Metacarpophalangeal Joint Implant Arthroplasty with a Silastic Spacer

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ABSTRACT: We evaluated Silastic implant arthroplasty in the metacarpophalangeal joints of rheumatoid patients by a prospective analysis of the cases of twenty-eight patients. One hundred and fifteen such implants were followed for an average of fifty-four months (range, twenty-four to 125 months). The postoperative active motion of the metacarpophalangeal joint averaged 43 degrees, from 13 degrees of extension to 56 degrees of flexion. The average range of active motion of the metacarpophalangeal joint increased 17 degrees over preoperative values. Ulnar drift occurred in forty-nine fingers (43 per cent), and fracture of the spacer occurred in twenty-four joints (21 per cent). The sites of three spacers became infected, and treatment required the amputation of one finger. Preoperative and postoperative key pinch and grip strengths were unchanged. Patient satisfaction was high; twenty patients (71 per cent) experienced significant pain relief, nineteen patients (68 per cent) felt that they had much better hand function, and twenty-three patients (82 per cent) thought that the cosmetic appearance of the hand was improved.

The patient with rheumatoid arthritis frequently experiences painful destruction and deformity of the metacarpophalangeal joints of the hands. Since the early 1960's, this clinical problem has most often been treated by implant arthroplasty. The surgical implants have evolved from three basic design concepts: (1) metallic hinged prostheses (Flatt & Brannon), (2) cemented and semiconstrained prostheses (Steffee, Strickland, St. George, and Schultz), and (3) plastic interposions in the form of silicone rubber marketed as Silastic (Swanson), polyethylene (Nicolle), and Silastic and Dacron (Niebauer). Currently the Silastic spacer is widely used for metacarpophalangeal joint reconstruction in rheumatoid hand.

Clinical reports have indicated that the Swanson Silastic spacer performs satisfactorily. The spacer is biocompatible. Silastic arthroplasty results in the short-term correction of finger deformities and in pain relief. Close scrutiny, however, identified significant differences among four clinical reports in the following areas: (1) postoperative active range of motion of the metacarpophalangeal joint; (2) recurrence of finger deformities; (3) host-bone tolerances, implied by radiographic changes; and (4) frequency of fracture of the Silastic spacer. There is also a paucity of clinical information about comparisons between preoperative and postoperative active motion; hand function, as determined by measurements and patient-function questionnaires; and acceptance of the procedure by the patient.

The purpose of this study is to present an evaluation of Silastic implants in metacarpophalangeal joint arthroplasty. We hope that this information will contribute to the resolution of the differences noted in previous studies, supplement existing knowledge, and provide the basis for better understanding of the clinical performances of Silastic spacers in reconstruction of the rheumatoid hand.

Materials and Methods

Twenty-eight patients, two men and twenty-six women, were evaluated. They had received a total of 115 metacarpophalangeal-joint arthroplasties at the University of Iowa since 1969. All of the patients had adult-onset rheumatoid arthritis. The age at follow-up ranged from twenty-one to seventy-eight years (average, fifty-six years). Thirty-three index, twenty-seven long, twenty-seven ring, and twenty-eight small fingers had been operated on. The length of the postoperative follow-up ranged from twenty-four to 125 months (average, fifty-four months).

Their hospital records were studied and, in addition, all patients returned for a physical examination, radiographs, functional testing, and completion of an activities and personal-satisfaction questionnaire. The physical examination included measurements of the proximal interphalangeal joint, the metacarpophalangeal joint, and wrist motion. Active ranges of motion were calculated by assigning a value of zero to arthrodesed joints, joints from which prostheses had been removed, and amputated digits. In digits with a swan-neck deformity, the active motion into hyperextension at the proximal interphalangeal joint was also included in the calculation of active motion. Values for maximum extension and flexion were calculated by including the angular degrees of a fused joint as both a maximum extension and a maximum flexion value, and by omitting amputated digits in the calculations. Digital stability and deformities were assessed. Preoperative radio-
graphs indicated the severity of the rheumatoid disease involving ninety-three fingers. There were eighty-six metacarpophalangeal subluxations or dislocations (sixty-one complete dislocations), seventy-seven digital deviations (thirty-six of more than 30 degrees), ninety narrowed joint spaces (sixty-nine with complete loss), and ninety joints with periarticular erosions (sixty-two with four large erosions or more). Postoperative posteroanterior and lateral radiographs were examined for the osseous response to the implant and for implant failure. Functional testing included key-pinch and grip-strength measurements using a pinch gauge (B and L Engineering [Pinso], Santa Fe Springs, California) and a Jamar dynamometer (Asimow Engineering, Los Angeles, California). The questionnaire rated activities of daily living. The patients described their ability to perform twenty-two tasks, formulating a rating scale similar to the one described by Swanson et al. A score of 22 points indicated total independence in performing the tasks and a score of 66 points indicated inability to perform the tasks and implied complete dependence. The patients evaluated their satisfaction with both the appearance of the hand and pain relief on a 3-point scale. In that scale, 1 point meant that they felt much worse and 5, that they were much improved. The patients were also asked whether they would or would not have the surgery performed again. One of us (D. G. S.) administered all of the examinations and questionnaires.

