Scapho-trapezio-trapezoid arthrodesis for treatment of chronic static and dynamic scapho-lunate instability: A 10-year perspective on pitfalls and complications

Goals of reducing wrist pain, allowing a stable active wrist range of motion, and retarding degenerative changes make arthrodesis of the scapho-trapezio-trapezoid joint a popular treatment for chronic static and dynamic scapho-lunate instability; however, pitfalls and complications have not been well studied. Forty-seven wrists in 46 patients over a 10-year period revealed a complication rate of 52%. Failure to attain perfect scaphoid reduction consistently resulted in persistent incapacitating pain. Radial styloid-scaphoid impingement, observed after "successful" limited wrist fusion, was effectively treated by simple styloectomy. Carpal osteomyelitis, lunate avascular necrosis, pin-track infection, progressive medial carpal translation, and intractable pain without arthrosis complete the spectrum of complications managed in this series. Careful preoperative patient screening and attention to detailed recommendations will assist surgeons in avoiding the many potential problems associated with this procedure. (J HAND SURG 1990;15A:408-14.)

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Use of scapho-trapezio-trapezoid arthrodesis for management of both static and dynamic chronic scapho-lunate instability has reached major community acceptance during the past decade. The technique has been effective in reducing or eliminating incapacitating pain of predegenerative scapho-lunate dissociation, while improving strength and stability of the injured wrist. Preserved arcs of radiocarpal and midcarpal motion after scapho-trapezio-trapezoid arthrodesis, form the foundation for postoperative functional wrist mechanics. Retardation or prevention of progressive radiocarpal and intercarpal arthrosis, as one anticipates in untreated chronic rotary subluxation of the scaphoid, is an attainable goal with this technique.

In 1982, Goldner criticized the technique of limited wrist arthrodesis for chronic rotary subluxation of the scaphoid because of the anticipated loss of 50% of normal wrist motion in attaining the goals of reconstruction. Numbers of reported patients to that time had been small, and follow-up was inconsistent. Strong advice had been given by many respected authors for the pursuit of ligamentous reconstruction. At best, attempts could be made to restore damaged areas without additional surgical injury, even though it was well-recognized that there was questionable utility and availability of damaged ligamentous tissue, poor healing of replacement tissue, (i.e., tendon grafts), and difficulty accessing damaged areas surgically.

Since 1982, several authors have contributed critical evaluations of long-term wrist function after scapho-trapezio-trapezoid arthrodesis; however, as the popularity of this useful tool of the hand surgeon's armamentarium has increased, so have the difficulties encountered in applying the technique.

To improve understanding of the potential conse-
Fig. 1. A-B, Acceptable reconstitution of scaphoid attitude for scapho-trapezio-trapezoid arthrodesis. To minimize propensity for degenerative change, scapho-lunate diastasis must be less than 3 mm, and the lateral scaphoid angle must be less than 40 degrees. Temporary stabilizing subcutaneous K-wires are removed at 6 weeks.

Fig. 2. A-B, Return to gainful employment was not possible in both patients in this series in whom Staphylococcus aureus (coagulase +) osteomyelitis developed. Proximal row carpectomy was done for each, after initial debridement and 6 weeks of intravenous antibiotics.

sequences of employing this type of limited wrist arthrodesis to chronic painful scapho-lunate instability, a careful assessment of all observed complications associated with this procedure over a 10-year period has been made. This analysis lead to changes in philosophy of patient selection, technical alterations, and modifications in aftercare. Together, they reflect a heightened awareness of the fine details necessary to achieve more consistent satisfactory results.

Materials

A retrospective review of 47 wrists in 46 consecutive patients over a 10-year period (1978 to 1988) was done. All patients' charts and x-ray films were reviewed and each complication critically analyzed. Each patient in the series had either chronic static or dynamic scapho-lunate instability, with complete or partial dissociation of the scapho-lunate joint caused by a tension injury to the mobile (lateral) column of the carpus. The
Fig. 3. A-B, Insidious cartilage breakdown, synovitis, and styloid-scaphoid impingement pain were observed in two patients over a 10-year period. C-D, Both patients had relief of pain after simple radial styloidectomy; the painless arc of motion increased not only in flexion and extension, but also in ulnar and radial deviation.

interosseous scapho-lunate ligament and the radio-scaphoid portion of the ligament of Testut were partially or completely disrupted. Static dissociation (23 wrists in 23 patients) could be demonstrated on planar x-ray films, with scapho-lunate diastasis ranging from 3 to 7 mm. Comparison anteroposterior (AP) radial/ulnar deviation and axial-loading ("clenched fist") x-ray films were used in more subtle cases. The average scaphoid attitude (radio-scaphoid angle) on true-lateral x-ray film was 71 degrees.

