Chronic scapholunate instability treated by scaphocapitate fusion: A midterm outcome perspective

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Accepted: 29 November 2010

KEYWORDS
Scapholunate instability; Intercarpal fusion; Scaphocapitate fusion; STT fusion; Wrist

Summary
Introduction: Chronic scapholunate instability can lead to functional deficits and radiocarpal osteoarthritis. A number of procedures, namely scapho-trapezio-trapezoid (STT) fusion, scaphocapitate (SC) fusion or soft tissue reconstruction procedures, aim to improve function while protecting the wrist from osteoarthritis.

Hypothesis: Define the role of scaphocapitate fusion in comparison to STT fusion and capsulodesis and ligament reconstruction.

Material and methods: A clinical, radiographic and functional evaluation was performed on 31 SC fusion cases with an average follow-up of 5 years.

Results: Range of motion was 41° in flexion and 39° in extension. Radial-ulnar deviation was 43°. Strength was 32.5 kgf (Jamar). The DASH was 27% and the PRWE was 25%. Fifty percent of the wrists were pain-free at rest. Ninety-four percent of patients were satisfied with the procedure. Seventy-eight percent of patients had returned to their occupation. Radiographic analysis revealed that consolidation was obtained at 10.1 weeks. The postoperative radioscaphoid angle was 55° with good radioscaphoid congruence. There was no osteoarthritis in the radioscaphoid joint in 84% of the cases. The non-union rate was 13%.

Discussion: These data are similar to the few series that exist. STT fusion leads the same clinical results, but it is technically more difficult and has a higher rate of complications. Capsulodesis and ligament reconstruction provide the same functional results as SC fusion, but with slightly less stiffening. However, these techniques do not seem to protect the wrist from arthritic degeneration at longer follow-up. SC fusion is superior to STT fusion for the treatment of chronic scapholunate instability. This is a pain-relieving intervention with good clinical results and preservation of scaphoid stability. As a component of the surgeon’s armamentarium, it can be held in the same regard as capsulodesis and ligament reconstruction for cases of...
Introduction

Chronic scapholunate instability often leads to functional wrist disability with reduced range of motion, loss of strength and pain, mostly during forceful and grasping manoeuvres. The instability can have either a traumatic or degenerative etiology. The timeline of the arthritic progression of this instability has been well defined. A deficiency in the scapholunate ligamentous constraints results in posterior, rotational subluxation of the scaphoid, with lack of joint congruence between the scaphoid fossa of the radius and the proximal pole of the scaphoid. The goals of the various surgical procedures are to improve function while maintaining radioscaphoid congruence to reduce functional signs, bring a certain amount of pain relief and allow for a return to occupational or recreational activities. Additional goals include avoiding recurrence of the instability and most importantly, protecting the wrist from arthritic degeneration. Soft tissue reconstruction procedures and bone procedures such as partial fusion have been proposed.

Here we report on our experience with scaphocapitate fusion as a treatment for chronic scapholunate instability, to be able to define the indications.

Materials and methods

Surgical technique

Scaphocapitate fusion was performed under regional anaesthesia. A tourniquet was placed on the upper arm to obtain a bloodless operative field. A dorsal approach was used and the extensor retinaculum was incised between the third and fourth compartment. The extensor pollicis longus and extensor digitorum were reflected. The posterior interosseous nerve was resected to partially denervate the wrist. A capsulotomy with a radial-based triangular flap was performed according to Berger et al.

The radiocarpal and midcarpal joint spaces were evaluated for arthritic lesions, which would be a contraindication for fusion. Any scapholunate ligament remnants were resected to allow for easier reduction of the scaphoid. Rotational subluxation of the scaphoid was reduced through an external "joystick" manoeuvre, by the means of a 10/10 mm K-wire inserted into the proximal pole of the scaphoid (Fig. 1). The scaphoid and capitate were freshened down to bleeding cancellous bone (Fig. 2). Two 12/10 mm K-wires were used to maintain the reduction and provide provisional scaphocapitate fusion.

