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Study of anthropometric measurements to predict contracted pelvis

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Abstract

Background: To study the efficacy of using maternal height, foot length, external pelvic measurements, sacral rhomboid dimensions as predictors of contracted pelvis (CP) in a cohort of our population and proposed to include estimated fetal weight as an additional parameter as a predictor of cephalopelvic disproportion.

Methods: In 1000 uncomplicated primigravida after 37 weeks gestation, transverse and vertical diagonal (TD and VD) of the sacral rhomboid, intertrochanteric diameter, biacromial diameter, foot length in centimeters, height in centimeters and weight in kilograms and birth weight of the baby in kilograms were recorded. Postdelivery, patients fell into two groups: Group-1: control (no CP) - women having uncomplicated vertex vaginal delivery, Group-2: cases (CP) - this group will include women with pelvic disproportion having: Caesarean section for disproportion detected on pelvic assessment or for non-descent/non rotation of the fetal head, Vacuum or forceps delivery for prolonged second stage, Vaginal delivery complicated by obstruction, birth trauma or unexplained intrapartum asphyxia.

These two groups will be compared for their outcome. Data was analyzed using t-test, Pearson's-Chi square, Fishers exact test and multivariant logistic regression.

Results: Cephalopelvic disproportion was present in 123 women. In univariate analysis, maternal height, foot length, intertrochanteric diameter and biacromial diameter were found to be associated with cephalopelvic disproportion, Rhomboid dimensions were smaller in CP group (TD of rhomboid P value < 0.001, VD of rhomboid P value 0.001). For transverse diagonal, when the 10th percentile (<9.5 cm) was taken as cut off, 219 women were identified to be at risk and 55 (25%) actually had CP. Odds ratio indicated that transverse diagonal < 9.5 cm alone increased the risk by 3.5 times (95% CI 2.33– 5.31). Mean vertical diagonal of sacral rhomboid (VD) was also 0.95 cm less in group 2 which also was statistically significant (p = 0.001). Both dimensions of sacral rhomboid below 10th percentile increased CP by 10 times (OR 10.9, 95% CI 5.62-21.35).

Conclusion: Clinical external parameters Viz: most significant to predict the contracted pelvis were Maternal Height, Foot Length, ITD, BAD, TD and VD.

Smaller dimensions of sacral rhomboid are promising screening parameter for contracted pelvis which can be used in community to pick up high risk primigravida women.

Keywords: Contracted pelvis, sacral rhomboid, primigravida, vaginal delivery, caesarean section.

Introduction

Knowledge of pelvic deformities, and obstruction of labour resulting there from, was held up well into the 16th century. Maternal death remains a major health problem in some developing region of world such as sub-Saharan Africa & South Asia and among these 20-30% are attributable to complications of cephalopelvic disproportion [2]. Pelvic disproportion complicates 2-15% and the antenatal prediction of this condition and timely management is essential for decreasing its contribution to obstetric mishaps[3]. From centuries, the various methods to assess the pelvis antenatally has been in practice with variable outcome. These methods include manual pelvimetry, instrumental pelvimetry, radiological pelvimetry with sophisticated gadgets like x-ray, MRI & CT scan. Aranzio first suggested the use of whole hand. This method was elaborated by Johnson, a pupil of Smellie, and by Ramsbotham many years later. The only method which has stood the test of time and is still employed universally is that described by the pupil of Smellie [1]. The constant efforts are to device a method which can predict the cephalopelvic disproportion with fair accuracy, which is easy to learn, easy to employ and universally accepted by the examiner and the subjects. The method should be less invasive and should not be harmful to the mother and fetus. The manual method though universally has limitations like, the subject is not co-operative so does not accept it, moreover the assessment vary from one examiner to other, so it is not uniform. Most women in the developing world are not able to avail the high level of health care so it is essential to develop simple and reliable screening parameters that can be used by all health personnel including the trained birth attendant, midwives, and nurses. The present study was conducted with the aim to evaluate various Anthropometric Measurements like Sacral Rhomboid, maternal height, foot length, age and weight for prediction of cephalopelvic disproportion. Maternal height is presently the only parameter incorporate in antenatal charts for identification of women at risk of pelvic disproportion, anthropometric measurements viz. maternal weight, foot length and external pelvic measurement may increase the likelihood of predicting CPD. In the 19th century, Adolf Gustav Michaels described a rhomboid on the lower back overlying the sacrum. The posterior iliac spine bonds it on either side, L5 vertebra superiorly and upper end of natal cleft inferiorly. Michaels noticed that its shape and size differed in women with and without contracted pelvis [3].

