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Original Research Article

Macroscopic and histological evaluation of the posterior cruciate ligament in arthritic knees

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ABSTRACT

Background: The function of Posterior Cruciate Ligament (PCL) in Total Knee Arthroplasty is currently under debate. Supporters of PCL retention suggest better soft tissue balance as well as proprioception, whereas the adversaries have reported an unstable late flexion. Whether the PCL is retained or removed, the results of knee replacement remains the same. The aim of the present study was to look for the morphologic and histological changes in PCL, that aids in assessing its competence, and to compare these with macroscopic changes.

Materials and Methods: A prospective study was performed on 50 osteoarthritic knees. Both the cruciate ligaments were examined macroscopically during Total Knee Replacement surgery, and classified as normal, fatty, mucinous, or cystic. The PCL was also studied and staged histopathologically, and was compared with its macroscopic appearance.

Results: On macroscopic examination, fatty type degeneration was the most common type of degeneration in both PCL and ACL, seen in 68% and 56% cases respectively. Histopathologically, majority of the PCLs (52.4%) were in stage 1 of degeneration. 5 PCLs that appeared macroscopically normal showed degeneration microscopically and 8 PCLs that were histologically normal had fatty as well as mucinous degeneration on macroscopic examination.

Conclusion: PCL exhibits degenerative and chronic traumatic modifications of different degrees on microscopic examination. These changes cannot be predicted from macroscopic inspection of the knee at the time of surgery. The frequency of these changes suggests that PCLs in an osteoarthritic knee are of varying quality, and this should be considered by the surgeon while selecting the type of knee replacement.

1. Introduction

Osteoarthritis (OA) is one among the commonly seen disorders of joints,[1] that leads to disability in adults more than 65 years of age.[2] There are both systemic as well as local factors that not only predispose to the disease, but also determine it's distribution and severity.[3] Patients that are affected with OA have significant pain as well as functional challenges while doing day to day activities, resulting in low productivity and deteriorating quality of life.[4–6] Since the degenerative changes are seen in the cartilage, meniscus and ligaments, it has been identified as a whole joint disease.[7]

The posterior cruciate ligament (PCL) is a crucial structure of the knee joint, essential for knee kinematics, along with the anterior cruciate ligament (ACL).[8–10] One of the key features in the process of knee Osteoarthritis is that the PCL degeneration starts ahead of articular cartilage degeneration.[11] Most common histopathological degenerative changes in PCL are marked loose, stiff, cystic, mucinous, or myxoid patterns, ruptured and an abnormal, disorganized parallel collagen structure.[12] PCL degeneration has been evaluated widely using Magnetic

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resonance imaging (MRI). However, only rupture, mucoid degeneration, and ganglion in PCLs can be detected using MRI. Also, the sensitivity of MRI is not enough to assess the quality within the ligaments.[13] A conventional modality inorder to evaluate knee OA is Computed Tomography (CT).[14]

Conservative treatment methods are effective for the management of mild to moderate OA, whereas an end stage knee OA requires surgical management, i.e Total Knee Arthroplasty (TKA).[15] PCL is crucial in biomechanics of the knee joint, and also it is an important structure in patients diagnosed with end stage knee OA undergoing Total Knee Arthroplasty (TKA).[16] There are two basic types of total knee arthroplasty (TKA): cruciate retaining (CR) and the posteriori stabilised (PS).[17] The retention of PCL during TKA is still controversial.[18] PCL retention is said to provide improved soft tissue balance and proprioception, while it can cause late flexion instability. The outcome of knee replacement is reported to be similar, whether the PCL is retained or removed.[14] During TKR, a macroscopic and microscopic assessment of the cruciate ligaments, can help to evaluate the incidence of degeneration of these ligaments, and also to identify the cases where PCL could be retained.[18] The aim of the present study was to assess the PCL for macroscopic as well as microscopic changes, from which its competence could be evaluated, and compare these with the macroscopic changes.

2. Materials and Methods

A prospective observational study of 50 osteoarthritic knees was performed, that underwent a Cruciate retaining type of Total Knee Replacement at Aster Medcity, Kochi, from August 2022 to November 2022.

