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Magnetic resonance imaging analysis of relationship of intercondylar notch width and alpha angle in anterior cruciate ligament injury

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Abstract
Aims and Objectives: To determine the relationship between alpha angle and intercondylar notch width measurements and ACL tears.
Materials and Methods: A total of 100 subjects were included in this study. Patient's with ACL injury were grouped as cases (torn group) and those without ligament injury were grouped as controls (intact group).Controls age and sex were matched with that of the cases.
Type of study: Prospective Study
Place of study: Department of radiodiagnosis, Kamineni institute of medical sciences, Narketpally
Sample size: 100
Duration of study: 1ST October 2021-30 September 2022(12 Months)
Results: A total of 100 subjects were included in present study. Mean age of the study subject's was 34 years. Mean alph angle among intact ACL group was 44° and mean alpha angle among torn ACL group was 51°. Mean intercondylar notch distance among intact ACL group was 22 mm and mean intercondylar notch distance among torn ACL group was 15 mm.
Conclusions: Higher alpha angle and narrow intercondylar notch width patients are more prone to ACL tears.

Keywords: MRI knee, torn ACL, intact ACL, alpha angle, intercondylar notch width

Introduction

The Anterior cruciate ligament (ACL) restraints anterior translation of tibia on the femur and provides rotational stability to knee joint. ACL injury is serious and etiology is multifactorial [1-3]. Few studies have shown joint anatomy and morphology are the predisposing factors for ACL injury [2, 3].

Narrow intercondylar notch has smaller ACL and additionally there is impingement of the ACL at the anterior and posterior roof of the notch and also stretches the ACL over the medial edge of the lateral femoral condyle hence predisposing it to tear [1, 3]. Alpha angle is the angle between the longitudinal femoral axis and Blumensaat Line (BL). It is increased in torn ACL knee joints compared to the normal knee joints. The angle is measured in sagittal section [1].

An identification of the predisposing factors for ACL injury in the knee may help reduce the number of ACL injuries [4-9]. Hence this study was conducted to measure two morphological factors i.e. alpha angle and intercondylar notch width using MRI and its importance in ACL injured patients.

Materials and Methods

A total of 100 subjects were included in this study. Patients knee joint images were obtained from hospital PACS and consent waiver form was submitted. Patient's with ACL injury were grouped as cases (Torn group) and those without ligament injury were grouped as controls (Intact group). Controls age and sex were matched with that of the cases.

MRI images were obtained from 1.5 tesla siemens MR scanner. In PDW axial section, the intercondylar notch width was measured as the narrowest distance between the two femoral condyles [1].

In sagittal section (PDW) where entire intercondylar notch is seen Blumensaat Line was drawn along the roof of the interondylar notch of the femur and another line is drawn along the long axis of the femur, the angle intercepted is alpha angle [1]. The study results were subjected for statistical analysis.

Results

In the present study a total of 100 subjects were included. Patients with ACL injury were grouped as cases (torn group) and those without ligament injury were grouped as controls (intact group).Controls age and sex were matched with that of the cases. The collected data were subjected to statistical analysis and relationship of intercondylar notch width and alpha angle between intact ACL and torn ACL were analysed.

Representative figures

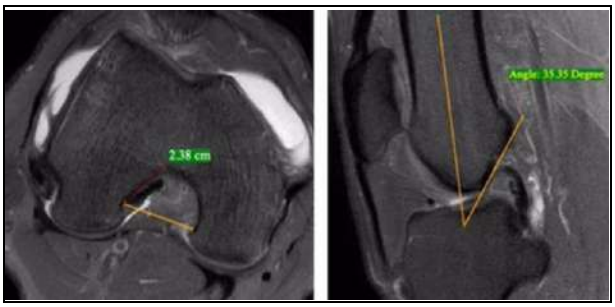

Fig 1: Wide intercondylar notch width and low alpha angle in a patient with no ACL tear

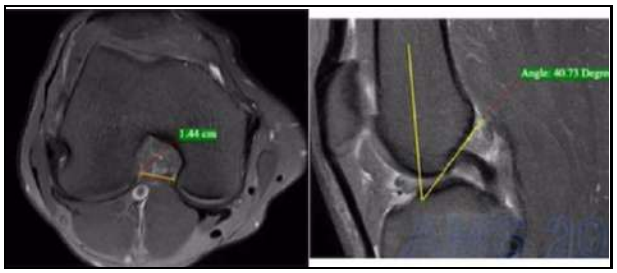

Fig 2: Narrow intercondylar notch width and high alpha angle in a patient with ACL tear

Table 1: mean age of study subjects in intact ACL and torn ACL

	Intact ACL (n = 50)	TORN ACL (n = 50)	t value	P value
	Mean ± standard deviation	Mean ±standard deviation		
Age	34.5200±6.66774	34.1200±5.80162	0.476	0.636

No significant age differences were found among torn and intact ACL's.

