

# Potential Association between Anterior Cruciate Ligament Tear and “Bi-Collateral” Ligamentous Rupture: A Retrospective Study

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## Abstract

**Background:** Anterior cruciate ligament (ACL) tears are common complications of knee trauma. This entity can be reliably diagnosed by Magnetic Resonance Imaging. There is a lack of data on the epidemiology of ACL tears in Sub-Saharan Africa. The aim of this study is to describe the radiological aspects of post traumatic ACL tears in a black African setting (Yaounde Teaching Hospital). **Methods:** ninety six (96) MR studies of the knee were retrospectively reviewed. They were realized on a low field device (0.2T) from July 2012 to December 2013. All the examinations were indicated for knee trauma. Ligamentous, meniscal, bony and joint lesions were sought on coronal and sagittal sections. **Results:** the sample consists of 70% (68/96) of men. The mean age is  $35.36 \pm 11.86$  years. The prevalence of ACL tears is 45.8% (44/96) of which 36 (81.81%, 36/44) are total tears. 23 (24%) have associated meniscal lesion and 8 (8.3%) have a simultaneous damage of the collateral ligaments. The most frequently injured part of the meniscus is its posterior horn (12/23 cases). Meniscal and “bi-collateral” ligament injuries are independently associated to ACL tears. **Conclusion:** The prevalence of ACL tears at the Yaounde Teaching Hospital is 45.8%. It is independently associated to meniscal tears and concomitant injury of the tibial and fibular collateral ligaments.

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## Keywords

**Anterior Cruciate Ligament, Magnetic Resonance Imaging, Meniscal Tears, Knee, Trauma**

### 1. Introduction

Anterior cruciate ligament (ACL) tear is one of the commonest ligamentous injuries of the knee [1]. Although its overall incidence in the general population is unknown, there are some estimates suggesting that about 15,000 ACL tears occur due to ski practice in France and 175,000 ACL repairs are performed in United States each year [2]. Sport is the largest provider of ACL tears. In France, five sports are responsible for 90% of ACL tears: football, skiing, rugby, basketball and judo [3].

A complete physical examination can diagnose ACL tear in 80% of cases but it is often difficult to achieve in emergency because of pain and it provides little information about the exact extent of injury. That is why medical imaging examinations are usually necessary [4].

Magnetic Resonance Imaging (MRI) is a precious diagnostic tool in a traumatic setting because of its excellent tissue contrast and non-invasive character [5]-[8]. MRI of the knee quickly becomes the largest non-neurological application of this technology and remains the best exploration technique of ACL [9] [10]. With a sensitivity of 90% - 100% and a specificity of 82% - 100% for the diagnosis of ACL tears, MRI is currently the imaging technique of choice to confirm the suspected diagnosis of rupture and search for associated injuries which may influence the therapeutic protocol [11]-[16].

Despite its many advantages, MRI is a poorly expanded technology in African countries. The first MRI unit in Cameroon was installed at the Yaounde University Teaching Hospital in 2008, followed by another one in Douala city in 2010.

There are numerous patients with knee trauma and suspected ACL tear in our country, as well as qualified orthopaedic surgeons; but to the best of our knowledge, there are no data in the medical literature about ACL tears in our setting. Yet the knowledge of the epidemiology of this disease is useful to better organize its prevention and care in a given environment. We, therefore, carry out this study to describe the MRI aspects of ACL tears and its associated lesions in the Yaounde Teaching Hospital (Cameroon).

