Assessment of Maternal Abdominal Subcutaneous Fat Thickness (Sft) Measured by Ultrasound as an Independent Predictor of Adverse Pregnancy Outcomes

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Abstract

Introduction: Obese pregnant women are at increased risk for a variety of maternal and perinatal complications. The maternal risks related to obesity include Gestational Diabetes mellitus, Preeclampsia, increased caesarean sections. The fetes is at risk of stillbirth, preterm birth and congenital anomalies. This study focuses on the use of Maternal abdominal subcutaneous fat thickness (SFT) as a surrogate measure for central obesity as measured by ultrasound, and determining its efficacy compared to BMI in predicting obesity related pregnancy complications.

Objective: To measure mid-trimester SFT in antenatal women and establish SFT as an independent predictor of obesity related adverse pregnancy outcomes.

Methods: This was a prospective cohort study. 150 pregnant women between 20-40 years of age were recruited. Demographic data of each participant was collected from the OPD. USG for abdominal subcutaneous fat thickness (SFT) was done at 18-22 wks period of gestation. The participants were followed up to labour. Adverse pregnancy outcomes and their correlation with the SFT measured was studied.

Results: There was significant positive correlation between BMI and SFT (r=0.591, p<0.001). A positive correlation was noticed between BMI and adverse pregnancy outcomes such as PIH, GDM, preterm birth, postdates and NICU admissions. SFT independently showed a positive correlation with the above parameters. The mean SFT among women without PIH was 11.45 mm, and with PIH was 16.48 mm [p <0.001]. Mean SFT were 11.68mm and 16.24 mm among the ladies without and with GDM respectively [p<0.001]. The mean SFT for term pregnancies was 12.06 mm whereas the mean SFT for preterm births was 14.21 showing positive correlation between SFT and preterm birth. SFT also showed positive correlation with need for NICU admission for neonates [SFT avg being 11.72mm and 14.94 mm in the 2 groups]. A comparative analysis was done between BMI and SFT regarding their correlation to the various outcomes. SFT showed higher correlation coefficients for these variables than BMI, with lower p values suggesting more statistical significance.

Conclusion: BMI showed a positive correlation with adverse pregnancy outcomes in mother as well as fetes, SFT showed greater and more statistically significant correlation for adverse outcomes. Thus it was concluded that SFT is a better independent predictor of obesity related adverse pregnancy outcomes.
and/or early pre-implantation embryo is mostly vulnerable to the
effects of maternal obesity resulting in long-lasting endocrine and
metabolic effects for the offspring [1]. There are a number of meth-
ods to quantitatively define and categorize obesity. They are –

1. Body mass index (BMI): It is calculated by a person's weight in
kilograms divided by their height squared in meters.
2. Abdominal Circumference
3. Body Fat Percentage
4. SFT (subcutaneous fat thickness)

BMI is the most widely used criterion. However, BMI has a dis-
advantage that it does not reflect fat distribution or the ratio of
adipose to non-adipose tissue. Other disadvantages include not
accounting for gender, ethnicity, muscle mass, and frame size [2].
Maternal abdominal subcutaneous fat thickness can be used as a
surrogate measure for central obesity and is readily and accurately
measured by ultrasound, a quick, safe modality used routinely in
pregnancy. Some recent studies demonstrated that subcutaneous
adiposity is associated with insulin resistance [4]. From retrospective
studies there is some indication that abdominal SFT at mid preg-
nancy between 18- and 22-weeks’ gestation is superior to BMI to
identify risk for obesity related pregnancy complications.

2. Objective
We aimed at establishing Abdominal SFT (as measured by USG)
as a novel, reliable marker to predict obesity related adverse
pregnancy outcomes.

3. Materials and Methods
   • Study design: prospective cohort study
   • Study setting: Obstetrics & Gynaecology department of ESI
     PGIMSR and associated model hospital, Basaidarapur, New Delhi.
   • Study period – from December 2018 to February 2020
   • The age of the study population – 20-40yrs
   • Sample size – 150

4. Procedure
A prospective longitudinal cohort study was conducted in the de-
partment of Obstetrics & Gynaecology, ESI PGIMSR, New Delhi
over a period of 2 years from 2018-2020. Pregnant women were
recruited from the ante natal OPD after meeting the inclusion and
exclusion criteria.

