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Correlation of notch width index in knees with mucoid degeneration of anterior cruciate ligament to normal knees

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Abstract

Background: Notch width index (NWI) is a most widely used two dimensional measurement of Intercondylar notch volume of the knee. ACL with mucoid degeneration if often underdiagnosed or overlooked cause of nonspecific knee pain and mild restriction of knee movements. ACL in this condition appears bulky and characteristically shows mucinous material along its fibers. We aim to find any correlation of Notch width index in knees with mucoid degeneration of ACL to knees of age matched controls.

Methods: In this study, 32 patients diagnosed with Mucoid degeneration of ACL based on Magnetic Resonance studies were included. Notch width Index i, e width of the intercondylar notch divided by intercondylar width at 2/3 notch depth was measured on a coronal section on MRI. This data was compared with age matched controls using Pearson's correlation Co efficient.

Results: 22 patients in study group were females and 10 were males with age ranging from 25-73 years (Median age 45.5 years) The NWI in Mucoid degeneration of ACL when compared to normal knees showed a significant decrease (NWI -0.222 ± 0.03 Mean in Mucoid ACL group; NWI 0.311 ± 0.03 in controls) in Intercondylar notch width viz Notch stenosis. Female patients compared to male had decreased NWI with 0.222 Mean.

Conclusions: Mucoid degeneration of ACL leading to bulky ACL causing stenosis of the notch is evident in this study. However larger sampling size and volumetric analysis by other methods are needed to better manage this poorly understood condition.

Keywords: anterior cruciate ligament (ACL), notch width index (NWI), magnetic resonance imaging (MRI)

Introduction

Mucoid degeneration of ACL is an entity which is poorly understood, rare, often underdiagnosed and debilitating to the patient with no universally accepted theory of origin^[1, 2]. Most patients affected are mid aged adults and clinical presentation ranges from posterior knee pain, pain on deep flexion of knee and limited range of motion^[3]. Patients usually have no obvious trauma history or clinical instability of the knee^[4].

After Kumar *et al* described this entity for the first time in 1999⁵ many authors have suggested various modes of management^[6-8]. In his MRI study of 4221 knees Bergins *et al* revealed a prevalence of Mucoid degeneration of ACL in 1.8% to 5.3% and some cases were asymptomatic^[9]. His study also differentiated between a spectrums of afflictions of ACL namely mucoid hypertrophy, degeneration or infiltrating ACL pseudocysts, from purely cystic lesions^[9]. Although Mucoid Degeneration of ACL is regarded as rare, under diagnosis or misdiagnosis or reported as ACL tear is possible^[6, 8, 10-13].

The relationship between the function of the anterior cruciate ligament and the width of femoral intercondylar notch has long been recognized^[14]. Notch width index (NWI) is a most widely used two dimensional measurement of Intercondylar notch volume of the knee. Described by Souryal and Freeman in 1988 NWI is defined as the width of the intercondylar notch at the level of the popliteal groove divided by the bicondylar width at the same level^[15]. Hypothesising stenosis of intercondylar notch in cases of Mucoid degeneration of ACL, In this study we aim to find any correlation of NWI in knees with Mucoid degeneration of ACL to knees of age and sex matched controls.

Methods

In this prospective study, 32 patients presenting to outpatient department and diagnosed with Mucoïd degeneration of ACL based on Magnetic Resonance studies (MRI) during 2019 to 2021 were included. Mucoïd ACL knees constituted case group and corresponding age and sex matched normal knee MRIs constituted control group.

After initial assessment of history and clinical examination patients with clinical suspicion of mucoïd degeneration underwent MRI (1.5 tesla, Siemens) of the knee. All the patients had knee pain and no trauma history or instability. After consent for study was obtained 32 patients reported as mucoïd degeneration were grouped as case group out of which 21 were females and 11 were males.

Age and sex matched individuals with normal ACL morphology on MRI were chosen as controls. Patients with history of trauma or any previous knee surgery, previously known cases of Osteoarthritis, connective tissue disorder and patients with systemic bone disorders were excluded. Notch width Index i, e Width of the Intercondylar notch divided by Intercondylar width at 2/3 notch depth was measured on MRI. Although multiple views of Radiographic imaging the intercondylar notch have been proposed such as Holmblad 45 degree, Holmblad 70 degree, and Rosenberg views [17, 18] the Holmblad 70° view is accurate as per study by Anderson *et al* [19]. However in our study we chose to evaluate Intercondylar Notch in MR Imaging. MRI was done in supine position with their knees extended. After obtaining Axial, coronal and sagittal images the anatomic landmarks of notch boundaries were defined.

On axial Sections Notch width was measured by the following method. The notch width was the length between the medial projection of the lateral femoral condyle and the lateral projection of the medial condyle. (Figure) 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 [16, 20]. All images were analyzed and the required measurements were obtained by the second author.

