Total Wrist Arthroplasty for Posttraumatic Arthritis with Radius Deformity

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Abstract

Keywords

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- posttraumatic arthritis

Newer implant designs and expanding experience have led to a gradual increase in the use of total wrist arthroplasty (TWA) for the treatment of posttraumatic arthritis. New challenges, however, may be encountered with this application, including bony deformities, previous or existing hardware, osteonecrosis, soft tissue injuries, and severe joint stiffness. Because the goals—to relieve pain and provide a functional range of motion—are the same as for more common TWA indications, these technical challenges, along with often higher patient expectations, are important considerations. This article presents possible solutions to these unique surgical challenges, including important preoperative planning to mitigate risks, and the expected outcomes in these patients.

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Materials and Methods

Between 2007 and 2012, I performed five procedures using this surgical technique for the treatment of posttraumatic arthritis associated with a distal radius malunion (►Fig. 1). Patient age ranged from 52 to 68 years, including three men and two women, and two dominant and three nondominant wrists. The Universal 2 (“UNI 2”) TWA system (Integra Life Sciences, Plainsboro, NJ, USA) was used in all patients. As described subsequently in the surgical technique under “Accommodating Bony Deformities,” the radial component that would normally be used for the contralateral wrist was

used by inserting it upside down to accommodate the radius deformity and thus avoid the need for a corrective osteotomy. The remainder of the procedure used the standard technique for the implant system; however, more time is required to raise the scarred joint capsule and to avoid disrupting the distal radioulnar joint (DRUJ) as well as to manage secondary malalignment of the proximal carpal row for an accurate carpal resection. None of the components were cemented. One patient had a concurrent carpal tunnel release for preoperative symptoms.

Surgical Technique

There are potentially many factors that influence preoperative planning and eventual surgical technique, but several key elements are common:

1. Exposing the joint sufficiently while preserving necessary injured structures
2. Removing existing hardware and managing bony voids
3. Creating space for the components by appropriate bony resections
4. Accommodating deformities caused by prior injury or treatment
5. Preparing the radial canal, which may be obstructed by malunion and remodeling

Fig. 1 (a) Posteroanterior (PA) and (b) lateral radiographs of a 62-year-old female with painful posttraumatic arthritis associated with a distal radius malunion of the right wrist. (c) PA and (d) lateral radiographs at 3 years postoperative following total wrist arthroplasty using a radial component, normally intended for the contralateral wrist, that has been inserted upside down to accommodate the radius deformity.

6. Recognizing sites of osteonecrosis that may influence component fixation
7. Managing the DRUJ when affected by injury or joint preparation
8. Determining whether osteointegration or cementing is appropriate fixation

Despite the unique challenges that impose necessary surgical modifications, the standard surgical technique described for an implant system should be used as much as possible to maximize efficiency and accuracy.^{1,2} Thus, only technique modifications will be described in this article, with the assumption that the remaining necessary preparation and implantation will follow standard technique. Although the descriptions will be based on the Freedom wrist arthroplasty system (Integra Life Sciences, Plainsboro, NJ), the principles as well as most details will apply equally to other implant systems.

Exposure

If a prior skin incision is present, it should be used again whenever possible to avoid skin healing complications. When a midline dorsal skin incision was used previously, the extensor retinaculum is opened through the fourth extensor

compartment and raised in continuity with the overlying skin, which preserves the vascularity of the skin and reduces the risk of wound healing problems. Tendon bowstringing is typically not a problem postoperatively because the extensor retinaculum heals with the skin.

Several capsulotomy options are available; however, the most important concept is to gain adequate exposure to perform the procedure accurately, particularly because patients with posttraumatic arthritis are prone to have substantial wrist stiffness. I prefer to use the same broad, distally based flap described for a standard exposure because it allows for extensive release of contracted tissue, management of deformities, and easier closure including capsular augmentation using either extensor retinaculum or allograft when necessary to increase its length to improve wrist flexion.

