Conservative Treatment of Extra-articular Colles’ Type Fractures of the Distal Radius: Prospective Study

Joško Smilović, Ranko Bilić1

Department of Surgery, Čakovec County Hospital, Čakovec; and 1Department of Orthopedic Surgery, Zagreb University School of Medicine, Zagreb, Croatia

Aim. To determine the anatomical and functional results of conservative treatment of extra-articular Colles’ type fractures of the distal radius and the borderline value of each anatomical parameter for the best possible correlation with functional end result.

Methods. This prospective study included 54 patients. Standard radiographs were made of both wrists in two directions after the fracture, then of the injured side on day 11 following repositioning, and finally of the union of bone segments. Anatomical results were assessed by evaluating the dorsal angulation, loss of radial inclination, and loss of radial length. Functional results were assessed by the evaluation of pain, range of active motion, grip strength, and appearance of the wrist joint.

Results. Statistically significant association was found between the anatomical and functional results (chi-square = 16.3, p<0.001). Excellent or good anatomical and functional results were obtained in 24 patients, whereas in 30 patients both treatment outcomes were assessed as fair or poor. If ≤10 degrees of dorsal angulation was taken as a borderline value for a good outcome, there was significant association with a good functional result (chi-square = 23.6, p<0.001). However, if ≤9 degrees loss of radial inclination was taken as a borderline value for a good outcome, no association with a good functional result was found (chi-square = 3.9, p = 0.530). If ≤6 mm of radial shortening was taken as a borderline value for a good outcome, again no association existed with a good functional result (chi-square = 6.43, p = 0.011).

Conclusion. We found an association between anatomical and functional results after conservative treatment of extra-articular Colles’ type fracture of the distal radius. Acceptable borderline dorsal angulation was ≤9 degrees; acceptable loss of radial inclination was ≤3 degrees, and acceptable loss of radial length was ≤2 mm.

Key words: casts, surgical; Colles’ fracture; hand strength; prospective studies; radiography; range of motion, articular; treatment failure

The fracture of the radial bone in a typical zone accounts for 10-17% of all fractures treated at emergency care units (1, 2). It also accounts for 74.5% of all forearm fractures (3). This type of fracture occurs most commonly between the age 6 and 10, and between the age 60 and 69 (4). In the group of patients aged above 60, women suffer this type of fracture nearly 7 times more often than men (4).

Many physicians assume that the distal radial bone fracture does not require special attention since the resulting deformity rarely damages the wrist function (5, 6). However, such opinions have recently undergone a significant revision, particularly with regard to complex intra-articular fractures of the distal radial bone, which as a rule require surgical treatment (7-10). Union with a deformity is the most common complication following a distal radial fracture (11).

We performed a prospective study to assess the anatomical and functional results of the conservative treatment of extra-articular fracture of the radial bone in the typical zone. We evaluated correlations between single parameters of the anatomical results (dorsal angulation, loss of radial inclination, and loss of radial length) and functional end results to determine the borderline value of each anatomical parameter that would correspond the best with a functional end result.

Patients and Methods

Patients

The study was carried out at the Čakovec County Hospital during 1996-1998. We prospectively followed up 54 patients with simple and impacted extra-articular fractures of the distal segment of radial bone in the typical zone (Colles’ type) who underwent conservative treatment (Fig. 1). The patients were classified according to Müller’s classification (12) into A2 group of the
distal segment of radial bone fractures (extra-articular fracture of the radius, simple and impacted), location 2-3 (2 signifying forearm and 3 signifying the distal segment). There were no patients with reverse Colles’ fracture (Goyrand-Smith’s fracture). There were 20 male and 34 female patients. The mean age of men was 43.7±15.6 years (range, 19-71 years), and the mean age of women was 59.9±13.8 years (range, 17-86 years). In 51 patients the right hand was dominant, whereas three patients were left-handed. The right hand was affected in 19, and the left hand in 35 patients. In 22 patients, the fracture occurred in the dominant and in 32 patients in the non-dominant hand. The incidence of fracture was highest in patients aged 60-69 years. In this age group, the incidence of fractures was higher in women than in men (however, there were 3 men and 21 women older than 60 years), which corresponds with data reported in literature (2,4).

