International Journal of Reproduction, Contraception, Obstetrics and Gynecology
Archana R et al. Int J Reprod Contracept Obstet Gynecol. 2021 Apr;10(4):1472-1477
www.ijrcog.org
pISSN 2320-1770 | eISSN 2320-1789

DOI: https://dx.doi.org/10.18203/2320-1770.ijrcog20211123

Original Research Article

Diagnostic accuracy of sacral rhomboid dimensions in prediction of cephalopelvic disproportion in primigravidae

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Received: 12 January 2021
Revised: 14 February 2021
Accepted: 15 February 2021

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ABSTRACT

Background: Cephalopelvic disproportion (CPD) is associated with significant maternal and fetal morbidity and mortality in developing countries. CPD complicates 2-15% of pregnancies. This study aimed to determine the diagnostic accuracy of sacral rhomboid dimensions in the prediction of CPD in primigravidae
Methods: This prospective study was conducted on 400 primigravidae at 37-week gestation in Department of Obstetrics and Gynaecology at Lady Hardinge Medical College, New Delhi. Women with height>145 cm were subjected to measurement of transverse and vertical diagonals (TD and VD) of sacral rhomboid prior to delivery. Following delivery, the women were divided in two groups: control group (normal delivery, n=290) and study group (caesarean section for CPD, n=56). The sacral rhomboid dimensions were compared in both the groups and statistically analysed.
Results: The mean maternal height in both the groups showed no significant difference (156.88±5.7 vs 155.02±4.75, p=0.011). However, in univariate analysis, maternal height of≤154.5 cm, VD ≤10.25 cm and TD≤9.75 cm showed a diagnostic accuracy of 58.3%, 55.4% and 78%, respectively. Of all the parameters, TD≤9.75 cm was the most significant factor in predicting CPD (34% vs 13%), OR 3.3 (95%CI: 1.7- 6.7, p<0.001).
Conclusions: A simple measurement of transverse diameter of sacral rhomboid is a better predictor of CPD in an average height Indian primigravidae. It can be used in community hospital to detect high risk primigravidae.

Keywords: Cephalopelvic disproportion, Sacral rhomboid dimensions, Primigravidae, Caesarean section

INTRODUCTION

Cephalopelvic disproportion (CPD) is one of the most common problems that medical practitioners encounter in obstetrics, particularly in developing countries. It is well established that CPD, if not detected in time and managed promptly, can lead to dangerous complications to both mother and child. Obstructed labor, the direct clinical consequence of CPD, is estimated to be responsible for around 8% of maternal deaths worldwide.[1] CPD often leads to prolonged labor that may cause post-partum haemorrhage, post-partum infection and obstetric fistulas due to compression by fetal head against the bladder and traumatic delivery affecting both the mother and fetus. Maternal mortality from obstructed labor is largely the result of ruptured uterus or puerperal infection, whereas perinatal mortality is mainly due to asphyxia. In view of the fact that most women in developing countries find it difficult to avail high level of healthcare, it is critical to develop reliable screening parameters that can be used by medical practitioners at primary level for identifying women at risk for CPD.

In most clinical settings, maternal height is being used as the only means to identify women at risk of CPD - it is assumed that shorter the mother, greater the likelihood of

CPD. However, it has also been observed that maternal height in isolation, has very limited value in accurately predicting CPD. Further, since anthropometry and stature of women vary between women of different ethnic origins, it is important to identify the most sensitive predictors of CPD for a particular population. In 1851, Michaelis described a rhombus-shaped contour in the sacral region on the lower back, with the size and shape of the rhomboid differing in women with and without contracted pelvis.[2] The objective of our study was to evaluate the diagnostic accuracy of vertical and transverse diagonal of Michaelis sacral rhomboid as predictors of CPD and to compare its efficacy to other measures like maternal height, weight and external pelvic parameters.