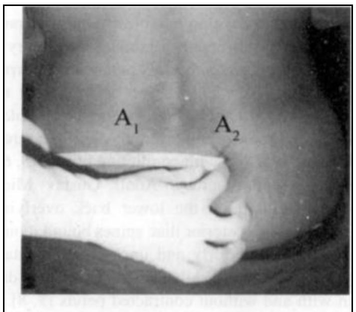
Measurement of maternal height has been used as a simple means to identify women at risk of cephalopelvic disproportion as it is assumed that shorter the mother greater the likelihood of cephalopelvic disproportion. However, maternal height in isolation has limited value for predicting cephalopelvic disproportion risk and combining anthropometric measurements may increase the likelihood of predicting cephalopelvic disproportion.

Methods

The proposed prospective study was conducted in Department of Obstetrics and Gynecology, Kamla Nehru State Hospital for Mother and Child, IGMC, Shimla. It included primigravidae ≥ 37 weeks of pregnancy attending the antenatal clinic. The exclusion criteria was:-

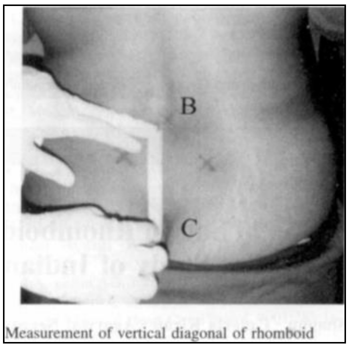
- Women with pelvic, leg deformity or deformity in gait
- Other than Cephalic presentation
- Twin pregnancy
- Intrauterine fetal demise
- Major congenital anomalies of the fetus
- Complicating surgical or medical illness
- Delivered fetuses <2.5kg or >3.5kg
- Elective caesarean section & C.S. for reasons other than dystocia.

The written consent was taken from the patient and her attendant. The detailed antenatal history, obstetric history, menstrual history, past history, family history and personal history was taken and noted in proforma. General physical examination, systemic examination, per abdomen examination with special emphasis on measurement of fundal height and abdominal girth, the estimated fetal weight was calculated by the product of symphysiofundal height in cm and abdominal girth in cm and expressed in grams [18]. Pelvic assessment was done and sacral rhomboid was measured by taking the following points.



Measurement of transverse diagonal of rhomboid

- A1 and A2 was marked on back of the women between two posterior iliac spines as protuberances on the dimples overlying gluteal region



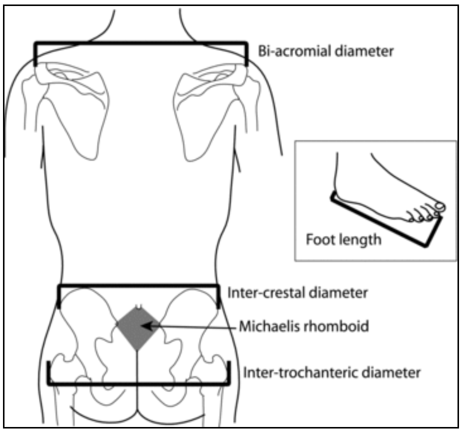
Measurement of vertical diagonal of rhomboid

- Point B-over the spine of L5 vertebrae, this corresponds to the upper border of sacrum
- Point C-uppermost point of natal cleft which represent the lower border of sacrum

Vertical diagonal (VD) of sacral rhomboid will be measured between point B and C

Transverse diagonal (TD) will be measured from point A1 to A2

Intercrestal distance, Intertrochanteric distance, and Biacromial distance will be measured as shown in the figure.



Foot size will be measured by foot stand.

These measurements were recorded separate from the antenatal record so that they will have no bearing on the subsequent labour management of the subject. The delivery events were recorded and its outcome recorded as per the Proforma.

Following delivery the women will be allotted into two groups

Group-1: control (no CP) - women having uncomplicated vertex vaginal delivery

Group-2: cases (CP) - this group will include women with pelvic disproportion having:-

A) Caesarean section for disproportion detected on pelvic assessment or for non-descent/non rotation of the fetal head

B) Vacuum or forceps delivery for prolonged second stage

C) Vaginal delivery complicated by obstruction, birth trauma or unexplained intrapartum asphyxia

These two groups will be compared for their outcome. Data was analyzed using t-test, Pearson's-Chi square, Fishers exact test and multivariate logistic regression.

