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Performance of maternal abdominal subcutaneous fat thickness in predicting cesarean section

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Abstract

Introduction: Overweight and obesity during pregnancy is associated with increased risk for cesarean delivery. BMI is the most frequently used parameters to define and to assess risk of pregnancy related complications. Maternal abdominal subcutaneous fat thickness (SCFT) can be used as a measure of obesity. The present study was done to find association of maternal SCFT with risk of cesarean section.

Methods: 200 women with singleton live pregnancy at 16-18 weeks were included in the study after obtaining written informed consent. Ultrasonography was done to assess foetal wellbeing and rule out congenital malformation. Maternal abdominal subcutaneous thickness was measured. All women were followed during labour till discharge. ROC curve analysis was done to predict the risk of cesarean section. Odd ratio for SCFT mediated risk of cesarean section was calculated.

Results: 32.5% women had cesarean delivery. Mean SCFT was also significantly more in women delivered by cesarean than who delivered vaginally (p <0.001). ROC curve analysis for SCFT showed that SCFT above 11.5 mm (AUC=0.735) predicted LSCS with a sensitivity of 86.2% and specificity of 47.4% and Youden index of 0.34. Increased abdominal SCFT was significantly associated with increased risk of LSCS. . Using 11.5 mm cut -off value (by ROC curve) for SCFT, the odd ratio of LSCS was 7.5 (95% CI 3.4056 – 16.5837, p <0.0001). Stitch line infection was seen in 15.38% women.

Conclusion: This study observed that measurement of SCFT by ultrasonography at 16-18 weeks pregnancy is a significant predictor of cesarean section.

Keywords: Cesarean Section; Obesity; Body Mass Index; Subcutaneous Fat Thickness; Ultrasonography

1. Introduction

An increasing number of women in India have been undergoing a cesarean section (C-section) to deliver babies compared to five years ago. As per data from the National Family Health Survey 5 (NFHS) on delivery care C-section births in India is increased 4.3 percentage points over five years, from 17.2 per cent (NFHS-4, 2015-16) to 21.5 per cent (NFHS-5, 2019-2021) [1]. There is also increase in women who are overweight or obese (BMI ≥ 25 kg/m2) from 20.6% (NFHS -4, 2015-2016) to 24% (NFHS-5, 2019-2021) [1]. The rising prevalence of overweight and obesity during pregnancy is associated with the occurrence of a greater number of complications during pregnancy, childbirth, or the postpartum period [2]. Obese women appear to have a twofold increase in risk for a cesarean delivery, compared with

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non-obese women [3, 4]. Various studies done in the past also shows a positive association between pre-pregnancy BMI and cesarean delivery which makes women with higher BMI at a greater risk of delivery complications compared to those with lower BMI [5, 6].

Till date BMI is most frequently used parameters to define obesity and risk assessment of obesity-related pregnancy complications [7]. BMI does not account for the amount of muscle mass or fat distribution or the proportion of adipose to non-adipose tissue [8, 9]. Central abdominal obesity (adipose tissue around the trunk) is associated with increasing the risk of cardiovascular disease, hypertension and diabetes, whereas peripheral adiposity (adipose tissue around the bottom and thighs) appears to be protective [7]. Central obesity can be assessed with computed tomography (CT), magnetic resonance imaging (MRI) or body densitometry. CT and MRI are impractical tools during pregnancy. Maternal abdominal subcutaneous fat thickness (SCFT) can be used as a measure for central obesity and can be measured by ultrasound easily [10, 11]. Very few studies done in the past observed that abdominal SFT at mid-pregnancy between 18- and 22-weeks' gestation is superior to BMI to identify risk for obesity-related pregnancy complications [7, 12, 13]. The present study was done to find association of maternal SCFT with risk of cesarean section.

2. Material and methods

This was a prospective observational study conducted in the Department of Obstetrics and Gynaecology. 200 women with singleton live pregnancy at 16-18 weeks were included in the study after obtaining written informed consent. Demographic data was collected about each woman. BMII was calculated for all. Woman with medical disorders and previous cesarean delivery were excluded. Ultrasonography was done to assess foetal wellbeing and rule out congenital malformation. Maternal abdominal subcutaneous thickness was measured from the subcutaneous fat layer to the outer border of the rectus abdominus muscle at the level of the linea Alba. Three measurements were taken for subcutaneous thickness for each woman and mean subcutaneous thickness was determined. All women were monitored during ANC, labour as per protocol. They were followed after delivery till discharge. Intraoperative complication if any in women undergoing cesarean section, puerperal pyrexia, stitch line infection were noted.

