Lunate silicone replacement arthroplasty in Kienböck’s disease: A long-term follow-up

We report a long-term follow-up (average, 5 years) of 10 patients who had lunate silicone replacement arthroplasty for treatment of Kienböck’s disease. Clinical results were assessed on relief of pain, return to normal occupation, and range of motion. At 18- to 20-months follow-up, eight patients had satisfactory results, whereas at final follow-up only five of the patients had satisfactory results. Three of five patients with radiographs averaging 57 months after operation had evidence of particulate synovitis. Contrary to our previous publications on silicone replacement arthroplasty, it was concluded that the success rate for silicone replacement arthroplasty and the incidence of particulate synovitis do not warrant the continued use of silicone replacement arthroplasty as a primary treatment modality for Kienböck’s disease. (J HAND SURG 1990;15A:401-7.)


The clinical and radiographic features of lunate malacia were first described by Kienböck in 1910. Since then, a variety of treatment modalities have been used in Kienböck’s disease, including immobilization, revascularization techniques, radial shortening or ulnar lengthening procedures, limited intercarpal fusions, proximal row carpectomy, and silicone replacement arthroplasty (SRA). First introduced by Swanson in 1970, SRA of the lunate has been popular and has met with reasonable success rates, at least in the short term. Multicenter (including our own) reports in 1977 and 1982 by Lichtman and associates suggested that SRA was a rational form of treatment, and that the newer high density elastomer was stable when used in relatively advanced Kienböck’s disease.

However, controversy surrounding the indications for SRA remain unresolved, and the increasing recognition of wear particle synovitis as a cause for delayed treatment failure has prompted some clinicians to question whether this remains a viable treatment option. Since our two earlier reports were relatively short-term, it was decided to review the long-term results to ascertain if previous conclusions were still valid. This report is a study of 10 patients with Kienböck’s disease treated with SRA at an average follow-up of 5 years.

Materials and methods

Thirteen patients with Kienböck’s disease had SRA at Naval Hospital, Oakland. Eleven of the 13 patients were available for follow-up. One of the 11 patients had stage IV Kienböck’s, a relative contraindication to SRA, and therefore was deleted from the study. The remaining 10 patients were interviewed by telephone and returned questionnaires relating to pain relief, occupation, and ability to participate in normal daily activities. Eight of 10 patients obtained medical follow-up, either through the Hand Service at Naval Hospital, Oakland, or from their local orthopaedist. Postoperative x-ray films were available in 10 cases, and long-term
Table I. Patient profiles

<table>
<thead>
<tr>
<th>Case</th>
<th>Age/sex</th>
<th>Occupation</th>
<th>Variance</th>
<th>Stage</th>
<th>Follow-up</th>
<th>Long-term x-ray follow-up</th>
<th>Result at 20 months</th>
<th>Result at last follow-up</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20/M</td>
<td>Computer design, USAF</td>
<td>−2 mm</td>
<td>III</td>
<td>73 mo</td>
<td>Satisfactory</td>
<td>Satisfactory</td>
<td>No restrictions, mild pain with heavy use</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>59/F</td>
<td>Retired nurse</td>
<td>0 mm</td>
<td>III</td>
<td>55 mo</td>
<td>Cysts, DJD</td>
<td>Satisfactory</td>
<td>Unsatisfactory</td>
<td>Silicone synovitis, chronic subluxation, pain with daily use</td>
</tr>
<tr>
<td>3</td>
<td>20/M</td>
<td>Aircrew, USN</td>
<td>0 mm</td>
<td>II</td>
<td>74 mo</td>
<td>Large radial cyst</td>
<td>Satisfactory</td>
<td>Satisfactory</td>
<td>Silicone synovitis, full activity</td>
</tr>
<tr>
<td>4</td>
<td>27/F</td>
<td>Clerical, USN</td>
<td>−1 mm</td>
<td>III</td>
<td>80 mo</td>
<td>No change</td>
<td>Satisfactory</td>
<td>Unsatisfactory</td>
<td>Pain with typing, job change</td>
</tr>
<tr>
<td>5</td>
<td>25/F</td>
<td>Clerical, USN</td>
<td>−2 mm</td>
<td>III</td>
<td>57 mo</td>
<td></td>
<td>Unsatisfactory</td>
<td>Unsatisfactory</td>
<td>Revision anchovie-for pain control; pain free</td>
</tr>
<tr>
<td>6</td>
<td>22/F</td>
<td>Airman, USAF</td>
<td>−2 mm</td>
<td>II</td>
<td>57 mo</td>
<td></td>
<td>Unsatisfactory</td>
<td>Unsatisfactory</td>
<td>Medical separation, pain with daily use</td>
</tr>
<tr>
<td>7</td>
<td>18/M</td>
<td>Heavy labor, USMC</td>
<td>−2 mm</td>
<td>III</td>
<td>69 mo</td>
<td>Satisfactory</td>
<td>Satisfactory</td>
<td>No limitations, pain free</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>22/M</td>
<td>Heavy labor, USAF</td>
<td>−2 mm</td>
<td>III</td>
<td>37 mo</td>
<td>No change</td>
<td>Satisfactory</td>
<td>Pain free</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>22/M</td>
<td>Air traffic controller, USN</td>
<td>+1 mm</td>
<td>II</td>
<td>35 mo</td>
<td></td>
<td>Satisfactory</td>
<td>Pain free</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>22/M</td>
<td>Sailor, USN</td>
<td>−2 mm</td>
<td>III</td>
<td>62 mo</td>
<td>Cysts, collapse</td>
<td>Satisfactory</td>
<td>Unsatisfactory</td>
<td>Silicone synovitis; constant pain</td>
</tr>
</tbody>
</table>

