The Treatment of Chronic Scapholunate Dissociation: An Evidence-Based Assessment of the Literature

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No clear consensus exists on the best treatment for patients with chronic symptomatic scapholunate dissociation uncomplicated by arthritis. Although most surgeons agree that operative intervention is indicated, their preferences are divided between soft-tissue and bony procedures. Even within these treatment categories, opinions vary. Because no definitive guidelines are available for choosing among these options, discussion about the best course of management continues.

At the 55th Annual Meeting of the American Society for Surgery of the Hand (ASSH) in October 2000, Perry's presentation focused on the variations in the management of scapholunate dissociation. In this study, a questionnaire was sent to all members of the ASSH, in which a case of wrist instability in a 35-year-old male laborer 9 months following a fall from a ladder was presented. Clinical examination revealed dorsal swelling, tenderness, and a positive Watson shift test. Radiographs demonstrated scapholunate dissociation. The surgeons were asked how they would treat this patient. Of the 488 respondents, approximately all (99%) advocated surgical intervention. Forty-five percent opted for a soft-tissue procedure, 36% a bony procedure, and 19% preferred to wait before making a clinically dependent choice. This finding, hardly a mandate for a soft-tissue procedure, mirrors the current state of the literature regarding treatment.

The current knowledge on scapholunate dissociation was investigated. The anatomy and pathomechanics of scapholunate dissociation were reviewed and current methods used for clinical examination and imaging techniques were investigated. The literature concerning the various treatment modalities was then analyzed. An evidence-based assessment was conducted to evaluate the outcomes of different treatment methods. The quality of published results was evaluated, and the evidence for and against a soft-tissue procedure was compared with the evidence for and against a limited wrist fusion.

The hypothesis for this evidence-based assessment was that soft-tissue repairs of scapholunate dissociation produce better results than limited wrist fusions.

BACKGROUND

Anatomy

The lunate is located in the center of the proximal carpal row. The scaphoid lies to its radial side. Proximally, both articulate with the distal radius: the
lunate with a spheroidal fossa and the scaphoid with an elliptical fossa. Distally, the lunate articulates with the capitate, which lies in the center of the distal carpal row. The scaphoid bridges the two carpal rows; its distal pole articulates with the trapezium and trapezoid.

The scapholunate ligament complex is commonly described as having intrinsic and extrinsic components.

**Intrinsic Portion of the Scapholunate Ligament Complex.** The scapholunate interosseous ligament connects the ulnar aspect of the proximal pole of the scaphoid to the radial aspect of the lunate. It is a strong ligament and has a key role in preventing carpal collapse. The ligament is composed of three distinct components. The thick dorsal region is made up of short, transversely oriented collagen fibers. The proximal region is composed primarily of fibrocartilage, extending into the cleft between the scaphoid and lunate and is analogous to the knee meniscus. The thin palmar region consists of obliquely oriented collagen fascicles, just dorsal to the long radiolunate ligament. An isolated injury to the intrinsic scapholunate portion will not result in diastasis.

Kozin reported that additional injury to the extrinsic ligaments—the volar radioscapohapitate, long radioscapohapitate, and short radioscapohapinate ligaments—is required to demonstrate radiographic diastasis. Acute injuries may be severe enough to cause immediate diastasis. Less severe injuries, which are common, may lead to gradual extrinsic ligament attrition. Patients with such injuries do not develop scapholunate widening and carpal instability for weeks or even months after injury.

**Extrinsic Portion of the Scapholunate Ligament Complex.** The radioscapohapitate ligament extends from the radial styloid through a groove in the waist of the scaphoid to the palmar aspect of the capitate. It functions as a fulcrum around which the scaphoid rotates. The long radiolunate ligament runs parallel to the radioscapohapitate, extending from the palmar rim of the distal part of the radius to the radial margin of the palmar horn of the lunate. The space of Poirier is the interval located between the radioscapohapitate and long radiolunate ligaments at the midcarpal joint. The short radiolunate ligament is contiguous with palmar fibers of the triangulofibrocartilage complex, originating from the palmar margin of the distal radius and inserting into the proximal palmar surface of the lunate. The radioscapohapunate ligament (ligament of Testut) is a synovially invested neurovascular pedicle derived from the anterior interosseous and radial arteries and anterior interosseous nerve.