Results

The data was analysed using PASW - SPSS software. Average NWI of this study was 0.22 which was comparable to 0.23 in study by Souryal *et al.* [15], 0.28 in study by Chandrashekar *et al.* [21] and 0.26 as in study done by Anderson *et al.* [19]. Sample age and sex may be the reason for the difference between studies.

Demographic data as displayed in Table 1 are males were 10 (mean age 50.8±15.85 years) and female 22 (mean age 46.95±10.20 years) of 32 from the mucoïd degeneration group. The NWI measured in the study group ranged from 0.18 to 0.27 and displaying a mean of 0.222±0.03 whereas NWI in control group ranged from 0.25 to 0.38 with mean of 0.311±0.03.

Paired t-test was applied to compare for difference of mean notch width index of experimental and control groups and results are shown in Table 2. The mean difference between Mucoïd and control group was 0.088 and was statistically significant (<0.001.)

As shown in Table 3, Pearson correlation coefficient was calculated to determine the correlation between the NWI measured between Mucoïd index group and age and sex matched controls. There was a positive correlation observed between notch width index of experimental and control groups (r = 0.672, p-value <0.001).

Table 1: Shows in males were 10 (mean age 50.8±15.85 years) and female 22 (mean age 46.95±10.20 years) of 32 from the mucoïd degeneration group.

	N	Mean	Std. Deviation	Minimum	Maximum
Female	22	46.95	10.20	25	70
Male	10	50.80	15.85	32	83
Total	32	48.16	12.11	25	83

There were totally 32 cases in each control and experimental groups. Of them 22 were females and 10 were males. The mean age of females was 46.95 ± 10.20 and males was 50.80 ± 15.85.

Table 2: Shows in the mean difference between Mucoïd and control group was 0.088 and was statistically significant (<0.001.)

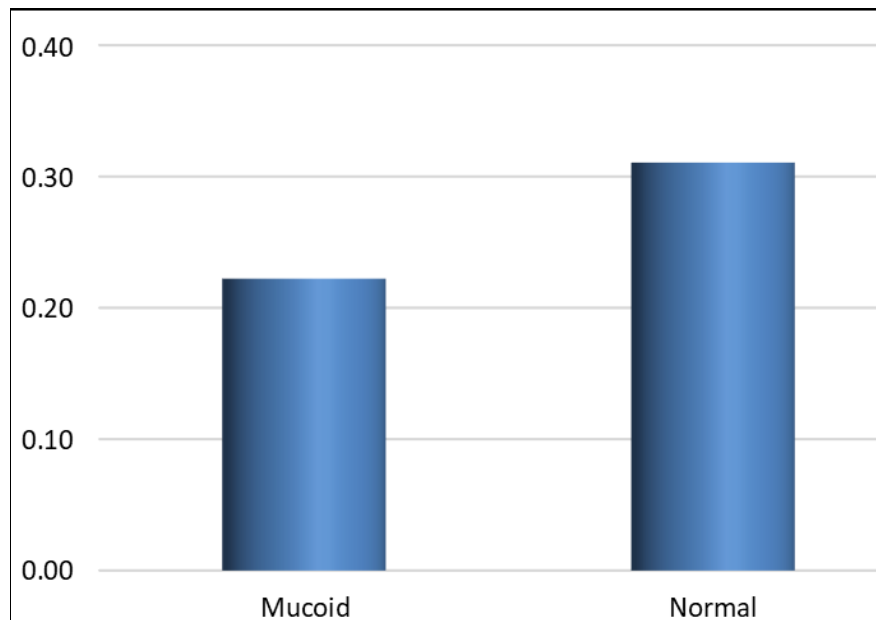
Parameters	N	Mean	Std. Deviation	Mean Difference	t-value	P-Value
Notch, Width, Index, Muc	32	0.222	0.03	0.088	-20.196	<0.001
Notch, Width, Index, Norm	32	0.311	0.03			

The mean notch width index in experimental group and control group was 0.222 ± 0.03 and 0.311 ± 0.03 respectively

with a mean difference of 0.088. The difference was highly statistically significance with P-value <0.001.

Table 3: Pearson correlation coefficient was calculated to determine

Pearson's Correlation	Notch, Width, Index, Norm	
Notch, Width, Index, Muc	N	32
	r	0.672
	P-value	<0.001



Graph 1: There was a positive correlation observed between notch width index of experimental and control groups ($r = 0.672$, p -value < 0.001).

Dis-criptive statistics like mean and standard deviation was computed for age of males and females. Paired t-test was applied to compare for difference of mean notch width index of experimental and control groups. Pearson's correlation coefficient applied to compute the amount of correlation in notch width index between the groups.

