

Palmar Shelf Arthroplasty for Rheumatoid Wrist Arthritis: Long-Term Follow-Up

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Abstract

Rheumatoid wrist arthritis is common and affects about 1.5 million people in the United States. For advanced disease, arthrodesis and implant arthroplasty have been recommended as treatment options. In 1970, palmar shelf arthroplasty was introduced, and initial results were encouraging but not reproducible. In 1990, Dr. Skoff modified the original procedure with good results in patients followed for 2 to 7 years.

This study reports the results of 13 patients (9 women, 4 men; average age, 43 years) who were followed up for an average of 13.2 years (range, 10 to 20 years) after undergoing modified palmar shelf arthroplasty. The patients were interviewed and examined, and wrist radiographs were taken. The patients completed a questionnaire that used a 10-point pain analog scale and the Quick Disabilities of the Arm, Shoulder and Hand (DASH) and Modernized Activity Subjective Survey (MASS) Scoring Systems.

Scoring results demonstrated improvement in pain at rest and with activity. MASS and Quick DASH scores improved by 76% ($P < .001$). Wrist range of motion averaged 35° extension and 32° flexion. One patient required wrist fusion; none of the remaining 12 patients required surgical revision. Patient satisfaction was very high, and radiographic results demonstrated maintenance of the radiocarpal pseudarthrosis without ankylosis.

The long-term results of modified palmar shelf arthroplasty demonstrated enduring analgesia and mobility without the complications of an implant. Modified palmar shelf arthroplasty is a reasonable surgical alternative for advanced rheumatoid arthritis of the wrist.

Rheumatoid arthritis afflicts approximately 1.5 million people in the United States.¹ Although perhaps not the initial site of manifestation of the disease, wrist involvement eventually occurs in 85% of patients.² Recent advancements in the treatment of rheumatoid arthritis with medication have greatly reduced the total number of patients

requiring surgical intervention.³ Nevertheless, lack of access, tolerance, or response to antirheumatoid medication results in progressive destruction of the radiocarpal, intercarpal, and distal radioulnar joints.⁴ Total wrist arthrodesis has been the gold-standard surgical intervention for advanced rheumatoid arthritis at the expense of motion.⁵ Implant arthroplasty preserves some wrist motion at the expense of unpredictability of outcome over time.⁶

Palmar shelf arthroplasty was introduced in 1970 by Albright and Chase⁷ as a noninterpositional hemiresectional arthroplasty of the distal radius and ulna. The initial results were encouraging, but the series was small. Subsequent reports of the palmar shelf procedure by other investigators have been inconsistent concerning outcome, with pain and spontaneous ankylosis of the radiocarpal joint cited as major adverse findings.^{8,9} In 1990, Dr. Skoff initiated and has since followed a cohort of patients with advanced rheumatoid arthritis of the wrist treated by a modified version of the palmar shelf arthroplasty procedure. The modifications—distraction, interposition, and prolonged immobilization—were designed to improve outcome consistency. In 1999, Dr. Skoff¹⁰ reported the results of 14 patients treated with the modified palmar shelf arthroplasty procedure with a follow-up time of 2 to 7 years.

In the current continuation study, Dr. Skoff reports the results of 13 patients followed for a minimum of 10 years who were treated with the modified palmar shelf arthroplasty procedure for advanced rheumatoid arthritis of the wrist.

Materials and Methods

The research protocol for this study was approved by institutional review board, and informed consent was obtained from each patient. Thirteen adult patients (9 women, 4 men) were enrolled in this study. Average age at the time of surgery was 43 years (range, 30 to 54 years). Average age at the time of follow-up was 56 years (range, 46 to 65 years), and the average follow-up was 13.2 years (range, 10 to 20 years). The patients were interviewed and examined, and biplanar wrist radiographs were taken. An independent occupational therapist participated in the examination of the patients. The patients completed a questionnaire that used a 10-point visual analog pain scale and the Quick Disabilities of the Arm, Shoulder, and Hand (DASH) and Modernized Activity Subjective Survey (MASS) Scoring Systems to assess wrist function and subjective complaints both preoperatively and postoperatively. Standard error was