Dorsal ligaments also contribute to wrist stability. The dorsal radiocarpal ligament originates from the dorsal margin of the distal radius and inserts at the lunate, lunotriquetral interosseous ligament, and dorsal tubercle of the triquetrum. The dorsal intercarpal ligament originates from the triquetrum and extends radially to insert into the lunate, the dorsal groove of the scaphoid, and the trapezium.

**Kinematics**

Wrist motion is commonly described as having two degrees of freedom: flexion and extension in the sagittal plane and ulnar and radial deviation in the frontal plane. The wrist motors primarily attach distally into the bases of the metacarpals. During flexion and extension, the carpal rows tend to angulate simultaneously. Cineradiograms show that the proximal and distal rows angulate equally in flexion and extension. During radial and ulnar deviation, more motion occurs between the distal and proximal rows than at the radiocarpal joint. With radial deviation to 20°, a concomitant 25° palmar angulation of the proximal row also is present. With ulnar deviation, 25° of dorsiflexion occurs.

A number of theories have emerged explaining the complex intercarpal movements that occur during wrist motion; the two main theories are the columnar theory and the ring theory. Both were devised prior to cineradiography and neither fully explains wrist kinematics. A combination of these two theories may provide the best model.

Because the proximal carpal row has no direct tendon attachments, it can be thought of as an intercalated segment. Landsmeer demonstrated that intercalated segments fall into a zigzag collapse pattern with compressive loading. Linscheid et al noted that the lunate tends to dorsiflex relative to the distal radius and capitate as the scaphoid is destabilized, thus forming a dorsiflexed intercalated segment instability pattern deformity. A capitulonate angle >15° is considered abnormal. The scaphoid flexes to accommodate the shortened carpal length.

**Mechanism of Injury**

Wrist instabilities involving the scapholunate joint have been divided into dynamic and static categories. Two distinct types of incomplete ligamentous injury may produce a dynamic scapholunate instability pattern: 1) limited volar interosseous and radioscapohapinate ligament failure, and 2) scapholunate interosseous and radioscapohapitate ligament failure. Both injuries result in dynamic carpal instabilities during wrist motion without altering the static bony alignment at rest.

Mayfield et al reported a laboratory study in which cadaveric wrists and forearms were used to demonstrate injury to the scapholunate interval. Frozen cadaveric specimens were used in simulating a fall on the outstretched hand causing wrist extension, ulnar deviation, and intercarpal supination. Under these loading conditions, the scapholunate joint was the first carpal joint to be injured. Ligamentous injury then progressed around the lunate to produce sequential instability of the scapholunate, capitulonate, and triquetrolunate. Four stages of progressive perilunar instability were described:

- Stage I: Scapholunate dissociation
caused by injury to the scapholunate interosseous and palmar radioscapo-
capitate ligaments.

- Stage II: Dislocation of the capito-
lunate joint through the space of
Poirier.

- Stage III: Separation of the tri-
quetrum from the lunate with associ-
ated injury to the lunotriquetral and ulnotriquetral ligaments.

- Stage IV: Palmar lunate dislocation
due to injury to the dorsal radio-
carpal ligament.

Variants may occur. Radial styloid,
transscaphoid, transcapitate, and trans-
triquetral fractures may be associated
with perilunate injuries. In these frac-
ture dislocation variants, the injury pat-
tern is still believed to be a progression
from radial to ulnar arc. On the ulnar
side of the wrist, the plane of failure
involves the lunotriquetral ligament,
palmar ulnocarpal ligaments, and ulnar
styloid process.

