Proximal row carpectomy with capsular interposition arthroplasty for advanced arthritis of the wrist

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Advanced osteoarthritis of the wrist or the distal articulation of the lunate with the capitate has traditionally been treated surgically by arthrodesis. In order to maintain movement, we performed proximal row carpectomy with capsular interposition arthroplasty as an alternative to arthrodesis in eight patients with advanced arthritis and retrospectively reviewed their clinical and radiographic outcomes after a mean follow-up of 41 months (13 to 53). The visual analogue scale (VAS) for pain at its worst and at rest, and the patient-rated wrist evaluation score improved significantly after surgery, whereas ranges of movement and grip strength were maintained at the pre-operative levels. Progression of arthritis in the radiocapitate joint was observed in three patients, but their outcomes were not significantly different from those without progression of arthritis.

Proximal row carpectomy with capsular interposition arthroplasty is a reasonable option for the treatment of patients with advanced arthritis of the wrist.

Following proximal row carpectomy, the complex link system of the wrist is converted to a simple hinge-like joint. As the curvature of the proximal pole of the capitate does not match the facet for the articulation of the radius with the lunate of the distal radius, proximal row carpectomy would be expected to result in early cartilage degeneration and reduced movement. Also, the effect of relative tendon lengthening might result in reduced grip strength. However, despite these potential disadvantages, proximal row carpectomy has been used successfully to treat arthritis of the wrist since first described by Stamm in 1939.

Many authors have reported favourable results after proximal row carpectomy for collapse following scapholunate dysfunction and scaphoid nonunion, advanced Kienbock’s disease and perilunate dislocation. Pain was relieved and between 60% and 70% of movement and between 60% and 90% of the grip strength of the normal side was achieved in most patients. These outcomes were well maintained beyond ten years of follow-up, in spite of arthritic changes in the radiocapitate joint.

Existing cartilage degeneration of the proximal capitate or lunate fossa has been considered as a contraindication to proximal row carpectomy, especially if it is full thickness, centrally located or > 3 mm. Total arthrodesis of the wrist is traditionally recommended for these patients, but has fallen out of favour because of its high complication rate and the limitations to daily activities caused by loss of wrist movement. Proximal row carpectomy, combined with capsular interposition arthroplasty, has been proposed as an alternative, but few studies have been conducted on the outcome of this procedure. The purpose of this study was to evaluate the outcome after proximal row carpectomy with proximally based interposition arthroplasty of a capsular flap for advanced arthritis of the wrist.

Patients and Methods
We performed a retrospective review of patients who had undergone proximal row carpectomy with capsular interposition arthroplasty for advanced arthritis of the wrist. The study was approved by our institutional review board.

The operation was performed on eight wrists in eight patients (six men, two women, with a mean age of 44.3 years; 28 to 64), between March 2004 and June 2006. All had severe pain, uncontrolled by conservative measures, and advanced arthritis, with full-thickness degeneration of the cartilage of the proximal capitate and/or the lunate facet on intra-operative inspection. The right wrist was involved in three patients and the left in five, with involvement of the dominant hand in three.

The aetiology was advanced Kienbock’s disease in three cases, scaphoid nonunion with...
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Scaphocapitate arthritis in two, chronic perilunate dislocation/subluxation in two and calcium pyrophosphate deposition disease in one (Table I). Radial styloidectomy was performed simultaneously in two patients, posterior interosseous neurectomy in two and carpal tunnel release in one (Table I).

There had been no previous surgery except in one patient (case 8), who had a coexisting scaphoid nonunion advanced collapse and gout. He had undergone arthroscopic synovectomy three months earlier and took oral medication for gout.

Under general or regional anaesthesia and through a dorsal midline or transverse incision, the extensor retinaculum was identified and hinged open from the second to the fifth extensor compartments. After retracting the extensors, a proximally based dorsal capsule is elevated from just proximal to the second and fourth carpometacarpal joints to the distal articular margin of the radius. The capsular flap is held by forceps. b) The dorsal capsular flap is interposed between the proximal capitate and the lunate facet of the distal radius.

