

# CLINICAL, RADIOGRAPHIC, AND PATIENT-REPORTED RESULTS OF SURFACE REPLACING PROXIMAL INTERPHALANGEAL JOINT ARTHROPLASTY OF THE HAND

Mohana Amirtharajah,\* Duretti Fufa,\*\* Nina Lightdale,† Andrew Weiland††

## ABSTRACT

The purpose of this study was to evaluate the one-year clinical, radiologic and patient-reported results of surface-replacing proximal interphalangeal joint arthroplasty (SR-PIP) of the hand. Fifteen patients with 18 joints underwent the procedure, and nine patients with 11 joints had follow-up of at least one year's duration. Of these joints, six had a diagnosis of osteoarthritis with no history of trauma, three had post-traumatic arthritis, one had psoriatic arthritis, and one had erosive arthritis. The mean clinical follow-up was at 3.3 years, and the mean radiographic follow-up was at 3.1 years. The average post-operative gain in range of motion at the PIP joint was 28 degrees and was statistically significant. Six patients completed self-reported questionnaires at a mean of 4.8 years post-operatively. The mean Disabilities of the Arm, Shoulder and Hand (DASH) score post-operatively was 17, and the Michigan Hand Questionnaire (MHQ) score for overall satisfaction was 70. There were three complications but only one reoperation. Seven of 11 joints showed some evidence of subsidence on follow-up radiographic examination. However, no joints were revised secondary to loosening. Longer follow-up is needed to determine if this observable radiologic subsidence leads to symptomatic loosening of the implant.

## Introduction

Degenerative disease of the proximal interphalangeal (PIP) joint of the hand is a very difficult condition to treat. Arthrodesis at this joint is not always well-tolerated,

particularly in the ulnar digits where a lack of flexion has a significantly detrimental effect on grip strength. Historically, silicone implants were used at this joint to try and restore motion. Although patients did report good relief of pain, these implants were complicated by breakage and decrease in survivorship after nine years.<sup>1</sup> Pyrolytic implants have also been developed, and some studies have reported good patient satisfaction with their use.<sup>2</sup> However, other studies have shown the results of these implants to be unpredictable and somewhat disappointing in patients with post-traumatic arthritis.<sup>3,4</sup> In addition, these pyrolytic implants are also susceptible to "squeaking".<sup>3,5</sup>

More recently, a surface-replacement PIP-joint arthroplasty (SR-PIP) has been developed with Linscheid et al reporting particularly good results in patients with degenerative arthritis.<sup>6</sup> During the course of this series, the authors observed somewhat better results in patients who had a dorsal approach.<sup>6</sup> In another series of patients receiving this implant, Jennings and Livingstone report that 60% of their patients found their results of this procedure to be very satisfactory; however, they also report a revision rate of 26% in a total of 43 joint arthroplasties at average follow-up of 37 months.<sup>7</sup> Similarly, Luther et al reported 14 of 24 patients in their series needing reoperating.<sup>8</sup> In that study, patients did have an increase in PIP joint range of motion of 21 degrees as well as a mean DASH score of 24 at an average of 27 months. Furthermore, multiple studies have shown lower rates of loosening in cemented versus non-cemented implants.<sup>7,9</sup>

The purpose of this study is to report the results of a single-surgeon series of patients undergoing SR-PIP arthroplasty. In this series, all implants were inserted through a dorsal approach and cemented. Results are reported using clinical, radiographic, and patient-reported outcomes.

## METHODS

### Materials

The implant used in this study was the SR-PIP system, previously of Avanta, now produced and marketed by Small Bone Innovations (SBI, New York, NY). The proximal phalangeal component consists of a metallic cobalt chromium alloy. The middle phalangeal component is made from ultra-high molecular weight polyethylene and titanium.

