Total Wrist Arthroplasty With Destot Prostheses in Patients With Posttraumatic Arthritis

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Purpose: To analyze the functional and radiologic results after Destot arthroplasty, a wrist prosthesis designed for posttraumatic arthritis, and to define the indications for the use of the implant.

Methods: Using the Meuli point score system, 28 Destot total-wrist arthroplasties in 25 patients with stage 2 or 3 scaphoid nonunion advanced collapse and scapholunate advanced collapse were evaluated for 12 to 96 months after surgery.

Results: The overall ratings of the study group were excellent in 17 cases, good in 6, fair in 1, and poor in 4. Eighty-four percent showed improved range of motion and grip strength. Four patients experienced postoperative complications. No imbalance or dislocation was noted after surgery.

Conclusions: The Destot implant seems to be a good solution to restore functional range of motion after posttraumatic wrist arthritis when arthrodesis is required by nonmanual laborers older than 50 years of age. (J Hand Surg 2003;28A:405-413. Copyright © 2003 by the American Society for Surgery of the Hand.)

Key words: Total wrist arthroplasty, posttraumatic arthritis.

Despite being one of the first joints to be replaced by a prosthesis,[1,2] the widespread application of total wrist arthroplasty was a late development.[3–5] After flexible implant arthroplasty was developed by Swanson,[6–13] metal-polyethylene total wrist replacements began to be used.[4,14] Other devices have been developed in the past 25 years.[3,4,15–25] Various implants are currently in use and polyarthritis, especially rheumatoid arthritis, is the most common indication. Arthrodesis of the wrist was the treatment of choice for posttraumatic arthritis. Although wrist fusion is the gold standard for manual laborers with posttraumatic arthritis, not every arthrodesis ensures a positive outcome.[20] The resulting permanent loss of range of motion (ROM) represents a considerable handicap. When patients who have undergone previous total wrist arthrodesis and a contralateral wrist arthroplasty are surveyed, the majority, if not all, prefer the function of the prosthetically implanted wrist because it affords greater dexterity.[24,37]

Total wrist arthroplasty for posttraumatic arthritis remains uncommon[6,25–32]; however, the wrist, more than any other joint, is essential for augmentation of fine motor control of the hand and fingers and hand grasp strength. In 1990, a group of French and Belgian hand surgeons, the Destot group, decided to work on the development of a new total wrist prosthesis for posttraumatic arthritis. An approximation of the kinesiologic and anatomic features of the wrist were considered to achieve the current 1991 design, integrating American, Swiss, German, English, and French prosthetic innovations.[3–5,13–25,30,32] The goal

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of this study is to evaluate both the clinical and functional outcomes and to clearly identify the indications for the Destot prosthesis.

Materials and Methods

Patient Demographics

From March 1992 to November 2000, 35 Destot devices were implanted in patients in 6 French and Belgian hand surgery hospitals. All the patients received preoperative information on the risks and benefits of total wrist arthroplasty versus wrist fusion. From this number, 25 patients could be located for follow-up evaluations, with 28 total implants (2 bilateral procedures, 1 revision with a new Destot implant). The study group included 20 men and 5 women ranging from 56 to 75 years in age (mean, 62.5 years). The group was selected from patients with a known preoperative diagnosis of posttraumatic arthritis: 14 wrists with scaphoid nonunion advanced collapse, 12 wrists with scapholunate advanced collapse, and 1 wrist with nonspecific traumas.

Prosthesis Design

The Destot implant is a nonconstrained, metal-polyethylene condylar prosthesis (Fig. 1). The radial and carpal components are of 316-L steel.[33] The prosthetic stems have a sandblasted/porous-coated surface to eliminate the need for cement and to enhance osseointegration.[34] The concave articular surface of the radial component is made of ultrahigh–molecular weight polyethylene. The stem of the radial component is V-shaped and has grooves at either side for bone growth. These grooves are superficial, and the removal of the stem is not very difficult, even after many months or years. The carpal component is made in 2 parts. Proximally, there is a 316-L steel condylar section. Distally, the metacarpal section, with its long metacarpal stem, is supported by a stair-shaped steel plate with a small cylinder for the condylar component and an opening for a 4.5-mm spongiosa screw.

