# CHAPTER II : REVIEW OF LITERATURE

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## 2.1 INTRODUCTION:

A literature review is perhaps the most important step in this process. It not only helps to access the general utility of the research question but also provides an excellent basis for selecting a research question (Rubin and Babbie, 2010). A review of literature is an account of what is already known about a phenomenon, as well as the information and concepts that have already been formed on a certain research issue (Sharma, 2011) As described by Humphrey (n.d.), A literature review is more than a synopsis of another author's papers or books; it is a systematic written study of previously published research on a certain topic or subject. It analyses the data, ideas, or theoretical concepts offered in this article, book, or other publication in context. "It is aimed to exhibit familiarity with earlier research on the issue picked for investigation, which helps to illustrate how the research improves the researcher's understanding of the topic," says Lawrence (2011).The researcher has identified several sources and reviewed the available literature on the proposed research theme from both Western and Indian sources, and presented the same in this chapter based on the objectives of the study.

## 2.2 OTHER RELATED STUDIES ON THE PATELLA

### 2.2.1. THE GEOMETRY OF PATELLA AND PATELLAR TENDON MEASURED ON KNEE MRI (2007)

**Jae Ho Yoo, Seung Rim Yi, Jin Hong Kim[74]**

The author studied the geometry of the patella and patellar tendon in relation to gender and anthropometry using axial and sagittal magnetic resonance scans of one hundred and seventy-two knees (142 men, 30 females) of one hundred and sixty-three people (135 males, 28 females).The author concluded that males had more geometry of the patella and patellar tendon than females (P 0.001).

### 2.2.2. CLINICAL MEASUREMENT OF PATELLAR TENDON: ACCURACY AND RELATIONSHIP TO SURGICAL TENDON DIMENSIONS (2013)

**Chad Zooker, Rajeev Pandarinath, Matthew J Kraeutler, Michael G Ciccotti, Steven B. Cohen[28]**

Preoperative planning for anterior cruciate ligament (ACL) reconstruction uses the patellar tendon breadth and length. The study's author investigated the accuracy of preoperative measurements obtained using skin palpation. He also compared these measures to the actual dimensions of the tendon after surgery. At full extension and 900 degrees of flexion, the patellar tendon was measured. Prior making an incision, the breadth of 53 patients having ACL replacement using patellar tendon autograft was measured with the knee in 900 degrees of flexion. After grafting, the center section of the patellar tendon was measured. There was no clinical difference between the estimated pre-incision and surgical width measurements.

### 2.2.3. MORPHOMETRIC ANALYSIS OF THE PATELLA AND PATELLAR LIGAMENT OF SOUTH AFRICANS OF EUROPEAN ANCESTRY (2013)

**Oladiran I., OlatejuIllke philander, Mubarak a. Bidmos[119]**

During the investigation, 46 South African cadavers of European descent (25 females and 21 males) were dissected on both knees. A Vernier caliper was used to take measurements of the patella and patellar ligament. Several studies have looked into how morphometric assessments of the patella bone and patellar ligament have aided researchers in human identification, knee implant design, and knee surgery processes. Based on the articular facets, the author classified the Patellae bone. Except for the dimensions of patella thickness and breadth, the author concluded that there was no significant variation between the measurements taken from both knees. The size of the patella, patellar ligament, and articular facets was sexually dimorphic. Additional investigations of the patella and patellar ligaments in South Africans of European ancestry indicated significant connections with Type B patellae.

### 2.2.4. POSITION OF THE PATELLA IN ADULTS IN CENTRAL INDIA: EVALUATION OF THE INSALL-SALVATI RATIO (2013)

**Sachin Upadhyay, HKT Raza, Pranay Srivastava[132]**

Using lateral radiographs, the author evaluated 800 knees of 200 men and 200 women, ranging in age from 18 to 50 (mean, 30) years. To see if the Insall-Salvati ratio was effective, researchers looked at the occurrence of patella Alta and Baja in typical Indian population. Using a vernier caliper, the Insall-Salvati ratio was calculated by comparing the patellar tendon length (LT) to the patella length (LP). The mean LT/LP ratio was 1.14. The ratio was considered normal at 40% based on the 95 percent confidence interval. Females had a considerably greater LT/LP ratio than men. The patella Alta cut-off criterion in our Indian individuals was significantly greater than in our western subjects. Patella Alta (ratio >1.5) and Patella Baja (ratio *0.7), respectively, were found in 2.8 percent and 1% of the current cohort. People who squat, sit cross-legged, and kneel are less likely to use the Insall-Salvati ratio to determine the patellar position than people who sit cross-legged and kneel like the Indian population.

### 2.2.5. SEX DETERMINATION BY APPLYING DISCRIMINANT FUNCTIONAL ANALYSIS ON PATELLAR MORPHOMETRY (2013)

**I. Kayalvizhi, S. Arora, B. Dang, Swati Bansal, R. K. Narayan[70]**

The author examined thirty-one skeletons (19 males and 12 females) from both sides of the North Indian population using patella bone measurements. Exterior and internal articular facets were measured for maximum length, width, thickness, height, and width. When additional long bones, skulls, and pelvis bones are not accessible or when long bones are fractured after large occurrences, patellar measures, according to the author, can reveal sex in the North Indian population. So perhaps that will be the future way of determining sex using your own population's basic characteristics.

### 2.2.6. MORPHOMETRIC MEASUREMENT OF THE PATELLA ON 3D MODEL RECONSTRUCTED FROM CT SCAN IMAGES FOR THE SOUTHERN CHINESE POPULATION (2014)

**Shang Peng, Zhang Linan, Hou Zengtao, Bai Xueling, Ye Xin, Xu Zhaobin, Huang Xu[135]**

The author provided morphometric data on the patella for the southern Chinese population for total knee arthroplasty, patellar resurfacing procedures, and prostheses design. CT slices of the knee joints were acquired from both knees of forty Chinese volunteers using a computer tomography scan (twenty females and twenty males aged 20 to 25 years). Based on the CT data, the software Mimics was used to create a 3D model. Six couples have a relationship.(H-W, H-T, H-HAF, W-T, W-HAF, T-HAF) of the variables H: height, W: width, T: thickness, and HAF: Height of articulating facet was measured, which showed a significant correlation. The study concluded that males have larger patellae than women in the southern Chinese population studied.

### 2.2.7. KNEE CAP: A MORPHOMETRIC STUDY (2017)

**Magi Murugan, Sri Ambika, Virendar Kumar Nim[110]**

The patella is beneficial for personal identification since it is resistant to postmortem changes, according to the author. According to the author, the measurements and categorization of the patella are clinically relevant for determining the size of a patellar implant. A total of 65 dry right and left patella of both sexes were assessed for morphometric measurements of the patella. The articular facets were also used to classify the patella. The patellar height is essential for patellofemoral surgeries such as total knee arthroplasty, proximal tibial osteotomy, and ACL restoration, according to the author. The author further revealed that knowledge can be beneficial to the orthopedic surgeon in for the various surgical procedures involving the knee especially in designing patellar implants.

### 2.2.8. MORPHOMETRIC STUDY OF PATELLA AND ITS ROLE IN SEX DETERMINATION (2017)[45]

**Dr. Poonam Vohra**

The author studied sixty patella bones on both sides; the morphometric parameters were measured for maximum thickness, maximum width, and maximum height. The study revealed comparison of males and females for all the parameters shows a high statistical significance and therefore author concluded that Patella can be taken into consideration for the determination of gender particularly in the vicinity of long bones, pelvis, and skull.

### 2.2.9. SURFACE AREA OF PATELLAR FACETS: INFERENTIAL STATISTICS IN THE IRAQI POPULATION (2017) [157]

**Ahmed Al-Imam, Zaid Al-Zamili, Rawan Omar**

The goal of this study was to examine at the patella's morphometric parameters to see if there was a statistical association between the surface areas of the patellar articular facets and the patella. A digital Vernier Caliper, an electronic balance, and Image J. image analysis software were used to measure the morphometry of forty patellar bones. The surface area versus patellar weight association was the strongest. The area of the lateral facet was consistently bigger than the area of the medial facet. These findings are critical for restoring normal patellofemoral unit biomechanics and must be properly considered during knee surgeries and implant designs.

### 2.2.10. MORPHOMETRIC STUDY OF KNEE CAP (PATELLA) (2018)

**Rupa Chhaparwal, Sanket Hiware, Parth Chhaparwal, Nidhi Chhaparwal[130]**

For various criteria, the author examined fifty dry human patellae. The study provides a variety of morphometric parameters as well as unique data on patellar aspects, according to the author. The data is useful for patella implant design and is important from a biomechanical standpoint.

