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## ORIGINAL ARTICLE

# Mucoid degeneration of the anterior cruciate ligament: frequently under-diagnosed entity in MRI <sup>☆</sup>

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### KEYWORDS

ACL (anterior cruciate ligament);  
 Mucoid degeneration;  
 MRI

**Abstract Objective:** The purpose of our study was to describe the MR appearance of mucoid degeneration of the anterior cruciate ligament and to address its clinical significance.

**Patients and methods:** A database search of 2000 knee MRI examinations revealed 32 examinations (Chart 1) with reported mucoid degeneration of the anterior cruciate ligament.

**Results:** Of 32 examinations that met imaging criteria, all patients (100%) had different degrees of mucoid degeneration. Associated ganglia were seen in eight patients; located in the proximal ligament in four examinations (12.5%) and the distal ligament in two (6%) and involved the mid-portion of the ligament in two (6%).

Intra-osseous cysts were noted distally in 15 examinations (47%), proximally in four (12.5%) and on both sides in six (19%). All our patients had accessible medical records; no clinical evidence of instability was reported.

Four patients who underwent arthroscopy had an intact anterior cruciate ligament at that time.

**Conclusion:** Anterior cruciate ligament mucoid degeneration has specific MRI features and should not be misdiagnosed as partial or total tear, and typically not associated with ligament instability.

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<sup>☆</sup> This work was not presented anywhere.

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### Introduction

Mucoid degeneration of the ACL is a rare process that has been described in a few reports (1). With increasing use of magnetic resonance imaging (MRI) to evaluate the knee, a number of cases have been accumulated to date (2).

The pathogenesis of mucoid degeneration of the ACL remains unknown. Some theories suggest that it may simply be the result of senescent degeneration, while others suggest that it may evolve from the synovial tissue entrapment between ACL fibers, either congenital or acquired (3). Trauma has also been proposed as an etiologic factor (4) since it is considered a

likely cause of tendon mucoid degeneration and many patients with ACL mucoid degeneration have a history of mild or non-specific trauma (5).

Patients with this condition characteristically do not complain of knee instability, and the Lachman test (for evaluating the integrity of the ACL) is typically negative. It is a disease of the elderly, probably related to degeneration and aging. Clinical data are often non-contributory with respect to the anterior cruciate ligament, and most patients are referred for imaging studies as having nonspecific pain, osteoarthritis, or a suspected meniscal tear. It may be difficult for general radiologists to achieve this diagnosis because of the lack of references to this subject in the major textbooks. Nevertheless, mucoid degeneration of the ACL is an already well-defined entity, with established MRI criteria for its diagnosis (6).

On MR images, the criteria for mucoid degeneration include a bulky ligament of increased signal intensity on images obtained with all pulse sequences, with discrete fibers easily distinguished on T2-weighted images but poorly differentiated on T1-weighted and intermediate-weighted images. Degeneration may involve either the posterolateral or antero-medial bundle of the anterior cruciate ligament (6,7). Mucoid degeneration may coexist with ACL ganglia, as well as with intra-osseous cysts at the femoral and tibial attachments, most commonly at the tibial insertion (4).

The individual fibers may be difficult to see, especially in T1WI, but are more conspicuous in T2WI, and the sagittal images are the most important in this setting, showing the ACL its entire length. Both bundles of the ligament (anteromedial and posterolateral) have to be intact in their entire length to exclude the partial tears (1).

There is an association between the intraligamentous ganglion cyst of the ACL and its mucoid degeneration, and it is believed that they may represent a continuum of degenerative changes. Although both conditions most often occur independently, it has been recently demonstrated that they frequently coexist (4,6).