**DIAGNOSIS**

**Accurate Clinical Evaluation**

Wrist injuries with initially normal
radiographs are frequently designated
as "sprains." The severity of such a
"sprained" wrist may be underestima-
ted and scapholunate ligament injury
under-diagnosed owing to the normal,
initial radiographs. These injuries usu-
ally are protected until they become
asymptomatic, but pain persists in
some patients. In such patients, further
evaluation is necessary to determine
whether partial ligament injuries and
instability are present. This conclusion
is documented by a report of a consecu-
tive series of 100 cases with a wrist
injury (excluding fractures) seen in an
emergency department, in which 19
patients demonstrated an increased gap
radiographically on the clenched fist
view.12 Of these 19 patients, 5 had sig-
nificant scapholunate instability.

A detailed history of the mechanism
of injury is important. For instance, if
the patient fell with the wrist in a pa-
mar-flexed position, it is less likely that
an injury to the scaphoid or scapholu-
nate ligament has occurred because the
volar scapholunate ligament is not pri-
marily loaded. On the other hand, rup-
ture of the dorsal radioulnar ligament
may have occurred if the wrist was in a
pronated position. A fall on the dorsi-
flexed wrist, with localization of
painful symptoms at the thenar emi-
ence, will lead to scapholunate insta-
bility.

On physical examination, the exact
area of tenderness must be localized.
Palpation of the wrist includes the
anatomic snuffbox. Tenderness in this
region is a classic sign of scaphoid
fracture. If scapholunate ligament
injury is present, tenderness may be
present in the snuffbox, but tends to be
greatest at the proximal end of the
snuffbox under the extensor carpi
radialis longus tendon. Occasionally,
an associated click or a sensation of
giving way may be present if firm pres-
sure is applied.13

In scapholunate dissociation, a dis-
tinct sulcus may sometimes be palpated
dorsally between the scaphoid and
lunate while slightly flexing and
extending the wrist. Watson et al14
described a maneuver to provoke the
scapholunate instability that occurs
with wrist loading. This is known as the
"Watson shift test," in which the wrist
is moved from ulnar to radial deviation
with pressure applied to the distal pole
of the scaphoid. The test is positive if a
click is produced dorsoradially in the
scapholunate joint. Pain or laxity
during this maneuver may be more subtle
indications of scapholunate ligament
injury.

**Radiographic and Other Diagnostic
Studies**

Anteroposterior (AP) and lateral
radiographs of the wrist usually are the
first diagnostic study obtained.11 On the
AP wrist radiograph, an interval >3 mm
suggests a scapholunate ligament injury.
On the lateral view, the normal scapho-
lunate angle (angle of Alexander) is 47°
(range: 30°-60°). In scapholunate disso-
ciation, a dorsal intercalated segment
instability pattern is seen. This results
from disruption of the scapholunate lig-
ament and the extrinsic volar scapho-
lunate ligaments. The vertical lunate
axis extends beyond 15°. The scaphoid
rotates palmarly, and the scapholunate
angle increases beyond 60°.

In patients with dynamic wrist insta-
ibility, routine wrist radiographs are
normal. Special radiographic views,
such as the clenched fist view, in which
compression is transmitted across the
wrist, demonstrate widening at the
scapholunate joint. Scapholunate
widening may also be demonstrated by
cineradiography or 6-view motion
studies of the wrist.2 Widening of the
scapholunate interval is accentuated
with the wrist in ulnar deviation. As the
wrist moves into radial deviation, the
scaphoid flexes and becomes perpen-
dicular to the plane of the radius. The
"signet ring sign" is produced when the
distal scaphoid pole is imaged "end-
on." Beckenbaugh13 noted that if a
scapholunate gap is present in ulnar
deivation, it may often close in radial
deivation.

Arthrography can be used to study
the integrity of the carpal ligaments.
Midcarpal, radiocarpal, and distal
radioulnar arthrography, the so-called
triple-phase test, may reveal interrup-
tion of the intrinsic intercarpal liga-
ments. Contrast material injected into
the midcarpal joint does not normally
cross into the radiocarpal joint unless
an intrinsic ligament tear is present.
Unfortunately, arthrography is associ-
ated with false positive and false nega-
tive results, which may render interpre-
tation difficult.