### 2.2.11. MORPHOMETRIC STUDY OF PATELLAR MEASUREMENT: AN OVERVIEW FROM EASTERN ZONE OF INDIA (2019)

**Sudipa Biswas, Suranjali Sharma[28]**

The purpose of this study was to look at the morphometric and comparative aspects of patella in India's eastern region. The patella was classified using the dimensions of the articular facets, as well as the dimensions of the patella and articular facets. The width, height, thickness, and width of the patella's medial and lateral facets, as well as the size and form of the articular surface, are all important elements in influencing the patellofemoral joint's stability and patellar implant design. According to the author, morphometric study of the patella is critical in forensic identification, implant design, and knee reconstruction techniques. The right implant dimensions can help knee replacement surgeries last longer and be more successful.

### 2.2.12. INTRAOPERATIVE PATELLA DIMENSION MEASUREMENT IN ASIAN FEMALE PATIENTS AND ITS RELEVANCE IN PATELLAR RESURFACING IN TKA (2020)

**Shaifuzain Ab Rahman, Amran Ahmed Shokri, Muhammad Rajaie Ahmad, Ahmad Filza Ismail, Nur Syahida termizi[28]**

This study found that implants for total knee arthroplasty in Asian patients are frequently manufactured using anthropometry from the Western population, resulting in issues with patella sizing, particularly in Asian females with smaller patellae. The researchers measured intra-operative patellar dimensions in female patients and compared them to contemporary prosthetic devices. The data was matched to the smallest implant size from three manufacturers. The patella's articular surface was discovered to be oval in shape; with a width-to-height ratio of 1.31.Only 17.9% of the three manufacturers studied were suitable for the least implant size. Female patients had a thinner and smaller patella that couldn't accommodate patellar components, according to the Caucasian database. As a result, the author underlined that orthopedic implant makers should consider optimizing the breadth of patellar prosthesis as well as their thicknesses.

## 2.3. OTHER RELATED STUDIES ON THE DISTAL END OF THE FEMUR

### 2.3.1. GENDER AND SIDE-TO-SIDE DIFFERENCES OF FEMORAL CONDYLES MORPHOLOGY: OSTEOMETRIC DATA FROM 360 CAUCASIAN DRIED FEMORI (2012)

**Ioannis Terzidis, Trifon Totlis, Efthymia Papathanasiou, Aristotelis Sideridis, Konstantinos Vlasis, and Konstantinos Natsis[73]**

A morphometric analysis of the femoral condyles in the dry femur bone was done to determine gender and side differences. A total of 360 (Greek) Caucasian dried femur bones were analyzed using a digital caliper. On both sides, the parameters did not differ much. Furthermore, because there was no statistically significant difference between the two sides, the author suggested that preoperative testing be done on the contralateral healthy side. The study further revealed that the data can help for the design of knee prostheses.

### 2.3.2. ANTHROPOMETRIC MEASUREMENTS OF THE HUMAN DISTAL FEMUR:A STUDY OF THE ADULT MALAY POPULATION (2013)

**Fitdriyah Hussain, Mohammed Rafiq Abdul Kadir, Ahmad Hafiz Zulkifly, Azlin Sa'at, Azian Abd. Aziz, Golam Hossain, T. Kamarul, Ardiyansyah Syahrom[57]**

The author of the existing study recruited a total of one hundred healthy individuals randomly for morphometric measurements of the distal end of femurs from the Malay population. The Malay population's distal femur was smaller than the Chinese population's, but greater than the Indian population's (P 0.05). Though it is commonly known that Asians have a smaller distal femur than Westerners, ethnic differences in Asia may need to be taken into account when constructing the right knee implant. Because there was a large disparity between ethnicities within the Asian population, the author concluded that Asian knee sizes could not be applied universally throughout the Asian population. This research may be incorporated into future implant designs in order to give better implant fits for the Asian population on a bigger scale.

### 2.3.3. A STUDY OF FEMORAL CONDYLAR MORPHOMETRY (2015)

**Dr. Sujay Mistry[47]**

The degenerative bone disease may be exacerbated by the relative incongruence of knee joint surfaces with repetitive high compressive forces, which was evident in the present study. A suitable femoral component size is required to maintain the normal functional range of motion of the knee without impingement. As a consequence, this study was designed. A total of a hundred and twenty-seven femur bones were studied for morphometric measurements of the distal end of the femur and it was concluded that no significant left-right asymmetry was established. This information can be useful in prosthesis design for Indians.

### 2.3.4. MORPHOMETRIC ANALYSIS OF CONDYLES AND INTERCONDYLAR NOTCH OF FEMUR IN NORTH INDIAN POPULATION AND ITS CLINICAL SIGNIFICANCE (2017)

**Shweta Jha, Renu Chauhan[139]**

The present study was carried out to examine the morphometry of femoral condyles and intercondylar notch in the North Indian population as the literature is sparse in this area. According to the author, a narrow intercondylar notch increases the risk of ACL injury, but the data is conflicting. It was determined that intercondylar notch morphometry prevented ACL injuries and provided appropriate treatment for knee problems.

### 2.3.5. MORPHOMETRIC STUDY OF LOWER END OF DRY FEMUR INGUJARAT REGION AND ITS CLINICAL IMPLICATION (2017)

**Ankur Z Zalawadia, Dhara H Parekh, Shailesh M Patel [10]**

The purpose of the TA study was to see if there is a sexual dimorphism in the lower end of the femur, as well as discrepancies in morphometric data from various communities around the world and in the India. The author studied 120 dry femurs of known gender and found them significantly larger in males than females. Andhra Pradesh and West Bengal have smaller findings than the Caucasian population.

### 2.3.6. A MORPHOMETRIC AND RADIOLOGICAL STUDY OF THE DISTALEND OF FEMUR IN WEST BENGAL POPULATION (2017)

**Ananya Biswas, Santanu Bhattacharya[12]**

The author used Martin's sliding calipers, diaptograph, and Sigma View software to examine the morphometry of the distal end of femurs bilaterally on seventy dry adult femurs of unknown sex and 50 digital radiography plates of known age and sex for this work. The transverse and vertical dimensions of the medial condyle, as well as intercondylar width, demonstrated considerable two-sided asymmetry among the other metrics. Only bicondylar width demonstrated sexual dimorphism on both sides, according to the radiologic examination. A comparison of the bicondylar angle between the right and left sides of males found substantial differences when compared to females, whereas bicondylar breadth between the two sides of males, but not females, demonstrated significant asymmetry.

### 2.3.7. MORPHOMETRIC STUDY OF DISTAL END OF FEMUR IN INDIAN POPULATION (2018)

**Dr. Saima Rashid, Dr. Tawheed Ahmad, Dr. Afshan Saleem, Dr. Sangeeta Gupta, Dr. Summaira Jan [48]**

In the present study, the author observed eighty adult dry femurs for distal anthropometric measurements of femur shaft and measured using a vernier caliper. The author supports the literature obtained with the present study that might facilitate biomedical engineers in designing knee replacement prostheses of appropriate size for the Indian population.

### 2.3.8. A MORPHOMETRIC STUDY OF INTERCONDYLAR NOTCH OF FEMUR AND ITS CLINICAL SIGNIFICANCE (2018)

**Prasanna Veera Kumar Attada [124]**

Thirty dry femurs were used in the investigation, fifteen on the right side and fifteen on the left. According to the author, the intercondylar notch exhibited inverted 'U' shape morphology in 14 (46.66%) specimens and an inverted 'V' shape in 16 (53.34%) specimens.

### 2.3.9. A STUDY OF MORPHOMETRIC ANALYSIS OF DISTAL END OF FEMUR AND ITS CLINICAL IMPORTANCE (2019)

**Vinay G, Vikram S [153]**

The morphometry of the distal end of the femur is crucial in developing implants for total joint arthroplasty, according to the author. The author sought to compare the morphometric data of the right and left sides of the femur, as well as look into the morphometric data of the femur's distal end. The author discovered no statistically significant parameters between the right and left femurs. The results of this study will aid biomedical engineers in developing a knee replacement prosthesis that is appropriate for Indian patients undergoing knee replacement surgery.

### 2.3.10. A STUDY OF MORPHOMETRIC ANALYSIS OF CONDYLES OF ADULT DRY FEMUR OF HUMANS IN GUJARAT REGION (2019)

**Hiren S Chavda, NishitaK Jethva, Sudarshan Gupta[67]**

To gather particular morphometric data of femoral condyles and compare the right and left sides, the author adopted a direct method. In this study, the direct approach is used to provide critical morphometric data on the femoral condyles. The author proposed that morphometric data of various parameters be used in the design of implants and the choice of suitable prostheses to improve the result of knee replacement surgery.

### 2.3.11. MORPHOMETRIC ANALYSIS OF LOWER END OF FEMUR AND ITS CLINICAL SIGNIFICANCE (2020)

**SelvapriyaSivaramalingam, SasiKrishnanGunasekaran[134]**

The purpose of this study is to determine the clinical importance and conduct a complete investigation of the morphometry of the lower end of the adult dry femur in the Coimbatore district of Tamilnadu, India. A total of 72 adult dry femur bones from both sides were investigated.