METHODS

This was a prospective observational study conducted in the department of Obstetrics and Gynaecology at Lady Hardinge Medical College and Smt. Sucheta Kriplani Hospital, New Delhi during the period November 2014 to December 2016. Ethical clearance was taken from the Institutional Ethical Committee. The study included 400 primigravidae, aged between 18 to 30 years who were at or beyond 37 weeks of pregnancy attending the antenatal clinic or admitted in the maternity wards. Those with short stature (height less than 147cm), BMI>30 kg/m^2, external deformities of foot, spine or pelvis, multiple gestation, other obstetric complications like APH, PIH, PROM, IUGR, medical or surgical complications, and those who delivered fetuses<2kg or>4 kg were excluded from the study. After obtaining informed written consent, the women were made to undergo a complete general, physical and obstetric examination. In all these women, height (cm), Michaelis sacral rhomboid and external pelvic parameters (cm) (i.e., intercrestal, intertrochantric and interspinous diameters), clinical estimate of fetal weight (gm) by Johnson's formula (EFW(J)) and by USG (EFW(U)) were recorded along with neonatal birth weight (gm). Maternal height was measured with the women in standing position by a stadiometer with an accuracy of 0.5 cm in the antenatal clinic.

Transverse diagonal of the Michaelis sacral rhomboid area (the distance between two notches in superior posterior iliac spines at two transversal ends of sacrum) was measured by taking the distance between the protuberances on the dimples overlying gluteal (points A1 and A2) (Figure 1). Similarly, the vertical diagonal of Michaelis sacral rhomboid (the distance between the fifth lumbar and the last sacral vertebra) was measured by taking the distance from the apex of natal cleft to the point on the fifth lumbar vertebra (points B and C) (Figure 2). A single observer recorded these measurements using a flexible graduated measuring tape. The intertrochanteric diameter, intercrestal and interspinous diameter were measured by Lafayette external pelvimeter with the woman in standing position (Figure 3).

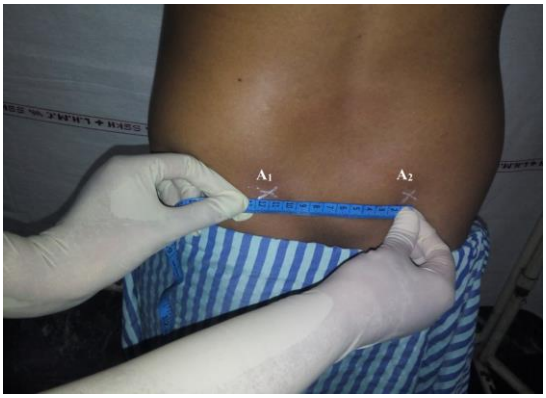

Figure 1: Measurement of transverse diagonal of Michaelis sacral rhomboid.

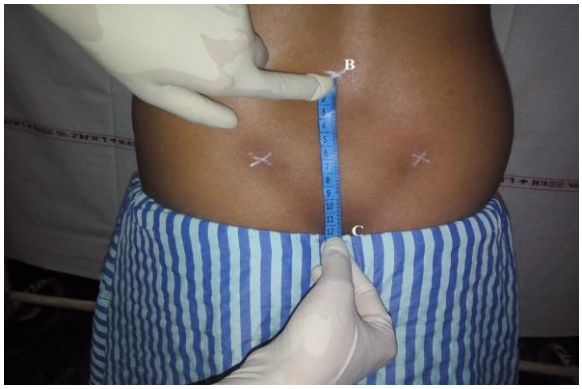

Figure 2: Measurement of vertical diagonal of Michaelis sacral rhomboid area.

Johnson's formula for estimation of fetal weight (EFW) in vertex presentation is:

Fetal weight (g)=SFH (cm) n×155

Here, SFH=Symphysio -fundal height, n=12 if vertex is above ischial spine or 11 if vertex is below ischial spine.

After the clinical estimations of estimated fetal weight, an Ultrasonic estimation of fetal weight was done by Hadlock formula based on biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femoral length (FL). These measurements were recorded in a proforma separate from the antenatal record. The included women were followed up till delivery. Following delivery, the women were allotted into two groups.

Group 1

Control group, women who had a normal vaginal delivery.