The indications that we used for the implantation of the Silastic spacer in the metacarpophalangeal joint of the rheumatoid hand included persistent pain despite adequate medical management or previous surgical synovectomy, functional impairment associated with severe palmar subluxation, dislocation of the proximal phalanx, or persistent ulnar drift of the fingers combined with destruction of the joint. Other factors that might modify the result are disease in the proximal and distal interphalangeal joints and carpal vasculitis and associated decreased wound-healing potential, the existence of concomitant connective-tissue disease, and the patients’ motivation and expectations. Surgical technique included collateral ligament and ulnar intrinsic releases, extensor tendon centralization, and reattachment or reconstruction of the radial collateral ligament of the index metacarpophalangeal joint. The technique did not specifically preserve the volar interosseous muscle to the index finger.

Early rehabilitation consisted of the application of a Swanson-type splint with dorsal outriggers for rubber-band extension and slight radial deviation of the fingers. The splint was applied three to seven days after surgery, depending on local wound conditions. Active metacarpophalangeal-joint exercise was encouraged. After one month the patients began light use of the hand in activities of daily living. Night-time splinting was used for as long as four months in patients with persistent extensor lag.

![Fig. 1](image-url)

Preoperative and postoperative average values for active maximum flexion and extension with corresponding ranges of motion for the metacarpophalangeal and proximal interphalangeal joints.
therapists supervised the rehabilitation program during the patients' visits to the outpatient clinic.

Results

Preoperative motion: Preoperative range-of-motion measurements were available for seventy-seven fingers (67 percent). The metacarpophalangeal joints showed an average active range of motion of 26 degrees (range, zero to 85 degrees), a position of average active extension of 60 degrees (range, 10 to 110 degrees), and a position of maximum active flexion of 86 degrees (range, 50 to 112 degrees). The proximal interphalangeal joints showed an average active range of motion of 62 degrees (range, zero to 110 degrees), a position of average maximum active extension of 16 degrees (range, +45 to 110 degrees), and a position of average maximum active flexion of 78 degrees (range, 30 to 110 degrees).

Postoperative motion: The postoperative physical examination of the digits showed an average active range of motion of the metacarpophalangeal joint of 43 degrees (range, zero to 100 degrees). The position of average maximum active extension was 13 degrees (range, +50 to 100 degrees) and the position of average maximum flexion was 56 degrees (range, 10 to 105 degrees). The average range of motion of the proximal interphalangeal joint in the fingers that had been operated on was 58 degrees (range, zero to 110 degrees). The position of average maximum active extension was 23 degrees (range, +69 to 95 degrees) and the position of average maximum flexion was 81 degrees (range, zero to 110 degrees) (Fig. 1). Over-all there was an increase in the average active motion of 17 degrees for the metacarpophalangeal joint and a decrease of 4 degrees for the proximal interphalangeal joint. The data on preoperative and postoperative motions of the joint are summarized in Table I.

Deformity: Ulnar drift recurred in forty-nine fingers, but was less than 30 degrees in all but one. Pronation was observed in thirty-one fingers; a swan-neck deformity, in twenty-one; and a boutonnière deformity, in eighteen. Clinical testing showed positive intrinsic tightness in twenty-

![Fig. 2](image1.png) ![Fig. 3](image2.png)

**Fig. 2**: Bone resorption about all spacers, with cortical erosion in the proximal phalanx of the small finger. **Fig. 3**: Bone production appearing as osteophytes in the second metacarpal.
nine fingers and persistent extensor-tendon subluxation or dislocation in thirty-one.

Function: Hand function was evaluated postoperatively in thirty-four hands using key-pin strength and grip-strength measurements. Key-pin strength averaged twenty-eight newtons (range, nine to forty-nine newtons) and grip strength averaged sixty-two newtons (range, eighteen to 142 newtons). These values could be compared with preoperative ordinary to recurrent digital deformity and prominence of the spacer. In four fingers the extensor digitorum communis tendon had ruptured postoperatively.