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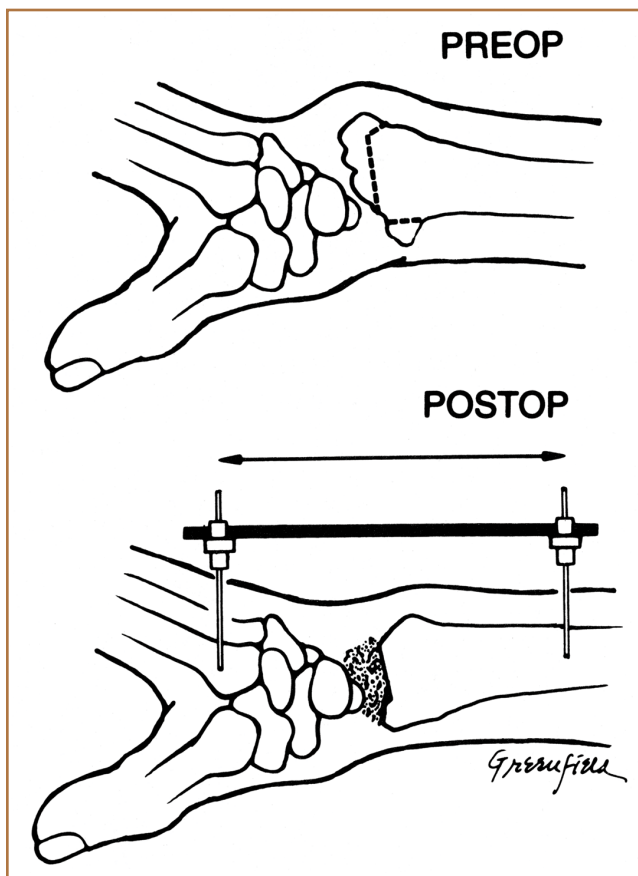


Figure 1. Schematic of modified palmar shelf technique with distraction/interposition. Reprinted from *Plastic and Reconstructive Surgery*, vol. 104, issue 7, Hillel Skoff, Palmar Shelf Arthroplasty, the Next Generation: Distraction/Interposition for Rheumatoid Arthritis of the Wrist, pages 2068-2072, Copyright 1999, with permission from Wolters Kluwer Health.

calculated. Preoperative to postoperative comparison used the 2-sample t test to derive the P value. All of the patients were under the active care of a rheumatologist from before the time of surgery until the time of follow-up examination. By the time of the current study, disease control had evolved from gold, hydroxychloroquine, and nonsteroidal anti-inflammatory drugs (NSAIDs) to methotrexate and biological disease-modifying antirheumatic drugs (DMARDs), the latter taken by all of the patients in this study. Clinical indications for the procedure were unremitting wrist pain, loss of motion, loss of function, and deformity despite maximal medical management; there were no absolute clinical contraindications.

Surgical Technique

The modified palmar shelf arthroplasty begins with a dorsal longitudinal incision (Figure 1). A radical extensor tenosynovectomy is performed on all 6 dorsal compartments. A complete dorsal capsulectomy is then performed along with a radical synovectomy of the radiocarpal, ulnocarpal, intercarpal, and distal radioulnar joints. The distal radius is excised parallel

to the intact dorsal cortex preserving the volar cortex (the “palmar shelf”). The size of the conservative bony resection is just sufficient to reduce the radiocarpal joint from its typical volar subluxation without traction to the wrist. The distal ulna is then excised at a length equal to that of the radius to create neutral variance and stabilized with surrounding soft tissues. Scapholunate stabilization for scapholunate dissociation, when present, is performed by debridement of the opposing cartilage surfaces of the scaphoid and lunate followed by bone-anchor intercarpal fixation. Careful attention is directed to preserving the proximal facing cartilage of the scaphoid and lunate. Bone wax is applied to the resected distal radius and distal ulna, and 1 g of microfibrillar collagen (Avitene; Davol Inc, Warwick, Rhode Island) is packed into the nascent radiocarpal joint space as an interpositional material. A simple external fixation frame spanning the wrist joint from the radial diaphysis to the third metacarpal is inserted in distraction mode to create a space of approximately 7 mm. The fixator is left in place for 6 weeks and is then replaced by casting until completion of immobilization at 3 months. Mobilization of the wrist is then initiated, and the patient is instructed to use a wrist brace for sleep and for activities requiring more force than activities of daily living for an additional 9 months.

Results

Scoring system results demonstrated a consistent decrease in the pain analog scale at rest, from a preoperative score of 5 to 8 to a postoperative score of 0 to 2, and with activity, from a preoperative score of 6 to 9 to a postoperative score of 1 to 3. The MASS score showed a mean (SE) improvement of 76% (10%; range, 40% to 100%); the Quick DASH score decreased from a preoperative mean (SE) score of 63 (6; range, 50 to 82) to a postoperative mean (SE) score of 16 (6; range, 0 to 36), for a series composite 76% (SE, 9%) improvement as a consequence of surgical reconstruction. This difference was statistically significant, ($P < .001$). Wrist range of motion was a mean (SE) of 35° (7°) of extension and 32° (4°) of flexion, for a mean (SE) motion arc of 67° (8°).

