

# The relationship of the notch width index of the femur to the incidence of anterior cruciate ligament tears

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## Abstract

**Introduction:** It has been proposed that a narrow intercondylar notch may increase the risk of anterior cruciate ligament (ACL) injury but the data are conflicting. We performed this cross-sectional study to investigate the significance of Notch width index for ACL tears.

**Materials and Methods:** All adult patients with knee problems, who were referred to the Department of Orthopaedics Amrita Institute of Medical Sciences, Kochi and underwent MRI knee, from August 2016 to August 2018, were included in this study. Axial and longitudinal MRI was performed using 1.5 Tesla or 3 Tesla MRI with the patient's knee in an extended position. In all patients, the femoral notch Index was measured. Patient were divided into 2 groups depending on their NWI (<0.2 or >0.2) Because of the effect of osteoarthritis in decreasing the intercondylar notch index, cases with obvious osteoarthritis were not included in the study. To test the statistical significance of the difference in Femoral Notch Width Index with respect to gender Student's t test was used. To test the statistical significance of difference in percentage's with respect to ACL tear (yes or no) and Femoral Notch Width Index(<0.2 or >0.2) Chi-square test was used.

**Results:** 300 patients were enrolled in the study. The age range was 20-50 years. We found that group 1 (<0.2 NWI) has higher percentage of ACL tear as compared to group 2 (>0.2 NWI). We also found that male's have a higher NWI as compared to females (p value <0.001).

**Conclusion:** ACL tear was found to be higher among the patients with NWI < 0.2 as compared to patients with NWI >0.2 which is statistically significant.

**Keywords:** Anterior cruciate ligament, Sports injury, Intercondylar notch width index, Knee, Arthroscopy knee.

## Introduction

The anterior cruciate ligament (ACL), which is located in the intercondylar notch of the femur, is one of the major stabilizing intracapsular ligaments in the knee joint. ACL is proximally attached to the postero-medial surface of the lateral femoral condyle and distally to the anterior part of the intercondylar eminence of the tibia. Injuries to the knee joint are common in athletes and the ACL is the most frequently ruptured ligament of the knee.<sup>1</sup> Unfortunately, ACL injuries can be devastating.

Numerous reconstructive procedures have been devised to treat an ACL tear.<sup>2</sup> However, there is no ideal substitute for an athlete's normal ACL. Obviously, finding ways to predict the risk of ACL injury and preventing it is of paramount importance. It has been suggested that a narrow intercondylar notch may increase the risk of ACL injury.<sup>3</sup> To study the role of notch stenosis in ACL tears, use of notch width index (NWI)—the ratio of the width of the intercondylar notch to the width of the distal femur at the level of the popliteal groove—eliminates magnification variability and differences in patient body size and stature.<sup>4</sup> Some studies have mentioned that there is a relationship between femoral intercondylar notch stenosis and ACL tears<sup>5-8</sup> while others have not<sup>9-11</sup> If this relationship exists, it could be an important variable to identify athletes at risk for development of ACL tears. We performed this cross-sectional study to investigate if a narrow intercondylar notch width is a risk factor for development of ACL tears.

## Objectives

1. Primary objective: To Study the relationship between notch width index of the femur and the incidence of

anterior cruciate ligament tears in skeletally mature patients between age group of 20-50 years who presents with knee pain.

2. Secondary: To investigate possible risk factors for anterior cruciate ligament tear in skeletally mature patients of age group of 20 to 50 years who present with knee pain.

## Materials and Methods

### Selection and Description of Participants

The study included all adult patients who presented to the Orthopedics OPD with complaints of knee pain and history of trivial fall or sports injury between August 2016 and August 2018.

### Exclusion Criteria

1. Skeletally immature patients,
2. Patients with fractures around the knee
3. Patients with established Osteoarthritis of the Knee and
4. Patients above 50 years of age.

### Evaluation Methodology

These patients underwent MRI of the affected knee on the advice of the consultant orthopedic surgeon. Patients were evaluated by a Siemens 1.5 Tesla 3 Tesla MRI. Patient is placed in supine position with the knee in a closely coupled extremity coil. The knee is externally rotated 15–20 degrees (to facilitate visualization of the ACL completely on sagittal images). In all patients the distal femoral condylar width and the Notch Width were measured. The notch width was the length between the medial projection of the lateral femoral condyle to the lateral projection of the medial condyle. Both transcondylar width and notch width were measured on a line drawn through the popliteal groove,

which was parallel to a line drawn across the most distal aspect of both condyles. We used the maximal measures of transcondylar and notch widths on axial views of the knee MRI to calculate the ratio between them as NWI (Fig. 1). NWI less than 0.20 was considered as critical. All measurements were reviewed by both authors. Patients with NWI >0.2 were in group 1 and with <0.2 as group 2. Partial tears of ACL were diagnosed based on the presence of bulging, border irregularities or abnormal signals on T2W sequences of the knee MRI (Fig. 2).

