



## Normal Tibial Metaphyseal-diaphyseal Angle of Nigerians

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### ABSTRACT

A total of 219 anterior-posterior radiographs of the knees of 111 males and 108 females were used to measure the metaphyseal-diaphyseal angle (MDA) using the Levine-Drennan technique. The mean MDA for males was  $1.55 \pm 1.2$  degrees and  $1.4 \pm 1.2$  degrees for females. These values were noted to be higher in those aged 0-5 years for both sexes. After this age, the MDA gradually approaches the neutral angle of 0 degrees. There was no significant difference between the mean MDA for males and females ( $P > 0.05$ ). The MDA for both males and females was also shown to correlate positively ( $r = 0.689$ ) indicating that sex does not impact significantly on the value of the angle.

**Key words:** Metaphyseal-diaphyseal angle, Blount's disease, Physiologic bowing.

The metaphyseal-diaphyseal angle (MDA) is the angle created by the intersection of a line through the transverse plane of the proximal tibial metaphysis with a line perpendicular to the long axis of the tibial diaphysis (Levine and Drennan, 1982). This angle represents the degree of deformity of the proximal end of the tibia (Foreman and Robertson, 1985).

As with other radiologic measurements, the ability to use the metaphyseal-diaphyseal angle is related to its measurement validity and reliability (Foreman and Robertson, 1985). There is lack of uniformity in the literature on the tibial diaphyseal line in the measurement of the metaphyseal-diaphyseal angle. Although Levine and Drennan described the MDA in tibia vara using the lateral border of the tibial cortex, some other studies use diaphyseal line drawn along the mechanical axis of the tibia i.e from the center of the knee to the center of the ankle, some others use diaphyseal line drawn along the longitudinal axis of the fibula (Auerbach et al, 2004). Although, either method of defining the longitudinal axis is acceptable to measure MDA, the Levine-Drennan technique is more commonly used because it shows more consistency and offers better reproducibility.

In this study, the Levine-Drennan technique for measuring MDA is used to determine the normal tibial metaphyseal-diaphyseal angle of Nigerians from radiographs.

This will serve as a baseline in assessing the degree of deformity of the proximal tibia in Nigerians, and permit early differentiation between Blount's disease and physiological bowing. Also sexual differences in the normal MDA of Nigerians are also noted.

### MATERIALS AND METHODS.

The study is a multi-center study, 219 anterior-posterior radiographs of the knees of normal patients were examined. The study took place from January 2006 to June 2007.

The radiographs used were those of patients with no proximal tibial deformity (normal knees). The age of the study population was between 0-25 years. Films were randomly selected into the study based on the following inclusion criteria:

- (1). The films must be of good quality.
- (2). The femur-tibial joint space should be open.
- (3). The patella should be completely superimposed on the femur.
- (4). No rotation of the femur and or tibia should be seen.

### Measurement Technique

The MDA was measured using a protractor after drawing a metaphyseal line 'M' through the medial and lateral corners of the proximal tibial metaphysis and a diaphyseal line 'D' through the longitudinal axis of the tibia parallel to the lateral cortex of the tibia. The

MDA is completed by a line 'A' through the point of intersection of 'M' and 'D' perpendicular to 'D'. The angle subtended by 'M' and 'A' is the MDA measured using a protractor (Fig. 1). For consistency, all measurements were done by one examiner under the same conditions i.e using a viewing box.

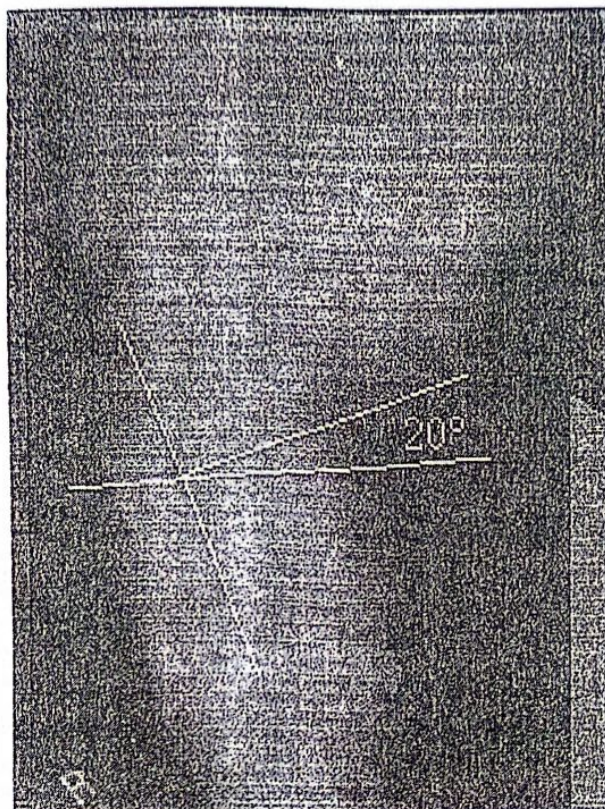


Fig. 1: Measurement of MDA using the Levine-Dreman technique.