Group 2

Study group, those with CPD resulting in operative delivery (caesarean section) for indications like CPD

detected during pelvic assessment in labor or for non-descent/non rotation of fetal head.

The sensitivity and specificity of these measurements were computed and receiver operating characteristic (ROC) curves plotted. Stepwise logistic regression was used to identify predictors of CPD. The optimal cut-off for each variable was obtained using the ROC analysis. To obtain predicted probabilities, all the variables with the optimal cut-off that were significant at the 0.2 level in the univariate analysis were included for the logistic regression. Analysis of variance followed by post-hoc Tukey's test was used to compare differences between the vaginal delivery and CPD groups.

Figure 3: Lafayette external pelvimeter.

RESULTS

Out of the 400 women, 290 had vaginal delivery and 110 women had caesarean delivery. Women who had caesarean section for CPD, non-progress of labor, deep transverse arrest served as the study group (n=56) and women with normal vaginal delivery served as control group (n=290). Women with LSCS for indications like fetal distress (n=44) were excluded from the study. Based on the ROC curves for each measurement, the cut off threshold value with highest sensitivity and specificity was identified.

The difference in the mean height in the study group and control group was found to be statistically non-significant (155.02 +4.75 cm vs 156.88+5.7 cm, p=0.011) (Table 1).

Mean transverse diagonal of sacral rhomboid (TD) was 10.08±0.92 cm in group 2 (vs 10.5±0.97cm in group 1), which is 0.42 cm less and statistically significant (p<0.002). For univariate analysis, TD=9.75 cm was taken as cut off, and 34% had CPD. Odds ratio indicated that TD<9.75 increased the risk of CPD by 3.3 times (95% CI [1.77-6.66]).

Mean vertical diagonal of sacral rhomboid (VD) was 9.95±1.2cm in group 2 (vs 10.65±1.28 cm in group 1), which is 0.7 cm less in group 2 and statistically significant (p<0.001). In univariate analysis, VD=10.25 cm was taken as cut off and 73% had CPD. Odds ratio indicated 2.9 times increased risk of CPD with VD<10.25 (95%, CI [1.6-5.4]). It was also found that mean intertrochanteric, intercrestal and interspinous diameters were not significantly different between group 1 and group 2 (Table 1-3).

Table 1: Comparison of the Mean maternal parameters in two groups.

Maternal parameter	Study group (LSCS) (n=56) Mean±SD	Control group (NVD) (n=290) Mean±SD	P value
Height (cm)	155.02±4.75	156.88±5.7	0.011
TD (cm)	10.08±0.92	10.5±0.97	0.002
VD (cm)	9.95±1.2s	10.65±1.28	<0.001
Intertrochantric (cm)	31.3±1.82	31.38±1.67	0.382
Intercrestal (cm)	26.05±2.08	26.34±2.53	0.217
Interspinous (cm)	23.5±1.73	23.78±2.1	0.174
EFW (J) (gm)*	3439.05±404.07	3362.19±370.95	0.081
EFW (U) (gm)**	2960.19±290.57	3000.87±368.13	0.222

* EFW (J): Estimated fetal weight by Johnson's formula; **EFW (U): Estimated fetal weight by USG

Table 2: Univariate analysis of maternal parameters (based on cut off values).

Maternal parameter		Study group (LSCS) (n=56)		Control group (NVD) (n=290)		P value
		N	%	N	%	
Height (cm)	≤ 154.5	30	54	118	41	0.037
	> 154.5	26	46	172	59	
TD (cm)	≤ 9.75	19	34	39	13	<0.001
	> 9.75	37	66	251	87	
VD (cm)	≤ 10.25	41	73	139	48	<0.001
	> 10.25	15	27	151	52	
EFW (J) (gm)	≤ 3332.5	23	41	139	48	0.173
	> 3332.5	33	59	151	52	

Table 3: Diagnostic accuracy of maternal parameters (univariate analysis).