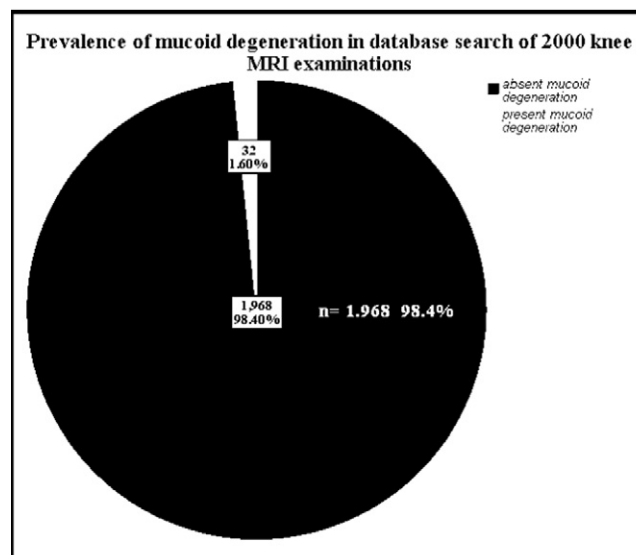
## Patients and methods

This is a retrospective study. A database search of 2000 knee MRI examinations revealed 32 examinations with reported mucoid degeneration of the anterior cruciate ligament (Chart 1).

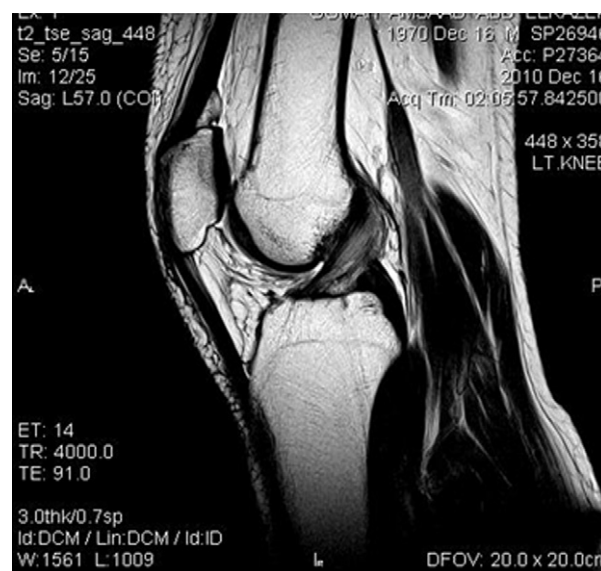
Unenhanced MRI of the knee was performed using multiple machines:

- A 1.5-T closed MRI unit (Avanto, Siemens) with a dedicated knee coil.
- A 0.35-T open MRI unit (Magnetom C, Siemens) with a dedicated knee coil.
- A 0.2-T open MRI unit (Airis mate, Hitachi) with a dedicated knee coil.

Imaging criteria for mucoid degeneration included ill-defined ACL on T1-weighted and proton density-weighted images but with both bundles seen as intact on T2-weighted images, increased girth compared to normal, increased signal intensity on all sequences, normal orientation of the ligament, and celery-stalk appearance (Figs. 1 and 2).

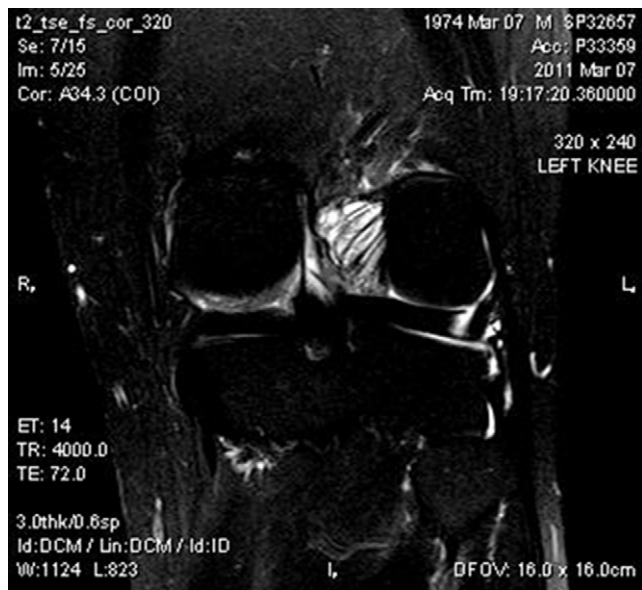


**Chart 1** Prevalence of mucoid degeneration in the studied population.



**Fig. 1** Sagittal T2 (TSE) demonstrates celery-stalk sign. High-signal-intensity ACL is seen with low-signal-intensity fibers running parallel to its long axis.