\*Mission Bay Ortho Institute, San Francisco, CA

\*\*Hospital for Special Surgery, New York, NY

†Children's Hospital of Los Angeles, CA

††Hospital for Special Surgery, New York, NY

Contact Author:

Mohana Amirtharajah, MD, Assistant Professor  
Hand and Upper Extremity Service  
Department of Orthopaedic Surgery  
University of California, San Francisco  
Mission Bay Ortho Institute  
1500 Owens Street,  
San Francisco, CA 94158  
(415) 353-2808, (415) 885-9643

### Study Design

Institutional Review Board approval was obtained for this study. A retrospective chart review revealed 15 patients with 18 joints who had undergone PIP joint arthroplasty by the senior author with this implant. Of these 18 joints, there was one index, seven middle, eight ring, and two small fingers. Eight patients with a total of 11 joints had radiographic and clinical follow-up of at least one year. Six patients completed the patient-reported outcomes questionnaires after surgery.

### Outcomes

All patients were evaluated with PA and lateral radiographs of the operated finger. Radiographs were evaluated for signs of subsidence, periprosthetic radiolucency, and loosening.<sup>7</sup> Range of motion measurements were made by the senior author using a small joint goniometer. At follow-up, patients were assessed with the Disabilities of the Arm, Shoulder, and Hand and Michigan Hand Questionnaire. The DASH is scored from 0-100 with 100 showing greater disability. The MHQ consists of six categories: function, activities of daily living (ADLs), work, satisfaction, aesthetics and pain. The MHQ is scored from 0-100 with 100 showing better function except for the pain portion that is scored from 0-100 with 0 indicating no pain. Statistical analysis was performed using an unpaired t-test.

### Surgical Technique

All surgeries were performed by the senior author in accordance with the implant technique guide. A dorsal tendon-splitting approach was used in all cases. The collateral ligaments and volar plate attachments were preserved and the joint opened in a “shotgun” fashion. The distal and proximal bone cuts were made with a sagittal saw. The intramedullary cavities were opened manually with an awl. Trial implants were used to test for fit and stability in all cases prior to choosing the final implant. All cases were cemented. The extensor mechanism was repaired in all cases.

## RESULTS

### Demographics

Fifteen patients (three men and 12 women) underwent PIP arthroplasty on a total of 18 joints. Of these patients, eight had osteoarthritis with no history of trauma, six had post-traumatic arthritis, one had rheumatoid arthritis, one had psoriatic arthritis, and one had erosive arthritis. The mean age at the time of surgery was 53 (range 22-74). Of the nine patients with 11 joints that had at least a one-year follow-up, six had osteoarthritis with no history of trauma, three had post-traumatic

arthritis, one had psoriatic arthritis, and one had erosive arthritis. The average age at time of surgery for these patients (three men and six women) was 59 (range 38-74). This data set included six middle, four ring, and one small finger.

### Clinical and Radiologic Outcomes

Average clinical follow-up was 3.3 years (range 1.0-6.8) years and radiographic follow-up was 3.1 years (range 1.0-5.7). Pre-operative range of motion of the PIP joint averaged 22-55 degrees (33-degree arc of motion) and post-operative range of motion averaged 13-74 degrees (61-degree arc of motion). The final average gain in arc of motion was 28 degrees. This difference was statistically significant ( $p=0.025$ ). On serial radiographs, seven of 11 joints (64%) showed some signs of subsidence (Figures 1 and 2). In two of these patients, subsidence was seen as early as one year (Figures 3 and 4).

Complications included one superficial infection treated with oral antibiotics, and one dislocation treated with closed reduction and a period of immobilization. One patient underwent reoperation consisting of an extensor tenolysis for stiffness approximately seven months after the initial surgery.