Maternal parameter	Sensitivity	Specificity	PPV	NPV	Accuracy	Odds ratio	95% CI	
							Lower	Upper
Height (cm)	53.57	59.31	20.27	86.87	58.38	1.682	0.950	2.978
TD (cm)	34.0	86.55	49	87.15	78.03	3.305	1.771	6.667
VD (cm)	73.21	52.07	22.78	90.96	55.49	2.969	1.605	5.493
EFW (J) (gm)	41.07	52.07	14.20	82.07	50.29	0.757	0.424	1.351

PPV: Positive predictive value; NPV: Negative predictive value

Table 4: Diagnostic accuracy of combination models.

Combination models	P value	Sensitivity	Specificity	PPV	NPV	Accuracy	Odds ratio	95% CI	
								Lower	Upper
HT+TD	0.005	64.29	54.48	21.43	88.76	56.07	2.155	1.201	3.866
HT+VD	0.017	83.93	30.00	18.80	90.63	38.73	2.238	1.067	4.695
TD+VD	0.001	80.36	47.59	22.84	92.62	52.89	3.714	1.910	7.224
TD+VD+EFW	0.042	87.50	22.76	17.95	90.41	33.24	2.063	0.905	4.700

PPV: Positive predictive value; NPV: Negative predictive value

The clinical estimates of fetal weight (Johnson's) and by USG were also found to be insignificant (p=0.081 & p=0.222) (Tables 1, 2). The mean actual birth weight in the study and control groups was 2927.23+384.50 gm and 2841.91+300.94 gm respectively; again, the difference was statistically insignificant.

In the multivariate analysis (by logistic regression curve), combination of maternal height (≤154.5cm) with Transverse diagonal (≤9.75cm) of Michaelis sacral rhomboid area (HT+ TD) showed diagnostic accuracy of 56.07% (Sensitivity of 64.29%, specificity of 54.48% and positive predictive value of 21.43%). It was also found that the combination of HT+TD, increased the risk by 2.1 times (OR: 2.1; 95% CI: [1.2- 3.8], p=0.005) (Table 4).

Combination of maternal height (≤154.5 cm) with vertical diagonal (≤10.25 cm) of Michaelis sacral rhomboid area (HT+VD) had diagnostic accuracy of 38.73% (Sensitivity of 83.93%, specificity of 30.00% and positive predictive value of 18.80%). It was also found that the combination of HT+VD increased the risk by 2.2 times (OR: 2.2; 95%CI: [1.06- 4.69], p=0.017) (Table 4).

When Transverse Diagonal (≤9.7 5cm) was combined with Vertical Diagonal (≤10.25 cm) of Michaelis sacral rhomboid area (TD +VD), it was found that this combination increased the risk of CPD by 3.7 times (OR: 3.7; 95%CI: [1.9-7.2], p=0.001). However, the diagnostic accuracy of the combination TD+ VD was found to be 52.89% only (Table 4).

Multivariate analysis combining TD+VD+EFW(J) was found to be less significant (p=0.042)

DISCUSSION

The objective of the present study was to evaluate various maternal parameters as predictors of CPD in primigravidae with normal height. The incidence of CPD in the study group was found to be 14%, which is comparable to Bansal et al 12%, Rossiter et al 9-11% and Deepika 12%.[3-5]

The difference in the mean height of women in the study group (155.02+4.75 cm (R=148-164 cm) and control group (156.88+5.7cm (R=147-173 cm) was insignificant (p<0.011). Thus, the distribution of women in the study group and control group was found to be statistically insignificant. Our results were comparable to with that of Heevy et al, which also did not reveal any statistical difference between the control group (>150 cm) and study group (<150 cm) in relation to risk of caesarean section.[6] Kara et al also could not demonstrate any statistical difference in their study.[7] The importance of height as an index of pelvic adequacy and, moreover, of reproductive efficiency has been extensively studied by Baird; who found that as the height of mother decreases, the rate of caesarean section rises.[8] In another Indian study done by Bansal et al the mean maternal height was significantly less in cases who had caesarean delivery for CPD compared to those with normal vaginal delivery [(150.5±7.25 vs 154±5.97cm, (p value<0.003)].[3] A high percentage of women (31/ 36) in this study had height below 10th percentile (146.5 cm) and 25% of these had contracted pelvis. A similar observation was made by Benjamin et, where the mean maternal height of the women who underwent LSCS was significantly lesser than the women who had vaginal delivery [152.1±6.0cm vs 157.1±6.6 cm, p<0.001].[9] However, unlike in our study, they had included women with height<149 cm.