Knee MRI examinations that did not meet the criteria for anterior cruciate ligament mucoid degeneration were excluded. Examinations were also excluded of patients who had a history of trauma to prevent the potential inclusion of an injured anterior cruciate ligament. Patient symptoms, clinical assessment of the anterior cruciate ligament by an orthopedic specialist, as well as arthroscopic reports, were obtained from patient records when available. Four patients had arthroscopic surgery. No positive signs or symptoms of knee instability are noted in the medical reports of the chosen patients. Stability of the anterior cruciate ligament was assessed by an orthopedist using Lachman's test.



**Fig. 2** Coronal T2WI with fat saturation demonstrates the characteristic “celery-stalk” pattern; both ligamentous bundles (anteromedial and posterolateral) are intact.

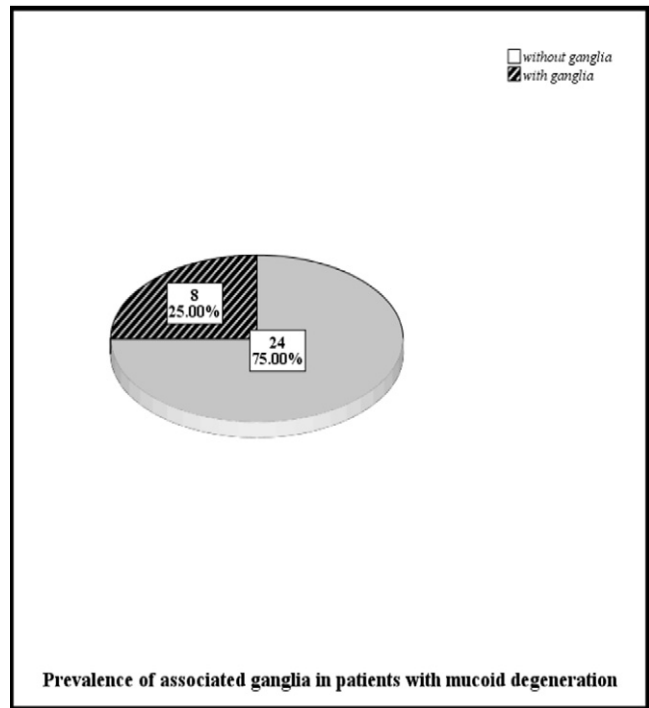
**Results**

Of 32 examinations that met the imaging criteria, all patients (100%) had different degrees of mucoid degeneration. In 30 examinations (93%), mucoid degeneration involved the entire anterior cruciate ligament. In two examinations (7%), mucoid degeneration involved the distal half of the anterior cruciate ligament only (Fig. 3 and Chart 3).

Associated ganglia (Chart 2) were seen in eight patients; located in the proximal ligament in four examinations (12.5%) and the distal ligament in two (6%) and involved the mid-portion of the ligament in two (6%) (Figs. 7–9).

Associated joint effusions were small in 16 (50%) examinations, moderate in six (18%), and large in two (7%). On eight (25%) examinations, no appreciable joint effusion was present.

Chronic synovitis was seen in eight (25%) patients manifested as irregular posterior border of Hoffa pad of fat and



