A rational postoperative management program for metacarpophalangeal joint implant arthroplasty

Forty-six consecutive patients with rheumatoid disease had 250 primary metacarpophalangeal joint implant arthroplasties performed using the Swanson-designed silicone implant. Surgical indications included moderate-to-severe subluxation, moderate-to-severe limitation of motion, or moderate-to-severe ulnar deviation. Most joints had all three abnormalities. Three patients (12 arthroplasties) were lost to follow-up. Of the 238 remaining arthroplasties, minimum follow-up was 6 months; 163 arthroplasties were followed for 1 year or longer; and 92 arthroplasties were followed for 2 years or longer. All patients underwent a postoperative management program including: supervised maximum passive range of motion beginning at 5 days, constant dynamic splinting through 6 weeks, dynamic night splinting through at least 14 weeks, and active "encouragement" featuring performance demonstrations at follow-up intervals. Before operation the mean range of passive motion was 76° with a standard error of 3°; by 6 weeks the mean range of passive motion was 78° ± 1° and was maintained at this level through 2 years. Mean range of active motion before operation was 43° ± 3°; by 6 weeks the mean range of active motion was 57° ± 2° and was maintained at this level through 2 years. Active motion was significantly greater after operation (p < 0.01). Arc of motion was shifted significantly toward extension both actively and passively. No joint developed recurrent ulnar deviation or subluxation if the silicone implant maintained structural integrity. Three joints developed significant (15°) radial deviation. There were no infections. The active and passive motion measured is significantly greater in this series than in other published reports. Although this study does not compare various postoperative schemes in a controlled experiment, we believe that the early motion and prolonged splinting program outlined is a major factor responsible for increased range of motion.


Because the metacarpophalangeal joint deformities associated with rheumatoid disease create such severe functional abnormalities, developing a successful method of reconstruction has been a major goal. Prior to the mid 1960's, resection arthroplasty with soft tissue release was the only reconstructive technique used commonly. Although some patients had superb functional restorations, the results of resection arthroplasty were variable and unpredictable. Since the introduction of the first replacement arthroplasty by Flatt in the 1960's, several arthroplastic techniques using implantable devices have been developed. Each device and each technique has strong proponents and strong opponents. All agree, however, that successful metacarpophalangeal joint arthroplasty depends on proper patient selection, adequate operative technique, and careful postoperative management. Selection criteria and technical considerations have been debated vigorously in recent years, but the rationale and effectiveness of postoperative therapy programs have received little attention. We have developed a post-surgical management scheme based on the biology of scar tissue and the reaction of the body to implanted silicone which differs from most programs and seems to improve our results. This program was developed specifically for arthroplasties using the Swanson-designed silicone implant. A technique we find highly satisfactory and preferable to other methods. However, because most of the available implant devices have at least one silicone soft-tissue interface and because all alloplastic implants are subject to scar encapsulation, the biological principles on which this program was developed seem applicable to all current arthroplasty techniques.
Biological rationale

Although medical grade silicone rubber is extremely unreactive when compared to other implantable materials, living tissues react to silicone by forming a capsule of scar tissue. Initially, solid silicone implants are surrounded by small amounts of clotted blood and sparse collections of white blood cells. Within 3 or 4 days of implantation, fibroblasts begin to appear in the surrounding tissues and invade the area adjacent to the implant. By the end of the first week, the fibroblast has replaced the white blood cell as the most frequent cell type. By the end of the second week, the space around the implant is filled completely by these actively metabolizing cells. As fibroblasts migrate into the capsular space, budding capillaries follow. Although collagen fibers are the most prominent feature of the mature capsule, fibers cannot be visualized by the light microscope until the fourth or fifth day following implantation. Once fibers appear, however, collagen accumulates rapidly. From the third to the sixth week, the number of fibroblasts within the capsular space diminishes slowly. As the cell population decreases, capsular collagen fibers increase. Gradually, the capsule changes from a predominantly cellular structure to a predominantly extracellular tissue. Based on light microscopic examination, the encapsulation process seems to be complete by 6 to 8 weeks. The solid implant is surrounded completely by a tightly fitting, closely applied scar capsule of varying thickness composed of moderately thick collagen bundles and a small number of fibroblasts. Histological examination of the scar capsule after 8 weeks fails to show significant changes in the collagen fibers or cell population. The vascular pattern changes slowly over a longer interval. The interface between the solid silicone implant and the capsule is composed of a layer of cells whose origin and physiological function remain controversial. The best evidence suggests that these lining cells are fibroblasts. Although their function may be important when solid silicone implants are replaced secondarily by autographs, there is no evidence that the lining cells play a significant role in the physiological function of permanently implanted silicone. The architectural arrangement and the biological properties of the scar capsule, however, are crucial factors determining the mechanical behavior of the permanent implant.

