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Case Report

Salvage Operation for a Failed Total Wrist Prosthesis and Darrach Procedure by Total Wrist Revision and Distal Radioulnar Joint Arthroplasty

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An unstable distal ulnar stump after Darrach resection, alongside pathology of the radiocarpal joint, is difficult to manage without fusion of at least one joint. Currently, no standard 2-in-1 arthroplasty is available. We report the case of a 72-year-old woman with loosening of the radial stem of a Universal 2 total wrist prosthesis combined with radioulnar impingement after a Darrach procedure. Because of poor radial bone stock, the standard fixation technique of a semi-constrained distal radioulnar joint prosthesis (Aptis) was not possible. We present a technique to fix the semi-constrained distal radioulnar joint prosthesis as well as a total wrist prosthesis by a custom 3-dimensional printed flange prosthesis to the ulnar border of the radius. Three years after surgery, the patient remained pain-free, with 60° flexion, 75° extension, 80° pronation, and 80° supination.

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Management of a distal ulna resection failure, such as a Darrach procedure, or a total wrist arthroplasty (TWA) failure can be challenging. Treatment options to manage painful ulnar stump instability and associated impingement after a failed distal ulna resection include stabilizing soft tissue procedures using autologous tissue or allografts,[1,2] wide resection or lengthening of the distal ulna,[3,4] creation of a single-bone forearm,[5] and constrained distal radioulnar (DRUJ) arthroplasty.[6–10]

Surgical techniques for failed TWA include implant revision, resection arthroplasty, and conversion to a wrist arthrodesis.[11–16]

Management of combined problems of the DRUJ and radiocarpal joint is even more challenging. We report a patient with loosening of the radial component of a Universal 2 total wrist prosthesis (Wright Medical Group NV, Memphis, TN) combined with radioulnar impingement of the unstable distal ulnar stump after a Darrach procedure. A paucity of studies exists regarding surgical options to address similar problems.

Case Report

A 72-year-old woman presented with persistent right wrist pain, severe wrist synovitis, ulnar deviation, and global dysfunction of pronosupination of the forearm and wrist mobility. Eight years earlier, she had received a Universal 2 total wrist prosthesis for the treatment of stage 2 scapholunate advanced collapse wrist.[17] In a second stage, a Darrach resection was performed for impingement between the wrist prosthesis and the distal ulna. This resulted clinically in an unstable ulnar stump with impingement of the ulna against the ulnar side of the radius. Both procedures were performed at an outside institution.

Upon standard wrist x-ray, loosening of the radial component of the wrist prosthesis was observed along with scalloping at the ulnar border of the radius (Fig. 1). A computed tomography (CT) scan of the wrist demonstrated substantial bone loss in the distal radius resulting from the loosening. Infection was ruled out by scintigraphy and negative infection parameters (sedimentation rate, white blood cell count, and C-reactive protein) in the blood.

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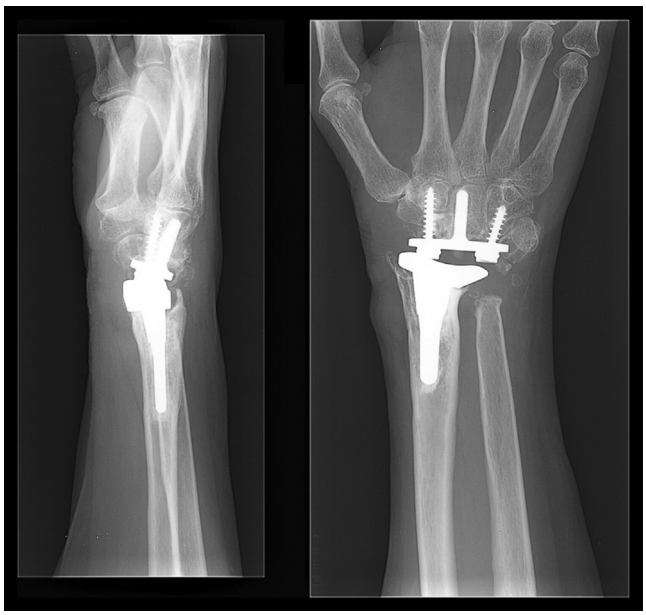

Figure 1. Preoperative radiographs of a 72-year-old patient with stage 2 scapholunate advanced collapse wrist treated with a Universal 2 total wrist prosthesis and a Darrach resection in a second operation for ulnar-sided wrist pain. Loosening of the radial component of wrist prosthesis is evident; the patient presented with an unstable distal ulnar stump.

