Original Research Article

The Anterior Transverse Ligament of Knee: Morphological and Morphometric Study in Formalin Fixed Human Fetuses

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Abstract

The objective was to study the morphology and morphometry of transverse ligament of the knee joint in south Indian population. The present study included 53 formalin fixed foetuses which were obtained from the department of Anatomy. There were 106 knee joints which were available for the present study. A vernier caliper of 0.02 mm accuracy was used to measure the length of the transverse ligament. Among our specimens, transverse ligament of the knee was observed in 87.7% of the cases. It was observed bilaterally in 81.1% of cases. The double transverse ligaments were not observed in any of our specimens. The mean length of the transverse ligament measured 3.7 ± 1.5 mm. The statistically significant difference was not observed between the right and left sided transverse ligaments or gender with regard to its length (Student's t test; $p > 0.05$). The morphological and morphometric data related to the transverse ligament of the knee in human foetuses have not been reported. The present study provides additional information on the morphology and morphometry of the transverse ligament in human foetuses. We believe that the data of the present study will provide support to the foetal anatomy, concerning the surgical procedures and arthroscopy of the knee joint. The findings are enlightening not only for Orthopedic Surgeons, but also for the Morphologists and Embryologists.

Keywords: Knee joint, morphology, morphometry, transverse ligament

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Introduction

The anterior transverse ligament of knee connects the anterior horn of medial meniscus to the anterior convex margin of the lateral meniscus (1). This ligament is also known as anterior intermeniscal ligament and transverse geniculate ligament. The detailed information is not available in the literature about this ligament, its morphological anatomy, its prevalence among different populations (2) and its involvement in different pathological entities of the knee joint (3). It was reported that the transverse ligament may be a rudimentary part of the connective tissue which forms the menisci. The transverse ligament plays an important role in stabilization of the menisci during movements and in prevention of hyper rotations (4,5). Although its function is not clear, recent interest in this structure is because of its radiographic appearance in

magnetic resonance imaging (MRI) scans and plain lateral knee radiographs (6). Successful arthroscopic evaluation, surgical repair and meniscus allograft transplantation can be enhanced by a precise anatomical knowledge of this ligament. In the present era of meniscal allograft arthroscopic surgeries, the attachments of the transverse ligament will not be spared. Few surgeons had considered this structure as an anatomical variant and ended up in showing lack of interest. However, it was described that, this ligament may be mistaken for pathologic conditions of the knee joint such as anterior horn meniscal tears (7,8). It has been stated that, during the surgical procedure, it is imperative to maintain the attachments of the transverse ligament. This is believed to minimize the degenerative changes of the knee joint articular cartilages (9). In the present study, the aim was to investigate the prevalence of the anterior transverse ligament using foetal cadaveric material in south Indian population and the objectives were to study its morphology and morphometry.

Materials and Methods

Embalmed human foetal cadavers which were available in the department of Anatomy were used in the present study. The study was performed with 106 knee joints (53 right and 53 left knee joints; from 27 female and 26 male foetuses) which were preserved in 10% formalin solution. The crown rump lengths of the foetuses ranged from 160 mm until 340 mm. Each knee joint was considered as a separate sample and not as a pair from each foetus. The foetuses which exhibited musculoskeletal abnormalities were excluded from the present study.

The dissection of skin and muscles around the knee joint was performed initially which was followed by approach to the joint cavity with a longitudinal incision given anteriorly on either side of the joint capsule. The ligamentum patellae, medial and lateral collateral ligaments were cut transversely. This was followed by dissection of joint capsule and the cruciate ligaments. The femoral condyles were cleared from the attachments to expose the superior aspect of the tibia. The anterior aspect of the tibial plateau was cleaned and the transverse ligament (Fig. 1) was identified. The dissections of all the knee joints were performed and data of the ligament were recorded on a standardized collection sheet. A Vernier caliper of 0.02 mm accuracy was used for measuring the transverse ligament length. All the measurements in the present study were performed by the same person who was an author of this investigation and this had minimized the errors to some extent. Statistical analysis between the sides and genders were performed by using the paired samples t-test and independent t-test. If the p-value was less than 0.05, it was considered to be statistically significant. The statistical package for the social sciences software 15.0 was used in the present study for the statistical analyses and the data obtained were represented as mean ± standard deviation.

