DO THE EXTERNALLY MEASURABLE PELVIC DIAMETERS ESTIMATE THE RELEVANT BIRTH CANAL PARAMETERS IN A REPRODUCTIVE-AGE WOMAN? PELVIMETRY BY REFORMATTED COMPUTED TOMOGRAPHY AT SODO CHRISTIAN HOSPITAL, SOUTH ETHIOPIA

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ABSTRACT

INTRODUCTION: Assessment of the size of the female pelvis is an important obstetric practice to identify mothers at risk of cephalopelvic disproportion. The present study was aimed at assessing the prediction capability of intertuberous diameter, anterior interspinal diameter, and bi-trochanteric diameters on the pelvic inlet and mid-pelvis diameters as an alternative method to estimate different birth canal parameters.

METHODS: Institution-based retrospective study design was conducted on randomly sampled 423 abdominopelvic computed tomography images of reproductive-age women who visited Sodo Christian Hospital from September 2018 to November 2020. Pelvic diameters were measured on 3D workstation using multiplanar reconstruction and volume rendering images. Multivariate regression analysis were done for assessing the relationship between the variables by using STATA 16.

RESULTS: The present study demonstrated that, the intertuberous diameter (ITD) is a significant predictor of obstetric conjugate diameter (OCD), transvers diameter of pelvic inlet (TDI) and interspinous diameter (ISD). A millimeter increase in ITD is associated with 0.552 mm, 0.558 mm, and 0.74 mm increase in OCD, TDI, and ISD, respectively. The TDI is the only lesser pelvis diameter significantly predicted by the anterior interspinal diameter (AISD). A millimeter increase in AISD is associated with 0.229 mm increase in TDI.

CONCLUSION: As to the present study, the ITD is a potential predictor of the pelvic inlet and mid pelvic diameters. Besides, only the TDI could be estimated from AISD, whereas the BTD could not estimate any of the birth canal parameters. To obtain better perditions on lesser pelvis parameters, further studies by including additional anthropometric and pelvimetric variables is required.

KEYWORDS: Bi-trochanters, Intertuberous diameter, Mid-pelvis, Pelvic inlet, Pelvimetry

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INTRODUCTION

In the developing world, where most women deliver outside health centers and emergency transport is difficult to obtain, procedures like cesarean section (CS) cannot be performed in peripheral health centers. Hence, the ability to early identify women who are at high risk of Cephalopelvic Disproportion (CPD) is crucial in reducing feto-maternal morbidity and mortality either by timely refer to well-equipped health centers or by preparing them for elective CS [1, 2].

In health facilities in low-income countries where there is a limited resource, measuring and estimating internal pelvic parameters and predicting the outcome of labor is still performed by a routine clinical pelvimetry, in which the internal pelvic parameters are estimated and inferred subjectively. Because of such reason, clinical pelvimetry has been found to have a limited value and becomes a lost art [3, 4].

Although radiological pelvimetry, particularly CT as it has been described as the most accurate, patient-friendly, and provide reliable picture for high quality pelvimetry [5, 6], high costs and availability remains a major problem for using such instruments especially for developing countries like Ethiopia [4, 7]. To escape such problems different studies have been conducted to evaluate the correlation between easily measured greater pelvic and other anthropometric measurements with the internal birth canal parameters.

Due to the availability of obstetric pelvimeter even in low-income countries, the prediction of delivery complications by using external pelvimetric parameters has been commonly used [8]. Some related studies in Cameroon and Ethiopia have reported that using external pelvimetry in combination with other anthropometric parameters could be helpful in the screening of generally contracted pelvis particularly in developing countries with a limited resource. However, these studies were not assessed and clarified the direct relationship between such anthropometric measurements and external pelvic parameters with the birth canal parameters. Therefore, such conclusions could enhance subjectivity [1, 9-11].

Hence, this study attempted to assess the prediction capability of bi-trochanteric diameter (BTD), anterior interspinal diameter (AISD), and intertuberous diameter (ITD), which can be measured easily and externally, on obstetric conjugate diameter (OCD), transverse diameter of pelvic inlet (TDI) and inter-spinous diameter (ISD) of the lesser pelvis, which cannot be directly or precisely measured through clinical digital examination, by using reconstructed abdominopelvic CT scanned images of reproductive age women.

