Original Article

Morphology of Intra-articular Structures and Histology of Menisci of Knee Joint

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Abstract

Introduction: Menisci and cruciate ligaments are intra-articular structures of knee, and injury to these structures is common. Morphometric data gained in the study will help in analyzing the variations among humans and correlating it with the possibility, location, and type of injuries as well as better interpretation of structures during magnetic resonance imaging and arthroscopy which will further help in reconstructive surgeries of knee. **Materials and Methods:** Width and thickness of the medial menisci (MM), lateral menisci (LM), and maximum length and width of anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL) were taken on twenty knees. Histological examination of menisci was done. **Results:** Width of MM was 0.601–0.700 cm at anterior horn (AH) in 45% of cases, 1.000–1.500 cm at posterior horn (PH) in 60% of cases, and 1.000-1.500 cm at body in 30% of cases. Thickness of MM at AH (45%) and PH (40%) was 0.401–0.500 cm and at body (35%) was 0.501–0.600 cm. Width of LM at AH (35%) was 0.801–0.900 cm, at PH (45%) was 0.901–1.000 cm, and at body (35%) was 1.000–1.500 cm. Thickness of LM at AH (45%) was 0.301–0.400 cm, at PH (50%) was 0.401–0.500 cm, and at body (40%) was 0.601–0.700 cm. Length of ACL in maximum percentage of specimens (55%) was 3.01-3.50 cm. Width of ACL in 25% specimens were 0.801-0.900 cm and in another 25% specimens were 1.001-1.500 cm. Length of PCL in maximum percentage of specimens (50 %) was 3.51-4.00 cm. Width of PCL in 80 % of specimens was 1.001-1.500 cm. Histological examination of menisci showed fibrocartilage (outer two-thirds) and hyaline cartilage (inner one-third). Orientation of fibers was circumferential with intermingled radial fibers. Fibroblasts, chondrocytes, and unclassified cells were arranged as single, paired, or in rows along the direction of fibers except in hyalinized part. Blood vessels were present toward the peripheral part. **Conclusions:** The maximum width of MM was at PH and for LM it was at the body. Maximum thickness was at the body for MM as well as LM. Width of PCL was more as compared to ACL.

Keywords: *Cruciate ligaments, meniscus, morphology*

Introduction

The knee joint is a complex compound condyloid variety of joint. It comprises two separate joints, i.e., the femoropatellar which is a sellar joint and the femorotibial which is a bicondylar joint. The latter is further partly divided by menisci between the corresponding articular surfaces. Awkward movements, falls, collisions, sudden twists, excessive force, and overuse can result in a range of injuries to this joint and the structures supporting it. The stability of the joint is dependent on several muscles (quadriceps and hamstrings), the medial menisci and lateral menisci (MM and LM), and ligaments (anterior cruciate ligament [ACL], posterior cruciate ligament [PCL], tibial collateral, and fibular collateral). Out of these, ACL, PCL, MM, and LM are intra-articular structures [Figure 1]. The cruciate ligaments lie within the capsule of the knee joint but not within the synovial membrane. They originate from the surfaces of femoral condyles facing the intercondylar fossa and are inserted on to tibial plateau and cross each other like the limbs of an "X." The menisci are two wedge-shaped semilunar sections of fibrocartilaginous tissue between femoral condyles and tibial plateaus attached anteriorly and posteriorly to intercondylar areas. They are weight bearing structures, increase the joint congruency, stabilize the joint, improve articular cartilage nutrition, facilitate the rotation of opposing articular surfaces of joint during lock home movements, and play a significant role in shock absorption and lubrication along with transmitting body weight from femur to tibia. Menisci are further divided into anterior third or anterior horn (AH), middle

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third (body), and posterior third or posterior horn (PH). Most parts of the menisci are avascular (white zone), but the outermost 20% of the meniscus has blood supply (red zone).[1] Morphometric parameters in the present study will help in analyzing the variations among humans and correlating it with the possibility, location, and type of injuries as well as better interpretation of structures during magnetic resonance imaging and arthroscopy which will further help in reconstructive surgeries of knee.

