International Journal of Life Sciences, Biotechnology and Pharma Research Vol. 14, No. 2, February 2025 Online ISSN: 2250-3137
Print ISSN: 2977-0122

DOI: 10.69605/ijlbpr_14.2.2025.79

ORIGINAL RESEARCH

Comprehensive cadaveric study regarding histological and morphometric evaluation of the ligamentum mucosum in human knee joints

[1]Dr. Vijayta Singh, [2]Dr. Amit Kumar Yadav, [3]Dr.Vinod Kumar, [4]Dr. Ved Parkash Yadav

[1]Associate Professor, Department of Pathology, Maharaja Suhel Dev Autonomous State Medical College, Bahraich, Uttar Pradesh, India
[2]Assistant Professor, Department of Anatomy, Maharaja Suhel Dev Autonomous State Medical College, Bahraich, Uttar Pradesh, India
[3]Assistant Professor, Department of Orthopaedics, Maharaja Suhel Dev Autonomous State Medical College, Bahraich, Uttar Pradesh, India
[4]Assistant Professor, Department of Anatomy, Autonomous State Medical College, Kaushambi, Uttar Pradesh, India

Corresponding Author
Dr. Ved Parkash Yadav
Assistant Professor, Department of Anatomy, Autonomous State Medical College, Kaushambi, Uttar Pradesh, India
Email: vedprakash.yadav444@gmail.com

Received: 12 January, 2025 Accepted: 29 January, 2025 Published: 17 February, 2025

ABSTRACT

Background: LM or ligamentum mucosum has been implicated in plica syndrome which is a painful knee condition resulting from edematous, fibrotic, and thickened synovial plica. LM can be used for reconstruction of the anterior cruciate ligament tear. **Aim:** The present study was assessed for histological and Morphometric Evaluation of the Ligamentum Mucosum in Human Knee Joints. **Methods:** The study assessed 40 adult human cadavers. The intraarticular structures of the knee joint were exposed by reflection of the patella, and the LM, along with its type, was identified. The thickness, width, and length of the LM joint were measured in all the cadavers. The Structure of the LM was assessed using hematoxylin and eosin stains. **Results:** The study results showed that LM was seen in all the knees studied. Type I LM was predominant with a single band seen in 85% of cadavers. Type 2a and 2b were seen with double bands and triple bands respectively. Type 3 LM was seen as a vertical septum that divided the joint cavity into two compartments. The thickness of LM at the distal and proximal end was significantly higher on the left side and the length of the ligament was found to be 28.14±2.33mm. LM had rich vascularization and was comprised of dense connective tissue. **Conclusion:** The present study concludes that LM was initially considered an accidental finding. However, its presence is now being confirmed and is now considered an anatomical feature. Knowledge concerning LM is vital for the assessment of anterior knee pain with the detection of no definitive pathology.

Keywords: Anterior cruciate ligament, synovial plica, plica syndrome, knee pain, meniscus

INTRODUCTION

LM (ligamentum mucosum) is a ligamentous tissue seen inside the cavity of the knee joint extending from the infrapatellar pad of fat to the intercondylar notch of the femur and is covered with the synovial membrane. It is located in the front of the ACL (anterior cruciate ligament) and, sometimes shows partial attachment to ACL (anterior cruciate ligament). Ligamentum mucosum is better known as infrapatellar plica and was earlier considered as a vestigial remnant of the knee. The ligamentum mucosum could be completely missing or absent or can be seen as a thin, fragile band that moves to a solid and fibrous structure. Hence, the possible biomechanical behavior of the ligamentum mucosum can be seen in various forms.[1]

Presently, the ligamentum mucosum of the knee joint is been explored comprehensively for assessment of its structure and function for stabilization of the knee joint. It has gained attention as a specialized ligament

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owing to its possible effect on the biomechanics of the knee, clinical presentation, and implication in various knee-related disorders. Few literature studies have assessed the relationship between the LM and the surrounding structures, anatomical organization,and histological makeup and data has reported that LM has a proprioceptive function and could be a source of nociception. Assessment of the structure of LM can have relevance in understanding its potential effect on the clinical manifestation of various knee disorders including anterior knee pain and plica syndrome.[2]