**Chart 2** Prevalence of associated ganglia in mucoid degeneration in the studied population.

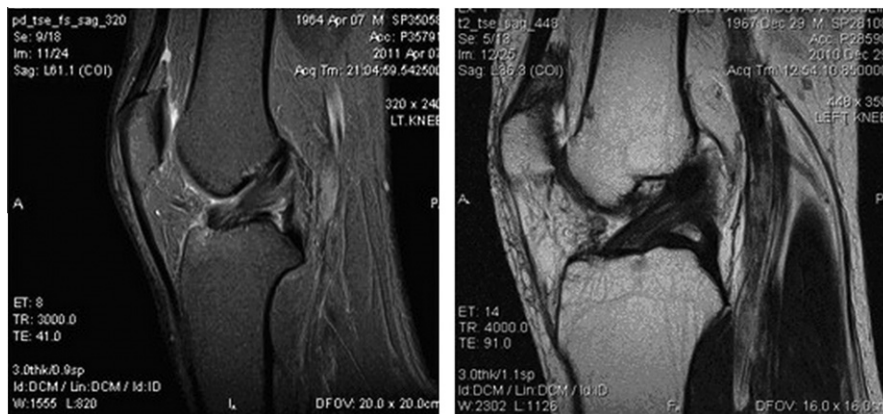
detectable synovial thickening lining the supra-patellar pouch seen as intermediate T1 signal compared to the low signal of the synovial fluid (Fig. 5 and Chart 4).

Intra-osseous cysts (Chart 5) were noted distally in 15 examinations (47%), proximally in four (12.5%) and in both sides in six (19%). The mean diameter of intra-osseous cysts was 3.5 mm at the tibial insertion and 4 mm at the femoral origin (Figs. 4 and 6).

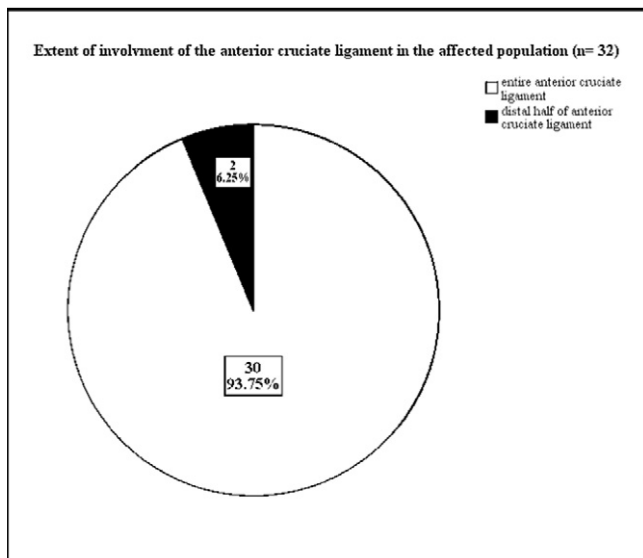
All our patients had accessible medical records; no clinical evidence of instability was reported.

A 60-year-old female patient (Fig. 5) had a bilateral mucoid ACL.

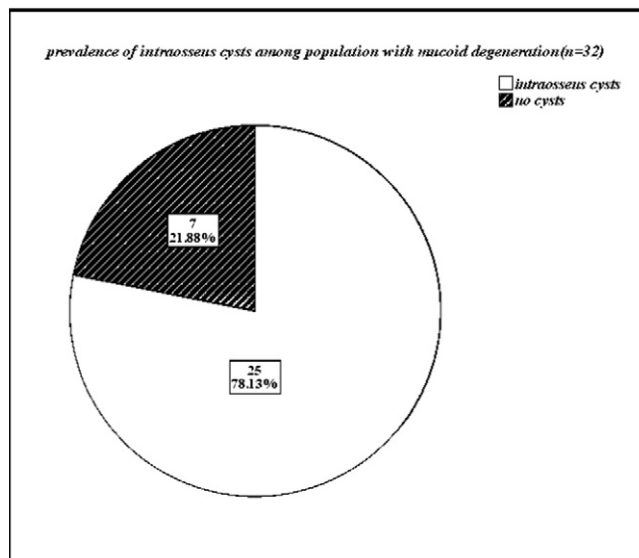
In the 32 cases, (18 men and 14 women) (Chart 6), age ranged from 35 to 60 years, and none reported any major trauma history. All patients complained of knee pain.