Magnetic resonance imaging (MRI)
can be used to survey the wrist for liga-
ment tears. The images obtained are
detailed, but difficulties in correlating
occult MRI findings with patient symp-
toms and arthroscopic and operative
findings have led to less reliance on
this study.

Wrist arthroscopy has the highest
sensitivity and specificity among the
special studies group in diagnosing the
carpal ligament injuries responsible for
carpal instability. This modality is
more accurate than arthrography or
MRI for detecting the site and extent of ligament injuries. The radiocarpal and midcarpal joints may be examined and the intercarpal joints probed. In cases of scapholunate dissociation, the diagnosis is confirmed if the probe or arthroscope can be passed between the midcarpal and radiocarpal joints.

**Treatment**

The management of patients with acute scapholunate dissociation varies among surgeons, but the options include closed reduction and cast immobilization; closed or open reduction and percutaneous Kirschner wire fixation; open reduction; direct repair of the scapholunate ligament and support of the repair with K-wires, capsulodesis, or both; and open reduction and replacement of the scapholunate ligament with tendon graft, suture anchors, or some other structural device. It is important to re-establish a normal scapholunate relationship to prevent abnormal wrist kinematics or collapse that may lead to articular surface wear and post-traumatic arthritis.

The preferred method of treatment is open reduction of the carpus through a dorsal approach, placement of at least two 0.045-inch K-wires to pin the scaphoid to the lunate and capitae, and direct repair of the scapholunate ligament. Ligament repair is performed with direct suture for ligaments torn in their midsubstance or with pullout sutures or suture anchors for ligaments avulsed from bone. The reduction should be protected and supported with cast immobilization for at least 8 weeks.

The feasibility of secondary ligamentous repair (>3 weeks post-injury) depends on identification of a substantial, reparable scapholunate interosseous ligament and reduction of the palmarly flexed scaphoid without extensive dissection. The extent to which the scaphoid becomes fixed in palmar flexion depends on the magnitude of the initial capsular injury and the scarring and capsular contracture, which increase over time. Closed reduction alone or closed reduction and percutaneous pin fixation are not uniformly successful in maintaining carpal alignment and achieving satisfactory long-term outcomes in wrists with acute scapholunate instability.

Late diagnosis is frequent, owing to the incipient nature of the symptoms. Closed treatment has been of little value except in those patients with minimal symptoms. Many treatments have been proposed for reconstruction of the symptomatic chronic scapholunate injury. Some surgeons advocate techniques that prevent scaphoid flexion during wrist motion by joining the distal and proximal row by fusion to prevent collapse, while others advocate soft-tissue reconstruction using intrinsic or extrinsic tissue. In 1987, Blatt described a method of surgical stabilization of the wrist with a dorsal capsulodesis. This technique is an indirect soft-tissue reconstruction in which a radius-based flap of wrist capsule is inserted into the distal pole of the scaphoid, which prevents the scaphoid from collapsing into excessive flexion.

In 1967, Petersen and Lipscomb recommended arthrodesis of the scaphoid, trapezium, and trapezoid as treatment for rotatory subluxation of the scaphoid. Watson et al emphasized that the position of the scaphoid in scaphoid, trapezium, and trapezoid arthrodesis must be approximately 45° from the long axis of the forearm when viewed laterally. If fused in a more vertical position, or in line with the forearm, wrist motion may be significantly limited, owing to the incongruous alignment of the scaphoid surface in relation to the elliptical fossa of the radius. The scaphoid, trapezium, and trapezoid fusion maintains a neutral scaphoid position between the proximal and distal carpal rows. Scaphoid, trapezium, and trapezoid fusion is contraindicated in an arthritic wrist.

Other intercarpal or limited wrist fusions have been tried. Scapholunate fusion has been criticized because it produces an unacceptable limitation in wrist motion. High bending moments also cause high nonunion rates. Scaphocapitate fusion locks the scaphoid into position by the immobile articulation between the capitae and middle metacarpal; it also creates a load-bearing column across the fusion site that may accelerate wear and subsequently produce arthritic changes in the radioscaphoid joint.

