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First Carpometacarpal Joint Anatomy and Osteoarthritis: MR Imaging Overview

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Abstract

The first carpometacarpal (CMC) joint consists of seven ligaments. The magnetic resonance imaging (MRI) examination of the first CMC joint should be performed in a high field 1.5/3 T MRI with a dedicated hand coil for high-resolution images. Degeneration of anterior oblique ligament (AOL) is the most important cause for the development of osteoarthritis of first CMC joint. Since the AOL undergoes a predictable pattern of alteration at its metacarpal attachment as degeneration proceeds, MRI imaging can provide an accurate assessment of this ligament.

Keywords

- anterior oblique ligament
- first carpometacarpal joint
- osteoarthritis

Introduction

The magnetic resonance imaging (MRI) examination of the first carpometacarpal (CMC) joint should be performed in a high-field 1.5/3 T MRI with a dedicated hand coil for high-resolution images. The anatomy is depicted with T1-weighted and proton-density (PD)-weighted images. Pathological findings are best demonstrated on PD-weighted fat-saturated or short tau inversion recovery (STIR) images.[1,2] The metacarpal base and trapezium are concavo-convex (►**Fig. 1**) in opposing planes allowing a wide range of motion.[3]

The first CMC joint consists of seven ligaments.[2] The anterior oblique ligament (AOL) attaches to the articular margin in the volar aspect, while the dorsal ligamentous complex and the intermetacarpal ligament inserts along the dorsal aspect of the first CMC joint. The dorsal deltoid ligament comprises of three components, namely dorsoradial (DRL), dorsocentral (DCL), and posterior oblique ligaments. Other ligaments are the dorsal trapeziometacarpal ligament and ulnar collateral ligament.[4,5]

AOL originates from the volar tubercle of trapezium and attaches to the volar aspect of first metacarpal base (►**Fig. 2**). Degeneration of AOL is the most important cause for the development of osteoarthritis (OA) of first CMC joint.[6] The dorsal ligament complex originates at the dorsal aspect of the trapezium with a broad insertion on the dorsal aspect of the first metacarpal (►**Fig. 2**). The DRL courses below the abductor pollicis longus tendon and the DCL lies beneath the extensor pollicis brevis tendon. Intermetacarpal ligament is an extracapsular ligament from the second metacarpal to the first metacarpal base (►**Fig. 3**).

Case Report

A 53-year-old female presented with pain, tenderness, and restriction of motion of the left thumb at the left first CMC joint. There was no previous history of trauma. Diagnosis of OA was made on MRI with stripping of AOL from the first metacarpal base. The anatomy of this joint is complex comprising of seven ligaments and MRI is the modality of choice for evaluating this complex ligamentous anatomy.

MRI was done that showed mild effusion with joint space narrowing and articular cartilage loss at the first CMC joint. There was stripping of the AOL from the metacarpal insertion with formation of adjacent volar synovial recess (►**Fig. 4**) and subluxation of the first metacarpal bone. Subchondral edema and cystic changes were noted in the trapezium with marginal osteophytes (►**Fig. 4**) in the first metacarpal base

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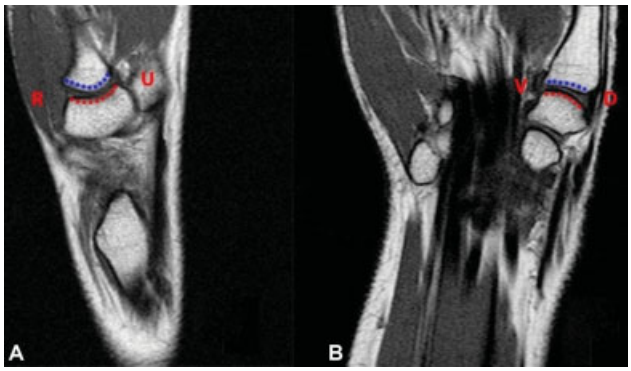

Fig. 1 Sagittal T1-weighted (**A**) and coronal T2-weighted (**B**) images demonstrating first carpometacarpal joint articulation. Metacarpal base is concave dorsovolar and convex radioulnar (violet line). The trapezium is concave radioulnar and convex dorsovolar (red line).

and trapezium. Based on the above imaging findings, diagnosis of first CMC arthritis was made.

Intermediate proton-density fat-saturated (PDfs) signal intensity with thickening of dorsal ligament complex and intermetacarpal ligament was noted. No evidence of tear of these ligaments was evident on MRI. Mild thickening with surrounding fluid is seen at the insertion of the abductor pollicis longus tendon (►**Fig. 4**). These findings were suggestive of chronic strain of the adjacent ligamentous and tendinous structures.

Although the dorsal ligaments are the apparent primary restraint to traumatic dorsal subluxation, degeneration of the AOL has a primary role in development and progression of thumb CMC joint OA. With degeneration, the fibrocartilaginous insertion of the AOL retreats distally on the metacarpal and a volar synovial recess forms with variable osteophyte formation (►**Figs. 5** and **6**). As degeneration progresses, periosteal stripping of the AOL insertion ensues and this recess enlarges. Dorsal translation of the metacarpal increases and, at its end point, the ligament detaches. Periarticular ganglion cysts are often seen as degeneration proceeds (►**Fig. 7**).