Fluoroscopy was used to verify that radioscaphoid congruence had been established; the radioscaphoid angle had to be approximately 45° in the lateral view (Figs. 3 and 4).

Patients

This was a retrospective study carried out at one centre. From 1999 to 2007, 58 scaphocapitate fusion procedures for chronic scapholunate instability were performed, either...
following the failure of scapholunate ligament reinsertion or bone-ligament-bone graft, or as a first-line procedure because of the chronic nature of the lesion.

An independent examiner (other than the surgeons) re-evaluated 31 fusion procedures in 30 patients, 24 men and six women. Average age at fusion was 43 years (range 20—65). The following injury mechanisms were documented in our series: 74% (23/31) had indirect trauma to the wrist, with 16% being high energy injuries (three articular radius fractures, one wrist perilunate dislocation, one radius fracture combined with a wrist perilunate dislocation), 26% (7/31) had no known trauma incident. Fifty-seven percent were work-related injuries. Thirty-five percent of the patients had a failed primary ligament reconstruction surgery.

On average, fusion was performed 25 months after this first surgery (range 8—72). Arthroscopy was performed in 23 wrists to ensure that radiocarpal or midcarpal osteoarthritis were not present, as this is a contraindication for fusion. The arthroscopy procedure was carried out separately from the scaphocapitate fusion. Based on the arthroscopy, it was determined that 61% of wrists had Grade 3 scapholunate instability and 39% had Grade 2 instability (classification based on Dreant et Dautel [3]). Wrists that were not subjected to arthroscopy presented with significant scapholunate instability on static radiographs. There was an average period of 15.8 months (range 1—48) between the start of symptoms and scaphocapitate fusion. Patients were away from work for an average of 5.2 months (range 0—36) before the fusion.

Review methods

Bilateral clinical evaluation of the wrists included an evaluation of range of motion and strength (Jamar dynamometer) of the operated wrist relative to the contralateral wrist. Wrist height, lateral deviation in the frontal plane [4], along with the radioscaphoid, radioulnar and scapholunate angles were compared on the preoperative and review radiographs. The time needed for consolidation, non-union rate, radiocarpal or midcarpal osteoarthritis, styloid-scaphoid
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impingement were also evaluated, as were complications and failures associated with this procedure.

A functional evaluation was done using DASH [5] and PRWE [6] scores. The PRWE is a subjective score that evaluates overall wrist function. It evaluates the feasibility of performing common and specific activities of daily living, and the pain that occurs when these activities are performed. A score out of 150 points is calculated, then expressed on a scale of 100, to evaluate overall functional deficit (0% healthy wrist; 100%: completely disabled wrist). Return to work, either in the same position or a new position, was recorded. A Chi² test was used to compare the nominal qualitative variables and a Student t-test was used to compare averages. The alpha level was 5% (P = 0.05).

Results

The average follow-up at the time of review was 5 years (range 8 months to 8 years). Out of the 58 fusion procedures that were performed, 27 cases (47%) were either lost to follow-up or had an incomplete clinical or radiographic file, thus 31 cases were available for review. The dominant hand was affected in 70% of the cases.

Complications

The complication rate, excluding non-unions, was 5.4% (Type 1 complex regional pain syndrome). There were no infections.

Subjective and functional results

The DASH score was 27% (range 0—76). The PRWE revealed an overall disability of 25% (range 0—90) relative to the healthy wrist. Fifty percent of the wrists were pain-free and the other patients had a slight pain that was scored as 1.5/10 on the visual analog scale. The pain increased up to a maximum of 4/10 when certain activities were performed, such as carrying heavy loads or repetitive movements. Ninety-four percent of patients were satisfied with the procedure as carrying heavy loads or repetitive movements. Ninety-three percent of patients had returned to their occupation, with 22% having changed to another type of activity. The average time away from work after the surgical procedure was 5.8 months.