Patient satisfaction: Patient satisfaction with the procedure was high. Twenty-three (82 per cent) of the patients thought that the appearance of the hand was much improved, nineteen (68 per cent) felt that their hand function was much improved, and twenty (71 per cent) experienced significant

measurements in twenty-four hands, in which the average key-pin strength value had been thirty-one newtons and the average grip strength, seventy-four newtons. Thus, there was no significant net change in key-pin and grip-strength values postoperatively. Patient function was evaluated using the twenty-two-task scale of activities of daily living. Postoperatively the average score was 26 points, while the preoperative score had been 25 points. Thus, there was no measurable change in the patients' hand function.

Radiographic findings: Postoperative radiographs were inspected for osseous response, including bone resorption and production, and for the integrity of the implant. Bone resorption about the implant was seen in forty-six joints (Fig. 2) and bone production, in thirty-nine joints (Fig. 3). Twenty-four implant fractures were noted at both the stem-hinge junction (Fig. 4) and within the hinge itself, with collapse and fragmentation (Fig. 5).

Complications: Three arthroplasties became infected, requiring amputation of one finger, removal of one spacer, and surgical drainage of one joint. No hand had spacer migration through cortical bone or dermal ulcerations sec-

Fig. 4: Fracture at the hinge-stem junction, indicated by displacement on a posteroanterior radiograph showing the spacer.
Fig. 5: Fracture of the hinge, with fragmentation and collapse.

pain relief. Twenty-four (86 per cent) stated that they would elect to undergo the procedure again.

Discussion

In this clinical study we evaluated the use of Silastic spacers in reconstruction of the rheumatoid hand. The patients were not randomized into a comparative non-treatment group, nor did the patients have to satisfy rigid clinical criteria for inclusion in the study. We do think that the data obtained help to resolve differences between results reported in previous studies.

Active motion of the metacarpophalangeal joint, as a clinical factor that is easily measured and presumably correlates with function, has been emphasized in previous studies. Swanson reported a range of metacarpophalangeal joint motion of 61.5 degrees and 53 degrees in the Grand Rapids and Field Clinic studies, respectively, from six months to five years after surgery. These data do not include an average follow-up and represent a passive range of motion.

"a force of 0.45 kilogram was applied to the distal arm of the goniometer (ten centimeters from the axis of rotation)
on the direction of flexion or extension as the case might be. A more meaningful assessment of active motion, which is related more directly to function, was reported both by Mannerfelt and Andersson and by Beckenbaugh et al. Mannerfelt and Andersson found a range of 40 degrees of active metacarpophalangeal joint motion at an average follow-up of 2.5 years, and Beckenbaugh et al. reported a range of 38 degrees at 2.5 years. Our study included an evaluation at an average of fifty-four months postoperatively, and we noted 43 degrees of active motion. Our data and those of others indicate that an active range of motion of the metacarpophalangeal joint of about 40 degrees may be expected if complications do not occur. However, active flexion may decrease with time, as indicated by the serial tomographic studies of Hagert et al.

The range in which metacarpophalangeal joint motion occurs was described by Swanson and others as being from 2.5 degrees of extension to 65 degrees of flexion. Mannerfelt and Andersson graphically presented the results of mean active extension and flexion, showing a range from 10 degrees of extension to 50 degrees of flexion. Our results (13 to 56 degrees) compare very favorably with theirs. Mannerfelt and Andersson also noted a slight (5-degree) postoperative increase in active motion of the metacarpophalangeal joint and Swanson and de Groot Swanson, a 9-degree increase in average active motion. A more favorable but surprisingly small 17-degree postoperative increase was measured in our patients. This larger increase in motion in our patients may be due to the fact that in our patients the hands were more severely involved than in the patients of Swanson and de Groot Swanson. Importantly, the postoperative range of motion of the metacarpophalangeal joint in all clinical studies has moved from a flexed to a more extended, and consequently functional, position of the digits.