### 2.3.12. MORPHOMETRIC ANALYSIS OF LOWER END OF ADULT DRY FEMUR IN SOUTH INDIAN POPULATION – A CROSS-SECTIONAL OBSERVATIONAL STUDY AND ITS CLINICAL SIGNIFICANCE (2020)

**Mahalakshmi Rajan, Kalpana Ramachandran[100]**

In this present study, the author attempts for morphometric analysis of the adult dry femur for the numerous structural parameters of the lower end of the femur. The main objectives were to study the study provides to give morphometric data of femoral condyles by the direct method was the main objective of the study with the aim of utilizing of same knowledge for the proper selection of the properly matched prosthesis and to eliminate the postoperative complications after implants.

### 2.3.13. MORPHOMETRIC STUDY OF FEMORAL CONDYLES IN VISAKHAPATNAM ZONEOF ANDHRA PRADESH REGION (2020)

**Dr. Umamaheswara Rao Sunnapu, Dr. Veerraju A. N. V. V, Dr. A. Vasanthi[49]**

Timely intervention, well-being appropriate measurement of femoral condyles is having a more gain in minimalizing the complications of the surgical procedure, and to produce qualitative results after the surgery. For this, the present author studied a total hundred dry femur bones of unknown sex of both sides for its morphometric parameter analysis. The author stated that the literature given will provide very significant knowledge and will be very helpful in designing implants, manufacturing knee implantations, and additional benefits in qualitative more effective results of knee replacement operations and thus to the illness of patients.

## 2.4. OTHER RELATED STUDIES ON THE TIBIA

### 2.4.1. MORPHOMETRIC ANALYSIS OF UPPER END OF TIBIA (2014)

**Swati Gandhi, Rajan KumarSingla, Jagdev Singh Kullar, Rajesh Kumar Suri, Vandana Mehta[142]**

A study conducted by Swati Gandhi et al intended to assess the numerous morphometric and structural parameters of the condylar and intercondylar area of the tibia bone. They studied fifty female and fifty male adult human tibiae bones and found them to be

statistically significant with a p-value<0.05; When the two sexes on both sides are compared. By evaluating the morphometric parameters of the upper end of the tibia, the study considerably contributes to the data for unicompartmental and total knee arthroplasty in the Indian population. Furthermore, they showed the fundamental and special significance of the present knowledge for the technical advancements in the 6orthopedic surgeries like the reconstructive surgical procedures involving the knee.

### 2.4.2. MORPHOMETRIC STUDY OF TIBIAL CONDYLAR AREA IN THE NORTH INDIAN POPULATION (2014)

**Ankit Srivastava, Dr. Anjoo Yadav, Prof. R.J. Thomas, Ms. Neha Gupta[9]**

The current study aimed to collect data on 150 dry tibia bones from the North Indian population, 70 from the right side and 80 from the left, using the literature of morphometric investigations on tibial condyles. These bones' age and gender were unknown. The author provides a wealth of information that anatomists, anthropologists, and orthopaedic surgeons can use to perform unicompartmental knee arthroplasty, full knee arthroplasty, and meniscal transplantation treatments.

### 2.4.3. ANATOMICAL MORPHOMETRY OF THE TIBIAL PLATEAU IN SOUTH INDIAN POPULATION (2016)

**Bukkambudhi Virupakshamurthy Murlimanju, Chetan Purushothama, Ankit Srivastava, Chettiar Ganesh Kumar, Ashwin Krishnamurthy, Vandana Blossom, Latha Venkatraya Prabhu, Vasudha Vittal Saralaya, Mangala Manohar Pai[24]**

The current learning included data from 150 dry tibia bones from the North Indian population, 70 of the right side and 80 of the left. These bones were unknown in terms of age and gender. The author provides a wealth of information that anatomists, anthropologists, and orthopedic surgeons can use for unicompartmental knee arthroplasty, full knee arthroplasty, and meniscal transplantation treatments.

### 2.4.4. A MORPHOMETRIC STUDY OF THE PROXIMAL END OF TIBIA IN NORTH EASTKARNATAKA POPULATION WITH ITS CLINICAL IMPLICATION (2017)

**Sandeep S. Malegaonkar, Dhananjai B. Naik, Sidra Shireen[133]**

The current study included data from 150 dry tibia bones from the North Indian population, 70 of the right side and 80 of the left. These bones were unknown in terms of age and gender. The author provides a wealth of information that anatomists, anthropologists, and orthopedic surgeons can use for unicompartmental knee arthroplasty, full knee arthroplasty, and meniscal transplantation treatments. Furthermore, they suggested that the result of this study will be significantly helpful in the cases of Total Knee Arthroplasty and unicompartmental arthroplasty procedures and meniscal reconstruction and meniscal transplantation and to prepare a properly matched prosthesis of accurate size.

### 2.4.5. MORPHOMETRIC STUDY OF UPPER END OF TIBIA IN GUJARATREGION AND ITS CLINICAL IMPLICATION IN KNEE ARTHROPLASTY (2017)

**Ankur Z Zalawadia, Shailesh M Patel[11]**

The purpose of this study was to establish a baseline for sexual dimorphism in the upper end of the tibia bone; in addition to alterations in morphometric characteristics. A total of one hundred and twenty dry tibias of known gender were used in this study. The author noticed that the data in males was much larger than in females. The findings were much less than the Caucasian and North Indian populations, but significantly greater than the population of South India. The author also consults the literature for information on limited availability, which can be helpful in choosing the correct and sized knee prosthesis.

### 2.4.6. A MORPHOMETRIC STUDY OF THE PROXIMAL END OF THE TIBIA IN SOUTH INDIAN POPULATION WITH ITS CLINICAL IMPLICATIONS (2018)

**Chandni Gupta, Jitendra Kumar, Sneha Guruprasad Kalthur, Antony Sylvan D'souza[31]**

The author examined fifty adult fully ossified dry human tibia bones and measured several proximal end tibia characteristics. The author observed significant variations and suggested that the results of their study can influence the treatment outcome in the Unicompartmental knee arthroplasty, and total knee arthroplasty procedure involving knee.

### 2.4.7. MORPHOMETRIC STUDY OF PROXIMAL END OF TIBIA WITH ITS CLINICAL IMPLICATIONS IN NORTH INDIAN POPULATION (2018)

**Bhadoria Pooja, Pangtey Babita, Mishra Sabita[18]**

To guide for designing the tibial prosthesis in seeking the diversity of Indian population the author intended to study the morphometric parameters of the upper end of human tibia bones. For this author studied a total two hundred and twenty-four dry tibia bones for the various morphometric measurements. With p 0.05, they discovered a considerably higher link between the medial and lateral tibial condyles on both sides. The findings of the study suggested that morphometric features of the articular and non-articular parts of the upper end of the tibia bone should be used as a foundation for applying reference knowledge for unicompartmental and total knee arthroplasty procedures in the Indian population.

### 2.4.8. MORPHOMETRIC STUDY OF PROXIMAL END OF DRY ADULT TIBIAE (2019)

**Juned Labbai[83]**

For the present study the author studied a total one hundred and fifty dry adult tibiae bone, for measuring various morphometric measurements of tibia bone. The study provided a comprehensive data which aids literature for providing significant help in the designing of proper sized implants for the arthroplasty procedure involving knee.

### 2.4.9. MORPHOMETRIC ANALYSIS OF PROXIMAL END OF THE TIBIA (2019)

**Nadia Ahmad, Deepa Singh, Aksh Dubey S. L. Jethani[112]**

To highlights the baseline, need for the properly sized prosthesis specific to the Indian population the author studied a total sixty adult human dry bones belonging to the both sides; right and left. The author considered various morphometric measurements including tibial pleatu and intercondylar area of tibia and suggested that observing the physique state and anatomical profile the morphometry of the tibial condyle is smaller for the Indian population and hence the proper sizing of prosthesis for any considerable population can be the discussion.

### 2.4.10. MORPHOMETRIC STUDY OF UPPER END OF TIBIA IN DAKSHINA KANNADA POPULATION (2020)

**Chaitra D., Divya Pai, Pretty Rathnakar, Remya K.[112]**

The numerous morphometric characteristics of the upper end of the tibia bone were measured with the goal of providing a guide to orthopaedic surgeons and other surgeons for a better comprehensive outcome and to prevent post-operative complications of total knee replacement surgeries. The research was carried out on a total of 75 dry tibia bones. The mature tibiae bone was measured in various morphometric ways. According to the author, the standard prosthesis on the market was created for Caucasians. Because the measures in the south Indian population are smaller than those in the Caucasians, the literature offered can fill in the gaps in the data needed to choose more suitably sized prostheses for the south Indian population undergoing knee surgery.