Clinical results

Range of motion in the wrist was reduced because of the scaphocapitate fusion (Table 1). Flexion was 41° (range 20—66), which was 37% less than the contralateral side; extension was 39° (range 14—60; 29% less). Radial deviation was limited to 11° (range 5—24; 52% less) and ulnar deviation was 32° (range 8—46; 18% less). Flexion-extension range of motion was 80° (range 40—114) and radioulnar deviation was 43° (range 18—66). Average grip strength on the Jamar dynamometer was 32.5 kgf (8—57; 19% less).

Radiographic results

Fixation was carried out with standard staples in 86% of the fusion procedures. A cancellous bone graft from the radius was used in 81% of the fusion procedures. Thirteen percent of the reviewed fusion cases had not fused.

Radiographic analysis revealed that consolidation had occurred in 10.1 weeks (range 6—13). The height and deviation index in the frontal plane of the wrist were maintained at follow-up; these were normal before the surgical procedure. The preoperative radioscaphoid angle changed from 60° (range 30—78) to 55° (range 31—74) after surgery; there was little change in the radioulnar angle (−6° to −9°). There was little change in the scapholunate angle (66° preoperative, range 30—100; 63° postoperative, range 46—94).

There was no radioscaphoid osteoarthritis in 84% of the cases. Styloid-scaphoid impingement was found in 22% of the wrists, but it had little clinical effect. Perioperative styloidectomy was performed in 32% of the fusion procedures to prevent styloid-scaphoid impingement, and was performed postoperative in 7% of the cases because of symptomatic impingement.

Radiocarpal or midcarpal arthritis was found in 16% of the wrists; all of these wrists had a previous articular radius fracture or wrist perilunate dislocation. Two of the wrists required a complete radiocarpal fusion.

Table 1  Clinical results for the series.

<table>
<thead>
<tr>
<th>Operated wrist</th>
<th>Extension</th>
<th>Radial Dev.</th>
<th>Ulnar Dev.</th>
<th>Flex/Ext Range</th>
<th>Rd/Ul Dev. Range</th>
<th>Jamar (kgf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexion 41° (20—66)</td>
<td>39° (14—60)</td>
<td>11° (5—24)</td>
<td>32° (8—46)</td>
<td>80° (40—114)</td>
<td>43° (18—66)</td>
<td>32.5 (8—57)</td>
</tr>
<tr>
<td>Healthy wrist</td>
<td>−37%</td>
<td>−29%</td>
<td>−52%</td>
<td>−18%</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>Age</td>
<td>% Work-Related</td>
<td>F°</td>
<td>E°</td>
<td>RD°</td>
<td>UD°</td>
<td>Jamar (kgf)</td>
</tr>
</tbody>
</table>

Table 2  Scaphocapitate fusion series.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Delay (months)</th>
<th>#-SLI</th>
<th>Follow-up (months)</th>
<th>Age</th>
<th>% Work-Related</th>
<th>F°</th>
<th>E°</th>
<th>RD°</th>
<th>UD°</th>
<th>Jamar (kgf)</th>
<th>No fusion %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pisaro et al. [12]</td>
<td>16</td>
<td>11—4</td>
<td>23.4</td>
<td>32</td>
<td>—</td>
<td>32</td>
<td>42</td>
<td>10</td>
<td>24</td>
<td>29</td>
<td>12</td>
</tr>
<tr>
<td>Saffar [16]</td>
<td>18</td>
<td>33—33</td>
<td>26</td>
<td>39.4</td>
<td>40</td>
<td>37.2</td>
<td>51.3</td>
<td>10.3</td>
<td>29.2</td>
<td>—</td>
<td>15</td>
</tr>
<tr>
<td>Our study</td>
<td>16</td>
<td>31—31</td>
<td>60</td>
<td>43</td>
<td>57</td>
<td>41</td>
<td>39</td>
<td>11</td>
<td>32</td>
<td>32.5</td>
<td>13</td>
</tr>
</tbody>
</table>

#-SLI: number of scaphocapitate fusion in the series—number of scapholunate instability in the series.
Statistical analysis

Many factors were evaluated for their effect on the outcomes: age, preoperative work stoppage greater than 12 months, work-related injury, history of primary reconstruction of the scapholunate ligament. None of these factors lead to a statistically significant difference in the clinical, functional and radiographic results. However, patients with a work-related injury tended to have worse functional results and greater time away from work (8.3 months on average).