### Statistical Analysis

Results were reported as mean(x)  $\pm$  standard deviation (SD). Test of statistical significance of the mean MDA for males and females was compared using the student t-test. The difference was considered statistically significant when  $P < 0.05$ . The correlation between the MDA for males and females was done using the Pearson's linear 'r' test.

### RESULTS

Table 1 shows the age distribution of the subjects. 219 subjects met the inclusion criteria, 111 males and 108 females. The mean ages were  $11.7 \pm 7.9$  years and  $12.1 \pm 7.2$  years for males and females respectively. The age range was 0-25 years.

Table 2 shows the mean MDA for males. The mean MDA for males was  $1.55 \pm 1.2$  ( $^{\circ}$ ) with a range from 0-5 $^{\circ}$ . The MDA was highest in those between 0-5 years and gradually approached 0 $^{\circ}$  as age increases.

Table 3 shows the mean MDA for females. The mean MDA for females was  $1.4 \pm 1.2$  ( $^{\circ}$ ) with a range from 0-5 $^{\circ}$ . The MDA was highest in those between 0-5 years and gradually approached 0 $^{\circ}$  as age increases.

There was no significant difference between the mean MDA for males and female ( $P > 0.05$ ). There was also a positive correlation between the mean MDA-LD for males and females ( $r = 0.689$ ).

Table 1. Age distribution of the population.

Age (yrs)	No. Males	No. females
0-5	37	26
6-10	12	19
11-15	16	27
16-20	28	21
21-25	18	15
Total	111	108

Table 2. Distribution of mean MDA for males.

Age (yrs)	Mean MDA	Range
0-5	$1.95 \pm 0.47$	0-5
6-10	$1.58 \pm 0.74$	0-4
11-15	$1.38 \pm 0.47$	0-3
16-20	$1.21 \pm 0.31$	0-3
21-25	$0.94 \pm 0.33$	0-2

Table 3. Distribution of mean MDA for females.

Age(yrs)	Mean MDA	Range
0-5	$1.65 \pm 0.32$	0-5
6-10	$1.53 \pm 0.27$	0-4
11-15	$1.30 \pm 0.17$	0-3
16-20	$1.10 \pm 0.18$	0-3
21-25	$0.80 \pm 0.20$	0-2

**Table 4. Measurement of MDA for differentiating between physiologic bowing And tibia vara.**

Age (months)	MDA (degrees)
Physiologic bowing	Average (range)
11-20	5.1 ± 2.8 (0-11)
21-30	3.3 ± 3.1 (0-10)
Tibia vara	
11-20	16.4 ± 4.3 (8-22)
21-30	13.7 ± 4.3 (7-22)

### DISCUSSION

The differential diagnosis of bowing in the young child includes physiologic bowing and pathologic bowing (Schoenecker et al, 1990). The latter most commonly due to infantile tibia vara or Blount's disease. Levine and Drennan defined physiologic bowing as more than 10 degrees of bilateral varus noted after the age of 18 months. Physiologic bowing most commonly involve varus deformity of the tibia and femur while Blount's disease is a pathologic deformity of the proximal tibia (Schoenecker et al, 1990). Clinically it may be difficult to differentiate the two as both diseases represent two different points on the same spectrum, as the end result of the persistence of infantile bowing.

Radiographic distinction between physiologic bowing and Blount's disease may not be initially obvious. Measurement of MDA helps to identify the location, severity and serves as a more specific guide in differentiating both conditions (Levine et al, 1982, Feldman et al, 1993, Bashner et al, 1991). From the works of Kate (table 4) and Feldman et al, if the MDA is less than 10 degrees chances are (95% probability) that the bowing is due to physiologic bowing. Conversely, if the MDA is greater than 16 degrees the chances are (95% probability) that the bowing is due to Blount's disease. Patients between 10 and 16 degrees are usually indeterminate and require close follow-up to note progressive remodeling or the occurrence of Blount's disease.

From this study the mean MDA for males was  $1.55 \pm 1.2$  degrees and  $1.4 \pm 1.2$  degrees for females. This values were noted to be higher in those aged 0-5 years for both sexes. This can be

accounted for by the normal varus knee alignment seen during infancy, which remodels to a neutral femoral-tibial alignment at approximately 14 months of age. After this age the MDA gradually approaches the neutral angle of 0 degrees (Salenius et al, 1975, Greene, 1993, Engel et al 1974), similar to results noted in this study in both males and females. The MDA for both males and females was also shown to correlate positively ( $r=0.689$ ) indicating that sex does not impact significantly on the value of the angle.

### CONCLUSION

We conclude therefore that the normal MDA for males averages  $1.55 \pm 1.2$  degrees and  $1.4 \pm 1.2$  degrees for females amongst Nigerians. This value gradually decreases to a neutral angle of 0 degrees as age increases. Angles above these values may indicate physiologic bowing or tibia vara. The difference between the mean MDA for male and females was not statistically significant ( $p > 0.05$ ). It is therefore possible to make early diagnosis of physiologic bowing as well as monitor remodeling or development of Blount's disease.

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