Materials and Methods

To carry out the study, forty each of menisci and cruciate ligaments were taken by dissecting twenty human cadaveric knee joints. Width and thickness of the MM and LM were measured at three points – AH, body, and PH. Maximum length and width of ACL and PCL were taken [Figure 2]. All the measurements were taken in centimeters (cm) with a vernier caliper. For histological examination (under light microscopy), sections were taken from peripheral and medial most parts of the menisci. Some of the sections were also taken at the junction of outer two-third and medial one-third parts. Hematoxylin and eosin staining of the tissue was done using descending series of alcohol, xylene, and other reagents. Slides were examined under Nikon Trinocular Research Microscope Model-E-200 under magnification power of ×100 and ×400 [Figure 3].

Results

Width of MM in 45% of specimens was in the range of 0.601–0.700 cm at AH, whereas it was in the range of 1.000–1.500 cm at PH in 60% and body in 30% of cases. These were the maximum values. Differences in

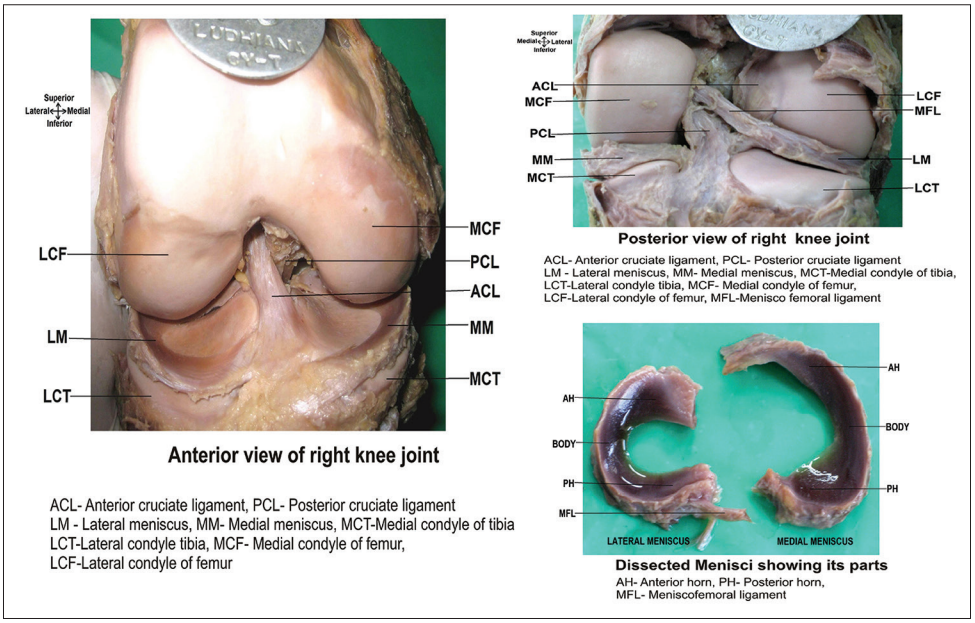

