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Mean Intercondylar Notch Width Index in Cases With and Without Anterior Cruciate Ligament Tears

Background/Objective: 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 if a narrow intercondylar notch width is a risk factor for ACL tears.

Patients and Methods: All adult patients with knee problems, who were referred to the MRI department of Poursina Hospital, Rasht, Iran, from October 2006 to October 2007, were included in this study. Axial and longitudinal MRI were performed using a 1-T Phillips machine with the patient's knee in an extended position. In all patients, the femoral notch and the distal condylar width were measured. Cases with normal ACL were used as control and patients with a complete or incomplete tear of ACL were chosen as case group. Because of the effect of osteoarthritis in decreasing the intercondylar notch index, cases with obvious osteoarthritis were not included in the study. Independent sample *Student's t* test was used to compare the means.

Results: 328 patients were enrolled in the study. The age range was 18-72 years. We found no significant difference in the mean notch width index (NWI) in patients with (0.296) and without (0.298) an ACL tear ($P>0.05$). In addition, there was no significant difference in the frequency of ACL tears in patients with and without critical notch stenosis ($P>0.05$).

Conclusion: We did not find a relationship between narrow intercondylar notch width and ACL tears and we do not recommend a knee MRI to predict the probability of ACL injury.

Keywords: Anterior Cruciate Ligament, Intercondylar Notch, 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.¹ Unfortunately, ACL injuries can be devastating. Numerous reconstructive procedures have been devised to treat an ACL tear.² 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.³ 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.⁴ Some studies have mentioned that there is a relationship between femoral intercondylar notch stenosis and ACL tears,⁵⁻⁸ while others have not.⁹⁻¹¹ If this relationship exists, it could be an important variable to identify athletes at risk for development

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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.

Patients and Methods

From October 2006 to October 2007, all adult patients with knee problems (including pain in or around the knee, presence of an audible click and trauma) referred to the MRI department of Poursina Hospital, Rasht, Iran were enrolled in this study. Exclusion criteria were any connective tissue or systemic bone disease, history of knee fracture or knee operation.

Patients were evaluated by a 1-T Philips MR machine while their knees were extended and axial and sagittal images were taken. In all patients, the femoral notch and the distal condylar 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 normal ACLs were used as the control and patients with a complete or incomplete tear of

ACL were chosen as the case group. 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).

Data were analyzed by SPSS ver 11.01 (SPSS Inc, Chicago, IL, USA). The mean notch size, femoral bi-condylar width, and NWI between injured and non-injured patients were compared by independent sample *Student's t* test. The level of significance was set at 0.05.

Results

This study included 328 patients. The age range was 18–72 years. There were 146 patients less than 30 years of age; 100 were in the 31 to 40-years age group and 82 were older than 41 years (Table 1).

An ACL tear was found in 148 patients. The mean±SD NWI was 0.298±0.05 and critical notch stenosis (NWI of equal or less than 0.20) was found in 11 patients. Considering critical notch stenosis, no significant difference was found in different age groups ($P > 0.05$).

We found no significant difference in the mean NWI in patients with and without an ACL tear (Table 2). In addition, there was no significant difference in the frequency of an ACL tear in patients with and without critical notch stenosis ($P = 1.0$). Considering women and men separately, we found no significant difference in the mean NWI in patients with and without an ACL tear.

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.¹² Results of our study did not support such association.