## 2.5. OTHER RELATED STUDIES ON THE MENISCI OF THE KNEE

### 2.5.1. MORPHOLOGICAL STUDY OF THE MENISCI OF THE KNEE JOINT IN ADULTCADAVERS OF THE SOUTH INDIAN POPULATION (2010)

**B.V. Murlimanju, Narga Nair, Shakuntala Pai, Mangala Pai1, Chethan P, Chandni Gupta[25]**

The author of this study wanted to know how often different shapes of lateral and medial meniscus, as well as discoid meniscus, are in the South Indian population. In addition, the author attempts to establish macroscopically the morphological variances of the various menisci forms. C-shaped, crescent-shaped, and discoid-shaped lateral meniscuses were identified. The U-shaped, sided V-shaped, sickle-shaped, crescent-shaped, and C-shaped groups of the medial meniscus were studied. For this study, they examined 138 menisci from 54 cadaveric knee joint specimens. The lateral meniscus is 61.1 % C-shaped and 38.9 % crescent-shaped, according to the findings. They discovered 50 % crescent-shaped, 38.9% sided V-shaped, and 11.1 % sided U-shaped medial meniscus. Furthermore, the author discovered that the lateral meniscus was 61.1 % C-shaped and 38.9 % crescent-shaped. In the medial meniscus, they found 50 % crescent-shaped, 38.9% sided V-shaped, and 11.1 % sided U-shaped. Furthermore, no discoid-shaped medial or lateral meniscus was found in the investigation, according to the author.

### 2.5.2. MENISCUS MORPHOMETRIC STUDY IN HUMANS (2010)

**Braz, PRP, Silva, WG[21]**

The author studied a total of forty menisci with primary objective to evaluate the morphometric variations in the meniscus. The study indicated that the distance between the anterior and posterior horns in the medial meniscus is much higher than that of the lateral meniscus. Although there were no significant differences in length between the anterior, medium, and posterior regions of the lateral meniscus, the posterior region of the medial meniscus was found to be wider. The author went on to argue that current data can considerably improve the meniscus repair literature.

### 2.5.3. CLINICALLY ORIENTED MORPHOMETRIC STUDY OF MEDIAL AND LATERAL MENISCI OF THE KNEE JOINT IN ADULT CADAVERS (2012)

**B.V. Murlimanju, N. Nair, B. Kumar, A. Krishnamurthy, C. Gupta, P. Chethan[26]**

The primary goal of this research was to identify the outside and inner borders of the medial and lateral menisci, as well as the distance between the anterior and posterior horns. The author observed that the peripheral length and inter horn distance of the

medial meniscus were longer than those of the lateral meniscus, which was statistically significant at p0.05. They also discovered that some of the results were not statistically significant.

### 2.5.4. MORPHOMETRIC ANALYSIS OF ADULT MENISCI- A CADAVERIC STUDY (2013)

**Mamata Panigrahi, S. Senthil Kumar [101]**

The study was place in 2013 at the Department of Anatomy, Sri Ramachandra Medical College and Research Institute, Porur, Chennai, India, and lasted two years. A total of 38 menisci were found in the corpse, eight bilaterally and twenty-two unilaterally, with a mean age of 45-55 years. The author aimed to describe the anatomical and pathological features of meniscus and carried out the morphometric study of menisci. For this, anatomical features and different shapes of menisci were considered. The incidence of discoid lateral meniscus was found to be 5%. The Menisci are not optional or expendable structures, according to the author, and play an important part in appropriate knee joint biomechanics.

### 2.5.5. MORPHOMETRIC ANALYSIS OF THE MENISCI OF THE KNEE JOINT IN POPULATION OF EAST GODAVARI REGION OF ANDHRA PRADESH (2014)

**Narayan Rao, Anirban Das Gupta, A. V. Raju[113]**

The author investigated the morphometric parameters of the menisci in the population of Andhra Pradesh East Godavari region. Menisci from 100 knee joints were dissected by the author. The key goals of this study were to observe and measure the breadth of menisci, the length of their outer and inner borders, the thickness of their outer circumferences, and the distance between their anterior and posterior horns. A 0.02 mm vernier caliper and a non-elastic cotton thread were used for all morphometric measurements. After comparing the current study's meniscal measurements to other accessible literature, the author discovered certain morphological changes in the meniscus in the Godavari region of Andhra Pradesh, India.

### 2.5.6. MORPHOLOGY OF MENISCI OF KNEE JOINT IN ADULT CADAVERS OF NORTH KARNATAKA (2015)

**Veeresh Itagi, V. S. Shirol, Jayasudha K.[152]**

The author examined 120 menisci in the north Karnataka population for the prevalence of various lateral and medial meniscus forms. The morphological variations of menisci forms were also analyzed macroscopically and characterized. The findings of this study suggest that health care providers treating meniscal injuries should be aware of any structural differences in the menisci, as this will make the rehabilitation process easier.

### 2.5.7. MORPHOLOGICAL STUDY OF THE MENISCOFEMORAL LIGAMENTS (2016)

**Geetharani BG, Betty Anna Jose, Shashirekha M, Varsha Mokhasi[58]**

Collateral and cruciate ligaments provide the chief support for the knee joint. The meniscofemoral, transverse meniscal, and coronary ligaments provide secondary support. The meniscofemoral ligaments and their attachments in forty cadavers from the south Indian population were considered in this study. The length and mid width of the Meniscofemoral ligaments, as well as all of their attachments, were measured. Anterior meniscofemoral ligament alone was observed in 12.5% of knee joints, posterior meniscofemoral ligament alone was observed in 30% of knee joints and both ligaments were observed in 37.5 % of knee joints. In 20% of knee joints, both ligaments were absent. The anterior meniscofemoral ligament was 2.79cm long and 1.27cm wide on average. In older cadavers, the posterior meniscofemoral ligament was more common and larger than the anterior meniscofemoral ligament. In this study, posterior meniscofemoral ligaments were observed to have a higher incidence and morphometric outline than anterior meniscofemoral ligaments.

### 2.5.8. MORPHOMETRIC STUDY ON TIBIAL MENISCI INWEST INDIAN CADAVERS (2016)

**Soniya A Gupta, Saiprasad P Bhavsar, Alka Singh, Medha V Ambiye[140]**

Tibial menisci of knee joint are more commonly injured in young population especially in persons involved in sports activities. These menisci are cartilaginous structures with poor blood supply to the inner portion. Most of the times, these damaged menisci need to be transplanted. It requires the knowledge of size and shape of the menisci. The author aimed to study to classify the menisci according to its shape and identify the discoid meniscus in the Western Indian population.

### 2.5.9. MORPHOLOGICAL STUDY OF MENISCI OF KNEE JOINT IN HUMAN CADAVERS (2018)

**Shital Bhishma Hathila, Kintu kumar K Vyas, V. H. Vaniya, Bhavin B Kodiyatar[28]**

The author's goal in this study was to measure the length, thickness, and width of 60 cadaveric healthy menisci at three different points: anterior, middle, and posterior, and compare data between medial and lateral menisci. Different menisci characteristics were measured using a digital vernier caliper and analysed using Microsoft Excel. In three points: anterior, centre, and posterior, the author discovered a statistically significant difference (p0.05). In the study, there was no significant difference in outer circumference length or thickness in both menisci.

### 2.5.10. OBSERVATIONAL STUDY OF MORPHOMETRIC PARAMETERS OF THE MEDIAL MENISCUS OF THE KNEE JOINT IN 30 ADULT CADAVERS (2018)

**Amandeep Kaur, Preeti Chaudhary, Gurdeep Singh Kalyan, Gurwinder Singh Bal[28]**

The study's goal was to look at the morphometric differences in the menisci in 30 adult knees. The study's value is emphasized by the lack of relevant data regarding medial meniscus anatomical variance. Despite slight anatomic changes in morphology within the same species, the author found that the left and right-side medial meniscus in the identical individual were morphologically analogous.

### 2.5.11. SHAPES OF MENISCI OF KNEE JOINT: A HUMAN CADAVERIC STUDY (2019)

**Shashidhar, Sridevi N.S.[138]**

The medial and lateral menisci are important for maintaining joint health and stability because they play vital roles in knee joint stability, function, and dynamic loading.The goal of the study was to determine the frequency of various shapes of the Lateral and Medial Menisci, as well as their clinical importance in ligament injuries of the knee joint. The numerous morphological forms of Menisci determined in were seen, with the crescent type being the most common subgroup and Lateral Menisci being C shaped. A single incomplete Discoid Lateral Meniscus specimen was discovered, which is unusual. This insight, according to the author, will aid in the study of degenerative illnesses affecting the Menisci of the knee joint.