Table 2: mean alpha angle of study subjects in intact ACL and torn ACL

	Intact ACL (n = 50)	Torn ACL (n = 50)	t value	P value
	Mean ±standard Deviation	Mean ±standard deviation		
Alpha angle (degrees)	44.58±4.862	51.28±1.938	9.820	<0.001

The mean alpha angle was higher in patients with a torn ACL than in those with intact one

Table 3: Mean intercondylar notch width of study subjects in intact ACL and torn ACL

	Intact ACL (n = 50)	Torn ACL (n = 50)	t value	P value
	Mean ± standard deviation	Mean ± standard deviation		
Intercondylar notch width (mm)	22.76±2.076	15.96±1.958	17.839	<0.001

Intercondylar width was significantly lower in torn ACL group than in those with intact one

Roc curve for alpha angle in torn ACL group

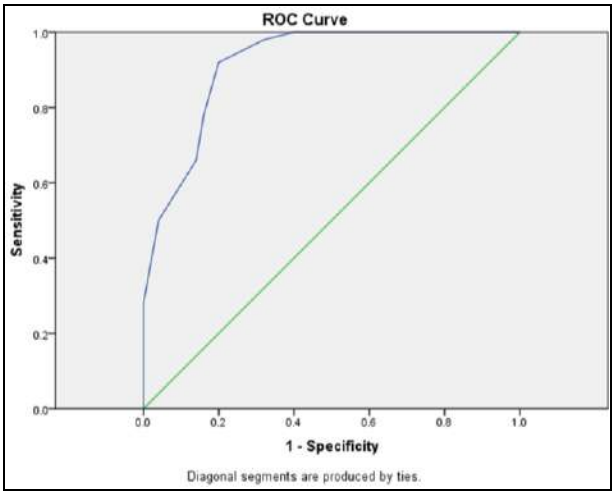

Fig 3: Roc curve for alpha angle in torn ACL group

ROC curve for predicted probability of the logistic regression equation analysis Area under the curve 0.915 (95% CI, 0.861-0.969, p<0.001).

Roc curve for intercondylar notch width in torn ACL group

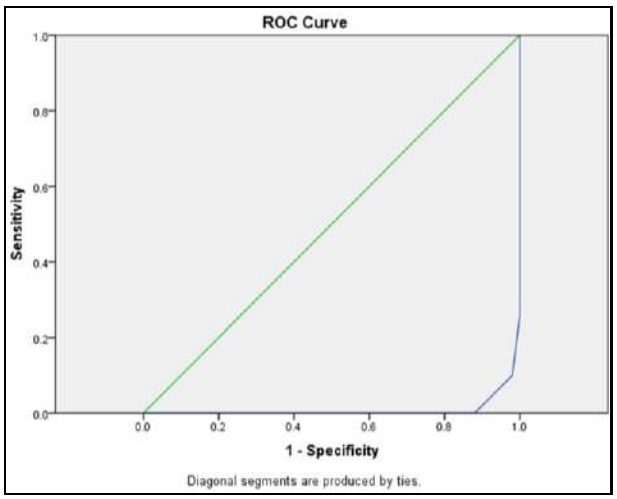

Fig 4: Roc curve for intercondylar notch width in torn ACL group

ROC curve for predicted probability of the logistic regression equation analysis Area under the curve 0.009 (95% CI, 0.00-0.20, p<0.001)

Discussion

The number of ACL tears is increasing because there is a greater number of people participating in sports. Consequently, identification of the factors associated with an increased risk of having an ACL tear is important [10].

Some studies have shown that morphology of the intercondylar notch is one of the parameters that predisposes athletes to an ACL tear [10, 11].

In present study, the alpha angle and intercondylar notch distance were significantly different between patients with or without ACL tear. In addition as has been published by many authors, the intercondylar notch width was narrowest in patients with pathological ACL tear [12-16].

Cha *et al*. [12] measured the intercondylar notch width, notch index, sagittal notch angle, and notch angle. They found that patients with mucoid ACL hypertrophy showed a narrower notch, a more pronounced notch angle, and a smaller notch area than controls, highlighting the importance of the intercondylar notch in the development of an ACL tear. They constructed a mathematical model that evaluated the role of the intercondylar notch in impingement of the ACL [12].

This fact was supported by the findings of Fu and Musahl [16] who postulated in 2013 that the impingement of the ACL against the intercondylar notch is a main factor for ACL tears.

Smith *et al*. [17] identified several other factors such as hormonal, genetic, cognitive function, previous injury, and extrinsic factors that are associated with an ACL tear.

Majority of the publications indicate that the risk for having a torn ACL is multifactorial. Understanding these factors and the complex interactions among them is important to clearly establish predisposition to ACL tears. There are many studies that evaluated different anthropometric measures, the index of the intercondylar notch [11, 18, 19, 20, 21, 22] and lateral condyle morphology [23, 24]

The goal of the present study was to identify patients who are predisposed to ACL tears using two morphological features, which can be measured with MRI [12, 21, 25].

The alpha angle and intercondylar notch width measurements may be useful in daily medical practice to evaluate the knee prior to ACL reconstruction.

Conflict of Interest

Not available

Financial Support

Not available

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