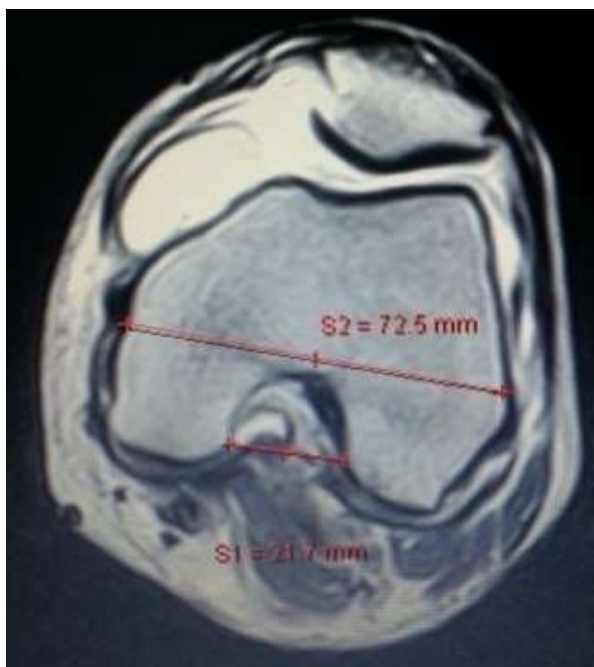


Fig. 1: Showing measurement of Notch width Index =S1/S2



Fig. 2: MRI image showing partial ACL rupture on sagittal plane

**Statistical Analysis**

It was performed using IBM SPSS version 20.0 software. Categorical variables are expressed using frequency and percentage. Numerical variables are presented using mean and standard deviation. To test the statistical significance of the difference in Femoral Notch Width Index with respect to gender Student’s t test was used. To test the statistical significance of difference in percentage’s with respect to ACL tear (yes or no) and Femoral Notch Width Index(<0.2 or >0.2) Chi-square test was used.

**Results**

A total of 300 patients were included in the study out of which 183 males and 117 females. Patients were assigned into two main groups based on the value of femoral notch width. Among the 300 patients, 183 patients (61%) had NWI more than 0.2 while 117 patients (39%) had NWI less than 0.2.

Notch width index was found to be higher among the male patients as compared to female patients and the result shows statistical significance (p value <0.001).

In our study the results suggested that there is a significant higher incidence of ACL Tear in patient with NWI <0.2 (29.06%) as compared to patients with NWI >0.2(19.67%). The mean values of NWI were found to be higher in males as compare to the females with mean values of 0.25379 and 0.20287 respectively. Their p values are statistically significant of < 0.001.

**Table 1: Describing the Association of Notch Width Index (NWI) with anterior cruciate ligament (ACL) tear**

NWI	ACL Tear		p value
	Yes	No	
<0.2(n=117)	35(29.9%)	82(70.1%)	0.042
>0.2(n=183)	36(19.7%)	147(80.3%)	

**Table: 2 Comparison of mean Notch width index (NWI) among gender**

Gender	n	Mean Femoral Notch Width	sd	p value
Male	183	0.253	0.062	<0.001
Female	117	0.202	0.081	

**Discussion**

Previous studies have shown an association between femoral notch stenosis and ACL tears. Based on these findings, recommendations such as performing a notch view radiography before participation in athletic activities and counseling athletes with stenotic intercondylar notches have been proposed.<sup>12</sup> Palmer et al were the first to suggest that a narrow intercondylar notch may increase the risk of ACL injury in 1938(3). This suggestion was supported by Souryal et al. who developed the concept of NWI as a way to predict the risk of ACL injury in 1998.<sup>4</sup> Using CT, Houseworth et al. concluded that a narrow posterior notch may predispose a person to ACL injury.<sup>13</sup> Anderson et al. reported that

anterior outlet notch stenosis increases the risk of ACL injury.<sup>14</sup> In a two year prospective study, La Prade and Burnett concluded that athletes with a stenotic notch were at significant risk of an ACL rupture.<sup>12</sup> The proposed relationship between the risk of ACL injury and a narrow intercondylar notch was based on the hypothesis that the size of the ACL correlates with the size of the intercondylar notch.<sup>5</sup> This hypothesis, however, has been challenged by new data. Muneta et al. found that ligament size was not different in knees with an NWI greater and less than 0.20.<sup>15</sup> Clinically, Herzog et al. found no significant differences between the notch measurements of athletes with chronic ACL tears and the control group with both radiograph and MRI measurements.<sup>9</sup> Similarly, Shickendantz and Weiker compared unilateral ACL injury, bilateral ACL injury, and non injured subjects and found no significant differences between the groups. They concluded that intercondylar notch measurements should not be used to predict the potential for injury to the ACL.<sup>10</sup> Lombardo et al. also did not find an association between NWI and the rate of ACL injury in professional male basketball players.<sup>11</sup> We studied 300 patients with knee problems. Considering the association between NWI and the rate of ACL injury, in group 1, 35 (29.9%) had ACL tear and in group 2, 36(19.7%) had ACL tear. A limitation in our study was that our subjects were not limited to athletes and the presence of other mechanisms of ACL injury, including direct trauma, may ameliorate the role of narrow NWI in ACL injury.

### Conclusion

The aim of the study was to compare the relationship between Notch Width Index of the femur and the incidence of anterior cruciate ligament tears in skeletally mature patients between the age group of 20–50 years who present with knee pain. For this purpose 300 patients who had presented to the department with complaints of knee pain were studied by undertaking MRI of the knee joint.

1. There was male to female predominance (Male: Female – 61:39) and these patients were in the age group of 20–50.
2. There is higher incidence of anterior cruciate ligament injury among individuals with lower values of Femoral Notch Width Index. Its mean value being 0.20287.
3. There is statistical significance in the variation of Notch Width Index among different gender, and that Males had a higher notch width compared to the females.

**Conflict of Interest:** None.

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