Chronic Scapholunate Dissociation: Ligament Reconstruction Combining a New Extensor Carpi Radialis Longus Tenodesis and a Dorsal Intercarpal Ligament Capsulodesis

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Abstract: Scapholunate dissociation (SLD) is the commonest cause of carpal instability and wrist osteoarthrosis. The value of early diagnosis and treatment of this injury is well established in the literature. When a partial or total rupture of the scapholunate ligament is treated with early anatomic reduction and repair, functional results may be good to excellent. However, if this ligament is not addressed acutely then an overall carpal malalignment may seem progressively as a result of failure of the secondary scaphoid stabilizers. Chronic SLD will lead to scapholunate advanced collapse and progressive painful arthritis of the wrist. Although most surgeons agree that operative intervention is indicated, no clear consensus exists on the best treatment for patients with chronic SLD. Several procedures have been described that include some sort of partial fusion, capsulodesis, tenodesis, or bone-ligament-bone graft. If there is no evidence for arthrosis, soft-tissue procedures using either capsulodesis or tenodesis may be carried out in an attempt to preserve radiocarpal and intercarpal motion whereas avoiding fusion. This article describes a scapholunate ligament reconstruction combining a new dorsal extensor carpi radialis longus tenodesis and a dorsal capsulodesis for the treatment of chronic SLD.

Key Words: scapholunate dissociation, carpal instability, capsulodesis, tenodesis

HISTORIC PERSPECTIVE

Tenodesis and capsulodesis procedures have become a popular option for reconstructing the dysfunctional scapholunate ligament with a capsular/ligament strip or tendon graft in patients with reducible nonarthritic SLD. The primary goals of these soft-tissue procedures include pain relief, reestablishment, and maintenance of carpal alignment to prevent osteoarthritic changes, and preserve functional wrist mobility.

Capsulodesis techniques varied with both radiocarpal and intercarpal capsulodesis. In 1987, Blatt proposed a capsulodesis using a proximally based flap of dorsal wrist capsule inserted into the distal pole of the scaphoid tethering it to the radius to stabilize the forceful flexion of the scaphoid.1 Herbert modified this technique using the same reversed capsular flap reinserted proximally into the Lister tubercle.2 A similar
procedure is recommended by Linscheid and Dobyns with a proximally based strip of the dorsal intercarpal ligament (DICL). The problem with these procedures is that they fail to correct directly the SL gap and limit wrist motion, particularly flexion, as the transferred capsule tethers the distal pole of the scaphoid to the distal radius. Thus, in 1999 Slater developed a procedure including the DICL for scapholunate reinforcement. In this capsulodesis, the DICL is elevated from its insertion on the trapezium and trapezoid, rotated proximally, and secured to the distal pole of the scaphoid. So, the proximal carpal row is linked together (triquetrum to the distal pole of the scaphoid) to decrease the SL diastasis and the scapholunate angle is corrected equally well. Schweizer and Steiger described another option that included the DICL, but inserting it into the proximal rather than into the distal part of the scaphoid to fix the SL space in anatomic position, without focusing on scaphoid flexion. In 2002, Walsh et al described a technique that involved the use of a DICL strip detached from the ulnar insertion on the triquetrum, rotated proximally, and reinserted into the dorsal lunate. This reconstruction also included the ability to limit rotatory subluxation of the scaphoid and at the same time stabilize the SL joint. In contrast to Blatt capsulodesis, none of the abovementioned methods cross the radiocarpal joint.

The major advantage of dorsal capsulodesis compared with tenodesis is the technical ease of the procedure. However, capsulodesis seem to have a tendency to stretch out over time. Sometimes the joint capsule, which had been attenuated by repeated proximal pole subluxation, is too weak to resist the strong flexion forces acting on the scaphoid.

