

# Mucoid degeneration of the anterior cruciate ligament: MRI, clinical, intraoperative, and histological findings

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## Abstract

**Purpose** To describe the clinical, MRI, intraoperative, and histological features of mucoid degeneration of the anterior cruciate ligament (ACL).

**Methods** This study included 10 patients (average age 47 years, range 19–69 years) who underwent surgery due to clinical diagnoses of mucoid degeneration of the ACL. All patients underwent preoperative magnetic resonance imaging (MRI) and were arthroscopically treated.

**Results** All 10 patients reported preoperative posterior knee pain. MRI indicated a thickened ACL with increased signal on all sequences. Postoperatively, only six of 10 patients were confirmed by biopsy to have a mucoid degeneration of the ACL. An associated intraosseous tibial cyst or ganglion was observed only in patients with a definitive diagnosis of mucoid degeneration.

**Conclusions** Mucoid degeneration of the ACL can be suspected in patients with posterior knee pain associated with a thickened ACL. Associated findings such as an intraosseous tibial or ganglion cyst help to rule out differential diagnosis.

**Keywords** ACL · Mucoid · Intraosseous tibial cyst · Ganglion

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## Introduction

Mucoid degeneration of the anterior cruciate ligament (ACL) has been suggested in patients with back knee pain and limitation of knee flexion associated with a bulky ACL as shown by magnetic resonance imaging (MRI) [3, 6]. However, this association is not sufficient to establish an accurate diagnosis, as its presentation and appearance can mimic other pathologies such as partial ACL tears, ganglion cysts, and synovial chondromatosis [7, 12]. Mucoid degeneration of the ACL, with a reported prevalence of 0.43% [9], affects middle-aged patients and is thought to be secondary to ACL degeneration. Patients characteristically do not complain of knee instability, and the Lachman test is typically negative. When mucoid degeneration is present, MRI reveals an ill-defined but intact ACL with increased girth and normal orientation of the ligament. Histologically, mucoid degeneration results in a mucoid substance in the connective tissue containing glycoproteins and mucoproteins [9]. Mucoid degeneration has been associated with ganglions and intraosseous femoral and tibial cysts, suggesting the presence of a global mucoid degeneration of the connective tissue of the joint [1].

The objective of this study is to describe the clinical, MRI, and histological features of mucoid degeneration of the ACL in a series of patients with a clinical diagnosis of mucoid degeneration.

## Materials and methods

Inclusion criteria consisted of those patients who underwent surgery with a clinical diagnosis of mucoid degeneration of the ACL.

Retrospectively, 10 patients diagnosed with mucoid degeneration of the ACL (five women and five men) between 2004 and 2008 were included in the present study. Patients were  $47 \pm 17$  years old, with a range of 19–69 years. All patients had a preoperative MRI of the knee. Clinical criteria for mucoid degeneration were established according to previous data [3, 9] in patients with knee pain (especially back knee pain) and the inability to flex beyond  $70^\circ$  and  $90^\circ$ . Unenhanced MRI of the knee was performed using a 1.5 T MR unit (Signa, General Electric, Medical Sygma) with a dedicated knee coil (Medrad), a 15- to 16-cm field of view, and a 4 mm section thickness. The sequences used were T1, T2, and axial T2 fast spin echo. The MRI criterion for mucoid degeneration was an ACL bulk occupying almost the intercondylar notch with an increased signal in T2. Both ligament bundles had to be imaged as intact from origin to insertion to exclude partial tears. All patients were treated initially with nonsteroidal anti-inflammatory drugs and knee sparing activity for a minimum of 6 months before considering surgery.

All patients underwent arthroscopy. In all patients, the notch was first widened using a 4-mm sheathed motorized burr (Smith and Nephew, Andover, MA), and then arthroscopic biopsy specimens of the hypertrophic portion of the ACL were obtained. Arthroscopic debridement of the ACL removed nearly half of the native ACL. A stability examination (Lachman Test and Drawer sign) was performed after debridement. Postoperatively, the patients were allowed weight bearing as tolerated with crutches. Knee motion was not limited.

Biopsies were performed in all patients during arthroscopy and were immediately preserved in 4% buffered formaldehyde solution. Tissue was stained with hematoxylin and eosin and Alcian blue to detect mucoid degeneration of collagen fibers. Conventional light microscopy was used for histological examination, and staging was established according to Nelissen et al. [10] as follows: stage 0, no mucoid degeneration with slight fibrosis in some areas; stage 1, early stage with slight degeneration starting between the collagen bundles and collagen bundles still in a normal parallel arrangement; stage 2, moderate focus of mucoid degeneration with irregular structure of the collagen fibers; and stage 3, extensive mucomyxoid degeneration with total loss of fiber structure and bundle integrity.

Statistical analyses were carried out with GraphPad software (GraphPad Software, La Jolla, CA). Fisher's exact test was performed to compare the association between mucoid degeneration and intraosseous tibial cyst or ganglion. Significant differences were established at  $P < 0.05$ , and 95% confidence intervals (95% CIs) were applied.

## Results

Clinically, all 10 patients reported knee pain and limitation in knee flexion and exhibited a diffuse thickened ACL in the MRI. None of the patients showed signs of instability. Four patients possessed a trauma history during the last two consecutive years before the office visit. Mucoid degeneration of the ACL was confirmed postoperatively by histology in six patients; all six patients manifested an intraosseous tibial cyst or a ganglion associated with the diffuse thickened ACL (Fig. 1,  $P < 0.005$ , 95% CI 54–100). In contrast, other associated lesions such as edema and meniscus tear were observed only in the four patients where mucoid degeneration could not be confirmed by histology.

