Influence of sex and age on sonographic infant hip indices

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ABSTRACT

Background: Ultrasound is a non-invasive, cheap and readily available imaging modality for studying the infant hip. Early detection of developmental hip subluxation, acetabular dysplasia and the prevention of late presentation of a developmentally dislocated hip with consequent secondary premature degenerative arthritis are goals that all practitioners should strive for.

Objectives: Provision of axial indices of alpha and beta angles of the infant hip joint in Kano, Nigeria using ultrasonography to establish a normogram as reference values for further studies is the objective of this study.

Methods: This descriptive prospective study was conducted at the Radiology Department of Aminu Kano Teaching Hospital, Kano state, Nigeria. Successive four hundred appropriately consented infants were recruited for this study. The axial angle relationships of both hip joints were measured using 7.5 MHz linear transducer of Mindray DP-8800 Digital plus ultrasound machine.

Results: The mean alpha and beta angles for both hips in females were 56.590 and 49.580 respectively while those for males were 56.730 and 50.530 respectively. Minimum and maximum alpha angle for both hips ranged from 380 to 780 while the beta angles ranged 290 to 660 respectively. The age group 1-3 months has the highest frequency of respondents (251) while age group 10 - 12 months has the lowest (22). There was no statistically significant difference in the alpha and beta angles between males and females hips and age of the infants did not affect the hip indices.

Conclusion: The study showed no statistical significant difference in the measured alpha and beta angles between males and females. Age of measurement in infants did not affect the hip indices.

Key words: Infant hip, Ultrasound, Alpha and Beta angles, Male and Female

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INTRODUCTION

Generally, there is inadequate data on the sonographic anatomy of the infant hip in our environment with most studies having been conducted abroad. Describing the sonarthrographic morphology/anatomy of the hip joint and documenting standardized axial measurement parameters will serve as a reference normogram for our environment. A study of this nature will also undoubtedly stimulate interest by raising the confidence level of clinicians to the procedure, thus

impacting their prescription pattern for requesting the procedure and ultimately encourage screening of the hip in the neonatal period with resultant reduction in morbidity.¹ An apparently normal hips at birth, might acquire developmental dysplasia in the first year of life. Globally the incidence of hip instability at birth is said to be 3 – 10/1000 and frank dislocation is 1 – 1.5/1000.²⁻⁵ Diagnosis of such cases on clinical grounds alone is usually difficult as they may present with no symptoms or signs during this latent period of

dysplasia. These conditions can result in permanent disability if misdiagnosed; hence selective screening sono-arthrography is usually advocated. The infant hip joint has a number of well-known axial relationships on plain radiography; the Y line, the acetabular angle (normally 15° - 35°), the iliac angle (normally 44° - 74°), shenton's line and the Von Rosen's line.^{5,6} However, indices used in hip sono-arthrography which include alpha angle ($\geq 60^{\circ}$), beta angle ($\leq 77^{\circ}$), acetabular depth, percentage femoral head coverage (FHC), lateralization measurements and dynamic hip joint stress tests of Herck are preferred in infants because of the danger of over exposure to ionizing radiation in this population.^{2,6} Among these indices, the alpha and beta angles are most preferred due to the ease of reproducibility of the measurements, as well as their low inter observer variability.^{1,6,7}

The superiority of ultrasound over radiography and other diagnostic methods in the examination of the hip and diagnosis of congenital dislocation and dysplasia of the hip has been established.^{7, 8 - 14} Ultrasound is a noninvasive, cheap and readily available imaging modality for studying the infant hip. It is noteworthy that, previous studies conducted on hip angular indices in Nigerians as reported by Obikili *et al*¹⁵, Singh *et al*¹⁶ and Tahir *et al*¹⁷ were all based on plain hip radiographs evaluation in adults. To the best of our knowledge there is paucity of study on infant hip ultrasound in Nigeria.

Studies conducted in multiple countries have shown that hip angle values may differ between distinct ethnic groups, thus indicating the need for regional investigations^{16,18,19}.

The objective of this work was to analyze the distribution of established sonographic hip

indices based on Graf classification in normal healthy infants with special attention to the influence of age and sex in Kano state, Northwestern Nigeria.

SUBJECTS AND METHODS

Four hundred infants were recruited for the study after informed/written consent by their parents/guardians. The subjects in the present study were all black infants from Nigerian population. This descriptive prospective study was conducted at the Department of Radiology, Aminu Kano Teaching Hospital, Kano state, North western Nigeria.

