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A comparative study on range of medial and lateral rotation of tibia between school going students and college going students of Jabalpur, Madhya Pradesh, India

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Abstract

The knee joint is the largest joint in body and structurally most complicated. Although it is generally considered to be modified hinge joint. Which permits very free flexion and extension. It is complex and involve gliding and rotation of free leg. Since data are not available about the range of medial and lateral rotation of tibia. This study was proposed to find out the range of medial and lateral rotation and tibia affected actively by person of different age groups and also to find out any differences which can be attributed to handedness, profession and sex of the individual. The study was conducted on boys and girls subjects of two different age group, first group was 10-17 years aged school going students and second group was 18-25 years aged college students. These subjects are from different cast and races forming the local population. The subjects were selected only after confirming that there was no involvement of knee joint by any disease. The range of lateral, medial and total rotation of tibia in school going students is significantly higher than the college going students. All the tibial rotation are found to be slightly higher in girls than the boys in both groups. Since at 10-17 years the growth and development of bones is not yet complete and the structure of knee joint has reached its adults configurations therefore these values may be taken as temporary.

Keywords: Range of tibia rotation, lateral tibia rotation, medial tibia rotation, total tibia rotation

Introduction

The knee joint is largest joint in the body, and is composed of the patella-femoral joint and the medial and lateral tibio-femoral joints. It is a weight-bearing structure with complicated movement pattern. The movements that occur at the knee joint are flexion, extension, adduction, abduction, and rotation, which is the most complex [1-2].

The movements that occur at the knee joint are flexion and extensions and, also a limited amount of active rotation; the joint is justifiably regarded as a modified hinge joint It differs from a typical hinge joint not only in that some rotation may occur, but also because the axis of rotation at the joint during the movement of extension moves forward and vice - versa during flexion, whereas in a typical hinge joint, such as the elbow joint, the axis of movement is constant. The axis changes its position during movement owing to a difference in curvature of different parts of the femoral condyles. To-wards the end of extension there is also an accompanying rotator movement of the femur upon the tibia when the foot is on the ground and as this is of considerable importance.

In addition, to the hinge movements of flexion and extension, some rotation of the leg around a vertical axis can take place at the knee except when the joint is fully extended. In full extension, apart from the special, small rotator movements already described, all rotation is prevented by the tension of the collateral and cruciate ligaments. Rotation is most free, about 50 degrees when the knee is flexed to about a right angle [3].

Two types of rotational movements are described. Adjunct rotation refers to those passive rotator movements of the tibia which are possible when the Knee is flexed. Conjunct rotation is the obligatory rotational movement occurring between tibia and femur during flexion and extension conjunct rotation has been held to occur late in extension commencing some 30

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degree before full extension has been reached. This movement is considered to lock and thus render more stable the fully extended knee and is reiterated current major anatomical texts [4-5].

Since data are not available about the range of medial and lateral rotation of tibia. This study was proposed to find out the range of medial and lateral rotation and tibia affected actively by person of different age groups and also to find out any differences which can be attributed to handedness, profession and sex of the individual.

Materials and Methods

Selection of site and Subject

The present study was conducted in different areas of Jabalpur, Madhya Pradesh, India. Male and female subjects were selected at random for the study having age range 10 to 25 years. The total age group was further classified into two groups i.e.; School going students group 10 to 17 years (n=200) and college going students group 18 to 25 years (n=200). Out of 200 people in each school going students group and college going students group, 100 intimates are male and 100 intimate are female in both groups. The study protocol was approved by the Human Ethical Committee of the institution and the experiment was performed in accordance with the ethical standards of the committee and with the Helsinki Declaration. The subjects were invited to participate and, after agreeing, provided their informed consent. The inclusion criteria were as follows: (1) no history of knee injury; (2) no history of knee surgery; and (3) no history of knee disease or existing knee disease

Inspection method

The subject was seated on a chair and he/she was asked to put his/her foot on the rotating platform with his/her knee semi flexed (90 degree). The foot was fastened with the help of straps to make sure that when the subject was performing

medial and lateral rotation of tibia there was no movement occurring at any of the joints of foot.