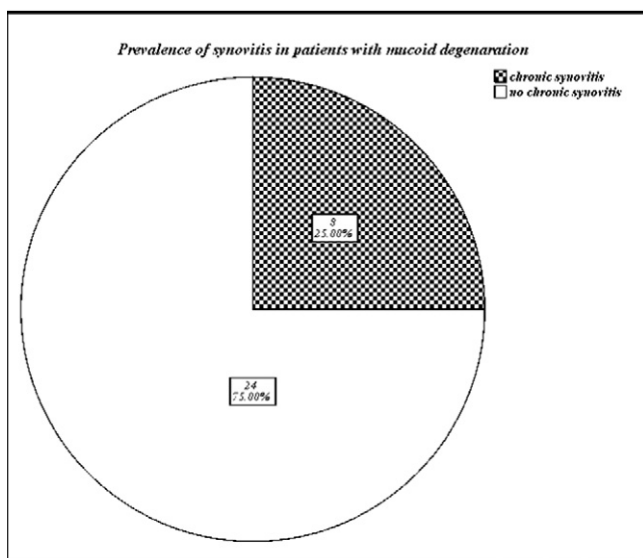
**Fig. 3** Sagittal PD fat suppression WI (left) and T2WI (right) of two different patients showing mucoid degeneration of the lower two-thirds of the ACLs.



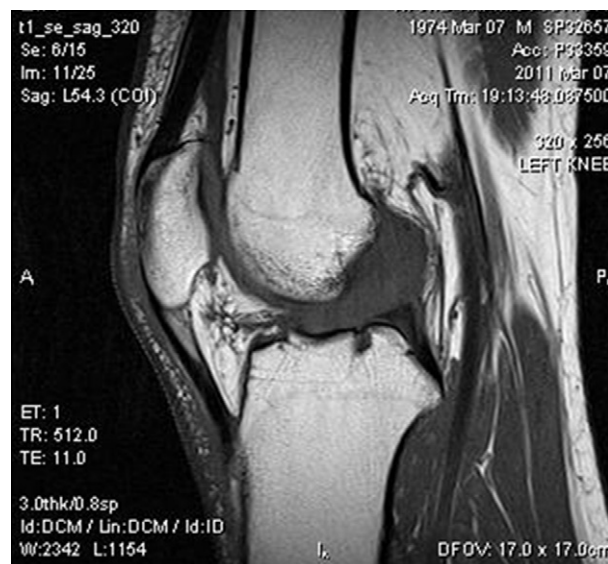
**Chart 3** Extent of involvement of anterior cruciate ligament in the affected population.



**Chart 5** Prevalence of intra-osseous cysts with mucoid degeneration in the studied population.



**Chart 4** Prevalence of synovitis with mucoid degeneration in the studied population.



**Fig. 4** Sagittal T1WI shows the club-shaped appearance of the degenerated ACL, with ill-defined fibers. Small intra-osseous cyst is seen evident at the tibial ligamentous attachment.

Four patients who underwent arthroscopy had an intact anterior cruciate ligament at that time.

Arthroscopic findings are usually intact ACL without any laxity, but the ACL shows external expansion or bulging appearance. Also yellowish discoloration of the ACL is noted during arthroscopy (Fig. 10).

Charts 1–5 demonstrate the prevalence of other MRI findings associated with mucoid degeneration.

**Discussion**

Mucoid degeneration of the ACL is an already well-defined entity, with established MRI criteria for its diagnosis (6).

Mucoid degeneration of the ACL is suspected when an apparently thickened and ill-defined ligament with increased signal intensity on all sequences in MRI is identified in a patient with a physically intact ligament and no obvious trauma history (7).