METHODS

An institution-based retrospective study was conducted in the radiology department of Sodo Christian Hospital, Southern Ethiopia. A total of 804 abdominopelvic CT scanned images of reproductive age women who were scanned in the Hospital for another purpose from September 2018 to December 2020 were available in the Hospital's picture archiving and communication system (PACS). Of these, 648 abdominopelvic CT images were fulfilled the inclusion criteria. The calculated sample size was 423 by using single population mean formula taking 50% population standard deviation since we could not find related studies conducted in Ethiopia and neighbor countries. By using the image ID as a sampling frame, a computer-generated simple random sampling technique was used to draw the CT scanned images of study participants. Only the CT images of women who visited the Hospital from September 2018 to December 2020 and were free from any disease which affects the bony pelvis such as pelvic bone fractures, visually decreased bone mass, pronounced curvatures of the vertebral column were included in the present study [9].

The pelvimetry was performed on three-dimensional workstation (Ad Wantage Workstation for Diagnostic Imaging) using multiplanar reconstruction and volume-rendered

abdominopelvic CT images with a slice thickness of 1.25mm. A structured checklist was used to record the measurements of all the variables of interest. All measurements were taken in millimeter (mm) and recorded in a checklist.

The AISD was measured transversely at the widest distance between the two anterior superior iliac spines, and the BTD was measured transversely at the widest distance between the two greater trochanters (Figure 1).

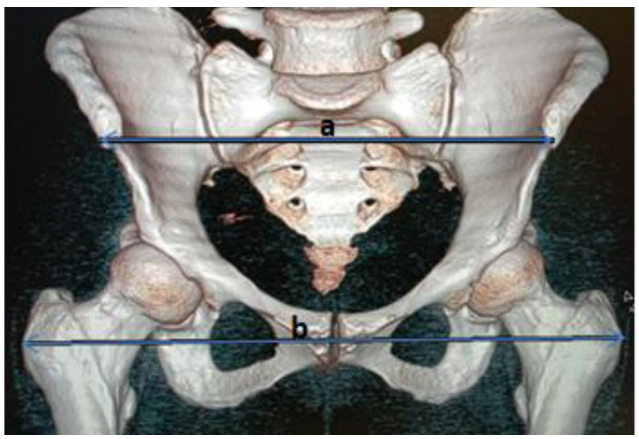

Figure 1. Measurements of the AISD (a), and the BTD (b). A reconstructed CT scanned image obtained from the Sodo Christian Hospital's PACS, 2020.

The OCD was measured between the center of the sacral promontory and the posterior surface of the symphysis pubis, and TDI was measured transversely at the widest distance of the pelvic brim (Figure 2).

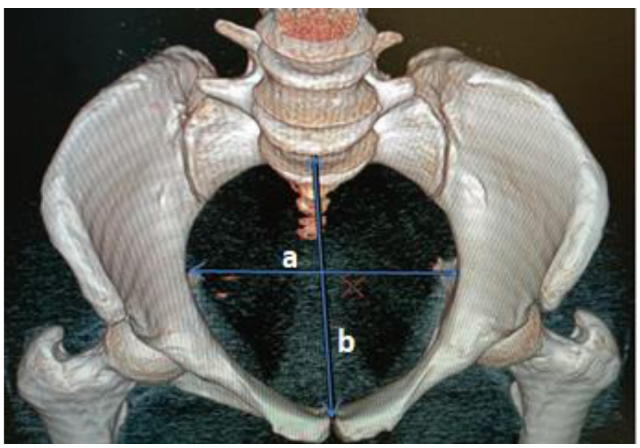

Figure 2. Measurements of the TDI (a) and OCD (b). A reconstructed CT scanned image obtained from the Sodo Christian Hospital's PACS, 2020.

The ISD was measured at the medial edge of the two ischial spines, and the ITD was measured at the level of inner margins of the ischial tuberosities transversely (Figure 3).

Figure 3. Measurements of ISD (a) and ITD (b). A reconstructed CT scanned image obtained from the Sodo Christian Hospital's PACS, 2020.

To maintain the data quality, each measurement was done by two radiologists on the same reconstruction and then results were averaged for analysis. To measure reproducibility of measurements, the inter observer variability were evaluated by the intra-class correlation coefficient (ICC) on the first thirty observations of the two examiners, and agreement was considered good when ICC was ≤ 0.8 and excellent when ICC > 0.9 2, 12. The Intra-class correlation coefficient (ICC) was range from 0.94 to 0.99 and excellent for all parameters in the present study.

Study Variables

In the present study, the intertuberous diameter (ITD), the anterior interspinal diameter (AISD), and the bi-trochanteric diameter were the independent variables, while the obstetric conjugate diameter (OCD), transvers diameter of pelvic inlet (TDI), and interspinous diameter (ISD) were taken as dependent variables.