Table I. Demographic data

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age (yrs)</th>
<th>Gender</th>
<th>Dominant hand</th>
<th>Occupation</th>
<th>Follow-up (mths)</th>
<th>Underlying disease*</th>
<th>Operation†</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>44</td>
<td>M</td>
<td>Y</td>
<td>Manager</td>
<td>53</td>
<td>Chronic perilunate subluxation</td>
<td>PRC with capsular interposition</td>
</tr>
<tr>
<td>2</td>
<td>51</td>
<td>M</td>
<td>Y</td>
<td>Construction worker</td>
<td>52</td>
<td>Chronic perilunate dislocation</td>
<td>PRC with CI, carpal tunnel release</td>
</tr>
<tr>
<td>3</td>
<td>34</td>
<td>M</td>
<td>N</td>
<td>Construction worker</td>
<td>46</td>
<td>SNAC stage 3</td>
<td>PRC with CI, capsular interposition, carpal tunnel release</td>
</tr>
<tr>
<td>4</td>
<td>28</td>
<td>M</td>
<td>N</td>
<td>Computer programmer</td>
<td>45</td>
<td>Kienbock stage 3a</td>
<td>PRC with CI, styloidectomy</td>
</tr>
<tr>
<td>5</td>
<td>53</td>
<td>F</td>
<td>N</td>
<td>Domestic help</td>
<td>45</td>
<td>Kienbock stage 4</td>
<td>PRC with CI, styloidectomy</td>
</tr>
<tr>
<td>6</td>
<td>43</td>
<td>M</td>
<td>Y</td>
<td>Taxi driver</td>
<td>49</td>
<td>Kienbock stage 4</td>
<td>PRC with CI, neurectomy PIN</td>
</tr>
<tr>
<td>7</td>
<td>64</td>
<td>F</td>
<td>N</td>
<td>Housewife</td>
<td>26</td>
<td>CPPD</td>
<td>PRC with CI</td>
</tr>
<tr>
<td>8</td>
<td>37</td>
<td>M</td>
<td>N</td>
<td>Manager</td>
<td>13</td>
<td>SNAC stage 3</td>
<td>Prior arthroscopic synovectomy for a gouty wrist</td>
</tr>
</tbody>
</table>

* SNAC, scaphoid nonunion advanced collapse; CPPD, calcium pyrophosphate deposition disease
† PRC, proximal row carpectomy; CI, capsular interposition; PIN, posterior interosseous nerve

Fig. 1a Photographs showing operative technique of proximal row carpectomy with capsular interposition arthroplasty. a) The proximally based dorsal capsule is elevated from just proximal to the second and fourth carpometacarpal joints to the distal articular margin of the radius. The capsular flap is held by forceps. b) The dorsal capsular flap is interposed between the proximal capitate and the lunate facet of the distal radius.
carried out first by incising the scapholunate and lunotriquetral interosseous ligaments. The lunate, triquetrum and scaphoid were then removed piecemeal with a ronguer helped by a 1.6 mm Kirschner wire used as a joystick. Great care was taken to avoid damage to the radioscaphocapitate ligament. Radial styloidyctomy was performed only when impingement of the radial styloid with the carpus was obvious on radial deviation. After copious irrigation, capsular interposition was undertaken by suturing the radial end of the capsule to the radioscaphocapitate ligament and the ulnar end to the ulnocarpal ligament, using 3/0 absorbable sutures (Fig. 1b). After checking the range of movement, any remaining capsule was repaired if this did not cause tension. Otherwise, it was left unrepaired. The extensor retinaculum was repaired with the tendon of extensor pollicis longus placed outside the 3rd extensor compartment. The skin was closed with a 4/0 absorbable subcuticular suture and a sterile dressing and volar short arm splint were applied. Finger movements were initiated immediately after surgery and a short-arm cast was applied after the swelling had subsided and maintained until four weeks after operation. Active and passive exercises were then begun. The patients were advised to use the affected wrist for daily activities, but to avoid lifting or carrying objects heavier than 2 kg until three months post-operatively in order to protect the interposed capsule.