Results

This prospective study was conducted at Indira Gandhi Medical College, approved by ethical committee. Out of the women who were enrolled initially, 120 were excluded according to our exclusion criteria from the study and a total of 1000 women who fulfilled the inclusion criteria were recruited in the study.

Out of 1000 women recruited in the present study, depending on the outcome they were allocated into two groups:

Group 1 (n=877): Women undergoing normal vaginal delivery.

Group 2 (n=123): Women undergoing caesarean section for contracted pelvis/CPD and forceps/ventouse application for prolonged second stage of labour.

In the group 2, 75 underwent caesarean section and 48 had operative vaginal deliveries. These women were older than women in group 1 (p value < 0.001), both the groups did not match each other. Age was significantly associated with contracted pelvis. Mean weight of women was 69.16 ± 3.91 kgs in group 1 and 69.67 ± 4.08 kgs in group 2 (p value = 0.17) and no significant difference was observed between the two groups. Mean height was significantly different in two groups and had a positive correlation with disproportion (p value = < 0.001). Mean gestational age was almost similar in two groups, 36 weeks 6 days and 37 weeks 4 days respectively. The difference between the two groups was not found significant (p value=0.072) (Table 1).

Table 1: Baseline characteristics in the two groups

Parameters	Group 1 (n=877)	Group 2 (n=123)	P value
Age in years	23.63	26.24	<0.001
Height (cm)	157.21	143.32	<0.001
Weight (Kg)	69.16	69.67	0.17
Gestational age	36+6	37+4	0.072

Mean maternal height was significantly less in group 2 (P value <0.001). 110 women were identified with height below 10th percentile (<145 cm) out of which 35 (31.8%) were inferred to have CP. Odds ratio indicated a 4.25 times (95% CI 2.62-6.88) increased risk of disproportion at this cut off (Tables 2, 3)

Foot length in centimeter was significantly less in group 2 (p value < 0.001). 102 women were identified with foot length < 23 cm out of which 30 were identified to have CP. Odds ratio indicated 3.72 times (95% CI 2.24-6.16) increased risk of disproportion at this cut off.

Mean transverse diagonal of the sacral rhomboid (TD) was 1.06 cm less in group 2 and was statistically significant (*p*<0.001). When the 10th percentile (<9.5 cm) was taken as cut off, 219 women were identified to be at risk and 55 (25%) actually had CP. Odds ratio indicated that transverse diagonal < 9.5 cm alone increased the risk by 3.5 times (95% CI 2.33– 5.31) (Tables 2, 3).

Mean vertical diagonal of sacral rhomboid (VD) was also 0.95 cm less in group 2 which also was statistically significant (p = 0.001).

Mean Biacromial and intertrochanteric distances were statistically significant between group 1 and 2 (Table 2). 10th percentile cut off for these parameters indicated 4.88 and 4.16 times the increased risk of having CP respectively (Table 3).

Table 2: Comparison of maternal parameters in the two groups

Maternal Parameters	Group 1 n = 877 Mean ± SD	Group 2 n = 123 Mean± SD	P –value
Height (cm)	157.21 ±6.65	143.32±3.64	<0.001
Foot Length (cm)	25.33 ± 1.51	24.17 ± 1.78	< 0.001
ITD (Intertrochanteric diameter)	38.92 ±5.11	30.54±4.84	< 0.001
BAD (Biacromial diameter)	44.36 ± 5.90	34.78 ± 5.4	< 0.001
TD (Transverse diagonal of rhomboid)	10.31±.76	9.25 ± .60	< 0.001
VD (Vertical diagonal of rhomboid)	11.86±5.11	10.91±.05	0.001

Table 3: Univariate analysis of 10th percentile cutoffs of maternal parameters

Parameters	No. of women	Group =1	Group =2	Odds ratio	CI (95%)	X^2 value / P value
Height ≤145 cm >145 cm	110 890	75 802	35 88	4.25	2.62-6.88	43.65 / 0.000
Foot Length ≤23cm >23cm	102 898	70 807	30 93	3.72	2.24-6.16	32.27/ 0.000
Intertrochanteric diameter ≤28 cm >28 cm	165 835	117 760	48 75	4.16	2.70– 6.40	51.65 / 0.000
Biacromial Diameter ≤34cm >34cm	158 842	108 769	50 73	4.88	3.1– 7.52	65.10/ 0.000
Transverse diagonal ≤9.5 cm >9.5 cm	219 781	164 713	55 68	3.52	2.33– 5.31	42.68 / 0.000

From table 4, it is observed that birth weight was statistically significant as their means were not comparable 2750±250 gm and 3150±300gm in group 1, and group 2 respectively (p value=0.001). Babies born to the disproportion group were heavier.