Although the time intervals may vary slightly, the encapsulation of solid silicone rubber parallels the development of a scar following any simple injury. Because all scars seemed stable by 6 to 8 weeks using histological endpoints alone, biologists accepted the notion that wound healing was a dynamic process but ended within 1 month of injury. This hypothesis is incorrect. Clinical observation demonstrates that slowly and progressively all scars change shape with time. In addition, experimental studies have proven that physical properties of scars change steadily for up to 1 year following injury. The slowly progressive changes in shape and physical characteristics of scars seem to correlate with the chemical events of wound healing. In spite of their histological appearance, direct measurements demonstrate that scars remain metabolically active structures for many months. As an example, the turnover of scar collagen remains significantly elevated for at least 4 months in experimental animals and probably much longer in man. Collagen molecules are being removed constantly while new molecules are being synthesized and deposited. This prolonged turnover of extracellular fibrous protein seems to be responsible for the slow architectural and physical changes demonstrated in scars. Although direct measurements have not been performed, the clinical behavior and the limited amount of experimental data available suggest that the scar surrounding solid silicone implants also remains a metabolically active structure changing shape and physical properties slowly for months.

The prolonged metabolic turnover of scar collagen provides a chemical mechanism for scar remodeling, but the precise size and shape scars attain is controlled by other factors. Experimental and clinical evidence suggest that longitudinal and shearing stresses are the primary forces responsible for the remodeling of soft tissue scars. Recently, with experimental techniques, the influence of tension on scar remodeling has been demonstrated conclusively. Although the precise way in which the magnitude, rate of application, frequency, duration, and direction of stress application control the ultimate size and physical properties of scar tissue has not been defined completely, every reconstructive surgeon and therapist uses the controlled application of stress to achieve these goals. Empirically, persistent tension of relatively low magnitude seems to be the most effective way of changing scar shape.

In summary, all implanted alloplastic material, including solid silicone rubber, becomes encapsulated by scar tissue. In spite of the histological appearance, the scar capsule remains metabolically active, changing shape and physical properties for months, not weeks, following implantation. Finally, controlled tension is the major factor influencing the ultimate size and shape of the capsular scar tissue.
Management program

A successful metacarpophalangeal joint arthroplasty must provide excellent flexion and extension, preferably over 70°, while providing static stability resisting abduction and adduction. In order to achieve these goals, the capsule surrounding the silicone implant must be a specific size and shape. Scar tissue on the volar and dorsal aspects of the capsule must remain elongated allowing flexion and extension, whereas tissue on the lateral aspects of the implant must remain short and compact creating stability (Fig. 1).

The goals and technique of postoperative management follow directly from the biological and mechanical considerations. In order to obtain the maximal postoperative function, we must (1) form the longest possible volar and dorsal capsule by providing early, maximal motion in the flexion-extension plane; (2) maintain, by prolonged dynamic splinting, capsular length throughout the extended period of scar remodeling; and (3) prevent lateral or medial instability by minimizing stress on the lateral capsular elements.