Figure 1: Gross anatomical features of intra-articular structures of knee joint

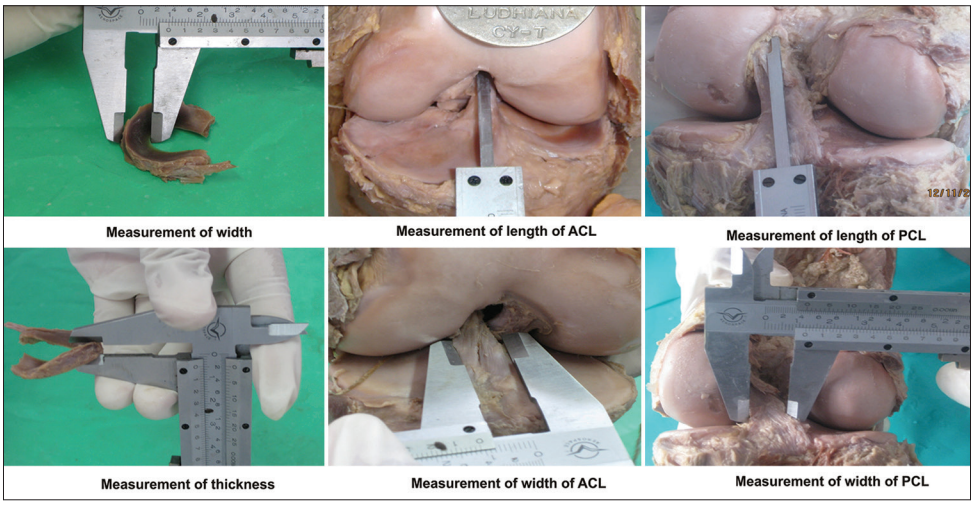

Figure 2: Methods of measurements

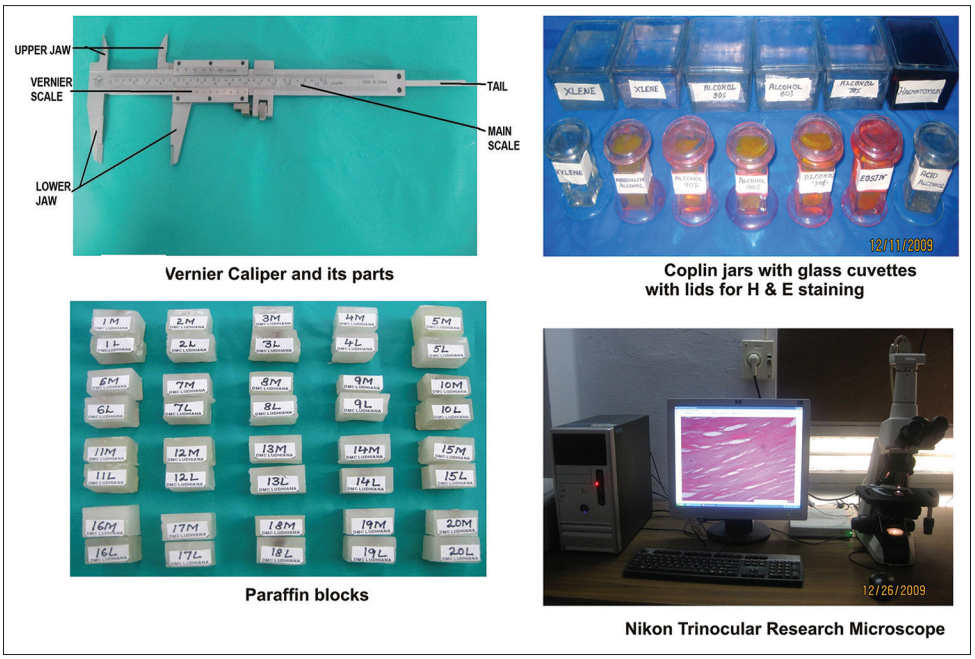

Figure 3: Material for the study

mean values of width of MM at AH (0.707 ± 0.091 cm), PH (1.109 ± 0.240 cm), and body (0.826 ± 0.252 cm) were found to be statistically nonsignificant.

Thickness of MM in 45% of specimens at AH and in 40% of cases at PH was in the maximum range, that is, 0.401–0.500 cm, as compared to body where maximum cases were in the range of 0.501–0.600 cm. Differences in mean values of thickness of MM at AH (0.483 ± 0.103 cm), PH (0.458 ± 0.084 cm), and body (0.583 ± 0.129 cm) were found to be statistically nonsignificant.

Width of LM in 35% of specimens at AH was in the range of 0.801–0.900 cm, PH width in 45% of cases was in the range of 0.901–1.000 cm, and at body, maximum cases (35%) were observed in the range of 1.000–1.500 cm. The difference of mean values of width of LM was observed statistically nonsignificant at AH (0.835 ± 0.0891 cm), PH (0.872 ± 0.0842 cm), and body (0.928 ± 0.158 cm).