x-ray follow-up averaging 57 months (range, 31 to 80 months) was available in 5 cases.

The average age at presentation was 25 years (range, 18 to 59) (Table I). The nondominant hand was involved in 7 of 10 cases. Negative ulnar variance was present in 7 of 10 patients (average, 1.9 mm); 2 had neutral variance, and 1 had positive variance. Three of 10 patients related a specific traumatic event to the onset of symptoms, and the remaining 7 experienced a gradual onset of wrist pain without history of acute trauma. The time from onset of symptoms to surgery ranged from 8 months to 2 years, with an average of 14 months. All patients were staged using the staging system devised by Lichtman and associates (Fig. 1).4, 11-13

There were three stage II patients and seven stage III patients.

Indications for surgical intervention were patients who had stage II or stage III disease with (1) continued pain unresponsive to conservative care, (2) inability to maintain employment because of wrist symptoms, or (3) unwillingness to pursue further conservative care.

Surgical contraindications included (1) history of septic arthritis, (2) psychiatric illness, (3) workmen’s compensation or litigation pending, and (4) systemic illness or condition making surgical intervention hazardous.

Surgical technique, as described by Lichtman,4, 11-13 employs a dorsal transverse incision, preserving a thin shell of palmar lunate cortex to maintain soft tissue attachments and adequate dorsal capsular closure. The Swanson high performance (HP) lunate prosthesis (Dow-Corning, Midland, Mich.) was used in all patients. In no patient was suture or temporary Kirschner wire fixation used to stabilize the prosthesis. All patients had the affected wrist immobilized for 6 weeks after operation and were then started on physical therapy. Postoperative x-ray films were obtained at 2 weeks in all cases.
Criteria for evaluation of surgical results were based largely on the level of pain relief because this was the primary indication for surgery. To obtain a satisfactory rating a patient must have met the following criteria (all others were classified as unsatisfactory): (1) Have minimal or no pain in activities of daily living and normal avocational activities; (2) have returned to the same or similar occupation; and (3) maintained or improved the preoperative range of motion in the affected wrist. The radiographic presence of continued carpal collapse or silicone synovitis without clinical symptoms did not preclude a satisfactory rating.

Results

All 10 patients were treated with the HP Swanson silicone lunate prosthesis (Table I). The average postoperative follow-up was 60 months (range, 35 to 80 months). Satisfactory results were obtained in five patients and unsatisfactory in five. Four of the five unsatisfactory results had pain that was greater than or equal to their preoperative state, while another had pain with repetitive movements of her affected wrist, forcing her to seek different employment (case 4). One patient with continued postoperative pain of 2 years' duration had removal of the silicone lunate prosthesis and soft tissue interpositional arthroplasty with complete relief of pain (case 5).

Postoperative dislocation of the prosthesis occurred in two patients within 2 weeks of the original procedure. One patient was returned to surgery for open reduction and continues to have a satisfactory result 73 months after surgery (case 1). The other patient at 55 months follow-up is awaiting surgery. She has pain with daily use and can subluxate and reduce her prosthesis at will, though at 20-month follow-up she had a satisfactory result (case 2).

No postoperative wound infections occurred. However, three of the five patients with long-term x-ray follow-up (average, 57 months) had x-ray evidence of wear-particle or particulate synovitis.