Treatment

Standard radiographs were made of both wrists in two directions after the fracture, of the injured sides on the eleventh day following reposition, and upon the union of bone segments (Fig. 2). After the reduction of the fracture, the arm was immobilized by dorsal plaster bandage, with the wrist joint at neutral position and mild ulnar deviation. After the eleventh day, a circular plaster bandage was applied for 3 to 4 weeks.

Anatomical Evaluation

The X-rays were used to determine radial inclination (Fig. 3), palmar tilt (or palmar slope) (Fig. 4) of the distal radial bone segment, and the radial bone length (Fig. 5) according to Bilić et al (13). The method of measurement of the radial bone length according to Bilić et al (13), when compared with other measurement methods, is not so much affected by the changes in the radial and palmar angles and the result is significantly less influenced by the rotation of the distal fragment in frontal and sagittal planes. Anatomical results (Table 1) were assessed on the basis of criteria established by Stewart et al (14).

Functional Evaluation

A goniometer was used for the measurement of the flexibility of wrist joint of the healthy and injured hand not sooner than 6 months after treatment. Dynamometer (Collin Dynametar Adult, MEDICON, Tuttlingen, Germany) was used to measure the strength of the wrist grip, whereas deformity of the wrist joint and painfullness were assessed on the basis of criteria described by Fernandez et al (15). For the assessment of functional results we used the same criteria and rated the results as follows: 1) excellent – no pain, normal or almost normal motion, grip strength of not less than 80% of the normal, and no visible deformity; 2) good – no pain, moderate limitation of motion (not less than 65 to 70% of normal), grip strength of not less than 70% of normal, and no deformity; 3) fair – moderate pain during work activities, limited motion of 40-65% compared with normal, grip strength of 50-70% compared with normal, and mild deformity; 4) poor – persistence of pain during work or daily activities, severe loss of motion (less than 40% compared with normal), reduction of grip strength to less than 40% compared with normal, stiffness of finger joints with impairment of function of the hand, and mild to severe deformity (15).

The parameters measured in the healthy hand were used as control assessment criteria for treatment result.

Determination of Acceptable Borderline Values

To determine the borderline value for the best possible correlation between anatomical and functional results on the basis of the obtained data, we further analyzed parameters important for anatomical results: further loss of radial length (mm), each single degree of radial inclination loss, and dorsal angulation. Thus the acceptable borderline values were obtained for anatomical parameters in cases when functional result was expected to be excellent or good. Each anatomical parameter, the borderline value of which was obtained in this way, was tested for correlation with functional findings.

Statistics

Statistical analysis was performed using SPSS version 7.0 (SPSS Inc., Chicago, IL, USA). We analyzed associations between different parameters of anatomic result (based first on Stewart’s classification and then on our proposed classification) to the functional result using chi-square test of association. The chi-square test of association, shown in 2x2 table where the fields with excellent and good results and the fields with tolerable and poor results were combined, was used in the analysis of association between anatomical and functional results. P-value <0.001 was considered statistically significant. To examine strengths of associations, we computed odds ratios (OR) with 95% confidence intervals (CI) for the functional result in relation to the anatomic result.

Results

The radial inclination in healthy hands was 20-30 degrees (mean±SD, 26.6±2.9 degrees). Palmar angulation of healthy hands was 0-15 degrees (mean±SD, 7.9±4.1). The length of the radial bone varied from 8 mm to 18 mm (mean±SD, 13.2±1.8 mm).

The anatomical result was excellent in four patients, good in 20, satisfactory in 18, and poor in 12 patients. The functional result was excellent in 10 patients, good in 14, fair in 16, and poor in 14 patients.

There was a statistically significant association between anatomical and functional results (chi-square=16.3; d.f.=1; p<0.001; Table 2). The odds
ratio for functional result in relation to the anatomic result was OR = 12.0 (95% CI, 3.3-43.4).

According to Stewart et al (14), acceptable dorsal angulation was ≤10 degrees, acceptable loss of radial inclination was ≤9 degrees, and acceptable loss of radial bone length was ≤6 mm (Table 1).