Discussion

The first CMC joint OA is common disorder in postmenopausal women and increases with overuse or trauma.

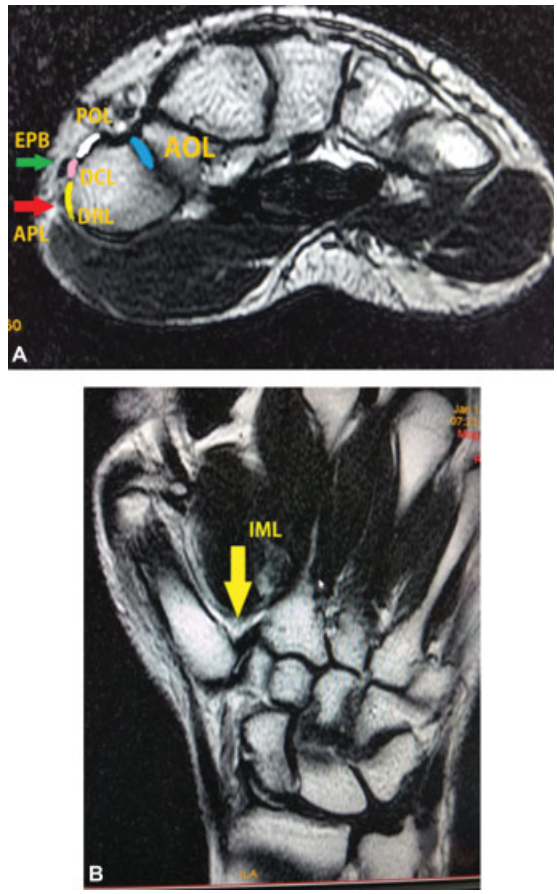

Fig. 3 Sequential coronal PDfs images (**A**) showing the relationship of the first carpometacarpal joint ligaments to the abductor pollicis longus (APL) and extensor pollicis brevis (EPB) tendons. Coronal T2-weighted image (**B**) demonstrating the intermetacarpal ligament (IML) (yellow arrow) extending between the first and second metacarpal base. AOL, anterior oblique ligament; DCL, dorsocentral ligament; DRL, dorsoradial ligament; POL, posterior oblique ligament.

Degeneration of AOL is the primary contributor for the development of OA, and it correlates well with the severity of arthritis. The insertion at the first metacarpal base retreats and leads to volar synovial recess formation. With the progression, stripping of AOL results in complete detachment leading to enlargement of the recess and dorsoradial translation of the first metacarpal. As the degeneration progresses, there is cartilage loss and subchondral changes

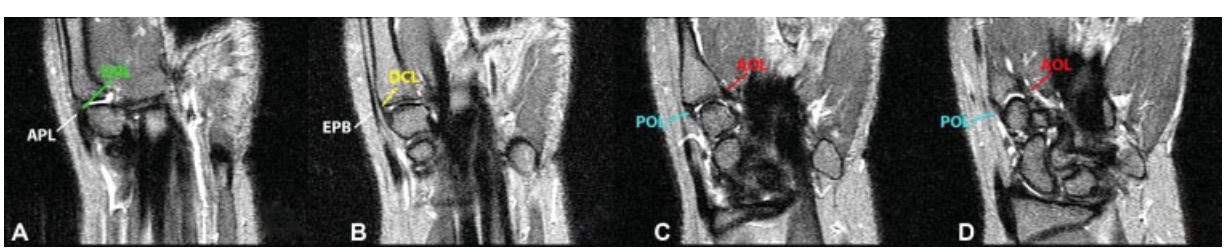

Fig. 2 Sequential coronal PDfs images from radial to ulnar aspect showing the anatomy of the first carpometacarpal joint ligaments. In the radial aspect, dorsoradial ligament (DRL) (green line) courses below and is reinforced by the abductor pollicis longus (APL) (white line) tendon. (**A**) The dorsocentral ligament (DCL) (yellow line) is located beneath the extensor pollicis brevis (EPB) (white line) tendon. (**B**) In the ulnar aspect of the joint, both anterior oblique ligament (AOL) (red line) and posterior oblique ligament (POL) (blue line) are identified. (**C, D**) AOL originates at the volar tubercle of trapezium and attaches to the volar beak of the first metacarpal base.