An empty polyethylene cylinder occupies the space between the steel cylinder of the plate and the condylar device (Fig. 2). This third rotary axis allows more than typical wrist motions and more movement than devices such as the Meuli prosthesis.[35,36] The prosthesis is available in 4 sizes for both the radial and the carpal sides. Specific instruments have been designed to make appropriate bone cuts and facilitate insertion of this device.

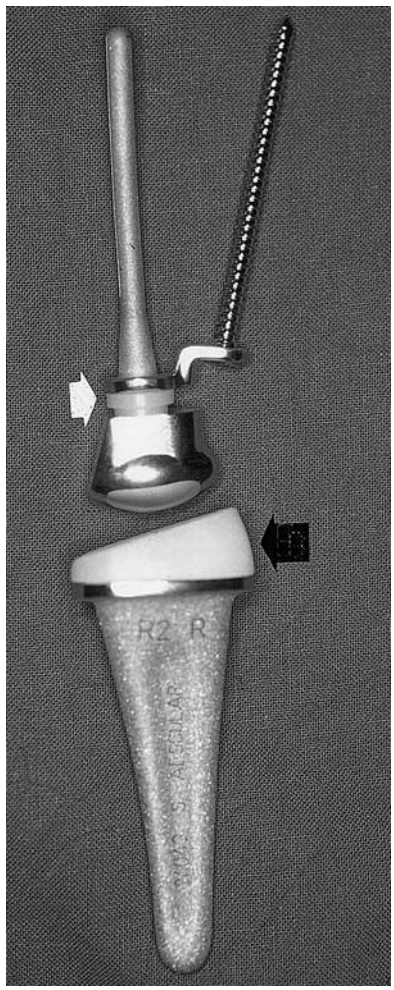

Figure 1. Assembled Destot implant. The black arrow shows the radial polyethylene part of the implant and the white arrow shows the polyethylene cylinder.

Surgical Technique

The standard total joint aseptic precautions are used: perioperative dosing of prophylactic antibiotics and postoperative wound drainage. During the surgery, the correct position of the radial and carpal stem is assessed by using a fluoroscopic intensifier in the anteroposterior and lateral plane. After a dorsal wrist incision, the dorsal retinaculum is reflected from the Lister tubercle and the extensor tendons are laterally retracted. The posterior interosseous nerve is resected, and the Lister tubercle is removed. The capsule is then opened, exposing the midcarpal joint. The lunate, the scaphoid , and the proximal quarter of the capitate are then resected. The capitate bone is opened with an awl. The awl is inserted in the direction of the third metacarpal until the base plate has been opened and the tip is positioned in the middle third of the middle metacarpal. A specially designed

Figure 2. Component parts of the Destot implant.

curved rasp is used to create the middle metacarpal implant bed.

The radial medullary space is opened centrally, along the longitudinal axis of the radius. With a saw, the radial styloid is resected horizontally on a tangential line of the distal part of the distal radioulnar joint. A specialized drill is inserted with fluoroscopic control in the direction of the radial centromedular canal. The final preparation for the radial implant is performed with a medullary gouge so that the dorsal and palmar implant edges are close to the bone margin.

The radial component is inserted into the prepared implant bed, followed by the carpal component, by using a 4.5-mm screw in the second metacarpal. The size of the intermediate, mobile, condylar-carpal component is chosen to reconstruct the carpal height. After implantation of the final condylar component, the wrist capsule is closed over the device to protect the overlying tendons.

The hand is placed in 10° to 20° of extension during the immediate postoperative period. Active ROM is begun as soon as the patient can tolerate the activity, usually between the fourth and seventh postoperative day. A plastic palmar splint is used for 3 weeks after the surgery for control of pain and surrounding soft tissue cicatrization.

Data Analysis

For this study, an independent hand surgeon who was not a member of the Destot group collected the data and evaluated the patients during the postoperative course. He examined and interviewed these patients between September 2000 and June 2001. The mean number of months of follow-up evaluations was 47 months (range, 12–72 months).

Patients' postoperative results were evaluated with the Meuli Total Wrist Arthroplasty Point Score System[37] (Table 1). This tool evaluates both subjective parameters (patient satisfaction, pain, and function) and objective parameters (ROM, grip strength, and radiographic findings). A rating scale of 4 levels was developed: excellent, scores of 11 and 12; good, 9 and 10; fair, 7 and 8; and poor, scores six and lower. To gauge patient satisfaction with the procedure, the participants were asked if they would undergo the same procedure in the opposite wrist if they had the same level of pain and limitations as in the operated wrist.

