

Inter Condylar Notch Width Index among Anterior Cruciate Ligament Injury Patients

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ABSTRACT

Introduction: The anterior cruciate ligament (ACL) is one of the major stabilizers of the knee joint and is commonly injured. It has been shown that narrow notch houses thinner ACL, and has high chance of ACL- notch impingement during knee movement. Several other studies show that smaller notch width index (NWI) is associated with the risk of ACL rupture in the skeletally immature population.

Objective: This study was done to evaluate the association of intercondylar notch index with ACL injury.

Methods: A cross sectional comparative study was conducted in Department of Orthopedics, National Trauma Center, Nepal in 42 patients above 18 years of age with clinical suspicion of ACL injury. Based on the magnetic resonance imaging, patients with knee injuries were classified into ACL injury and Non- ACL injury group which was considered as controls. Case and controls were then compared based on notch width index.

Results: Age of the patients ranged from 19 to 54 years with the mean age of 34.02 ± 7.83 years. The mean NWI was 0.241 ± 0.013 which was less than the NWI of 0.259 ± 0.014 in the control and it was statistically significant with the p-value of < 0.001 .

Conclusion: Low notch width index (NWI) was found in ACL injury group compared to non-ACL injury group and it was statistically significant.

Keyword: Anterior cruciate injury; notch width index; magnetic resonance imaging; orthopedics.

INTRODUCTION

The anterior cruciate ligament (ACL) is one of the major stabilizers of the knee joint.¹ Various intrinsic and extrinsic factors are associated with ACL injury.²

skeletally immature population.³ An intricate relationship exists between the ACL and the intercondylar notch, and stenosis should be documented and corrected at the time of surgery.

The ratio of notch width at $2/3^{\text{rd}}$ height and maximum condyle width should be < 0.2 and the angle of notch opening should be more than 50° .

⁴ A stenotic posterior intercondylar notch found to be associated with ACL tears.⁵

Intercondylar notch width varies according to sex, height, age and ethnicity.⁶ Nepalese are smaller in physique than western population, so

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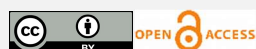
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Smaller NWI, as measured by MRI, is associated with the risk of ACL rupture in the



they may have narrow notch, thus increasing the risk of ACL injury.⁷ The notch width index (NWI) among Nepalese population has been reported to be 0.28 ± 0.06 which differs from western population. NWI is the ratio of the width of the intercondylar notch to the width of the distal femur at the level of the popliteal groove on a tunnel view radiograph.¹¹ This study aimed to identify the association between intercondylar notch width index and anterior cruciate ligament injury in Nepalese population.

METHODS

A quantitative, cross-sectional analytical, comparative study was conducted in the emergency and outpatient department of Orthopedics at National Trauma center, Kathmandu, Nepal from November 2021 to July 2022. Sample size was calculated using the formula for estimating difference between two means as shown below.⁸

$$N = 2(Z_{\alpha} + Z_{\beta})^2 S^2 / d^2$$

Where,

N = sample size required

Z_{α} = z deviate corresponding to the α error rate which is 1.96 for $\alpha = 5\%$

Z_{β} = z deviate corresponding to the β error rate which is $Z_{\beta} = 1.28$ at 80% power

S = standard deviation is 0.03 from a study conducted by Ouyang et al.

d = difference to be detected = mean difference between two groups which is $0.2 - 0.18 = 0.03$ from a study conducted by Ouyang et al.⁹

$$N = \frac{2(1.96 + 1.28)^2 \times 0.03^2}{(0.03)^2}$$

$$(0.03)^2$$

= 21 in each group

A total of 42 patients were included by purposive sampling method among which 21 patients with ACL injury were included as cases and the age and sex matched 21 patients with knee injuries without ACL injury were included as controls after obtaining written informed consent.

Patients with previous multi ligamentous injury to the knee patients with previous knee surgery, patients with knee deformity, femoral or tibial fractures, patients below 18 years of age and patients who did not consent to the study were excluded. MRI was conducted by 1.5 Tesla Philips Achieva and the measurements were made using Intelliselle Portal software. The femoral notch width index was calculated by dividing the femoral notch width (NW) by the transcondylar or intercondylar width (ICW).¹⁰ The NW was measured as the length between the medial projection of the lateral condyle and the lateral projection of the medial condyle of the femur. The intercondylar width (ICW) was determined by measuring the line passing through the groove and running parallel to the line drawn between the condylar ends, across the most distal aspect of the femur as shown in Figure 1. NWI was calculated by dividing the Notch width at the level of popliteal groove with bi-condylar width at the same level. Statistical analysis was done using SPSS version 16. Comparisons between means were made using

the T test, with p-value less than 0.05 deemed significant.

Ethical clearance was taken from the Institutional Review Board of National Academy of Medical Sciences Ref. No. 979/2078/79.

RESULTS

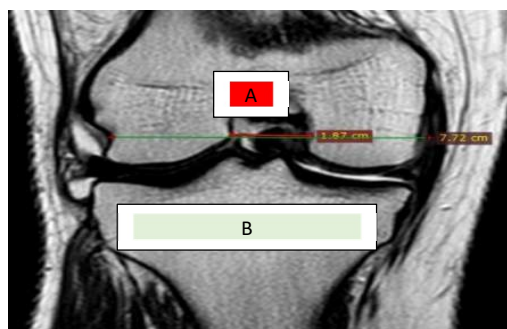


Figure 1: Measurement of Notch width (A) and Intercondylar width (B) for Notch Width Index.