Plica syndrome is a condition that affects the knee joints when synovial plica is edematous, fibrotic, and thickened. The mediopatellar or the suprapatellar fold is seen to be involved constantly with the plica syndrome. Even though, the LM was initially considered as incidental, recent literature data depicted that it can become ruptured, fibrotic, or thickened causing hemarthrosis.[3]

It has also been noted that LM limits the extension of the knee and causes anterior knee pain. Hence, the importance of LM has increased owing to its clinical significance. Few of the literature studies are available concerning the structure of LM and to assess if the structure is clinically significant. Existing literature data is scarce in the Indian context concerning the histological and morphological structures of LM.[4]The present study was assessed for histological and Morphometric Evaluation of the Ligamentum Mucosum in Human Knee Joints.

MATERIALS AND METHODS

The present cadaveric study was assessed for histological and Morphometric Evaluation of the Ligamentum Mucosum in Human Knee Joints. The cadavers were from the Department of Human Anatomy of the Institute. Verbal and written informed consent were taken from all the subjects before participation.

The study assessed 40 formalin embalmed cadavers from 38 males and 2 females from the Human Anatomy Department of the Institute. The cadavers were selected after the exclusion of any cadaver with signs of surgery on knee joints or specimens that had flawed dissection. The mean age of the cadavers was 68.7±12.6 years.

For dissection, cadavers were placed in the supine position and two types of dissection were performed for exposure of the knee cavity where the first type was done according to Cunningham's Manual of Clinical Anatomy.[5]Skin incision was made around the superior patella border and the incision extended downward on the lateral and medial side of the patella. The patella was downward reflected to expose the ligaments. In a few specimens, the knee cavity was exposed by patella reflection upward for a clear assessment of LM to the infrapatellar pad of fat.Hence, a skin incision was made around the inferior border of the patella which was extended upward to the lateral and medial sides of the patella, and patella reflection was done upward.

Identification of LM was done and its proximal attachment to the femur and distal attachment to the infrapatellar pad of fat was identified. The type and shape of LM were assessed and four types of ligaments were seen where type 1 was a single band from its proximal to distal attachments, Type 2 was a split type with multiple bandsType 2 was a split type with multiple bands, and type 3 as vertical septum dividing the knee cavity into two compartments.

The length measurement was done from the proximal to the distal end of LM. Thickness and width were measured at the distal, middle, and proximal zones of LM. LM thickness was assessed mediolaterally and width from the superior border to the inferior border. Gross measurement was done using a Vernier Caliper to the nearest millimeters. Three repetitions were done for each measurement and the mean was considered final.

In the histological study, digital, middle, and proximal LM segments were assessed and tissue sections of 5 µm thickness were taken from all three segments. Nearly 5-7 slides of each segment were taken and stained using eosin and hematoxylin stains and stained slides were assessed under a bright field microscope to locate the presence of blood vessels, connective tissue septum, collagen bundles, and images were captured using a digital camera.

Statistical analysis of the gathered data was done using SPSS (Statistical Package for the Social Sciences) software version 24.0 (IBM Corp., Armonk. NY, USA) for assessment of descriptive measures, Student t-test, ANOVA (analysis of variance), and Chi-square test. The results were expressed as mean and standard deviation and frequency and percentages. The p-value of <0.05 was considered.

RESULTS

The present cadaveric study was assessed for histological and Morphometric Evaluation of the Ligamentum Mucosum in Human Knee Joints.The study assessed 40 formalin embalmed cadavers from 38 males and 2 females from the Human Anatomy Department of the Institute. The length of the LM was measured from the intercondylar notch of the femur to the infrapatellar pad of fat. The mean length of the LM was 28.14 ± 2.33 mm.

The study results showed no significant difference in the length of LM on the right and left side with p=0.23. A similar non-significant difference was seen for the width of LM on the proximal, middle, and distal side with p=0.23, 0.47, and 0.34 respectively. A similar non-significant difference was seen for the thickness of LM on the middle side with p=0.80. However, significantly higher thickness was seen on the proximal and distal side on the right side compared to the left side with p=0.02 and 0.05 (Table 1).

