

Posterior Femoral Condyle Offset; a Novel Anatomical Risk Factor for Anterior Cruciate Ligament Injury

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Abstract

Anterior cruciate ligament injuries are serious conditions which can affect human life, that is the reason numerous investigations have been led to discover peril factors whether modifiable or unmodifiable to stamp out individuals in danger. Thus, the reason for our investigation is to see if expanded back femoral condyle profundity evaluated as back condyle counterbalance and proportion is a danger factor that may influence rate of ACL wounds. The diagrams of 100 successive patients who went through arthroscopic foremost cruciate tendon medical procedure performed by muscular specialists at Banha college emergency clinic and al Haram emergency clinic from 2017 to 2019 were reflectively looked into. Another 100 patients who were not griping of any knee wounds or shakiness were screened as control group. After patients were screened for qualification, they were partitioned into 2 gatherings: 1. A benchmark group comprising of patients with no neurotic association of the ACL. 2. Patients with ACL injury. Control bunch was coordinated to the investigation bunch by age, sex, stature, weight, and BMI. A patient couldn't be associated with the two gatherings. Applicants were incorporated just in the event that they had excellent standard radiographs, incorporating a horizontal view with <6 mm of cover between the back equal parts of the average and sidelong condyles. Back condyle counterbalance was estimated and recorded and looked at between the two gatherings. Back femoral condyle counterbalance cutoff estimation of >67.8 was related with expanded ACL injury with 76% affectability and 74% particularity. In this way, an expanded back femoral condyle proportion of the distal portion of the femur was essentially connected with expanded pervasiveness of ACL wounds. This investigation found that expanded femoral condyle profundities evaluated as (back femoral condyle counterbalance and back femoral condyle proportion) is related with expanded commonness of ACL wounds.

Keywords: Posterior condyle offset, ACL injury, Anterior cruciate ligament, Risk factors.

1. Introduction

Injuries to the front cruciate tendon (ACL) can effectsly affect personal satisfaction and are expanding in commonness among dynamic individuals [1, 2]. That is the reason, numerous investigates have been committed to the ID of peril factors for ACL injury attempting to create screening estimates that may stamp vulnerable people [3].

different danger factors have been affirmed, including sex, weight record (BMI), dynamic knee valgus [4], helpless hip muscles [5], neuromuscular elements [6], hormonal segments [7,8,9,10], unusual joint Laxity [11,12], unevenness in quadriceps-hamstring proportion [13], and past contralateral or ipsilateral ACL wounds [4,14,15,16].

Furthermore, various hard morphologic variables have been connected to expanded danger of ACL injury. A shallower average tibial profundity [17] and an expanded horizontal tibial level slant [17, 18, 19] have been accounted for to incline patients to ACL wounds, and an expanded back tibial slant was found to foresee high-grade rotatory knee laxity [20] and ACL injury hazard. Distal femoral morphology, as a low indent width, and score width list [21], have additionally been appeared to have be related with ACL wounds and contralateral ACL tears [22].

These discoveries feature the significance of femoral and tibial hard qualities as they identify with knee biomechanics and risk of ACL injury. In any case, back femoral condylar balance recently concentrated as it influences developments and different parts of knee joint mechanics [23], it is contended whether this factor may influence rate of ACL crack.

Thusly, the reason for this examination was to decide if expanded back femoral condylar profundity, measured as the back femoral condyle proportion, is a danger factor for ACL injury. It was guessed that an expanded back femoral condyle proportion would relate with an expanded danger of ACL injuries.

2. Materials and methods

Following faculty review board approval, the charts of 100 consecutive patients who underwent arthroscopic anterior cruciate ligament surgery performed by orthopaedic surgeons at Banha university hospital and Al Haram hospital from 2017 to 2019 were retrospectively reviewed. Another 100 patients who were not complaining of any knee injuries or instability were screened as control group.

After patients were screened for eligibility, they were divided into 2 groups:

1. A control group consisting of patients with no pathological involvement of the ACL.
2. Patients with ACL injury.

The control group was matched to the study group by age, sex, height, weight, and BMI. A patient could not be affiliated with both groups.

Magnetic resonance images (MRIs) were reviewed by orthopaedic surgeons and by a musculoskeletal radiologist to determine concomitant injuries, including injuries to the medial and lateral collateral ligaments, posterior cruciate ligament, medial patellofemoral ligament, medial and lateral menisci, capsule, and articular cartilage.

Patients were carefully examined and tested for ACL injury and joint stability. candidates were included only if

they had high-quality standard radiographs, including a lateral view with <6 mm of overlap between the posterior halves of the medial and lateral condyles. A maximum overlap of 6 mm was chosen on the basis of a pilot interobserver reliability analysis that was performed to determine the upper limits of acceptable rotation of radiographs Fig (1).

