ORIGINAL RESEARCH

Incidence of Muroid Degeneration of Cruciate Ligaments in Patients Undergoing Primary Total Knee Replacements – A Study of 42 Knees

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ABSTRACT

Muroid degeneration of the ACL is largely an underdiagnosed condition. These are often misjudged as partial tears of ACL on routine MRI evaluation. Here we histologically analyse the incidence of muroid degeneration of the cruciate ligaments in 32 patients who underwent primary total knee arthroplasty in our institute. 10 among them had bilateral total knee replacements making the total sample size 42 knees.

ACL samples were sent for histopathological evaluation from 41 knees (one knee was an ACL deficient knee), and PCL samples were sent from patients who underwent total knee replacements with posterior stabilising implants. out of these 41 samples of ACL, 60.9 % turned out to be positive for muroid degeneration. 9 out of 13 PCL samples (69.5%) turned out to be having muroid degeneration.

This study shows that the real incidence of muroid degeneration of cruciate ligaments is much more than what is reported in literature. This emphasises the role of preoperative MRI to look for coexisting painful muroid degeneration even in elderly patients with early osteoarthritis, which is an arthroscopically treatable condition thus delaying the total knee replacements in these patients. The higher incidence of muroid degeneration in cruciate ligaments associated with advanced arthritis raises the question of functional integrity of PCL in these patients, making the use of posterior stabilising implants more advisable in patients with advanced stages of osteoarthritis.

Key Words: Muroid Degeneration, ACL, PCL, Total Knee Replacement, Cruciate Retaining, Posterior Stabilising, MRI

INTRODUCTION

Muroid degeneration of the anterior cruciate ligament (ACL) was first reported by Kumar et al in 1999.¹ Even though it is a rarely reported condition, recent studies show that the incidence of muroid degeneration is higher than that was initially thought.² These degenerations are often misjudged as partial ligament tears. The etiology of the muroid degeneration remains unclear, but the studies have proved an invariable association to old age.³ And even in situations where the ACL is intact on macroscopic evaluation, there may be histological changes that question the integrity of the ligament.⁴

Here we put forward a study of histological examination of cruciate ligaments from 42 knees after total knee arthroplasty in our hospital, either with cruciate retaining (CR) or posterior stabilising (PS) implants.

LITERATURE REVIEW

The first case of muroid degeneration of ACL was reported by Kumar et al in 1999.¹ Since then, many case reports have been published regarding the etiology, histology and biomechanical implications of the muroid degeneration of the cruciate ligaments. In a study of 4221 knees by Bergin et al,⁵ they found that the condition was far more frequent than was initially thought.

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Figure 1. T2 weighted MRI images (sagittal and coronal cuts) showing celery stalk appearance of ACL

Figure 2. Celery stalk (picture taken from internet)

Epidemiology

According to Bergin et al, Mean age of incidence of mucoid degeneration was 42 years, and there is no gender predilection.⁵ Another study by Salvati et al⁶ showed mean age of incidence to be 44 years, and a slight male predilection (1.28:1) for incidence of mucoid degeneration of cruciate ligaments.

Clinical Findings

It is a condition with insidious onset. Patients usually attribute the symptoms to a trivial trauma in the past, but no definitive evidence for the relationship of trauma to subsequent mucoid degeneration have been established in the literature.² Posterior knee pain is the most consistent finding.² The pain is usually caused by the extrusion of the hypertrophic ACL into the posterolateral compartment of the knee on knee flexion. The range of motion is gradually limited over a period to around 100 degrees of flexion. Joint effusion may or may not be an associated finding. The ACL is usually non-functional, but need not demonstrate any signs of instability clinically. Though mucoid degeneration of cruciates are associated with pain and reduced range of movements, this condition is usually not associated with instability of the knee.^{7,8}

Imaging

Gold standard for diagnosis of mucoid degeneration of ACL is Magnetic Resonance Imaging (MRI). Classical MRI findings include intermediate signal intensity in T1 (2,7–9) weighted images and an increased signal intensity in T2 weighted images. The ligament will appear thick, wavy and hypertrophied. The mucoid substance is seen intermingled with the collagen

fibres dissecting between them, but not interrupting them. The typical appearance of ACL in mucoid degeneration was described as “Celery stalk” appearance (**Figure 1,2**) by many authors.^{2,9-11}

Radiological differential diagnosis include a partial tear of the ACL, ganglion cyst or even a malignant process.² Shelly et al has reported case of metastatic adenocarcinoma of the lung into the knee mimicking mucoid degeneration of the ACL.¹²

Arthroscopic findings

It is characteristically described as bulky ACL with decreased vascularity filling the intercondylar notch. The yellowish tinge of mucoid degeneration can be seen on macroscopic examination with the naked eye. Most of them are nonfunctional.