2.1. *Inclusion criteria*

1. Age >18 years
2. Failure of medical management
3. Patients willing to undergo physiotherapy

2.2. *Exclusion criteria*

1. Age <18 years
2. Secondary arthritis of knee resultant of previous trauma/ inflammatory causes
3. Previously operated for ligament injuries
4. Patients undergoing unicompartmental knee arthroplasty

In 50 knees, the gross appearance of both cruciate ligaments were assessed during TKR. It was categorised as normal, abnormal or ruptured. Histological examination of the ligaments was also done, and was classified as: stage 0 (normal), stage 1 (degeneration of < 1/3 of the collagen fibers), stage 2 (degeneration of 1/3–2/3 of the collagen fibers) and stage 3 (degeneration of > 2/3 of the collagen fibers). Histologically abnormal and degenerated ligaments were either loose, mucoid, myxoid, or cystic.

Statistical analysis was done using chi-square test. A p-value < 0.05 was considered significant.

3. Results

Out of the 50 knees analysed, majority were of females (86%) and belonged to a median age group of 60 – 69 years (56%). The replacement was unilateral in only 12 cases (24%), whereas both the knees were replaced in 38 cases (76%). The majority of the knees replaced (54%) were right sided. (Table 1)

Table 1: General characteristics

Characteristic	n (%)
Age (years)	
40 – 49	2 (4%)
50 – 59	11 (22%)
60 – 69	28 (56%)
70 – 79	9 (18%)
Sex	
Male	7 (14%)
Female	43 (86%)
Unilateral/ bilateral	
Unilateral	12 (24%)
Bilateral	38 (76%)
Side	
Right	27 (54%)
Left	23 (46%)

On macroscopic examination, fatty type degeneration was the most common type of degeneration in the PCL, seen in 68% cases. This was the same with regard to ACL, where 56% cases showed fatty type degeneration. The least common type of degeneration seen in PCL was hyaline type degeneration whereas that in ACL was mucinous type, seen in 1 case each. PCL and ACL were macroscopically normal in 12% and 18% of the cases respectively. (Figures 1, 2, 3 and 4)

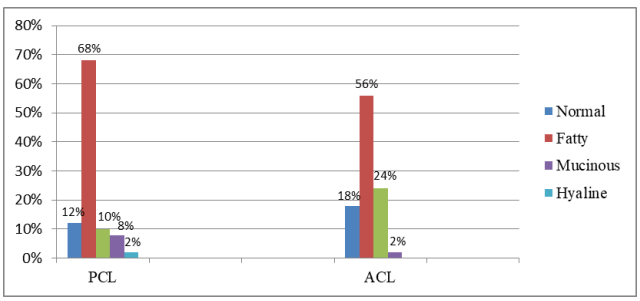

Fig. 1: Macroscopic examination of ligaments

On histological evaluation, 8 PCLs were found to have no degeneration (Stage 0) whereas 42 PCLs were degenerated.

(Figures 5 and 6) Out of this 42 degenerated PCLs, 22, 18 and 2 PCLs were in stage 1, 2 and 3 respectively (52.4%, 42.9% and 4.8%) (Figures 7, 8, 9 and 10). This had a p value <0.05, and hence was found to be statistically significant.