Statistical Analysis

The data analysis was performed by using STATA version 16 program. The normality of the distribution was tested through Shapiro-Wilk test.

The level of significance was determined based on two-tailed tests and a p-value of < 0.05 was considered as statistically significant. Pearson correlation and partial correlation analysis were applied to measure the degree and strength of correlation between intertuberous diameter (ITD), anterior interspinal diameter (AISD) and bi-trochanteric diameter (BTD) with the obstetric conjugate diameter (OCD), transverse diameter of pelvic inlet (TDI) and interspinous diameter of the mid pelvis (ISD). To measure the partial effect of ITD, AISD and BTD on OCD, TDI and ISD, a multivariate regression analysis was performed after checking the presence of dependency between the dependent variables by using multicollinearity test. The multivariate regression analysis model can be described by the equation: $Y_{nxp} = X_{nx(k+1)}\ \beta(k+1)xp + \varepsilon$, where Y is the dependent variable, X is the independent variable, is a parameter to be estimated and is the error term.

Ethical approval

This study was carried out after obtaining ethical approval from Arba Minch University institutional research ethics review board/IRB (Ref.no: IRB/567/12; Issue date: 26/11/2020). As the study was a retrospective review of archive data, the need for consent was waived by the ethics committee. No personal identifiers were used in the study.

RESULTS

The mean age of women who participated in this study was 33.79 ± 8.86 (SD) years (range 15 to 49 years).

Parameter correlation

The Pearson's correlation analysis demonstrated that, all the three externally unmeasurable lesser pelvis diameters have shown significant linear correlation with externally measurable, BTD and ITD. TDI is the only lesser pelvis diameter which has a significant correlation with AISD of the greater pelvis (p<0.05) (Table 1).

Table 1. Results of Pearson's correlation between ITD, AISD, BTD, and the internal lesser pelvis parameters of women participated in the study at Sodo Christian Hospital from September 2018 to November 2020.

Parameters		BTD	AISD	ITD
OCD		0.586	0.047	0.329
	Sig. (2- Tailed)	0.000	0.340	0.000
TDI		0.639	0.443	0.399
	Sig. (2- Tailed)	0.000	0.000	0.000
ISD		0.831	-0.001	0.505
	Sig. (2- Tailed)	0.000	0.979	0.000

After controlling the effect of other third variables on the correlation analysis, the partial correlation analysis revealed that the BTD was not a significant predictor of OCD, TDI, and ISD. Similar to Pearson's correlation analysis, the ITD is a significant predictor of all the three lesser pelvis diameters. Besides, the AISD is a significant predictor of TDI of the lesser pelvis only. The ITD can predict about 27%, 45% and 58% of the OCD, TDI, and ISD respectively. About 36% of the TDI is predicted by the AISD (Table 2).

Table 2. Partial Correlation Results of OCD, TDI, and ISD with ITD, AISD, BTD of women participated in the study.

	Variable	Partial Corr.	Partial Corr. ^2	Significance Value
OCD	ITD	0.5181	0.2684	0.0000
	AISD	0.0774	0.0060	0.1130
	BTD	-0.0197	0.0004	0.6871
TDI	ITD	0.6688	0.4473	0.0000
	AISD	0.5965	0.3558	0.0000
	BTD	-0.0643	0.0041	0.1879
ISD	ITD	0.7644	0.5842	0.0000
	AISD	0.0213	0.0005	0.6635
	BTD	0.0682	0.0046	0.1626

The Partial Effect of ITD, AISD and BTD on the OCD, TDI and ISD

The multicollinearity test has shown the presence of relationship among the dependent variables; hence to measure the partial effect of the ITD, AISD, and BTD on the pelvic inlet and mid pelvis diameters, multivariate regression analysis was performed with taking the OCD, TDI, and ISD as dependent variables and the ITD, AISD, and BTD as independent variables (Table 3).

Table 3. Multivariate Regression Analysis Results of ITD and AISD with OCD, TDI, and ISD of women participated in the study.

