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THE ROTATIONAL PROFILE OF THE LOWER EXTREMITIES OF NIGERIAN CHILDREN

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ABSTRACT

Lower extremity rotational problems are common findings in children worldwide. The approach to treatment of such problems requires knowledge of the normal rotational profile of the children in any particular environment.

This study was carried out to establish the normal values of the rotational profile of the lower extremities of Nigerian children residing in Benin City

The rotational profile parameters which included the hip rotation angles and the thigh foot angles of the lower extremities of 492 children aged between 3 and 10 years were determined by the clinical method described by Cheng et al.

There is a gradual increase in the mean Medial Hip Rotation Angle (MHRA) value from 37.9 ± 9.1^0 and 41.0 ± 9.8^0 respectively for male and female children at age 3 to a maximum mean MHRA value of 44.5 ± 11.0^0 at age 6 for male children and 51.0 ± 11.8^0 at age 9 for female children. The mean lateral Hip Rotation Angle (LHRA) value show a reverse trend as there is gradual decrease from a maximum mean LHRA of 52.1 ± 12.8^0 and 50.0 ± 13.7^0 for male and female children respectively at age 3 to a minimum value of 40.0 ± 15.9^0 and 38.9 ± 17.6^0 for male and female children respectively at age 8.The Thigh Foot Angle (TFA) values which were 4.6 ± 4.1^0 and 4.5 ± 3.9^0 in male and female children respectively increased to a similar value of 15.0 ± 3.3^0 in both sexes at age 10.

The lower extremity rotational profile of Nigerian children showed similar changes with age when compared to white American and Chinese children.

INTRODUCTION

The lower extremity in the course of growth undergoes rotational changes. The lower extremity buds develop during the fourth week in-utero with the great toe in a pre-axial position. During subsequent pre-natal development heredity, intra-uterine positioning and mechanical forces influence the rotational changes of the developing femur and tibia. Postnatally as the femur rotates medially the tibia on the other hand rotates laterally up till the age of eight or ten years when little or no further changes occur[1].

Rotational abnormalities such as increased femoral anteversion, medial tibial torsion or metatarsus adductus cause intoeing while external rotation contracture of the hip or internal tibial torsion of the leg cause outtoeing.

Most of these rotational abnormalities represent variability during a stage of normal childhood development and may correct spontaneously with growth. However rotational problems that arise from pathological conditions such as cerebral palsy, hip dysplasia, slipped upper femoral epiphysis, poliomyelitis and malunited fractures of the lower extremities may be persistent and progressive thereby requiring treatment.

KEYWORDS: *rotational profile,lower extremites, Nigerian children*

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In the 1950's several X-ray techniques including biplanar roentgenography[2-8], stereophotogrammetry[9], axial roentgenography[10] and fluoroscopy[11-14] were developed to measure femoral and tibial torsion. In the 1970's the new imaging techniques of computer tomography (CT)[15-18] and ultra sound scans[19-24] became available and were applied to problems of rotational malalignment. These imaging techniques are expensive and sometimes may involve radiation. In addition they are not more accurate than clinical methods[16-26]. The clinical methods are cheap, reliable, reproducible and avoid exposure of children to radiation. They involve the assessment of both medial and lateral hip rotation angles values, the thigh foot angle and the foot progression angle. Knowledge of the normal values for the parameters of the rotational profile in a given population is essential to orthopedic surgeons in the management of rotational abnormalities. Although many studies have been conducted to establish mean values for the rotational profile in some races[27,28] data describing similar values for these measurements are lacking for majority of ethnic groups. Previous reports from other workers[29] have shown that there are differences between Nigerian children and various other populations as regards some skeletal angles such as knee angles. Therefore the aim of the present study is to provide baseline data concerning the mean values for the rotational profile of lower extremities of normal Nigerian children aged 3 and 10 years.

METHODOLOGY

This was a community based cross sectional descriptive study that was conducted within Benin City, the capital of Edo State, Nigeria. The data was collected between May and August 2010. The city is situated in the tropical rain forest zone at 122mm above sea level. It comprises three local government areas (LGA'S)- Oredo, Egor and Ikpoba- Okha.

The 984 limbs included in this study were both lower extremities of 492 subjects (264 male and 228 female) ranging in age from 3 years to 10 years. These subjects were Nigerian children who had no musculoskeletal abnormality. They were selected from private and public nursery and primary schools within the 3 LGA'S.