Patients were evaluated before operation and at a mean of 41 months (13 to 53) after, using the same methods. Subjective evaluation included a pain visual analogue scale (pain VAS) during the most painful and resting states and a patient-rated wrist evaluation scoring system, which is a validated 15-item wrist-specific questionnaire that assesses pain and function. It is scored from 0 to 100, with higher scores indicating a worse condition, and has been reported to show good responsiveness, validity, and reliability. Statistical analysis. Wilcoxon’s signed-ranks test was used to compare VAS for pain, patient-rated wrist evaluation scores, range of movement, grip strength and the width of the radiocapitate joint space in the post-operative radiographs was measured as none, mild (joint space narrowing only), moderate (narrowing with subchondral sclerosis), or severe (narrowing with cystic change). The radiocapitate joint space in the post-operative radiographs was rated as none, mild (joint space narrowing only), moderate (narrowing with subchondral sclerosis), or severe (narrowing with cystic change). The radiocapitate joint space was measured using Picture Archiving and Communications System (PACS, PiViewStar, Infinitt, Seoul, Korea), which was accurate to 0.01 mm, he measured it twice and averaged the results. As observed by others, the radiocapitate joint space was very wide during the immediate post-operative period and reduced slowly over several weeks until the capitate settled into the lunate facet. In order to avoid this ‘settling’ period we compared the radiocapitate joint space at the final visit with that measured at three months post-operatively instead of immediately after. Secondary arthritic changes of the proximal capitate and lunate facet were rated as minimal (no change), moderate (sclerosis only) or severe (sclerosis and subchondral cysts). We considered radiocapitate arthritis to have progressed when the width of the radiocapitate joint at the final visit was reduced by > 30% compared to that at three months, or when any accompanying secondary changes of the proximal capitate and lunate facet of the distal radius had increased.

### Table II. Summary of outcomes shown as mean (range)

<table>
<thead>
<tr>
<th>Outcomes*</th>
<th>Pre-operative</th>
<th>Post-operative</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain VAS (rest)</td>
<td>3.0 (1 to 5)</td>
<td>0.8 (0.0 to 2.5)</td>
<td>0.02</td>
</tr>
<tr>
<td>Pain VAS (max)</td>
<td>7.6 (5 to 10)</td>
<td>3.1 (1 to 6)</td>
<td>0.02</td>
</tr>
<tr>
<td>PRWE score</td>
<td>66.8 (42.5 to 82.5)</td>
<td>22.4 (10 to 53)</td>
<td>0.01</td>
</tr>
<tr>
<td>Flexion</td>
<td>33.1 (5 to 70)</td>
<td>33.1 (15 to 45)</td>
<td>0.94</td>
</tr>
<tr>
<td>Extension</td>
<td>35.6 (10 to 70)</td>
<td>38.8 (10 to 50)</td>
<td>0.49</td>
</tr>
<tr>
<td>Radial deviation (°)</td>
<td>2 (-15 to 10)</td>
<td>8.1 (5.0 to 10.0)</td>
<td>0.08</td>
</tr>
<tr>
<td>Ulnar deviation (°)</td>
<td>28.3 (20 to 35)</td>
<td>28.1 (15 to 35)</td>
<td>0.49</td>
</tr>
<tr>
<td>Grip power (kg)</td>
<td>21.5 (5 to 43)</td>
<td>20.3 (10 to 36.7)</td>
<td>0.78</td>
</tr>
<tr>
<td>Joint space (mm)</td>
<td>2.3 (1.1 to 3.6)</td>
<td>2.2 (0.5 to 5.2)</td>
<td>0.34</td>
</tr>
</tbody>
</table>

* VAS, visual analogue scale; PRWE, patient-rated wrist evaluation
Results
The mean pain VAS at rest improved significantly from 3.0 to 0.8 (p = 0.02) with a mean reduction of 2.2 (0 to 5; Table II). The mean pain VAS at worst improved significantly from 7.6 to 3.1 after surgery (p = 0.02), with a mean reduction of 4.5 (-1 to 8; Table II). The mean patient-rated score also improved significantly from 66.8 to 22.4 (p = 0.01), with a mean reduction of 44.4 (13 to 68.5; Table II). Seven patients had less or no pain both at its worst and at rest after surgery. However, one had more pain when performing moderate activity, although he did not change his job as a taxi driver. Only one patient left her job, but for a non-medical reason. All but case six were very satisfied or satisfied with their results. The average flexion, extension, and ulnar deviation were not changed significantly by surgery (p > 0.05). The average radial deviation was improved, but this did not reach statistical significance (p = 0.08; Table II). The mean grip strength after surgery was 20.3 kg or 66.8% of that of the contralateral hand, which was not significantly different from pre-operatively (p = 0.78; Table II).

In post-operative radiographs the mean joint space between the proximal capitate and distal lunar facet of the radius was 2.3 mm (1.1 to 3.6) at three months post-operatively, and 2.2 mm (0.5 to 5.2) at the final visit. This difference was not significant (p = 0.34). Five of the eight patients (63%) showed no radiographic evidence of progression of radiocapitate arthritis (Fig. 2).

Three patients (one woman and two men, mean age 43 years, 34 to 53) had narrowing of the joint space. One was a heavy manual worker. The dominant hand was involved in one patient. Their outcome assessments showed
a mean patient-rated score of 25.2 points (10 to 53) and one was dissatisfied. However, the rate of satisfaction and average patient-rated score were not significantly different from those of patients without progression of narrowing of the joint space (p = 0.46 and p = 0.38, respectively).

