Anatomical study of the carpal attachment of the triangular fibrocartilage complex

Shinji Nishikawa, Satoshi Toh

From Mutsu General Hospital, Aomori, Japan

There have been few descriptions of the site of attachment onto the triquetrum, the so-called meniscal homologue, of the triangular fibrocartilage complex (TFCC). We have investigated the sites of attachment onto the triquetrum of 87 TFCCs collected from embalmed cadavers.

All TFCCs were smoothly attached to the triquetrum. In 79 (46 cases, 90%) they were attached to the triquetrum and fifth metacarpal bone, and in eight (5 cases, 10%) they were attached widely on the articular surface of the triquetrum.

It is necessary to have accurate positional information about the normal triquetrum and TFCC in order to perform arthroscopy. The meniscal homologue attached to the triquetrum is smooth in almost all cases. In about 10% of joints the TFCC is attached to the lunotriquetral ligament, either partly or completely obscuring the articular surface of the triquetrum.

J Bone Joint Surg [Br] 2002;84-B:1062-5.

Received 6 November 2001; Accepted after revision 11 March 2002

The triangular fibrocartilage complex (TFCC) is continuous from the articular surface of the radius, covers the ulnar head of the distal radio-ulnar joint and forms the articular surface on the ulnar side. Palmer and Werner¹ stated that the TFCC is a structure composed of a disc which separates the distal radio-ulnar joint and the wrist, the surrounding ligament, and tissues continuous from the carpal area. Elias², based on histological studies, regarded the tissue which continued from the triangular fibrocartilage (TFC) to the carpal bone as a meniscal homologue which is difficult to separate from the TFC.

Hogikyan and Louis³ carried out postmortem studies of the ulnar complex ligament of the fetal wrist and examined histologically samples collected from the triquetrum and the attachment of the TFCC. They concluded that the ulnar carpal ligament extends from the ulnar styloid process to the TFC, and that the meniscal homologue and its end attach to the triquetrum and the fifth metacarpal bone. They subdivided the patterns of its attachment to the triquetrum into four types: a small, thin structure and focal attachment (group 1, 28%); a small, thick structure and focal attachment (group 2, 39%); a thick structure and broad attachment to between one-third and one-quarter of the triquetrum (group 3, 28%); and a broad attachment covering the entire triquetrum (group 4, 5%).

Ono et al⁴ stated that during the embryonic stage the TFCC extends from the radio-ulnar end to the base of the fifth metacarpal bone and attaches to the ulnar side of the ulnar head, ulnar styloid process, and ulnar side of the carpal bone (the triquetrum and the hamate). During the fetal stage, vacuolisation develops between the lunate and triquetrum, separating the latter from the TFCC and, during this process, there is a possibility that diverse variations in the morphology of the ulnar side of the wrist will develop.³ They conducted arthrography on 870 joints and reported the presence of a congenital dividing wall (bicompartimentalisation) which connected the lunotriquetral ligament and the TFCC in seven joints.

These studies have shown that there are variations in the attachment of the TFCC to the triquetrum. These sites of attachment are readily observable on arthroscopy and their examination is anatomically important. In this study, we used wrists collected from cadavers and investigated the morphology of the TFCC and the site of its carpal attachment to the triquetrum.

Materials and Methods

We collected 87 wrists (40 right and 47 left) from 51 embalmed cadavers (20 male and 31 female). The mean age at death was 74.1 years (40 to 99). In wrists with severe osteoarthritis it was difficult to observe the ulnar attachment of the TFCC because of wear. Hence, in only 26 cadavers, was it possible to examine both right and left wrists. A horizontal incision was made at the dorsum of the

S. Nishikawa, MD, Chief
Department of Orthopaedic Surgery, Mutsu General Hospital, Kogawa-cho 1-2-8, Mutsu, Aomori, 035-0071, Japan.

S. Toh, MD, Associate Professor
Department of Orthopaedic Surgery, Hirosaki University School of Medicine, Zaifu-cho 5, Hirosaki, Aomori 036 8076, Japan.

Correspondence should be sent to Dr S. Nishikawa.

©2002 British Editorial Society of Bone and Joint Surgery
0301-620X/02/712979 \$2.00

Fig. 1

Photograph and diagram showing attachment on the ulnar edge of the triquetrum (group 1 or 2). The joint surface of the lunate and triquetrum and the lunotriquetral ligament were observed. The TFCC attached to the ulnar side of triquetrum (Sca, scaphoid; Lu, lunate; Tri, triquetrum; Ra, radius; TFCC, triangular fibrocartilage complex; LT, lunotriquetral ligament).

Fig. 2

Photograph and diagram showing partial attachment of the TFCC on triquetrum (group 3). The joint surface of the lunate and the lunotriquetral ligament were observed. A part of the TFCC attached at the lunotriquetral ligament, and the joint surface of the triquetrum was partially observed (abbreviations are as in Figure 1; ☆, partial attachment of the TFCC on the triquetrum).

wrist and the triquetrum, lunotriquetral ligament (LT) and TFCC were examined macroscopically.