On the fifth day after operation, we remove the soft compression dressing which was applied at the time of operation. Using Orthoplast or Aquaplast, we construct a dorsal splint with the wrist in 15 to 20° of extension (Fig. 2). A brass welding rod outrigger with rubber bands and finger loops holds the metacarpophalangeal joints of index, long, and ring fingers in extension and slight radial deviation. The little finger does not receive a separate loop, but is taped to the ring finger. Tension of the rubber bands is adjusted to keep the index, long, and ring fingers in approximately 10° of extension; the little finger usually lies in approximately 20° of extension. As the postoperative swelling subsides, we adjust and reshape the splint as often as necessary to maintain a perfect fit. Although we have used “universal splints” occasionally, we prefer individually fitted appliances. The majority of our patients have significant deformities of wrist, thumb, and elbow; individually prepared splints allow us to accommodate fixed deformities in other joints.

Unless under the direct control of the hand therapists, hands are maintained in splints constantly for 6 weeks. During this interval, individual fingers never are allowed to assume an ulnar-deviated posture. After the sixth week, patients remove the splints during the day and use their hands actively. All patients, however, reapply the splints at night through at least the 14th week.

Follow reapplication begins with "first 8 w".

From the above, it is clear that the hand is being used, and the therapist and patient may not be satisfied with the motion allowed in the program of therapy.
The length of time and the type of night splint applied are determined by range of motion measurements. Active and passive ranges of motion are measured weekly or more frequently if necessary during the first 8 weeks, then monthly up to 6 months.

From the fifth day through the third week, patients are seen daily in the Hand Rehabilitation Center. After the application of moist heat for 15 to 30 minutes, the hand therapists move each metacarpophalangeal joint through a complete range of pain-free passive motion at least 10 to 15 times. During these range-of-motion exercises, each finger is controlled in axial alignment and no radial or ulnar deviation is permitted. As long as passive motion is maintained at 70°, this minimal exercise program is maintained. If joints become painful or swollen, or if passive motion cannot be maintained at 70°, the frequency and duration of passive exercises along with the frequency and duration of the application of moist heat is adjusted. For example, if a patient is having difficulty maintaining 70° of passive motion and the joints remain free of pain and nonreactive, the therapist increases the number of passive movements and may increase the duration of the program to an hour or longer. In contrast, if a patient maintains motion easily but has swollen, uncomfortable joints thereafter, the frequency and duration of the passive program is decreased. Moist heat and the gentle application of tension are the keys.

Following the passive exercises, the resting splint is reapplied and active flexion and extension exercises are performed in the splint. Active motion in the splint begins on the sixth day and continues indefinitely. Patients are taught to activate their extensor tendons by extending the metacarpophalangeal joints while maintaining the interphalangeal joints in flexion. This "intrinsic minus extension" allows the extensor tendons and the extensor hoods to glide maximally and eliminates the intrinsic overactivity seen so frequently. If patients have excessive proximal interphalangeal joint flexion (over 85°) during active flexion exercises, we frequently immobilize the interphalangeal joints at 45° using small dorsal aluminum splints. Proximal interphalangeal joint immobilization concentrates the flexor power of sublimis and profundus tendons at the metacarpophalangeal joint and improves the power of active flexion significantly.

From the fourth through the eighth week, the average patient is seen weekly in the Hand Rehabilitation Center, then monthly up to 6 months. At the beginning of the fourth week, or earlier if the range-of-motion measurements indicate, a rubber powered flexion band is applied to all of the fingers (Fig. 3). Again, tension is applied in 15° of radial deviation. The initial application of the flexion band is for a 2-hour period. We gradually increase the interval of application to allow overnight use by 5 weeks. The frequency, duration, and direction of dynamic splinting always is determined by the passive and active range-of-motion measurements. The magnitude of the force applied always is kept low enough to prevent pain, swelling, or other indications of injury. If passive flexion is decreasing, flexion bands are applied more frequently, with more power, and for longer intervals; if passive extension is decreasing, dynamic extension splints replace the flexion bands as the primary splinting mode. In addition to active exercises in the dynamic splints, patients perform the same type of passive joint exercises previously performed by the therapists.