During arthroscopy, the ACL appeared bulbous and hypertrophied in all 10 patients. In the six patients with a definitive diagnosis of mucoid degeneration, a yellowish mass was interspersed between the ACL fibers.

Histological examination confirmed mucoid degeneration, manifested by myxomatous degeneration of the ACL, in six patients (Fig. 2). In the other four patients, histological evaluation revealed neovascularization and inflammatory infiltration, suggesting tissue in the process of repair.

## Discussion

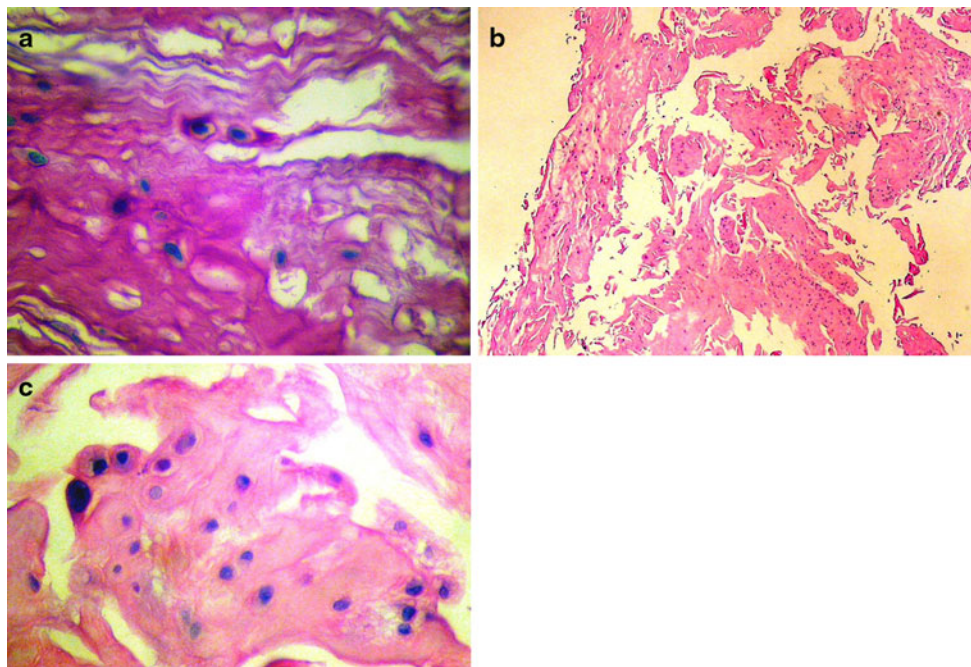
This study included 10 patients with clinical diagnoses of mucoid degeneration of the ACL. Postoperatively, only six of these patients were definitively diagnosed with mucoid degeneration of the ACL. Interestingly, MRI revealed that these six patients had an associated intraosseous tibial cyst or ganglion. The other four patients reported a trauma history but did not exhibit these associated lesions.

Posterior knee pain and limitation of knee flexion associated with a diffuse thickened ACL are not sufficient to establish an accurate diagnosis of mucoid degeneration [2–4, 8, 11]. Discrete intraosseous cysts were identified in 77% of patients with mucoid degeneration of the ACL and in 66% of patients with intraosseous ganglia in a retrospective study, suggesting that mucoid degeneration of the ACL and ganglia of the ACL may share a similar pathogenesis [1]. Similarly, four of six patients (66%) with mucoid degeneration of the ACL exhibited associated intraosseous cysts in the present study. Mucoid degeneration of the ACL and ganglion cyst formation may share the same pathology secondary to a mucinous degenerative change in the connective tissue, perhaps even as a precursor to a complete tear [1, 7].

In contrast, a previous study indicated that the presence of a bulky ACL with positive trauma history, concomitant



**Fig. 1** **a** Sagittal T1 view of the ACL by MRI. Mucoïd degeneration of the lower third of the ACL is evident, with a ganglion cyst originating from the middle third. **b** The intrinsic signal intensity of the lesion is fairly similar to that of the synovial fluid seen in the suprapatellar bursa



**Fig. 2** **a–c** Histological evaluation with hematoxylin and eosin showing distorted collagen fibers with multifocal mucoid degeneration. Mucoid degeneration of the ACL was the definitive diagnosis

bone contusions, or meniscus tears was suggestive of partial lesions of the ACL [5]. The four misdiagnosed patients in the present study reported trauma histories suggestive of a partial tear of the ACL, rather than mucoid degeneration of the ACL.

The small number of cases included in the present study represents a major limitation, including more patients will determine whether the various associated lesions in mucoid degeneration and other pathologies will enable accurate clinical diagnoses. We considered only those patients who underwent surgery and had a tissue biopsy. Although all

patients were diagnosed preoperatively with mucoid degeneration of the ACL, the histology confirmed it in only six of the 10 patients. According to the MRI, these six patients possessed an intraosseous tibial cyst or a ganglion in addition to the bulky ACL.

## Conclusion

Mucoid degeneration of the ACL is a rare condition affecting patients with posterior knee pain and limitation of

knee flexion in association with a diffuse thickened ACL. However, misdiagnosis is common. Associated ganglia or tibial cysts were present in patients with mucoid degeneration of the ACL; In contrast, none of the misdiagnosed patients showed exhibited these associated lesions. These observations imply that the identification of associated lesions may help to determine an accurate diagnosis of ACL mucoid degeneration.

**Conflict of interest** None.

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