Discussion

Although the surgical procedure was described in the 1950s [7], very few studies have been published where scaphocapitate fusion was used as a treatment for chronic scapholunate instability (Table 2).

The current study had a good 5-year follow-up, even up to 8 years, despite a significant number of patients being lost to follow-up or having incomplete files. Even if this is a retrospective study without preoperative clinical data, these medium term results with a rarely used surgical intervention are valuable. The range of motion in flexion-extension and radioulnar deviation allow for most daily living activities and professional activities to be performed. Because strength was restored and pain reduced, a large number of our patients returned to the same position in their occupation, despite the high rate of work-related injuries. The protection of the wrist from arthritic degeneration at a 5-year follow-up is an important piece of data. Permanent re-centering of the proximal pole of the scaphoid relative to the radial fossa is a contributing factor. The fusion did not have a direct impact on the lunate, as there was little change in the radio-lunate angle. This study did not find any osteoarthritis in the lunate-capitate joint. It is more important to set the radioscaphoid angle at 45° and restore radioscaphoid congruence during the intervention than to set the scapholunate angle, which is the mathematical resultant of the radioscaphoid and radio-lunate angles. Experimentally, a radioscaphoid angle between 30° and 57° provides 60% of the range of motion of a healthy wrist, which is sufficient for activities of daily living [8]. The radioscaphoid angle must be set under perioperative fluoroscope guidance.

In all reported series, fusion reduced the range of motion of the wrist relative to the contralateral side. Experimentally, this reduction was a result of scaphocapitate movement being blocked during wrist movements [9], notably in flexion and radial deviation. There was less of a constraint on extension and ulnar deviation, as the motion of the scaphocapitate unit in these movements is less than in flexion. However, the clinical range of motion was less than experimental range of motion [10].

The amount of pain reduction reported in different published series varies. Climate-related pain was reduced over time in 13% to 46% of patients and increased for certain forceful manoeuvres, but remained moderate for 23% to 41% of the patients [11–13]. The pain reduction after fusion is a result of scaphoid stabilization and re-centering of its proximal pole relative to the scaphoid fossa on the radius. Resection of the posterior interosseous nerve also resulted in partial denervation. For a wrist in neutral position under experimental conditions, scaphocapitate fusion results in the radio-lunate joint and scapholunate ligament being unloaded, and greater load being placed on the radioscaphoid joint [10,14,15]. During radial deviation, constrained movement of the scaphoid against the proximal concavity of the radiocarpal joint can also increase loading. Increased pressure on the cartilage of the proximal pole of the scaphoid could explain the residual pain that occurs when certain activities are performed, notably movements at the extremes of the range of motion.

Non-unions are a dreaded complication. It puts a strain on the functional results and casts a shadow over the prognosis. The published rate varies between 12% and 23% [11,12,16]. Our series had one of the highest fusion rates, despite mostly using fixation without compression. Well-executed freshening and a cancellous bone graft harvested from the radius are essential. The use of compression screws often requires an additional lateral approach, which increases the risk of damage to the superficial branches of the radial nerve. However, there is on-going debate about the best method of internal fixation. No published data indicates that fixation with compression screws is better than without, or vice versa. Rigid immobilization of the wrist with a fibreglass, short-arm splint until consolidation occurs seems to be standard practice.

Neither the published literature, nor this study provides data to support a benefit of systematic radial styloidectomy on pain and range of motion during a scaphocapitate fusion, to the same degree as it does for STT fusion. Additional styloidectomy was done in only 7% of our cases.