At 6 weeks daytime splinting is discontinued. The patients are instructed to use their hands for the next 2 weeks to do light-duty activities. We discourage the use of hands for heavy labor during this 2-week interval, but we encourage as much useful motion as possible. At 8 weeks all restraints are eliminated and patients are encouraged to use their hands for all activities, including heavy use. Unlike most programs, however, our "encouragement" is an active process. When patients return for their routine visits, the therapist lists the activities performed by the patient. The patients then are required to demonstrate these activities in the workshop (i.e., pound nails, write, use a paint brush, etc.). Because several patients are seen together in the
**Table I. Flexion and extension measurements**

<table>
<thead>
<tr>
<th></th>
<th>Before operation (n = 238)</th>
<th>1 week (n = 238)</th>
<th>6 weeks (n = 238)</th>
<th>6 months (n = 238)</th>
<th>1 year (n = 163)</th>
<th>2 years plus (n = 92)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td></td>
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<td></td>
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<tr>
<td>Extension</td>
<td>−42.5 ± 3.8*</td>
<td>−19.9 ± 1.2</td>
<td>−13.3 ± 1.2</td>
<td>−8.2 ± 1.2</td>
<td>−11.4 ± 1.9</td>
<td>−9.2 ± 2.9</td>
</tr>
<tr>
<td>Flexion</td>
<td>85.7 ± 2.0</td>
<td>54.0 ± 1.4</td>
<td>70.0 ± 0.9</td>
<td>70.1 ± 1.1</td>
<td>68.8 ± 1.5</td>
<td>66.8 ± 2.4</td>
</tr>
<tr>
<td>Passive</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Extension</td>
<td>−17.9 ± 2.9</td>
<td>−2.1 ± 0.5</td>
<td>−0.6 ± 0.4</td>
<td>−0.6 ± 0.5</td>
<td>−0.5 ± 0.5</td>
<td>−0.8 ± 0.7</td>
</tr>
<tr>
<td>Flexion</td>
<td>92.7 ± 1.8</td>
<td>67.7 ± 1.4</td>
<td>78.9 ± 0.8</td>
<td>78.9 ± 1.1</td>
<td>78.4 ± 1.6</td>
<td>76.6 ± 3.0</td>
</tr>
</tbody>
</table>

* Mean Degrees ± standard error.

**Table II. Range-of-motion measurements**

<table>
<thead>
<tr>
<th></th>
<th>Before operation (n = 238)</th>
<th>1 week (n = 238)</th>
<th>6 weeks (n = 238)</th>
<th>6 months (n = 238)</th>
<th>1 year (n = 163)</th>
<th>2 years plus (n = 92)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[5 to 86]†</td>
<td>43.0 ± 3.0*</td>
<td>34.5 ± 1.7</td>
<td>57.0 ± 1.4‡</td>
<td>62.3 ± 1.5‡</td>
<td>57.0 ± 2.2‡</td>
<td>57.1 ± 3.0‡</td>
</tr>
<tr>
<td>[25 to 109]</td>
<td>[7 to 58]</td>
<td>[37 to 82]</td>
<td>[34 to 85]</td>
<td>[30 to 87]</td>
<td>[28 to 79]</td>
<td></td>
</tr>
<tr>
<td>Passive</td>
<td></td>
<td></td>
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<tr>
<td>[25 to 109]</td>
<td>75.6 ± 2.7</td>
<td>65.0 ± 1.5</td>
<td>78.3 ± 0.7</td>
<td>78.8 ± 1.0</td>
<td>78.0 ± 1.6</td>
<td>76.0 ± 2.9</td>
</tr>
<tr>
<td>[25 to 109]</td>
<td>[38 to 90]</td>
<td>[66 to 90]</td>
<td>[61 to 97]</td>
<td>[60 to 103]</td>
<td>[60 to 103]</td>
<td></td>
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</tbody>
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* Mean degrees ± standard error.
† Maximum and minimum in degrees.
‡ Significantly greater than before operation, p < 0.01.