The Silastic prosthesis has been reported to improve digital deformities, including metacarpophalangeal subluxation and ulnar and rotatory deviations. Swanson reported a 98.1 per cent rate of successful correction of ulnar drift and a 99.5 per cent rate of successful correction of joint subluxation and dislocation. Mannerfelt and Andersson, graphically displaying their results as degrees and sectors of deviation, demonstrated significant improvement of preoperative ulnar-deviation deformities. Virtually all of their patients had only zero to 30 degrees of ulnar deviation at follow-up. Beckenbaugh et al. summarized their results as an 11.3 per cent total rate of recurrence of subluxation, ulnar drift, or rotation. Our observation of a 43 per cent recurrence of ulnar drift is higher and may reflect a more rigid assessment criterion and a longer period of follow-up. However, only 1 per cent of our patients demonstrated more than 30 degrees of recurrent ulnar deviation. The recurrence of ulnar deviation, pronation deformity, and swan-neck and boutonnière deformities in our patients also reflects the effects of chronic disease on adjacent joints and soft tissues and the continued presence of abnormal stresses across the reconstructed metacarpophalangeal joint.

The most important consideration in reconstruction of the rheumatoid hand is the restoration of function, but it has been least addressed in previous clinical studies. Subjectively, 96 per cent of the patients of Mannerfelt and Andersson and 60 per cent of the patients of Beckenbaugh et al. believed themselves to be functionally improved, as did 68 per cent of our patients. There is much less available objective data relating to the direct measurement of hand function. Mannerfelt and Andersson combined power, motion, and finger-deviation data, and reported that 98 per cent of their patients had improvements that were consistent with better function. They noted, however, that there was no postoperative change in grip and pinch strengths. Our data agree entirely, in that there was no postoperative change in functional level. In summary, although these patients described subjectively improved postoperative function, this perception was not supported by measured increases in strength or by marked improvement in activity levels.

Previous studies have not provided a preoperative radiographic evaluation of the patients’ hands. The preoperative radiographic analysis of our patients indicated the severity of the disease of the metacarpophalangeal joints, including many fingers with complete dislocation of joints, ulnar deviation of more than 30 degrees, complete loss of joint spaces, and four large periarticular erosions or more. These data may facilitate future comparisons between studies.

The postoperative radiographic findings of bone resorption and new-bone formation reflect host-bone response to stresses transmitted through and around the Silastic spacer. Although such changes were frequent, they were of low magnitude and did not appear to represent, at least for the period of our follow-up, a significantly deleterious factor. Except for the work of Hagert et al., little attention has been paid to the long-term radiographic implant-bone relationship. In thirty-six fingers, carefully evaluated by anteroposterior and lateral tomograms, those authors found cortical erosion adjacent to the implants in nine metacarpals, in eight proximal phalanges, and on nineteen occasions in both bones. These results suggest that our radiographic incidence of erosion (41 per cent) is conservative, as we used plain radiographs rather than the more discriminating tomograms. Bone production in our study occurred near 35 per cent of the implants, a figure that compares closely with the observation of 50 per cent of Hagert et al. They noted that bone production appears as a volar metacarpal spur, that it is associated with prosthetic migration, and that it is present on plain radiographs but is localized only with tomography.

Fracture rates have varied widely among clinical studies. Swanson, in 1972, reported rates for the original silicone of 1.9 per cent and 0.88 per cent in the Grand Rapids and Field Clinic series, respectively. Swanson and de Groot Swanson later revised this estimate upward to 7.6 per cent, but claimed a fracture rate of only 1.6 per cent for the improved silicone. Mannerfelt and Andersson, however, found a fracture rate of 2.8 per cent; Beckenbaugh et al., of 16 per cent; and Hagert et al., of 24 per cent (including
both stem fractures and hinge fragmentation). Our analysis of stem fractures and hinge fragmentation, which included implants utilized prior to 1974, agrees closely with that of Hagert et al., with a 21 per cent fracture rate. Implants used since 1974, with improved resistance to tear propagation, may lower short-term fracture rates. Further evaluations of implant fracture rates must consider both the hinge and the body, if studies are to be inclusive. With any non-biological implant in the environment of a living joint, the incidence of component failure will increase with time. Fracture of the Silastic implant may prove to be an unimportant clinical consideration, as an association between spacer fractures and poor clinical results has not been documented.

Silastic fragmentation was not associated with synovitis or lymphadenopathy in our series.

Despite limited active motion of the metacarpophalangeal joint, a high rate of recurrence of finger deformity, and little measurable change in function of the hand, our patients remained satisfied with this procedure. They were pleased with the pain relief and with the improvement in the appearance of the hand, and 86 per cent of them stated that they would undergo this surgery again.

Resection arthroplasty with Silastic spacers remains the most widely used operative procedure in the reconstruction of the rheumatoid metacarpophalangeal joint. Knowledge of the benefits and limitations of this procedure will permit the surgeon and patient to approach surgery with realistic expectations.

References