BMI was not statistically different in the two groups in our study. Studies done earlier had similar finding– Helen and Brunno; however, study by Young et al found that women with higher BMI are at higher risk for disproportion. In the present study, women with BMI>30 were excluded.[10-12]

External pelvimetric measurements was the first technique used to predict cephalopelvic disproportion. In the present study, the external pelvimetric measurements i.e., intertrochanteric, intercrestal and interspinous diameters in the study and control groups were found to be statistically insignificant (31.3+1.82cm vs 31.38+1.67cm, p<0.382; 26.05+2.08 cm vs 26.34+2.53 cm and 23.5+1.73cm vs 23.78+2.1 cm, p<0.174).

Our results were consistent with that of Bansal et al, who observed no difference in the mean intercrestal distance and intertrochanteric distance in the control group and study group [25.4±1.74 cm vs 25.3±1.82 cm (p<0.65)] and [29.9±1.84 cm vs 29.8±1.95 (p<0.86)] respectively.3 Benjamin et al (2011) also did not find any significant difference in the mean intercrestal and intertrochanteric distance in the control group and study group [(27.2±1.9 cm vs 28.9±3.7cm (p<0.628)] and [30.6±1.8 cm vs 28.9±3.7 cm (p<0.086)].[8] Similarly, Rahele et al observed the mean intertrochanteric diameter in normal delivery group and dystocia group was almost same (31.1±1.8 cm vs 31.0±2.2cm, p<0.557).[13] Rozenholc et al in their study found that the mean intertrochanteric diameter in dystocia group was significantly lower compared to that in normal delivery group (23.9±2.9cm vs 25.1±2.9cm, p<0.001).[14] Similarly, Liselele et al found that all the three external pelvic diameters -intercrestal diameter, interspinous diameter and intertrochanteric diameter were significantly lower in the dystocia group.[15]

Adolf Michaelis suggested the importance of Michaelis sacral rhomboid area in evaluation of pelvic capacity for the first time in 1851.[2] Sacral rhomboid is an area whose dimensions are considered as an indirect measure of pelvic capacity. An abnormal size of Michaelis sacral rhomboid area is a predictor of abnormal pelvic size, with a shorter transverse diagonal than the vertical diagonal suggesting a smaller pelvis. However, the cut off values for these diameters for the purpose of predicting CPD is still not established.

In the current study, the mean transverse diagonal of Michaelis sacral rhomboid area of the study group was comparatively lower than that of the control group [10.08+0.92cm and 10.5+0.97cm respectively, p<0.002], which were comparable to Bansal et al (2008) (10.04±0.91 cm vs 10.54±0.71 cm, p=0.003), Lislele et al (2000) (9.8±1.5 cm vs 10.7±1.1 cm, p<0.001), Rahele et al(9.7±0.9 cm vs 10.3±0.7 cm, p=0.00) and Rozenholc et al (2007) (10.1±1.6 cm vs 10.9±1.1 cm, p<0.001).[3,13-15] Further, the cut off TD<9.5 cm had sensitivity 34%, specificity 86% and highest diagnostic accuracy of 78%; with the risk of CPD increasing by 3.3 times. These findings were consistent with Liselele et al (sensitivity 43%, specificity 90%), Rozenholc et al (sensitivity 45%, specificity 92%) and Rahele et al (diagnostic accuracy of 81%).[13-15]

