Reconstruction of the Scapholunate Ligament Using Capitohamate Bone-Ligament-Bone

Toshiyasu Nakamura, MD, PhD¹ Koji Abe, MD¹ Takuji Iwamoto, MD PhD² Kensuke Ochi²
Kazuki Sato, MD, PhD²

¹Department of Orthopaedic Surgery, International University of Health and Welfare, Sanno Hospital, Tokyo, Japan

²Department of Orthopaedic Surgery, Keio University, Tokyo, Japan

J Wrist Surg 2015;4:264–268.

Address for correspondence Toshiyasu Nakamura, MD, PhD, Department of Orthopaedic Surgery, Clinical Research Center, International University of Health and Welfare, Sanno Hospital, 8-10-16 Akasaka, Minato-ku, Tokyo, 107-0052, Japan (e-mail: toshiyasu@ae.em-net.ne.jp).

Abstract

Background The biomechanical properties of the capitohamate (CH) ligament are equivalent to those of the scapholunate (SL) interosseous ligament. We reconstructed the SL ligament using the CH bone-ligament-bone substitute for chronic injury of the SL ligament.

Patients and Methods Beginning in 2008, 15 wrists of 14 patients with an average age of 38 years underwent this procedure with a minimum follow-up of 2 years. Thirteen wrists had an SL joint gap more than 3 mm, and two had a complete SL ligament disruption with a severe dorsal intercalated segment instability (DISI) deformity. Kirschner wires (K-wires) were removed 8 weeks after the surgery, then active ROM exercise began. Pain (on visual analog scale [VAS]), wrist motion (angle), radiographic characteristics, such as SL gap (mm) and SL angle, and Modified Mayo Wrist Score (MMWS) were evaluated.

Technique The SL joint was reduced by manipulation or with the use of joysticks, then temporary fixed with K-wires. A dorsal trough was then made between the scaphoid and the lunate. The proximal half of the CH ligament was harvested with attached bone from the capitate and hamate (CH bone-ligament-bone), inset into the SL trough, and fixed firmly with 1.2-mm diameter titanium screws in the scaphoid and lunate, respectively.

Results The VAS improved from 77 preoperatively to 12 postoperatively. The average wrist extension/flexion was 74°/60°. There was no ossification of the reconstructed SL at the final follow-up. The SL gap improved from an average of 4.8 mm to an average of 2.1 mm, and the SL angle changed from 67° to 55°. The MMWS improved to 82 points postoperatively from a preoperative average of 47 with eight excellent, five good, and two fair results.

Keywords

- ▶ scapholunate ligament
- ▶ capitohamate ligament
- ▶ reconstruction
- ▶ chronic injury

Since Linscheid et al described the kinematics of carpal instability in 1972,¹ a scapholunate (SL) ligament injury has been recognized as a common but difficult injury to treat. With an acute SL ligament tear, a direct repair and temporary fixation of the scaphoid and lunate with 2 to 3 Kirschner wires can be successful. Chronic tears lead to widening of the SL gap and collapse of the proximal and distal rows of the carpus with subsequent periscaphoid degenerative changes.²

When the SL ligament ruptures completely (volar, membranous, and dorsal portions), rotatory subluxation of the scaphoid can occur.³ The treatment of chronic SL ligament injuries, however, is still controversial. Several surgical procedures have been described that utilize the dorsal capsule of the wrist⁴ or flexor carpi radialis tendon⁵ to stabilize flexion and rotation of the scaphoid. A slip of the dorsal intercarpal ligament also can be used to reconstruct or to reinforce the

Fig. 1 (a) Complete disruption of the SL ligament was noted with the scaphoid flexed and triquetrum extended. (b) Lateral radiograph shows a DISI deformity.

Fig. 2 (a) Complete disruption of the SL ligament was noted (white arrow). (b) Illustration of the reconstruction technique (coronal view). (c) Reconstruction of the dorsal portion of the SL ligament by CH bone-ligament-bone. (d) Posteroanterior (PA) radiograph after the reconstruction of the SL ligament.

scapholunate ligament in either fresh or chronic SL ligament injury.⁶

Biomechanically, the dorsal portion of the SL ligament has been found to be the strongest stabilizer of the SL joint in comparison to the volar and central parts.⁷ Reconstruction of the dorsal SL ligament with bone-ligament-bone grafts has been described by several investigators.⁸⁻¹⁰ Several donor sites have been proposed, including the second or third carpometacarpal (CMC) joints, the navicular-cuneiform joint in the foot, and the extensor retinaculum.¹¹⁻¹⁶ Ritt et al showed that the biomechanical properties of the capitohamate (CH) ligament are equivalent to those of the SL ligament,^{17,18} which makes it a suitable candidate for bone-ligament-bone reconstruction of the dorsal SL ligament.

In the present study, we report our clinical results of reconstruction of the SL ligament using a CH bone-ligament-bone substitute.