Discussion

Relation between ACL injuries with inter condylar notch has been well recognised. Our aim was to find out correlation between Mucoïd degeneration of ACL and notch width using Notch width Index. We found a statistically significant (P -value < 0.001) difference in NWI of case and control group. And Pearson's Correlation co efficient test showed Positive Correlation of NWI between Mucoïd group and control group implying Notch stenosis is present in knees with Mucoïd degeneration of ACL. According to Murshed KA *et al.* [23],

Males had higher notch volumes than female population in our study.

Female patients in the study group had a decreased NWI 0.222 Mean compared to male patients with NWI 0.272, whereas in control group females had NWI 0.310 and males had NWI of 0.311 a negligible high.

Notch width index in our study showed very minimal increase in males compared to females whereas a study by Carola F. van Eck *et al.* [22] found a increase in notch volume in males than females. However their study was based on radiological assessment of notch volume (X-ray / CT based Holmblad 45° view, 70° view and Rosenberg notch views) and our study is based on MRI.

Limitation of our study include low sample size and volumetric analysis of the notch based on 3D rendering in MRI maybe better compared to 2 dimensional assessment of the notch.

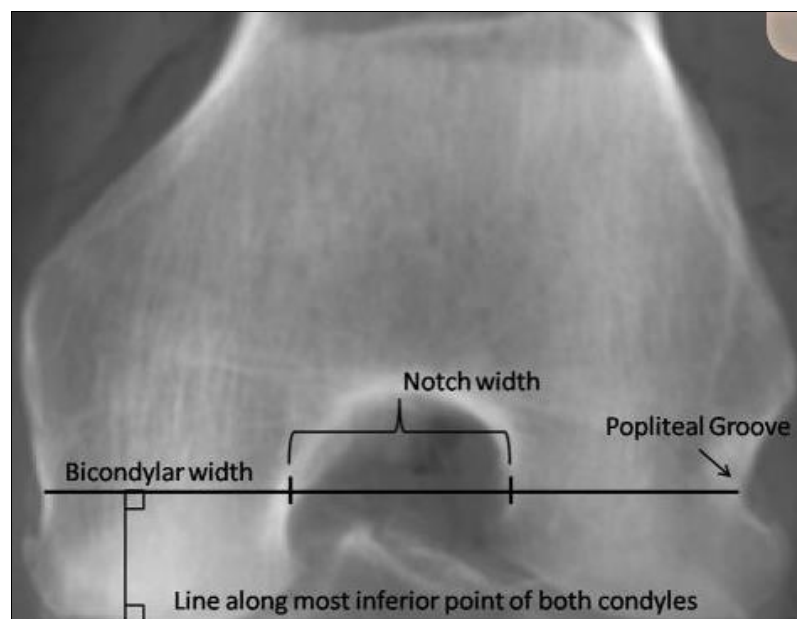


Fig 1: Measuring the Notch width and Intercondylar width (Picture courtesy - Carola F. van Eck *et al.* [22], Journal of knee surgery Sports medicine)



Fig 2: Measuring Notch width Index on MRI (Coronal section)

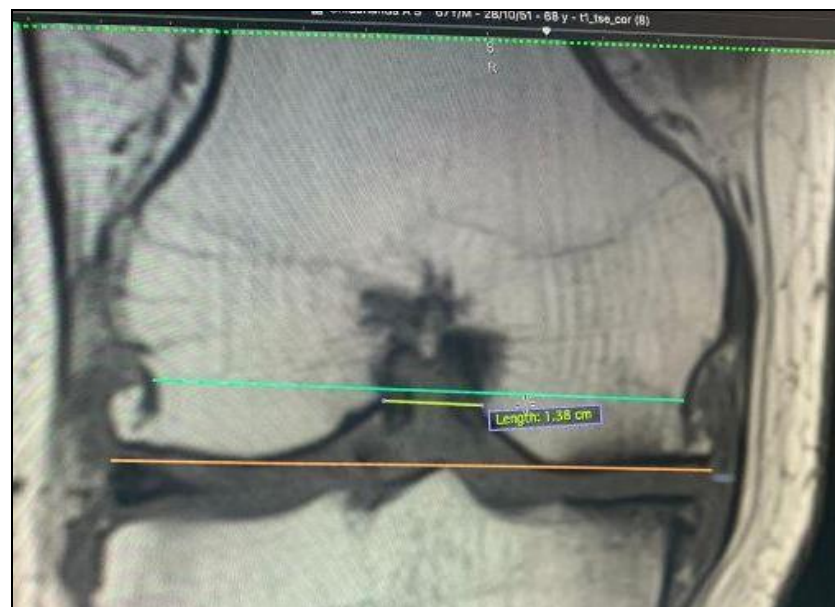


Fig 3: Measuring Notch width Index on MRI (Coronal section)

Conclusion

Mucoid degeneration of ACL leading to bulky ACL caused by stenosis of the notch is evident in this study. Males had a negligible increased notch width index compared to females across both case and control groups. We conclude Decreased Notch width index might be one of the cause for Mucoid Degeneration of ACL.

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