The goal of a scapho-trapezio-trapezoid fusion is also to stabilize the horizontal "rocking-chair" motion of the scaphoid. Excellent functional results have been reported by Watson et al. [17]. These results are better overall than with scaphocapitate fusion or soft tissue reconstruction procedures. A meta-analysis of 258 cases by Siegel et al. [18] (Table 3) showed different results than Watson. In comparison to our study, range of motion was identical, strength was comparable and the non-union rate was equivalent. In contrast, the complication rate (excluding non-unions) was 43%, which included infections of the material, radioscaphoid arthritis, Type I CRPS or persistent irritation of the radial nerve. This rate was 5.4% in our study. A scapho-trapezio-trapezoid fusion is technically more difficult. It is more difficult to set the position of the scaphoid on its base; the experimentally-defined radioscaphoid angle needed to obtain acceptable wrist range of motion is more limited, between 30° and 47° [8].

A scapholunate (SL) fusion procedure has also been described (Table 3). Experimentally, this type of fusion only slightly reduces the range of motion of the wrist. Although reasonable, it is not appropriate for all types of injuries to the scapholunate ligamentous constraints. There is a significant non-union rate, 35% to 72% [19–21]. The results are unpredictable, and seem to be better on subjective measures than objective ones [20].

Soft tissue reconstruction procedures (Table 3) have a similar reasoning when it comes to improving the function of the wrist and stabilizing the scaphoid. Since the midcarpal joint is not blocked, these procedures do not reduce...
Table 3  SST fusion, SL fusion, capsulodesis and ligament reconstruction.

<table>
<thead>
<tr>
<th>Authors (technique)</th>
<th>n</th>
<th>Follow-up (months)</th>
<th>F(^{\circ})</th>
<th>E(^{\circ})</th>
<th>RD(^{\circ})</th>
<th>UD(^{\circ})</th>
<th>Strength/CL side</th>
<th>SL Angle pre/postoperative</th>
<th>RS Osteoarthritis</th>
<th>Good &amp; V. Good results</th>
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<tbody>
<tr>
<td><strong>SST fusion</strong></td>
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<tr>
<td>Siegel et al. [18]</td>
<td>258</td>
<td>—</td>
<td>62%</td>
<td></td>
<td></td>
<td></td>
<td>74%</td>
<td>—</td>
<td>15 to 30%</td>
<td>Idem SC</td>
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<tr>
<td><strong>SL fusion</strong></td>
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<tr>
<td>Alnot et al. [19]</td>
<td>10</td>
<td>48</td>
<td>46</td>
<td>47</td>
<td>15</td>
<td>34</td>
<td>—</td>
<td>—</td>
<td>—</td>
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<tr>
<td>Chick et al. [20]</td>
<td>4</td>
<td>28</td>
<td>—47%</td>
<td>—24%</td>
<td>—52%</td>
<td>—48%</td>
<td>+10%</td>
<td>—</td>
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<tr>
<td>Zubair y et al. [21]</td>
<td>10</td>
<td>99</td>
<td>41</td>
<td>46</td>
<td>17</td>
<td>36</td>
<td>63</td>
<td>—</td>
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<tr>
<td><strong>Capsulodesis</strong></td>
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<tr>
<td>Dréant (Berger) [22]</td>
<td>25</td>
<td>41</td>
<td>48</td>
<td>56</td>
<td>24</td>
<td>29</td>
<td>88%</td>
<td>/64(^{\circ})</td>
<td>—</td>
<td>—</td>
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<tr>
<td>Moran (Berger) [23]</td>
<td>14</td>
<td>36</td>
<td>44</td>
<td>49</td>
<td>12</td>
<td>26</td>
<td>—</td>
<td>55/62(^{\circ})</td>
<td>12%</td>
<td>30%</td>
</tr>
<tr>
<td>Schweizer (DILC) [24]</td>
<td>22</td>
<td>63</td>
<td>48</td>
<td>50</td>
<td>20</td>
<td>34</td>
<td>87%</td>
<td>65/53(^{\circ})</td>
<td>31%</td>
<td>63%</td>
</tr>
<tr>
<td>Gajendran (DILC) [25]</td>
<td>16</td>
<td>86</td>
<td>50</td>
<td>55</td>
<td>17</td>
<td>36</td>
<td>—</td>
<td>66/62(^{\circ})</td>
<td>50%</td>
<td>57%</td>
</tr>
<tr>
<td>Deshmukh (DILC) [26]</td>
<td>44</td>
<td>22</td>
<td>40</td>
<td>38</td>
<td>4</td>
<td>13</td>
<td>65%</td>
<td>45/48(^{\circ})</td>
<td>0%</td>
<td>54%</td>
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<tr>
<td><strong>Ligament reconstruction</strong></td>
<td></td>
<td></td>
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<tr>
<td>Garcia-Elias (3LT) [27]</td>
<td>38</td>
<td>48</td>
<td>51</td>
<td>52</td>
<td>16</td>
<td>29</td>
<td>65%</td>
<td>—</td>
<td>23%</td>
<td>—</td>
</tr>
<tr>
<td>Moran (Brunelli) [28]</td>
<td>15</td>
<td>36</td>
<td>40</td>
<td>43</td>
<td>16</td>
<td>26</td>
<td>63%</td>
<td>63/54(^{\circ})</td>
<td>13%</td>
<td>40%</td>
</tr>
<tr>
<td>Talwalkar (3LT) [29]</td>
<td>55</td>
<td>48</td>
<td>47</td>
<td>56</td>
<td>18</td>
<td>29</td>
<td>80%</td>
<td>—</td>
<td>—</td>
<td>79%</td>
</tr>
<tr>
<td><strong>Our Study</strong></td>
<td>31</td>
<td>60</td>
<td>41</td>
<td>39</td>
<td>11</td>
<td>32</td>
<td>81%</td>
<td>66/63(^{\circ})</td>
<td>16%</td>
<td>—</td>
</tr>
</tbody>
</table>