Dynamic scapho-lunate instability was found in patients who had suffered a tension injury and had pain with activities when the wrist was axially loaded over the scapho-lunate joint. Static x-ray films did not reveal a change in the gap between the scaphoid and lunate, but a tear of the interosseous scapho-lunate ligament could be demonstrated by cinearthrography.

In cases of dynamic instability (24 wrists in 23 patients), work-up of a positive history of injury and chronic disabling pain was supplemented by planar x-ray films and cinearthrography. Although static x-ray films revealed no abnormal relationship between the scaphoid and lunate, leakage of contrast material on x-ray film indicated a traumatic fenestration in the damaged interosseous scapho-lunate ligament. This finding was noted in all patients in this group.

The operative technique used in these 46 patients, refractory to conservative management, was consistent in philosophy, but imprecise in practice. Effort was made to anatomically reduce the scaphoid, closing any abnormal scapho-lunate diastasis. Internal fixation ranged from 2 to 5 K-wires, with some patients undergoing supplementation of K-wire fixation by either staples or screws. All wrists were initially placed in plaster-reinforced long arm dressings for 10 to 14 days. In the first six patients in this 10-year series, wrists were immobilized in short arm thumb spica casts with forearms in neutral rotation for 6 weeks. The next 41 wrists were immobilized for 6 weeks in long arm thumb spica casts after surgery, followed by at least 4 weeks (usually 6) of immobilization in short arm thumb spica casts. Immobilization was extended until each scapho-trapezio-trapezoid arthrodesis was interpreted as healed, or until nonunion was believed to have developed.

Results

Open scaphoid reduction and closure of abnormal scapho-lunate diastasis (Fig. 1, A and B) were accomplished in only 39 of 47 cases. Efforts made to restore the radio-scaphoid angle to a normal 40 to 45 degrees were unsuccessful in all patients except for the eight in whom the diastasis was not reduced. The average postoperative angle for the series was 44 degrees, within the normal range.

Twenty-eight (52%) complications were recorded in 24 patients over a 10-year period, with follow-up averaging 60 months and all patients treated at the same center (Table I).
Scapho-trapezio-trapezoid arthrodesis

Fig. 4. A, PA x-ray film at 6 weeks demonstrates anatomic scaphoid reduction and subcutaneous K-wires before removal. B, Three-year follow-up clearly demonstrates a pseudarthrosis at the fusion site. Nonunion or pseudarthrosis of the scapho-trapezio-trapezoid arthrodesis mass was found in 15% of the patients in this series; each was treated by refusion with iliac crest cancellous graft. Secondary refusion resulted in successful arthrodesis in each case.

Pin tract infections were noted sometime during the first 6 weeks in 8% (n = 4) of the series. Each of these patients had percutaneous K-wires left protruding through the skin. Broad spectrum oral antibiotics were used to treat each infection. In one case, early removal of one of the two K-wires resulted in an immediate loss of scaphoid reduction; in this patient radio-carpal arthritis and pain rapidly developed subsequently requiring total wrist fusion.

Infection did not occur in any patient stabilized by subcutaneous fixation, whether by staples, subcutaneous K-wires, or screws. All subcutaneous K-wires were left in place for at least 6 weeks, allowing incorporation of bone graft in the three-bone fusion mass; removal was usually done with the patient under local anesthesia.

Osteomyelitis and carpal pyarthrosis developed in 4% (n = 2) of the patients, with Staphylococcus aureus identified in cultures obtained during initial surgical debridement in both cases. Care of each required multiple debridements, parenteral antibiotics for 6 weeks, and proximal row carpectomy to preserve stability and a small degree of motion (Fig. 2, A and B). Both patients regained some functional use of their hands, but were unable to return to their previous gainful employment.

