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Value of Magnetic Resonance Imaging to Estimate Posterior Tibial Slope of Knee Joint with and without ligamentous Injuries

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Original Article

Summary

Posterior tibial slope play an important role for bearing weight and affects the knee joint stability, No data are available regarding the normal values of slope among Iraqi population whether with or without injuries therefore, we aimed to get a reference range for this slope among healthy Iraqi population and to compare it with cases of ligamentous injury. A cross-sectional study was conducted during a period of one year, included 178 patients of both genders who met the inclusion criteria and agreed to participate in the study. We found that the median lateral and medial PTS was 6.67 and 6.88, respectively, among healthy group , the 10th - 95th percentile for lateral and medial PTS was 4.65-9.10 and 4.82 - 8.50 , respectively. Among the studied group, 35 cases of ligamentous injury were detected , their PTS was not significantly different than healthy population (P>0.05). Also the PTS was neither affected by the site of injury, age of patients nor body mass index, (P>0.05). In conclusion , PTS among Iraqi population was lower than that reported in other countries and our findings could be used as a reference range. PTS value was not associated with the presence of ligamentous injury, age of the patients or body mass index.

Keywords: *Posterior tibial slope, MRI, knee joint, Ligamentous injury*

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1. INTRODUCTION

The knee joint plays an important role in daily work of persons so studying the factors that could affect the knee joint stability is important. An important factors in weight bearing and plan design that affect the knee joint stability is the posterior tibial slope , which plays important role for bearing weight … (1,2). The posterior tibial has an impact on flexion gap and posterior femoral rollback that are related to wide range of knee motion.(3) Since the knee joint injuries are present in most of daily practice of the orthopedic department so studying the PTS is important and significant to find the normal values and measurements that could play an important role in identification and management of knee injuries, because change in this slope could affect the management. The slope of the tibia is really the slope of the plateau of the tibia bone extending from the anterior to the posterior relative to the longitudinal line (4). It is a key parameter in the knee joint biomechanics and play an important role in the anteroposterior stability of the knee joint .(5,6). The orthopedic surgeon usually tries to return the anatomical position of the body organs as much as possible to its normal axis and angles . So it is important to know these angles and its normal measurement to achieve normal configuration of the lower limb. (7). Nonetheless, no available data regarding the normal values of slope among Iraqi population whether they have ligamentous injury or not .Therefore the present study tried to find the reference range for these measurements and could be used as baseline for further studies. (8,9). Role of MRI in knee joint examination is well documented in many studies and literatures, due to its excellent soft-tissue contrast; and it is proved to be very beneficial for identifying these important structures. On the other hand, in short period after injury , it is unreliable to assess the knee , that makes the MRI an important tool in diagnosis (10). MRI protocols universally used in knee examination the proton density (PD) and T2-weighted fast spin with and without using fat suppression are usually used to get good anatomical details and detect the diseased area . Fat suppression make the bone marrow and soft tissue edema more clear on fluid–sensitive sequences , and non-fat suppressed images increase conspicuity of bone marrow abnormalities on short echo time (TE) sequences (11) (12). On the MRI The normal anterior cruciate ligament (ACL) appears as low signal band, that is seen as parallel to the intercondylar roof. The intermingled fatty and connective tissues give striated appearance to the ACL that must not be falsely diagnosed as pathology . The normal Posterior cruciate

ligament (PCL) in MRI appear also as low signal intensity ,unlike ACL, it has no striated appearance pathology (12). Injury of the ACL is frequently seen in orthopedic sport medicine particularly in young athletes, in spite of the fact that some programmes (that used to prevent the ACL injury to occur) have been introduced. Posterior cruciate ligament (PCL) injury happens far less often than does ACL (13,14)

2. PATIENTS and METHODS

A cross sectional study was during the period 1stSeptember 2017 to 1stSeptember2018. Included 178 Patient complaining from pain at the knee joint who visited the outpatient clinic of orthopedic department who met the inclusion criteria and agreed to participate in this study .