Hardware Removal and Bony Voids

Any existing hardware in the wrist will likely need to be removed to prepare the bones properly to accept component stems and fixation screws. Unfortunately, bony integrity can sometimes be difficult to assess on preoperative X-ray images, and only after hardware removal can characteristics such as completeness of prior attempted fusions, bony necrosis,

erosions, cysts, and deformity be determined. Thus, the surgeon should be prepared with alternatives to accommodate different findings following hardware removal. For example, if a circular plate was used to perform an intercarpal fusion, then the carpus may be too extensively compromised for proper stem and screw fixation; however, this determination may not be possible before direct surgical inspection. A previous resection (e.g., a scaphoid excision) may necessitate bone grafting when using some systems to optimize component support or fixation. I prefer to avoid using allograft because the incorporation is less predictable. Autograft can often be obtained from the resected portion of the carpus and the distal radius when preparing for the radial component. If the distal ulna is to be resected, it can also be a source of autograft. In some cases, a more remote autograft may need to be taken.

Bone Resection

If the prior injury or treatment has substantially shortened either the distal radius or the carpus, then the standard technique may not create sufficient space for the implants. In nearly all such cases the resection will need to be greater on the radius so as to not compromise distal component fixation. Fortunately, this alteration can be accomplished with minimal change in the technique. If possible, preoperative radiographs can be used to template and estimate the amount of additional radius resection and its possible effect on the DRUJ, but this should be confirmed at surgery. If the wrist is subluxated preoperatively, then distraction and reduction of the wrist at surgery may better determine the level of optimal resection, particularly if the components are held simultaneously against the dorsal surface of the wrist under fluoroscopy. In most cases, making the carpal cut first at the standard level using fluoroscopic guidance is appropriate and will allow the wrist to be reduced into a more normal position. In more severe deformities, the initial radius cut can be conservative to allow an assessment of implant fit, with additional resection made later if necessary. Similar principles and technique are used for conversion of a prior complete wrist fusion or prior four-corner fusion, though some variation is likely required.

In the presence of a previous proximal row carpectomy (PRC), the surgeon should expect to require a more extensive radius resection to accommodate wrist shortening as well as managing the bony void left by the scaphoid excision (see preceding "Hardware Removal and Bony Voids") and the DRUJ (see subsequent "Managing the DRUJ"). Most implant systems do not require technique alterations in the absence of a triquetrum.

At the time of trial implantation, assess joint tightness and stability. If more radius resection is needed, then a freehand cut parallel to the previous resection is made, but avoid making an excessive cut, as typically a small amount, such as 2–3 mm, will make a substantial difference. Conversely, if the wrist is too loose, then a polyethylene component of greater thickness can be used, but before inserting a thicker component, ensure that the volar capsule has not been disrupted and is the cause for the looseness. The capsule can be repaired or augmented if needed.

Accommodating Bony Deformities

Perhaps the greatest potential challenge in a posttraumatic wrist is a distal radius malunion, which may require several alterations to the standard technique to accommodate the components. In the typical severe radius malunion that has dorsal angulation, dorsal displacement, and radial translation, the loading axis of the wrist and the articular surface are no longer aligned with the radial shaft and its canal. Thus, either an osteotomy of the radius or a different position of the radial component will be necessary. Although I normally prefer to restore the normal loading axis of the wrist in TWA, I believe it is appropriate to compromise radial component placement to minimize the complexity and morbidity of the procedure in an established malunion with posttraumatic arthritis. In five such patients, I have inserted the radial component upside down. Because the radial component of most systems is not symmetric (i.e., it is right- and left-specific), this technique requires the use of the component intended for the contralateral wrist. For example, a right distal radius malunion would require a left radial component inserted upside down (► Fig. 2). Using this technique typically

Fig. 2 (a) PA and (b) lateral fluoroscopy images showing a wrist arthroplasty using a radial component normally intended for the contralateral wrist that has been inserted upside down to accommodate the radius deformity.

obviates the need for a radius osteotomy and allows for minimal resection of the distal radius. Furthermore, this technique accommodates the established soft tissue contractures and thus avoids the need for extensive soft tissue releases or other rebalancing procedures.

Preparing the Radial Canal

The primary objective in preparing the canal for the radial component is proper longitudinal axis alignment, as defined by the normal radial shaft; however, as previously described, it may be appropriate to allow the axis to be translated in the radioulnar and/or anteroposterior planes. What should be avoided is angulation relative to the normal longitudinal axis, which would position the articular tray with abnormal tilt and potentially cause reduced motion, joint instability, articular impingement producing increased polyethylene wear, and component loosening.

The main obstacles to identifying and preparing the best path through the distal radius and into the distal shaft are deformity caused by malunion and sclerotic bone produced by fracture healing or in response to hardware. Accurate identification of the canal using fluoroscopy, and use of cannulated drills followed by burring through sclerotic bone, will help avoid cortical penetration and fractures during canal preparation as well as optimize component alignment.