Results

In gross observation of the ulnar side of the wrist, the joint surface of the lunate and the triquetrum and the lunotriquetral ligament were observed. The TFCC was attached to the ulnar side of the triquetrum (Fig. 1). Those joints were in groups 1 or 2 according to the classification of Hogikyan and Louis³ since they could not be differentiated on gross observation. Attachment to the ulnar side of the triquetrum was seen in 79 joints (46 cases, 90%). The joint surface of the lunate and the lunotriquetral ligament were observed. A part of the TFCC attached to the lunotriquetral ligament and the joint surface of the triquetrum was partially observed (Fig. 2). These were in group 3. The TFCC was attached widely on the articular surface of the triquetrum in four joints (3 cases, 4.6%), and the joint surface of

the lunate was observed. The TFCC attached to the lunotriquetral ligament and the joint surface of the triquetrum was covered by the TFCC (Fig. 3). In four joints (3 cases, 4.6%) of group 4, the attachment to the ligament completely covered the articular surface of the triquetrum. The attachment patterns belonging to groups 3 and 4 were noted in three of the 26 specimens which were examined on both sides. Two of these showed the same pattern of attachment on both sides (group-3-type attachment in one and group-4-type in the other). The other case showed unique patterns on each side (group 3 on the right side and group 4 on the left side).

Discussion

There have been few descriptions of the morphology of the meniscal homologue of the attachment site on the carpal bone.² Lewis, Hamshire and Bucknill⁵ observed the shape of the TFCC from the viewpoint of comparative anatomy.

Fig. 3

Photograph and diagram showing the TFCC broadly attached to the triquetrum (group 4). The joint surface of the lunate was observed. The TFCC attached to the lunotriquetral ligament and the joint surface of the triquetrum was covered by the TFCC (abbreviations are as in Figure 1; ★, TFCC broadly attached on the triquetrum).

Fig. 4

Arthroscopic view of partial attachment of the TFCC on to the triquetrum (group 3). A part of the triquetrum is covered with soft tissue (★) which extends from the TFCC discoid section to the triquetrum with no meniscoid projection (Tri, triquetrum; PR, prestyloid recess).

They concluded that during the evolution of man from anthropoids, the discoid section of the TFCC developed distal to the ulnar head where the triquetrum and pisiform had formed a joint within the wrist, separating the pisiform completely and the triquetrum partially. They added that by successive evolution, this discoid section joined the ulnar carpal ligament on the palmar aspect.

The TFCC is a structure which developed during the evolutionary stage when man, with his wrists and forearms newly released from the role of supporting body-weight, acquired bipedal locomotion and forearm rotation, and the movement of the distal radio-ulnar joint was separated from that of the wrist. During the embryonic stage, the TFCC extends from the palmar side of the distal radio-ulnar joint, with its site of attachment extending widely from the ulnar side of the radius to the ulnar side of the carpal bone, and undergoes involution as the embryo develops.³ Eventually, it settles at the pivotal position for the tissues composing the ulnar side of the wrist.

In their radiological evaluation of 870 wrists, Ono et al⁴ observed seven (0.8%) with congenital bicompartimentalisation, which is an abnormal dividing wall extending from the LT to the TFCC separating the wrist into the radial and ulnar sides. This wall may be the cause of pain at the ulnar side of the wrist and can be seen on arthrograms. This condition resembles group 4 of the classification of Hogikyan and Louis³ in which the attachment section to the carpal bone of the TFCC covers the ligament section so that the articular surface of the triangular bone cannot be observed. In their study, one of the 18 cases (6%) was classified as group 4. In our study, four of the 87 joints (4.6%, 3 cases) have the same classification.

In the study of Ono et al⁴ five of 18 cases (28%) belonged to group 3, while our study showed a much smaller figure with three cases, four joints (4.6%). The reason for this discrepancy may be that we examined the articular surface grossly, and only recognised the portion facing the discoid section of the TFC as the articular surface of the triquetrum, failing to identify the exact dimensions of the latter. Because only those cases in which the triquetrum is covered extensively are included in group 3 of the Hogikyan classification system, which was originally designed for the evaluation of histological specimens, it is possible that our count was lower than expected.

After examining the area of attachment of the TFCC to the carpal bone, we showed that there are variations in the attachment as indicated by Hogikyan and Louis³ and Ono et al.⁴ This finding requires further study to differentiate between these variations and injuries to the LT, and to show the relationship to the triquetral impingement ligament tears reported by Watson and Weinzweig.⁶

In the diagnosis and treatment of pain on the ulnar side of the wrist, accurate arthroscopic assessment is essential. It is necessary to have information about the appearances of the normal triquetrum and TFCC. At arthroscopy, the meniscal homologue may appear to extend in a meniscal

form on the ulnar side of the wrist but, in reality, it resembles a smooth synovium-like membranous structure which extends from the discoid section of the TFC to the triquetrum with no meniscoid projection. The section attached to the triquetrum is smooth and, as confirmed in our study, the site of attachment is on the ulnar articular side of the triquetrum in almost all cases. In about 10% of cases, the meniscal homologue is attached to the ligament of the lunotriquetral ligament, obscuring the articular surface of the triquetrum (Fig. 4).

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References

1. **Palmer AK, Werner FW.** The triangular fibrocartilage complex of the wrist: anatomy and function. *J Hand Surg* 1981;6:153-62.
2. **Elias MG.** Soft tissue anatomy and relationships about the distal ulna. *Hand Clinic* 1998;14:165-76.
3. **Hogikyan JV, Louis DS.** Embryologic development and variations in the anatomy of the ulnocarpal ligamentous complex. *J Hand Surg* 1992;17A:719-23.
4. **Ono H, Gilula LA, Marzke MW, Obermann WR.** Bicompartimentalization of the radiocarpal joint. *J Hand Surg* 1996;21A:788-93.
5. **Lewis OJ, Hamshere RJ, Bucknill TM.** The anatomy of the wrist joint. *J Anat* 1969;106:539-52.
6. **Watson HK, Weinzweig J.** Triquetral impingement ligament tear (TILT). *J Hand Surg* 1999;24B:321-4.