Thickness of LM at AH in maximum percentage of specimen (45% cases) was noticed in the thickness range of 0.301–0.400 cm. PH thickness in 50% of specimens was in the range of 0.401–0.500 cm and 40% of specimens were found under the thickness range of 0.601–0.700 cm at the body. Mean value of thickness of LM at AH (0.358 ± 0.087 cm), PH (0.516 ± 0.079 cm), and body (0.594 ± 0.119 cm) showed no statistically significant difference.

Length of ACL in maximum percentage of specimens (55%) was 3.01-3.50 cm. Width of ACL in 25 % specimens were 0.801-0.900 cm and in another 25 % specimens were 1.001-1.500cm.

Length of PCL in maximum percentage of specimens (50%) was 3.51-4.00 cm. Width of PCL in 80 % of specimens was 1.001-1.500 cm. Statistical difference in values of length and width of ACL and PCL was found to be statistically highly significant.

Histological findings

Transverse sections of menisci taken from the outer two-thirds had lots of fibrous tissue. The main orientation of fibers was circumferential with intermingled radial fibers. These radial fibers were radiating in various directions in relation to circumferential fibers which were seen to be running along the length of the meniscus [Figure 4]. In vertical sections made at midportions of menisci, cut sections of circumferential fibers with intervening radial fibers were observed. The cells in these slides showed varied appearance under low magnification. They were seen interposed in the interlacing network of collagen fibers. Cells which looked like fibroblasts were most commonly found with exceptionally few numbers of chondrocytes present in between. The majority of cells were present in single rows. These cells appeared as elongated or spindle shaped. They were without any pericellular matrix or lacunae [Figure 4]. The nuclei of the cells were also observed as small, elongated, or spindle-shaped bodies. Some round-to-oval cells were also seen in the fibrous matrix. These appeared to be typical cartilage cells with pericellular matrix. Under high magnification, these rounded cells were clearly visible to be lying within the lacunae. These cells were present as single, paired, or lying in rows along the direction of fibers [Figure 5]. In few of the slides, cut sections of blood vessels were also seen showing its vascular nature.

Few of the sections taken from the junction between the outer two-thirds and medial one-thirds showed lots of

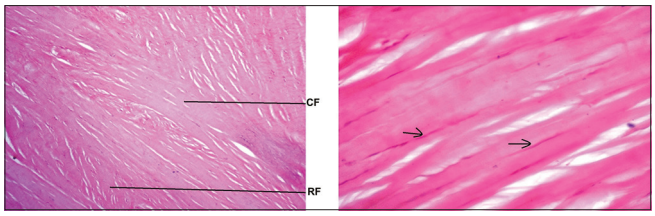

Figure 4: Transverse section of meniscus showing circumferential fibers, radial fibers, and spindle-shaped cells

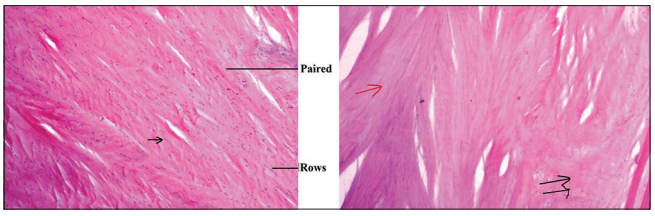

Figure 5: Transverse section showing oval cells arranged as single (one black arrow), paired, in rows, hyalinized area (two black arrows), and fibrous area (red arrow)

fibers, embedded in the matrix. It had both types of cells, i.e., fibroblast-like cells as well as round-to-oval cartilage cells with pericellular matrix.

The sections which were taken from the medial most part characteristically appeared as hyaline cartilage [Figure 5]. They showed homogeneous appearance. No fibers could be distinguished. The cells in homogeneous matrix were oval to rounded lying in the lacunae. These lacunae were clearly distinguishable on higher magnification. They were present singly or paired but were not in rows. They were lying haphazardly. No blood vessel was visible in this area, in any of the slides, showing its avascular nature.