The mean vertical diagonal of Michaelis sacral rhomboid area of the study group was comparatively lower than that of the control group (9.95±1.2 cm vs. 10.65±1.28 cm, p<0.001), which was comparable to studies conducted by Lislele et al (2000) (10.9±1.8 cm vs 11.9±2.1 cm, p<0.001), Bansal et al (2008) (11.39±1.1 cm vs 11.85±1.027 cm, p=0.012).[3,15] In the present study, the cut off for VD was taken as<10.26 cm, and this had sensitivity of 73%, specificity of 52% and diagnostic accuracy of only 55.4%; with the risk of CPD increasing by 2.9 times. However, vertical diagonal of Michaelis sacral rhomboid was an insignificant factor in the study by Rahele et al the mean vertical diagonal in the NVD and dystocia group was 9.4±0.9 cm and 9.6±1.0 cm (p=0.200).[13]

In the present study, the difference in the mean estimated fetal weight for the study group and control group by Johnson's formula (3439.05+404.07 gm vs 3362.19+370.95 gm) and by USG (2960.19+290.57 gm vs 3000.87+368.13gm) was not significant. Bansal et al and Wanchai et al found that there was a significant difference in the actual birth weight (gm) between the cases and controls.[3,16] The findings of Benjamin et al in 2011 and Rahele et al in 2014 was in accordance with the present study–with both studies observing an insignificant difference in the mean estimated fetal weight (Johnson's formula) among cases and control group i.e. (3556±410 gm vs 3365±399 gm, p<0.023) by Benjamin et al and (3811±409 vs 3204±378 gm, p=0.059) by Rahele et al.[9,13] Fetal weight was found not to be a significant factor in the present study; probably other factors like malposition of the head could be the contributor in causing CPD.

Combination of maternal HT+TD had the diagnostic accuracy of 56.07% (p<0.005) with a sensitivity of 64.29%, specificity of 54.48% and positive predictive value of 21.43%. Thus, addition of height to TD further decreased its predictive value from 49% to 21% and accuracy from 78% to 56%. Rozenholc et al found the combination of a maternal height less than or equal to the 5th percentile and Michaelis transverse less than or equal to the 10th percentile resulted in the best sensitivity (53%), specificity (92%), positive predictive value (47%) and positive likelihood ratio (6.6).[14] Bansal et al also observed a significant increase in the detection rate of CPD using maternal height, transverse and vertical diagonals of sacral rhomboid in combination with, the detection rates increasing to 50–60% and the risk increasing manifold.[3] The various cut offs used in the study by Bansal et al was comparatively lower (height<146.5 cm, TD<9.5 cm and VD 10.5 cm) than ours.3 Hence, maternal height was found to be a significant factor in predicting CPD.

Combination of TD+VD increased the risk of disproportion by 3.7times (OR: 3.7; 95%CI: 1.9-7.2, p=0.001) but had diagnostic accuracy of 52.8% only.

Our results confirm previous studies showing the limitations of maternal height to predict cephalopelvic

disproportion. Abnormal size and shape of the Michaelis sacral rhomboid area, was reported to be associated with abnormal pelvis. Our study shows that the transverse diagonal of the sacral area is the strongest anthropometric predictor for cephalopelvic disproportion.

CONCLUSION

Measurement of maternal height has been used as a simple means to identify women at risk of CPD, as it is considered that shorter the mother, greater the likelihood of CPD. In cases where the mother has an appropriate height with an average fetal weight, mother's transverse diagonal of Michaelis sacral rhomboid is a very promising parameter in predicting CPD and hence it should be added in the antenatal chart. The size of the Michaelis transverse is associated with the transverse pelvic capacity. Therefore, a lowered transverse pelvic capacity may be more critical resulting in CPD during labour. Since anthropometry and stature of women of different ethnic origins vary, it is important to identify the most sensitive predictors of CPD for a particular population. In conclusion, measurements of the transverse diagonal of the Michaelis sacral rhomboid area by using a measuring tape may represent a simple method to detect nulliparous women at risk for cephalopelvic disproportion in peripheral antenatal clinics and to refer such women to better resource setting, thereby leading to long term impact in reduction of maternal and neonatal morbidity and mortality.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Archana R, Patra S. Fetal Diagnostic accuracy of sacral rhomboid dimensions in prediction of cephalopelvic disproportion in primigravidae. Int J Reprod Contracept Obstet Gynecol 2021;10:1472-7.