To treat this challenging case, we employed the semi-constrained DRUJ prosthesis (Aptis, Aptis Medical, Glenview, KY) to address the unstable ulnar stump. Use of this prosthesis was hampered by the presence of the wrist prosthesis stem as well as substantial bone loss in the radius as a result of stem loosening. From an analysis of the 3-dimensional models derived from the CT scan, it was clear that the bone stock at the ulnar border of the radius had to be preserved. Adequate fitting of the Aptis prosthesis onto the ulnar edge of the radius could be optimized using a 3-dimensional printed flange that hugged the ulnar edge of the radius (Fig. 2B1). The flange itself was secured to the radius using posteroanterior locking screws positioned in the best available bone stock (Fig. 2A1, A4). The locking peg of the Aptis prosthesis was shortened to avoid colliding with the prosthetic stem of the wrist prosthesis (Fig. 2B3). The Aptis prosthesis itself was placed more proximal compared with conventional placement to allow placement of 2 screws proximal to the tip of the prosthetic stem of the wrist prosthesis. These 2 proximal screws also compressed the flange to the radius.

The radial component of the wrist prosthesis was revised to a new cemented stem. The distal component of the wrist prosthesis did not show signs of loosening at that time and was left in place. Because there were extensive signs of polyethylene wear and particle-induced synovitis, a liner exchange was performed. Self-rehabilitation was started 10 days after surgery. Weight lifting was limited to 20 lb and torsion loading was restricted until 3 months after surgery.

Two years after placement of the Aptis prosthesis, the patient presented with loosening of the carpal component of the wrist prosthesis (Fig. 3). On radiographs, it was clear that the ulnar screw had backed out, the radial screw had broken, and the wrist had gone into ulnar deviation. Because of the radiographic appearance and compromise in the patient's function, a revision was performed. The distal component was revised with screws augmented with bone cement. This second-look operation allowed surgical inspection of the first reconstruction, which showed no loosening in the radial component or at the DRUJ arthroplasty.

At 3 years' follow-up after the revision, the patient remained pain-free and reported satisfaction with wrist function, with painless 80° pronation and supination, 60° wrist flexion, and 75° extension (Figs. 4, 5).

Discussion

When this patient first presented, there were 2 problems: (1) radial loosening of a Universal 2 total wrist prosthesis, and (2) scalloping of the distal ulnar stump from an unstable Darrach procedure. Although generally successful, one of the most common major complications of the Darrach procedure is painful radioulnar convergence. Risk factors are a too-large resection of the ulna, a lack of soft tissue stabilization procedures, or the functional demand of the patient. Failure rates of the Darrach procedure range from 7% to 40%.[3,4,7,8] Two years after the first reconstruction, the patient presented with a third problem: loosening of the distal component of the TWA. Implant loosening, usually of the carpal component, is the most common cause of revision after TWA; rates are approximately 2% to 26%.[11,12]

Treatment options for a failed TWA resulting from implant loosening include revision arthroplasty, resection arthroplasty, and arthrodesis. Implant revision is particularly difficult because of the compromised bone stock associated with loosening of the components of the primary TWA. Fischer et al[11] reported an implant survival of 74% after 5 years after revision arthroplasty. Conversely, conversion of a TWA to a wrist arthrodesis results in a stable wrist, but at the expense of motion. Reported fusion success rates range from 52% to 95%.[13,15]