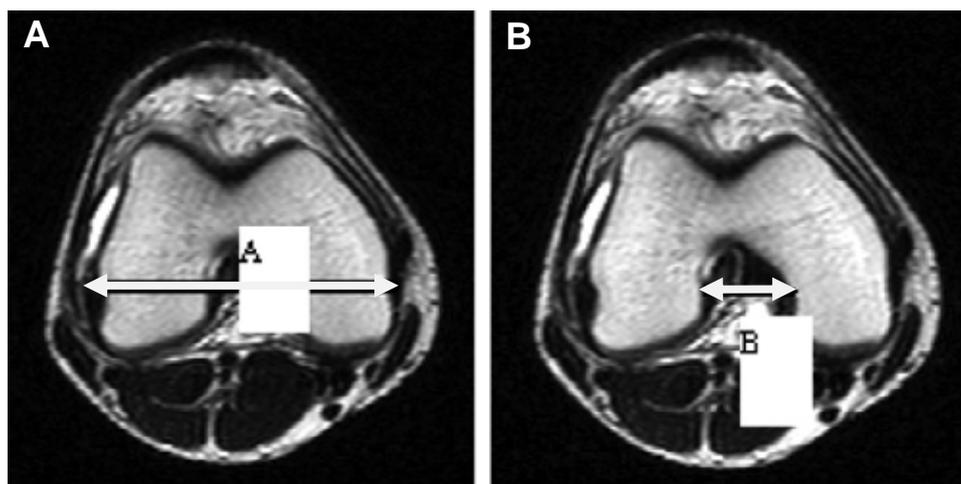
Palmer et al. were the first to suggest that a narrow intercondylar notch may increase the risk of ACL injury in 1938.³ This suggestion was supported by Souryal et al. who developed the concept of NWI as a way to predict the risk of ACL injury in 1998.⁴ Using CT, Houseworth et al. concluded that a narrow post-

Table 1. Age Distribution of Patients and its Relation to ACL Rupture

Age	Normal ACL		Ruptured ACL	
	n	%	n	%
< 30	54	37	92	63
30–40	71	71	29	29
> 41	55	67.1	27	32.9
Total	180	54.9	148	45.1

Table 2. Comparison of Mean NWI in Patients with Normal and Ruptured ACL

Anterior Cruciate Ligament	Notch Width Index			
	Mean	SD	t	P
Normal ACL (n=180)	0.298	0.06	0.16	0.873
Ruptured ACL (n=148)	0.296	0.05		



Figs. 1A & B. The method we used for measuring notch width index (NWI). Intercondylar notch index=B/A

erior notch may predispose a person to ACL injury;¹³ Anderson et al. reported that anterior outlet notch stenosis increases the risk of ACL injury.¹⁴ In a two-year prospective study, LaPrade and Burnett concluded that athletes with a stenotic notch were at significant risk of an ACL rupture.¹² 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.⁵

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 0.20.¹⁵ 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.⁹ 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.¹⁰ Lombardo et al. also did not find an association between NWI and the rate of ACL injury in professional male basketball players.¹¹

We studied 328 patients with knee problems. Considering the association between NWI and the rate of ACL injury, we did not find any significant differences in the mean NWI or the prevalence of critical notch stenosis in patients with and without an ACL tear, in all patients and in male and female patients, separately. Our results, however, must be interpreted

with caution. That was a cross-sectional study and results of a prospective study would be more reliable. We studied subjects with knee problems, which may cause a selection bias. Since there is no report indicating a relationship between NWI and other knee problems except osteoarthritis, we believe that these factors are not critical. Another 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.

In conclusion, we did not find a relationship between a narrow intercondylar notch width and an ACL tear and therefore, we cannot recommend performing a knee MRI to predict the probability of an ACL injury.