### 2. Methods

#### 2.1. Patients and Sampling

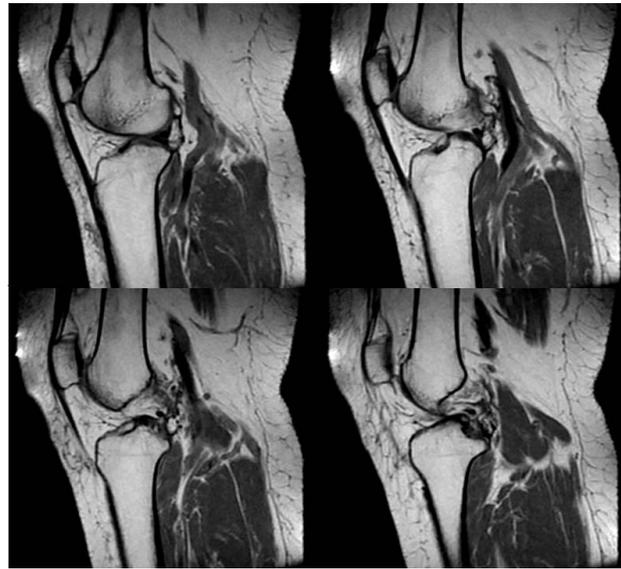
A retrospective review of all patients who underwent a MRI examination of the knee for trauma at the Yaounde Teaching Hospital between July 2012 and December 2013 was performed. This is a national referral hospital with over 40,000 new patients seen per year. Our sample consisted of all patients who came to do an MRI because of knee injury during the study period. Then we excluded those with tumors, infections, gonarthrosis, and previous knee surgery or isolated posterior cruciate ligament tear (**Figure 1**). Clinical data collected from the electronic medical records were age, sex and the knee's side. The radiological files were reviewed collegially.

#### 2.2. MRI Protocols and Reading Methods

The MRI examinations were performed using a 0.2 T device (Signa Profile Excite Lightspeed VCT, GE Healthcare). Patients were installed supine in the MRI unit with the knee positioned in neutral rotation and extension into a dedicated cylindrical extremity coil. Feet were introduced into the magnet first.

Fast spin echo and proton density T1-weighted and T2-weighted images obtained in sagittal and coronal views were used in this study. Protocols settings were as follows: field of view 18 cm, slice thickness of 3 mm without interslice gap and a matrix of  $512 \times 512$ .

Radiological files were stored in DICOM format, transferred to an off-line workstation, and loaded to a software package for image data analysis and visualization (Clear Canvas Workstation 2.0 SP1). Proofreading was done collegially by the main investigator and two senior radiologists on a 21 inch monitor with a maximal resolution of  $1368 \times 768$ .



**Figure 1.** Consecutive sagittal views of the knee; proton density fast spin echo weight sequences: total rupture of Anterior Cruciate Ligament and Posterior Cruciate Ligament.

### 2.3. Radiological Data of Interest

ACL tears were classified as total or partial ruptures [3]. Meniscal lesions were searched according to the criteria proposed by Crues and Stoller [17]. As recommended by Ravey *et al.* we only reported stage III lesions as post traumatic meniscal tears [12]. Other findings sought were: collateral ligament injuries (contusions or rupture), posterior cruciate ligament tears, bone lesions, quadriceps and patellar ligament lesions, anterior tibial translation and joint effusion.

### 2.4. Ethical Considerations

We obtained ethics approval from the ethics committee of the Yaounde Teaching Hospital. It was considered that this study did not require informed consent from patients.

### 2.5. Statistical Analysis

Statistical testing included the Kolmogorov-Smirnov test for normality, Fisher test for testing gender-related variability and logistic regression for assessing association between ACL tears and other lesions. All statistical analyses were performed using SPSS software (SPSS, version 20.0; SPSS Inc., Chicago, IL., USA). The level of statistical significance was set at  $p < 0.05$ .

## 3. Results

### 3.1. General Characteristics of the Study Population

The study population consisted of 96 patients aged 16 to 59 years. The sample was normally distributed ( $p = 0.213$ ) with a mean age of  $35.36 \pm 11.86$  years. There were 68 men (70.8%; sex ratio: 2.43). The left and right knees were represented in equal numbers ( $n = 48$ ) (Table 1). The overall prevalence of ACL tears was 45.8% (44/96) with no gender difference ( $p = 0.20$ ). Total tears were strongly predominant (36/44; 81.8%).