Results

In the present study, transverse ligament (Fig. 2) was observed in 87.7% of the cases (93 knee joints). The ligament was not present (Fig. 3) in 12.3% cases (13

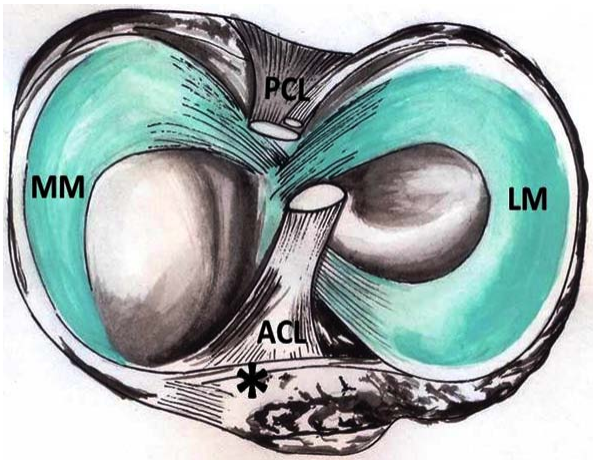

Figure 1: Schematic diagram of superior aspect of the left tibia showing the intracapsular ligaments of the knee joint (asterisk-transverse ligament, ACL- the anterior cruciate ligament, PCL- the posterior cruciate ligament, MM- the medial meniscus, LM- the lateral meniscus)

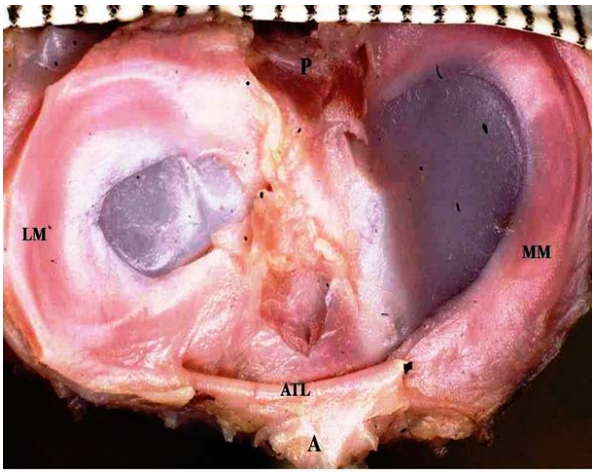

Figure 2: Right knee joint of the fetus showing the anterior transverse ligament (ATL) which is attaching the anterior horns of both the menisci (A – anterior, P – posterior, MM – medial meniscus, LM – lateral meniscus).

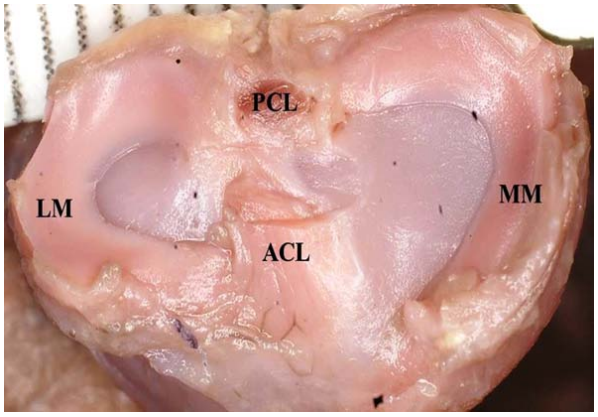

Figure 3: Right knee joint of the fetus showing the absence of anterior transverse ligament (ACL – anterior cruciate ligament, PCL – posterior cruciate ligament, MM – medial meniscus, LM – lateral meniscus).

knee joints). It was observed bilaterally in 81.1% of cases (43 foetuses, 86 knee joints). In 7 knee joints (7 foetuses, 13.2%), it was observed unilaterally. The ligament was absent on the left side in 2 (7.4%) females and 3 (11.5%) males. It was absent on the right knee joint in 2 (7.4%) females and it was absent bilaterally in 3 (11.5%) males. The double transverse ligaments were not observed in any of our specimens. Its mean length was 3.7 ± 1.4 mm in males and 3.7 ± 1.6 mm in females. The mean length was 3.8 ± 1.5 mms and 3.5 ± 1.5 mms for the right and left knee joint transverse ligaments of the fetuses respectively. There was no significant difference in the length of the transverse ligament among the male and female foetuses. The right and left sided ligaments also exhibited not significant differences. This was analyzed statistically ($p > 0.05$). The mean length of the transverse ligament measured 3.7 ± 1.5 mm.