Recognizing Sites of Osteonecrosis

Although not a substantial problem in most cases, sites of osteonecrosis should be expected and identified, because these sites can create difficulties during bony preparation and can influence eventual osteointegration of the implant. Sclerotic bone surrounding sites of osteonecrosis in the distal radius can cause the broach to deflect from the desired path. The carpus is particularly susceptible to osteonecrosis and fragmentation. Although the resection level and fixation are not typically altered due to its presence, greater care in preparation for intercarpal fusion is necessary.

Managing the DRUJ

Most newer systems are designed to preserve the DRUJ because it is believed to produce a better clinical outcome if the joint is not arthritic. Maintaining the integrity of the DRUJ is usually not problematic if the joint is well aligned, especially in patients with ulnar negative variance. However, in some patients, particularly those with ulnar positive variance, the cut that is necessary to accommodate the implant may require partial resection of the sigmoid notch. In this case, additional management of the DRUJ may be required, such as a Darrach or hemiresection arthroplasty, to avoid creating an incongruent or unstable DRUJ and or impingement between the ulnar head and the implant or the remaining carpus.

Selecting Osteointegration or Cementing

The quality of the bone and bioactivity of the distal radius metaphysis may be substantially compromised by injury and age. If during distal radius preparation the cancellous bone is soft from osteopenia or reduced by injury, then cement

fixation should definitely be considered, particularly in the very elderly. Although I prefer uncemented fixation of components, I have encountered cases of late radial component migration and loosening due to poor bone, which has lead me to using cement fixation more often. Furthermore, bold older and newer TWA designs have performed well in patients with cement fixation.

Cement fixation should also be considered in cases with more extensive osteonecrosis involving either the radius or the carpus, particularly in elderly patients. However, recommendations for cement fixation of the carpal component vary more widely with implant systems because of greater variability in component fixation design.

Results

Active range of motion exercises began 2 to 9 days following surgery, with use of a removable splint between exercises. Splinting was discontinued at 4 to 6 weeks depending on swelling and discomfort. Strengthening exercises began after 6 weeks, allowing for implant osteointegration before more stressful use of the hand.

None of the patients had early complications, including no cases of instability.

All patients had clinical and radiographic follow-up at 1 year, two had further follow up at 3 years, and one had a 5-year follow-up. No statistical analysis of outcome measurements was attempted because of the small number of patients. Active wrist flexion at 1 year varied among these patients, and it appeared to correlate with preoperative range. In three patients, the preoperative active flexion ranged from 9 to 22 degrees, and the active flexion at 1 year postoperative remained limited, with a range of 15 to 27 degrees. Preoperative radiographic deformity was not greater in these patients, but operative records described severe arthrofibrosis. Wrist extension at 1 year follow up was better and varied less among these patients than flexion did, with a range of 24 to 39 degrees. In the three patients who had longer follow-up, there was some deterioration in motion, ranging from 3 to 9 degrees loss of flexion and 4 to 13 degrees loss of extension. All patients used their affected hand for routine daily activities; however, all reported avoidance of stressful activities, including sports, because of reduced strength. One patient reported intermittent use of a wrist brace because of episodes of wrist pain; the brace provided near-complete pain relief. None of the patients requested removal of the wrist implant.

No revisions have been performed to date. There has been no radiographic evidence of radial component subsidence or other signs of loosening. Two patients, at 3 and 5 years postoperative, show carpal component subsidence measuring 2 and 4 mm respectively, with 10 degrees radial tilt of the component in the latter wrist.

Conclusions

Although each posttraumatic wrist presents additional and often unique challenges, good preoperative planning and

precise surgical technique can produce gratifying results for the surgeon and the patient. However, the surgeon should anticipate the need to use modifications of the standard technique and be ready to alter the preoperative plan during the procedure depending on the surgical findings. Because of these additional challenges, the surgeon should be very familiar with the surgical technique and instruments of the chosen implant system and ensure that appropriate supporting surgical instruments and staff are present. Although the literature continues to add evidence to the outcomes of TWA, the results with newer implant designs in patients with posttraumatic arthritis is unknown. However, proper patient

selection and good surgical planning and technique will likely optimize the outcome.

Conflict of Interest

I serve as a consultant and receive royalties from Integra Life Sciences (Plainsboro, NJ).

References

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