### 3.2. Lesions Associated to ACL Tears (Table 2)

Twenty-three cases (23/96; 24%) of meniscal tears were found, including 16 cases (36.4%) significantly associated with ACL tears ( $p = 0.002$ ). Meniscal tears were more frequent on the medial meniscus ( $p = 0.008$ ) and particularly its posterior horn ( $p = 0.023$ ). Simultaneous rupture of collateral ligaments (“bi-collateral” tear) was

**Table 1.** General characteristics of the study population.

	ACL tear <i>n</i> = 44(%)	No ACL tear <i>n</i> = 52(%)	<i>p</i> -value
Sex			
Men	34 (77.3)	34 (65.4)	0.20
Women	10 (22.7)	18 (34.6)	
Age group			
16 to24 years	11 (25)	15 (28.85)	0.37
25 to34 years	13 (29.55)	8 (15.38)	
35 to 44 years	8 (8.18)	14 (26.92)	
45 to 59 years	12 (27.27)	15 (28.85)	
Kneeinjured			
Left	24 (54.5)	24 (46.2)	0.41
Right	20 (45.5)	28 (53.8)	

**Table 2.** ACL tears-associated lesions.

	ACL tear <i>n</i> = 44(%)	No ACL tear <i>n</i> = 52(%)	<i>p</i> -value
Meniscaltear	<b>17 (38.6)</b>	6 (11.5)	<b><i>p</i> = 0.002</b>
Meniscalsidetear			
<b>Medial</b>	<b>10 (22.7)</b>	4 (7.7)	<b><i>p</i> = 0.008</b>
Lateral	3 (6.8)	0	
Medial and lateral	4 (9.1)	2 (3.8)	
Meniscalhorntear			
MM-anteriorhorn	2 (4.5)	0	<b><i>p</i> = 0.023</b>
<b>MM-posteriorhorn</b>	<b>12 (27.3)</b>	5 (9.6)	
LM-anteriorhorn	4 (9.1)	2 (3.8)	
LM-posteriorhorn	3 (6.8)	0	
Collateral ligament tears			
Tibial	12 (27.3)	6 (11.5)	<i>p</i> = 0.07
Fibular	11 (25)	5 (9.6)	<i>p</i> = 0.07
<b>Tibial and fibular</b>	<b>7 (15.9)</b>	1 (1.9)	<b><i>p</i> = 0.01</b>
Meniscaltear	<b>17 (38.6)</b>	6 (11.5)	<b><i>p</i> = 0.002</b>
Meniscalsidetear			

MM: Medial Meniscus; LM: Lateral Meniscus.

significantly associated with ACL tears ( $p = 0.016$ ). Joint effusion (49/96, 51.04%;  $p = 0.82$ ) and bone contusion (29/96, 30.2;  $p = 0.3$ ) were other frequent joint lesions encountered, but none of them was significantly associated to ACL tears (**Table 3**).

On multivariate analysis, meniscal tears and “bi-collateral” ligamentous tear were found to be independently associated with ACL tears (**Table 4**).

#### 4. Discussion

This study indicates that ACL tears are the most frequent lesions of the injured knee in Yaounde University Teaching Hospital with 45.8% prevalence and no gender difference. The factors associated with those lesions are meniscal tears and “bi-collateral” ligamentous tears. The posterior horn of medial meniscus is the most frequently injured.

**Table 3.** Miscellaneous joint lesions.

	ACL tear <i>n</i> = 44(%)	No ACL tear <i>n</i> = 52(%)	<i>p</i> -value
Joint effusion	23 (52.3)	26 (50)	0.82
Contusion of tibial condyles			
Lateral	4 (9.1)	3 (5.8)	0.26
Medial	6 (13.6)	3 (5.8)	
Contusion of femoral condyles			
Lateral	6 (13.6)	1 (1.9)	0.35
Medial	4 (9.1)	2 (3.8)	
Elongation of the patellar tendon	3 (6.8)	1 (1.9)	0.4
Posterior cruciate ligament tear	3 (6.8)	0	0.96
Anterior tibial translation	2 (4.6)	0	0.20
Contusion of the fibular head	1 (2.3)	0	0.45
Avulsion of the intercondylar tubercles	1 (2.3)	0	0.45

MM: Medial Meniscus; LM: Lateral Meniscus.

