The rheumatoid wrist after resection of the distal ulna

Thirty-three wrists in 25 patients with rheumatoid arthritis were followed for an average of 3.8 years after resection of the distal ulna. These patients, including those who had adjunctive implantation of a silicone rubber cap, manifested considerable amounts of carpal collapse, carpal translocation, rotational change of the wrist, and radial shift of the ulna. The progression of these complications was unpredictable. Four patients required revision. Three of these four patients had no articular contact between the lunate and radius on their preoperative x-ray film. Excision of <20 mm of the distal ulna is an acceptable range of resection. In 15% of the wrists, an osseous carpal stabilizer was seen on the preoperative x-ray film as a reliable radiographic indicator of radiocarpal stability. Another 12% of patients developed a bony carpal stabilizer during the postoperative period. (J HAND SURG 10A:837-44, 1985.)

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Excision of the distal ulna for acute disruption of the ulnocarpal complex was initially described by Moore in 1880. This technique was later used by Darrach after the turn of the century, and the so-called Darrach procedure has since enjoyed general acceptance as a treatment for posttraumatic, congenital, and rheumatoid derangements of the inferior radioulnar joint. In recent years some authors prefer to avoid resection of the distal ulna because it removes normal restraining anatomy that stabilizes the carpus. Other authors recommend surgical pseudarthrosis or arthrodesis of the distal radioulnar joint with osteotomy of the ulna as alternate management for disorders of the ulnocarpal complex. This study retrospectively analyzes our experience with excision of the caput ulnae to identify useful radiographic information for proper patient selection.

Material and methods

A total of about 15 cases of resection of the distal ulna are performed at the University of Missouri Hospital and Clinics and the Harry S. Truman Veterans Administration Hospital each year. Patients with rheumatoid arthritis were selected for this investigation only if their preoperative x-ray films were preserved and if postoperative films existed or were obtainable by patient recall. A total of 33 wrists in 25 patients were evaluated. Eight patients had bilateral procedures. Ten patients were men, and 15 were women. The average age was 61 years, with a range of 21 to 75 years. The average follow-up was 3.8 years, with a range of 12 to 131 months.

The factors correlated from the patients’ x-ray films included: (1) loss of carpal height, (2) the change in ulnocarpal distance, (3) the change in rotation of the hand, (4) the shift in the longitudinal axis of the ulna, (5) the rate of surgical revision, with special attention to the percentage of preoperative radiolucent contact, (6) the amount of ulna excised, and (7) the presence or development of a bony carpal stabilizer. All measurements were obtained from posteroanterior x-ray films of the patients’ wrists.

Carpal height was measured from the base of the third metacarpal to the distal subchondral plate of the radius. In the normal cadaver wrist, carpal height can be reproducibly measured along the midaxis of the third metacarpal. The resulting carpal-metacarpal length ratios are not consistent, however, in patients with rheumatoid arthritis. We chose to simplify the measurement of carpal height along a vertical line as illustrated in Fig. 1. Carpal collapse, or the difference between preoperative and postoperative carpal heights, was cat-
Fig. 1. The carpal height (c) is measured vertically from the base of the third metacarpal to the distal subchondral plate of the radius. The ulnocarpal distance (d) is the horizontal distance from the midaxis of the ulna to the center of the capitate at a site located one fourth the length of the capitate distal to its proximal end.

capitate is close to the center of rotation of the hand in the coronal plane, and it is not altered by radial or ulnar deviation of the hand. Postoperative ulnocarpal distance was assessed by superimposing the postoperative x-ray film on the preoperative x-ray film to reconfirm the preoperative relationship of the ulna. The outline of the distal radius on each x-ray film was aligned to coincide as the spatial reference. Carpal translocation, or the difference between preoperative and postoperative ulnocarpal distances, was categorized similar to a previously described system: mild, $\leq 5$ mm translocation; moderate, 6 to 10 mm translocation; marked, $>10$ mm translocation.

For purposes of calculation, rotation of the hand in a radial direction was assigned a (+) positive value, and rotation of the hand in an ulnar direction was designated as a (−) negative change. In each preoperative and postoperative x-ray film, as seen in Fig. 2, it was assumed the hand was in a resting posture.

With superimposed x-ray films, the change in the position of the longitudinal axis of the ulna in the coronal plane was measured along the horizontal line passing through the center of the capitate at a point located one fourth the length of the capitate distal to its proximal end (Fig. 3). Radialization of the ulna, or the difference between the preoperative and postoperative longitudinal axis of the ulna, was graded as follows: mild, $\leq 6$ mm radial shift; moderate, 7 to 14 mm radial shift; marked, $>14$ mm radial shift.

In those patients requiring surgical revision, the percentage of preoperative contact of the lunate and the radius was calculated by direct measurement of the

Fig. 2. The arc of rotational change of the hand is calculated from the angle formed by a line drawn in the longitudinal axis of the third metacarpal, which intersects a line drawn in the longitudinal axis of the radius.
proximal articular surface of the lunate that apposed the articular surface of the radius. The measurement was expressed as a percentage of the transverse width of the lunate.