Evaluation of SRA correlated with disease stage revealed the following: Stage II, two satisfactory and one unsatisfactory result; Stage III, three satisfactory and four unsatisfactory results.

The degree of negative ulnar variance did not correlate with the surgical result.

The range of motion remained constant or improved in all patients except one.

Discussion

Lichtman and colleagues reported on their initial use of SRA for treatment of Kienböck's disease in 1977. It was concluded that early treatment with SRA was indicated because of the poor results seen in stage III disease: 4 (of 10) unsatisfactory results at an average follow-up of 25 months. In 1982, we expanded the indications for SRA after reviewing an additional 16 patients treated with the new Swanson high-performance (HP) silicone lunate prosthesis and obtaining satisfactory results in 12 of 13 patients with stage III disease, with an average follow-up of 18 months. The superior results were ascribed to the improved design and the structure of the prosthesis. In the present series, four of seven patients with stage III disease had unsatisfactory results (all for pain) when evaluated at an average of 60 months' follow-up. However, if rated at 18 to 20 months after operation, only two of seven patients had unsatisfactory results.

Our overall results for the 1977, 1982, and the current study are compared in Table II. The results of the current study more closely approximate the 1977 study. In searching for an explanation for the discrepancy between the 1982 study and the present one, we noted...
that the 1982 study (and the 1977 study\textsuperscript{13}) included patients from four different institutions and involved multiple surgeons. In our current study, all the patients were treated at Naval Hospital, Oakland, with the same senior surgeon (D. M. L.) in 9 of the 10 cases. Whether or not the institution and surgical variance contributed to the difference in results, the results of the present series are of concern. This suggests that the outcome of SRA in stage III is actually closer to what was reported in the 1977 study (40\% unsatisfactory), and that the change in the prosthesis design and elastomer really did not make a difference as originally concluded in the 1982 study. Nevertheless, the current study, with all patients being treated by the same surgical technique, reveals that SRA results for stage III are not good in the short-term and deteriorate even further with time.

A combination of factors may contribute to the deterioration of treatment results with time. Watson\textsuperscript{10} has shown that the silicone lunate prosthesis works well as a spacer, but collapses up to 22\% and allows scaphoid rotation when loaded moderately, as in making a fist. These abnormal biomechanics over a prolonged period could produce a chronic irritation at the wrist.

Localized foreign body synovitis, or wear-particle synovitis, in response to silicone rubber prostheses, is being reported with increasing frequency.\textsuperscript{3, 17-19} Wear-particle synovitis in the wrist is manifested radiographically by generalized osteopenia of the carpus, subchondral cysts, and loss of carpal height. Clinically, patients complain of increasing pain, stiffness, and swelling in the affected joint. Several investigators have implicated microparticulate silicone fragments from constant wear and stress on the prosthesis.

Smith and colleagues\textsuperscript{18} reported on nine patients in whom wear-particle synovitis developed after silicone implant surgery; four of those patients had SRA for Kienböck's disease. Histologic studies of the synovium were made in eight of those patients; the studies revealed particulate foreign body material in the synovial tissue with giant cells and chronic inflammatory cells in abundance. All patients in that series required revi-
Fig. 3. A, The immediate postoperative films of case 2 show subluxation of the prosthesis without cyst formation. B, At 31 months after surgery the subluxation persists and cysts are present in the capitate.

Fig. 4. A, Preoperative film of case 3 shows stage II Kienböck's disease. B, At 6 months after surgery there is a diastasis between the prosthesis and the scaphoid, but no cysts are apparent. C, A film taken at 74 months, however, shows progression of the diastasis and large cysts in the radius and scaphoid. This patient is asymptomatic.

sion surgery. They concluded that patients should obtain regular clinical and x-ray evaluation for a minimum of 8 years after SRA. Synovectomy, excision of the implant, and appropriate reconstructive procedures are indicated in patients in whom symptomatic silicone synovitis develops. Excision of the implant with curettage of cysts has been curative in all cases.