Many surgical techniques have been described to manage ulnar stump instability after the Darrach procedure, including stabilizing soft tissue reconstructions and/or interpositions, wide resection of the ulna, total DRUJ arthroplasty, lengthening of the distal ulna, and reconstruction involving a single-bone forearm.[1–10] A paucity of information remains comparing these techniques. Soft tissue stabilization of an unstable ulnar stump is usually performed employing an autologous or allograft tendon to stabilize the ulna and interpose tissue between the radius and ulna.[1,2] Ulnar lengthening or shortening displaces the point of impingement without addressing stability.[3,4] One-bone forearms are thought to be the last attempt at a salvage procedure for failed Darrach because of the marked limitations patients experience.[5]

Distal radioulnar joint arthroplasty has been demonstrated to be an effective salvage procedure for symptomatic patients after failed Darrach procedures. Instability of the ulnar stump after resection is bidirectional: anteroposterior instability is usually well-tolerated and the radioulnar instability can be painful and disabling.[10] Implant arthroplasty was introduced as salvage for this instability in 1973 using silicone implants.[8] Although silicone implants were susceptible to dislocation and breakage, they demonstrated the value of recreating an ulnar head. An isolated ulnar head replacement was introduced by Stanley and Herbert in 1995[18] with a modular prosthesis consisting of a metallic stem inserted into the ulna and a metallic or ceramic ulnar head. Other, similar implants followed, but successful stabilization of the ulna required significant attention to soft tissue stabilization and alignment.[8] The semi-constrained DRUJ prosthesis (Aptis) provides stability through its semi-constrained design, without the need for further soft tissue stabilization. Moreover, it provides a viable option for treating painful radioulnar convergence after multiple failed procedures at the DRUJ.[6–10]

In our patient, management of distal ulnar stump instability alongside the presence of a failing total wrist prosthesis

