</td>
<td>13 (17%)</td>
<td>-</td>
<td>4 (30%)</td>
</tr>
<tr>
<td>B1</td>
<td>12 (16%)</td>
<td>2 (17%)</td>
<td>3 (25%)</td>
</tr>
<tr>
<td>B2</td>
<td>5 (7%)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>7 (9%)</td>
<td>22 (29%)</td>
</tr>
</tbody>
</table>

**Table I.** Number of corrective osteotomies of the distal radius, re-corrections and hardware removals, performed in the academic (A1, A2) and district (B1, B2) hospitals in the years 2006-2010.

<table>
<thead>
<tr>
<th>Surgical approach</th>
<th>Number</th>
<th>Re-correction</th>
<th>Hardware removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volar</td>
<td>57 (76%)</td>
<td>5 (9%)</td>
<td>15 (26%)</td>
</tr>
<tr>
<td>Dorsal</td>
<td>12 (16%)</td>
<td>2 (17%)</td>
<td>4 (33%)</td>
</tr>
<tr>
<td>Both</td>
<td>1 (2 %)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Unknown</td>
<td>5 (6 %)</td>
<td>-</td>
<td>3 (60%)</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>7 (9%)</td>
<td>22 (29%)</td>
</tr>
</tbody>
</table>

**Table II.** Type of surgical approach used for the corrective osteotomy of the distal radius, with the concomitant number of re-corrections and hardware removals.
after a corrective osteotomy of the distal radius. A wedge of the crista iliaca bone (63%),
a donor graft (7%) or a piece of ulna or femur (3%). In 22% of the cases no bone wedge
was inserted and in 5% the type of bone graft was unknown. (Table III)

Due to re-corrections and hardware removals, the total re-operation rate was 38%.
Seven patients (9%) needed a re-correction. Five of these seven patients (7%) needed a
re-corrective osteotomy of the radius, while two patients (2%) underwent an additional
ulna shortening osteotomy to compensate for the under-correction of the corrective oste-
otomy of the radius. The mean time between the first and second correction osteotomy
was 11 months (range 3-24). One patient underwent a third corrective osteotomy. In 22
patients (29%) hardware removal was performed. Fifteen volar plates (68%) and 4 dorsal
plates (18%), in 3 cases (14%) the type of removed plate was unknown. The mean time
between the correction osteotomy and hardware removal was 15 months (range 4-48).
Two complications (3%) other than hardware related were reported. One patient needed a
tenotomy of the flexor carpi ulnaris (FCU) post-operatively and another patient underwent
debridement at the crista donor site.

**DISCUSSION**

We provided an overview of surgery data of the corrective distal radius osteotomy proce-
dures. Corrective procedures of the distal forearm bones are done by orthopaedic, plastic
and trauma surgeons. In this way the procedure is carried out by many different specialists.
This is sometimes considered disadvantageous for the expertise of the surgeon and the
training of residents since it is assumed that patients could benefit from a single specialized
team dedicated to the distal radius procedures. *(10)*

Other long-term studies do report the same higher re-operation or hardware removal rates
as we found in our patient group. Our study confirms results found in previous investiga-
tions: in a study of Lozano-Calderon the hardware removal rate is 45% (10 out of 22
patients), also at an average of 15 months between the correction osteotomy and the plate
removal. *(11)* Also Prommersberger et al. report removal of the fixation plate in 16 patients
(55%) of the total 29 patients. *(12)*

<table>
<thead>
<tr>
<th>Bone graft</th>
<th>Number</th>
<th>Re-correction</th>
<th>Hardware removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crista bone</td>
<td>47 (63 %)</td>
<td>4 (9%)</td>
<td>14 (30%)</td>
</tr>
<tr>
<td>Donor bone</td>
<td>5 (7 %)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>No graft</td>
<td>17 (22 %)</td>
<td>2 (12%)</td>
<td>6 (35%)</td>
</tr>
<tr>
<td>Otherwise</td>
<td>2 (3 %)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Unknown</td>
<td>4 (5 %)</td>
<td>1 (25%)</td>
<td>2 (50%)</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>7 (9%)</td>
<td>22 (29%)</td>
</tr>
</tbody>
</table>

**Table III.** Type of bone graft used for the inserted wedge.
Our long-term re-operation rate and number of hardware removals is higher than previously described in short-term follow-up studies. (7-9) In contrast to our experience, Ladd et al. describe only 2 hardware removals (14%) but 4 other major re-operations (28%) in a study with 14 patients and a mean follow-up of 29 months. (7) In a study with a mean follow-up of 30 months Oskam et al. report no hardware removal and 2 secondary operations (9%) in 22 corrective osteotomies. (8) Finally, Wada et al. even present a study were no hardware removal and no re-operations are performed at all (mean follow-up 17 months). (9) An explanation for our higher rates may be the long-term follow-up of our study with a mean of 37 months (range 6-66) and the fact that the mean time period between the correction osteotomy and hardware removal was 15 months (range 4-48).

An interesting finding is that in hospital A2 nine of the 13 procedures (69%) were performed without the use of a supporting bone wedge. To our knowledge there is only one study that reports the possibility of leaving out a bone graft after a corrective osteotomy of the radius. Wieland et al concluded that bone grafting is not necessary. (13)

The non-hardware related complication rate of the conventional corrective osteotomies performed with 2D imaging is low (3% in this retrospective study) so the procedure is relatively safe. Like Fernandez, we do not consider plate removal as a complication. (4) However, the re-operation rate is quite high (38%), for a large part due to hardware removal (29%).

This study has some limitations. This retrospective study provides numbers of reoperations and complications, but does not describe clinical outcomes such as subjective outcome scores in patients.

Further research is needed towards possible causes for the high re-operation rate, other than due to hardware removal. Another topic that needs further investigation is the possibility for alternative fixation methods, regarding the frequent occurrence of hardware removal. Hopefully, new and improved future operative techniques will improve the quality of care and thereby the quality of life for the patient. But to be able to prove this we will need future prospective long-term follow-up studies, using these new and improved techniques.

In conclusion, corrective osteotomies are often a good and only option in the case of a malunited distal radius, but the procedure is not ideal and can give problems over the longer term. Future research should focus on improving the corrective osteotomy procedure in general and on avoiding re-operations due to plate removal in particular.
REFERENCES