Tendon grafts have been reported to replace a scapholunate ligament. From the first reported tendon reconstruction of the SL ligament by Dobyns et al in 1975, the procedures have considerably evolved. The original technique consisted of passing a strip of tendon graft through anteroposterior tunnels in the proximal pole of the scaphoid and the lunate to recreate the dorsal SL ligament. At that time, the procedure provided unsatisfactory results because the holes drilled into poorly vascularized bone areas induced fractures or joint degenerations. Sixteen years later Almquist et al described the use of the so-called “four-bone ligament reconstruction”. Through a dorsal and palmar approach a distally based strip of the extensor carpi radialis brevis (ECRB) tendon was passed through the holes made in the capitate, scaphoid, and lunate, and finally fixed to the distal-palmar radius. The major problem of this method came from crossing both radiocarpal and midcarpal joints, which provided wrist stiffness. Linscheid and Dobyns proposed another option using a distally based strip of the extensor carpi radialis longus (ECRL) passed through a hole made in the distal scaphoid to prevent flexion collapse and fixed to the dorsal lunotriquetral ligament to close the SL gap. In 1995, Brunelli and Brunelli advocated a procedure with a strip of FCR that was passed through a tunnel in the distal pole of the scaphoid, pulled dorsally reducing the scaphoid to its position, and sutured to the dorsal radius. Both methods based their effectiveness in the stabilization of the proximal and distal ends of the subluxating scaphoid. Moreover, the holes were drilled far from the SL joint in which the 2 bones are poorly vascularized. The Brunelli procedure was first modified by Van Den Abbeele et al, who suggested not...
to cross the radiocarpal joint but to anchor the tendon onto the dorsum of the lunate or onto the dorsal radiotriquetral ligament (RTqL). By incorporating some features from these procedures, García-Elías et al.\textsuperscript{12} described a new modification named “the 3-ligament tenodesis” or “3LT procedure” as this tenodesis replicated the action of 3 ligaments (scaphotrapezial-trapezoidal, dorsal SL, dorsal radiotriquetral). Recently, Bleuler et al.\textsuperscript{13} described a dynamic tenodesis through a minimally invasive dorsal approach fixing the ECRL just to the dorsal aspect of the distal scaphoid with a screw. However, this technique only controlled 1 aspect of the deformity (flexion of the scaphoid).

As García Elías described, the ideal tenodesis should prevent rotary subluxation (flexion and pronation) of the scaphoid and extension-ulnar translation of the lunate. Although most modern techniques would include these aspects, most types of these tendon reconstructions are technically difficult to carry out with the need to drill several carpal bones. On the basis of the similar concepts of tendon stabilization, we developed a reconstructive technique that uses a strip of the ECRL combined with a DICL capsulodesis (Fig. 1) by a unique dorsal approach. Our tendon reconstruction technique may offer several advantages: (1) as a single dorsal approach is needed and suture anchors are used, it is technically simpler than other procedures; (2) tunnels through the scaphoid are not required, and thus, the risk of fracture or necrosis is avoided; (3) the tenodesis can be combined with a well-known capsulodesis (Walsh-technique)\textsuperscript{6} by the same dorsal approach seeking more consistent and predictable prevention of radiographic deterioration without adding increased morbidity. The purpose of this article is to describe our preferred surgical option for the treatment of this challenging injury since the senior researcher (PDC) developed this technique in 2003.

**INDICATIONS/CONTRAINDICATIONS**

When selecting treatment for chronic SLD one must first establish whether there is dynamic or static carpal instability. Patients with dynamic instability have normal radiographs, and their diagnosis is made by physical examination with tenderness over the scapholunate interval and a positive scaphoid shift maneuver. Carpal malalignment can only be seen by radiologic stress-views. Reviews of surgical treatment of dynamic carpal instability report equally high success rates with both tenodesis as capsulodesis.\textsuperscript{11,12,14–16} Thus, in these cases we prefer to carry out a dorsal capsulodesis as described by Walsh et al using the dorsal intercarpal ligament, which is technically simpler. In contrast, treatment of those patients with a static instability remains controversial. The long-term results are still unpredictable, with no optimal procedure.\textsuperscript{14,17–19} As described by García Elías et al.\textsuperscript{12} we believe that patients with static reducible scapholunate instability without arthritis represent the best candidates to carry out some
type of tendon reconstruction to stabilize not only the proximal SL joint but also the distal palmar component of the scaphoid. Contraindications for some type of soft-tissue procedure include those cases in which it is impossible to make an anatomic reduction of carpal bones (static irreducible instability) or when radiocarpal osteoarthritic changes are already present.