A compass printed on a paper was kept under the rotating platform. The degree of medial and lateral rotation of tibia was marked on the paper by carefully observing the position of pointer (in line of axis of 2nd toe) after the subject had completed the respective movements under supervision.

Medial and lateral rotation of tibia in both limbs were measured in three different positions of femur

Position I	Intercondylar distance 00
Position II	Intercondylar distance 12.5 cm
Position III	Intercondylar distance 25 cm

The other foot was rested on a stool with knee extended, so that there was no obstruction and interference with medial and lateral rotation of tibia under study.

Statistical analysis

Data are expressed as mean \pm SD. Two tail t-test and correlation coefficient determined by product moment correlation coefficient were employed to compare the data using the statistical package for social science software (SPSS software: 20.0.0, USA). $p \leq 0.05$ was considered as a significant difference.

Results

1. The average length of tibia and foot

It was observed from the result that the average length of tibia of girls was significantly ($\#P < 0.05$) higher than boys in school going students, on the other hand the average length of tibia of was significantly ($\#\#P < 0.01$) increased in boys than the girls of college going students. The average length of tibia and length of foot both are increased significantly ($\#\#\#P < 0.001$) in college going students than the school going students in both boys and girls (Table 1).

Table 1: The average length of tibia and foot of boys and girls individuals in both school going students group (n= 200) and college going students group (n= 200).

Groups		Average length of Tibia	Average length of foot
School going students (n = 200)	Boys (n = 100)	33.45 \pm 2.28	19.14 \pm 2.27
	Girls (n = 100)	34.08 \pm 2.17#	19.05 \pm 1.64
College going students (n = 200)	Boys (n = 100)	37.56 \pm 1.86##,***	21.52 \pm 2.03***
	Girls (n = 100)	36.77 \pm 1.71***	21.52 \pm 2.03***

Values are expressed as mean \pm standard deviation (SD). Significant at $\#P < 0.05$, $\#\#P < 0.01$, Boys vs Girls; Significant at $\#\#\#P < 0.001$, School going students vs College going students

2. The distribution of mean medial, lateral and total rotation of right tibia at three intercondyler position

From the result it was observed that there was no significant difference in the mean medial, lateral and total rotation of right tibia at three intercondyler position between boys and girls in school going students. In college going students the girls have significantly higher mean medial rotation ($\#\#\#P < 0.001$; $\#\#P < 0.01$; $\#P < 0.05$), mean lateral rotation

($\#P < 0.05$) and mean total rotation ($\#\#\#P < 0.001$; $\#P < 0.05$) of right tibia at three intercondyler position respectively comparison to boys. The mean medial, lateral and total rotation of right tibia at three intercondyler position was significantly higher ($\#\#\#P < 0.001$; $\#\#P < 0.01$; $\#P < 0.05$) in school going students than college going students in both boys and girls (Table 2).

Table 2: The distribution of mean medial rotation, lateral rotation and total rotation of right tibia at three intercondyler position of boys and girls individuals in both school going students group (n= 200) and college going students group (n= 200).

Groups		Mean medial rotation			Mean lateral rotation			Mean total rotation		
		Position-I	Position-II	Position-III	Position-I	Position-II	Position-III	Position-I	Position-II	Position-III
School Going students (n=200)	Boys (n=100)	24.22±3.69***	24.63±3.91**	26.12±4.37***	31.91±3.31***	31.04±3.59***	31.57±3.56***	56.13±5.97***	55.67±5.85***	57.69±6.39***
	Girls (n=100)	24.18±3.69**	25.31±4.09*	25.91±4.73**	31.72±3.38**	31.10±3.78**	31.77±3.58*	55.90±6.07***	56.41±6.05***	57.68±6.46**
College going students (n=200)	Boys (n=100)	18.59±5.54	18.92±6.12	19.18±6.95	25.17±5.83	25.59±4.91	25.72±5.56	43.36±11.23	44.51±9.59	44.90±10.65
	Girls (n=100)	20.48±4.29###	21.38±5.23##	21.04±5.22#	27.12±4.90#	26.86±4.57#	27.45±5.28#	47.60±7.84####	48.24±8.83####	48.49±8.68###