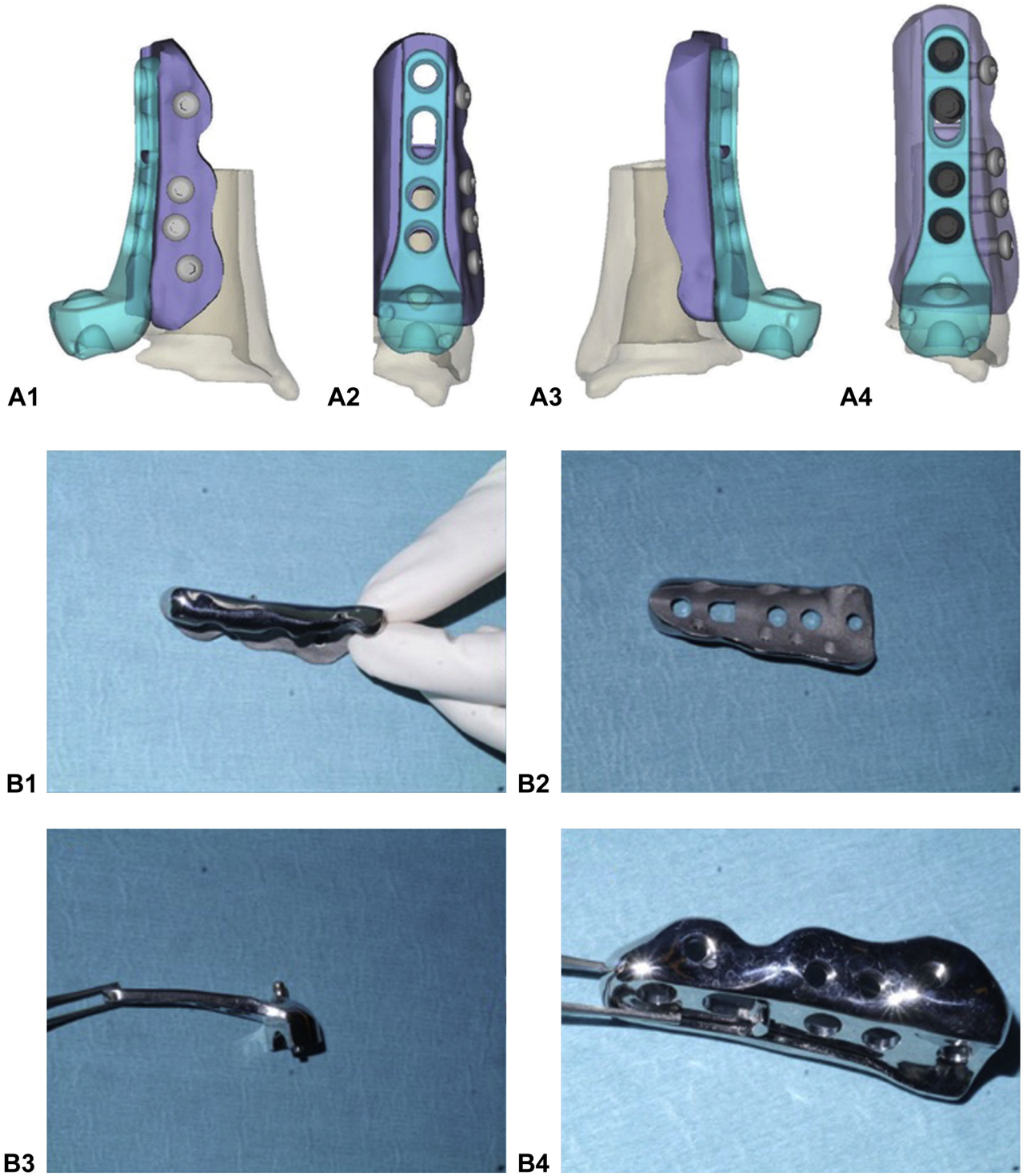

Figure 2. Three-dimensional planning of the custom-made implant to ensure fixation of the Aptis prosthesis to the radius next to the proximal stem of the wrist prosthesis. **A1, A4** The flange is secured to the radius using posteroanterior locking screws positioned in the best available bone stock. **A2, B4** Press-fit locking of the Aptis prosthesis onto the flange is ensured by adding a locking peg on the flange in the distal position of the oblong hole of the Aptis prosthesis. This allows press-fit fixation between the flange and the Aptis prosthesis. **B1** Adequate fitting of the Aptis prosthesis onto the ulnar edge of the radius could be optimized using a 3 dimensional–printed flange that hugs the ulnar edge of the radius. **B2** The undersurface of the flange is molded after the bone model of the radius obtained from the CT scan data. **B3** The locking peg of the Aptis prosthesis is shortened to avoid colliding with the prosthetic stem of the wrist prosthesis. **B4** The upper surface is shaped to accommodate the undersurface of the Aptis prosthesis.

represented a challenging situation. The limited radius bone stock compromised fixation of the radial component of the DRUJ arthroplasty while making revision TWA difficult. One option considered was a wrist arthrodesis combined with an Aptis prosthesis. However, the patient was unwilling to give up wrist motion, and wrist arthrodesis after failed TWA involves the use of extensive bone grafts to replace bone defects with at least 3 months' postoperative immobilization.[13] Another option involved reconstructing a single-bone forearm combined with revision of the wrist prosthesis. However, losing pronosupination is even more limiting