### Self-Reported Outcomes

Six patients completed questionnaires at an average of 4.8 years post-operatively (range 0.3-6.8). The mean DASH score was 17. For the operated hand, the MHQ score for function averaged 66, for ADLs 78, for work performance 80, and for aesthetics 65. Pain scores on the MHQ averaged 22 (0 indicates no pain). The MHQ score for overall satisfaction averaged 70. For the contralateral, non-operated hand, MHQ score for function averaged 82, ADLs 85, aesthetics 70, pain 15, and satisfaction 78. None of these results reached statistical significance. One patient had bilateral surgeries so results for the “normal”



Figure 1. Radiographs taken immediately post-operatively.

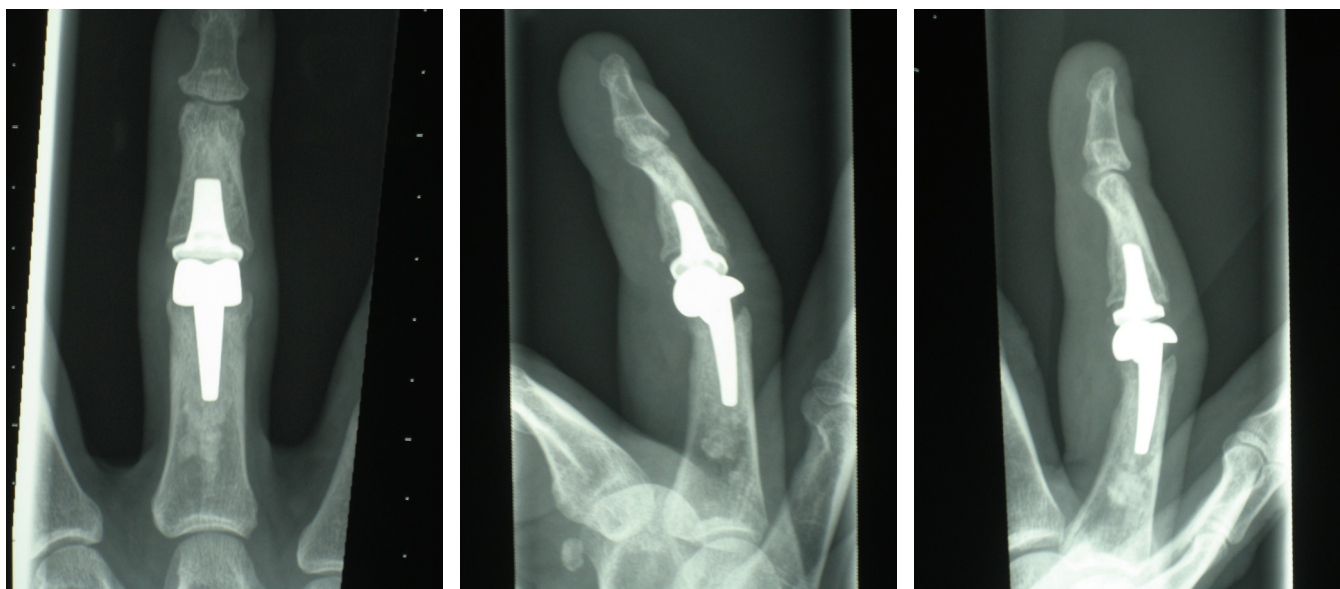


Figure 2. Radiographs of the same patient in Figure 1 taken 5.5 years after surgery. Note the slight subsidence of the proximal component and the radiolucency seen dorsally.



Figure 3. Radiographs taken immediately post-operatively.

hand were excluded. Four of the six patients stated they would have the procedure again. Of the two who would not, one patient cited lacked of motion postoperatively, and the other patient's clinical course was complicated by dislocation of the joint.

### DISCUSSION

Treatment of arthritis at the PIP joint has remained one of the unsolved problems in hand surgery. The index and middle fingers are subject to such strong lateral forces during pinch activities that an implant at the PIP joint would need significant lateral stability for long-term survival. Arthrodesis at these joints provides good lateral stability but at the expense of motion. In contrast, although arthrodesis may be fairly well-tolerated in the index finger, fusion of the ulnar digits causes significant difficulty with power grip. Thus, surgeons have looked



Figure 4. Radiographs of the same patient in Figure 3 taken just one year post-operatively showing some signs of subsidence.

toward developing a durable implant that can withstand lateral forces but preserve motion.