Values are expressed as mean ± standard deviation (SD). Significant at # $P < 0.05$, ## $P < 0.01$, Boys vs Girls; Significant at *** $P < 0.001$, School going students vs College going students

3. The distribution of mean medial, lateral and total rotation of left tibia at three intercondyler position

It was observed from the result that there was no significant difference in the mean medial, lateral and total rotation of left tibia at three intercondyler position between boys and girls in school going students. In college going students the girls have significantly higher mean medial rotation (## $P < 0.01$) of left tibia at intercondyler position- II, but mean lateral rotation

(# $P < 0.05$) and mean total rotation (### $P < 0.001$; # $P < 0.05$) of left tibia at all intercondyler position was significantly higher in girls compared to boys. The mean medial, lateral and total rotation of left tibia at three intercondyler position was significantly higher (*** $P < 0.001$) in school going students comparison to college going students in both boys and girls (Table 3).

Table 3: The distribution of mean medial rotation, lateral rotation and total rotation of left tibia at three intercondyler position of boys and girls individuals in both school going students group (n= 200) and college going students group (n= 200).

Groups		Mean medial rotation			Mean lateral rotation			Mean total rotation		
		Position-I	Position-II	Position-III	Position-I	Position-II	Position-III	Position-I	Position-II	Position-III
School going students (n=200)	Boys (n=100)	24.89±3.98***	24.13±4.54***	25.23±4.68***	30.43±3.73***	30.83±3.44***	30.99±3.93***	55.32±6.67***	54.96±6.62***	56.22±7.26***
	Girls (n=100)	25.13±3.67***	25.08±3.99***	25.47±4.32***	30.68±3.46***	31.04±3.44***	31.46±3.00***	55.81±6.04***	56.12±5.70***	56.93±5.68***
College going students (n=200)	Boys (n=100)	19.68±6.10	18.86±6.09	19.51±6.55	24.79±5.14	25.87U4.81	25.95±5.35	44.47±9.85	44.73± 9.28	45.46±10.09
	Girls (n=100)	21.00±5.18	21.04±4.73##	21.08±5.16	26.97±4.46###	27.62±4.23##	27.51±4.84##	47.97±8.44##	48.66±8.02####	48.59±8.52##

Values are expressed as mean ± standard deviation (SD). Significant at # $P < 0.05$, ## $P < 0.01$, Boys vs Girls; Significant at *** $P < 0.001$, School going students vs College going students

4. Correlation between medial, lateral and total rotation and length of right tibia

The co-relation coefficient between length of tibia and rotation in studied groups is shown in table 4. The medial rotation of right tibia showed an inverse co-relation between length of tibia and medial rotation in school going students and the observed co-relation coefficient at position-I, position-II and position-III were significant (** $P < 0.01$; * $P < 0.05$). In college going students the length of tibia was found to be positively co-related with medial rotation of tibia but statistically the co-efficient of co-relation were

insignificant. The lateral rotation of right tibia showed negative co-relation with length of tibia for school going students and all these observation were statistically significant (* $P < 0.05$) while college going students were found with positive co-relation but statistically none was found significant. The co-relation between length of tibia and the total rotation were negative for school going students while college going students had a positive co-relation but statistically school going students had significant co-relation (** $P < 0.01$) with length of tibia while college going students did not show any significant co-relation (Table 4).

Table 4: Co-relation between medial rotation, lateral rotation and total rotation three intercondyler position and length of right tibia in both school going students group (n= 200) and college going students group (n= 200).

Groups	Medial rotation and right tibia			Lateral rotation and right tibia			Total rotation and right tibia		
	Position-I	Position-II	Position-III	Position-I	Position-II	Position-III	Position-I	Position-II	Position-III
School going students (n = 200)	- 0.300**	- 0.146*	- 0.247**	- 0.180*	- 0.159*	-0.109	- 0.284**	- 0.196**	- 0.235**
College going students (n = 200)	0.095	0.125	0.069	0.153	0.117	0.131	0.101	0.138	0.116

Significant at ** $P < 0.01$; * $P < 0.05$

5. Correlation between medial, lateral and total rotation and length of left tibia

In case of the left tibia the length was observed negatively co-relative with medial rotation but only the observation at position-III was found significant (* $P < 0.05$) in school going students, while college going students showed positive co-

relation and this was significant (* $p > 0.05$) in position-I observation while rest were insignificant. The total rotation showed negative week co-relation with length of tibia for school going students while the college going students showed a positive and significant co-relation (* $P < 0.05$) (Table 5).