4.1 Inclusion Criteria
Pregnant women with singleton intrauterine pregnancy presenting
to the OPD in first trimester

4.2 Exclusion Criteria
   • History of cardiovascular diseases
   • Diabetes mellitus
   • Chronic hypertension
   • Smoking

Demographic data was collected about each participant at the first
antenatal visit from the OPD; these included age, height, weight,
smoking habit, and parity. Informed consent was obtained from the
patients and relatives. USG for abdominal subcutaneous fat thick-
ness (SFT) was done at 18-22 wks period of gestation. All scans
were performed by the same operator using a high-resolution multi
frequency B-mode scan 2.5–5.0 MHz transducer.

SFT measurements were performed in the midline of the pelvis
demonstrating uterus, cervix and placenta. Three measures were
taken from the skin line to the peritoneum, and the mean measure
will be used. The first measurement was done close to the midline
and two measurements were taken 5 mm on either side to take into
account the curvature from the ultrasound transducer face, ensur-
ring the measurements were done perpendicular to the anterior bor-
der. The callipers were placed from skin line to peritoneal fascia.

The participants were followed up to labour. The following ad-
verse pregnancy outcomes were observed and their correlation
with the SFT measured were studied:
1. pregnancy-induced hypertension
2. Gestational Diabetes Mellitus
3. Caesarean section
4. Preterm delivery (< 37 weeks POG)
5. Post datism
6. Neonatal respiratory distress and NICU admission

The same outcomes were correlated with BMI. The women were
stratified into BMI categories according to World Health Organiz-
ation (WHO). Analysis was performed for BMI distribution and
SFT measures.

5. Statistical Analysis
Statistical testing was conducted with the statistical package for
the social science system version SPSS 17.0. Continuous variables
were presented as mean SD or median (IQR) for non-normally dis-
tributed data. Categorical variables were expressed as frequencies
and percentages. Correlation between BMI and SFT were done
using Pearson correlation. For all statistical tests, a p value less
than 0.05 was taken to indicate a significant difference.

6. Results
In this study, the 150 participants were divided into 4 categories
according to BMI: Underweight [BMI<18.5], Normal [BMI 18.5-
24.9], Overweight [BMI 25-29.9] and Obese [BMI >30]. We
compared the SFT values among the various BMI categories (un-
derweight, normal, overweight, obese). SFT 1, SFT 2 and SFT 3
are the measurements taken in the same woman at 3 different
points 0.5mm apart and SFT Avg is the average value of the 3
measurements. The individual SFT measurements as well as SFT
average showed a linear relationship with BMI which was statisti-
cally significant [table 1] There was significant positive correla-
tion between BMI and SFT1 (r=0.590, p<0.001), SFT 2 (r=0.595,
The incidence of PIH showed a positive correlation with obesity as measured by BMI. SFT 1, SFT 2, SFT 3 and SFT Avg showed increasing values as we moved from the group with no PIH (SFT Avg = 11.45 mm) to the group with PIH (SFT Avg = 16.48 mm), hence showing an average difference of 5 mm among the groups. This linearity had a p value of 0.001, hence being statistically significant. [Tables 3 & 4]

The incidence of GDM followed an increasing trend according to the maternal BMI. The figures were 0%, 6.7%, 22.5% and 44.4% in UW, NORMAL, OW and OBESE groups respectively. This pointed towards a strong association between GDM and obesity with a p value of 0.001 which was significant. [Table 5 / Fig 2.]

Likewise, comparison of SFT and GDM showed a positive correlation between the 2 parameters. Mean SFT values were 11.68 mm and 16.24 mm among the groups without and with GDM respectively, hence confirming that an increased SFT was a predictor of adverse pregnancy outcome such as GDM. The finding was statistically significant as the p value was <0.001.[Table 6]

Women with normal BMI showed term deliveries in 93.3% and preterm births in only 6.7%. This was less compared to underweight category (16.6%), overweight group (17.5%) and obese category (22.2%). Hence the plot showed a J shaped curve, thus showing a positive association of preterm birth with both underweight as well as overweight/obese groups. However this association was not statistically significant [p value=0.163]. Whereas, the incidence of preterm births showed a linear relation with SFT. The mean SFT for term pregnancies was 12.06 mm whereas the mean SFT for preterm births was 14.21 mm showing an average increase of 2.2 mm in the preterm group. [Tables 7 & 8] This derivation also reached statistical significance, with the p values of 0.036[SFT1], 0.023[SFT2], 0.034[SFT3] and 0.032[SFTAVG].