## 2.6. OTHER RELATED STUDIES ON LIGAMENTS OF THE KNEE JOINT

### 2.6.1. ANATOMY OF THE LATERAL COLLATERAL LIGAMENT: A CADAVER AND HISTOLOGICAL STUDY (2006)

**Espregueira-Mendes M. Vieira da Silva**

The anatomical investigation of the lateral collateral ligament was described in this paper. The ligament's size, as well as its femoral and fibular attachments was measured. The LCL's interactions with other anatomical structures, particularly the biceps femoris' terminal fibre branches, were described. The ligament fibres and their osseous attachments were also described histologically.

### 2.6.2. THE ANATOMY OF THE MEDIAL PART OF THE KNEE (2007)

**Robert F. LaPrade, Anders Hauge Engebretsen, Medical Student, Thuan V. Ly, Steinar Johansen, Fred A. Wentorf, Lars Engebretsen[51]**

The goal of this research was to confirm the qualitative architecture of the medial structures of the knee and to quantify their anatomic attachment sites as well as their correlations to relevant osseous landmarks. The ligament structures on the medial sides of the knee have a consistent pattern of attachment, according to the author.

The discovery of the gastrocnemius tubercle, as well as the quantitative relationships revealed here, will be particularly useful in the study of anatomical repairs and reconstruction techniques requiring intricate ligamentous injuries that may harm the medial components of the knee.

### 2.6.3. MORPHOMETRIC STUDY ON THE TIBIAL COLLATERAL LIGAMENT (2007)

**Anu Vinod Ranade; Rajalakshmi Rai; Latha Venkatraya Prabhu; Mangala Kumaran, Arunachalam Kumar[13]**

In the current study, the author looked at a comprehensive investigation of the tibial collateral ligament diameters and anatomical variances. With the declining importance of anatomical structure as a preclinical subject and recent effective attempts to decrease total exhausting teaching hours for dissection operations, as well as the paucity of cadavers, baseline data of this type is becoming increasingly uncommon. With these factors in mind, the author uses a series of dissections to characterise the ligament's gross morphological features.

### 2.6.4. CORRELATION BETWEEN THE MORPHOMETRIC PARAMETERS OF THE ANTERIOR CRUCIATE LIGAMENT AND THE INTERCONDYLAR WIDTH: GENDER AND AGE DIFFERENCES (2009)

**Lazar Stijak Æ Vidosava Radonjic´ Æ Valentina Nikolic´ Æ Zoran Blagojevic´ Æ Milan Aksic´ Æ Branislav Filipovic[94]**

The author made an attempt to conduct the study on total fifty cadavers for the anatomical morphometric parameters of the anterior cruciate ligament. The length of the anteromedial and posterolateral bundles of the ACL, the mean length and width of the ligament, the length and width of tibial insertion, and the length and width of femoral insertion were all investigated by the author. The intercondylar width was also measured at the popliteal groove level.

The author reported a bigger intercondylar notch in men than in women, and concluded that men have a wider ACL than women. Furthermore, the ACL width was found to have a positive relationship with male intercondylar notch width but not with female

intercondylar notch width. The length and width of the ACL femoral insertion were related to the width of the male intercondylar notch.

### 2.6.5. THE ANTERIOR INTERMENISCAL LIGAMENT OF THE KNEE AN ANATOMIC STUDY (2010)

**Eric W. Nelson, Robert F. LaPrade[51]**

The presence of the anterior intermeniscal ligament of the knee, its attachment patterns, and its relationships to other anatomic structures within the knee were highlighted by the author. An anterior intermeniscal ligament was observed in total forty-seven specimens (94%).The average length was 33mm, and the average width of the mid-substance was 3.3mm. The average perpendicular distance between the anterior intermeniscal ligament and the anterior edge of the anterior cruciate ligament's tibial insertion was 7.8 mm, ranging from 2.0 to 13.5 mm.

Furthermore, in all, twelve knees (24%) had the anterior intermeniscal ligament as the predominant attachment for the anterior horn of the medial meniscus; seven knees (14%) had no tibial insertion, and five knees (10%) had only a fine fascial tibial connection. The author suggests that a thorough understanding of the anterior inter-meniscal ligament's anatomical structure is critical for avoiding patient injury during various surgical procedures, particularly when performing arthroscopic minimally invasive ACL reconstructions in close proximity to the anterior inter-meniscal ligament.

### 2.6.6. MORPHOLOGY OF THE MEDIAL COLLATERAL LIGAMENT OF THE KNEE (2010)

**Fang Liu, Bing Yue, Hemanth R Gadikota1, Michal Kozanek1, Wanjun Liu, Thomas J Gill, Harry E Rubash, Guoan Li**

The author's major goal in this work was to identify the anatomical and quantitative morphology of the MCL in human knees. The MCL anatomy was studied using ten human cadaveric knees. According to the author, the distal section of the dMCL (meniscotibial ligament-MTL) was 1.7 times wider than the proximal portion (meniscofemoral ligament-MFL), and the MFL was nearly 3 times longer than the MTL. The morphological data on the MCL, according to the author, is particularly useful for

improving MCL-related pathology therapies and conducting MCL release during total knee arthroplasty procedures.

### 2.6.7. THE IMPORTANCE OF THE MEDIAL PATELLOFEMORAL LIGAMENT IN THE LATERAL DISPLACEMENT AND INCLINATION OF THE PATELLA: A RADIOGRAPHIC STUDY IN CADAVERS (2011)

**Edimar Fávaro, Nilson Roberto Severino Tarciso Fávaro, Arnaldo José Hernandez[28]**

The medial patellofemoral ligament (MPFL) is the main static stabilizer that keeps the patella from moving to the side. To assess the patellofemoral joint's stability, the authors used radiography to look for lateral displacement and inclination of the patella before and after the MPFL section in the knees of cadavers. The length and width of the medial patellofemoral ligament were 4.8 cm and 1.6 cm, respectively. Based on the findings of this study, the author concluded that the medial patellofemoral ligament is crucial in the lateral inclination and displacement of the patella when the knee is flexed at 45 degrees.

### 2.6.8. TIBIAL INSERTIONS OF THE POSTERIOR CRUCIATE LIGAMENT: TOPOGRAPHIC ANATOMY AND MORPHOMETRIC STUDY (2012)

**Julio Cesar Gali, Hector Campora de Sousa Oliveira, Bruno Cesar Bracher Lisboa, Bruno DiSerio Dias, Fabiana de Godoy Casimiro, Edie Benedito Caetano[84]**

The anatomical and morphometric foundations of the posterior cruciate ligament's tibial insertions were examined in order to aid in the development of anatomical tibial tunnels during ligament surgical repair. The author concluded that the anterolateral bundle had a larger tibial insertion area than the posteromedial bundle based on the findings of this study; the insertion regions of the two bundles were compared. Because of the differences in the tibial insertion area of the posterior cruciate ligament, single or double tibial tunnel anatomical reconstructions of this ligament should be advised depending on the individual features.

**2.6.9. OBLIQUE POPLITEAL LIGAMENT – AN ANATOMICAL STUDY(2012)**

**Lucas Pinto D'Amico Fama, Vagner Messias Fruhelingb, Barbara Pupimb, Carlos Henrique Ramosc, Márcio Fernando Aparecido de Mourad, Mário Nambac,e,João Luiz Vieira da Silvad, Luiz Antônio Munhoz da Cunhaf,Ana Paula Gebert de Oliveira Francog, Edmar StievenFilhoh[28]**

The author looked at the architecture of the oblique popliteal ligament, including its size, expansion, and anatomical relationships, in this paper. Eleven human cadaver knees were dissected to examine the anatomy and measure the anatomical structures and interconnections of the oblique popliteal ligament. The oblique popliteal ligament had an average distance of 7.4mm between its origin and the tibial plateau, an average thickness of 7.3mm at its origin, a length of 33.6mm, and a tibial plateau angle of 34.8.

**2.6.10. MORPHOMETRY OF THE FIBULAR COLLATERAL LIGAMENT: ANATOMIC STUDY WITH COMPREHENSIVE REVIEW OF THE LITERATURE (2014)**

**Todd M. Chappell, Prakash N. Panchani, Garrett D. Moore, R. Shane Tubbs, Mohammadali M. Shoja, Marios Loukas, Piotr B. Kozlowski, Khurram H. Khan, Anthony C. DiLandro, Anthony V. D'Antoni[28]**

The current study's author focused on FCL morphology and literature evaluations on the structure. To determine the FCL, seventy knees were dissected. The articular surface's length, width, distance between proximal and distal attachments, and distance between proximal and distal attachments was made. The average length and breadth of FCLs were 48.3mm and 4mm, respectively. Furthermore, regardless of age or gender, the author identified a direct correlation between the proximal and distal attachments to the articular surface. A bifurcate ligament with two distal bands and a trifurcate ligament with three distal bands are both attached to the fibular head, according to the author.