Radiographic measurements for the two study groups were performed by a single blinded author with use of standard lateral knee radiographs.

Detailed steps to measure posterior femoral condyle offset

- To determine the long axis of the distal part of the femur, 2 circles separated by 5 cm were centered on the femoral shaft. The more distal circle was placed at the most proximal aspect of the trochlea.
- A line passing through the center of both circles was considered the long axis of the distal femoral shaft (line 1).
- The axis of the femoral condyle was then determined by drawing a line between the most posterior point and most anterior point of the lateral condyle (line 2).
- The distance from the intersection of these lines to the posteriormost point of the condyle (A) was divided by the total anteroposterior length of the condyle (AB) Fig (2).
- The posterior condyle offset was calculated as A/AB which was multiplied by 100%. This ratio was defined as the posterior femoral condyle offset ratio A/AB %.

Inclusion criteria

- Patients with isolated ACL injury
- Age group between 15 to 50 years old
- Negative or mild knee osteoarthritis
- isolated contralateral ACL injury

Exclusion criteria

- Poor quality or malrotated X-rays
- Multiligamentous injury
- Previous distal femur fractures
- Patients younger than 15 years old or older than 50
- Patients with moderate to severe knee arthritis
- Previous distal femur osteotomies
- Patients with discoid meniscus
- Femoral dysplasia
- Very obese patients

Data Management and Analysis

The collected data was revised, coded, tabulated and introduced to a PC using Statistical package for Social Science (SPSS 25). Data was presented and suitable analysis was done according to the type of data obtained for each parameter.

i. Descriptive statistics

1. Mean and Standard deviation (\pm SD) for parametric numerical data, while Median and Interquartile range (IQR) for non-parametric numerical data.
2. Frequency and percentage of non-numerical data.

ii. Analytical statistics

1. Student T Test was used to assess the statistical significance of the difference between two study group means.
2. Mann Whitney Test (U test) was used to assess the statistical significance of the difference of a non-parametric variable between two study groups.
3. Chi-Square test was used to examine the relationship between two qualitative variables
4. The ROC Curve (Receiver Operating Characteristic) provides a useful way to evaluate the Sensitivity and specificity for quantitative Diagnostic measures that categorize cases into one of two groups.

iii. P- value: level of significance

- $P > 0.05$: Non significant (NS).
- $P < 0.05$: Significant (S).
- $P < 0.01$: Highly significant (HS).

3. Results

A total of 200 patients with a minimum of 6 months of follow-up met the inclusion criteria and were included in the final analysis. These patients were stratified into 2 groups:

- 100 patients in the control group.
- 100 patients in the ACL injury group.

Descriptive analysis

Personal data was collected and recorded as well as measurements from plain x-rays Table (1, 2).

Univariate analysis demonstrated a significant difference in Age (p-value 0.003) and height (p-value 0.033) between the control group and the ACL injury group. There were insignificant differences in sex (P-value 0.141), weight (P-value 0.24) or BMI (P-value 0.61) between any of the groups Table (3).

In the entire cohort, there was a significant difference in the posterior femoral condyle measurements (A distance) and total lateral condyle measurements (AB distance) between both groups (P-value < 0.001). As well as, posterior femoral condyle offset and ratio (PCO, PCOR) showed significant differences between control and ACL injury group Table (4).

The ROC Curve (Receiver Operating Characteristic) (fig 3) revealed that Posterior femoral condyle offset cutoff value of >67.8 was associated with increased ACL injury with 76% sensitivity and 74% specificity.

Thus, an increased lateral femoral condyle ratio of the distal part of the femur was significantly associated with increased prevalence of ACL injuries. ACL injury group had significantly higher posterior femoral condyle ratios compared with the control group Table (5).

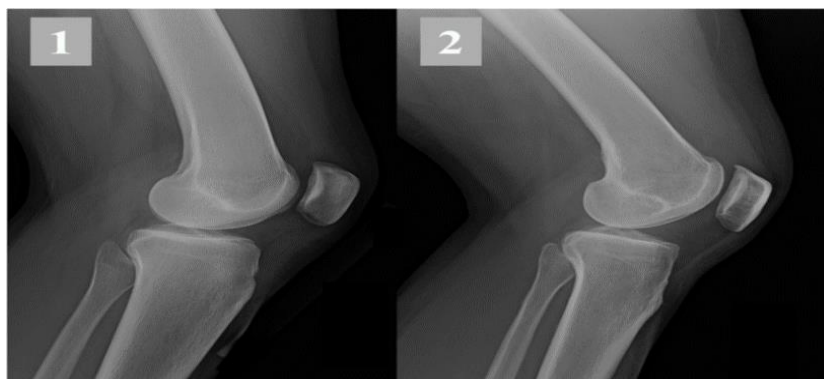


Fig (1) Lateral plain radiographs of knee showing < 6mm condylar overlap.