Hand Rehabilitation Center, these demonstrations of activity often become friendly contests between individuals. The therapists actively promote this type of polite competition. Patients are encouraged and praised for their performance.

Following the 6-week program of constant splinting, all patients, regardless of their range of motion measurements, are required to wear night splints through the 14th week. The splinting program alternates from flexion to extension, as necessary, maintaining 75° of passive motion. At the end of 14 weeks, passive and active range of motion are measured and night splinting is discontinued. Patients are seen again 2 weeks later and the measurements are repeated. Over 85% of our patients maintain their active and passive range of motion during this 2-week trial interval and the splinting program is discontinued permanently. In the 15% who begin losing motion, we encourage resuming the night splinting program, then test again in one month by discontinuing the night splinting temporarily. None of our patients has used the night splints for longer than 6 months.

**Study population**

We have reviewed 250 consecutive primary metacarpophalangeal joint implant arthroplasties performed prior to July, 1976, in patients with proven rheumatoid disease. Thumb reconstructions were specifically excluded. The population includes 46 patients (39 women and seven men), ranging in age from 28 to 76 years (mean age, 58 years). All patients were followed through 3 months, but three patients (12 arthroplasties) were lost to follow-up prior to the 6-month endpoint. One patient died of accidental causes, one patient left the state permanently, and one cannot be traced.

The indications for operation included moderate-to-severe subluxation, moderate-to-severe limitation of motion, or moderate-to-severe ulnar deviation. All joints reconstructed surgically had at least one of these findings, over 85% had at least two abnomralities, and over 50% had all three problems. The majority of the patients complained of significant pain prior to reconstruction, either constantly or coincident with flare-ups of their rheumatoid disease in other areas.

The operative procedures all were performed by one surgeon (J. W. M.). Swanson-designed silicone implants were used exclusively. This report will not detail the specific operative technique or the specific selection criteria. This material, plus a detailed analysis of the pre- and postoperative status of individual finger joints including proximal interphalangeal joints, will be summarized in another publication. With some minor variations, however, the operative technique used paralleled that described by Swanson. In the more than 100 implant arthroplasties performed prior to this study, we occasionally sectioned the short flexor of the little finger in addition to the short abductor. When both tendons were sectioned, patients had difficulty regaining the flexion of the proximal interphalangeal joint. By using the radial branch we eliminated the need for the ulnar branch to maintain flexion.
regaining flexion in the metacarpophalangeal joint. More important, many patients could no longer flex the metacarpocarpal joint of the fifth ray, thus flattening the palm and eliminating the distal transverse arch. All patients in this series had only the tendon of the abductor digiti minimi sectioned at the musculocutaneous junction. By leaving the short flexor intact and by not using the rubber band-loop splint for the little finger, we eliminated the difficulties. All patients in this study group maintained their distal transverse arch and could actively flex and extend the metacarpocarpal joint of the little finger.

The exclusion of 12 joints for the reasons indicated left us a population of 238 implant arthroplasties followed for a minimum of 6 months and a maximum of over 3 years; 163 implants were followed for at least 1 year; and 92 implants were followed for at least 2 years. In spite of the complexities, patient acceptance
of the postoperative program was uniformly excellent. All 43 patients completed the therapy program and kept their follow-up appointments for measurements.

Joint measurements were performed by four hand therapists and technicians using a standard finger goniometer. All staff members included in the measurement program were trained specifically for the techniques utilized and their accuracy was tested periodically using standard hand models. Passive measurements were performed using a force of approximately one pound. In over 90% of cases, the preoperative measurements and all of the postoperative measurements for an individual patient were performed by the same staff member.