Worsing and colleagues\(^9\) were able to induce foreign body giant cell synovitis in 3 of 13 rabbits by implanting fine shavings from a Swanson silicone radial head prosthesis. The incidence of silicone-induced particulate synovitis is not known, but some authors state that the incidence will increase with time, and the asymptomatic patient should be followed indefinitely.\(^{20,21}\) Swanson\(^{14}\) has indicated that, in his experience, silicone foreign body synovitis is encountered in less than 1% of his
cases. More recent evidence has suggested that the old-
style prosthesis had a much lower incidence of foreign
body synovitis.24 Evidence obtained from total hip stud-
ies suggest that reaction to other polymers, including
copolymer methacrylate (PMMA) and polyethylene are
similar, histologically and histochemically, if not iden-
tical to silicone.25 A synovial-like lining has been iden-
tified with increased production of prostaglandin E2 and
collagenase similar to a rheumatoid synovial mem-
brane.26 The severity of the reaction has been shown to
be related to particle size (inversely), length of expo-
sure, and rate of particle production and not to the
chemical properties of the polymer. We, therefore,
think that the reaction should be called particulate or
particle-wear synovitis instead of silicone synovitis.
The reason that carpal implants seem to have such a
high incidence of particulate synovitis is their vulnera-
ble position in a high loading joint, their relative in-
stability, their intrasynovial position, and their use in
relatively young, active patients.

In our study, radiographic evidence of particle-wear
synovitis was present in three of the five patients who
obtained long-term x-ray follow-up (Figs. 2 through
4). One of the three patients manifested clinical symp-
toms of moderate-to-severe pain and swelling. This pa-
atient had an unsatisfactory result. Another patient has
pain and chronic instability with subluxation of the
prosthesis (case 2). She is awaiting surgery (Fig. 3).

The third patient with x-ray evidence of particle-wear
synovitis received a satisfactory rating and reported no
pain, swelling, or physical limitations (case 3). Radi-
ographically, in addition to mild scapholunate dissocia-
tion and scaphoid instability, he has early cystic de-
generation in the scaphoid, capitate, and triquetrum, as
well as a large subchondral cyst in the distal radius
(Fig. 4). Early postoperative films confirm these
changes have developed since surgery. Seventy-four
months have elapsed since his implant and the implant
remains an excellent clinical result. It is difficult to
certain why this patient with radiographic evidence
of silicone synovitis is asymptomatic. Also, three of
the patients with satisfactory long-term results (cases
1, 7, and 9) did not have long term x-ray follow-up
and could have similar radiographic findings. The ques-
tion whether radiographic synovitis will become symp-
omatic in all cases remains unanswered.

The only patient who had SRA for stage IV Kien-
böck’s disease (not included in this study) had an un-
satisfactory surgical result. This treatment failure could
have been anticipated and represents surgeon error in
the selection of appropriate treatment methods.

In light of these findings, we now reserve the use of
silicone implants for late stage III Kienböck’s disease
when there is a need to do an associated scaphocapitate
(SC) or scaphoid-trapezium-trapezoid (STT) fusion (to
reduce a chronically rotated scaphoid). Even for this
indication, other alternatives to silicone may be pref-
erable, such as an “anchovy” of rolled-up tendon, or
even leaving the collapsed lunate in place. By com-
bining SRA with STT or SC fusion, the compression load
is shifted away from the lunate to the scaphoid, thus
protecting the implant. When indicated, we now use
the “old-style” implant exclusively for use in the wrist.

For stage II or early stage III Kienböck’s disease, we
no longer use silicone because of the uncertainty re-
garding the incidence of particulate synovitis, espe-
cially in the early stages, since we do not believe that
an intercarpal arthrodesis should be done in a stage
where wrist architecture is generally undisturbed. We
would prefer to do an equalization procedure (for ulnar
minus or neutral variance) or a revascularization pro-
cedure (for ulnar positive) in early stages of the disease.

Conclusions

In this study we found that the results of silicone
lunate arthroplasty in the treatment of stage III Kien-
böck’s disease are not good in the short-term and de-
teriorate with time. Long-term follow-up in implant
surgery is necessary to adequately evaluate treatment
results. The high percentage of unsatisfactory results in
this study, with an average follow-up of 60 months,
suggests that SRA is not suitable for patients with stage
III disease.

Particle-wear synovitis was also identified as a late
complication of SRA. Although the numbers involved
in this study are small, the incidence of particle-wear
synovitis is significantly greater than reported by some
authors.14

The continued use of SRA (without intercarpal fus-
ion) in the treatment of Kienböck’s disease should be
discouraged. The use of silicone implants for Kien-
böck’s disease should be undertaken with great caution.
There are other methods for use in stage II (equaliza-
tion, revascularization), which offer the promise of
good results while preserving the lunate. For late stage
III, SRA using the old-style implant may be done as
an adjunct to SC or STT fusion. Further study is needed
to determine the frequency of particulate-wear synovitis
after SRA.

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