

# Total Wrist Arthroplasty

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Total wrist arthroplasty using current design implants has evolved into a fairly predictable procedure for rheumatoid, osteoarthritic, and posttraumatic patients. Although complications can occur, the incidence of these has dropped over the past decade with implant design modifications. The article summarizes the current use of total wrist arthroplasty and touches on issues of revision surgery, secondary fusion, complications, wrist fusion takedown, and radiolucency around implants. Technical tips are also provided for both primary and revision surgery. (*J Hand Surg Am.* 2016; ■(■):■–■. Copyright © 2016 by the American Society for Surgery of the Hand. All rights reserved.)

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**T**HE MAINSTAY OF TREATMENT FOR disabling pain related to pancarpal wrist arthritis has traditionally been arthrodesis. Whereas this procedure effectively treats pain, it also eliminates radiocarpal motion. The evolution of total wrist arthroplasty (TWA) has created the opportunity to treat disabling wrist pain while sparing motion. Recent innovations in wrist arthroplasty implants have improved outcomes, and modern implant designs offer improved stability and preservation of bone stock compared with early designs. Despite advances in implants and techniques, arthroplasty has not yet become the treatment of choice for wrist arthritis. In 2008 the number of wrist arthrodeses was nearly 10 times that of wrist arthroplasties.<sup>1</sup> A 2016 study comparing trends in TWA versus total wrist arthrodesis found that TWA has been performed less frequently since 2008.<sup>2</sup> Wrist arthrodesis is more likely to be chosen in younger patients and those with posttraumatic arthritis, whereas TWA is chosen more

frequently as a treatment option for older patients and those with rheumatoid arthritis.<sup>2</sup>

## HISTORY

In 1762, Dr Johann Ulrich Beyer, a physician in the Prussian army, was the first surgeon to perform wrist resection arthroplasty. Over 100 years later, in 1890, Themistocles Gluck made history when he performed the first total wrist arthroplasty. Gluck's implant was made of ivory and used a ball-and-socket design.<sup>3</sup> Since that time, total wrist implants have evolved from silicone implants to implants with metacarpal fixation, and to modern designs that maximize stability and longevity.<sup>4,5</sup>

At first, silicone implants were promising in the treatment of rheumatoid arthritis. These implants were largely designed as spacers, to maintain radiocarpal height and provide a painless articulating surface. However, silicone implants were found to have long-term problems, which caused them to become obsolete. These problems included implant breakage, cystic erosion in the surrounding bone, and marked synovitis.<sup>6</sup>

The next generation of total wrist prostheses, which includes the Volz implant (Stryker, Mahwah, NJ), used articulating components fixed to the metacarpals cemented into the distal radius. These implants were also largely unsuccessful owing to problems with instability and loosening. Whereas long-term outcomes demonstrated pain relief in 83% to 86% of patients, they also demonstrated a high rate of complications.<sup>7,8</sup>

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Subsequent implants, including the BIAx total wrist prosthesis (DePuy Orthopaedics, Warsaw, IN) and the first Universal total wrist implant, attempted to decrease the amount of bone resection and reduce problems of early implants. Despite some improvements, the BIAx and Universal total wrist implants had survival rates of only 85% and 75%, respectively.<sup>9,10</sup> The BIAx wrist tended to have problems related to carpal component fixation with carpal stem breakout from the metacarpal. The Universal implant tended to have problems related to dislocation. Advances in understanding of bone ingrowth and the development of cementless implants led to the modern generation of total wrist implants; cemented TWA is less frequently performed.

### CURRENT IMPLANT DESIGNS AND OUTCOMES

Because of problems with early implant designs, modern implants are designed to maximize bone stock and minimize instability. Modern implants incorporate porous coating technology for optimal bone ingrowth. They are secured to the radius through bony ingrowth rather than a cement interface. Fixation distally is accomplished via screw fixation to the carpus and index finger metacarpal rather than to the metacarpals alone. The radial component surfaces are wider and able to contain the elliptical polyethylene, metal-backed carpal component more effectively.<sup>11–14</sup>

The most commonly used modern implants are considered fourth generation and include the Universal 2 and Freedom Total Wrist Implant Systems (Integra LifeSciences, Plainsboro, NJ), the ReMotion Total Wrist System (Stryker, Kalamazoo, MI), and the Maestro Total Wrist System (Biomet, Warsaw, IN).<sup>1</sup>

Outcome studies comparing modern prosthetic designs with earlier-generation wrist prostheses have been promising so far. A recent study examined outcomes of 206 primary wrist replacements compared the Maestro, the Universal 2, BIAx, and ReMotion. All implants demonstrated improved pain scores and validated performance measures, but patients with the Maestro TWA did better in terms of motion and performance measures.<sup>15</sup> Five-year survival of both the Maestro and ReMotion prostheses was reported to be 90% to 97%, which is a notable improvement on older prosthetic designs.<sup>5,16,17</sup>

Relatively little is known about the long-term outcomes of modern total wrist arthroplasty, because it continues to evolve. One recently published article examined patients after bilateral total wrist arthroplasties, with an average of 14 years of follow-up. The

authors found a 93% satisfaction rate but reported that 7 of 13 patients required subsequent surgery.<sup>18</sup>

### SPECIAL INDICATIONS

#### Rheumatoid arthritis

Rheumatoid arthritis remains the most common indication for TWA, and patients with rheumatoid arthritis represent 51% to 71% of all patients receiving TWA.<sup>2,19</sup> Patients with rheumatoid arthritis classically have been described as leading low-demand, relatively sedentary lifestyles. They tend to have relatively poor bone stock, cystic erosions, poor preoperative motion, and major deformity. Because of these qualities, patients with rheumatoid arthritis are suited to implants that are contraindicated in young, active patients. Silicone implants were first developed to address the severe inflammatory arthropathy from rheumatoid arthritis, and may still be used occasionally for these patients. However, silicone implants are prone to catastrophic failure and synovitis.<sup>1</sup> Despite these problems, a long-term study of patients with rheumatoid arthritis treated with silicone TWA demonstrated reasonable pain relief and a high rate of patient satisfaction despite poor maintenance of carpal alignment.<sup>6</sup> When bone stock allows, modern TWA prostheses may be used successfully to treat this challenging group of patients. Most patients with rheumatoid arthritis undergo a concomitant Darrach procedure (Fig 1A, B).

#### Posttraumatic and osteoarthritis

Since 2003, the number of patients with non-rheumatoid arthritis who have been indicated for TWA has increased steadily.<sup>17</sup> Unlike patients with rheumatoid arthritis, patients with severe post-traumatic or primary osteoarthritis tend to be younger and more active. Because of this, surgeons should consider the longevity of implants as well as their ability to withstand greater stresses when planning an arthroplasty procedure. Despite concerns about whether TWA is suitable to a more active population, an international study that had at least 2 years' follow-up of more than 100 patients after TWA demonstrated greater satisfaction among patients with nonrheumatoid arthritis compared with those who had rheumatoid arthritis.<sup>17</sup> Another recent study of patients with posttraumatic wrist arthritis compared 22 patients treated with arthrodesis with 7 patients treated with arthroplasty. The authors concluded that complication rates were comparable between the procedures, but that patients undergoing TWA had

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