**MATERIALS AND METHODS**

Medline and Science Citation Index computer searches of the literature were performed using the terms "scapholunate dissociation," "carpal instability," and "scapholunate ligament." All English language citations between 1965 and 2000 were retrieved and reviewed. The references from each article were used to gain additional citations.

All studies using scapholunate treatments with sample sizes of ≥2 were included. The surgical treatment groups were divided into soft-tissue repairs and primary fusions. All soft-tissue reconstructions (eg, dorsal capsulodesis and tendon weaver) were grouped under the soft-tissue category, and all limited intercarpal fusions (eg, scaphoid, trapezium, and trapezoid and scapholunate) were grouped in the fusion category. Dynamic and static instabilities were included. Studies in which a type of intercarpal arthrodesis was performed for a variety of diagnoses (eg, degenerative joint disease and Kienbock’s disease) were reviewed; and, if possible, only those patients with the diagnosis of scapholunate dissociation were included in the study. Similarly, patients identified as having perilunate dislocations were excluded.

Only rarely were bilateral procedures performed in the same patient. When this occurred, the patient number was counted as two.

The most useful and most frequently listed data groups were analyzed: patient number; duration of symptoms prior to surgery; length of follow-up; percentage of postoperative flexion-extension arc compared to the noninvolved side; percentage of grip strength...
compared to the noninvolved side; presence or absence of painful symptoms; and complications. Additional data groups, which were inconsistently described by investigators, were not analyzed but included data such as millimeters of scapholunate diastasis; range of motion in ulnar and radial deviation; patient satisfaction; return to usual preinjury activities or return to work status; and radiographic evidence of reduction, arthrosis, and bony union. Complications were described rather than reported as a rate. When only absolute range of motion data were provided, a 150° flexion-extension arc was used as the normal value for the uninvolved side.10

RESULTS

The 212 Medline and Scientific Citation Index references yielded 91 articles pertinent to the treatment of scapholunate dissociation. Of these, 35 studies included patient data. A total of 27 studies between 1978 and 2000 met criteria for inclusion in the scapholunate dissociation treatment groups. All investigations were noncontrolled, nonrandomized case series. Seventeen studies involved soft-tissue scapholunate reconstructions (n=386 patients) and 10 studies reported limited intercarpal fusions (n=126 patients). Tables 1 and 2 detail the studies and collected data from the soft-tissue reconstruction and arthrodesis groups, respectively.

DISCUSSION

A recent surge of interest in the wrist has been noted. Knowledge about the joint, both its normal function and injury patterns, has increased exponentially. Wrist anatomy is now well understood, and current kinematic theories are believed to be reasonably accurate. Wrist ligament injuries have been a large focus of research; impressive quantities of data have accumulated over the past three decades. Improved clinical evaluation and imaging techniques have facilitated diagnosis.

New management techniques have evolved in response to increased understanding of wrist trauma. Operative repairs are more logical, and most are designed to merge the new knowledge on wrist injuries with basic orthopedic principles. Nevertheless, despite a vast amount of surgical experience and a number of reports in the literature, no consensus exists on the best operation for a chronic scapholunate dissociation. The surgeon is still faced with many choices. The purpose of this study was to try to narrow the choice and, specifically, to determine whether one avenue of management (soft-tissue procedures) was superior to the other (limited wrist fusions) for chronic scapholunate dissociation.

The management of patients with scapholunate dissociation varies according to how soon the patient presents after injury. If the diagnosis is made in the acute injury stage, the options for treatment include:

- closed reduction and cast immobilization,
- closed reduction and percutaneous K-wire fixation,
- open reduction with direct repair of the scapholunate ligament, and
- open reduction and repair of the scapholunate ligament with tendon graft, anchor sutures, or some other structural device.