Statistically significant association was found between the dorsal angulation of the radial bone upon completion of the treatment and functional results (chi-square = 23.6; d.f. = 1, p < 0.001; OR, 24.7; 95% CI, 5.8-104.4), with the 10 degree or less dorsal angulation as the borderline value (Table 3).

No statistically significant association was found between the loss of radial inclination and functional results (chi-square = 3.9, d.f. = 1, p = 0.530; OR, 4.7; 95% CI, 0.9-24.4), provided the 9 degree inclination or less was taken as borderline value (Table 4).

No statistically significant association was found between the loss of radial bone length and functional results (chi-square = 6.43, d.f. = 1, p = 0.011; OR not computed due to no cases with fair or poor functional result), provided ≤6 mm shortening was considered acceptable (Table 5).

To establish borderline values that would ensure the greatest association between anatomic and functional results, we examined associations of different anatomic borderline values and functional results.

When the value of ≤9 degrees was taken as a borderline for the acceptable dorsal angulation (Table 6), significant association with functional result was found (chi-square = 26.7, d.f. = 1, p < 0.001; OR, 42.0; 95% CI, 76.0-231.4). The value of ≤3 degrees was obtained for the acceptable reduction of radial inclination (Table 7). With this borderline value we found significant association with functional result (chi-square = 21.0, d.f. = 1, p < 0.001; OR, 19.5; 95% CI, 4.8-79). The value of ≤2 mm was obtained for the acceptable loss of radial length (Table 8), and again, association with functional result was statistically significant (chi-square = 16.6, d.f. = 1, p < 0.001; OR, 12.5; 95% CI, 3.4-45.7).
Discussion

Excellent or good anatomical and functional results were obtained in 24 out of 54 patients, whereas in 30 patients both treatment outcomes were assessed as satisfactory or poor. The limitations of our study were a small number of patients and wide range of their age. Our results are widely discrepant from other studies that found closed reduction and solid cast immobilization acceptable methods of the treatment in 75-80% of fractures of distal radial bone (2,16). Considering that our study subjects were patients with A2...
Table 6. Relation between dorsal angulation and functional result in 54 patients conservatively treated for extra-articular Colles’ type fractures of the distal radius – acceptable borderline dorsal angulation of ≤9 degrees

<table>
<thead>
<tr>
<th>Functional results</th>
<th>Dorsal angulation (degrees)</th>
<th>≤9</th>
<th>≥10</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent or good</td>
<td></td>
<td>18</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>Fair or poor</td>
<td></td>
<td>2</td>
<td>28</td>
<td>30</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>20</td>
<td>34</td>
<td>54</td>
</tr>
</tbody>
</table>

\[ z^2 = 26.7, \text{d.f.}=1, p<0.001 \]

Table 7. Relation between loss of radial length and functional result in 54 patients conservatively treated for extra-articular Colles’ type fractures of the distal radius – acceptable loss of radial inclination of ≤3 degrees*

<table>
<thead>
<tr>
<th>Functional results</th>
<th>No. of patients with loss of radial inclination (degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-3</td>
<td>18</td>
</tr>
<tr>
<td>≥4</td>
<td>26</td>
</tr>
</tbody>
</table>

*Chi-square = 21.0, d.f. = 1, p<0.001.

Table 8. Relation between loss of radial length and functional result in 54 patients conservatively treated for extra-articular Colles’ type fractures of the distal radius – acceptable loss of radial length of ≤2 mm*

<table>
<thead>
<tr>
<th>Functional results</th>
<th>No. of patients with loss of radial length (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2 mm</td>
<td>19</td>
</tr>
<tr>
<td>≥3 mm</td>
<td>7</td>
</tr>
</tbody>
</table>

*Chi-square = 16.6, d.f. = 1, p<0.001.

type extra-articular fracture of the radial bone, poor results that we obtained are even more unfavorable. Most authors have reported the treatment results of different fracture types and severity of the distal radial bone segment, including more severe intra-articular fractures. Cassebaum (5) reported obtaining 94.1% excellent or good functional results in 135 patients with radial bone fracture. Altissimi et al (17) obtained 87% excellent or good anatomical results in 297 patients treated for radial bone fracture by closed reduction. One of the possible explanations of our results could be that in our hospital reposition after fracture is often performed by residents in surgery, who are still not competent or critical enough. The other explanation could be that surgeons whose primary field of work is not traumatology very often deal with treatment of the fractures.