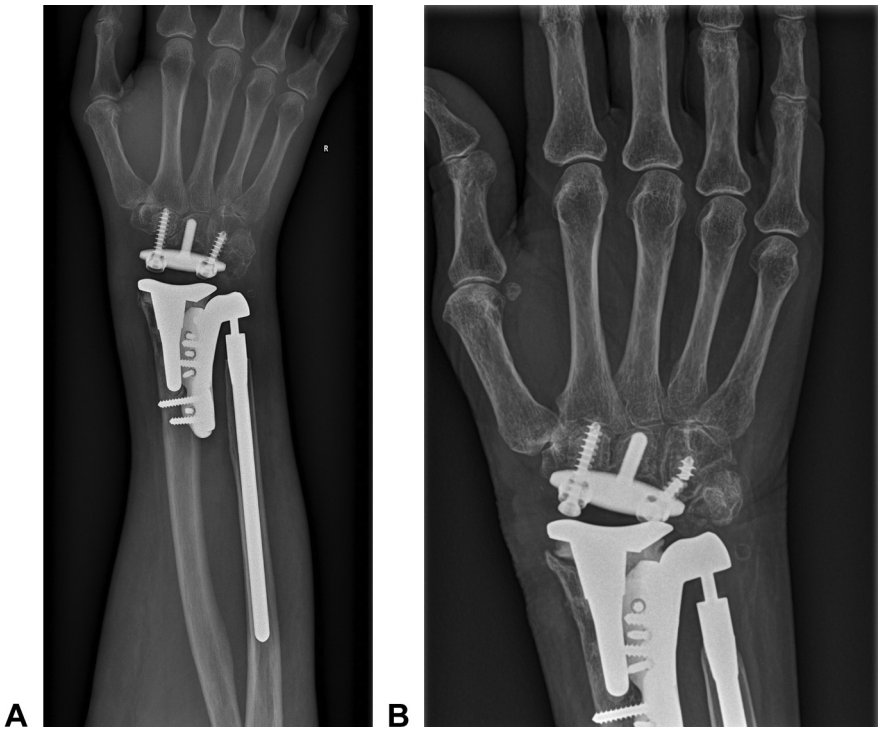

Figure 3. A Postoperative radiograph after placement of the Aptis prosthesis. **B** Radiograph 2 years after placement of the Aptis prosthesis showing loosening of the carpal component of the wrist prosthesis. Reintervention was necessary because the ulnar screw backed out, the radial screw broke, and the wrist went into ulnar deviation.

compared with giving up wrist mobility during daily activities. Reported complication rates are as high as 53%, the most common of which is nonunion (32%).[5] Finally, the option that was performed included revision of the wrist prosthesis combined with the placement of a DRUJ prosthesis.

When performing this technique, several questions needed to be addressed: (1) how to combine the implantation of these prostheses; (2) how to keep the available bone stock; and (3) how to optimize fixation of these implants in the remaining radial bone stock. To answer the first question, we used preoperative planning to optimize fixation of both implants and avoid conflict between the 2 prostheses. In primary Aptis placement, the ulnar border of the radius is flattened and adjusted to accommodate for orthogonal placement of the radial component. A distal transfixion peg allows the implant to be anchored in the subchondral bone stock of the radius. Neither radius shaping nor use of the transfixion peg was possible in this patient. Shaping the radius would have further impaired the already limited bone stock and the transfixation peg would have interfered with the radial stem of the wrist prosthesis. A 3 dimensional–printed, custom-made implant with screws in the anteroposterior direction was created to switch the fixation direction of the Aptis prosthesis in the optimal remaining bone stock on the ulnar ridge of the radius. The clinical team individually designed the custom-made implant in collaboration with Mobelife (Materialise NV, Leuven, Belgium). The undersurface of the flange was molded after the bone model of the radius obtained from the CT scan data and the upper surface was shaped to accommodate the undersurface of the Aptis prosthesis (Fig. 2B2, B4). Press-fit locking of the Aptis prosthesis onto the flange was ensured by adding a locking peg on the flange in the distal position of the oblong hole of the Aptis prosthesis. This allowed press-fit fixation between the flange and the Aptis prosthesis (Fig. 2A2, B2).

The radial component of the wrist prosthesis was revised using cement fixation. No extra bone resection was needed, and fixation of the implant was possible in the maximum remaining bone stock.

Figure 4. Postoperative radiograph showing the Universal 2 total wrist prosthesis combined with the custom Aptis prosthesis at 3 years after surgery.

Despite this, 2 years after placement of the Aptis prosthesis, reintervention was necessary because of a failure at the distal component. Revision surgery was necessary and confirmed stability at the DRUJ.