Data were entered in MS Excel sheet and statistically analyzed. To determine the cut-off value for predicting cesarean section, a receiver operating characteristic (ROC) curve analysis was conducted, and the area under the curve (AUC), sensitivity, and specificity calculated. Odd ratio for SCFT mediated risk of cesarean section was calculated. For all statistical tests a p value <0.05 was considered statistically significant.

3. Results

In our study out of 200 women 50 women (25%) were overweight and obese.

Out of 200 women, 65 women (32.5%) were delivered by LSCS. Table 1 shows association of age, BMI and SCFT with mode of delivery. Mean age of the women was significantly more in women delivered by cesarean than who delivered vaginally (25.65 ± 2.1 vs. 23.5 ± 2.9 years, p 0.0000). Mean BMI was significantly more in women delivered by cesarean than who delivered vaginally (24.51 ± 3.02 vs. 22.03 ± 2.53 kg/m^2, p <0.001). Mean SCFT was also significantly more in women delivered by cesarean than who delivered vaginally (14.28 ± 2.91 vs 11.61 ± 2.86 mm, <0.001).

Table 1 Association of Age, BMI and SCFT with Mode of delivery

Variables	Total (n=200)	Cesarean Delivery (n=65)	Normal Delivery (n=135)	P value
Mean Age (year)	24.17 ± 2.86	25.65 ± 2.1	23.5 ± 2.9	0.0000
Mean BMI (kg/m^2)	23.16 ± 3.01	24.51 ± 3.02	22.03 ± 2.53	<0.001
Mean SCFT (mm)	12.54 ± 3.13	14.28 ± 2.91	11.61 ± 2.86	<0.001

To find an effective cut-off value for predicting LSCS by BMI and ASCFT, a ROC curve analysis was conducted which showed that pre-pregnancy BMI above 23.1 kg/m^2 (AUC=0.931) predicted LSCS with a sensitivity of 69.2% and specificity of 65.9% and Youden index of 0.35. ROC curve analysis for SCFT showed that SCFT above 11.5 mm (AUC=0.735) predicted LSCS with a sensitivity of 86.2% and specificity of 47.4% and Youden index of 0.34. Positive predictive value of BMI and SCFT was 49.5% and 44.1% respectively. Negative predictive value of BMI and SCFT was

81.7% and 87.7% respectively. There was no significant difference in the diagnostic performance of BMI (Kg/m^2) and SCFT (mm) in prediction of LSCS (DeLong's Test p = 0.798). (Table 2 and Fig 1).

Table 2 ROC curve analysis for diagnostic performance of BMI and SCFT for prediction of LSCS

Predictor	AUROC	Sensitivity %	Specificity %	PPV (%)	NPV (%)	Youden Index	P value
BMI (Kg/m^2)	0.739	69.2	65.9	49.5	81.7	0.35	<0.001
SCFT (mm)	0.735	86.2	47.4	44.1	87.7	0.34	<0.001

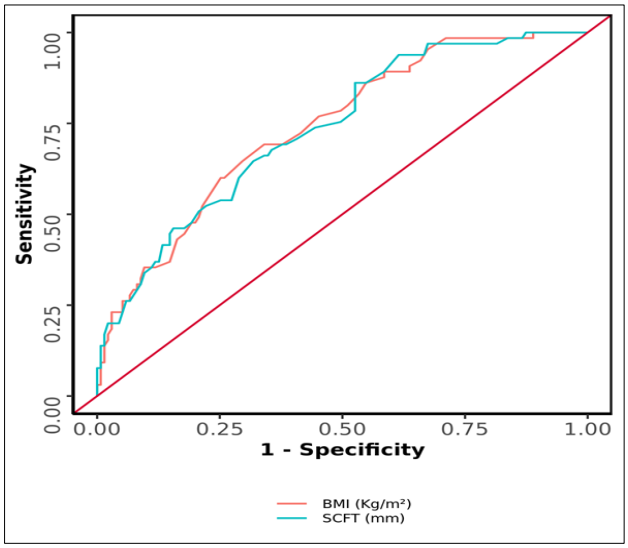

Figure 1 ROC curve analysis for diagnostic performance of BMI and SCFT for prediction of LSCS