Table 4: Comparison of fetal birth weight in two groups

Fetal parameter	Group 1	Group 2	P value
Birth weight (gms)	2750±250	3150±300	0.001

From table 5, it is observed that when individual maternal parameters were compared for their sensitivity and specificity, height had sensitivity and specificity 28%, 91%. Similarly Intertrochanteric diameter had sensitivity of 39% (48/123) and specificity of 86% (760/877). Biacromial Diameter had sensitivity and specificity of 40% and 87%. Transverse diagonal and vertical diagonal showing sensitivity and specificity of 44%, 81% and 28%, 83% respectively. Birth weight had sensitivity of 30% and specificity of 88%.

Table 5: Comparison of different maternal parameters

Sr. No	Maternal Parameters	Sensitivity	Specificity	Positive predictive value
1	Height (cm)	28% (35/123)	91% (802/877)	31.8%
2	Foot length (cm)	22%(22/123)	91.9%(806/877)	28%
3	Intertrochanteric diameter	39% (48/123)	86% (760/877)	29.09%
4	BiacromialDiameter	40% (50/123)	87% (769/877)	31.6%
5	Transverse diagonal	44% (55/123)	81% (713/877)	25.1%
6	Vertical diagonal	28% (35/123)	83% (723/877)	19.6%
7	Birth weight	30% (38/123)	88% (780/877)	28.14%

From table 6, it is observed that when combination models of the group were compared taking the 10th percentile cut off HT+TD had (OR 6.01, 95%CI3.44-10.99), Similarly when HT+VD and TD+VD were compared they had (OR 5.94, 9.91, 95%CI3.18-11.07, 5.17-19.05) respectively. These combination models were statistically significant (P value = 0.000).

Table 6: Combination Models

Parameters	Group 1	Group 2	Odds ratio	95% CI	X^2 value/p value
HT +TD ≤145cm+≤9.5cm	41 836	28 95	6.01	3.44-10.49	54.95/0.000
HT +VD ≤145cm+≤10.5cm	21 856	22 101	8.8	4.51-17.49	62.91/0.00
TD +VD ≤9.5cm+ ≤10.5m	20 857	25 98	10.9	5.62-21.35	81.73/0.000

Discussion

Pelvic disproportion complicates 2-15% of pregnancies and is associated with significant maternal and fetal complications. The antenatal prediction of this condition and timely management is essential for decreasing its contribution to obstetric mishaps. As most women in developing countries are unable to avail high level of health care, it is essential to develop reliable screening parameters that can be used by all health personnel at primary level. Present prospective study used various measurable maternal external parameters during antenatal period to predict contracted pelvis and timely management.

The incidence of pelvic disproportion/contracted pelvis in the present study is 12.3% which is comparable to studies by Shagun B *et al* (2011) [3] (12%) and Rossiter C E *et al* (1985) [5] (9-11%) respectively.

Age has significant correlation with women who had contracted pelvis as compared to women who delivered normally by the vaginal route. Contrary to these studies Liselele H B *et al* (2000) [6] had shown age had no correlation with contracted pelvis/CPD as study was conducted on smaller population (542). The ACOG bulletin has also reported age more than 35 years to be a risk factor for second stage dystocia [7]. Women's height is correlated to pelvic size and is currently used to predict cephalopelvic disproportion [8-11]. In our study women were shorter in disproportion group. When10th percentile values (<145 cm) were used risk of CPD was 4 times and up to 28% women with CPD could be detected using this parameter alone (sensitivity 28%). These findings were consistent with findings of various other authors [2, 3, 12].

Maternal weight was not different in the two groups statistically. Studies done earlier have reported similarly [13, 14], but study by Young TK [15] *et al* found that women with higher BMIs and pre pregnancy weight gain are at high risk for disproportion.

When different studies were compared for foot length conducted by Benjamin S J (2012) [2], Rozenholc A *et al* and present study were comparable to present study and had statistically significant co-relation. But contrary to the studies conducted by Awonuga *et al* [3] and Mahmood *et al* [16], no significant correlation was found (Have taken Foot Length <18cm and >18cm).

