

Applied Anatomy of Ligaments of Trapeziometacarpal Joint: A Cadaveric Study

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Abstract

Background: There are some current controversies in anatomy of ligaments of trapeziometacarpal joint. Understanding the anatomy of the ligaments of trapeziometacarpal joint is essential for anatomical reconstruction of these ligaments. **Objective:** To identify and describe the anatomical characteristics of ligaments of trapeziometacarpal joint. **Materials and methods:** Dissection of 30 hands from 15 fresh-frozen cadavers. **Results:** Five principal ligaments of trapeziometacarpal joint were identified. One volar ligament: anterior oblique ligament; three dorsal deltoid-shaped ligaments: dorsal radial, dorsal central, posterior oblique; and one ulnar ligaments: intermetacarpal. Dimensions of ligaments, of origin and insertion footprints were calipered. **Conclusions:** There are two systems of ligament at trapeziometacarpal joint: AOL on volar aspect and DRL, DCL and POL on dorsal aspect. In which, DCL is the strongest.

Keywords: Anterior oblique ligament, dorsal radial ligament, dorsal central ligament, posterior oblique ligament, intermetacarpal ligament, trapeziometacarpal joint.

Introduction

Human hand plays a very important role in living activities and manual labor of the mankind. In a hand, thumb is the major finger and responsible for 40% of the hand's function. Hand moves cleverly and flexibly, which is also a distinct characteristic of human-being⁽⁷⁾.

Trapeziometacarpal joint has a shape of saddle, doing large motions with permitted movements: flexion-extension, abduction-adduction and opposition⁽⁷⁾. To achieve those flexible moves, a firm system including articular capsule and ligaments is required⁽⁶⁾. Articulation defect may be due to several causes such as acute and chronic injury of the joint, arthritis. In some cases of dislocation and arthritis of trapeziometacarpal joint, ligament repair or reconstruction is recommended. Accurate understanding about anatomy, origin, insertion, quantity, footprints of these ligaments is very useful in these mending procedures.

There are five ligaments at the joint. One volar ligament: anterior oblique (AOL), three dorsal deltoid-shaped ligaments: dorsal radial (DRL), dorsal central (DCL), and posterior oblique (POL) and one ulnar ligament: intermetacarpal (IML). Accurately describing amount and form of trapeziometacarpal joint's ligaments is still controversial among Western scientists. In Vietnam, until now, there haven't been any studies about applied anatomy of this zone. The question is if there are any differences between anatomical shape and size of trapeziometacarpal joint ligaments of Vietnamese people and those of the Westerners.

Objectives

Identifying applied-anatomical characteristics of trapeziometacarpal joint:

- To certify the presence of ligaments at around trapeziometacarpal joint: AOL, DRL, DCL, POL and IML.
- To describe anatomical characteristics of these ligaments.

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Materials and Methods

We dissected 30 normal hands from 15 fresh-frozen cadavers of various ages in the Anatomy Department, University of Medicine and Pharmacy at Ho Chi Minh city.

Step 1: Collecting administrative information of cadavers after defrosting

Step 2: Dissecting method

- Incising skin, dissecting and removing soft tissues (Figure 1).
- Looking for AOL, DRL, DCL, POL, IML
- Measuring the size of AOL, DRL, DCL, POL, IML
- Cutting AOL, DRL, DCL, POL, IML at origin and insertion; marking the origin and insertion
- Measuring the footprint dimensions of origin and insertion

Step 3: Collecting data based on collecting form

- Certifying length, width, thickness of the ligaments: AOL, DRL, DCL, POL and IML
- Defining parameters of origin and insertion of AOL, DRL, DCL, POL and IML including A, B, C and A1, B1, C1

Variables

Way of measuring the size of AOL, DRL, DCL, POL and IML:

- Length: measuring from midpoint of origin to midpoint of insertion
- Width: distance between two borders of ligament
- Thickness: size from top to bottom of ligament, measured at the midpoint of ligament.

Way of measuring the caliber of origin and insertion A, B, C and A1, B1, C1:

- Origin: the position at dorsal and volar side of trapezium bone
- Insertion: the position at dorsal and volar side of base of first metacarpal bone

In which:

- A: The distance from the center of origin of AOL/DRL/DCL/POL/IML to articular side.
- B: The width of origin of AOL/DRL/DCL/POL/IML.
- C: The length of origin of AOL/DRL/DCL/POL/IML.
- A1: The distance from the middle of insertion of AOL/DRL/DCL/POL/IML to articular side.
- B1: The width of insertion of AOL/DRL/DCL/POL/IML.
- C1: The length of insertion of AOL/DRL/DCL/POL/IML.