Technique

Indications for this procedure include a nonrepairable complete disruption of the SL ligament with either dynamic SL instability or with a dorsal intercalated segment instability (DISI) pattern (►Figs. 1, 2a). A dorsal ligament-splitting capsulotomy as described by Berger and Bishop is used to expose the SL ligament.¹⁹ The distal aspect of this incision is extended ulnarly to expose the dorsal capitohamate ligament. The scapholunate joint is reduced by manipulation or by using Kirschner wires (K-wires) as joysticks, then temporarily fixed with two K-wires in addition to pinning of the scapho-capitate interval with one to two K-wires. Fluoroscopy is used to ensure an anatomic reduction of the scapholunate gap as well as rotatory realignment of the scaphoid and lunate. This is the key for success of this reconstruction. Usually the dorsal portion of the SL ligament was absent. The 5-mm × 10-mm × 5-mm (width, length, depth) rectangular gutter was made at the exact position of the dorsal portion of the SL ligament by a 5-mm chisel (►Fig. 2b). The proximal half of the CH ligament with capitate bone and hamate bone (CH bone-ligament-bone) was harvested to match the size as the gutter, then inset and rigidly fixed with 1.2-mm diameter titanium screws to the scaphoid and lunate to reconstruct the SL ligament (►Figs. 2c and d). When correctly inserted, the CH bone-ligament-bone graft maintains the scaphoid and lunate collinear with the capitate and hamate (►Figs. 3a, b).

Patients and Methods

Beginning in 2008, 15 wrists of 14 patients suffering from chronic SL instability were treated with CH bone-ligament-bone reconstruction by the senior author. The average age at the time of surgery was 38 years (range 25 to 75). There were

Fig. 3 Illustration of the surgical technique (axial view). (a) The CH bone-ligament-bone includes cartilage surfaces, (b) which are coplanar with the scaphoid and lunate articular surfaces.

13 male and 1 female patients and 11 right, 2 left, and 1 bilateral wrists. Thirteen wrists had an SL joint gap more than 3 mm and two had a complete SL ligament disruption with a DISI deformity. Two wrists had stage 1 scapholunate advanced collapse (SLAC) wrist with narrowing of the radial styloid-scaphoid articulation,² while 13 wrists were free of degenerative change. The etiology of injury included falls in

Fig. 4 (a) The integrity of the SL ligament reconstruction is noted at the time of K-wire removal (arrows). (b) PA radiograph 5 years after the SL ligament reconstruction. There was no ossification of the reconstructed SL ligament.

seven, traffic accidents in two, and sports-related trauma in six (including boxing in two, karate in two, and judo and weightlifting in one each). The K-wires were removed 8 weeks after the surgery and active range of motion (ROM) exercise began. In three wrists, the integrity of the reconstructed SL ligament was confirmed at the time of an open K-wire removal (►Fig. 4a). There was a minimum 2-year follow up (average 3.7 years, range 2–7 years).

We evaluated pain, which was evaluated by a visual analog scale (VAS); wrist flexion-extension motion (angle); radiographic characteristics, such as SL gap (mm) and SL angle pre- and postoperatively; and Modified Mayo Wrist Score (MMWS) at the time of final follow-up.

Results

All patients had pain on the dorsal side of the wrist, and tenderness between the third and fourth compartments. Five of 15 wrists had an additional triangular fibrocartilage complex (TFCC) injury with ulnar-sided wrist pain as well (treated with open repair in three wrists and reconstruction of the TFCC using an extensor carpi ulnaris [ECU] half-slip tendon in two). The VAS improved from a preoperative average of 77 (range 20–100) to a postoperative average of 12 (range 0–35). The average wrist extension range was 74° (range 65–90°), and flexion range was 60° (range 35–85°) postoperatively, as compared with a preoperative average extension range of 70° (range 54–90°) and flexion range of 77° (range 66–85°).

Radiographically, there was no ossification of reconstructed SL ligament (►Fig. 4b). The SL gap improved from a preoperative average of 4.8 mm (range 2.0–8.7 mm) to 2.1 mm (range 1.7–3.5 mm) at the time of final follow-up. There was normal motion of the scaphoid in radial and ulnar deviation (►Fig. 5). Two wrists with SLAC stage 1 experienced no further degeneration. The remaining 11 wrists had no

obvious degeneration of either the radiocarpal or midcarpal joints. Two wrists progressed to SLAC stage 2 from stage 1. Radiographically, the SL angle was 67° preoperatively and 55° degrees at the final follow-up. The MMWS improved to 82 points postoperatively from a preoperative average of 47. Using the MMWS there were eight excellent, five good, and two fair outcomes.

One Paralympic Judo player with a bilateral SL ligament injury developed widening of the SL gap due to back-out of the screws bilaterally, along with SLAC stage 2 degeneration, upon returning to the Judo National competition game soon after the K-wires' removal at 8 weeks following the surgery.