The Ultrasound of the infant hip was carried out using 7.5MHz linear transducer of the Mindray DP 8800 digital ultrasound machine. The infants were examined in the decubitus position (ie. lying in true lateral position with the hips flexed and adducted and supported by the parent). A coupling gel was applied generously on the lateral aspect of the infant's thigh/hip and while the mother was encouraged to keep the child pacified either by cajoling, breast feeding or use of a pacifying dummy. The transducer placed longitudinally over the femoral shaft was seen as an echogenic linear structure casting posterior acoustic shadow parallel to the transducer. The transducer was then moved cranially over the shaft of the femur and over the greater trochanter and held at right angles to all anatomical planes. The section plane should go through the middle of the acetabular fossa, as the acetabular roof and fossa to the Y joint with best imaged in its largest diameter.^{20, 21, 22} The os ileum and the femoral shaft will be seen as straight vertical lines, with the chondro-osseous boundary between femoral shaft and head, joint capsule, labrum and the cartilaginous femoral head with the ossification center, if already visible, will be seen in the central part of the image. The two angles (α and β) were then measured from the

image and these form the basis of Graf's hip ultrasound indices.^{23,24} In a case of dislocation, the femoral head will not be in place in the acetabular fossa, but would be visible more dorsally, laterally and cranially in the soft tissues or muscular structures while in subluxation, the tendency of the femoral head to lateralize and its instability during movement of the leg will be easily seen.²⁰

Inclusion Criteria: This includes infants referred to the ultrasound Clinic for ultrasound investigation other than hip ultrasound; Informed/written consent by the parents/guardians; and no clinical evidence of hip abnormality.

Exclusion Criteria: These were family history of developmental hip dysplasia, and those with musculoskeletal abnormalities.

Sample size: Calculated minimum sample size was 384. The sample size was then rounded up to 400 to allow for attrition rate of 4%.

Ethical Consideration: Ethical clearance and approval of the Ethical Committee of Aminu Kano Teaching Hospital, Kano state, Nigeria, was sought and obtained before commencement of the study.

Statistical analysis of data

The data obtained was analyzed using statistical package software for social sciences (SPSS) version 20. The range, mean values,

and standard deviations of the measured hip indices along with sex and age distribution were obtained. A p value of <0.05 was considered as statistically significant. Findings have been presented in the form of summarized numerical, graphical and tabular forms.

RESULTS

A total of 400 infants comprising 217 (54%) males and 183 females (46%) were recruited for the study as shown in Table I below.

Table I: Age and Sex distribution of the 400 respondents.

AGE (MONTHS)	SEX		FREQ.	%
	Male	Female		
1 – 3	128	123	251	62.75
4 – 6	56	37	93	23.25
7 – 9	21	13	34	8.5
10 – 12	12	10	22	5.5
TOTAL	217	183	400	100

The average of the mean alpha angle for both hips in both sexes was 56.66° while the mean for the beta angle was 50.05° (Tables II & III). The mean alpha and beta angles for both hips in the females were 56.59° and 49.58° respectively while those for males were 56.73° and 50.53° respectively (Tables II & III). Minimum and maximum alpha angle for both hips ranged from 38° to 78° while for the beta angles ranged 29° to 66° respectively.

Table II: Sex distribution of respondents with mean alpha and beta angles

SEX	Frequency (N)	Mean alpha angle	SD	Mean beta angle	SD
M	217	56.73	5.2	50.53	6.0
F	183	56.59	4.1	49.58	5.3

Table III: The average of the mean alpha and beta angles in both sexes

MALE		FEMALE		Average Mean alpha angle	Average Mean beta angle
aAngle	βAngle	αAngle	βAngle	56.66	50.06
56.73	50.53	56.59	49.58		

The age group 1-3 months has the highest frequency of respondents (251) while age group 10- 12 months has the lowest (22). (See Table I above) Correlation of the measured alpha and beta angles between the sexes of the respondents showed no statistically significant difference between the males and females. ($P=0.33$). (Fig 1)

Figure 1: A graph showing distribution and relationship of frequency and age/sex of respondents.

DISCUSSION

The controversy over the incidence of developmental dysplasia of the hip (DDH) stems mainly from an ambiguity of criteria for defining a genuinely pathologic neonatal hip. The objective of this work was to analyze the distribution of established sonographic hip indices based on Graf classification in normal healthy infants with special attention to the influence of age and sex. The distributions of measured alpha and beta angles of the hips in neonates and infants have been previously reported by various researchers and authors^{11-16, 19, 21} and most have reported variations based on genetic, geographic and cultural influences, making a study like this in our local community imperative.

The minimum and maximum alpha angles in this study were 38° and 78° respectively, while the minimum and maximum beta angles were 26° and 66° respectively. A study by Eli *et al*⁷ found a normal ranged alpha and beta angles in

all examined neonates and indicated a zero incidence of developmental hip dysplasia among Ethiopian Jews. The minimum value of alpha angle (38°) documented in this study was lower than that (43°) recorded in the east African study.⁵ This difference could be due heterogeneity in methodology as well as geographical, genetic or cultural variations.

The overall mean alpha and beta angles observed in this study was 56.66° and 50.06° respectively in both male and female respondents. A study by Kokavec *et al*⁷ among Slovakian infants also found similar results. The measured mean and ranges of alpha and beta angles in the present study showed no statistically significant variation between sex and age; similar to what was found in several other studies.^{7, 11, 21-26}

Studies conducted in multiple countries have shown that hip angle values may differ between distinct ethnic groups, thus indicating the need for regional investigations.^{16, 18, 19}

Several other observational studies have shown that morphologically normal hips with alpha and beta angles within the normal range, tend to remain normal with or without a co-existing instability, and 97% of sonographically immature hips tend to normalize spontaneously within 3 months.^{16, 18}

In conclusion this study showed no statistical significant difference in the measured alpha and beta angles between males and females. Age of measurement in infants did not affect the hip indices.