After successful fusion of the scapho-trapezio-trapezoid joint, degenerative radial styloid-scaphoid impingement developed in 4% (n = 2). Both patients experienced the insidious onset of radial wrist pain, increased by forced radial deviation and extension. Intraoperatively, degenerative changes were found between the waist of the scaphoid and the styloid. Pain relief was complete after styloidectomy in each case (Fig. 3, A through D).

Nonunion or pseudarthrosis of the three-bone fusion mass was noted in 15% (n = 8) of the cases. Immobilization was continued for at least 16 weeks after operation in preliminary long arm, followed by short-arm thumb spica casts. Identification of delayed union in two of the first six scapho-trapezio-trapezoid arthrodeses performed in the series resulted in prolonging the initial period of cast immobilization from 6 weeks to 10 to 12 weeks. Initial long arm thumb spicas were applied excluding the medial four fingers and their metacarpophalangeal joints, and excluding the interphalangeal joint of the thumb. It had not been believed necessary to immobilize the metacarpophalangeal joints of the index and long fingers as described by Watson.

Every patient with a post-fusion nonunion or pseudarthrosis reported pain; the definitive diagnosis was confirmed by planar x-ray films and tomograms. Three-phase scintigraphy, computerized tomography (CT), and magnetic resonance imaging (MRI) were used only occasionally to help establish the diagnosis. In each of the eight cases of established nonunion, iliac crest bone
Fig. 5. A-B, Failure to attain anatomic reduction of the scaphoid at the time of scapho-trapezio-trapezoid arthrodesis resulted in progressive lunate avascular necrosis and collapse during the 42 months, interval between late surgery for Stage II progressive perilunar instability (12/80), and long-term follow-up (5/85).

graft was used for refusion; the fusion mass healed with secondary surgery in every case (Fig. 4, A and B).

In one patient avascular necrosis of the lunate developed over a 5-year period. The scaphoid was not anatomically reduced at the time of surgery, and the healed STT fusion mass did not prevent collapse of the lunate. Progressive migration of the distal carpal row radially and proximally was observed, with x-ray changes of progressive arthrosis (Fig. 5, A and B).

Progressive carpal arthrosis was noted in 19% (n = 9) of the series, resulting in formal radiocarpal joint arthrodesis and two had wrist replacement arthroplasty with either a Swanson or Volz prosthesis. It was significant that each patient in whom progressive arthrosis developed had a “successful” three-bone fusion; but incomplete intraoperative reduction of the scaphoid was found in every case (Fig. 6, A through C). Progressive arthrosis was the largest percentage of complications noted in this 10-year series (Table I).

Intractable pain in the absence of radiographic signs of carpal arthrosis was observed in 6% (n = 3). Two of these patients demonstrated a measurable medial shift of the lunato-triquetral unit, in spite of what was considered an anatomically reduced scaphoid and successful scapho-trapezio-trapezoid union. Progressive diastasis was observed at the scapho-lunate interface, altering mechanics at the helicoidal triquetro-hamate joint (Fig. 7). In both cases the hamate was entirely “engaged” (hamate-low posture) with the wrist in both neutral and radial deviation positions, an unusual attitude for the triquetro-hamate joint. All patients in this category required total wrist arthrodeses.

Discussion

Pin-tract infection in four patients in whom percutaneous K-wires were used to maintain scaphoid reduction show the consequences of early pin removal: carpal collapse leading to rapid degenerative arthrosis, pain, and—in each case—even the total wrist arthrodesis. K-wires may be removed with security by 6 weeks, with further immobilization provided by cast alone. More recent cases have employed subcutaneous K-wires, staples, and on occasion, screws to reduce the propensity for pin-tract infection.

Persistent focal pain at the fusion site was evidence of scapho-trapezio-trapezoid nonunion. This complication could often be observed on routine planar x-ray films, but AP and lateral tomography provided definitive confirmation. Although often requested, three-phase scintigraphy was rarely useful during the first postfusion year because of normal active bone remodeling at the arthrodesis site. Whether radial or iliac bone graft was used primarily, all refusions of nonunions in this series were performed with iliac crest cancellous bone graft and internal fixation.