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It was seen that LM was present in all the cadavers, concerning the type of ligamentum mucosum present, Type 1 LM was seen in the majority of assessed cadavers as 85% (n=34) cadavers followed by type 2a LM in 10% (n=4) study cadavers. Type 2b and type 3 LM were noted in 2.5% (n=1) cadavers each (Table 2).

It was also noted that ligamentum mucosum was covered by the synovial membrane and comprised of dense regular connective tissue having parallelly arranged collagen bundles interspersed with fibrocytes. Also, between the bundles, loose connective tissue septa were observed. Throughout the ligament, rich vascularization was seen. In the distal part of LM, a similar collagen bundle arrangement was seen. However, a high amount of adipose tissue was seen surrounding the bundles.

Table 1: Comparison of various LM parameters on right and left sides in study cadavers

S. No	Side	Length (mm)	Width (mm)			Thickness (mm)		
			Proximal	Middle	Distal	Proximal	Middle	Distal
1.	**Right**	27.5±2.1	8.25±0.7	8.30±8.2	8.53±0.3	0.43±0.4	0.66±0.4	0.36±0.3
2.	**Left**	28.3±2.1	8.54±0.3	8.2±0.5	8.63±0.4	0.3±0.3	0.69±0.3	0.94
3.	**p-value**	0.23	0.23	0.47	0.34	**0.02**	0.80	**0.05**

Table 2: Prevalence of various types of ligamentum mucosum in the study subjects

S. No	Number of samples (n)	Prevalence (%)	Type	n (%)
1.	40 cadavers	100	**Types**	
2.			Type 1	34 (85)
3.			Type 2a	4 (10)
4.			Type 2b	1 (2.5)
5.			3	1 (2.5)

DISCUSSION

The preset cadaveric study assessed 40 formalin embalmed cadavers from 38 males and 2 females from the Human Anatomy Department of the Institute. The length of the LM was measured from the intercondylar notch of the femur to the infrapatellar pad of fat. The mean length of the LM was 28.14 ± 2.33 mm. These data were comparable to the previous studies of Norris M et al[6] in 2018 and Gonera B et al[7] in 2023 where authors reported comparable length of LM in their study subjects as seen in the present study. The study results depicted no significant difference in the length of LM on the right and left side with p=0.23. A similar non-significant difference was seen for the width of LM on the proximal, middle, and distal side with p=0.23, 0.47, and 0.34 respectively. A similar non-significant difference was seen for the thickness of LM on the middle side with p=0.80. However, significantly higher thickness was seen on the proximal and distal side on the right side compared to the left side with p=0.02 and 0.05. These results were consistent with the findings of Martin A et al[8] in 2023 and Bohnsack M et al[9] in 2004 where results of length and width comparable to the present study were also reported by the authors in their respective studies.

The study results also showed that LM was present in all the cadavers, Regarding the type of ligamentum mucosum present, Type 1 LM was seen in the majority of assessed cadavers as 85% (n=34) cadavers followed by type 2a LM in 10% (n=4) study cadavers. Type 2b and type 3 LM were noted in 2.5% (n=1) cadavers each. These findings were in agreement with the results of Iwanaga J et al[10] in 2021 and Lee PY et al[11] in 2017 where results reported by the authors in their studies were comparable to the results of the present study.

It was also seen that ligamentum mucosum was covered by the synovial membrane and comprised of dense regular connective tissue having parallelly arranged collagen bundles interspersed with fibrocytes. Also, between the bundles, loose connective tissue septa were observed. Throughout the ligament, rich vascularization was seen. In the distal part of LM, a similar collagen bundle arrangement was seen. However, a high amount of adipose tissue was seen surrounding the bundles. These study results were in line with the findings of GarcíaValtuille R et al[12] in 2002 and Blok A et al[13] in 2005 where data for ligamentum mucosum comparable to the present study were also reported by the authors in their respective studies.

CONCLUSIONS

Considering its limitations, the present study concludes that LM was initially considered an accidental finding. However, its presence is now being confirmed and is now considered an anatomical feature. Knowledge concerning LM is vital for the assessment of anterior knee pain with the detection of no definitive pathology.

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