Inclusion criteria: Adult Iraqi patients complaining of knee pain, regardless their gender and requested for knee joint MRI by specialist orthopedic who were suspected to have ligamentous injury

Exclusion criteria: Patient with one or more of the following was excluded from the study; sever osteoarthritis, rheumatoid arthritis, fracture in the proximal part of the tibia and lower femur, limb anomalies, gross handicap and lower limb length variability.

Study protocol and MRI technique for knee joint examination: The protocols used in this study in our center are

T1-COR-TSE, PD-TSE-SAG, T2-AXIAL, T2-SAG-FS-TSE. ACL and PCL were examined in the 4 imaging planes in accurate manner as following:

• T1-COR-TSE : TE: 17-SLICE:3 MM-.FL.ANGLE:150- PHASE: R-L-MATRIX: 205-256-FOV: 170- NEX:1- GAP:20%.

• PD-TSE-SAG: TR: 3000 -.FL.ANGLE:150 , 244-320- NEX: 1- GAP: 20%.

• T2-AXIAL: TR: 4600-TE:70-SLICE:3MM-.FL.ANGLE:150-PHASE:A-P-MATRIX: 192-256- NEX:1

• T2-SAG-FS-TSE:TR:4300-TE:84-SLICE:3MM-.FL.ANGLE:150-PHASE: H-F-MATRIX: 224-320-FOV:160- NEX:1- GAP:20%.

After clinical examination all patients were examined with MRI (closed type Siemens avanto syngo MRB 19 NUMARIS/4/MR 63393 ,1.5 Tesla MR Machine) We draw a line with cortex of the posterior tibia and another line vertical to first one , and another line just

touching the plateau of the tibia. Between the third and second line there will be an angle which is regarded as posterior tibial slopes in figure (4).

Data management and analysis were performed using statistical package of social science (SPSS)version 25 .Descriptive statistics presented as mean, standard deviation, frequencies and percentages . The continuous variables of posterior tibial slope (lateral and medial) of the studied group was assessed for normal statistical distribution. Furthermore, lateral and medial PTS measurement were presented as median interquartile range and tenth to ninety fifth percentile. Additionally the mean PTS was compared between participant with injury against those with no injury. The level of significance of less than or equal 0.05 was considered as significant .

3. RESULTS

A total of 178 patients were enrolled in this study with a mean age of 32.9 ± 10.4 (range : 18 – 70) years, however , majority of the studied group aged below fifty years where only 12 (6.7%) aged 50 years or above. Males were the dominant , contributed for 76.4% of the studied group with a male to female ratio of almost 3.2:1. The mean body mass index (BMI) was 27.2 ± 4.3 (range: 18.7 – 42.2) kg\m2 and 29.8% of the studied group had normal BMI, 82 patients (46.1%) overweight and 43 (24.2%) were obese, (**Table 1**). As shown in (**Table 2**), to find the cutoff points for normal group (with no injuries), the descriptive statistics for the lateral and medial tibial slops were analyzed, the mean (±SD) of the lateral PTS was 6.75 ± 1.41(range: 2.70 – 11.17) and for the medial one it was 6.77 ± 1.25 (range: 3.13 – 10.60). The median vales were not much different than the mean, for lateral and medial (6.67 and 6.88, respectively). Furthermore the percentiles values are shown in the same table. Moreover, the distribution of those participants according to the cutoff points of the percentiles revealed that majority of the studied group had a median lateral and medial PTS of 6.67 and 6.88, respectively (**Table 3**).

After estimation of the normal group cutoff points of the PTS, the median and mean levels were compared between two groups according to the presence or absence of cruciate ligament injury, i.e. the 143 (normal group) vs. the 35 cases with cruciate ligament injury, in addition to the comparison across the site of injury. The results of these comparisons are shown in (**Tables 4 & 5**), where no significant differences had been found between both

groups, (P>0.05). There was no statistically significant difference in the mean PTS nor among age groups. Similarly ,BMI showed no effects on the measurement of PTS ,there was no statistically significant difference among normal, overweight and obese patients (**Tables 6 &7**)

Table 1. Demographic characteristics of the studied group.