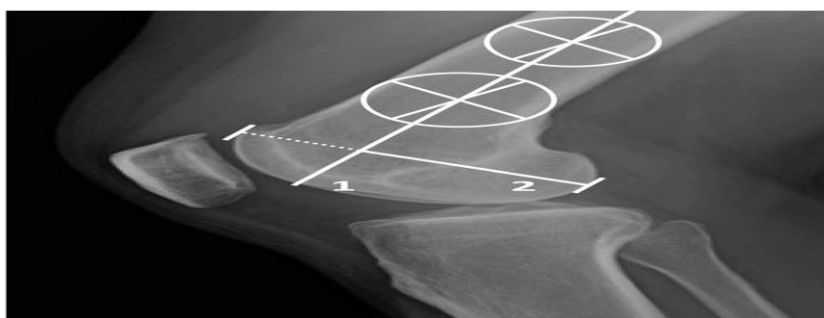


Fig (2) X-ray showing how to measure posterior femoral condyle offset.

Table (1) Descriptive analysis.

		Mean	SD	Median (IQR)
Group	Control	100	50.0%	
	Case	100	50.0%	
Age		35.11	8.93	36 (29 - 43)
Sex	Male	164	82.0%	
	Female	36	18.0%	
Height		1.71	0.08	1.7 (1.65 - 1.77)
Weight		82.85	11.64	82.5 (75 - 89.5)
BMI		28.38	2.57	28.08 (26.38 - 29.94)

Table (2) Descriptive analysis.

	Mean	SD	Median (IQR)
A	128.51	100.75	118.91 (78.6 - 163.86)
AB	185.50	151.23	169.98 (108.21 - 234.92)
PCO	0.68	0.04	0.68 (0.65 - 0.69)
PCOR	67.76%	3.76%	67.74% (64.95% - 69.36%)

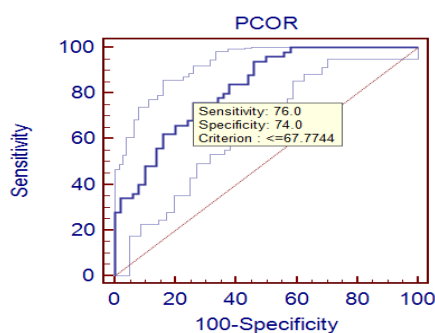


Fig (3) Roc Curve.

Table (3) Univariate analysis.

		Group		Student t-test of sig.	
		Control	Case	P- Value	Sig.
		Mean \pm SD N (%)	Mean \pm SD N (%)		
Age (years)		37 \pm 9.32	33.22 \pm 8.14	0.003	S
Sex	Male	78 (78%)	86 (86%)	0.141 ^(C)	NS
	Female	22 (22%)	14 (14%)		
Height (m)		1.72 \pm 0.09	1.69 \pm 0.07	0.033	S
Weight (Kg)		83.82 \pm 12.63	81.88 \pm 10.54	0.24	NS
BMI		28.28 \pm 2.61	28.47 \pm 2.55	0.61	NS

^(C) Chi-Square test of significance.

Table (4) Comparison between both groups as regard A, AB, PCO and PCOR.

	Group		Student t-test of sig.	
	Control	Case	P- Value	Sig.
	Median (IQR) Mean \pm SD	Median (IQR) Mean \pm SD		
A	141.43 (103.12 - 167.76)	85.27 (22.45 - 151.11)	<0.001 ^(M)	S
AB	210.27 (148.2 - 235.25)	118.97 (34.96 - 224.7)	<0.001 ^(M)	S
PCO	0.66 \pm 0.03	0.7 \pm 0.03	<0.001	S
PCOR	65.65% \pm 2.73%	69.88% \pm 3.45%	<0.001	S

^(M) Mann-Whitney test of significance

Table (5) Comparison between both groups as regard A, AB, PCO and PCOR.

	Group		Student t-test of sig.	
	Control	Case	P- Value	Sig.
	Median (IQR) Mean \pm SD	Median (IQR) Mean \pm SD		
A	141.43 (103.12 - 167.76)	85.27 (22.45 - 151.11)	<0.001 ^(M)	S
AB	210.27 (148.2 - 235.25)	118.97 (34.96 - 224.7)	<0.001 ^(M)	S
PCO	0.66 \pm 0.03	0.7 \pm 0.03	<0.001	S
PCOR	65.65% \pm 2.73%	69.88% \pm 3.45%	<0.001	S

^(M) Mann-Whitney test of significance.