	Variable	Coef.	Std. Err	T	P>|t|
OCD	AISD	.035082	. .0220898	1.59	0.113
	BTD	-.0102576	.0254481	-0.40	0.687
	ITD	.5524478	.0445571	12.40	0.000
	_cons	41.0921	7.642484	5.38	0.000
TDI	AISD	.2286927	.0150341	15.21	0.000
	BTD	-.0228429	.0173198	-1.32	0.188
	ITD	.5584255	.0303252	18.41	0.000
	_cons	17.77793	5.201412	3.42	0.001
ISD	AISD	.0066258	.015218	0.44	0.664
	BTD	.0245257	.0175316	1.40	0.163
	ITD	.7448523	.0306961	24.27	0.000
	_cons	11.2566	5.265025	2.14	0.033

Results of the multivariate regression analysis demonstrated that, the ITD has shown a significant positive effect on OCD, TDI and ISD. A millimeter increase in ITD is associated with 0.552 mm, 0.558 mm, and 0.74 mm increases in the predicted values of OCD, TDI, and ISD respectively. The AISD has shown a significant positive effect only with the TDI. A millimeter increase in the AISD is associated with 0.229 mm increase in the average value of the TDI. Beside this, the TDI of the pelvic inlet is the only diameter that is significantly and positively affected by the ITD and AISD. A millimeter increase in the ITD and AISD is associated with 0.787 mm increase in the average value of the TDI.

Findings of the multivariate regression analysis indicate that, women who have larger ITD are expected to have wider OCD, TDI, and ISD and women with larger AISD are expected to have larger TDI, respectively.

DISCUSSION

For health institutions in low-income countries like Ethiopia, predicting internal lesser pelvis diameters at the level of pelvic inlet and midpelvis by using externally measurable pelvic outlet, greater pelvis and hip diameters is crucial and clinically important issue. There are few studies in the literature that attempted to see the relation between obstetrically important pelvic cavity diameters with externally measurable hip and pelvic bone marking diameters [19].

Results of the current study demonstrated that, A millimeter increase in ITD is associated with 0.552 mm, 0.558 mm, and 0.74 mm increases in the predicted values of OCD, TDI, and ISD respectively. The AISD has shown a significant positive effect only with the TDI. A millimeter increase in the AISD is associated with 0.229 mm increase in the average value of the TDI. Predicting TDI from the values of ITD and AISD is clinically important. According to previous studies, low TDI is associated with dystocia and emergency caesarian section [13, 14]. Our finding on the association between ITD with OCD, TDI, and ISD can be explained as, women who have smaller ITD are expected to have narrower mid pelvis, which is represented by ISD and narrower pelvic inlet size, represented by OCD and TDI.

Based on the reports of previous studies, ISD is found to be the best predictor of head descent, emergency deliveries, instrumental extractions, and obstructed labor in comparison to other pelvic and fetal head parameters [13, 15-17]. In addition to this, studies have also reported a correlation between low OCD values with the probability of caesarean section and cephalopelvic disproportion [13-14, 18].

As far as our literature search is concerned, there is a paucity of imaging studies carried out to assess the predicting capability of intertuberous diameter (ITD) and anterior interspinal diameter (AISD) on obstetrically important pelvic inlet diameters, which are obstetric conjugate diameter (OCD) and transverse diameter of the pelvic inlet (TDI). However, a study conducted in Latvia has assessed the prediction capabilities of ITD, AISD, and BTD on interspinous diameter of the mid pelvis (ISD) only and reported that, unlike AISD and BTD, intertuberous diameter (ITD) was a potential predictor of interspinous diameter of the mid pelvis (ISD), which is consistent with the current report [19].

Conducting a study on the prediction and estimation of obstetrically relevant pelvic cavity diameters from easily and externally measurable pelvic diameters is would be very important in the fields of obstetrics and gynecology, especially for resource limited countries like Ethiopia. However, all the measurements in this study were done on CT images only, which is a limitation of the study.

CONCLUSION

Results of the current study demonstrated that, ITD is a significant predictor of OCD, TDI and ISD. Among the three lesser pelvis diameters, the TDI is the only diameter significantly predicted by the AISD. The BTD has found statistically insignificant to be a potential predictor of OCD, TDI and ISD. The findings of this study give a piece of baseline information on the predictive capabilities of the externally measurable greater pelvis and hip diameters to the main birth canal parameters.

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CONFLICTS OF INTERESTS

The authors declare that they have no conflicts of interests in the publication of this paper. We also would like to acknowledge Sodo Christian Hospital for giving us permission to conduct this study in the center.

ABBREVIATIONS

AISD: Anterior interspinal diameter
BTD: Bi-trochanteric diameter
ISD: Interspinous diameter
ITD: Intertuberous diameter
OCD: Obstetric conjugate diameter
TDI: Transvers diameter of pelvic inlet

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