Degeneration of the articular cartilage was rated intraoperatively as grade 1 (softening), grade 2 (fibrillation), grade 3 (partial-thickness defect) or grade 4 (full thickness). The articular surface of the proximal capitae showed grade 4 changes in all patients. Two had a 5 mm punched-out defect, and the other six had small full-thickness and peripheral partial defects, which made exact measurement difficult. However, most defects had diameters > 3 mm. The articular surface of the lunate facet showed grade 4 degeneration in four patients, grade 3 in one, grade 2 in one, and no degeneration in two.

Wound dehiscence occurred in one patient five days postoperatively and was sutured successfully.

Discussion
Although results have been reported after proximal row carpectomy,3,11 other studies have shown that severe cartilage degeneration on either side of the radiocapitate joint is likely to lead to a poor outcome.7,32 Modifications have been made to the operation to extend its indications. Of eight patients treated by osteochondral resurfacing of the proximal capitate and proximal row carpectomy, Tang and Imbriglia33 achieved pain relief in seven and a mean 66% arc of movement and 71% grip strength compared to the contralateral side at a mean follow-up of 18 months. Fitzgerald et al11 reported relief of pain in 11 of 14 patients, an average flexion-extension arc of 55° and an average grip strength of 15 kg at an average follow-up of 34 months after distraction resection arthroplasty for advanced arthritis of the wrist. Salomon and Eaton90 performed proximal row carpectomy with partial resection of the capitae in 12 patients with lunocapitate or radiolunate arthritis in order to match the curvature of proximal capitae with that of the lunate facet, and to enlarge the contact surface of the radiocapitate joint. Four of 12 patients received dorsal capsular interposition at the same time. Pain relief was obtained in 11 patients, along with a mean flexion-extension arc of 94°, and a mean grip strength of 26 kg at a mean follow-up of 55 months. However, the authors did not analyse separately those who underwent capsular interposition arthroplasty in addition to proximal row carpectomy and partial resection of the capitae.

Our study focused on the results of proximal row carpectomy with capsular interposition arthroplasty in patients with severe cartilage degeneration of the proximal capitae and/or lunate facet. This operation was found to provide significant improvements in pain relief and subjective functional assessments in seven of the eight patients. A mean flexion-extension arc of 71.9° and a mean grip strength of 66.8% were obtained after a mean follow-up of 41 months compared with the contralateral side. These results are comparable to those of the modified proximal row carpectomy mentioned above. Furthermore, proximal row carpectomy with capsular interposition arthroplasty appeared to prevent the progression of radiocapitate arthritis in five of the eight patients (62%), although progression of radiocapitate arthritis did not significantly affect the subjective outcomes.

Proximal row carpectomy with capsular interposition arthroplasty has advantages over total wrist arthrodesis. It is relatively easy to perform, in that adding capsular interposition arthroplasty to proximal row carpectomy requires only a few minutes. It has a very low complication rate and a shorter post-operative recovery. It preserves wrist movement and grip strength, and provides pain relief.34 Finally, if the procedure fails, it can be salvaged by arthrodesis,10,11

We believe that the dorsal capsule has several advantages over other types of interposition material such as fascia lata or allograft. Firstly, as the interposed dorsal capsule is well vascularised,35 it does not require distraction to protect the interposed tissue until revascularisation, as is the case in the elbow. Secondly, it may heal more rapidly and reliably in the same way that vascularised bone grafts provide more rapid and consistent union than non-vascularised grafts. Although the durability of the interposed capsule has never been reported, Diao et al18 observed a well-preserved interposed capsule during arthroscopic examination of a patient who had undergone proximal row carpectomy with capsular interposition nine months earlier.

The retrospective design of our study is a limitation, along with the small number of patients. This prevented our determining the effects of other procedures performed simultaneously in five of the eight patients and undermines to some extent our conclusion that loss of joint space did not influence outcome. The study cannot answer whether progression of arthritis could be prevented by proximal row carpectomy with capsular interposition due to the lack of an appropriate control group and a short follow-up period. Finally, the proportions of patients with involvement of the dominant hand and manual labourers were relatively small, which might have contributed to the favourable results. Notwithstanding those reservations, we conclude that proximal row carpectomy with capsular interposition arthroplasty is a reasonable option for the treatment of advanced arthritis of the wrist.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References