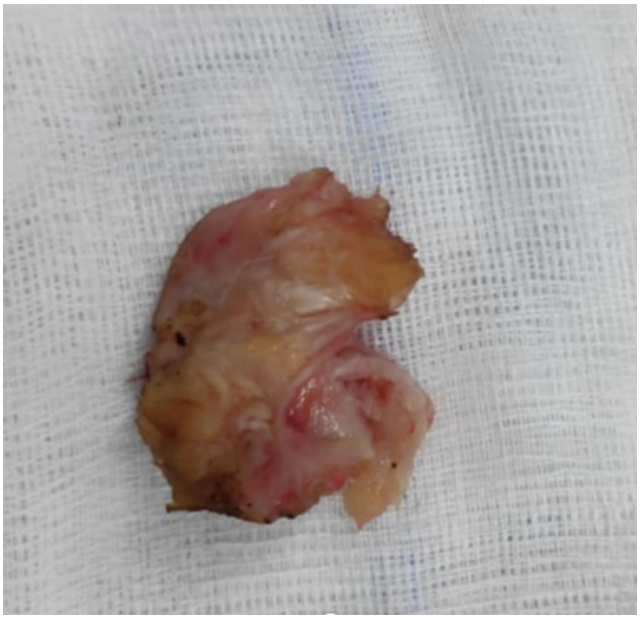

Fig. 2: Macroscopically normal ligament

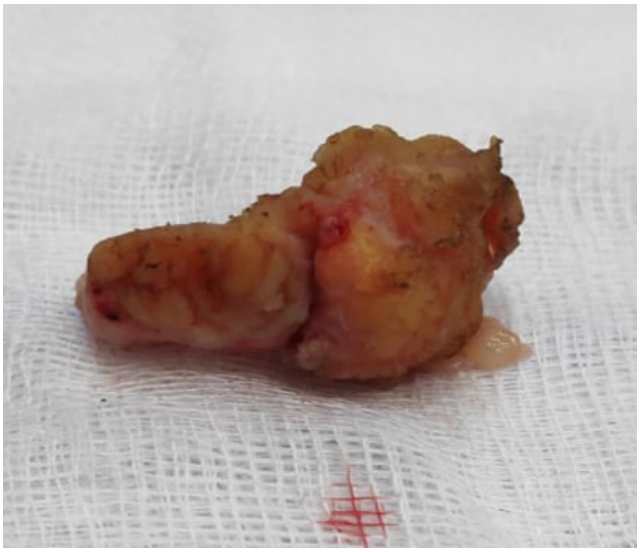

Fig. 3: Ligament macroscopically showing fatty degeneration

PCLs that appeared macroscopically normal showed degeneration microscopically, with 3 in stage 1, and 2 in stage 2 of degeneration. Out of the 8 PCLs that were histologically in stage 0 (no degeneration), 7 had fatty and 1 had mucinous degeneration on macroscopic examination. (Figure 11)