Increased BMI was significantly associated with increased risk of developing LSCS. BMI at a cut-off value of 25 kg/m^2 was associated with approximately 14 times [OR 14.4; 95%CI (6.6714 – 31.1939), p <0.0001] increased risk of LSCS. BMI at a cut-off 23.1 kg/m^2 (by ROC curve) was associated with approximately 8.6 times [OR 12.4; (95%CI (3.6171 – 20.8940); p <0.0001] increased risk of LSCS. Increased abdominal SCFT was significantly associated with increased risk of LSCS. Using 11.5 mm cut -off value (by ROC curve) for SCFT, the odd ratio of LSCS in 200 women screened was 7.5 (95% CI 3.4056 – 16.5837, p <0.0001). (Table 3)

Table 3 Association of BMI and ASCFT with risk of LSCS

	LSCS		Odd Ratio, 95%CI	P value
	Yes (n=65)	No (n=135)		
BMI (kg/m^2)				
<25	27 (41.5%)	123 (91.1%)	14.4 (6.6714 – 31.1939)	<0.0001
≥25	38 (58.5%)	12 (8.9%)		
BMI (kg/m^2) by ROC				
<23.1	23 (35.4%)	127 (94.1%)	8.6 (3.6171 – 20.8940)	<0.0001
>23.1	42 (64.6%)	8 (5.9%)		
ASCFT (mm) by ROC				
<11.5	26 (40.0%)	124 (91.9%)	7.5 (3.4056 – 16.5837)	<0.0001
≥11.5	39 (60.0%)	11 (8.1%)		

Table 4 shows association of SCFT with intra or post-operative complications. Out of 65 women who had LSCS, 5 (7.69%) women had anaesthesia related complications, 6 (9.23%) women had puerperal pyrexia and 10 (15.38%) women had stitch line infection. Mean SCFT in women who had intra/post-operative complications was more than in women without these complications.

Table 4 Association of SCFT with intra/post-operative complications

Complications	Mean SCFT (mm)	P value
Anaesthetic Complications		
Yes (n=5)	19.56 ± 1.79	<0.001
No (n=60)	12.29 ± 2.95	
Puerperal Pyrexia		
Yes (n=6)	13.59 ± 2.85	0.299
No (n=59)	12.43 ± 3.14	
Stitch line Infection		
Yes (n=10)	15.84 ± 4.26	0.011
No (n=55)	12.30 ± 2.97	

4. Discussion

Various studies done in the past have found a positive association between maternal pre-pregnancy BMI and cesarean delivery [3, 4]. However, adjusted odds ratios ranged from 1.7 to 4.0 when compared obese with non-obese women [4, 14].

Prevalence of overweight and obese women in our study was 25% which was higher than that observed by Doherty DA et al (18.1%) [15]. Mean age of all women in our study (24.16 ± 2.86 years) was lower than mean age observed in the study done by Kennedy et al [7], Suresh A et al [12], Eley et al [13], Sommer C et al [16] and Van Der Linden EL et al [17]. Mean age of the women was significantly more in women delivered by cesarean than who delivered vaginally (25.65 ± 2.1 vs. 23.5 ± 2.9 years, p 0.0000). Mean BMI was also significantly more in women delivered by cesarean than who delivered vaginally (24.51 ± 3.02 vs. 22.03 ± 2.53 kg/m^2, p <0.001). Surapanthapisit P [18] found no statistically significant differences in the average age between the cesarean group (25.6 + 6.5 years) and normal labor group (23.9 + 6.1 years) but found statistically significant differences (p < 0.001) in pre-pregnancy BMI between the cesarean group (22.7 + 4.8) and normal labor group (20.6 + 2.7). In our study mean SCFT was also significantly more in women delivered by cesarean than who delivered vaginally (14.28 ± 2.91 vs 11.61 ± 2.86 mm, <0.001) which is consistent with observation made by Kennedy et al [7] and Eley et al [13]. Increased BMI was significantly associated with increased risk of developing LSCS which is consistent with observation made by Doherty DA et al [15] and A.Pettersen-Dahl et al [19]. All of them in their respective studies observed that obese women were more likely to undergo cesarean delivery (<0.001).