DILC: dorsal intercarpal ligament capsulodesis; 3LT: 3 ligament tenodesis; RS Osteoarthritis: radioscaphoid osteoarthritis.
range of motion to the same degree. A reducible scaphoid is required for capsulodesis and ligament reconstruction procedures. A flexor carpi radialis tenodesis is a more global approach to treating chronic scapholunate instability than a dorsal capsulodesis. A capsulodesis carried out with the dorsal intercarpal ligament seems to result in less wrist flexion blockage than a radiocarpal capsulodesis. These series were inhomogeneous in terms of the severity of the scapholunate instability and injuries to the different stabilization structures. No procedure provided complete pain relief. Gajendran et al. [25] found asymptomatic radioscaphoid osteoarthritis in up to 50% of cases at their longest follow-up (DILC procedure), which might indicate that radioscaphoid congruence was restored but not maintained.

**Conclusion**

The number of treatment options that exist for chronic scapholunate instability point to the difficulty in treating this condition. Soft tissue reconstruction procedures have less of an impact on range of motion than partial fusion, and provide good functional results. However, long-term follow-up suggest that these techniques do not protect the wrist from osteoarthritis. Scaphocapitate fusion is a pain-relieving intervention that provides permanent stabilization. At a 5-year follow-up, the function of the wrist was improved, there was less pain during activities of daily living, many patients were able to return to work and the wrist seemed protected from osteoarthritis because radioscaphoid congruence was restored and maintained. Since SC fusion is easier to perform than STT fusion and has a lower complication rate, it would seem to be the best treatment approach for chronic scapholunate instability, when the scaphoid is difficult to reduce or cannot be reduced. It is also the best treatment approach with cases of failed ligament reconstruction or soft tissue reconstruction procedures. However, a longer follow-up is needed to understand the performance of this fusion and confirm the protective effect towards osteoarthritis.

**Conflict of interest statement**

None.

**References**