Discussion

The transverse genicular ligament of the knee is a normal anatomical variant which has been described on lateral plain radiographs of the knee (10). The ligament runs in the coronal plane just anterior to the knee joint capsule, in the posterior part of the Hoffa's fat pad. This ligament was described previously on magnetic resonance images as a source of misinterpretation of tears of the menisci (8,11). The junctions of the transverse ligament, the anterior horn of lateral meniscus and the tendinous insertions of the lateral meniscus have the appearance of a cleft in the lateral meniscus. This confusion is more common on the sagittal images of the nuclear magnetic resonance films. This can be a source of misinterpretation of oblique tears of the anterior horn of lateral meniscus (8,11).

The attachments of the transverse ligament and menisci provide stability to the menisci and prevent them from being thrown out of the knee joint during the compression. The transverse ligament minimizes the excursion on the anterior horn of the medial meniscus which occurs during the initiation of the knee flexion (12). It has been postulated that the role of the transverse ligament may be that of stabilizing the menisci during the movement of the knee (3,13) by anchoring both the menisci (14) and preventing excessive rotation of the anterior horns of the menisci (3,15).

Higgins reported that the transverse ligament is extremely variable in its prevalence, in 25% of cases it is found absent, in 4% it is represented by a membrane, in 10% it is a glistening bundle of fibrous tissue, in 15%, and it is a well-marked and has strong bundle of fibres (16). He reported that the remaining of his specimens presented unimportant variations. Higgins opined that there can be no question that the transverse ligament per se is an extra-capsular structure contained in the sub-patellar region, superficial to the true capsule (16). Its variability and its occasional connection with the accessory capsule points possibly to an extra-capsular origin (16).

Pauzat stated that the transverse ligament is always present in the knee joint (17). In comparison, Zivanovic found this ligament in 58% of his specimens and he reported that this ligament was well developed in 40% specimens and was thin in 18% of knees (18). In an anatomical study by Kohn and Moreno, this ligament was identified in 69% specimens (19). Berlet and Fowler found the transverse ligament in 24 of 34 cadaveric specimens (71%) (20). In contrast, Nelson and LaPrade identified a distinct transverse ligament in 94% of the cases they studied, either within or overhung by the retropatellar fat pad (6). Tubbs et al. identified the transverse ligament in 55% of limbs (3). In the present study of foetal knees, the transverse ligament was identified in 93 knees (87.7%) and bilaterally in 43 (81.1%) of the cadavers. In contrast, Tubbs et al. observed bilaterality of this ligament in 36 % of the cases (3). The data of the present study is not similar to the previous reports because the foetal specimens were studied in our investigation. All the previous studies on this subject were from the adult specimens. We can state that there are possibilities that the postnatal changes and post pubertal changes should occur in the morphology of the transverse ligament of the knee joint.

The findings of the present study reinforce the study from Berlet and Fowler (20). They reported that the

transverse ligament was invariably found in the knee joint either within or overhung by the retropatellar fat pad. The clear knowledge of common anatomical variants will help in the management of variant rare structures and would prevent misinterpretations during the radiological procedures. An understanding of the anatomical variations can prevent the unnecessary surgical procedures and subsequent iatrogenic injuries (21). We believe that the data of the present study may be useful to Clinicians, Surgeons and Anatomists alike. The morphometric data of the present study may be useful to the future biomechanical studies about the function of the anterior inter meniscal ligament (6). The knee injuries could be related to the presence of this peculiar ligament in the knee (2). The morphological knowledge of this ligament is enlightening while interpreting the radiological films in the clinics. This may help in differentiating the intracapsular diseases like osteochondral fragments in the joint, meniscal injury fragments and the pseudotear of the lateral meniscus from that of normal ligamentous structures of the knee joint (7). The data of the present study may be useful to the orthopedic surgeons, arthroscopic surgeons and radiologists. The data are essential to the anthropologists, embryologists and morphologists.

The present investigation has provided additional data on the morphology and morphometry of transverse ligament in human foetuses. We believe that the data of the present investigation will add to the morphometric data of the foetal anatomical structures, and will help the arthroscopic surgeons during the procedures of the neonatal knee joint.

The limitations of this present study included the sample selection as the study involved the formalin fixed foetuses. The formalin may have some effect on the transverse ligament and this may give a little bias in the measurements. The length may also vary depending on the pulling force from both the menisci. The other limitation is we did not measure the breadth of the transverse ligament in this investigation. The future implications of this subject include studying the transverse ligament microscopically and the structure can be studied in vivo by using the radiological methods like nuclear magnetic resonance imaging.

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