Table (6) Roc Curve.

AUC	95% Confidence Interval	Sig.	Cut off-Value	Sensitivity	Specificity
0.825	0.765 to 0.875	<0.001	>67.8	76%	74%

4. Discussion

The distinguishing proof of both modifiable and nonmodifiable danger factors for front cruciate tendon (ACL) injury is of fundamental significance to the muscular specialist who treats ACL wounds. Until this point in time, various danger factors have been distinguished. A few anatomic qualities have been related with an expanded danger of ACL injury, including a shallow average tibial level profundity, an expanded horizontal tibial level incline, and a diminished intercondylar score width.

The adjustments in bone morphology might be related with a raised danger of ACL injury for a few reasons identified with the effect of distal femoral morphology on knee kinematics, a theme that has been recently explored. It is conceivable that the changed tibiofemoral collaborations brought about by an expanded back

femoral condylar profundity add to the modified stride and stacking mechanics that are appeared to anticipate a more serious danger of ACL wounds a point that requirements further examinations and examinations.

Promptly recognizable anatomical danger factors, for example, an expanded back femoral condyle balance and proportion could help clinicians in distinguishing powerless people who may encounter more prominent advantage from focused ACL injury-avoidance advising, mediations, and guide treatment choices to distinguish patients going through ACLR who may profit by extra surgeries, for example, extra-articular tenodesis or anterolateral tendon recreation.

As far as anyone is concerned, the examination by Pfeiffer et al. is the first to investigate the impact of back femoral condylar profundity measured as back femoral condyle proportion (PCOR) on the danger of ACL injury.

The investigation directed by Pfeiffer came about a collector working trademark (ROC) bend examination which showed that a horizontal femoral condyle proportion of >63% was related with an expanded danger of ACL injury, with an affectability of 77% and a particularity of 72%. The creators estimated that an expanded back femoral condylar profundity may incline a person to ACL injury due to changed tibiofemoral mechanics or a general laxity of parallel and anterolateral knee structures in specific positions.

Our examination gathered the information from 100 patients who had ACL injury and contrasted the estimations and another 100 patients with typical knee tendons to distinguish the recipient working trademark (ROC) bend investigation and show the affectability and particularity of back femoral condyle balance as a novel anatomical identifier of ACL wounds.

The information from our examination showed that an expansion in back femoral condyle proportion of the distal portion of the femur was related with an expanded predominance of ACL wounds.

Upper leg tendon injury bunch had fundamentally higher back femoral condyle proportions contrasted and the benchmark group. Cutoff estimation of 67.8% for the horizontal femoral condyle proportion, which had a relating affectability of 76% and particularity of 74% for recognizing ACL injury.

This observational examination found that there is a relationship of ACL injury hazard with a part of back femoral condylar morphology that requires approval in extra associates just as research facility and forthcoming clinical examination to survey causality.

The contrasts between our investigation and the first examination cut-off worth could be because of race changes or the relative changes in ACL segment circulation in our nation. Likewise diminished frequency of ACL wounds in female Egyptians possibly due to misdiagnosis of knee problems or because of diminished commitment of Egyptian females in physical games. Leg tendon wounds in Egyptian females needs more examinations.

As this examination is an observational investigation with a restricted patient populace size, extra examination is expected to additionally decide the distal femur morphology in the Egyptian populace and its impact on the danger of ACL injury.

Likewise, the examinations acted in the first investigation presented by Pfeiffer et AL required top notch standard radiographs, explicitly a sidelong view with <6 mm of cover between the back equal parts of the average and parallel condyles. Therefore, a sizeable number of patients (n = 65) must be barred before investigation on account of abused radiographs.

The prohibition of almost 33% of the qualified patients in Pfeiffer's examination due to low quality imaging could present predisposition.

Attractive reverberation imaging (MRI), as opposed to sidelong radiographs, would be a more exact strategy to autonomously gauge back condylar profundity for both the average and the parallel femoral condyles. A couple of

distributed investigations have just exhibited methods for making such estimations with utilization of MRI [221].

The examination by Voleti et al. additionally shows that radiographs belittle back condylar profundity estimations when contrasted and MRI [222]. The utilization of MRI would permit to independently evaluate the back condylar profundities of the average and sidelong femoral condyles, to freely survey their effect on the danger of ACL injury, and to decrease estimation imprecision and patient prohibition as a result of malrotated radiograph.

5. Conclusion

In conclusion, this study found that increased femoral condyle depths quantified as (posterior femoral condyle offset and posterior femoral condyle ratio) is associated with increased prevalence of ACL injuries.

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