It is important to correct concurrent scapholunate deformity. Otherwise, alterations of wrist kinematics and abnormal articular surface loading can ultimately cause scapholunate advanced collapse and post-traumatic arthritis.16

The primary challenge with acute scapholunate ligament injuries is making an early diagnosis. Most patients who present with chronic radial-sided wrist pain report a history of mild wrist injury. In many cases, patients do not seek medical attention. Other patients, seen in emergency rooms or doctors' offices and diagnosed as having a mild wrist sprain, are treated with reassurance or short-term splinting and early movement. The proportion of these mild wrist sprains progressing to dynamic scapholunate instability is unknown. Similarly, it is not known whether dynamic scapholunate instability progresses to static scapholunate instability with radiographic separation of the scapholunate joint; and eventually, such patients then develop scapholunate advanced collapse (SLAC) wrist pattern degenerative arthritis. It is generally thought that progression occurs—at least in the more severe cases—but that it takes a long time (often 15-25 years) for SLAC wrist pattern degenerative arthritis to become severe enough to need surgical management. A long interval between the onset of pain is associated with scapholunate dissociation and the indications for salvage surgery for post-traumatic SLAC wrist pattern arthritis.

Limited wrist fusion, total wrist arthrodesis, and proximal row carpectomy are used in the management of SLAC wrist arthritis. The results of these procedures are well established, reasonably predictable, and usually satisfactory. Each procedure, however, leaves the patient with some residual wrist impairment, usually in the form of loss of motion, strength, power, and endurance. Therefore, the goal is to identify patients with scapholunate instability early and offer a reliable operative procedure, which ideally would restore function and alleviate pain.

The most commonly recommended surgical procedures for scapholunate dissociation in the absence of arthritis are the Blatt capsulodesis, scaphoid tenodesis, tendon reconstruction of the scapholunate ligament, and scaphoid, trapezium, trapezoid fusion. Other procedures, including arthroscopic joint debridement, autogenous bone-retinaculum-bone ligament reconstruction, and scapholunate or scaphocapitate fusion, are less commonly performed (Tables 1 and 2).

Reports on the surgical treatment of scapholunate dissociation have varied from those that describe the technical aspects of an operation to others that report the results of multiple patients treated using a single method. It is difficult to identify the best method.
because no report describes valid comparative results between different methods. In fact, no report documents the efficacy of surgical management.

This investigation was undertaken because we believed that an understanding of the pros and cons of the two procedures and a detailed knowledge of their outcomes were important but poorly understood clinical issues. Insufficient evidence was available for proper and satisfactory evaluation of the procedures.

Our initial plan was to collect data from multiple reported studies, pool the data, and perform a meta-analysis. Dickerson and Berlin\textsuperscript{46} defined meta-analysis as “the statistical analysis of a large collection of analysis results for the purpose of integrating the findings.” Our study found that the literature on scapholunate dissociation was not sufficiently homogeneous for meta-analysis, thus the evidence-based
assessment was used. Evidence-based assessment is an epidemiological method that has been developed for analyzing the strength of objective data, subjective results, and other information obtained from the literature.

The results of this study showed that the literature on the surgical management of scapholunate dissociation is not strong from the epidemiological point of view. Of the 212 reports obtained from the literature search, only 27 fulfilled the entry criteria for this study. All of the other reports concerned different aspects of scapholunate dissociation, such as its diagnosis or treatments that were described but no patient data were provided. All 27 reports concerned with soft-tissue procedures or limited wrist fusion procedures were case-series studies.

It is impossible to draw hard conclusions from a heterogeneous set of case-series studies. It is always possible that conclusions are inaccurate because results may be a matter of chance alone. At best, an evidence-based assessment of this type of literature may allow the reviewer to see trends.

It was useful to divide the surgical management of scapholunate dissociation into two broad general categories—soft-tissue procedures and bony fusions. Soft-tissue reconstructions are attractive because, theoretically, they most accurately restore normal anatomy: ligament reconstruction for a ligamentous injury. The surgeon should recognize that the viscoelasticity of tendons is less than that of the ligaments they replace. Skeletal procedures, on the other hand, have are more predictable and more permanent. For various reasons, it appears that neither strategy is ideal. Each has its own strengths and weaknesses.