The mean NWI among the cases was 0.241 ± 0.013 which was less than the NWI of 0.259 ± 0.014 in the control and it was statistically significant with the p-value of <0.05 . The gender specific mean NWI was also statistically significant among both ACL injury and non-ACL injury groups. The females had a smaller NWI in both ACL injury and non-ACL injury groups as shown in table 2.

Out of the total 42 patients, majority were males (59.5%). Male patients were more in both cases and controls as shown in table 1. Age of the patients ranged from 19 to 54 years with the mean age of 34.02 ± 7.83 years.

Table 1: Distribution of patients in accordance to gender.

Gender	Non-ACL injury	ACL injury	Total
Male	13 (61.9%)	12 (57.1%)	25 (59.5%)
Female	8 (38.1%)	9 (42.7%)	17 (40.5%)
Total	21 (100%)	21 (100%)	

Table 2: Notch Width Index in case and control according to gender.

Group	Number	NWI±SD	p-value
Non-ACL injury	21 (50%)	0.259±0.014	<0.001*
ACL injury	21 (50%)	0.241±0.013	
Males			
Non-ACL injury	13 (52%)	0.262±0.014	<0.001*
ACL injury	12 (48%)	0.242±0.013	
Females			
Non-ACL injury	8 (47.1%)	0.254±0.013	0.025*
ACL injury	9 (52.9%)	0.239±0.014	

*p-value < 0.05

The mean NWI according to age groups was significant for age groups 21-30 years and 31-40 years as shown in table 3. These groups also had the highest number of patients 11 and 14 respectively.

Table 3: Notch Width Index in case and control according to age groups.

Group	Number	NWI	p-value
<20 years			
Non-ACL injury	1 (2.3)	0.241	0.102
ACL injury	2 (4.7%)	0.232	
21-30 years			
Non-ACL injury	5 (11.9%)	0.258	0.006*
ACL injury	6 (14.3%)	0.234	
31-40 years			
Non-ACL injury	8 (19%)	0.261	0.002*
ACL injury	6 (14.3%)	0.243	
41-50 years			
Non-ACL injury	5 (11.9%)	0.257	0.102
ACL injury	4 (9.5%)	0.247	
>50years			
Non-ACL injury	2 (4.7%)	0.266	0.289
ACL injury	3 (7.1%)	0.247	

*p-value< 0.05

DISCUSSION

In this study the cases had a smaller mean NWI than controls. Females had lower NWI than males. There was a significant difference in mean NWI among cases and controls in this study. The gender specific NWI difference was also significant. The age groups 21 to 30 years and 31 to 40 years also had a significant NWI difference. Lower NWI may cause increased mechanical stress on the ligament which suggests narrow NWI is a risk factor for ACL

injury.¹² Understanding the risk factors of ACL injury may help take preventive measure to avoid injury in future.

Griffin et al noted that ACL-injured knees typically have smaller notch widths than non-injured knees, linking notch morphology to injury risk.¹³ Our study also found similar association with smaller notch associated with ACL injury. Anterior cruciate injury is common injury Intercondylar notch index is one of the intrinsic causes for ACL injuries.⁸

Butler et al found significant differences in intercondylar notch angles and widths in patients undergoing ACL surgery, stressing the need for correction of stenosis.¹⁴ Shen et al. similarly found smaller notch width indexes and specific angles significantly associated with ACL injuries, suggesting there are anatomical factors for risk of ACL injury.¹⁵

A case-control study in Nepal by Basukala et al also revealed that 40.67% of ACL-injured knees had a narrow notch width index (NWI < 0.27), compared to 22% in the non-injured group, with this difference being statistically significant ($p = 0.029$). The findings of the NWI was similar to this study.⁶

Contrary to this study a study conducted by Lombardo et al among basketball players reported the NWI was lower among cases 0.235 ± 0.031 than controls 0.242 ± 0.04 , however the differences were not statistically significant.¹⁶

Similar to this study Gupta et al. in 2021 also observed that females had a smaller mean notch width than males in both cases (21.1 ± 2 vs 16.9 ± 2.4) and controls (22.5 ± 2.3 vs 20.3 ± 2.7). The gender specific mean differences were

significant for both males and females in similarity to this study.¹²

However, there are a few limitations in this study. Other factors like intercondylar notch angle, posterior tibial slope and notch shape should have been taken into consideration along NWI as these indexes would help provide a better understanding. This is a case-control study which cannot determine the cause and effect. Randomization was not done cases and controls were matched according to sex and age which could have caused selection bias. The authors suggest further multi-centric study in the future as this would provide further confirmation of the findings.

CONCLUSION

A narrow notch width index (NWI) was found in ACL injury group compared to non-ACL injury group. The NWI differences were statistically significant in both males and females. Age groups 21-30 years and 31-40 years also had a statistically significant NWI differences. Narrow NWI is a risk factor for ACL injury.

Conflict of Interest: None.

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