In two of the sections of the menisci, the picture of cells was mainly atypical. These atypical cells were difficult to distinguish as either fibroblasts or chondrocytes. They were without lacunae and shape was found resembling that of chondrocytes.

Discussion and Conclusions

The maximum width of MM was at PH and for LM it was at the body. Results were similar to that of Erbagci *et al*.[2] but differ from that of Almeida *et al*.[3] Maximum thickness was at the body for MM as well as LM in accordance with Almeida *et al*.[3] but it differed from that of Erbagci *et al*.[2] This difference could be due to racial difference. Statistical difference in values at AH, PH, and body regarding width and thickness at three parts of menisci was found to be nonsignificant. ACL length was in accordance with the finding of Odensten and Gillquist[4] but differed from that of Kennedy *et al*.[5] and Girgis *et al*.[6] The reason could be due to the measurement of length of ACL in different positions. PCL length was matching with the finding of Inderster *et al*.[7] but it was more as observed by Girgis *et al*.[6] Maximum width of ACL and PCL, in the present study, was less as compared to the finding of Girgis *et al*.[6] Our PCL width recordings were similar to mediolateral diameter of the same measured by Inderster *et al*.[7] Value of width of PCL was more as compared to ACL. Statistical difference in the values of length and width of ACL and PCL was found to be statistically highly significant.

We had observed three types of cells such as fibroblasts, chondrocytes, and intermediate. These intermediate types of cells were difficult to classify compared to that of chondrocytes or fibroblasts. Fusiform or spindle-shaped cells without lacunae which resembled fibroblasts were present more at peripheral two-thirds and decreased as we went toward the inner concave margin. Round or oval cells lying in the lacunae resembling cartilage cells were interspersed along with fibrocytes, more in the substance and toward the inner margin. Most of our findings are in accordance with previous studies.[8,9]

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Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Williams A, Newell RL. Knee. In: Standring S, Berkovitz BK, Borley NR, Crossman AR, Davies MS, FitzGerald MJ, *et al.,* editors. Gray's Anatomy, Anatomical Basis of Clinical Practice. 39th ed. Philadelphia: Elsevier Churchill Livingstone; 2005. p. 1471-88.
2. Erbagci H, Gumusburun E, Bayram M, Karakurum G, Sirikci A. The normal menisci: *In vivo* MRI measurements. Surg Radiol Anat 2004;26:28-32.
3. Almeida SK, De Moraes AS, Tashiro T, Neves SE, Toscano AE, De Abreu RR. Morphometric study of menisci of the knee joint. Int J Morphol 2004;22:181-4.
4. Odensten M, Gillquist J. Functional anatomy of the anterior cruciate ligament and a rationale for reconstruction. J Bone Joint Surg Am 1985;67:257-62.
5. Kennedy JC, Weinberg HW, Wilson AS. The anatomy and function of the anterior cruciate ligament. As determined by clinical and morphological studies. J Bone Joint Surg Am 1974;56:223-35.
6. Girgis FG, Marshall JL, Monajem A. The cruciate ligaments of the knee joint. Anatomical, functional and experimental analysis. Clin Orthop Relat Res 1975;10:216-31.
7. Inderster A, Benedetto KP, Klestil T, Künzel KH, Gaber O. Fiber orientation of posterior cruciate ligament: An experimental morphological and functional study, part 2. Clin Anat 1995;8:315-22.
8. Messner K, Gao J. The menisci of the knee joint. Anatomical and functional characteristics and a rationale for clinical treatment. J Anat 1998;193:161-78.
9. Goyal N, Gupta M. A Study of Changes in Morphology of Osteoarthritic Articular Cartilage Using Computerized Image Analysis. J Histol 2013;2013:Article ID 981305. doi: 10.1155/2013/981305.