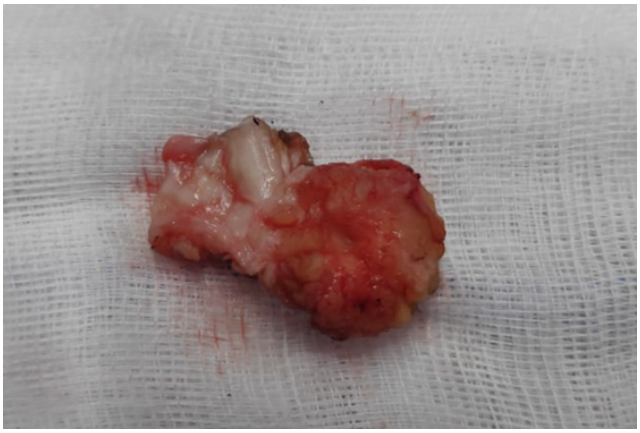

Fig. 4: Ligament macroscopically showing mucinous degeneration

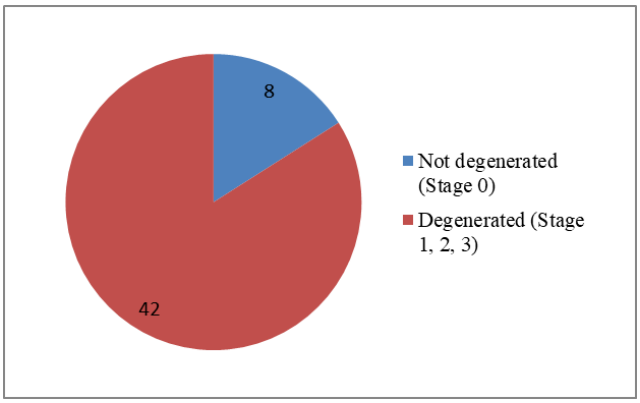

Fig. 5: Histological examination of PCL

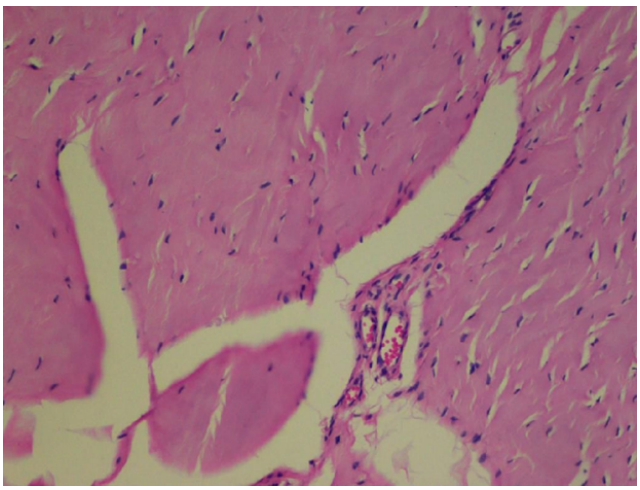

Fig. 6: Histopathologically normal PCL

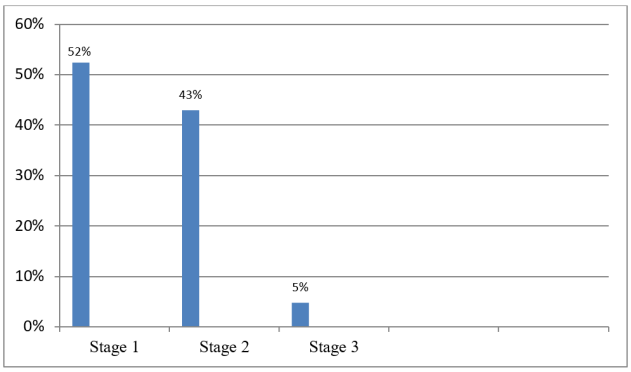

Fig. 7: Stage wise distribution of degenerated PCL

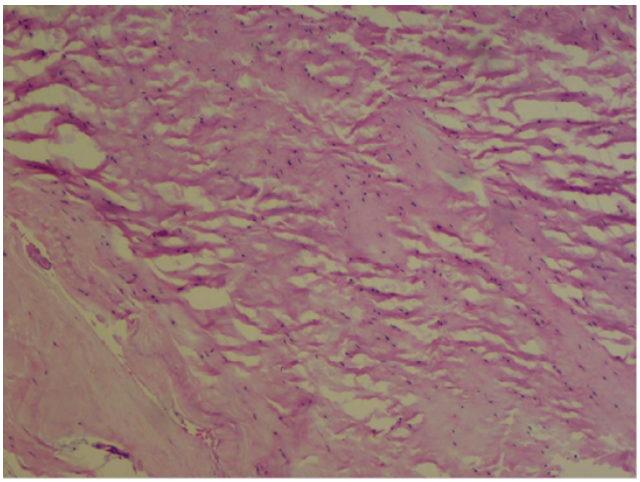

Fig. 8: Histopathologically stage 1 PCL

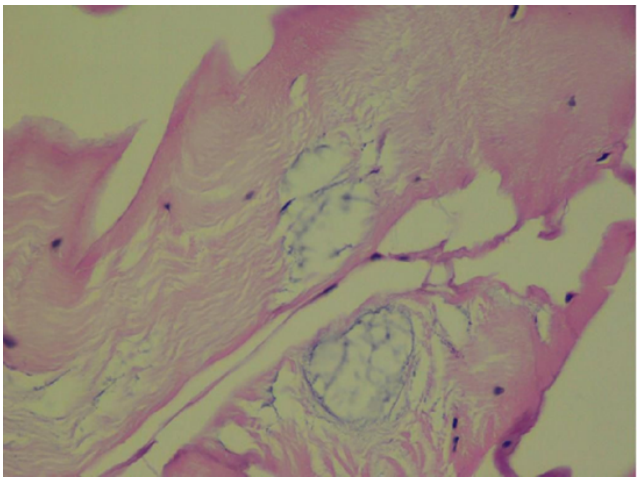

Fig. 9: Histopathologically stage 2 PCL

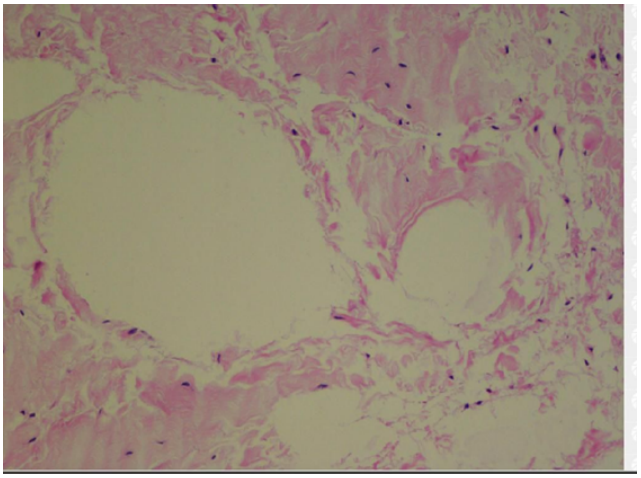

Fig. 10: Histopathologically stage 3 PCL

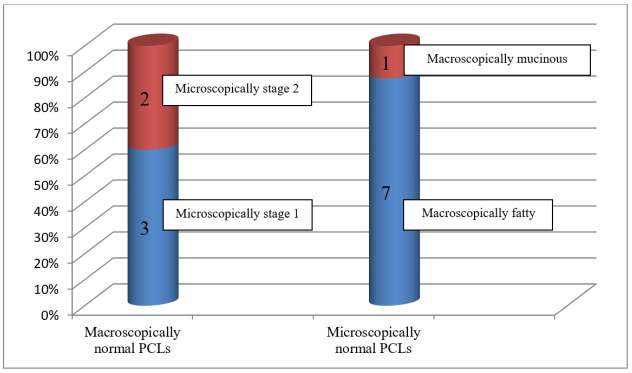

Fig. 11: Discrepancy in macroscopic and microscopic examination of PCL

4. Discussion

TKA is one among the most commonly done joint replacement surgeries, that seems to have exceeded the number of total hip replacement surgeries performed. The decision of retention/ removal of the PCL in TKA is still under debate.[19] PCL retention helps in better femoral roll back, higher stability, and improved physiological proprioception. However, there is no much difference in the clinical results when compared with its removal.[20] In this study, we examined the PCL from 50 osteoarthritic knees that underwent a Cruciate retaining type of Total Knee Replacement, in order to look for morphologic as well as histological changes.

On macroscopic examination, 68% PCLs showed fatty type degeneration while only 2% showed hyaline type degeneration. But the predominant degenerative change according to a study by Aggarwal et al,[21] was the presence of loose fibrous tissue, whereas mucinous type was the least common type of degeneration. Allain et al[18] examined PCL from 52 osteoarthritic knees and all of them