From a 10-year perspective, it is apparent that symptoms of progressive radiocarpal arthritis after scapho-trapezio-trapezoid arthrodesis evolve along two pathways:

1. Since scaphoid mechanics at the radio-scaphoid joint are severely compromised by scapho-trapezio-trapezoid fusion, erosive chondrolysis and synovial inflammation can result at the radial styloid-scaphoid interface. If isolated to the contact area between lateral scaphoid and styloid, simple styloidectomy radial to the origin of the radio-scapho-capitate ligament is effective in treating styloid impingement syndrome, and restoring painless function.

2. The more common and, unfortunately, more un-
Incomplete intraoperative scaphoid reduction led to rapidly progressive degenerative changes in 19% of the patients in this series, in spite of a "successful" scapho-trapezio-trapezoid arthrodesis in each case; this group represents the study's largest area of complications. In retrospect, it is apparent that this problem is avoidable by critical attention to details of scaphoid alignment.

Forgiving pathway to rapidly progressive degenerative change observed in this series followed incomplete intraoperative reduction of the scaphoid. Unless the scaphoid is restored to its normal anatomic attitude, early traumatic arthritis and progressive wrist pain is assured. Factors significant in assuring a perfectly aligned scaphoid should include: (1) elimination of scapho-lunate diastasis; (2) centralization of the proximal scaphoid pole in the scaphoid fossa of the radius; and (3) reconstitution of a radio-scaphoid angle of 45 degrees, with normal carpal height. Seven of 23 patients in this series experienced progressive radio-carpal arthrosis. In each case intraoperative failure to obtain perfect scaphoid alignment was demonstrated retrospectively. Salvage was by total wrist arthrodesis in five patients, and wrist replacement arthroplasty in two.

In the single patient in whom lunate avascular necrosis (AVN) developed despite a healed scapho-trapezio-trapezoid fusion showed loss of carpal height and an incompletely reduced scaphoid after surgery. Although speculative, the lunate AVN might not have been secondary to initial wrist trauma, but rather to failure to reconstitute the load-bearing capacity of the radial side of the carpus. Malalignment increased load-bearing by the lunate and progressive collapse between the second and fifth postfusion years. Had carpal height been restored by anatomic scaphoid reduction at the time of scapho-trapezio-trapezoid arthrodesis, collapse of the lunate might have been avoided.

Limitless combinations of wrist extension, ulnar deviation, and intercarpal supination at the time of impact-load are responsible for progressive ligamentous attenuation or rupture, which results in traumatic rotary subluxation of the scaphoid. Although the interosseous scapho-lunate ligament and the radio-scaphoid portion of the ligament of Testut are rendered incompetent, the radio-lunate portion of the ligament of Testut and the radio-lunato-triquetral ligament may be preserved; me-
dial shift of the lunato-triquetral unit is usually not observed. In this series, two patients experienced slowly progressive medial lunato-triquetral shift after “successful” scapho-trapezio-trapezoid fusion, resulting in chronic medial column inflammation, and eventual total wrist fusion. Local chronic inflammation at the triquetro-hamate joint appears secondary to progressive medial migration of the proximal row by attenuation of both the radio-lunato-triquetral ligament and the remaining radio-lunate portion of the ligament of Testut (Fig. 7).

Conclusions

1. Retrospective review of a series of 47 consecutive scapho-trapezio-trapezoid arthrodeses for chronic static and dynamic scapho-lunate instability over a 10-year period revealed a 52% complication rate.

2. Failure to pay close attention to technical details (closure of scapho-lunate diastasis and perfect alignment of the scaphoid) results in rapidly progressive degenerative arthritis at the radio-carpal joint.

3. Patients with even subtle preoperative radio-carpal and/or intercarpal degenerative changes are not candidates for scapho-trapezio-trapezoid arthrodesis.

4. K-wires used to maintain reduction of the scaphoid at the time of a fusion should be buried to avoid pin-tract infection and/or carpal osteomyelitis.

5. Three months of postoperative immobilization is necessary to minimize risks of scapho-trapezio-trapezoid nonunion. Tomography is helpful in determining the presence of nonunion or pseudarthrosis.

REFERENCES