Patients were also asked to rate the function of the wrist in their ability to perform activities of daily living as improved, unchanged, or worsened. Range of motion of the wrist was measured, and grip strength was assessed pre- and postoperatively with a dynamometer (Jamar dynamometer; Sammons Preston, Chicago, IL). Anteroposterior and lateral radiographs were taken at the last follow-up visit (Fig. 3). These were compared with radiographs taken immediately after surgery to assess the quality of fusion, to evaluate evidence of component loosening and malposition, to measure carpal height, and to identify complications such as metacarpal cortex perforation or prosthetic fracture.

Results

Objective Findings

Before surgery, all of the patients complained of severe pain and a marked reduction of hand function.

Table 1. Total Wrist Arthroplasty Point Score System

Criterion	Points
Patient satisfaction	
Most satisfied	2
Satisfied	1
Not satisfied	0
Pain	
No pain	2
Moderate pain	1
Severe pain	0
Function*	
Improved	2
Same	1
Worse	0
Motion	
Balanced within a functional arc of movement:	
Flexion, 30° to 40°; extension, 30° to 40°	2
Slight imbalance	1
Imbalance or ankylosis	0
Grip strength	
Improved	2
Same	1
Worse	0
X-ray films	
Correct placement and centering of implants; no signs of loosening	2
Incorrect placement and centering of implants; no signs of loosening	1
Wrong placement of implants; loosening or fracture of implants	0
Rating	
Excellent	11–12
Good	9–10
Fair	7–8
Poor	≤6

*Ability to perform everyday activities.

The average ROM was 20° of extension, 26° of flexion, radial deviation of 7°, ulnar deviation of 25°, pronation of 60°, and supination of 45°. At an average follow-up interval of 47 months, the mean ROM findings were: extension, 41°; flexion, 48°; radial deviation, 12°; ulnar deviation, 22°; pronation, 90°; and supination, 77° (Table 2). Twenty-one of 25 patients experienced considerable improvements in their ROM. Likewise, the mean grip strength improved in all of the study group patients from a preoperative value of 20 kgf (range, 5–35 kgf) to 32 kgf (range, 10–70 kgf).

Subjective Outcomes

After the surgery, the patients' pain rating improved markedly. Eighteen patients (72%) rated their pain as none, 5 (20%) as moderate, and 2 (8%) as severe. Of the patients, 21 (84%) were very satisfied with the results, 2 were satisfied, and 2 were not satisfied; 23 patients (92%) said they would undergo the procedure again.

Radiographic Evaluation

The preoperative x-rays identified advanced posttraumatic destruction of the wrist: 14 scaphoid nonunion advanced collapse wrists (6 at stage 2, 8 at stage 3) and 12 SLAC wrists (6 at stage 2, 6 at stage 3).[38,39] During postoperative follow-up evaluations, the carpal height ratio decreased during the 2 years after surgery, with no further changes thereafter. Its value rated as an average of 0.47. In 6 cases, there was x-ray evidence of migration of the carpal component associated with a twisting out of the second metacarpal screw and of metacarpal stem loosening in 3 cases. In each case the deviation of the tip of the stem (Figs. 4, 5) was radial and dorsal. Metacarpal stem fractures occurred in 2 cases (Fig. 6). In the follow-up x-rays, there were no signs of loosening on the radial stem. The patients were clinically asymptomatic when the metacarpal component failure was discovered on x-ray.

Each wrist was rated on the total wrist arthroplasty point score system by Meuli (Table 1). The overall results in the study were rated as excellent in 17