The literature suggests that surgical management tends to improve patients' symptoms. This is best illustrated in the series of Wintman et al.26 None of their patients reached a satisfactory outcome with the nonoperative treatment described. These authors emphasized that the patients' subjective pain ratings and subjective functional outcomes improved following surgery. In the majority of patients in this series, pain frequency was reduced from "pain throughout the day" preoperatively to "slightly greater than once a month" at the time of review. Subjective functional status also was markedly improved, such as brushing teeth, brushing hair, opening car doors, sweeping, shoveling, throwing, and using a screwdriver. Interestingly, subjective improvements were more dramatic than changes in the objective data, such as range of motion and strength.

The literature also documents a number of other important points, which have been gleaned from surgical experience. In children, wrist ligament injuries generally are believed to be less common than skeletal injuries. Zimmerman and Weiland47 noted that epiphyseal injuries about the wrist are more frequently recognized than isolated ligamentous injuries. They recommend soft-tissue procedures rather than intercarpal arthrodesis for the skeletally immature wrist to minimize the possibility of premature growth arrest.

One problem with soft-tissue recon-

<table>
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<th>Study</th>
<th>Type of Arthrodesis</th>
<th>No. Patients</th>
<th>Time to Surgery (mos)*</th>
<th>Follow-Up (mos)*</th>
<th>Range of Motion (%)*</th>
<th>Grip Strength (%)*</th>
<th>No. Patients With Painful Symptoms</th>
<th>Complications</th>
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<td>30</td>
<td>29</td>
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<td>80.7</td>
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<td>18</td>
<td>19</td>
<td>62.5</td>
<td>74</td>
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<td>4</td>
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<td>43.2</td>
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Abbreviations: ECRB=extensor carpi radialis brevis, ECRL=extensor carpi radialis longus, EPL=extensor pollicis longus, FCR=flexor carpi radialis, and RSD=reflex sympathetic dystrophy.

*Average.
†Improved.
struction is its lack of durability. Saffar et al.\textsuperscript{32} abandoned the use of tendon grafts for scapholunate ligament repair because they believed the procedure provided unacceptable results in terms of motion, grip strength, and radiographic findings. When the scapholunate gap was \(>4\) mm or when the scaphoid was not reducible, they preferred limited carpal arthrodesis.

Glickel and Millender\textsuperscript{22} noted that the radiographic appearance of the scapholunate gap and scapholunate angle did not appear to improve significantly after soft-tissue reconstruction. He postulated that repairs stretched out over time, and neither tendon grafts or ligamentous sutures could withstand the forces generated across the carpus in normal activity.

Proponents of skeletal procedures have argued that they are more predictable and permanent. Opponents of arthrodesis base their arguments principally on the associated long-term alterations in carpal kinematics that they suspect will occur. It is assumed that altered kinematics will produce abnormal loading and lead to post-traumatic arthritis; however, no objective evidence for this exists. It is nevertheless a generally accepted orthopedic principle, and untreated carpal disruptions, which lead to dorsal intercalated segment instability, have been shown to deteriorate to a SLAC wrist pattern post-traumatic arthritis.\textsuperscript{16}

Kleinman and Carroll\textsuperscript{48} reported a 52\% complication rate in 47 consecutive scaphoid, trapezium, and trapezoid fusions for chronic and dynamic scapholunate instability over 10 years. They pointed out that it is important to pay close attention to technical details. For instance, failure to close the scapholunate diastasis or imperfect scaphoid realignment results in progressive radiocarpal degeneration. They recommended 3 months of immobilization to minimize risk of nonunion. They also noted that K-wires used for skeletal fixation should be buried beneath the skin. They believed this reduced the risk of pin tract infection and the potential complication of carpal osteomyelitis.

Scapholunate fusions have been associated with nonunion rates as high as 47\%.\textsuperscript{30} The relatively high nonunion rate is attributed to the fact that only a small contact area exists between the two bones and also to the predicted high mechanical forces in the region. Hom and Ruby\textsuperscript{19} urged, however, that surgeons carefully review the results of scapholunate fusion. They noted that failure to achieve radiographic fusion did not necessarily correlate with poor outcome. The clinical results in some patients with failed scapholunate fusion were still good, suggesting that a fibrous union may afford adequate stability.