Swanson introduced a constrained silicone implant for the PIP joint in the 1960s.<sup>10</sup> Good pain relief has been reported from this procedure, although restoration of range of motion has been somewhat variable.<sup>1</sup> Periprosthetic bone resorption as well as implant breakage have been noted over time in these implants.<sup>1,11</sup>

In contrast to earlier constrained implants, newer implants have been developed in order to more closely recreate the normal joint anatomy. These types of im-

plants rely on the intact surrounding soft tissues for stability and require resection of only small amounts of bone. Minimally constrained pyrolytic carbon implants have been used as an alternative to silicone arthroplasty. Tuttle and Stern reported a total of 24 complications in 15 of these joints, with the most common being noticeable squeaking of the joint.<sup>3</sup> Fifty percent of patients in this series had incomplete pain relief. Only two joints showed radiologic evidence of loosening. Nunley et al showed inadequate relief of pain and lack of improvement in range of motion in patients who underwent pyrolytic carbon arthroplasty for post-traumatic arthritis of the PIP joint.<sup>4</sup> Interestingly, Bravo et al reported radiographic settling in 20 of 50 joints undergoing pyrolytic carbon arthroplasty.<sup>2</sup> However, only four cases in this series were revised for loosening.<sup>2</sup> These authors speculate that the implants “settle” into a stable position. Branam et al. compared the outcomes of silicone PIP implants to that of pyrolytic carbon implants.<sup>5</sup> These authors found that both groups had good pain relief and self-reported satisfaction with similar numbers of complications.

The original version of the SR-PIP joint arthroplasty (Avanta) consisted of a chromium cobalt proximal component and a pure ultra-high molecular weight polyethylene (UHMWPE) distal component designed to be cemented. Linscheid et al reported on 66 joints at an average of 4.5 years with 32 good, 19 fair and 15 poor results.<sup>6</sup> Interestingly, radiologic loosening was seen in only one joint. This study also found that results were better using a dorsal rather than a lateral or volar approach.<sup>6</sup> A kinematic study in cadavers of this implant, also by Linscheid’s group, revealed that the SR-PIP implant had a similar center of rotation and similar kinematics to a native joint.<sup>12</sup>

A later version of the implant (SBI) consisted of a distal component with a UHMWPE surface with a textured titanium stem allowing for press-fit, uncemented fixation. Johnstone et al compared the results of cemented versus uncemented SR-PIP arthroplasty and found that although patients had similar pain relief and gains of motion after surgery, there were significantly more cases with radiologic evidence of loosening in the uncemented group.<sup>9</sup> Thirteen out of 19 uncemented joints showed radiologic evidence of loosening compared with only one out of 24 cemented joints. The lead author now exclusively uses cement in his PIP joint arthroplasties.<sup>9</sup> Jennings et al also reported increased loosening in uncemented versus cemented prosthesis with 10 of the 11 revisions in his series associated with lack of cement.<sup>7</sup> In this series, although range of motion was not significantly improved after surgery, 88% of patients had a very satisfactory or satisfactory results.<sup>7</sup> In the series published by Luther et al, the mean DASH score was 24 and patients had an

average improvement in range of motion of 21 degrees.<sup>8</sup> However, 14 of 24 patients required reoperations.<sup>8</sup>

Our study showed a 28-degree average gain of motion at the PIP joint as well as minimal disability as reported on the DASH questionnaire. Both results are similar to those reported by Luther et al.<sup>8</sup> Our series was substantially smaller than the prior study; however, only one of our patients required reoperation. The MHQ showed a trend toward slightly worse scores on the operated hand; however, the small number of patients who responded to the questionnaire precludes meaningful statistical analyses.