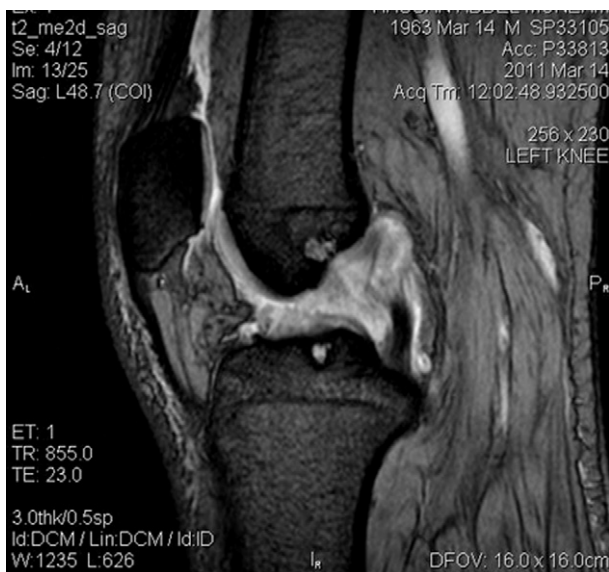
Our imaging criteria for mucoid degeneration recognized in the current study included ill-defined ACL on T1-weighted and proton density-weighted images but with intact fibers on T2-weighted images, increased girth and signal compared to normal orientation of the ligament, and celery-stalk appearance.

Mucoid degeneration of the ACL has been regarded as rare since its first imaging description (8), and even some of the





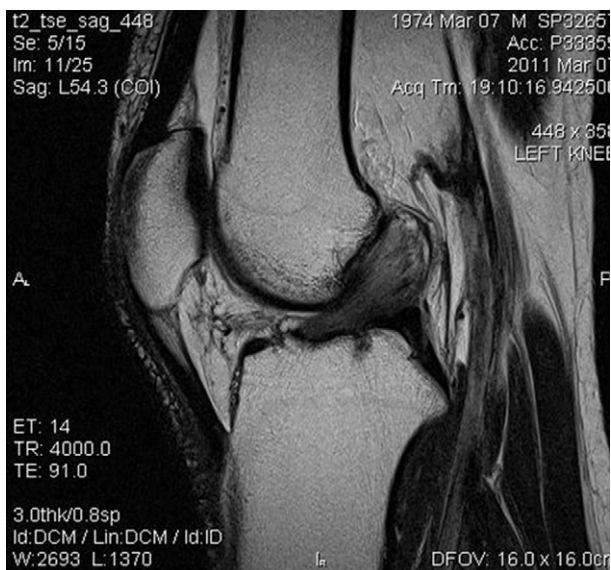
**Fig. 5** Coronal T2WI with fat saturation (upper left image) and sagittal T2WI (upper right image). Coronal T2WI with fat saturation (lower left image) and sagittal T2WI (lower right image) of the left (upper) and right (lower) knees of a 60-year-old woman. There are symmetrical and bilateral changes of both ACLs compatible with mucoid degeneration. Small ganglion cyst is seen at the proximal portion of the cruciate ligament in the left knee in the T2-weighted sagittal images. Bilateral degenerative changes and mild chronic synovitis are also noted. Right medial collateral ligament bursitis with loose bodies is noted.



**Fig. 6** Sagittal T2 gradient WI shows small intra-osseous cysts evident at the femoral and tibial ligamentous attachments.



**Fig. 7** Sagittal T2WI shows a well-defined proximal intraligamentous ganglion cyst of the degenerated anterior cruciate ligament.

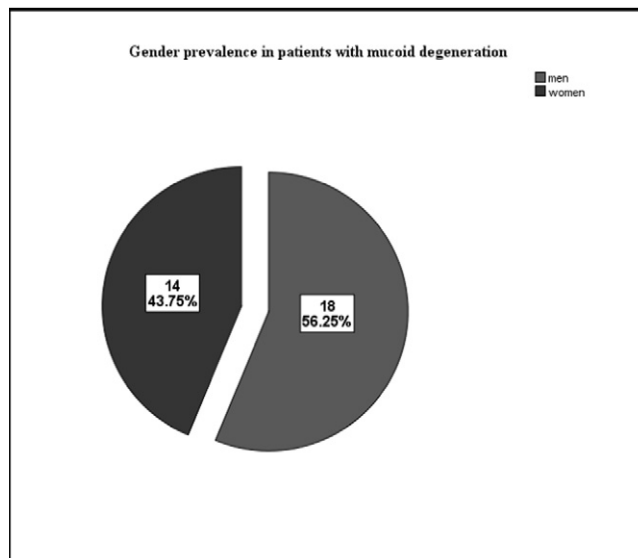


**Fig. 8** Sagittal T2WI displays two small ganglions proximal and distal to the degenerated anterior cruciate ligament. Note the high signal intensity of the cystic areas (similar to that of the synovial fluid) in contrast to the intermediate signal intensity of the ligament itself.

more recent works about this subject still consider it an uncommon occurrence (3,6,9), with most articles based on case reports. However, a recent paper suggested that the real incidence is probably higher than previously believed (4).