References

1. Roposch A, Graf R. Wright JG. Determining the reliability of the Graf Classification for hip dysplasia. *Clinical OrthopJnl*. 2006; 447: 119 – 124.
2. Renton P, Green G. Congenital Skeletal Anomalies. In; David Sutton (ed). *Text book of Radiology and Imaging (Volume 2)*, 7th edition. Churchill Living stone. Edinburgh. 2002; 1109 – 1152 and 1848 – 1849.
3. Moosa NK, Kumar PT, Mahmoudi SM. Incidence of developmental dysplasia of

- the hip in Dubai. Saudi Med J. 2010; 31: 94.
4. Eli P, Mark E, Alexander K, Viktor B. Neonatal Incidence of Hip Dysplasia. Ten Years of Experience. ClinOrthopRelat Res. 2008; 466: 771–775.
5. Wolfgang D. (ed). Radiology Review Manual. 6th Edition. Developmental dysplasia of the hip. Lippincott Williams and Wilkins Company. Philadelphia. 2007: 1-176.
6. Stoffelen D, Urlus M, Molanaers G, Fabry G. Ultrasound, radiographs and clinical symptoms in developmental dislocation of the hip: a study of 170 patients. J PediatrOrthop B. 1995; 4: 194-199.
7. Simon EA, Sacer F, Buerge M, Glaab R, Roos M, Kohler G. Inter – Observer agreement of ultrasonographic measurement of alpha and beta angles and the final type classification based on Graf method. Swiss Med. 2004; 134: 671 – 677.
8. Zeiger M, Hilpert S, Schulz R.D. Ultrasound of the infant Hip. Basic Principles. Paediatric Radiology. 1986; 16: 483 – 487.
9. Schuler P. Principles of Sonographic examination of the hip. Ultraschall Med. 1987; 1: 9 – 13
10. Roger C.S(ed), Tom W. (4th Edition) Hip ultrasound. In; Clinical Sonography. A practical Guide. Lippincott Williams and Wilkins. Baltimore, Philadelphia. 2007; 375—388.
11. Graf R. The ultrasound image of the acetabular rim in infants. Arch Orthop Trauma Surg. 1981; 99: 35.
12. Graf R. Fundamentals of Sonographic diagnosis of infant hip dysplasia. J. Paediatr, Orthop. 1984; 4: 735-7.
13. Schilt M. Hip Sonography for newborn screening. Praxis Bern. 2004; 15: 597 – 614.
14. Paton RW, Hindieja K, Thomas CD. The significance of risk factors in ultrasound surveillance of developmental dysplasia of the hip. J. Bone joint Surg. 2005; 87: 1264 – 1266.
15. Obikili E, Obioha FI, Okoye IJ. Collodiaphyseal angle of the femur in normal Nigerians of the south eastern zone. West Afr J Rad. 2009; 16: 32-34.
16. Singh SP, Ekandem GJ, Ani OEO, Onuba O. A study of the collodiaphyseal angle of the femur in Nigerians. West Afr. J Anat. 1986; 1: 28-32.
17. Tahir A, Hassan AW, Umar IM. A study of the collodiaphyseal angle of the femur in North east zone of Nigeria. Nigerian J of Medicine. 2001; 10: 234-236.
18. Bancroft L.W. Hip Ultrasound. Semin Musculoskeletal Radiol. 2007; 11: 126 – 136.
19. Sinergel E, Losik SB, Rosenberg HK. Sonography of Hip dysplasia. Ultrasound Quarterly. 2004; 20: 201 – 216.
20. Graf R. The diagnosis of congenital hip joint dislocation by ultrasound compound treatment. Arch Orthop Trauma Surg. 1980; 97: 177 – 233.
21. Zieger M, Schulz RD. Method and Results of Ultrasound in Hip Studies. Annals Radiol. 1986; 29: 383.
22. Stephen C, Richard N. A Guide to Radiological Procedures. 3rd edition. Ultrasound of the paediatric hip. W.B Saunders. London. 1983; 328-329.
23. Youzef Z, Ranilo JL Hip in children: Correlation of U.S. with anatomic and cryomicrotome sections. Radiologist. 1987; 165, 647 – 655
24. Clark MP, Harcke TH, McHugh P. Real time ultrasound in the diagnosis of congenital dislocation and dysplasia of the Hip. J. Bone, joint Surgery. 1985; 376, 400 – 412.
25. Graf R. Guide to Sonography of the infant hip. New York: Thieme Medical Publishers. 7th Edition. 1987.
26. Kokavec M, Bialik V. Developmental dysplasia of the hip. Prevention and real incidence. Bratisl Lek Listy. 2007; 108: 251-254.