were macroscopically normal. On histological evaluation, majority PCLs (52.4%) in our study were in stage 1 degeneration. This was similar to the findings by Allain et al[18] and Aggarwal et al,[21] where 30% and 43% of the PCLs were in stage 1 degeneration respectively.

PCLs that were macroscopically normal showed degeneration microscopically, and 8 PCLs that showed no degeneration microscopically showed fatty and mucinous changes on macroscopic examination. This is in concordance with a study by Allain et al,[18] where 52 PCLs were evaluated macroscopically as healthy, out of which 30 PCLs demonstrated changes on microscopic examination. This was a clear sign of difficulty to decide whether to retain the PCL during TKA purely on the basis of only macroscopic changes. Akisue et al[22] and Stubbs et al[23] also confirmed this absence of correlation between macroscopic assessment and degree of microscopic degeneration in PCL during OA.

5. Conclusion

Examination of a ligament macroscopically during TKA is not reliable to determine its microscopic and functional characteristics. PCL can seem to be intact biomechanically with good gross appearance. But, these PCLs may be originally degenerated, with varying degrees of degenerative changes on microscopy. Hence, the decision regarding retention of PCL during TKR is still under debate.

6. Source of Funding

None.

7. Conflict of Interest

None declared.

8. Ethical Approval

The study was approved by the Institutional Ethics Committee.

9. Informed Consent

Was obtained from all individual participants included in the study

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