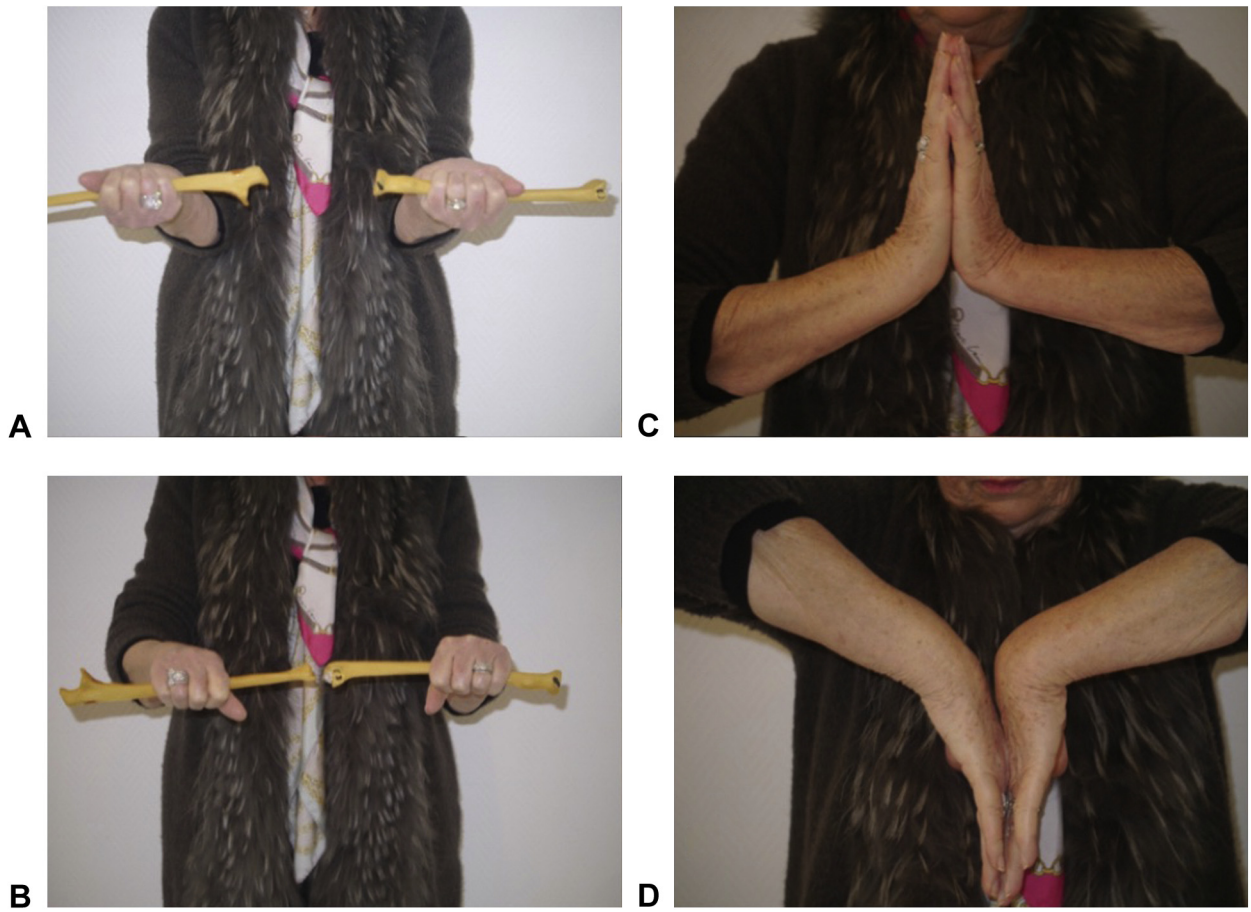

Figure 5. Range of motion after revision of the distal component of the total wrist prosthesis with cement at 3 years after surgery.

In the case presented here, the patient with a failed Darrach procedure and radial component loosening associated with bone loss after a TWA was treated with a revision TWA and custom DRUJ prosthesis. Ultimately, the patient did well after a second revision procedure involving distal component loosening of the TWA. This case highlights the challenges underlying these combined pathologies and presents a potential solution for surgeons to maintain wrist function and improve pain. Because these cases are rare and inherently variable, the importance of this case report is not so much in the technical details as in the engineering approach used to solve an unmet clinical need in a patient-specific fashion.

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