Discussion

Recently, there has been an interest in the use of osteoligamentous grafts to reconstruct the SL ligament.^{8–16} There are several donor site for bone-tissue-bone autografts; however, harvesting from the same extremity is much easier than from a different extremity. Cuénod described an SL reconstruction using a second CMC autograft with excellent clinical results in three cases.⁸ Kalb and Prommersberger obtained excellent clinical results in 16 patients who underwent this reconstruction with a mean follow-up of 6.3 years. However, six patients demonstrated radiographic widening of the SL gap.²⁰ Weiss described an SL reconstruction using a bone-retinaculum-bone autograft from third compartment region of the radius.⁹ He obtained excellent clinical results in patients with dynamic SL instability, while patients with a static SL dissociation had worse clinical results. His group later reported a long-term follow-up of 11.9 years with a deterioration in the clinical results.¹⁰

In the present study, we obtained excellent clinical and radiographic results of reconstruction of the SL ligament using a bone-CH ligament-bone substitute both for dynamic scapholunate instability and static SL dissociation.

Fig. 5 PA radiographs of (a) radial and (b) ulnar deviation. Note normal kinematics of the scaphoid.

There are several limitations in our study, including its retrospective design. We only have a relatively shorter follow-up of 2 to 7 years. We verified the integrity of the repair in only three cases. A longer follow-up of more than 10 years may be needed.

Conflict of Interest

None

References

- 1 Linscheid RL, Dobyns JH, Beabout JW, Bryan RS. Traumatic instability of the wrist. Diagnosis, classification, and pathomechanics. *J Bone Joint Surg Am* 1972;54(8):1612–1632
- 2 Watson HK, Ballet FL. The SLAC wrist: scapholunate advanced collapse pattern of degenerative arthritis. *J Hand Surg Am* 1984; 9(3):358–365
- 3 Watson H, Ottoni L, Pitts EC, Handal AG. Rotary subluxation of the scaphoid: a spectrum of instability. *J Hand Surg [Br]* 1993;18(1): 62–64
- 4 Blatt G. Capsulodesis in reconstructive hand surgery. Dorsal capsulodesis for the unstable scaphoid and volar capsulodesis following excision of the distal ulna. *Hand Clin* 1987;3(1):81–102
- 5 Brunelli GA, Brunelli GR. A new surgical technique for carpal instability with scapholunate dissociation. *Surg Technol Int* 1996;5:370–374
- 6 Viegas SF, Dasilva MF. Surgical repair for scapholunate dissociation. *Tech Hand Up Extrem Surg* 2000;4(3):148–153
- 7 Berger RA, Imeada T, Berglund L, An KN. Constraint and material properties of the subregions of the scapholunate interosseous ligament. *J Hand Surg Am* 1999;24(5):953–962
- 8 Cuénod P. Osteoligamentoplasty and limited dorsal capsulodesis for chronic scapholunate dissociation. *Ann Chir Main Memb Super* 1999;18(1):38–53
- 9 Weiss AP. Scapholunate ligament reconstruction using a bone-retinaculum-bone autograft. *J Hand Surg Am* 1998;23(2):205–215
- 10 Soong M, Merrell GA, Ortmann F IV, Weiss AP. Long-term results of bone-retinaculum-bone autograft for scapholunate instability. *J Hand Surg Am* 2013;38(3):504–508
- 11 Davis CA, Culp RW, Hume EL, Osterman AL. Reconstruction of the scapholunate ligament in a cadaver model using a bone-ligament-bone autograft from the foot. *J Hand Surg Am* 1998; 23(5):884–892
- 12 Harvey EJ, Hanel DP. Bone-ligament-bone reconstruction for scapholunate disruption. *Tech Hand Up Extrem Surg* 2002;6(1):2–5
- 13 Hofstede DJ, Ritt MJ, Bos KE. Tarsal autografts for reconstruction of the scapholunate interosseous ligament: a biomechanical study. *J Hand Surg Am* 1999;24(5):968–976
- 14 Müller M, Reik M, Sauerbier M, Germann G. A new bone-ligament-bone autograft from the plantar plates of the toes and its potential use in scapholunate reconstruction: an anatomical study. *Ann Plast Surg* 2008;61(4):463–467
- 15 Svoboda SJ, Eglseider WA Jr, Belkoff SM. Autografts from the foot for reconstruction of the scapholunate interosseous ligament. *J Hand Surg Am* 1995;20(6):980–985
- 16 Lutz M, Haid C, Steinlechner M, et al. Scapholunate ligament reconstruction using a periosteal flap of the iliac crest: a biomechanical study. *Arch Orthop Trauma Surg* 2004;124(4): 262–266
- 17 Ritt MJ, Berger RA, Bishop AT, An KN. The capitolunate ligaments. A comparison of biomechanical properties. *J Hand Surg [Br]* 1996; 21(4):451–454
- 18 Ritt MJ, Berger RA, Kauer JM. The gross and histologic anatomy of the ligaments of the capitolunate joint. *J Hand Surg Am* 1996; 21(6):1022–1028
- 19 Berger RA, Bishop AT, Bettinger PC. New dorsal capsulotomy for the surgical exposure of the wrist. *Ann Plast Surg* 1995;35(1): 54–59
- 20 Kalb K, Prommersberger KJ. Treatment of chronic scapholunate dissociation using Cuénod's bone-ligament-bone autograft [in German]. *Oper Orthop Traumatol* 2009;21(4–5):417–428