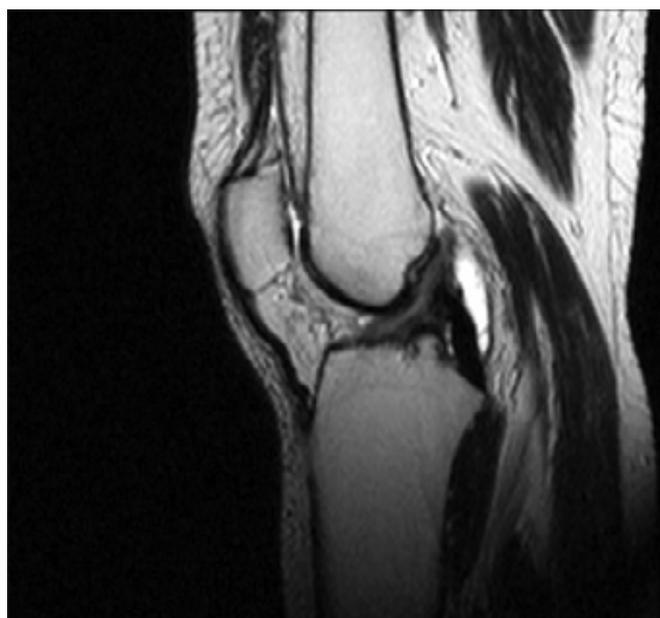


Fig. 2. Sagittal T2-weighted MRI demonstrating ACL tear

Conflict of interests

The authors declare that they have no competing interests.

References

1. Johnson RJ. The anterior cruciate ligament problem. *Clin Orthop Relat Res* 1983 Jan-Feb;(172):14-8.
2. Burnett QM 2nd, Fowler PJ. Reconstruction of the anterior cruciate ligament: historical overview. *Orthop Clin North Am* 1985 Jan;16(1):143-57.
3. Palmer I. On the injuries to the ligaments of the knee joint: a clinical study. 1938. *Clin Orthop Relat Res* 2007 Jan;454:17-22.
4. Souryal TO, Moore HA, Evans JP. Bilaterality in anterior cruciate ligament injuries: associated intercondylar notch stenosis. *Am J Sports Med* 1988 Sep-Oct;16(5):449-54.
5. Davis TJ, Shelbourne KD, Klootwyk TE. Correlation of the intercondylar notch width of the femur to the width of the anterior and posterior cruciate ligaments. *Knee Surg Sports Traumatol Arthrosc* 1999;7(4):209-14.
6. Good L, Odensten M, Gillquist J. Intercondylar notch measurements with special reference to anterior cruciate ligament surgery. *Clin Orthop Relat Res* 1991 Feb;(263):185-9.
7. Lund-Hanssen H, Gannon J, Engebretsen L, Holen KJ, Anda S, Vatten L. Intercondylar notch width and the risk for anterior cruciate ligament rupture. A case-control study in 46 female handball players. *Acta Orthop Scand* 1994 Oct;65(5):529-32.
8. Souryal TO, Freeman TR. Intercondylar notch size and anterior cruciate ligament injuries in athletes. A prospective study. *Am J Sports Med* 1993 Jul-Aug;21(4):535-9.
9. Herzog RJ, Silliman JF, Hutton K, Rodkey WG, Steadman JR. Measurements of the intercondylar notch by plain film radiography and magnetic resonance imaging. *Am J Sports Med* 1994 Mar-Apr;22(2):204-10.
10. Schickendantz MS, Weiker GG. The predictive value of radiographs in the evaluation of unilateral and bilateral anterior cruciate ligament injuries. *Am J Sports Med* 1993 Jan-Feb;21(1):110-3.
11. Lombardo S, Sethi PM, Starkey C. Intercondylar notch stenosis is not a risk factor for anterior cruciate ligament tears in professional male basketball players: an 11-year prospective study. *Am J Sports Med* 2005 Jan;33(1):29-34.
12. LaPrade RF, Burnett QM 2nd. Femoral intercondylar notch stenosis and correlation to anterior cruciate ligament injuries. A prospective study. *Am J Sports Med* 1994 Mar-Apr;22(2):198-202.
13. Houseworth SW, Mauro VJ, Mellon BA, Kieffer DA. The intercondylar notch in acute tears of the anterior cruciate ligament: a computer graphics study. *Am J Sports Med* 1987 May-Jun;15(3):221-4.
14. Anderson AF, Lipscomb AB, Liudahl KJ, Addlestone RB. Analysis of the intercondylar notch by computed tomography. *Am J Sports Med* 1987 Nov-Dec;15(6):547-52.
15. Muneta T, Takakuda K, Yamamoto H. Intercondylar notch width and its relation to the configuration and cross-sectional area of the anterior cruciate ligament. A cadaveric knee study. *Am J Sports Med* 1997 Jan-Feb;25(1):69-72.