Another common finding is the absence of synovial lining of the ACL. McIntyre et al in their study proposed an arthroscopic diagnostic criteria for ACL mucoid degeneration.¹³

1. ACL fibres intact
2. Increased ACL diameters
3. Yellow substance found by probing
4. Loss of synovial lining

Pathophysiology

One popular theory explaining the pathogenesis of mucoid degeneration is its temporal association with trivial trauma. Glycosaminoglycan, that contributes to the mucoid substance is secreted by the ACL fibroblast in response to trauma.²

Another theory puts forward the existence of ectopic synovial tissue within the ACL giving rise to mucoid degeneration.

eration.¹⁰ Kim et al in their study proposes that mucoid degeneration of ACL and mucoid cystic degeneration of the ACL presents a pathogenetic continuum. This study also shows association of ACL mucoid degeneration to osteoarthritis of the knee.¹⁴

Histology

The lesions contain yellow or brown thick or dense basophilic substances containing high density of glycosaminoglycans (hyaluronic acid). Hyaluronic acid is detected by staining with Alcian Blue stain.¹⁵

Mucoid degeneration of PCL

Mucoid degeneration of the PCL is even less frequently reported than mucoid degeneration of ACL. Kleinbert et al¹⁵ in their study, stated that in severe knee arthritis, PCL displays disorganisation of the parallel collagen fiber bundles. This collagen disorganisation and loss of integrity of the ligaments have been found to alter the functionality of the ligaments in significant animal studies.^{16,17} A study of histopathological analysis of the PCL by Martins et al¹⁸ in 2018 showed only a small percentage of patients with advanced arthritis retained PCL with a functional neurovascular bundle.

MATERIALS AND METHODS

Estimation of sample size

Sample size estimation considering $p < 0.05$ as acceptable significance and study with 80 % power

$$n = \{(1.96)^2 \times p \times q\} / d^2$$

As per the reference study,¹⁹ mucoid degeneration was observed in 53.6 % of the study population.

Hence,

$$p = 53.6\%$$

$$q = 100 - p = 46.4\%$$

$$d = \text{precision} = 15\%$$

Thus, $n = 42.4$, rounded off as 42 patients.

Patients who underwent primary total knee arthroplasty in our institute was included in the study. 10 of them had bilateral total knee replacements, making the sample size a total of 42 knees. Out of these, 34 knees had Kellgren and Lawrence²⁰ stage 4 osteoarthritic changes and 8 knees had stage 3 osteoarthritis on preoperative radiographic evaluation. They all underwent Total knee replacement with either CR or PS implants. The decision to retain or to sacrifice the PCL was made based on preoperative clinical examination and the intra-operative macroscopic examination of the integrity of PCL.

Figure 3. Chart showing incidence of mucoid degeneration of ACL in a sample of 42 knees

ACL from every case and PCL from patients who underwent Total knee replacement with PS prosthesis was sent for histopathological evaluation. All specimens were immediately preserved in formalin solution and was sent for histopathological examination as per routine laboratory practice.

RESULTS

- The sample consisted of 32 patients with a mean age of 63.5 years. 23 patients (71%) were females. 27 patients suffered from Osteoarthritis and 5 patients had Rheumatoid arthritis.
- 34 knees had Kellgren and Lawrence²⁰ stage 4 osteoarthritic changes and 8 knees had stage 3 osteoarthritis changes
- 10 patients underwent bilateral TKR, making the total sample size 42 knees.
- 29 (69%) underwent TKR using cruciate retaining implants and the rest 13 (31%) underwent posterior stabilising TKR.
- ACL from all the knees were sent for histopathological examination, except for 1 case in which no ACL was seen intraoperatively (ACL deficient knee). PCL was sent for histopathological examination from 13 patients who underwent TKR with posterior stabilising implants.
- Out of the 41 samples of ACL that was sent for histopathological examination, 25 (60.9%) turned out to be positive for mucoid degeneration (**Figure 3**). Histological picture was characteristic with fibrocollagenous tissue with myxoid degeneration (**Figures 4 A,B**).
- Out of 13 PCL samples sent for histopathological evaluation, 9 (69.2%) had changes suggestive of mucoid degeneration (**Figure 5**)
- All the 9 knees which had mucoid degeneration of PCL showed mucoid degeneration in their ACL samples too.

Figure 4A.

Figure 4B.

Figure 4. Histopathology section shows fibrocollagenous tissue with myxoid degeneration (A) H&E X100, and (B) H&E X400

This is in accordance with studies by Allain et al²¹ and Albert et al²² who proposed mucoid degeneration in the ACL gives way to mucoid degeneration in the PCL.

- Out of the remaining 4 knees, 2 had isolated mucoid degeneration of ACL alone.
- No cases of isolated mucoid degeneration of PCL was seen in the present study.
- Out of 10 patients who underwent bilateral TKR, 6 had CR implants in both knees, 3 had PS implants in both knees and 1 had CR implant in one knee and PS implant in the other. Among the histopathological results of these 10 patients, 2 patients had unilateral mucoid degeneration in ACL.