The ethical permission for the study was obtained from the University of Benin Teaching Hospital while consent was obtained from the headmasters of each school.

The sex and age of the subjects as at their last birthday were obtained and recorded. Thereafter the Medial Hip Rotation Angle (MHRA), Lateral Hip Rotation Angle (LHRA) and the Thigh Foot Angle (TFA) were measured bilaterally in all the subjects using the clinical methods described by Cheng et al[28].

In-toeing angles were expressed in negative degrees and out-toeing angles were expressed in positive degrees.

Each skeletal angle measured was divided according to age into eight groups. Results were expressed as mean ± standard deviation for each age group and sex. A 95% confidence level was used to calculated a confidence interval which is a range of values around the mean where the true (population) mean can be expected to be located, with 95% certainly T-test for independent samples was used for comparing mean angles for males versus females.

Analysis of variance (ANOVA) was used to compare the mean angles between age groups for each skeletal angle measured. Result were considered significant when $P<0.05$. The statistical software for data analysis used was the statistical package for social sciences (SPSS) version 16.0

RESULTS

A total of four hundred and ninety two children participated in this study. They were two hundred and sixty four males and two hundred and twenty eighty females giving a total of nine hundred and eighty four lower extremities. Each skeletal angle measured was recorded according to age into eight groups as shown in table 1.

Medial Hip Rotation Angle (MHRA)

The mean MHRA measured in the children are as shown in Table 2

Females exhibited 5^0 higher MHRA values compared to male children. The independent T-test was used to compare the MHRA values between both genders in each of the eight age groups.

This showed that there was no significant difference between the MHRA values in the male and female children except for the 7 and 8 year age groups where there was a significant difference between male and female MHRA values ($P= 0.006$) and ($P=0.014$). There is a gradual increase in MHRA values from 37.9 ± 9.1^0 and 41.0 ± 9.8^0 respectively for male and female children at age 3 to maximum mean MHRA values of 44.5 ± 11.0^0 at age 8 and 51.0 ± 11.8^0 at age 9 for male and female children respectively.

Using the analysis of variance there was significant difference in the MHRA values between the different age groups ($P=0.000$)

Lateral Hip Rotation Angle (LHRA)

The mean LHRA values measured for the children aged between 3 years and 10 years is as shown in table 3

The male children exhibited 1^0 higher LHRA values compared to female children and this is not statistically significant. There is a gradual decrease in the LHRA values with a maximum mean LHRA of 52.1 ± 12.8^0 and 50.0 ± 13.17^0 respectively for male and female children at age 3.These values decreased to a similar minimum value of 40.0 ± 15.9^0 that occurred at age 8 for male and at age 9 for female children. Analysis of variance show that there was significant difference between the age groups ($P=0.000$)

Thigh foot angle (TFA)

The mean TFA values measured in the children are as shown in
table 4

The independent T-test showed no significant difference between the TFA values of both gender in each of the eight groups. The TFA values increased from 4.6 ± 4.1^0 for male and 4.5 ± 3.9^0 for female children at age 3 to a similar value of 15.0 ± 3.3^0 for both sexes at age 10. There was a significant difference in the TFA values between the different age groups ($P=0.000$).

Discussion

In this study the MHRA values increased with age. The female children exhibited higher MHRA values compared to the male children. This is a similar finding to that found by Staheli et al[20] and Cheng et al[21] in white American and Chinese children respectively. There was no statistically significant difference in the MHRA values between male and female children except for the seven and eight

Table 1: Age and Sex Frequency Distribution of the age groups studied

Age(years)	Male	Female
3	28	22
4	33	25
5	34	25
6	34	28
7	34	30
8	34	30
9	34	34
10	34	34
Total	264	228

Table 2: The mean Medial Hip Rotation Angle (MHRA) for both sexes in the age groups studied.