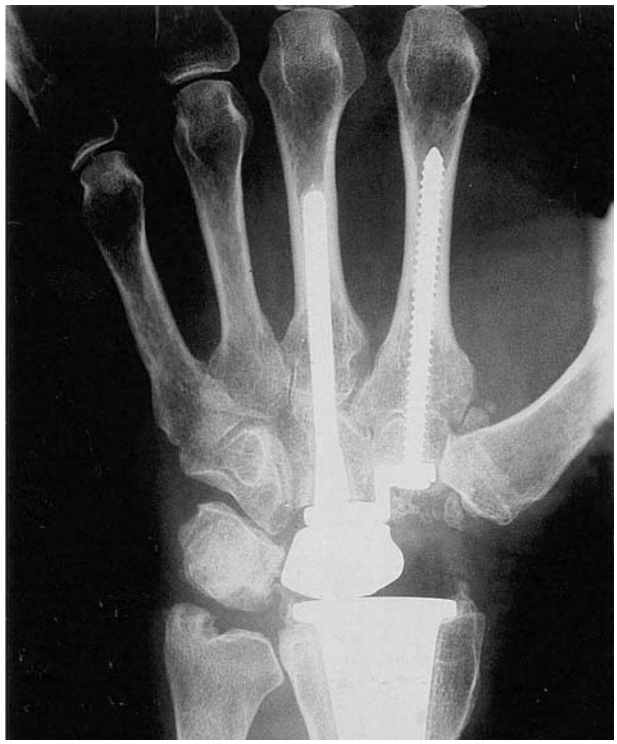

Figure 3. Anteroposterior view of the right wrist 4 years after total wrist arthroplasty.

Table 2. Average Preoperative and Postoperative ROM

	ROM Before Surgery	ROM at Last Follow-up Evaluation
Wrist extension	20° (5° to 40°)	41° (30° to 50°)
Wrist flexion	26° (5° to 42°)	48° (10° to 70°)
Radial deviation	7° (0° to 10°)	12° (5° to 20°)
Ulnar deviation	25° (20° to 31°)	22° (10° to 30°)
Pronation	60° (30° to 90°)	90°
Supination	45° (20° to 70°)	77° (50° to 90°)

cases, good in 6, fair in 1, and poor in 4. A survivorship analysis (Kaplan-Meier) showed that the percentage of survivors after 4 years was 85% (Fig. 7).

Complications

Two prostheses became infected. One infection occurred immediately after surgery and required only surgical cleaning and 6 weeks of intravenous antibiotics. Unfortunately, this patient subsequently experienced a metacarpal stem fracture related to wrist overuse during a period of wheelchair use after an unrelated foot surgery; the patient ultimately required a wrist fusion. A second case of infection occurred 6 months after the procedure immediately after a laceration to the dorsum of the wrist. The prosthesis was removed and an antibiotic-impregnated cemented spacer was inserted after debridement. Six weeks of intravenous antibiotics were administred. After the infection was resolved, the wrist was fused.

There were no prosthesis dislocations. One revision of the metacarpal component, however, was performed 3 years after the total wrist arthroplasty for a metacarpal stem fracture (Fig. 6). Three total wrist arthroplasties were performed on 2 patients with previous proximal row carpectomy. In both cases, the patients experienced severe pain after the

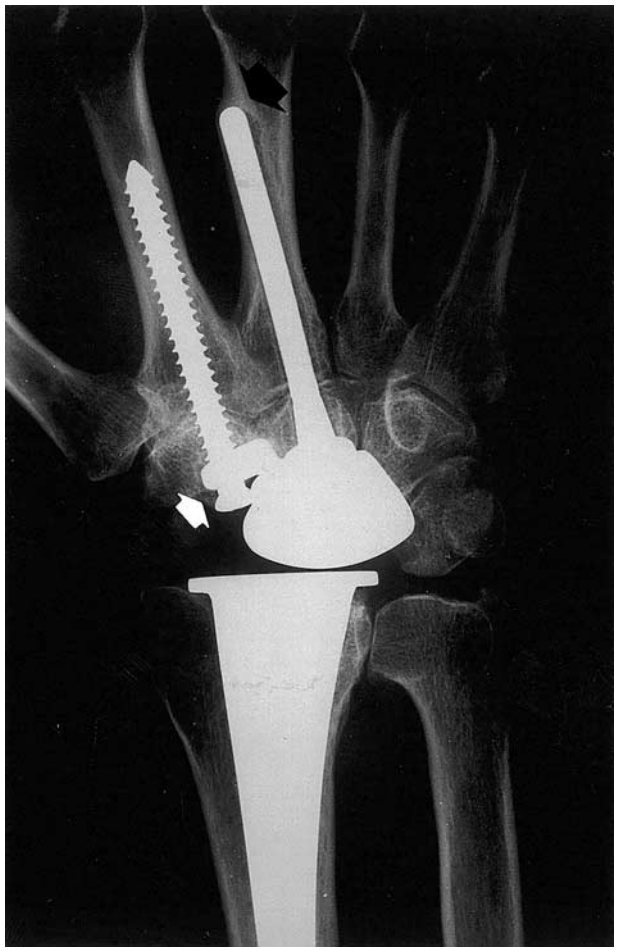

Figure 4. Posteroanterior view showing metacarpal stem loosening (black arrow) with radial and dorsal deviation of the tip of the stem and a partial backing out (white arrow) of the metacarpal screw.

