

# Three-Dimensional Description of Ligamentous Attachments Around the Lunate

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**Purpose:** To detail the location and area of specific ligament attachments on the 3-dimensional (3-D) surface morphology of the individual carpal bones.

**Methods:** We describe the attachment regions of both extrinsic and intrinsic intercarpal ligaments by using a combination of detailed dissection, computed tomography imaging, and a 3-D digitization technique and provide detailed information about ligament attachments around the lunate.

**Results:** The length, width, and thickness of each ligament are described in millimeters and its area of attachment is given in square millimeters and as a percentage of the bone surface and/or total ligament attachment area. The attachment sites of the ligaments also are shown visually on 3-D images of the bones.

**Conclusions:** This study improves the knowledge and understanding of carpal ligament anatomy, which can result in better intraoperative assessment of ligament integrity/disruption and allow more accurate and anatomic repair, reattachment, and/or reconstruction of carpal ligaments for the treatment of carpal instability. (*J Hand Surg* 2005;30A:685–692. Copyright © 2005 by the American Society for Surgery of the Hand.)

**Key words:** Lunate, proximal carpal bones, ligament, attachment, anatomy.

There have been a number of anatomic studies that describe the anatomy of the carpal ligaments.<sup>1–5</sup> Previous studies did not detail the location and area of specific ligamentous attachments on the 3-dimensional (3-D) surface morphology of the individual carpal

bones. A critical factor in assessing and treating carpal ligament injury and/or carpal instability is knowledge of the ligament attachment's location to assess its integrity to repair, reattach, or reconstruct the ligament. Successful reconstruction should depend on accurate information about the anatomic location of the normal ligamentous attachment. We describe the attachment regions of both extrinsic and intrinsic intercarpal ligaments involving the radius and proximal carpal row by using a combination of detailed dissection, computed tomography (CT) imaging, and a 3-D digitization technique and provide detailed information about ligamentous attachments around the lunate.

## Materials and Methods

### Specimen Preparation

Eight fresh-frozen cadaver upper extremities (mean age, 75.3 y; range, 64–85 y) were dissected carefully, both dorsally and volarly, and all ligaments were identified. The length, width, and thickness of

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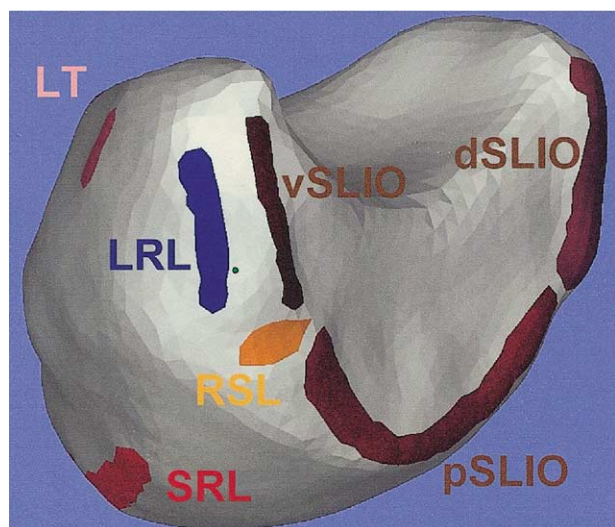
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**Figure 1.** A radiovolar view of the triangulated 3-D surface tiling of the right lunate. The attachment of each ligament is identified with a different color.

each extrinsic and intrinsic ligament between the radius, scaphoid, triquetrum, and lunate were measured with a standard caliper. The long radiolunate (LRL), short radiolunate (SRL), radioscapholunate (RSL), scapholunate interosseous (SLIO), lunotriquetral interosseous (LTIO), dorsal radiocarpal (DRC), and dorsal intercarpal (DIC) ligaments were measured basically as described in the literature by Berger.<sup>1</sup> In addition the lunotriquetral (LT) ligament also was measured and the attachment area of the ulnolunate (UL) ligament on the lunate was documented. After measurement each ligament was bi-

sected and the scaphoid, lunate, triquetrum, and trapezoid were removed with an intact stump of each ligament. The distal quarter of the radius was harvested with an intact stump of the ligaments. Residual synovium around the joint surface was removed and periosteum on each bone was dissected carefully to isolate the actual sites of ligamentous attachments. Specimens were dried; the attachments of each ligament were marked using an oil-based, sharp-pointed color marker; and these ligaments were removed carefully while the attachment outlines were preserved. Three small screws were placed in the individual carpal bones as fiducial markers to define the 3-D local coordinate system for each bone. Furthermore a single half pin was inserted into each bone to provide a firm fixation to the digitizing platform.

### Modeling the Ligamentous Attachments on Individual Bones

A digitizer (MicroScribe-3DX Digitizer; Immersion Corp., San Jose, CA) and original 3-D surface reconstruction software (Spider; developed by Orthopaedic Biomechanics laboratory, the University of Texas Medical Branch, Galveston, TX) were used to digitize manually entire bone surfaces at approximately 1-mm intervals. The accuracy of this digitizer is 0.23 mm. Different colors were used to mark each ligament attachment. The resulting sets of digitized points were modeled as triangulated surfaces, preserving the color-coded ligament attachment regions (Fig. 1). The software was used to triangulate the surfaces automatically;

**Table 1. Manual Measurements for Volar, Dorsal, and Interosseous Ligaments**

	Length (mm)	Width (mm)	Thickness (mm)
Volar ligaments			
LRL	15.9 ± 3.7	5.8 ± 0.9	1.2 ± 0.2
SRL	7.4 ± 1.7	10.6 ± 1.7	1.2 ± 0.4
RSL	9.2 ± 1.8	4.8 ± 1.4	0.7 ± 0.3
UL	18.1 ± 2.9	2.3 ± 0.3	0.7 ± 0.2
LT	7.8 ± 1.7	4.8 ± 1.8	0.7 ± 0.3
Dorsal ligaments			
DRC	17.7 ± 3.1	7.8 ± 1.4	1.1 ± 0.3
DIC	33.3 ± 3.5	6.1 ± 1.5	0.9 ± 0.3
Interosseous ligaments			
SLIO			
Volar	3.4 ± 1.0	5.7 ± 1.9	1.0 ± 0.5
Proximal	3.8 ± 1.8	11.3 ± 2.3	1.3 ± 0.3
Dorsal	3.8 ± 1.5	5.8 ± 0.9	1.7 ± 0.4
LTIO			
Volar	4.1 ± 1.7	6.0 ± 1.4	1.4 ± 0.5
Proximal	1.8 ± 0.6	10.2 ± 1.7	1.0 ± 0.4
Dorsal	3.2 ± 1.3	5.7 ± 1.9	1.0 ± 0.3

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