The amount of ulna excised in each patient was determined by direct measurement if immediate postoperative x-ray films were available or by the surgeon’s operative description. Finally, each patient’s x-ray films were inspected for an occult radiocarpal fusion or the presence of a bony shelf that stabilized the radiocarpal joint.

The cases were divided into two subpopulations. Group I included patients who had a Darrach resection arthroplasty. Group II consisted of patients who had excision of the distal ulna with placement of a silicone rubber cap. 10

Results

The change in carpal height, or carpal collapse, is compared for both groups in Table I. In group I, the average time of follow-up was 35 months for mild carpal collapse, 62 months for moderate collapse, and 86 months for marked collapse. The other smaller subpopulation, group II, did not show a linear relationship between carpal collapse and time.

The change in ulnocarpal distance, or carpal translocation, was compared for both groups in Table II. There was no linear relationship between change in ulnocarpal distance and time.

The postoperative change in rotational attitude of the hand in both groups is compared in Table III. In groups I and II, the change in rotational posture of the hand was somewhat equally distributed between rotation in the radial and ulnar directions. In group I, the average rotational change of the hand in mild, moderate, and marked carpal translocation was (+) 3°, (–) 6°, and (–) 12°, respectively.

The shift of the longitudinal axis of the ulna in the coronal plane, or the radialization of the ulna, is compared for both groups in Table IV. The percentage dis-
Fig. 4. A, This 63-year-old man with rheumatoid arthritis had resection of 24 mm of the distal ulna in his wrist that had no articular contact between the lunate (arrow) and radius. B, This patient required a surgical revision of his destabilized wrist with a stemmed silicone rubber spacer 30 months later. In our series, all three wrists with no preoperative radiolunate apposition later required revision.

Table IV.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mild</th>
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<th>Moderate</th>
<th></th>
<th>Marked</th>
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<tbody>
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<td></td>
<td>No./total</td>
<td>%</td>
<td>No./total</td>
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<td>No./total</td>
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<tr>
<td>I</td>
<td>18/26</td>
<td>69</td>
<td>6/26</td>
<td>23</td>
<td>2/26</td>
<td>8</td>
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<tr>
<td>II</td>
<td>4/7</td>
<td>57</td>
<td>2/7</td>
<td>29</td>
<td>1/7</td>
<td>14</td>
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Distribution of radial shift of the ulna was very similar in groups I and II.

Four wrists, or 12% of the total study population, required operative revision. Two patients had a dorsal wrist stabilization procedure, one patient had a radiocarpal arthrodesis, and a stemmed silicone rubber spacer was implanted in one patient’s wrist. Three of the four individuals who required revision had no contact between the articular surfaces of the lunate and radius before surgery (Fig. 4). The other patient had 62% apposition of the lunate to the radius, but he later required dorsal wrist stabilization because of severe radial rotation of the hand.

In group I, the overall average amount of ulna resected was 17.2 mm for 24 of 26 wrists with this information retrievable. This average varied within ±2 mm when calculated for each category of carpal collapse, carpal translocation, rotational change of the hand, and radialization of the ulna in which three or more patient’s data were available. The only exception to this was in wrists with marked carpal translocation in which the average amount of the distal ulna excised was 22 mm.

In group II, the overall average amount of ulna resected was 14.8 mm for six of the seven wrists with this information retrievable. This average varied within ±2.6 mm when calculated for each category in which three or more patient’s data were available.

Nine wrists were noted to have a bony radiocarpal stabilizer on the follow-up postoperative x-ray film. Four wrists had a radiolunate fusion, and five wrists had a bony shelf at the sigmoid notch of the radius that supported cases of findings. The x-ray film identifies confirmative patient findings with the incline.

Discuss

In the total axial excursion of the radial axis, the zygomatic migration is the incline.

Both groups of patients were implanted with the postoperative x-ray film. The progression in the group is because...
Fig. 5. A, The preoperative x-ray film of this 60-year-old woman with rheumatoid arthritis had a radiolunate fusion (arrow) that stabilized the carpus. A bony carpal stabilizer was seen on the preoperative films of 15% of our patients. B, 1 year after resection of 18 mm of the distal ulna, the patient's radiocarpal relationships remain essentially unchanged.

Discussion

In the cadaver model, the radius bears 60% of the total axial load when the wrist is in neutral. After excision of the distal ulna, the radius absorbs 100% of the axial load across the wrist. In the rheumatoid wrist, the zigzag deformity of the hand evolves with ulnar migration of the carpus secondary to shear forces along the inclined plane of the radial articular surface. Both groups I and II had nearly the same percentage of patients in each category of carpal collapse. In patients who had resection of the distal ulna without implantation of a silicone rubber cap, a longer length of time at follow-up correlated with an increase in carpal collapse. This temporal relationship corresponds to the observations of other investigators who have studied the postoperative rheumatoid wrist.