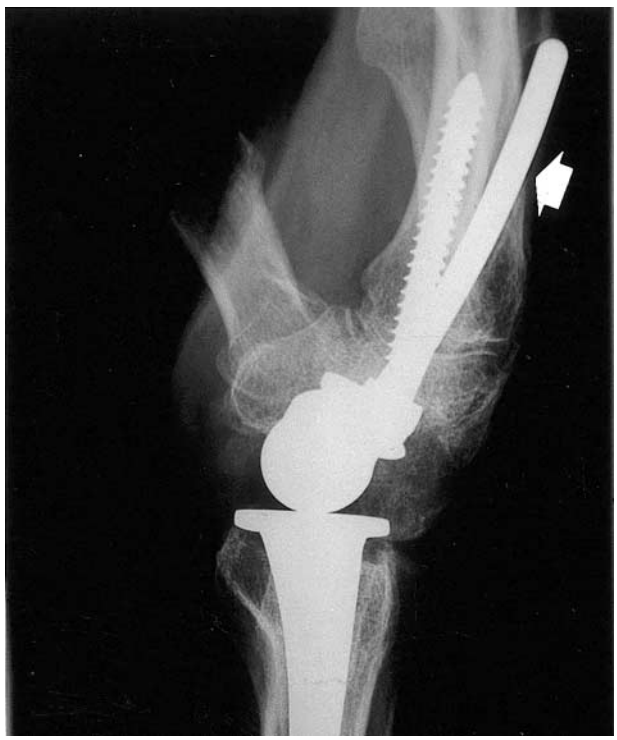

Figure 5. Lateral x-ray showing metacarpal stem loosening with dorsal deviation of the tip of the stem (white arrow).

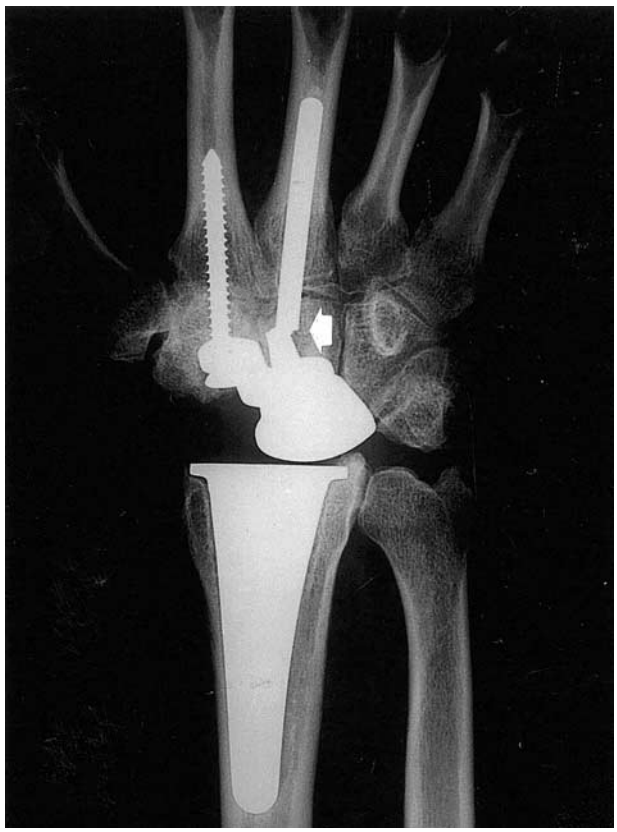

Figure 6. Posteroanterior x-ray showing a metacarpal stem fracture (white arrow).

wrist arthroplasty; the prostheses were removed. In each case, no sign of wear was discovered on the components, even on the polyethylene parts, but the removal occurred early after prosthesis implantation. One wrist was fused immediately, and a second one fused after a failed revision with a new Destot implant. The 4 cases that ultimately required wrist fusion were the youngest patients in the study group, and they were all male. We can suspect a high level of wrist activity in these 4 cases (1 motor-bike steeple-chase driver, 1 professional gardener, 1 manual laborer, and 1 who required use of a wheelchair). When implant removal was performed more than 6 months after implantation, no signs of wear were noted on the prostheses and both the radial and the metacarpal stems were tightly incorporated in the bone.