One patient required wrist fusion to correct wrist instability at 1 year postoperation. Of the remaining 12 patients, none have requested or required a revision procedure. All remaining patients experienced improvement with respect to both pain and function. Their American Rheumatism Association functional classification improved from class II (limited avocational activities only)/III (limited vocational and avocational activities) preoperatively to class I (unrestricted activities)/II (limited avocational activities only) postoperatively. No wrist fused spontaneously. There were no infections or skin flap losses. Patient satisfaction was very high; those with a contralateral wrist fusion (6 patients) preferred the arthroplasty, and those whose contralateral wrists had been successfully managed medically (6 patients) preferred the nonoperative treatment. The radiographic results demonstrated maintenance of both the iatrogenic radiocarpal pseudarthrosis without ankylosis, as well as sagittal plane radiocarpal alignment. Stable



Figure 2. Preoperative radiographs demonstrating typical radiocarpal, ulnocarpal, and pancarpal rheumatoid destruction.

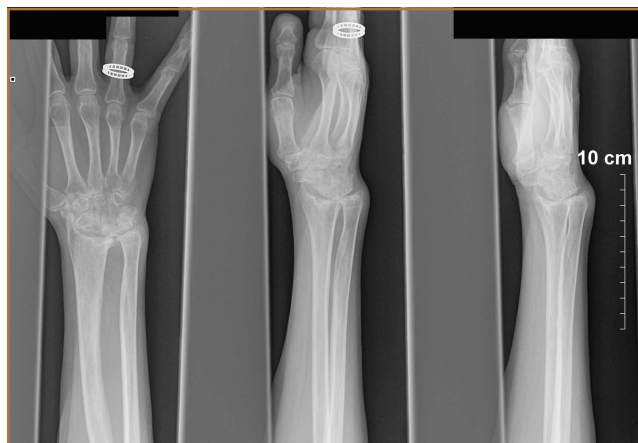


Figure 4. Postoperative radiographs of a patient at 10-year follow-up demonstrating equally weighted 2-bone forearm.



Figure 5. Postoperative radiographs of a patient at 15-year follow-up demonstrating bone-suture anchor fixation of periulnar soft tissues.

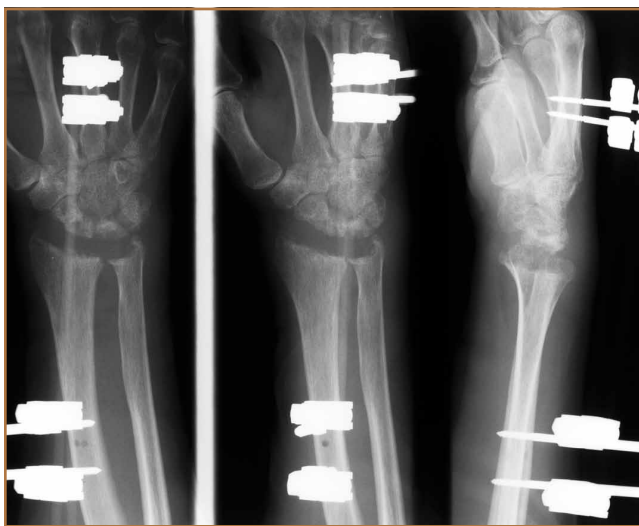


Figure 3. Postoperative radiographs at 6-week follow-up demonstrating distraction by external fixation.

finite translocation of the carpus toward the ulna was a common finding. The carpal shift reflects the loss of radiocarpal and ulnocarpal extrinsic ligaments and creates a more equally weighted 2-bone forearm (Figures 2-6).