Variable		No.	%
Age (year)	< 30	78	43.8
	30 - 39	52	29.2
	40 - 49	36	20.2
	≥ 50	12	6.7
	Mean ± SD	32.9 ± 10.4	-
Gender	Male	136	76.4
	Female	42	23.6
BMI	Normal	53	29.8
	Overweight	82	46.1
	Obese	43	24.2
	Mean ± SD (kg\m^2)	27.2 ± 4.3	-
	Range	18.7 – 42.2	-

SD: Standard deviation BMI :body mass index

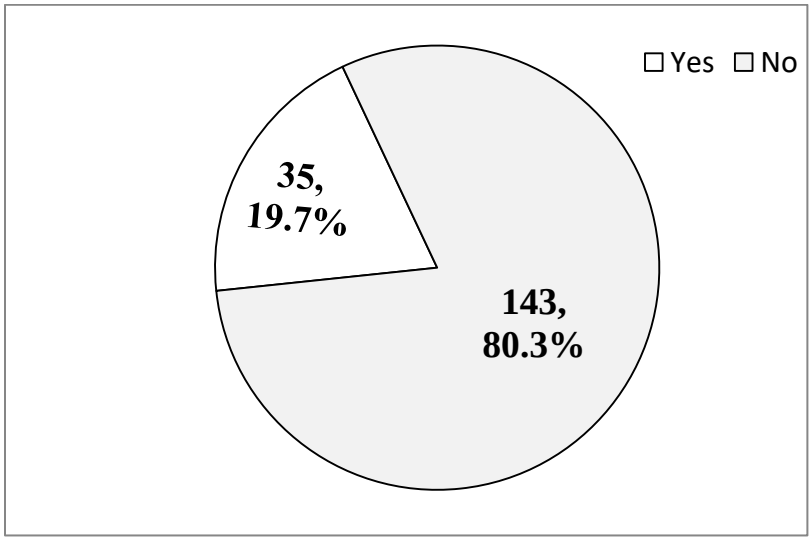

Figure 1. Distribution of the cruciate ligament injury among the studied group (N = 178)

Table 2. Distribution of the study participants according to the presence and site of injury			
Variable		Number	%
Injury	Yes	35	19.7
	No	143	80.3
Site of injury (n = 35)	ACL	25	71.4
	PCL	10	28.6
ACL :anterior cruciate ligament , PCL :posterior cruciate ligament			

Table 3. Descriptive statistics of the lateral and medial Posterior tibial angles of the normal group (N = 143)		
Statistic	Lateral posterior tibial slope	Medial posterior tibia slope
Mean ± SD	6.71 ± 1.42	6.84 ± 1.27
Range	2.70 – 11.17	3.13 – 10.60
Median(IQR)	6.67(5.93_7.63)	6.88(5.97_7.60)
10^{th} Percentile	4.65	4.82
95% CI for 10^{th} percentile	3.91 – 5.00	4.12 – 5.23
95^{th} Percentile 95	9.10	8.50
95% CI for 95^{th} Percentile	8.77 – 9.83	8.30 – 9.20
IQR: Interquartile range, SD: Standard deviation		

Table 4. Comparison of mean Lateral and medial posterior tibial slop across the presence of injury				
Slop		Injury		P. value
		Yes (N=35)	No (N=142)	
Lateral Posterior tibial slop	Mean	6.88	6.71	0.53
	SD	1.39	1.42	
Medial Posterior tibial slop	Mean	6.49	6.84	0.134
	SD	1.10	1.27	

Table 5. Comparison of mean Lateral and medial posterior tibial slop across the site of injury

Slop		Site of injury			P. value
		ACL	PCL	None	
Lateral Posterior tibial slop	Mean	6.66	7.43	6.71	0.285
	SD	1.54	.70	1.42	
Medial Posterior tibial slop	Mean	6.48	6.52	6.84	0.326
	SD	1.15	1.01	1.27	