### 2.6.11. MORPHOMETRIC STUDY ON CRUCIATE LIGAMENTS OF KNEE WITH GENDER DIFFERENCES: ACADAVERIC STUDY (2014)

**Anil Kumar Reddy Yelicharla, Ujwal Gajbe, Brijraj Singh[8]**

The study's goal was to take numerous measurements of the anterior and posterior cruciate ligaments in both sexes and statistically analyze the results. After examination, it was discovered that males' ACL length and width were substantially greater than females'. Except for length and width, PCL mean values showed substantial differences between males and females. The mean length of PCL differed somewhat between males (36.9 3.9 mm) and girls (36.9 3.4 mm), However, there was no statistically significant change (P>0.05).The author advised that orthopaedic surgeons should take into account the average gender variations in cruciate ligament morphometric measurements when undertaking surgical repair of cruciate ligaments independently or in clusters.

### 2.6.12. A MORPHOLOGICAL AND MORPHOMETRIC STUDY ON MENISCOFEMORAL LIGAMENTS OF KNEE JOINT AND ITS VARIATIONS (2018)

**Prerana aggarwal, Anwesa Pal, Asis kumar Ghosal, Indra Datta, Biswarup Banerjee[125]**

The author's goal in this work was to describe the prevalence of MFLs in human adult cadaveric knees, as well as their anatomical differences and size changes. In terms of the PCL, The anterior and posterior menisco-femoral ligaments were found. According to the author, every dissected knee joint possesses at least one MFL. Ten joints (26.3%) had both aMFL and pMFL, four (10.5%) joints exclusively had aMFL, and 24 joints only had pMFL (63.2 %). Auxiliary bands were found in 8 (21.05 %) of the joints (2 with only aMFL and 6 with only pMFL). In men, pMFL was shown to be more prevalent and longer than aMFL, as well as longer and broader at the lateral end. Because each knee joint has at least one MFL, as well as variances in architecture in the form of supplementary bands and size, it's vital to detect and separate these ligaments from surrounding tissues during radiographic and arthroscopic evaluation.

### 2.6.13. A CADAVERIC STUDY ON THE ANATOMY OF ANTERIOR CRUCIATE LIGAMENT IN VIETNAMESE ADULTS (2018)

**Trung Dung Tran, Quoc Lam Tran[149]**

In this study, the author wanted to report on the anatomical characteristics of the ACL in Vietnamese people. To explore the anatomical properties of the ACL, ten new knees were dissected. The length, diameter, and insertion site of the ACL were all measured. The average lengths of the ACL's AM and PL bundles were 30.6mm and 25.6mm, respectively. The femoral and tibial ACL attachment sites had typical diameters of 13.8 ±10.6 mm and 13.4±10.2 mm, respectively.

### 2.6.14. ANATOMICAL VARIATIONS OF KNEE LIGAMENTS IN MAGNETIC RESONANCE IMAGING: PICTORIAL ESSAY (2019)

**J. Tomczyk, M. Rachalewski, A. Bianek-Bodzak, M. Domżalski[85]**

The anatomical variations of knee ligaments, which can mimic diseased structures, were the focus of this study. A renowned but less common ligament that is infrequently observed and may cause the most concern was discoursed. The author suggests including instructions on how to modify planes to appropriately see a specific structure, which should make it easier to locate and distinguish those structures in clinical practice.

### 2.6.15. A PROPOSAL FOR A NEW CLASSIFICATION OF THE FIBULAR (LATERAL) COLLATERAL LIGAMENT BASED ON MORPHOLOGICAL VARIATIONS (2019)

**Łukasz Olewnika, Bartosz Goneraa, Konrad Kurtysa, Michał Podgórskib, Michał Polgujc[98]**

The goal of this work was to give the first comprehensive FCL classification that encompassed all major characteristics of morphological diversity. For the lateral compartment of the knee, a total of 111 lower limbs were dissected. All of the specimens had fibular collateral ligament, according to the author. The FCL is most commonly originated from the lateral femoral epicondyle and inserted on the lateral surface of the fibula head (72.1 % of the time) (Type I). There were also bifurcated (Type IIa — 12.6%) and trifurcated (Type IIb — 0.96%) ligaments with two and three distal bands seen.

Fusion of the FCL and ALL (Type IV — 8.1 %) was also observed, as was a double FCL (Type III — 6.3 %).

### 2.6.16. CADAVERIC STUDY OF MORPHOMETRIC ANALYSIS OF ANTERIOR CRUCIATE LIGAMENT AND ITS SIGNIFICANCE (2019)

**D.SampathKumar,M.R.Manimekalai[2]**

FCL and ALL fusion (Type IV — 8.1%), as well as Type III fusion (6.3 %). The researchers wanted to find exact morphometric data for anterior cruciate ligaments in the South Indian population. The researchers wanted to know how long and wide the anterior cruciate ligament was on average. The ACL's average length on the left side was 28.06mm, and its average width in the middle third was 10.33mm. On the right side, the average length of the ACL was 28.53mm, and the average width of the ACL in its middle third was 10.23mm. The author also underlined the relevance.

### 2.6.17. THE ANATOMICAL NUMERICAL MEASUREMENT OF POSTERIOR CRUCIATE LIGAMENT: A VIETNAMESE CADAVERIC STUDY (2019)

**Do Van Minh, Tran Trung Dung, Ngo Van Toan, Nguyen Huy Phuong, VO Sy Quyen Nang, Thien Chu Dinh[43]**

The purpose of this study was to describe how the PCL is measured anatomically in Vietnamese individuals. The macroscopic morphometric properties of the intra-articular PCL were described, including the attachment of the anterolateral and posteromedial bundles to the femur and tibia. Between the medial femoral cartilage rim and the central point of femoral ALB, PMB, and total PCL insertion, the shortest lengths measured were 7.0 0.79, 7.3 0.95, and 7.8 1.73 mm, respectively. The tibial PCL was placed 9.71.008 mm below the medial tibial plateau's cartilage plane.

### 2.6.18. MORPHOMETRIC ANALYSIS OF CRUCIATE LIGAMENTS (2019)

**Geetha rani B.G, Varsha Mokhasi, Tamsir Rong P.[61]**

The goal of this learning was to measure the length and width of the ACL and PCL in human knee cadavers and healthy people using an MRI approach. The ligaments' length and width were measured using vernier calipers. The ACL was substantially longer than

the PCL in the cadavers ($p<0.014$). The PCL was wider than the ACL (p 0.001). The author added to the ACL and PCL comparative morphometric data, emphasizing that the PCL was shorter and wider than the ACL, giving it a more stable knee joint structure.

### 2.6.19. MORPHOMETRIC ANALYSIS OF ANATOMY OF ANTERIOR CRUCIATE LIGAMENT OF KNEE AND ITS ATTACHMENTS - A CADAVERIC STUDY IN INDIAN POPULATION (2021)

**Mishra S, Mylarappaa, Sat apathy D, Samal S[105]**

Using 19 knees from ten human cadavers, the researchers measured the relative length, width, and stiffness of ACL bundles at 0, 90, and 140 degrees of knee flexion, as well as the maximum horizontal and vertical bundle footprints at tibio-femoral attachments. The average length and width of the anteromedial bundle's implantation on the tibial surface in boys and females, respectively, were 8.8mm and 9.0mm. The male and female posterolateral bundles were also measured and found to be 9.1mm and 7.8mm, respectively.

## 2.7. OTHER STUDIES RELARED TO KNEE:

### 2.7.1. THE ACCESSORY BANDS OF GRACILIS AND SEMITENDINOSUS: AN ANATOMICAL STUDY (2003)

**Candal-Couto JJ, Deehan DJ.[28]**

Since more than a decade, an Arthroscopic ACL reconstruction procedure using semitendinosus and gracilis tendons as graft has been a preferred method for treating ACL deficient knees. Furthermore, it has been noticed that finding accessory tendinous bands developing from these two tendons while harvesting them is highly common. The author of the current study noted that it has clinical implications and that more consideration should be exercised while using a tendon stripper to avoid cutting the main tendon. The author used a direct cadaveric observation approach after dissecting the tendons of gracilis and semitendinosus in ten embalmed adult human cadaveric lower limbs to examine these secondary bands and assess their anatomical changes. The author further concluded that accessory bands of semitendinosus and gracilis have a high variability.

### 2.7.2. DOES THE FABELLA CONTRIBUTE TO THE REINFORCEMENT OF THE POSTEROLATERAL CORNER OF THE KNEE BY INDUCING THE DEVELOPMENT OF ASSOCIATED LIGAMENTS? (2004)

**Takeshi Minowa , Gen Murakami, Hideji Kura, Daisuke Suzuki, Seung-Ho Han, Toshihiko Yamashita[144]**

The fabellofibular and arcuate ligaments are located on the knee's posterolateral side. In Japanese subjects, the Fabella bone is frequently missing. In the current work, the author attempted to morphometrically examines these structures in 212 knees. In 66 of the knees with a firm fabella, 38.1 % (40/105) had a thick FF ligament. A bony fabella accompanied a thick FF in 82.8 % (24/29) of cases when diagnosed histologically. Furthermore, in 77.9% (60/70) of knees, a thin or indeterminate FF ligament and an elastic-textured fabella co-existed.