Discussion

Rheumatoid arthritis of the wrist is common.¹¹ Should primary medical management become insufficient, predictable destruction of carpal architecture occurs. Both arthrodesis and arthro-



Figure 6. Postoperative radiographs of a patient at 20-year follow-up demonstrating both maintenance of sagittal plane alignment and coronal plane translocation of the carpus toward the ulna.

plasty restore proper alignment through radical debridement of rheumatoid pannus and bone.¹² Historically, surgeons have recommended arthrodesis because of its reliability, consistency, and stability, with successful outcomes of greater than 90% and complication rates of less than 20%.¹³ Despite a greater risk of complications, some patients have preferred implant arthroplasty because of its greater simulation of mechanical normalcy, particularly in the dominant wrist to enhance dexterity.^{14,15} The failure rates of wrist implants at the time the modified palmar shelf arthroplasty were performed in this study (1990-2003) were 4% to 7% per year at a series average of 4.3 to 7.3 years follow-up.^{16,17} While this represents an improvement over the previous generation of implants,¹⁸ the results remain unpredictable for long term dependability.¹⁹ Newer wrist implants—Universal II (Integra Life Sciences, Plainsboro, New Jersey), Re-Motion (Small Bone Innovations, Inc, Morrisville, Pennsylvania), and Maestro (Biomet, Warsaw, Indiana)—have become available for the wrist, but long-term outcomes have yet to be reported. The published 2- to 8-year results of these newer implants are inferior to those reported for modified palmar shelf arthroplasty at a similar period of follow-up.^{10,20,21,22}

A critical reading of the history of total joint replacement surgery suggests that a decade of clinical experience is required before the true efficacy, safety, reliability, and consistency of an implant can accurately be determined. Ironically, impressive 15-year results of the Swanson-type silicone wrist implant (Wright Medical, Memphis, Tennessee) have been reported from Europe, but the 50% rate of silicone synovitis has made this implant unpopular in the United States.²³ Comparing values of outcome in the surgical literature, the long-term results of modified palmar shelf arthroplasty are as effective for pain relief and as enduring as those reported for total wrist arthrodesis, and are as successful in restoring mobility as those reported for total wrist arthroplasty (English-language literature series composite range of arc motion of 45° to 75°), but without the potential dangers of an implant: breakage, loosening, infection, dislocation, or significant radial bone deficiency.^{24,25,26}

The structural basis for both original and modified versions of the palmar shelf procedure is hemiresection of the radiocarpal joint, without creating a fusion. Consequently, both versions preserve proximal carpal articular cartilage, and presumably rely upon an exuberant collagenous response in the resected joint space to provide stability as well as mobility and to create a pseudarthrosis without ankylosis. The modified palmar shelf procedure borrows a combination of accepted orthopedic techniques prevalent at the time of the series inception (1990) to accomplish this end. An external fixator replaced the original pins and plasters method for increased construct rigidity, adjustability, and wound access. Immediate and considerable distraction after osteotomy of the distal radius was added as the antithesis of the Ilizarov method of osteogenesis (diminutive, incremental distraction after a period of delay) to achieve the opposite effect: fibrous interposition.²⁷ Immobilization time was increased from 4-6 weeks to 3 months, in order to allow additional collagen maturation within the radiocarpal space, as recommended by Swanson.²⁸ Bone wax and microfibrillar

collagen were selected as commonly used hemostatic agents to protect the fragile skin flaps of steroid-dependent patients. The additional benefits of these agents also included the retardation of osteogenesis,²⁹ and the provision of substrate for formation of the collagen “wafer” within the resection site.³⁰ The composite effect of these modifications appears to be the creation of a more durable, biological, stress-bearing surface. The successful application of resection/interposition/distraction arthroplasty in the upper extremity is well established for arthritic involvement at both the first carpometacarpal and elbow joints, but this report for the wrist is unique.^{31,32} The concept is simple yet effective, and the technique forgiving.

Another consideration in the current era is cost. Assuming equal operating room times and identical anesthetics among the 3 procedures, and using 2013 Medicare Current Procedural Terminology (CPT) code reimbursement as well as list price remuneration for hardware expenses, the total price of modified palmar shelf arthroplasty is approximately \$2114 compared with \$3631 for plate arthrodesis and \$13,000 for implant arthroplasty. The additional cost of an implant must be justified by superior results,³³ which have not been demonstrated by either arthrodesis or implant arthroplasty.

The correlation of results in the current series between the validated scoring instruments Quick DASH and MASS was excellent. The principal deficiencies of this report are the lack of a control group other than historical and a nonrandomized selection of the treatment cohort. The principal strength is the length of continuous follow-up in the use of a single technique, and the most significant finding is the lack of clinical deterioration of outcome over time.

Conclusion

Modified palmar shelf hemiresectional arthroplasty with distraction and interposition consistently yields satisfactory clinical results in long-term follow-up in patients with advanced rheumatoid arthritis of the wrist. The results of modified palmar shelf arthroplasty described in this report compare favorably with the empirical subjective and objective parameters of outcome and with surgical literature outcomes of both wrist arthrodesis and implant arthroplasty.

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