Discussion

The first total wrist replacement was performed in 1890 by Themistokles Gluck in Berlin, Germany.[1] To improve the functional outcome, various total wrist endoprostheses have been developed and implanted during the past few years, with variable success rates.[3,4,15–25] All of these devices were developed for patients with wrist deformities resulting from rheumatoid arthritis.[8,25,28,32,35–37,40,41] Wrist fusion is relatively easy to achieve and is regarded as appropriate therapy for posttraumatic wrist arthritis. Despite the relatively high rate of complications after total wrist arthroplasty compared with other arthroplasties such as hip or knee replacements, patients' satisfaction with the procedure is high.[21,23,25,42,43] Patients who had a wrist fusion on 1 side and a contralateral wrist arthroplasty consistently preferred wrist arthroplasty to fusion.[24,37]

The Destot group wanted to develop a new prosthesis specifically for posttraumatic arthritis. In all previous studies,[31,36,40–44] wrist prosthesis for post traumatic arthritis is relatively uncommon: 14% for Volz[42] and 25% for Menon[24]. Furthermore, their study groups included patients with rheumatoid arthritis. The present study has only considered persons with posttraumatic arthritis. Our study group size is comparable with most previously published studies examining wrist prostheses.[15,20–22,25,32,36,40,42,43,45]

A stable, mobile, and pain-free wrist is essential for proper hand function[13] and should be the ultimate goal of the procedure. This study's current data have found that the Destot prosthesis provides decreased pain with ROM in 86% of recipients. Similar results were obtained in studies of other prostheses.[20–23,25,28,30–32,35–37]

In this study group, 2 patients with severe postop-

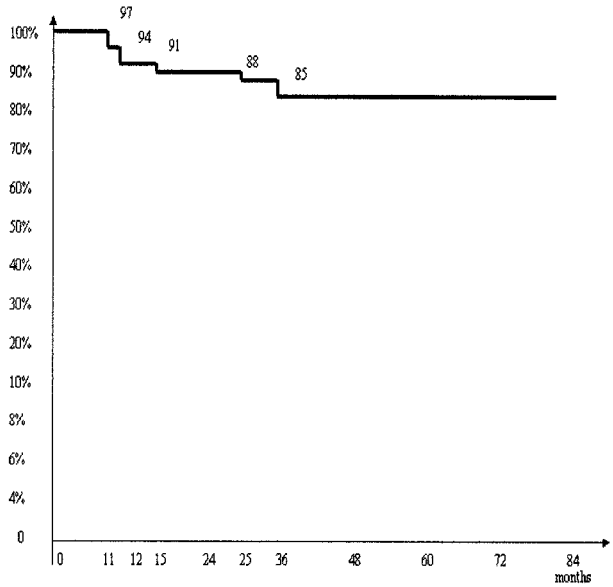

Figure 7. Survivorship of the implanted wrist prostheses showing overall probability of survival as a percentage versus time since operation.

erative pain had previous proximal row carpectomy and both wrists were finally fused. The Destot group now considers previous proximal row carpectomy as an absolute contraindication to wrist arthroplasty with the Destot device. The implant is designed to settle on the radial part of the triquetrum. When this bone fails, we can expect that the implant is unstable and painful. Moreover, when the triquetrum has been removed all the mechanical constraints go through the radius and increase the pain. Preservation of the triquetrum seems mandatory for achievement of a good functional and pain-free outcome with this implant. The triquetrum is an essential component of the medial rotation column.[19] Per Taleisnick,[19] its function is not only a "movable, piston-like pivot point," but also a block to ulnar drift of the prosthesis's carpal component. Moreover, the triquetrum is almost always free of arthritic lesions in posttraumatic arthritis.

Stability is a second problem in total wrist arthroplasty. Prosthesis dislocation is not uncommon in previously reported studies.[19,20,25,28,32,40] Figgie et al[21] did not report any dislocation; however, the trispherical prosthesis is a constrained device. This study did not discover any dislocations when using the Destot prostheses.