Prior reports have indicated that the anterior cruciate ligament mucoid degeneration seems to be largely misdiagnosed as partial ligamentous tears (6,9).

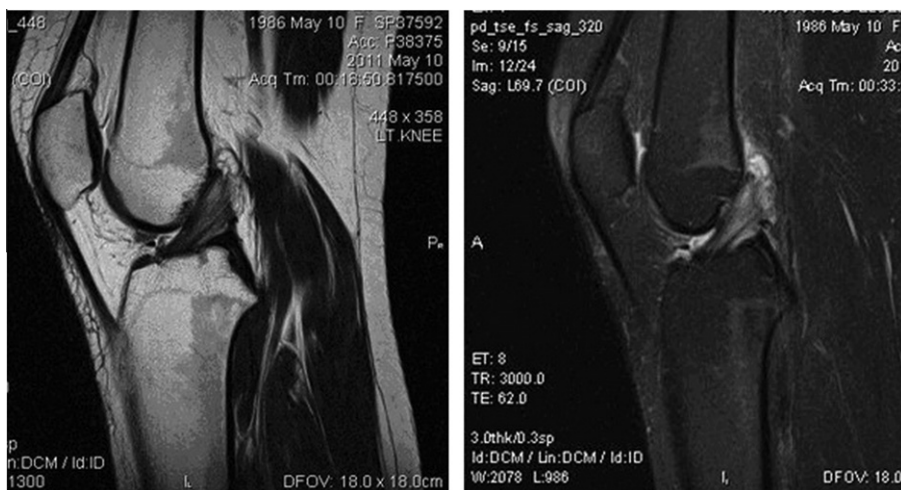
Mucoid degeneration is often mistaken for a chronic or acute interstitial tear at MR imaging (3,6,9). Abnormal signal intensity of the ACL is one of the primary signs of a tear but, unlike tears, in mucoid degeneration there is no discontinuity of the fibers, and secondary signs of tear are absent (6). The absence of clinical signs and symptoms consistent with instability also helps to avoid misdiagnosis (10).



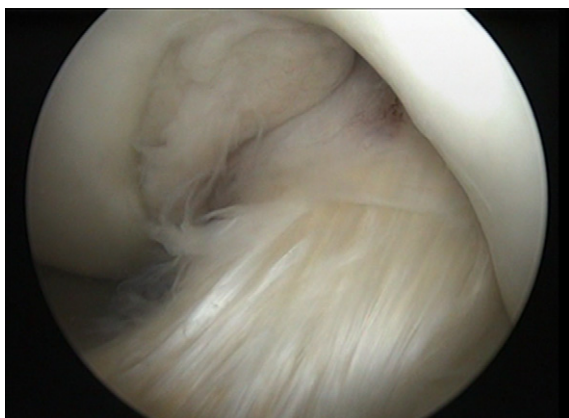
**Chart 6** Gender prevalence in patients with mucoid degeneration in the studied population.

The main differential diagnosis and the most important error to avoid in this setting, as previously described (6) is a tear of the ACL. In our experience, we have seen many cases of mucoid degeneration misdiagnosed as partially torn ACLs. However, if the above-described criteria are strictly followed, this differentiation can be safely done. Furthermore, clinical correlation is crucial, as long as patients with mucoid degeneration of the anterior cruciate ligament typically neither have a history of trauma or instability nor present a secondary stigmata of a ruptured ACL (such as bone bruises or anterior tibial subluxation), helping to rule out a ligamentous tear.