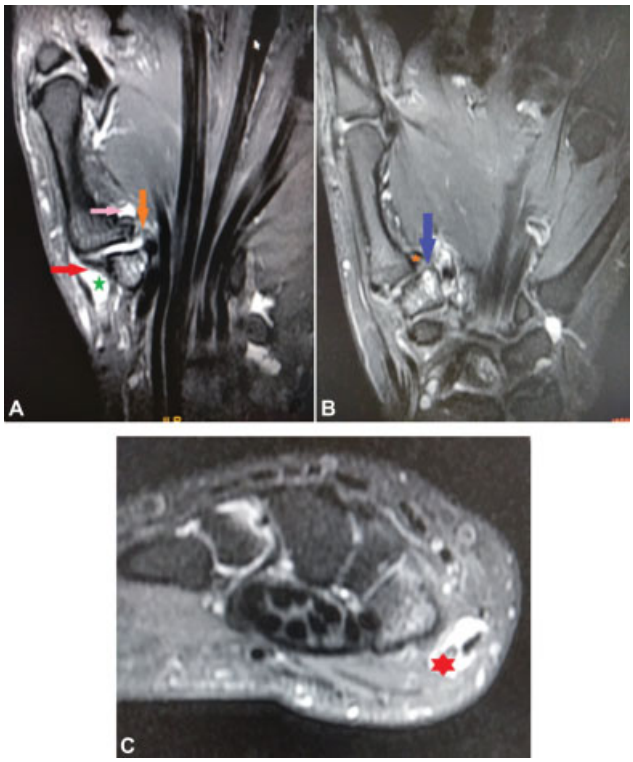

Fig. 4 Coronal PDfs image (**A**) showing mild joint effusion with stripping of the anterior oblique ligament (orange arrow) from the first metacarpal base, adjacent volar synovial recess formation (star), and mild thickening of the dorsal ligament (red arrow). Coronal PDfs image (**B**) demonstrating joint space narrowing with dorsoradial subluxation of the base of the first metacarpal bone and subchondral changes in the trapezium (blue arrow). Note the marginal osteophyte in the base of the first metacarpal (star). Axial PDfs image (**C**) showing surrounding fluid at the insertion of the abductor pollicis longus tendon (star).

in the trapezium and first metacarpal with chronic strain in the rest of the ligaments and adjacent tendons.

OA of the CMC joint of the thumb is characterized by articular degeneration owing to compression and rotational shear forces on the trapezium. As the disease progresses, the thumb metacarpal may become dorsoradially subluxated on the trapezium, resulting in hyperextension deformity of the

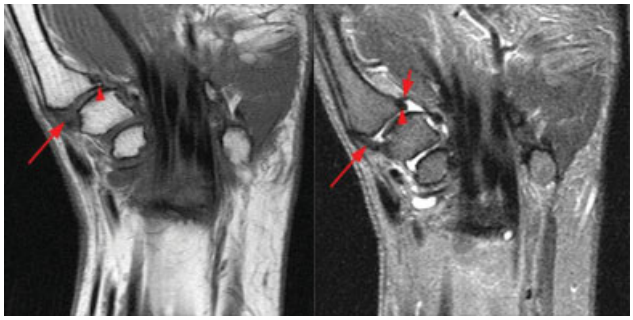

Fig. 5 Coronal T1-weighted (left) and short tau inversion recovery (STIR) (right) images. Volar beak osteophyte of the metacarpal (arrowheads) with dorsal capsuloligamentous thickening (arrows). The anterior oblique ligament is attenuated with distal retraction of its metacarpal attachment (short arrow) distal to the osteophyte, best seen on the STIR image (right).

Fig. 6 A coronal T2-weighted image demonstrates carpometacarpal joint osteoarthritis with a chronic distal tear of the anterior oblique ligament with retraction distally and a small ganglion cyst (arrowhead), thickened dorsocentral ligament (arrow), dorsal subluxation, and severe cartilage loss.

Fig. 7 A coronal short tau inversion recovery image reveals attenuation and distal retraction of the anterior oblique ligament (AOL) (arrow) with ganglion cysts (arrowheads) adjacent to the AOL and deep to the abductor pollicis longus (APL) tendon, respectively, and dorsoradial subluxation. Mild increase in signal intensity of the dorsoradial ligament may be due to normal variation, recent sprain or chronic degeneration.

metacarpophalangeal joint. Scaphotrapeziotrapezoidal arthritis, carpal tunnel syndrome, and DeQuervain's tenosynovitis are commonly associated with degenerative changes at the first CMC joint. Since the AOL undergoes a predictable pattern of alteration at its metacarpal attachment as degeneration proceeds, this would be the imaging target. Therefore, if a high-resolution MRI demonstrated partial AOL detachment with or without a small volar synovial recess and relatively intact articular cartilage, this would indicate that the patient is a candidate for ligament reconstruction, with the goal of preventing or delaying development of progressive OA.

Treatment includes conservative therapy, intraarticular steroids, or local anesthetic initially with surgery in refractory cases. The degree of ligamentous injury is difficult to assess and MRI with its superior resolution provides accurate assessment of the degenerative changes and the ligaments. Halt or delay in the progression of degeneration can be achieved in refractory cases. MRI can also rule out other causes for pain at the thumb base like carpal tunnel syndrome, tenosynovitis, and subtle fractures.

Conclusion

MRI is the modality of choice for first CMC joint due to its complex anatomy. Since there is a predictable pattern for the degeneration of the AOL, MRI imaging can provide an accurate assessment of this ligament. Prevention or delay in arthritis can be achieved before the loss of function especially in cases requiring surgery.

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Conflicts of Interest
There are no conflicts of interest.

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