Results

The mean flexion and extension measurements plus standard errors for both active and passive motion are included in Table I. Mean range of motion plus standard error and maximum and minimum measurements for both active and passive motion are presented in Table II. These figures represent all metacarpophalangeal joints. There were some interesting differences between the means for individual joints, but the differences were not statistically significant. Data for individual finger joints will be reported in a later publication.

Our patients had approximately 76° of passive motion before operation. The arc of motion was shifted significantly toward flexion; mean passive extension before operation was approximately −18°. After operation patients retained, but did not improve, their passive range of flexion and extension. By 6 weeks passive range of motion was over 75°, and this range was maintained throughout the study. Although the range of passive motion was not increased significantly, the arc of passive motion was changed dramatically. Following operation the arc of motion shifted significantly toward extension (Fig. 4). By 6 weeks passive extension essentially was normal in all individuals and remained normal throughout the study.

In contrast to the passive figures, the active measurements show highly significant differences between the preoperative and postoperative population. Active range of motion before operation was 43° and the arc of motion distinctly in flexion. Mean active extension prior to operation was approximately −43°. By 6 weeks active range of motion had improved by approximately 15°. This difference is significant statistically (p < 0.01). The improvement in range of active motion was maintained throughout the study and remained significant through 2 years. The improved range of mo-

tion was accompanied by a highly significant shift in active motion toward extension (Fig. 5). By 6 weeks the mean active extension was approximately 30° greater than the preoperative measurements.

None of the joints studied developed recurrent subluxation if the structural integrity of the implant remained intact. Although none of our joints with intact implants developed recurrent ulnar deviation greater than 10°, three joints in two patients with intact implants developed radial deviation of over 15°.

The implant devices used in this series were both the old style and the new, high-performance type. There were only two fractured implants in the 162 joints reconstructed using the new, high-performance implant. Both implants fractured at 24 months and neither of the joints were symptomatic. Neither of the two patients was aware that the implants had fractured. There were no recurrent axial malalignments or subluxation deformities in either one.

Of the 76 implants of the old style used, there were 28 fractures in seven patients. There were no fractures in 19 patients. Seven of the old-style implants fractured at 6 months, 10 at 12 months, one at 18 months, and 10 at 24 months. These seven patients with early fractures represent an interesting subgroup. As a part of their life styles, five of the seven used their hands for heavy labor; one patient was a Papago Indian woman who chopped half a cord of firewood every week. More important, the mean range of active motion in these seven patients was over 75°, a significantly greater active range of motion than the mean for the entire population. Eighteen of the joints with fractured implants developed recurrent subluxation or radial deviation greater than 15°. Joints with recurrent deformities had the fractured implants replaced with the new-style implants. All of the joints with replaced implants have been followed for over a year; there have been no recurrent fractures, no recurrent subluxations, and no patient has radial deviation of greater than 5°.

Although there were no infections in this series, one reconstructed joint in each of two patients developed a syndrome reminiscent of rheumatoid disease. In one intermittent pain and swelling lasted approximately 6 months; symptoms disappeared spontaneously and have not recurred for over 1 year. In the second patient who had had eight metacarpophalangeal joint arthroplasties, the reconstructed metacarpophalangeal joint of the long finger of one hand becomes painful and swollen synchronously with her recurrent rheumatoid attacks. Serial roentgenograms in both patients show no evidence of infection or osteomyelitis.

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Discussion

Our postoperative patients describe their hand as having maximum function. Our experience postoperatively has been that the patients were reluctant to return for additional surgery even though they had protracted pain and discomfort. In addition, the necessity of the surgery would likely be indicated only after initial therapy has failed.

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of the patients in this series with preoperative pain state that the reconstructed joints are not tender, no longer are subject to recurrent pain and swelling, and remain essentially free of pain.