**SURGICAL TECHNIQUE**

A 6 to 8 cm, S-shaped longitudinal incision of the skin and subcutaneous tissue is made on the dorsal aspect of the wrist centered on Lister tubercle (Fig. 2). The dorsal-sensory branches of the radial and ulnar nerve are identified and meticulously spared. The extensor retinaculum is divided along the third compartment and the extensor pollicis longus tendon is retracted radially. The retinacular septa between compartments II and IV are sectioned and the 2 retinacular flaps are sharply separated from the wrist capsule, elevated, and retracted. Arthrotomy is carried out by a radially based capsular flap as described by Berger et al after the dorsal rim of the radius, the radial border of the RTqL and the proximal edge of the DICL (Fig. 3). Care is taken to leave enough dorsal RTqL and DICL to facilitate later tensioning of the tendon reconstruction and creation of the dorsal capsulodesis. Once the proximal row is exposed the SL joint is inspected and the presence of a complete rupture of the SL ligaments with a static carpal instability is confirmed (Fig. 4). The scaphoid seems subluxated in a rotary fashion whereas the lunate seems abnormally ulnarly translated and extended. Reducibility is checked under fluoroscopy control by direct manipulation with K-wires as joysticks (Fig. 5). At this stage the surgeon should confirm that the scaphoid and lunate are reducible and that there are no cartilage changes. The 2 bones (scaphoid and lunate) are reduced and percutaneously stabilized with two 1.5 mm K-wires across the SL joint, or 1 across the SL joint and another across the SC joint. After carpal reduction and stabilization a distally based 5-cm long strip of ECRL is obtained through the same dorsal approach (Fig. 6) and passed under the dorsal capsule. Pulled distally, the tendon strip is fixed on the dorsal aspect of the distal scaphoid with an anchor suture to augment the palmar-distal connections of the scaphoid and prevent rotary subluxation. A channel is carved over the dorsal aspect of the scaphoid and lunate to uncover cancellous bone. Once the tendon strip has been passed under the dorsal capsule, the tendon strip is fixed on the distal and proximal poles of the scaphoid and lunate with 3 sutures anchors (stars) and finally sutured to the RTqL. Care is taken not to detach the scaphoid fibers of the DICL.
flap is then brought back to its original position and sutured (Fig. 9). The extensor retinaculum is finally reconstructed and the skin is closed. No drains are placed. Immediate post-operative x-rays showing the restoration of carpal alignment are taken and a short-arm spica cast is placed and maintained with the K-wires for 8 weeks.

**REHABILITATION**

Eight weeks after surgery, the K-wires and cast are removed. A protective wrist splint must be worn for another 4 weeks and a program of passive and active wrist range of motion under supervision is started. Patients are instructed to avoid forceful axial loading of the wrist, particularly in extension as with weight lifting or push-ups, for 6 months.

**COMPLICATIONS**

Potential complications include infection, chronic regional pain syndrome type I, radial neuroma, joint stiffness, and chondrolysis or osteolysis owing to the placement of the pins and anchors. In our series, there were no instances of these problems. No second surgeries have been necessary so far. As usual in this type of procedure, it is expected to find some limitation of mobility, especially wrist flexion.

**RESULTS**

Sixteen patients (16 wrists) with a symptomatic chronic SLD (Stage IV of Garcia Elias-classification) were surgically treated using this combined tenodesis-capsulodesis from September 2003 until November 2009. We recently reviewed retrospectively the first 8 wrists in 8 patients (7 men, 1 woman; average age: 39 y, range: 30 to 52 y) with a flexible static SLD and a minimum 1 year of follow-up (average: 23 mo, range: 12 to 58 mo). After surgery all patients noted pain relief. According to the visual analog scale (VAS: 0 to 10), the average postoperative pain was 3 (range: 1 to 5). The mean postoperative DASH score was 13 (range: 0.83 to 30). The mean postoperative Wrightington score was 73 (65 to 90).

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Functional results were excellent in 2 cases and good in 6 cases. As expected, it was radiologically observed in all cases some loss of reduction initially obtained. However, none of them had a recurrence of carpal collapse (Table 1). Our results are comparable with other tendon reconstruction techniques earlier described for static SLD. Therefore, we conclude that this new ECRL tenodesis combined with a DICL capsulodesis represent a reliable option for chronic SLD with a static reducible carpal instability.

REFERENCES