We obtained significant correlation between anatomical and functional results, which differs from the results obtained by Gartland and Werley (18), who obtained surprisingly good functional results despite poor repositioning and inadequate immobilization. Our results also differ from those reported by Cassebaum (5), Pool (19), and Young and Rayan (20), who obtained good function in cases where anatomical results were poor. However, the majority of authors report about significant correlation between anatomical and functional results (21-23).

Several studies tried to identify prognostic factors associated with distal radial bone fracture. As early as 1951, Gartland and Werley (18) noted that the loss of palmar tilt correlated best with functional results. Porter et al (24) maintained that dorsal angulation of 20 degrees and loss of radial inclination up to 10 degrees were acceptable from a functional point of view. Jenkins and Mintowt-Czys (23) found that the power of the wrist grip correlated with the inclination of articular surface of the radial bone in sagittal and coronal planes. Villar et al (25) found the correlation between the shortening of the radial bone the first week following immobilization and loss of the wrist grip power, but they found no correlation at all between the loss of radial inclination and power of wrist grip or range of motion in the wrist joint. Altissimi et al (17) reported that unsatisfactory final result might be expected when radial inclination was <5 degrees, dorsal angulation >15 degrees, and radio-ulnar index >5 mm. They defined the radio-ulnar index as a distance between the most proximal point in the articular surface of the radial bone and distal articular surface of the ulna. McQueen and Caspers (26) reported that functional results were less favorable in patients with dorsal angulation of the radial bone between 12 and 34 degrees, and radial shift of >2 mm. Solgaard (21) reported on 154 patients examined 3.5 years following the fracture of the distal radial bone treated by closed reduction and solid cast immobilization; he established correlation between the length of the radial bone and dorsal angulation and functional results. Salmon and Patten (27) defined malunion of distal radial fractures as dorsal angulation of 10 degrees, radial shortening of >3 mm, radial inclination of ≤17 degrees, and an intra-articular step of >1 mm. We analyzed all parameters that made up an anatomical result and tried to find borderline values as indicators of a later inadequate functional result. Thus, measuring anatomical parameters can have prognostic value. We concluded that acceptable borderline dorsal angulation was ≤9 degrees, acceptable loss of radial inclination ≤3 degrees, and acceptable loss of radial length ≤2 mm. In cases of Colles’ type of extra-articular fracture of the distal radius when these borderline values cannot be obtained or kept, it is necessary to perform surgery, with the aim of obtaining a good functional result upon completion of the treatment.

In our study, the radial inclination in healthy hands ranged from 20 to 30 degrees, which is in accordance with literature data (28,29). However, the mean value of 26.6 ± 2.9 degrees is higher than the 20 degree average described by Metz et al (28), 22 degrees described by Talensnik et al (30), or 23 degrees reported by Sceck (31). It is close to the average radial inclination value of 25.4 degrees as reported by Friborg and Lundström (32). The palmar tilt in our study ranged from 0 to 15 degrees, which is in accordance with other relevant studies reporting the range of values from 0 to 22 degrees (2,17,29,32). The mean value of 7.9 ± 4.1 degrees is lower than the most commonly reported average value of 14.5 degrees (28,29). Friborg and Lundström (32) also obtained an average of 14.5 degrees for palmar tilt when assessed on X-rays made in the way that the central beam fell vertically on the X-ray film during imaging procedure. However, when the central beam fell be-
low 15 degrees in cranial direction, the authors obtained the average palmar flexion value of 9.3 degrees. The length of radial bone measured by Bilić et al (13) ranged from 8 to 18 mm (mean value of 13.2 ± 1.8mm). Due to a wide range of measured parameters in healthy hands, it is necessary to make a comparative X-ray of both wrists, because measured parameters in healthy hand can be used as control criteria for the assessment of treatment results. We believe that further research would confirm the values of borderline parameters found in our research.

References
5 Cassebaum WH. Colles’ fracture: a study of end results. JAMA 1950;143:963-5.