Figure 1: Expose the dorsal ligaments



Figure 2: Expose the AOL on volar aspect



Figure 3: Measuring the length of AOL

Results

The samples

Table 1. Features of study samples

Features	No. Samples	Male : Female	Age	Duration from dead to dissection	Sample
Results	30	3 : 2	64,93	309,8 days	fresh-frozen cadaver

Anatomical characteristics of trapeziometacarpal joint

Table 2. Number of ligaments of trapeziometacarpal joint

Ligament	Volar	Dorsal	Ulnar
Number	1	3	1
Name of lig.	AOL	DRL, DCL, POL	IML

Dimension of ligaments

Table 3. Dimension of ligaments

Dimension (mm)	AOL	DRL	DCL	POL	IML
Length	9.3	4.0	9.3	12.8	10.0
Width	4.6	3.9	5.1	5.8	2.2
Thickness	1.0	4.0	1.9	1.8	1.0

Parameters of origin and insertion of ligaments

Table 4. Parameters of origin and insertion of ligaments

Origin - Insertion (mm)	AOL	DRL	DCL	POL	IML
A	4.0	4.0	4.2	4.0	2.2
B	4.1	3.9	4.1	3.8	2.3
C	4.4	4.0	4.2	5.0	2.2
A1	4.2	3.9	3.9	5.0	2.4
B1	4.2	3.7	3.9	5.1	2.1
C1	4.0	3.7	3.7	4.9	2.3

Discussion

The samples

In 30 dissected hands, we had a male/female ratio = 3/2 (18 males: 12 females). Meanwhile, Ladd's study (2012) had the male/female ratio = 11/4 (11 male : 4 female)⁽³⁾. The mean age of our samples was 64.9 years old, ranging from 32 to 87. All samples, which were from mature Vietnamese almost middle-aged, no trauma and no surgery or metacarpal defect, were kept cold at 30 minus Celsius degrees at Anatomy Department. The mean age of the subjects in our study was smaller than those of Ladd's study (2012), (76 years old, ranged from 43 to 99 years). The average duration from death to dissection was 309.8 ± 46.0 days, ranging from 253 to 660 days. The longer storage duration influenced the quality of dissected sample, because of the risk of degradation when defrosting and dehydrated tissue during cryopreservation.

Anatomical characteristics of trapeziometacarpal joint

Our study confirms the presence of five ligaments at trapeziometacarpal joint. These ligaments are: one volar ligament AOL, three dorsal ligaments DRL, DCL and POL, one ulnar ligaments IML. The number of our ligaments is similar to that of Pagalidis (1981), Haines (1944). It's likely that there were differences about conventions and names given by different authors. Ladd's study (2012) presents 7 ligaments around the joint but two of them do not belong to this articulation. Vice versa, most researches confirm the presence of 4 ligaments AOL, DRL, POL and IML, as described by Imaeda (1994), Hagert (2012)⁽²⁾ and Tan (2011)⁽⁸⁾. The amount and the way of naming ligaments of trapeziometacarpal joint are a little bit different until now by the authors in the world, but after this study, we support to opinion that there are five ligaments at around trapeziometacarpal joint. The disputed idea needs more studies^(2,4,8)

While operating on 30 hands, we realized significantly that there are 2 main systems to help stabilizing the thumb joint: volar side with AOL, dorsal side with 3 deltoid-shaped ligaments DRL, DCL, POL. The quantity of ligaments is not important. This discovery is applied practically in reconstruction ligaments of trapeziometacarpal joint^(1,5).

Table 5. Number of ligament of trapeziometacarpal joint

Author	Number	Name of ligaments	Difference
We	5	AOL, DRL, DCL, POL, IML	
Ladd (2012)	7	AOL, DRL, DCL, POL, IML, UCL, DTM-1	UCL, DTM-1
Hagert (2012)	5	AOL, DRL, DCL, POL, UCL	UCL
Tan (2011)	5	AOL, DRL, DCL, POL, IML	

UCL: ulnar collateral ligament; DTM-1: the first dorsal trapeziometacarpal ligament

Dimension of ligaments

We found the presence of all ligaments AOL, DRL, DCL, POL, IML. By comparison, the size of ligaments we measured is smaller than the average size of Ladd (2012), which is capable because of difference in stature between Vietnamese and Western people. The thickness of these ligaments is very small, so it is difficult to measure accurately. AOL is the thinnest one and DCL is the thickest and shortest among all ligaments of thumb joint⁽³⁾.

Based on the results of the size of ligaments measured, we can take a suitable specimen of flexor carpi radialis tendon for reconstruction of ligament system at trapeziometacarpal joint.

Parameters of Origin and Insertion of Ligaments

As what we know, the calibers of origin and insertion footprints of the ligaments have not been reported in any other authors' studies yet. But they take good part in reconstruction surgery of ligaments. Concretely, the results provide parameters of origin, insertion and distance from origin-insertion to articular surface, which helps anatomical reconstruction to obtain the best range of movement.

Practically applying to reproduce the palmar ligament system AOL in trapeziometacarpal joint arthritis with half of flexorcarpi radialis tendon, surgeons use a 2.7 mm drill bit to create an anteroposterior tunnel at base of the metacarpal bone. The distance from tunnel to articular line is equal to distance from the center of origin of AOL to articular surface. In our study, for Vietnamese, this is 4.2 mm. According to Merle (2011), this distance for clinical application is 5 mm, but there wasn't evidence support his opinion⁽⁶⁾.

After identifying the position to make a tunnel at the front base of the first metacarpal bone, we should drill to the anteroposterior direction that is parallel with joint surface. The opposite open of tunnel is behind the base of metacarpal bone, far from articular surface as the distance from the center of origin of DCL to joint surface. The average distance in our study is 3.9 mm. The outcome shows that we should adjust the drill bit a little slantly up following the anteroposterior direction.

Conclusion

There are five ligaments at around trapeziometacarpal joint. Four of those induce two major systems for stabilizing trapeziometacarpal joint: the volar ligament AOL and the dorsal ligament system DRL, DCL, POL. Of dorsal ligaments, DCL is the strongest ligament. In doing procedure of ligament reconstruction, we need to pay attention to its anatomical position.

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