DISCUSSION

It has been proposed that the suboptimal results in some patients after total knee replacement (TKR) is due to the failure to obtain normal knee biomechanics after the surgery. The drive these days has been to preserve as much of the native knee as possible. With advent of unicondylar knee and ACL sparing total knee prosthesis, the functional status of the cruciate ligaments come into question.

This study has highlighted the fact that mucoid degenera-

tion of the ACL is either an underdiagnosed or misdiagnosed condition. Many ACL specimens which appeared normal in macroscopic evaluation turned out to be having mucoid degeneration on microscopic evaluation. Allain and Gouttalier et al²¹ in their study reported a correlation between ACL and PCL degeneration. Several studies have been published showing clear association of degenerative changes in the PCL with advanced osteoarthritis. As per literature, 85 % of knees with severe osteoarthritis show degeneration of the PCL.^{21,23}

The purpose of preferring the CR prosthesis over PS prosthesis is to ensure proper femoral roll back during flexion of the knee and to enhance proprioception through retaining the PCL. Arthroplasty with PCL preservation demands not only a structural preservation of the ligament, but also functional preservation of its proprioceptive capacity.^{18,21} Nelisen et al²³ in their study proposes that the mucoid degeneration of the PCL mirrors the radiological arthritic status of the knee and advocates the use of PS implant in knees with advanced stages of arthritis even when the PCL is clinically intact. Allain et al²¹ and Albert et al²² in their studies reached the same conclusion that there was a higher incidence of degeneration in PCL in patients who had ACL degeneration. There is no evidence in the literature as to whether the mucoid degeneration of the PCL will further progress after cruciate retaining TKR restoring the normal biomechanics of the knee. In this study group, out of 13 samples, 9 turned out to be histologically positive for mucoid degeneration of PCL. This is a significant number, thus warranting further evaluation in this direction and a bigger study with a higher sample size.

With this observation of higher numbers of histological degeneration of PCL than that was previously thought, the logical conclusion would be to choose PS over CR implants in patients with advanced osteoarthritis. But data shows high patient satisfaction even with CR implants. These satisfactory results despite an insufficient PCL could be explained by the design and conformity of the implants and by the fact that the ligaments take on only a secondary role in the containment when the implant is submitted to axial loading.²⁴

Incidence of mucoid degeneration of PCL from 13 samples

Figure 5. Chart showing incidence of mucoid degeneration of PCL from 13 samples

MRI with cartilage study remains the gold standard in preoperatively diagnosing the mucoid degeneration of the cruciate ligaments and assessing the concurrent stage of osteoarthritis. The characteristic features in MRI is termed “celery stalk” appearance. The other features include an intermediate intensity signal in T1 weighted images and a high intensity signal in T2 weighted images. Preoperative diagnosis of mucoid degeneration of the cruciate ligaments help in planning the procedure better. Not to ignore the fact that mucoid degeneration in itself is a neurogenic pain generating condition associated with progressively decreased range of movement of knee mimicking the symptoms of severe osteoarthritis of the knee.²⁵ In patients with early osteoarthritis of knee, intractable pain and restriction of range of movements, the diagnosis of coexisting mucoid degeneration of the cruciate ligaments should be entertained. Mucoid degeneration, once proven with MRI, can be treated with minimally invasive arthroscopic procedures like ACL debridement and notchplasty or total ACL reconstruction, thus delaying TKR in young patients and even in old patients with early stage Osteoarthritis. MRI of the knee with cartilage study can also correctly grade the tricompartmental osteoarthritis status.

CONCLUSION

Mucoid degeneration of the cruciate ligaments is an underdiagnosed condition. The real incidence of mucoid degeneration is much higher than what has been already published in the literature.

There is a clear role for preoperative MRI of the knee with cartilage study in patients undergoing total knee replacements to look for mucoid degeneration in the cruciate ligaments and to assess the cartilage status of the articular surfaces. This will be of help especially when clinical findings and Xray findings do not match. This might allow for arthroscopic treatment of the condition thus delaying the TKR in patients of all age groups, and also help in avoiding postoperative patient dissatisfaction after total knee replacement. Preoperative MRI evaluation can give surgeon an insight to decide if the PCL should be retained or sacrificed during total knee replacement.

The decision to retain or sacrifice the posterior cruciate ligament during TKR in patients without preop MRI should not be based on clinical and intra-operative macroscopic examination of the integrity of the ligament alone, but also on the stage of arthritis and the degree of radiographic destruction of knee which parallels the histological degeneration of the cruciate ligaments.

If intraoperatively there are macroscopic features suggestive of mucoid degeneration of the ACL in patients with advanced osteoarthritis, it is better to select posterior stabilising implants than to retain the PCL, as in these patients, the chances of degeneration of PCL is very high.

This might lead to postoperative reduction of knee range of movements and can also cause postoperative posterior knee pain.

END NOTE

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