Table 5: Co-relation between medial rotation, lateral rotation and total rotation three intercondyler position and length of left tibia in both school going students group (n= 200) and college going students group (n= 200).

Groups	Medial rotation and left tibia			Lateral rotation and left tibia			Total rotation and left tibia		
	Position-I	Position-II	Position-III	Position-I	Position-II	Position-III	Position-I	Position-II	Position-III
School going students (n = 200)	-0.116	-0.027	-0.140*	-0.069	-0.041	-0.048	-0.109	-0.042	-0.122
College going students (n = 200)	0.120	0.115	0.119	0.155*	0.130	0.114	0.155*	0.139*	0.137

Significant at * $P < 0.05$

Discussion

Knee joint is described as a modified hinge joints. The main movements occurring are flexion and extension. 30° of conjunct movement has been described to be performed by femur when the foot is on the ground and the individual is extending the joint as in standing straight from sitting position.

Rotation on femur has been associated with locking and unlocking of knee joint. Probably this has received an overdue importance because of which rotation of tibia (performed when the foot is off the ground) has not been given much importance. There is scarcity of literature about the detailed study of medial and lateral rotation of tibia. However conjunct rotation of femur has been studied by various workers [6-7]. Scott FD (1987) [6] and Kettel Kamp *et al.* (1970) [7] have described 9-30° of rotation of femur associated with extension and flexion in their study in which radiographic assessment of knee joint rotation is made. He has worked out a co-relation between the degree of flexion at the knee and the % of rotation of femur occurring at different stages of flexion.

Romanes GJ (1981) [4] described that rotation of tibia is most free, about 50° when the knee is flexed to about right angle but does' not mention the range of medial and lateral rotation separately [3]. The range of passive rotation to be about 60-70° [8].

In the current study the rotation of tibia is performed actively by subject. The range of total rotation is measured along with range of medial and lateral rotation of both tibia in semi-flexed position of knee. The results of range of total rotation of right and left tibia of both the boys and girls in school going students indicates though insignificant but higher value on the dominant (Right) side. But this can be commented upon authentically only after studying the range of movement in left handed subjects. The range of medial, lateral and total rotation of tibia in school going students is higher than that in the college going students. Since at 10 to 17 years the growth and development of bones is not yet completed and the structure of knee joint has reached its adults configurations therefore these higher values may be taken as temporary. In 1953, Mayer [9] published series of article on mechanism of knee joint. He placed there in a table to show the ability of the foot and calf to rotate at various position of flexion. His method was to render the ankle immovable by a tight bandage and to record to motion by binding a ruler to the sole of foot. The angles measured were the angle between lines draw parallel to this ruler on a sheet of paper under the sole. Full extension being taken as a position of 180 degree.

In college going students the range of total rotation of right and left tibia in both boys and girls indicates an insignificant higher value on the right side. The total rotation of both tibia of school going students for both sexes are significantly higher if compared with those of college going students. In one female of age group 18-25 Years College going students the value are significantly high. Some of them gives history of practicing in dance classes since childhood and is now giving performance quite often. Whether effect of such exercises can have influence on the range of rotational movements of tibia?

This can be confirmed by performing study on a large number of subject of this progression. It indicates that the range of rotation of tibia is not affected by occupation of subject. No co-relation can be established between the length of tibia and range of medial and lateral rotation in any age group or sex.

Conclusion

Form the study it can be concluded that the range of lateral, medial and total rotation of tibia in school going students is significantly higher than the college going students. All the tibial rotation are found to be significantly higher in girls than the boys in both groups. Since at 11-17 years the growth and development of bones is not yet complete and the structure of knee joint has reached its adults configurations therefore these values may be taken as temporary.

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