BMI at a cut-off value of 25 kg/m^2 was associated with approximately 14.4 times [OR 14.4; 95%CI (6.6714 – 31.1939), p <0.0001] increased risk of LSCS. BMI at a cut-off 23.1 kg/m^2 (by ROC curve) was associated with approximately 8.6 times [OR 8.6; (95%CI (3.6171 – 20.8940); p <0.0001] increased risk of LSCS. Our observation was in line with observation made by Van Der Linden EL et al [17]. They observed that the risk of a caesarean section (CS) is increased for women with overweight (OR 1.53, 95% CI 1.48 to 1.58) and women with obesity (OR 2.36, 95% CI 2.15 to 2.59). Athukorala C et al [20] observed that overweight and obese women were more likely to undergo Caesarean section [1.63 (1.34-1.99)]. Gao X et al [21] found that mothers with pre-pregnancy overweight or obesity had a 1.93 fold risk of delivering an LGA infant. Bhattacharya S et al [22] observed that in contrast to women with normal BMI, women who were morbidly obese had a 3 times (95% CI 1.7, 6.1) higher risk of having an elective caesarean section, and 2.8 times (95% CI 2.0, 3.9) higher risk of an emergency caesarean section.

Using 11.5 mm cut -off value (by ROC curve) for SCFT, the odd ratio of LSCS was 4.9 (95% CI 2.3989 – 10.3481, p <0.0001) which is in line with observation made by A Suresh et al [12]. They observed that there is a significant risk of having LSCS in women with higher SCFT [OR 1.05 (95% CI 1.03-1.07), p <0.001]. Similar results were also observed by

Eley V et al [13] and Lindberger E et al [23]. The reasons for increase cesarean section in obese women is explained as increased amounts of soft tissue deposits in women with increased BMI may cause a relative narrowing of the pelvis and genital tract [24,25]. Increased amounts of soft tissue may also lead to weaker contractions due to the dilution effect, and can lead to labour arrest [2, 26, 27]. Other factors which may increase the risk of caesarean delivery in overweight/obese women are increase rate of induction of labour [28]. Due to the large body volume of obese women, more time may be needed for oxytocin to reach the optimal tissue level. During delivery, feto-placental circulation may be compromised by excess intra-abdominal adipose causing mechanical obstruction of labour and fetal distress prompting the need for caesarean birth [29].

In our study 5 women out of 65 women (7.7%) had anaesthetic complications and mean SCFT in women who had anaesthetic complications was significantly more than in women without anaesthetic complication (19.56 ± 1.79 mm vs. 12.29 ± 2.95 mm, p <0.001). Our results were consistent with results of Vricella L K et al [30]. They observed that morbidly obese women have significant risk for anesthesia complications during cesarean delivery in the form of complicated placement, failure to establish and insufficient duration of regional anesthesia. We observed puerperal pyrexia in 9.2% and Stitch line infection in 15.4% women and mean SCFT in these women was significantly more. Our observations were similar to that observed by Smid et al [31]. They showed that women with morbid obesity (BMI > 45 kg/m^2) are at increased risk of endometritis (AOR 1.26; 95% CI 1.07–1.49) and wound infections (AOR 3.77; 95% CI 2.60–5.46) compared to women with normal body weight. Thornburg et al [32] observed an increased risk of infection (OR 5.16; 95% CI 2.3–11.8) and wound dehiscence (OR 10.7; 95% CI 4.0–29.2) in obese women, regardless of the degree of their obesity.

5. Conclusion

This study observed that measurement of SCFT by ultrasonography at 16-18 weeks pregnancy is a significant predictor of cesarean section. Ultrasound measurement of SCFT is a quick, easy and reliable method and can be used for prediction of obesity related pregnancy complications. Overweight and obese women should be considered high risk and they should be monitored for their weight status during routine antenatal care procedure.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest.

Statement of informed consent

Informed consent was taken from all participants included in the study.

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