There are several reasons why the Destot prosthesis did not dislocate in the study group. First, and primarily, the surrounding soft tissue structures were always relatively healthy in the patients with posttraumatic arthritis. Second, carpal bone resection is minimized when using the Destot device. This leads to more surgical comfort when restoring carpal height with different sizes of the condylar component.[24] Third, the medial rotation column is preserved with the triquetrum and the distal radioulnar joint. This natural anatomic axis increases the stability of the device.

Progressive deformity, wrist imbalance, and loosening are the most common complications after total wrist arthroplasty. Cobb and Beckenbaugh[23] found 15% to 17%; Bosco et al,[43] 22%; Meuli and Fernandez,[35] 16%; and Menon,[20] 19%. No member of the study group developed any deformity, including ulnar deviation, even late in the follow-up period. However, radiographic studies indicated radial and dorsal deviation of the tip of the carpal component, with loosening around the carpal stem and screws in 6 cases. In other studies, failure of the carpal component was the major cause of lower satisfaction ratings at long-term follow-up evaluations.[46–48] Theoretically, the stress transmitted to the prosthetic fixation should be reduced by the extra degree of movement within the design of the implant. Despite this special design created to reduce biomechanical constraints, however, metacarpal stem loosening is one of the biggest problems in this study. For Menon,[24] one explanation for carpal loosening and wrist imbalance is the motion at the carpometacarpal joint. This permits mobility between the carpal stem and the metacarpal shaft. Moreover, even if the second and third metacarpals are considered as the fixed unit of the hand, there is inherent mobility between them and the carpus, which can explain micromovements and the slow metacarpal loosening.

The authors agree with Menon[24] that carpometacarpal mobility increases the stress on the metacarpal stem, especially on the screw. With vigorous hand and wrist movements (such as with manual labor and heavy lifting), the screw begins to disengage, allowing the carpal plate to move toward the ulnar aspect of the carpus. The radiographic center of rotation migrates ulnarly. This lengthens the moment arm of the radial deviators and leads to loosening, which in turn causes the metacarpal stem to move radially. Without carpal component replacement, stem migration will induce stem fracture, as seen in the 2 cases noted (Fig. 6). Because of this long-term evolution risk, and even if this migration is usually a radiologic discovery without clinical significance, the authors think that metacarpal fixation can be ameliorated. The researchers, along with Lorei,[48] believe that carpometacarpal fixation with screws is not an adequate biomechanical option. Currently under investigation is a new device with a single prong not longer than one third of the metacarpal length. We think that a wider and shorter stem with a small antirotation pin would be more stable. The moment arm of the radial deviators would decrease and the implant would be more stable. The shorter metacarpal part of the stem would be less subject to the movements between the capitate and the third metacarpal. The designers' hope is that this innovation will provide better distal stability, but at this time, such a modification has not been fully tested. Furthermore, most of the previous prostheses[28,35,37,41] are actually very different from the original model.

In this investigation, the increase in the postoperative ROM and grip strength was considerable. The active ROM achieved in this study approximated the results reported by Ferlic and Clayton[22] with the CFV prostheses, and by Cobb and Beckenbaugh[23] with biaxial prostheses. The increases in ROM in this

study exceeded those described by Palmer et al[49] (Table 2).

Complications seem to occur at a high frequency in this study group, but this compares similarly with the findings of other studies involving wrist replacement.[22,27–29,31–33,46–48,50] Loosening has been reported to occur more often in patients with posttraumatic osteoarthritis of the wrist; presumably, this is caused by the increased level of activity as compared with patients who have rheumatoid arthritis. The use of Destot prosthesis in younger patients with posttraumatic arthritis is not recommended because of a high frequency of complications. We do not recommend use of the Destot implant in patients younger than 50 years. However, in the whole study group, there was improvement in the patients' subjective measures of satisfaction.[48] Traumatic complications cited in the literature[51–53] (prosthesis dislocation, radial shaft fracture) were not found in this study.

The early results of this procedure were encouraging, but as in all wrist implants, some failures did occur. The Destot total wrist arthroplasty provides good pain relief and satisfactory ROM, but is associated with a significant loosening rate for the distal implant. Only nonmanual laborers older than 50 years with posttraumatic wrist arthritis who might be considered for arthrodesis, and in whom the permanent loss of wrist motion would represent increased disability, should be considered for the Destot device. Proximal row carpectomy is an absolute contraindication for this procedure. Patients should be advised of a 1 in 5 chance of failure within 5 years. A new design for metacarpal implant is under investigation and may be a satisfactory solution for distal component failure.

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