Pelvic measurements performed either by external pelvimetry or by x ray techniques, can provide markers of the risk for cephalopelvic disproportion. External pelvic measurements have been found to be correlated with internal pelvic measurements by x ray [16, 17]. In the present study, majority of external pelvic measurements were smaller among women having cephalopelvic disproportion.

ITD of the present study is comparable to the prospective study conducted by Rozenholc A *et al* (2007) [8] (32.0 ±3.6 in group1 and 29.0 ± 3.0 in group 2 respectively with p = value <0.001) and also Lisele H B (2000) [6] *et al*. Taking the 10th percentile cutoff ITD it has sensitivity 39% (48/123) and specificity 86% (760/877) with PPV 29.09% for predicting contracted pelvis which is comparable to study conducted by Rozenholc A *et al*.

Transverse diagonal of Michael's Rhomboid is compared it was found to be significantly smaller in group 2 (contracted pelvis/CPD) in present study (10.31±.76cm in group 1 and 9.25 ± .60 cm in group 2) P = value 0.001 which was comparable to prospective studies conducted by Shagun B *et al* (2011)[3] (10.54±0.71 in group 1 and 10.04±0.91 in group 2) P = value 0.003, Rozenholc A *et al* (2007) [8] (10.9±1.1) and (10.1±1.6 in group 2) P = value < 0.001.

The 10th percentile cutoff (< 9.5 cm) had sensitivity of 44% in identifying the women at risk of CPD in present study. These findings are consistent with those reported by Benjamin S J (2012) [2] and Hubert Lislele *et al*. who found sensitivity of 38%

and 43%, specificity of 91% and relative risk of 7.0 with 10th percentile cut off.

The mean VD of the sacral rhomboid is significantly smaller in the CPD group in present study (group 1, 11.86±5.11 Group2,10.91±.05) which was comparable to studies conducted by Lisele H B(2000) [6] (10.7 ±1.1, 9.8± 1.5) and Shagun B *et al* (2011) [3] (11.85 ± 1.027, 11.39 ± 1.1) in group 1 and group 2 respectively. 10th percentile cut off (<10.5 cm) had sensitivity of 28% and relative risk of 2.04 times.

This finding is contrary to that of Hubert Lisele *et al*. who did not find this parameter significant this can probably be attributed to the racial differences in pelvic architecture between African and Indian women.

Heavier babies were more common in the disproportion group this being an obvious finding as fetal size is an integral component of CPD. Present study is comparable to Rozenholc A *et al* (2007) [8] (3173 ±404 in group 1 and 3463 ± 400 in group 2 with p = value < 0.001) and Shagun B *et al* (2011) [3] (2810 ± 340 in group 1 and group 2, 3012 ± 417.6 respectively with p = value 0.001). Taking 10th percentile cutoff, Birth weight has (OR 3.59, 95% CI 2.27 – 5.69). Using as a single parameter it has sensitivity 30% (38/123), specificity 88% (780/877) and PPV 28.14%

When combination models using maternal HT+TD, HT+VD, TD+VD of sacral rhomboid were evaluated, in the present study they have (OR 6.01, 95% CI 3.44-10.49, OR 8.8, 95%CI 4.51-17.49 and OR 10.93, 95% CI 5.62-21.35) respectively.

Which was comparable to studies conducted by Shagun B *et al* (2011) [3] HT+TD (OR 8.86, 95% CI 2.9 27.05) HT+VD (OR 10.48, 95% CI 2.67 41.11) and TD+VD (OR 13.00, 95%CI 3.47 48.68). Out of these combination models TD+VD increases the risk of disproportion by 10 times and detection increased by 55%-60%. As actual number of women in group 2 is small, these combination models had very few subjects and their validity needs confirmation by larger studies.

Conclusion

Clinical external parameters Viz: most significant to predict the contracted pelvis were Maternal Height, Foot Length, ITD, BAD, TD and VD.

When combination models using maternal height, transverse and vertical diagonals of sacral rhomboid were evaluated, HT+TD were most significant and the relative risk was increased by 10.9 times. As actual number of women in group 2 is small, these combination models had very few subjects and their validity needs confirmation by larger studies. But we can safely conclude that sacral rhomboid dimensions were promising new parameters that warrant a place in antenatal screening charts alongside maternal height for timely identification of women at risk of CPD. In developing world, this can have a long-term impact in reducing maternal and neonatal morbidity and mortality.

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