**Table 4.** Lesions associated to ACL tears on multivariate analysis.

Lesion	<i>p</i> -value	$\beta^*$ [95% IC]
Meniscal tears	0.004	4.74 [1.63 - 13.82]
“Bi-collateral” ligamentous tear	0.04	9.33 [1.05 - 28.83]

\* $\beta$ : Logistic regression coefficient.

#### 4.1. Prevalence of ACL Tears

The predominance of ACL tears in traumatic knee disorders is now widely accepted [3] [18]. ACL is the main obstacle to anterior tibial translation; it provides secondary stabilization in response to internal tibial rotation and varus or valgus angulation. The main mechanisms of knee trauma are: external tibial rotation, internal rotation of the femur, extreme valgus unintentionally applied to a flexed knee, hyperextension and valgus or direct side impact [2].

#### 4.2. Association with Collateral Ligamentous Tears

The association between ACL tears and “bi-collateral” tears had not been previously reported. The tibial collateral ligament is more often injured in case of knee trauma due to forced valgus which causes its stretching and tearing, meanwhile the fibular collateral ligament can be broken due to external rotation or direct lateral knee injury [1] [13]. According to Guenoun *et al.* forced valgus and external rotation are part of the most common ACL tears mechanism, which may justify their association with “bi-collateral” ligamentous tears [3].

#### 4.3. Association with Meniscal Tears

The association between ACL tears and meniscal tears is well established in the literature as stated by Lecouvet *et al.* [1]. The medial meniscus is usually more injured because it is thinner, narrower and more “opened” than the lateral meniscus [8]. Lerais *et al.* had found that the posterior horn is preferably teared because meniscal tears often start there and gradually extend to the front, so that isolated lesions of the anterior horn of the medial meniscus does not exist [19].

#### 4.4. Gender Influence

We did not find any gender difference in the prevalence of ACL tears which is not consistent with the data of li-

terature recalled by Cimino *et al.* who stated that there is 1.4 to 9.5 times increased risk of ACL tears in women [4]. Some theories for this predominance in women have been suggested: poorer access to training facilities, hamstring strength, hormonal fluctuations, narrow intercondylar notch, increased  $Q$  angle and quadriceps dominance [4] [20] [21]. The absence of gender difference in our study is probably due to the overrepresentation of men who constituted 70.8% of the sample. Men are probably more often the victims of knee injury than women because they are most likely to practice sport which is the first provider of ACL tears [22].

#### 4.5. Limitations to the Study

We performed our examinations with a low field magnet (0.2 T). Several studies comparing low field (0.2 T) and high field (above 1.5 T) devices in the evaluation of ACL tears have found a poorer image quality and a longer examination time with low fields despite a comparable diagnostic accuracy [23] [24]. Thus, we considered this was not a limitation to carry out the study.

Three real limitations to this study should be mentioned: the limited sample size, overrepresentation of men and the lack of clinical data. MRI is a recent and still expensive technology (at least 225 U.S. dollars) in our country; clinicians do not prescribe enough and there are few patients who can afford it. The retrospective design of this study did not allow us to collect more clinical data in order to integrate them into our analysis and verify if, as previously reported, they could improve the detectability of ACL tears [5]. There is a necessity to continue this study prospectively on a larger and balanced sample in terms of gender, in order to validate its findings.

#### 4.6. Suggestions

Our results suggest that in case of knee trauma, the presence of a “bi-collateral” ligamentous tear (recognizable on clinical or ultrasound examination) increases the probability of ACL tear. This could be very useful in our country where MRI is not yet attainable for the majority of the population.

### 5. Conclusion

ACL tears are the most frequent lesions of the injured knee in Yaounde University Teaching Hospital and they are commonly total tears. Their prevalence is 45.8% without gender difference. The factors associated with those lesions are meniscal tears and “bi-collateral” ligamentous tears. The posterior horn of medial meniscus is the most frequently injured. Further prospective and population-based studies will be necessary to assess this particular association and provide more generalizable results.

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