The patients in group I had their wrists distributed in progressively diminishing numbers through the advancing categories of carpal translocation. The patients in group II had no wrists in marked carpal translocation. Because of our small sample selection, it is unknown whether this phenomenon is attributable to the presence of the silicone rubber cap. Our data did not show an increasing change in ulnocarpal distance as related to the follow-up period in either group. This contrasts with the observations of other investigators who have studied the rheumatoid wrist after surgery and observed a linear relationship between carpal translocation and time.

The extent of both carpal translocation and carpal collapse has been noted to directly correlate with the presence of ulnar drift at the metacarpophalangeal joints. Radial rotation of the wrist is another important factor in regulating ulnar drift of the digits at the metacarpophalangeal joint. Although the change in ulnar deviation of the fingers has been evaluated after wrist surgery in patients with rheumatoid arthritis, the subtle positional alterations of the intercalated carpal-metacarpal unit have not been closely assessed after simple excision of the distal ulna. The group I wrists were almost as likely to rotate a few degrees in the radial direction after surgery as they were likely to rotate a comparable amount in the ulnar direction. The influence of these small increments of rotational change of the wrist on the alignment of our patient’s digits was not measured. In a similar study by Thirupathi et al., however, it was observed that patients with preoperative ulnar deviation of the fingers improved and deteriorated in equal numbers. Despite the enhanced moment arm of the radial wrist extensors produced by ulnar migration of the carpus, the progression of carpal translo-
cation in our patients did not correlate with increasing rotation of the hand in a radial direction as postulated by others.4

In our series it was found that conventional excision of the caput ulnae detaches the distal ulna from its strong bony moorings to the radius via the triangular fibrocartilage complex, thereby allowing a shift in the longitudinal axis of the ulna in the coronal plane in almost every patient. To the best of our knowledge, this post-operative change in the ulnocarpal complex has not been previously quantified. An advanced category of radial shift was seen nearly equally in patients in whom an adjunctive silicone rubber cap was implanted as in patients who underwent a simple excision of the distal ulna (Fig. 7).

In the normal wrist, at least one half of the lunate is always apposed to the radius regardless of the wrist attitude as viewed on a posteroanterior x-ray film.14 In retrospect, close scrutiny of the radiolucent relationship was a dependable method in our series of identifying three fourths of the radiocarpal joints that later necessitated operative revision.

The ideal amount of ulna to excise is unknown. Darrach recommend 1 inch or about 19 mm.2 The suggested amount to excise ranges from 1" to 3 cm.13 If more than 1 inch is removed, some authors caution that troublesome instability of the ulna may develop.3 Removal of less than 2 cm may be the safest guideline.16,17 Our experience confirms that this range is acceptable. The group I individuals who developed marked carpal translocation had the largest average amount of bone (22 mm) resected. These data suggest that excessive resection of the caput ulnae may contribute to carpal translocation.

A bony radiocarpal stabilizer was observed in 27% of the wrists in our series. Only five wrists, or 15% of the study population, showed such a finding on x-ray films before surgery. The benefit of spontaneous radiocarpal arthrodesis in the rheumatoid wrist has been mentioned by Linscheid and Dobyns; however, the importance of the radial shelf has received scant attention in the literature. Preoperative recognition of a bony stabilizer in the wrist assures the surgeon of postoperative radiocarpal stability. The late development of a radiolucent fusion or a radial shelf after surgery occurred in 12% of our wrists, and it was unpredictable. The serendipitous appearance of one of these findings on the postoperative x-ray film in a rheumatoid wrist is welcomed, since it facilitates a long-term favorable result (Fig. 8).

Our current approach to the selection of patients with rheumatoid arthritis for resection of the distal ulna begins with a thorough history and physical examination to confirm derangement of the distal radioulnar joint.
Fig. 7. A, This 66-year-old man with rheumatoid arthritis had resection of the distal ulna and implantation of a silicone rubber cap. B, Despite the presence of the silicone rubber spacer, the longitudinal axis of this patient's ulna shifted 20 mm in the radial direction as seen in this x-ray film 42 months after surgery.

Fig. 8. A, This 75-year-old woman with rheumatoid arthritis had a conventional resection of the distal ulna. B, A radial shelf (arrow) supporting the patient's carpus developed after surgery as seen in this x-ray film 5 years after surgery. A bony carpal stabilizer developed in 12% of our patients after surgery.

The perilunate features of the patient's x-ray film are then inspected for a bony stabilizer or the absence of radiolunate articular contact. If the latter finding is observed, the patient is offered an arthrodesis of the radioulnar joint with osteotomy of the ulna or a dorsal wrist stabilization procedure. If a bony stabilizer is present, then a conventional Darrach procedure is preferred. Selection of patients beyond these criteria is performed on an individualized basis with the understanding that carpal deterioration is an unpredictable, but natural pro-
cess in the rheumatoid wrist. At operation we use a conservative resection of the caput ulnae by excising the least amount of bone that will ablate the deranged inferior radioulnar articulation. To assure stability of the ulna in the coronal plane, the amount excised may be as little as one half of the acceptable upper limit of 2 cm. A silicone rubber spacer is no longer implanted since we see no distinct advantage with its use.

REFERENCES