The morphology of the fabella and the arcuate ligament did not show any other strong correlations, according to the author. As a result, a hard or bony fabella appeared to be linked to FF ligament thickening. The thicknesses of the FF and arcuate ligaments, on the other hand, were adversely associated. No arcuate ligament could be found when the FF ligament was more than 5 mm thick, showing that it was as strong as the lateral collateral ligament. A well-developed arcuate ligament typically accompanied a thin or indeterminate FF ligament (61.9 %, 96/155). These ligaments appear to work together to stabilize the posterolateral corner, based on our findings.

### 2.7.3. ANATOMICAL VARIATIONS IN THE ANATOMY OF THE POSTEROLATERAL CORNER OF THE KNEE (2007)

**O. Raheem Æ J. Philpott Æ W. Ryan Æ M. O' Brien[28]**

This cadaveric study on twenty-two cadaveric knees described the architecture of the deeper structures of the posterolateral aspect of the knee, including the popliteus–tendon complex, arcuate ligament complex, popliteofibular ligament, and coronary ligament. The popliteofibular ligament has the most variations, according to the author, and the discrepancies, as well as the various nomenclatures used in the literature for these structures, make it difficult to evaluate and treat damage to them. In addition, injuries to

the posterolateral side of the knee that go untreated can contribute to chronic functional instability.

### 2.7.4. MORPHOLOGICAL ANALYSIS OF THE FABELLA IN BRAZILIANZ (2010)

**Julio Guilherme Silva, Carlos Alberto Araújo Chagas, Diego Faria Magalhães Torres, Lucia Servidio; Ari Cantuária Vilela,Walker André Chagas[28]**

In the current investigation, the author stated that fabella bone can be identified in the posterior region of the knee in a low-incidence situation. Furthermore, the anatomical literature report and its composition have been found to be moderately disputed. The bone is found within the gastrocnemius lateral head tendon. When it happens, however, it usually results in the absence of the arcuate ligament and the existence of the fabellofibular ligament in the knee.

Males are more likely to be infected with fabella. The author supported up the existing research on the anatomical and histological properties of the fabella. The authors have attempted to investigate the incidence of fabella presence and absence, its histological structure, and its connection with presence or absence in the current study. Sixty-two human cadaveric knees from Brazil were dissected, and the fabella was found in two distinct cases. For microscopic examination, the tissue was excised and preserved in 4% formaldehyde. Only a small fraction of Brazilians have the fabella, a sesamoid bone. According to the author, the existence of fabella causes the absence of the arcuate ligament and the presence of the fabellofibular ligament. Furthermore, histological and microscopic examinations revealed bone tissues that were devoid of osteoclasts.

### 2.7.5. INCIDENCE AND RADIOLOGICAL CHARACTERISTICS OF FABELLAE IN AN ASIAN POPULATION (2014)

**Chee Ping Chew, Kong Hwee Lee, Joyce Suang Bee Koh, Tet Sen Howe[28]**

The goal of this study was to find out how common fabella is in an Asian community and to use radiography and magnetic resonance imaging films to characterize the fabella's radiological properties. The author analyzed a total of eighty individuals who had knee arthroscopy between May 2005 and October 2009 to identify the presence and features of

the fabella. The current cohort study discovered a total of 31.25 % fabella prevalence. The fabella was measured at 7.06mm, 4.89mm, 6.12mm, and 33.19mm from the lateral femoral condyle, respectively.

The fabella was constantly bony and positioned in the gastrocnemius' lateral head, with an articulating facet on 52 % of the fabella. Men's fabella was found to be larger than women's, despite the fact that both were proven to be female. The presence of an articulating groove was related to a larger fabella, but not to the distance between the fabella and its embedded into the gastrocnemius' lateral head. In our population, the prevalence of fabella was lower than in regional studies. The author also discovered that the larger the fabella, the more likely it is to contain an articulating groove. The study's author stated that current knowledge can provide objective morphometric characteristics to assist distinguish the fabella bone from other loose masses or calcifications in the knee.

### 2.7.6. PES ANSERINUS STRUCTURAL FRAMEWORK AND CONSTITUTING TENDONSARE GROSSLY ABERRANT IN NIGERIAN POPULATION (2015)

**J. O. Ashaolu,T. S. Osinuga,V. O. Ukwenya, E. O. Makinde, A. J. Adekanmbi[79]**

The author of this study looked at morphological differences in pes anserinus development in the Nigerian population. The author used ten Nigerian human cadaveric knees to do so. The pes anserinus was positioned on the superior half of the tibia's medial border, as far inferiorly as 124.44mm from the tibial tuberosity (prolonged insertion).

The insertion was additionally linked to the fascia cruris and the region of the tibia adjacent to the tibia tuberosity (90 %). They discovered accessory bands of the sartorius, gracilis, or semitendinosus were part of the pes anserinus in 95 % of the cases analyzed, while monotendinosus, sartorius, gracilis, and semitendinosus tendons were present in just 5% of the cases. Meanwhile, the accessory tendon band may cause tendon graft prematurely. This morphometric marking can also aid to prevent donor site injury, nerve injuries, and post-operative hamstring weakening. The author also claimed that pes anserinus had a longer distal attachment, providing mechanical benefits.

### 2.7.7. A PROPOSAL FOR A NEW CLASSIFICATION OF PES ANSERINUS MORPHOLOGY (2018)

**Łukasz Olewnik, Bartosz Gonera, Michał Podgórski, Michał Polguj, Hubert Jezierski, Mirosław Topol[99]**

It is clinically important to harvest the semitendinosus and gracilis muscle tendons for the restoration of other tendons, particularly the anterior cruciate ligament (ACL). The presence of supplementary bands in PA tendons can make harvesting more difficult. As a result, the study's goal was to propose a new morphological classification for PA morphology. A total of 102 lower limb specimens were dissected using traditional methods. The PA's morphology and insertion (including accessory bands) were evaluated, as well as morphometric data.

The PA was present in all patients and was made up of the sartorius, gracilis, and semitendinosus tendons. Characterized by the presence of supplementary bands, the author identified six categories of PA. In 54 limbs, monotendinous sartorius, gracilis, and semitendinosus were found to be the most prevalent constituents (52.9 %). In addition, three different forms of insertion were identified (short, band-shaped and fan-shaped). The accessory bands to the fascia of the gastrocnemius muscle had a mean length of 63.5 mm between their insertion and origin. The existence of an accessory band, according to the author, can make the harvesting process more difficult. Furthermore, they believe that current information can be effectively used to surgical procedure planning.

### 2.7.8. MORPHOLOGICAL VARIANTS OF PES ANSERINUS IN SOUTH INDIA (2019)

**B.V. Murlimanju, R. Vadgaonkar, C. Ganesh Kumar, M.D. Prameela, M. Tonse, M. M. Pai, V. Blossom[27]**

The goal of this study was to look at how the pes anserinus varied in South Indians. Fifty-three embalmed human adult lower limbs were evaluated for this study. After dissecting the tendons that inserted at the anteromedial surface of the proximal tibia, the pes anserinus was examined macroscopically for morphological variations. Three tendons, the gracilis, semitendinosus, and sartorius, comprised the pes anserinus in 48 lower limbs (90.6 %).

The morphology of the pes anserinus was found to be convergent in 41 (77.4%), early in 7 (13.2%), and divergent in 5 lower limbs (9.4%). In three lower limbs, the semimembranosus muscle was involved in the development of pes anserinus (5.7%). In eight instances, the pes anserinus was entering into the fascia cruris rather than the tibia (15.1%).However, in 10 cases (18.9%), the insertion was both at the tibia and fascia cruris. The insertion was only at fascia cruris and not in tibia in 15.1% cases. The semitendinosus was giving an extra slip, which was attaching to the medial condyle of tibia in 7 cases (13.2%). It was giving slip to medial collateral ligament in 2 cases (3.8%) and ligamentum patellae in 1 case (1.9%). this information about morphological variants can be helpful to the surgeons to avoid the subsequent difficulties during the procedures like transplant surgeries and graft harvesting during reconstructive surgeries involving knee.

### 2.7.9. PES ANSERINUS: ANATOMY AND PATHOLOGY OF NATIVE AND HARVESTED TENDONS (2019)

**Brian R. Curtis, Brady K. Huang1 Mini N. Pathria, Donald L. Resnick, Edward Smitaman[22]**

The goal of this study is to explain the morphology and pathophysiology of the pes anserinus in order to improve imaging analysis of the results affecting these medial knee structures.