The most striking feature in this series is the amount of subsidence seen radiologically. Early signs of subsidence were in some cases quite subtle, but careful evaluation of serial radiographs showed some subsidence in seven of 11 joints. All cases in our series were cemented in contrast to prior series which showed increased rates of radiologic subsidence or loosening mainly in their non-cemented implants.<sup>7,9</sup> Interestingly, none of these cases has been revised for symptomatic loosening. These radiographic changes may represent stable “settling” of the implant as seen by Bravo et al in pyrolytic carbon implants, or they may represent early loosening that could eventually become symptomatic.<sup>2</sup>

In this small series of patients with SR-PIP arthroplasty, patients showed an increase in range of motion and reported fairly good function and pain relief on validated questionnaires. However, a large amount of radiographic subsidence was also seen on follow-up. Longer-term follow-up is needed to assess the survivorship of this implant.

## REFERENCES

1. **Takigawa, S., et al.** Long-Term Assessment of Swanson Implant Arthroplasty in the Proximal Interphalangeal Joint of the Hand. *Journal of Hand Surgery*, 2004. 29A(5): p. 785-795.
2. **Bravo, C.J., et al.** Pyrolytic Carbon Proximal Interphalangeal Joint Arthroplasty: Results With Minimum Two-Year Follow-Up Evaluation. *Journal of Hand Surgery*, 2007. 32A(1): p. 1-11.
3. **Tuttle, H.G. and P.J. Stern.** Pyrolytic Carbon Proximal Interphalangeal Joint Resurfacing Arthroplasty. *Journal of Hand Surgery*, 2006. 31A(6): p. 930-939.
4. **Nunley, R.M., M.I. Boyer, and C.A. Goldfarb.** Pyrolytic Carbon Arthroplasty for Posttraumatic Arthritis of the Proximal Interphalangeal Joint. *Journal of Hand Surgery*, 2006. 31A(9): p. 1468-1474.
5. **Branam, B.R., et al.** Resurfacing Arthroplasty Versus Silicone Arthroplasty for Proximal Interphalangeal Joint Osteoarthritis. *Journal of Hand Surgery*, 2007. 32A(6): p. 775-788.

6. **Linscheid, R.L., et al.** Development of a Surface Replacement Arthroplasty for the Proximal Interphalangeal Joints. *Journal of Hand Surgery*, 1997. 22A(2): p. 286-298.
7. **Jennings, C.D. and D.P. Livingstone.** Surface Replacement Arthroplasty of the Proximal Interphalangeal Joint Using the PIP-SRA Implant: Results, Complications, and Revisions. *Journal of Hand Surgery*, 2008. 33A(9): p. 1565-1572.
8. **Luther, C., G. Germann, and M. Sauerbier.** Proximal Interphalangeal Joint Replacement Arthroplasty with Surface Replacing Arthroplasty (SR-PIP): Functional Results and Complications. *Hand*, 2010. 5: p. 233-240.
9. **Johnstone, B.R., et al.** Cemented Versus Uncemented Surface Replacement Arthroplasty of the Proximal Interphalangeal Joint With a Mean 5-Year Follow-Up. *Journal of Hand Surgery*, 2008. 33A(5): p. 726-732.
10. **Swanson, A.B.** Flexible Implant Arthroplasty for Arthritic Finger Joints. *Journal of Bone and Joint Surgery*, 1972. 54A(3): p. 435-455.
11. **Pellegrini, V.D. and R.I. Burton.** Osteoarthritis of the Proximal Interphalangeal Joint of the Hand: Arthroplasty or Fusion? *Journal of Hand Surgery*, 1990. 15A(2): p. 194-209.
12. **Uchiyama, S., et al.** Kinematics of the Proximal Interphalangeal Joint of the Finger After Surface Replacement. *Journal of Hand Surgery*, 2000. 25A(2): p. 305-312.