Table 6. Comparison of mean lateral and medial tibial slop according to BMI categories of the studied group analysis

Slop		BMI category			P. value
		Normal (N=53)	Overweight (N=82)	Obese (N=43)	
Lateral Posterior tibial slop	Mean	6.67	6.84	6.66	0.734*
	SD	1.14	1.45	1.65	
Medial Posterior tibial slop	Mean	7.00	6.71	6.62	0.275*
	SD	1.24	1.13	1.44	

* Not significant

Table 7.Comparison of mean lateral and medial tibial slop according to age intervals of the studied group analysis

		Age (year)				P. value
		< 30	30 - 39	40 - 49	≥ 50	
Lateral Posterior tibial slop	Mean	6.81	6.66	6.49	7.45	0.214
	SD	1.51	1.17	1.48	1.36	
Medial Posterior tibial slop	Mean	6.89	6.79	6.52	6.74	0.544
	SD	1.29	1.18	1.27	1.17	

4. DISCUSSION

The tibial slope has important role in knee reconstruction surgeries . No available data regarding the posterior tibial slope are available among Iraqi population in orthopedic practice .Therefore the present study tries to find a reference figures of measurements of PTS. Regarding finding of male predominance and majority of patients were overweight in addition to the presence of ligamentous the injury 19.7% of the study participants have an injury in the ACL and PCL .These finding are in the current study, male prevalence was predominant ,majority were overweight and 19.7% of the patient had ACL and/or PCL ligamentous injury these finding were consistent with the epidemiological and clinical characteristics of the knee joint pain and injuries where previous studies reported that a predominance of male among injured patients and age variation were the prevalence of injuries decrease with advancing age . While it is more frequent in the overweight and obese patients. The present study found that the mean of the lateral posterior slope was 6.71,and that of the medial posterior tibial slope is 6.84.with the median of 6.67 and 6.88 respectively. On the other hand in another study for 50 American patients it was higher than present study as it illustrated by Moore et al (14±3.7) (range 7-22) (15). Other study by Matsuda et al found that PTS among 30 Japanese it was 10.7 (range 5-15.5). while in study by Chiu et al in 25 Chinese patients PTS was 14.7±3.7(range 5-22). (16,17). The discrepancy among different studies could be due to ethnic variation between different populations. In nearby countries, a study done in Iran on 108 patients PTS was 9.4±1.8°(range 2-18)reported by Hosseinzadeh et al .while in a study by Qureyshi et al PTS was reported in 431 patients 9.3±1.4° (range 1-19). (18). Finding of the present study when taking into account the 95% confidence interval of the mean was 5.73-9.83 in the lateral and 5.83-9.20 in the medial posterior tibial slope were majority of patients has a measurement of posterior tibial slope within this range . However ,there is wide range of variation in the measurement of slope worldwide and this may be due to individual height ,imaging technique and ethnic variation. Regarding relationship between PTS and ligamentous injury ,the present study found no significant association between the ACL injury and changes in PTS (p value >0.05). The present study was not free of limitations. Firstly the study was conducted in one center and could not be generalized to all Iraqi population, however more studies with larger sample and multicenter are suggested to overcome this issue .

The benefit of this study is that the above results of measurement of PTS can be regarded as reference for orthopedic surgeon to restore the normal position of the knee in the surgery.

5. CONCLUSIONS

Posterior tibial slope among Iraqi population was established and could be used as guidance for the orthopedic surgeon to restore this angle to normal as much as possible during the knee surgery. PTS measurement of the studied group was lower than that reported in other countries . Measurements of PTS were not affected by the cruciate ligamentous injury, age and BMI. We recommend that result of this study be used as guide for the knee joint orthopedic surgery and further studies still needed for further evaluation.

Ethical Clearance: Ethical clearance and approval of the study are ascertained by the authors. All ethical issues and data collection were in accordance with the World Medical Association Declaration of Helsinki 2013 for ethical principles for medical research involving human subjects, informed consent obtained from all patients. Data and privacy of patients were kept confidentially.

Conflict of interest: Authors declared none

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