Because it consists of the conjoined tendons of the sartorius, gracilis, and semitendinosus muscles and their insertions at the medial side of the knee, the pes anserinus is often overlooked during radiological assessments, according to the author. Some of the most common pathologic disorders that affect the pes anserinus are overuse, acute trauma, iatrogenic illnesses, tumors, and tumor-like lesions. Gout, while a typical cause of bursitis in places like the anterior knee and olecranon process of the ulna, is a rare cause of symptomatic pes anserinus bursitis, according to the author.

### 2.7.10. FABELLA PREVALENCE RATE INCREASES OVER 150 YEARS, AND RATES OF OTHER SESAMOID BONES REMAIN CONSTANT: A SYSTEMATIC REVIEW (2019)

**Michael A. Berthaume, Erica Di Federico and Anthony M. J. Bull[28]**

Because it consists of the conjoined tendons of the sartorius, gracilis, and semitendinosus muscles and their insertions at the medial side of the knee, the pes anserinus is often overlooked during radiological assessments, according to the author. Some of the most common pathologic disorders that affect the pes anserinus are overuse, acute trauma, iatrogenic illnesses, tumors, and tumor-like lesions. Gout, while a typical cause of bursitis in places like the anterior knee and olecranon process of the ulna, is a rare cause of symptomatic pes anserinus bursitis, according to the author.

Because the rates of other sesamoid bones have remained constant, as a result of the global increase in human height and weight, tibial length and muscle mass may have grown. Greater moment arm operating on the knee and crossing the tendons may arise from increased tibial length. When paired with the increased torque created by a larger gastrocnemius, the biomechanical stimulation required to induce fabella development could be produced.

### 2.7.11. AN UNUSUAL INSERTION OF AN ACCESSORY BAND OF THE SEMITENDINOSUS TENDON: CASE REPORT AND REVIEW OF THE LITERATURE (2020)

**Ł. Olewnik, M. Podgórski, M. Polguj[28]**

The Pes Anserinus has a wide range of morphological characteristics. The sartorius, gracilis, and semitendinosus are the three common tendinous insertions. The semitendinosus and gracilis tendons are regularly removed during anterior cruciate ligament replacement procedures. The presence of supplementary bands within the tendons of Pes anserinus has been reported to impede the harvesting process. The author attempted to offer a very unusual case report of insertion of the accessory band of the semitendinosus tendon to the soleus muscle fascia and tibia for this purpose. To promote more successful hamstring grafts, the author of the current study concluded the current classification should be expanded to include such "rare situations.

### 2.7.12. HUMAN BIOLOGICAL VARIATION IN SESAMOID BONE PREVALENCE: THE CURIOUS CASE OF THE FABELLA (2020)

**Michael A. Berthaume and Anthony M. J. Bull[28]**

The fabella is a sesamoid bone that develops beneath the gastrocnemius muscle's lateral head tendon. Fabella is now 3.5 times more frequent in humans as it was 100 years ago, with prevalence rates varied within and within populations. Fabella, in particular, is thought to be more common among Asians than non-Asians, equally common in men and women, possibly more common in the elderly, and bilateral examples appear to be more common than unilateral cases. The involvement of genetic and environmental factors in phenotypic variation have been speculated about but not thoroughly researched. Given its clinical and evolutionary significance, including being linked to a variety of knee conditions, creating medical concerns on its own, interfering with medical equipment, and being less common in humans than in animals. To evaluate possible variance in sexual dimorphic (n = 22 studies, 7911 knees), ontogenetic (n = 10 studies, 4391 knees), and global (n = 65 studies, 21626 knees) fabella prevalence rates, the author conducted a meta-analysis on data from research published from 1875 to 2018. In addition, the author looked into the proportion of cases that are bilateral (n = 37 studies, 900 people) and if fabella are more common in the left or right knee (n = 20 studies, 204 people). The findings show that fabellae are 2.47–2.60 % more common in men than in women, and that prevalence rates rise ontogenetically with age (i.e. 70 years old), meaning that fabellae can ossify at any age. Around 72.94 % of instances are bilateral, with fabellae accounting for the majority of unilateral cases.

The highest prevalence rates are found in Asia, followed by Oceania, South America, Europe, the Middle East, and North America, with the lowest rates found in Africa. Ossified fabellae can be detected by dissection in 36.80% of knees over the world. These findings suggest that, while the ability to create a fabella may be genetically determined, the mechanisms that cause fabella ossification may be influenced by the environment.

## 2.8. VARIABLES IDENTIFIED IN THE LITERATURE REVIEW:

Based on the literature reviewed, several variables identified by the researcher are listed below:

| Demographic variables | Research methodology | Materials used for study | Various Health problem | Various treatment prescribed |
|---|---|---|---|---|
| Age | Bone study | Cotton Thread | Existing established osteoarthritis | Total knee arthroplasty |
| Gender | Cadaveric study | Measuring tape | Abnormal bony deformities | Uni compartmental knee arthroplasty |
| Height | Radiological study | Digital vernier caliber | Abnormal bony positions | Ligament reconstruction procedure |
| Weight | CT Scan based Study | Sliding Vernier caliber | Abnormal gait pattern | Tendon reconstruction procedure |
| BMI | MRI based Study | Radiological Computational | | |
| Race | Intraoperative study | | | |
| Sample size | Pre-operative & Intraoperative study | | | |
| Occupation | | | | |
| Involvement in Sports activity | | | | |

**TABLE- 2.8: IDENTIFIED VARIABLES**

## 2.9. RESEARCH GAP:

A research gap is defined as "a research question or problem that has not been adequately or completely addressed in a particular field of study" (Moeini, 2014). Several researches have attempted to comprehend the anatomical study of knee joints, as well as their implications for overall physical health. The prevalence of knee disorders and surgical treatments is increasing due to population ageing and related factors such as obesity, sedentary lifestyle, and sports activity. Furthermore, Pain and a lack of functional capacity reduce quality of life and increase the risk of morbidity. A few studies have attempted to comprehend the understanding of knee joints. However, there are no studies where largely taken as a whole cadaveric analysis knowledge on knee joint has been imparted to enhance clinical ability to recognize the anatomical variations, morphometric analysis, macroscopic morphological anatomical variations, illness, deformities, surgical and non-surgical anatomical and clinical inter co-relations and provide the necessary interventions. Therefore, equipping with the cadaveric analysis of the knee joint and concepts of morphometric and morphological variations in the structures surrounding the knee joint in relation to the age, gender and side will help the modern practitioners to tackle the problems of knee illness and physical health and thus, reduce the burden on society. Furthermore, despite various studies present, the lack of disaggregated anatomical data enbloc on knees remains a significant challenge across the world. So, it is very significant to conduct a cadaveric based study that can focus on assessing the anatomical knowledge of knee joint and thereby, enhance the knowledge pertaining to the cause, clinical features, proper diagnosis, faulty biomechanics of joint, surgical reconstruction procedures, surgical replacement procedure, graft procedures, designing of properly matched prostheses, and in the various other management of physical and knee-related illness. The findings of the present study will try to bridge the gap that exists in the literature resources as well as in the understanding of mental health, physical health, and other illnesses among the populations. It can serve as a base for reference for any future research that will be taken upon the knee joint globally.

# *Chapter Summary:*

Understanding the anatomy of the knee joint is essential to know how early rehabilitation of the knee can be achieved. It is also reflected by the physique stature, age, gender, occupation, race, existing musculoskeletal disorders, developmental disorders, congenital abnormalities, degenerative disorders, and involvement in the sports activity of the individual. Hence, an attempt is made in this chapter to review the literature on various concepts of analysis of the bones participating, supporting ligaments and structures surrounding the knee joint, and its clinical implications. Various studies have made an attempt to analyze the structures involved in the knee joint with different methodologies, different tools, and different patterns. However, both National and International literature has revealed that morphometric analyses of the articular surfaces of bones forming the knee joint; including the patella, femur, and tibia are the principle key for the structural analysis of the knee joint. A couple of literature threw light on the anatomical analysis of several ligaments supporting the knee joint. Many works of literature review the menisci of the knee for its morphological and morphometric analysis. Most of the reviews stressed the role of different races, populations, genders, and sides in establishing their clinical influence in the medical and surgical management of treating knee problems. Nevertheless, a couple of reviews identified a significant role played by the anatomical variations in the structures related to the knee joint including bone, muscle, and neurovascular structures. The literature also gave an insight into why cultural and habitual customs involving frequent kneeling, squatting, and crossed leg sitting in some populations can influence the designing of knee prostheses. The literature also gave insights into, how the presence of various accessory bands of muscles and, the prevalence of presence and absence of various structures of the knee can enhance and seek help for more improved diagnosis and various surgical procedures in modern medicine. There is evidence in various literatures that cadaveric evaluations of the knee and anatomical analyses of its structures can be used to guide treatment and early rehabilitation. For the analytical observer, it needs to be understood that cadaveric analysis of the structure of the knee and implicating the knowledge clinically can influence the promotion of mental health, physical health, and overall wellbeing of an individual in the service to society.