Discussion

Our postoperative management program differs from those described previously in three ways: (1) We insist on early maximum passive motion. Most authors recommend early passive motion and state that they “encourage” patients to perform these manipulations. In our experience most patients are frightened of their postoperative reconstructions, either consciously or unconsciously. Without active supervision most patients are reluctant to assume the responsibility of providing the magnitude of motion necessary to form the volar and dorsal capsule in the longest possible configuration. In addition, patients tend to misunderstand the necessity of keeping fingers axially aligned. Stresses toward the radial or ulnar side of the hand create postoperative instability in this plane. (2) We insist on a prolonged dynamic splinting program. When we first began our postoperative treatment of metacarpophalangeal joint arthroplasties over 6 years ago, we assumed that encouraging patients to use their hands actively would maintain the gains achieved during the first 6 weeks of therapy. In approximately one-third of our patients, this assumption proved correct. In the other two-thirds, however, we noted a gradual decrease of active and passive motion during the next 2 to 4 months. Obviously “encouraging” our patients to use their hands actively did not provide the magnitude or duration of force on the volar or dorsal capsules to maintain passive mobility. This observation forced us to alter our postoperative program. Using a minimum of 14 weeks of dynamic night splinting, gains achieved during the first 6 to 8 weeks following operation are maintained. (3) We have made our “encouragement” an active process. During the transition from passive exercise-constant splinting to full-hand use, we insist that patients demonstrate to us in the Hand Rehabilitation Center the types of activities they perform. This skeptical attitude seems to provide the stimulus for maximum use.

Although this study was not designed to compare postoperative programs, our results compare favorably with other reported series. In 1975, Beekenbaugh and his co-workers reported their results using the Swanson-type implants. In their study passive and active motion was begun, on the average, 9 days after operation. The precise duration and details of the program were not defined. The mean passive range of motion in 169 implants was only 38°, compared to our mean of 78°. In 1972 Swanson reported his personal results and the results of the Field Trial Study. The postoperative program outlined for Swanson’s personal series closely approached our own, with the exception of the prolonged supervision and splinting. The mean range of passive motion for 358 implants was 62°. The postoperative program for the Field Trial Study was more difficult to evaluate. Many patients did not receive the type of postoperative program recommended by Swanson. The mean range of passive motion in over 3,400 implants was 53°. Although many other variables obviously are important, we feel that the differences in our postoperative management program are primarily responsible for the 25° increase in mean passive motion.

In addition to influencing the magnitude of motion and extension, our postoperative program seems to affect consistency of the results. In Beekenbaugh’s series, the smallest arc measured was 11°, the largest 45°. In Swanson’s series, 55 of 358 (15%) of the joints had an arc of motion less than 50°. In the Field Trial Series, 1,303 of 2,736 (48%) of the joints had an arc less than 60°. In our series all joints had a passive arc greater than 60° at 1 year, and 87 of 92 (93%) of the joints had an arc greater than 50° at 2 years or longer.

Although most authors have reported postoperative results in terms of passive range of motion, we feel that axial stability and active range of motion are the most important indicators of postoperative success. Using the program outlined, our patients achieved a significant increase in active range of motion after operation. More important, if the program is carried out fully, gains in active motion are maintained through at least 2 years. Mannerfelt and Andersson, in 144 Swanson-implant arthroplasties, using a postoperative management program featuring up to 6 months of dynamic splinting, reported a mean increase in active range of motion of 5°, from a preoperative value of 35 to 40°. Although the mean preoperative active range of motion is slightly greater (43° as opposed to 35°), the increase in active motion after operation in our series was approximately 15° at each end point. Perhaps the greater range of motion can be attributed to more careful supervision of the postoperative program.

Although this study was not designed to compare old-style vs. new-type silicone implants, our data demonstrate that the new implant fractures much less frequently than the old. More important, because the old-style implants fractured early in patients with large ranges of active motion, recurrent deformities were common. Our data suggest that if the high performance
type implants fracture, they fracture at a much lower rate and much later. Neither of the patients with fractured high performance implants had recurrent deformities and neither of the implants had to be replaced.

REFERENCES

1976 REPRINTED COPIES AVAILABLE

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