**CONCLUSION**

This evidence-based assessment of the literature on scapholunate dissociation was used to test the hypothesis that soft-tissue repairs of scapholunate dissociation produce better results than limited wrist fusions. Results demonstrated that the literature is too heterogeneous and individual reports are not epidemiologically strong enough to support or refute the hypothesis. The literature reflected a great deal of surgical experience and also demonstrated trends, which can be useful guides to good management decisions.

It is, therefore, still not possible to objectively recommend one surgical approach over another. Each described technique has strengths and weaknesses. Few differences are noted between the results of soft-tissue reconstructions and skeletal reconstructions, however, no comparisons between the two exist. Both interventions are logical. The results obtained from the individual operations were predictable. In some circumstances, one method may be chosen over another, eg, in children. Some surgeons prefer to perform soft-tissue reconstruction first because this can be converted to fusion if it is unsatisfactory.

Our basic understanding of wrist anatomy, kinematics, mechanism of injury, natural history, and diagnosis of wrist ligament injuries exceeds our ability to select the best treatment choice. The choice of operation is still largely determined by the experience and bias of the individual surgeon. Randomized, controlled, multicenter, clinical trials comparing different management strategies for patients with scapholunate dissociation are needed.

**REFERENCES**

1. Perry BH. A current perspective into the


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**The Treatment of Chronic Scapholunate Dissociation: An Evidence-Based Assessment of the Literature**

1. The thickest, strongest portion of the scapholunate interosseous ligament is located:
   - A. Distally.
   - B. Proximally.
   - C. Palmarly.
   - D. Dorsally.

2. A dorsal intercalated segment instability pattern seen on wrist radiographs indicates disruption of the scapholunate interosseous ligament and the:
   - A. Lunotriquetral ligament.
   - B. Extrinsic volar wrist ligaments.
   - C. Extrinsic dorsal wrist ligaments.
   - D. Triangular fibrocartilage complex.

3. The wrist ligament about which the scaphoid flexes is the:
   - A. Short radiolunate.
   - B. Long radiolunate.
   - C. Lunotriquetral.
   - D. Radioscaphocapitate.

4. The range of a normal scapholunate angle is:
   - A. 10°-40°.
   - B. 20°-50°.
   - C. 30°-60°.
   - D. 40°-70°.

5. An abnormal scapholunate interval as seen on an anteroposterior wrist radiograph is:
   - A. >2 mm.
   - B. >3 mm.
   - C. >4 mm.
   - D. >5 mm.

6. Which of the following most accurately describes the Watson shift test used in the clinical examination for scapholunate dissociation?
   - A. A click is perceived as the wrist is passively flexed and extended.
   - B. A click is perceived as the wrist is passively moved from radial to ulnar deviation with the examiner placing pressure at the proximal pole of the scaphoid.
   - C. A click is perceived as the wrist is passively moved from ulnar to radial deviation with the examiner placing pressure at the distal pole of the scaphoid.
   - D. A click is perceived when the wrist is passively brought from a supinated position into a pronated position and the examiner places pressure at the volar aspect of the lunate.
7. Which modality has the highest sensitivity and specificity in diagnosing carpal injuries that lead to intercarpal instability?
A. Arthroscopy.
B. Magnetic resonance imaging.
C. Triple-phase wrist arthrogram.
D. Wrist cineradiology.

8. The greatest complication associated with scapholunate arthrodesis is:
A. Infection.
B. Advanced degenerative changes.
C. Pain.
D. Nonunion.

9. Transfixing Kirschner wires through the scapholunate joint may most likely cause inadvertent injury to the:
A. Ulnar artery.
B. Median nerve.
C. Dorsal sensory branch radial nerve.
D. Dorsal sensory branch ulnar nerve.

10. In performing a triscaphe arthrodesis, what is the optimal position of the scaphoid with respect to the long axis of the forearm viewed laterally?
A. 30°.
B. 45°.
C. 60°.
D. 90°.
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