We have chosen the title of this paper to highlight that the mucoid degeneration of anterior cruciate ligament is really frequently under-diagnosed based on daily practice because a lot of knee MRI reports are written by radiologists who are not experienced in MSK imaging.



**Fig. 9** Sagittal T2WI (right) and PD fat suppression (left) show another well-defined proximal intraligamentous ganglion cyst of the degenerated anterior cruciate ligament.



**Fig. 10** Case 2: Arthroscopic view of the anterior cruciate ligament (ACL) shows yellowish discoloration within the ACL over the left knee.

Furthermore we claim that if a radiologist would follow strictly the imaging criteria of mucoïd degeneration in conjunction with the clinical data, a considerable number of mucoïd degeneration will be diagnosed instead of partial or complete tears.

J.L. Fernandes et al. (4) stated that, in daily practice, most subjects will not have surgical confirmation of imaging findings, as long as this group of patients characteristically do not have the signs of instability and, as such, do not demand surgical repair of their ACLs. Furthermore, since they are typically middle-aged or elderly, other causes of knee pain often coexist, such as meniscal tears (most likely to be degenerative) and osteoarthritic changes, that could explain their symptoms and are frequently not amenable to surgical correction.

MRI is superior to arthroscopy in diagnosing intrasubstance ligamentous abnormalities, and the diagnosis can and should be done based on imaging, since the clinical exam is also fairly insensitive. The finding of a clearly abnormal ACL strictly fulfilling the imaging criteria mentioned above and not associated with knee instability should not give a margin for error (4). This was in agreement with our results that were confirmed in four cases with arthroscopy showing the

intact anterior cruciate ligament in conjunction with MRI features of mucoïd degeneration as well as the absence of clinical manifestations of instability.

In conclusion, mucoïd degeneration of the anterior cruciate ligament has a very characteristic appearance at MRI and seen in patients without an evidence of knee instability. Radiologists should be aware of this condition that it is often misdiagnosed as a partial or complete tear of the ACL.

#### Grant support

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#### References

- (1) Nishimori M, Sumen Y, Sakaridani K. Mucoïd degeneration of the anterior cruciate ligament: a report of two cases. *Magn Reson Imaging* 2004;22:1325–8.
- (2) Yasuo N, Heido M. Mucoïd degeneration of the anterior cruciate ligament associated with subclinical instability in young patients. *J Orthop Sci* 2010;15:251–6.
- (3) Melloni P, Valls R, Yuguero M, Saez A. Mucoïd degeneration of the anterior cruciate ligament with erosion of the lateral femoral condyle. *Skeletal Radiol* 2004;33:359–62.
- (4) Bergin D, Morrison WB, Carrino JA, Nallamshetty SN, Bartolozzi AR. Anterior cruciate ligament ganglia and mucoïd degeneration: coexistence and clinical correlation. *Am J Roentgenol* 2004;182:1283–7.
- (5) Fealy S, Kenter K, Dines JS, Warren RF. Mucoïd degeneration of the anterior cruciate ligament. *Arthroscopy* 2001;17:E37.
- (6) McIntyre J, Moelleken S, Tirman P. Mucoïd degeneration of the anterior cruciate ligament mistaken for ligamentous tears. *Skeletal Radiol* 2001;30:312–5.
- (7) Hsu CJ, Wang SC, Fong YC, Huang CY, Chiang IP, Hsu HC. Mucoïd degeneration of the anterior cruciate ligament. *J Chin Med Assoc* 2006;69:449–52.
- (8) Kumar A, Bickerstaff DR, Grimwood JS, Suvana SK. Mucoïd cystic degeneration of the cruciate ligament. *J Bone Joint Surg Br* 1999;81:304–5.
- (9) Narvekar A, Gajjar S. Mucoïd degeneration of the anterior cruciate ligament. *Arthroscopy* 2004;20:141–6.
- (10) Papadopoulou Panagiota. Signs in imaging: the celery stalk sign. *Radiology* 2007;245:916–7.