Age	mean Medial Hip Rotation Angle (MHRA) (^{0})				P1
(years)	Male Mean ±SD	95%CI	Female Mean ±SD	95%CI	
3	37.9±9.1	34.4-41.5	41.0±9.8	36.7-45.4	0.252
4	39.9±11.9	35.8-44.1	45.0±8.8	41.5-48.5	0.073
5	42.0±8.6	39.0-45.0	45.0±9.8	41.1-48.9	0.217
6	44.5±11.0	40.6-48.3	48.5±11.1	44.2-52.8	0.157
7	43.9±9.6	40.6-47.4	49.9±9.0	46.6-53.3	0.014 *
8	40.0±15.9	40.6-47.3	50.9±9.7	47.3-54.5	0.006 *
9	40.8±15.0	40.3-49.6	51.0±11.8	46.9-55.1	0.052
10	42.0±8.0	41.7-50.3	49.6±11.3	45.7-3.5	0.217
P2		0.000			

P1- P-value of male vs female in each age group

P2- P-value between the different age group

SD- Standard deviation

CI- Confidence interval

*-Significant(P< 0.005)

TABLE 3: The mean Lateral Hip Rotation Angle (LHRA) for both Sexes in the age groups Studied

Age (years)	mean Lateral Hip Rotation Angle (LHRA) (^{0})				P1
	Male		Female		
	Mean ±SD	95%CI	Mean ±SD	95%CI	
3	52.1±12.8	47.1-57.0	50.0±13.7	43.9-56.1	0.578
4	49.8±10.3	46.2-53.4	47.8±9.9	43.8-51.9	0.463
5	47.9±10.7	44.2-51.7	47.9±9.4	44.1-51.7	0.995
6	47.9±11.0	44.1-51.8	46.0±10.5	41.9-50.0	0.482
7	46.0±9.6	42.6-49.4	45.3±8.2	42.8-48.3	0.768
8	40.0±15.9	34.4-45.1	38.9±17.6	32.4-45.5	0.800
9	40.8±15.0	35.6-46.1	40.0±15.9	34.4-45.6	0.815
10	42.0±8.0	39.2-44.8	40.0±15.9	34.4-45.5	0.515
P2		0.000			

P1- P-value of male vs female in each age group

P2- P-value between the different age group

SD- standard deviation

CI- confidence Interval

TABLE 4: The mean Thigh Foot Angle (TFA) for both sexes in the age groups studied

Age (years)	mean Thigh Foot Angle (TFA) (^{0})				P1
	Male		Female		
	Mean ±SD	95%CI	Mean ±SD	95%CI	
3	4.6 ±4.1	3.0-6.2	4.5 ±3.9	2.8-6.2	0.926
4	5.9 ±4.6	4.3-7.5	6.2 ±5.2	4.0-8.3	0.832
5	7.4 ±4.3	6.0-8.9	7.5±4.5	5.6-9.3	0.994
6	8.0 ±3.3	6.8-9.2	8.5±3.4	7.2-9.8	0.562
7	10.0 ±3.3	8.8-11.2	10.0±3.5	8.7-11.3	1.000
8	12.0 ±3.0	11.0-13.0	12.3±3.3	11.0-13.5	0.735
9	14.0 ±3.4	12.8-15.2	14.0±3.4	12.8-15.2	1.000
10	15.0 ±3.3	13.8-16.2	15.0±3.3	13.8-16.2	1.000
P2		0.000			

P1 P-value of male vs female in each age group

P2- P-value between the different age group

SD- standard deviation

CI- confidence Interval

year age groups. This finding is in contrast to that of Staheli[27] and Cheng[28] who reported significant differences between the MHRA values of both gender in all age groups. There is no clear reason to explain this difference in observation between the present study and the other workers[27,28] except that it may likely be due to a peculiarity of the population used in this study. With LHRA values there was a tendency to decreasing values with age. The male children exhibited 1^0 higher LHRA values when compared to the female children; however this difference was not statistically significant. Overall this finding is consistent with the report of previous studies[27, 28] on the rotational profile who all reported similar trends in white American and Chinese children.

Another finding of the present study is that the TFA values increased from the age of 3 years to 10 years. There is no significant difference between both genders in all the age groups studied. This finding is consistent with that of the other workers[18,27,28] and supports the fact that lateral tibial torsion tends to occur with increasing age.

Conclusion

The medial hip rotation increases as lateral hip rotation decreases while the thigh foot axis becomes more lateral with increasing age among Nigerian children. Therefore the Nigerian children in Benin City do not differ significantly in the rotational profile of their lower extremities from white American and Chinese children. The present study would stimulate further studies on the same subject using other methods of assessment of the rotational profile to corroborate our findings.

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