Tables 9-10 show the correlation of neonatal ICU admissions with obesity. An increasing trend was observed with increasing BMI, though this observation was not statistically significant. There was positive correlation between maternal abdominal SFT measurement and the requirement of neonatal Intensive care. It can be observed that the average SFT of mothers of those infants who did not require NICU admission was 11.72 mm with a standard deviation of 3.09 mm. As against this, the average SFT of mothers whose infants were admitted in NICU was 14.94 with a standard deviation of 3.44 mm. Similar trend was found among SFT1, SFT2 and SFT3 values (p <0.001).

Finally the individual relationship of BMI as well as SFT with the various parameters of the study were compiled [Table 11]. The analysis was made using Spearman’s correlation coefficient [ranging from -1 to +1]. The variables taken were incidence of PIH, GDM, Preterm, Postdates, and NICU admissions. Their correlation coefficients with BMI were 0.284, 0.266, 0.172, 0.147 and 0.157 respectively. In comparison to BMI, SFT showed higher correlation coefficients for these variables [0.454, 0.432, 0.226, 0.101 and 0.377 respectively]. The p values were lower for SFT suggesting greater statistical significance.

7. Discussion
In this study a significant positive correlation was established between BMI and mid-trimester SFT with a correlation coefficient of 0.591. This result was comparable to a study by Suresh A et al which showed a correlation coefficient of 0.53 [3].

PIH is classified as gestational hypertension, preeclampsia, eclampsia, chronic hypertension with superimposed pre-eclampsia. Gestational hypertension is defined as BP higher than 140 mm of Hg (systolic) or 90 mm of Hg (diastolic) on at least 2 occasions 4 hour apart in a woman who had normal blood pressure prior to 20 weeks. Preeclampsia is diagnosed when a woman with gestational hypertension also has proteinuria. The incidence of PIH showed a positive correlation with increasing BMI. An average of 5 mm increase in SFT measurements were seen in ladies with PIH. The mean SFT among women without PIH was 11.45 mm whereas the mean SFT of women with PIH was 16.48 mm. These values were statistically significant, with a p value <0.001, affirming the statement that SFT can be an effective marker for prediction of PIH.

Gestational diabetes mellitus (GDM) is defined as any degree of glucose intolerance with onset or first recognition during pregnancy. The definition applies whether insulin or only diet modification is used for treatment and whether or not the condition persists after pregnancy. Numerous studies across the world have reported an increased risk of gestational diabetes mellitus (GDM) among women who are overweight or obese compared with lean or normal-weight women. A Meta – regression analysis of 20 studies done by SY Chu et al indicated that high maternal weight is associated with a substantially higher risk of GDM [4]. A more recent prospective study by H Kansu Celik and colleagues showed a positive and significant correlation between a 50-g GCT level and BMI, WC, and SAT thickness (p<0.001) [5]. ROC curve analysis showed SAT [subcutaneous adipose tissue] thickness above 16.75 mm predicted gestational diabetes mellitus (GDM) with a sensitivity of 71.7%, a specificity of 57.1%. Similarly, in our study a positive correlation between GDM and BMI with a p value of 0.001 was derived. Mean SFT were 11.68 mm and 16.24 mm among the ladies without and with GDM respectively, hence confirming that an increased SFT is a predictor of GDM. The positive correlation of SFT with GDM and PIH were in coherence with the results obtained from a study by Kennedy NJ et al, which showed that with every 5 mm rise in SFT there was an increased risk of 22-24% for GDM and 18% for PIH [6].

Preterm is defined as babies born alive before 37 weeks of pregnancy are completed. It is the leading cause of infant mortality, neo-
Studies have reported that women with obesity grades 2 to 3 (BMI ≥35) have increased risks of very and moderately preterm delivery (<32 weeks and 32-36 weeks, respectively), while associations between overweight (BMI 25-<30) and obesity grade 1 (BMI 30-<35) and preterm delivery are less consistent [7,8]. Two studies have also recently reported an increased risk of extremely preterm delivery (< 28 weeks) among obese (BMI≥30) women [9,10]. In our study, The plot showed a J shaped curve, thus showing a positive association of preterm birth with both underweight as well as overweight/obese groups. Also, there was a positive correlation with SFT [11,12]. This was true for all 3 SFT measurements. The mean SFT for term pregnancies was 12.06 mm whereas the mean SFT for preterm births was 14.21 mm showing an average increase of 2.2 mm among the 2 groups. This correlation also reached statistical significance, with the p values of 0.036[SFT1] , 0.023[SFT2], 0.034[SFT3] and 0.032[SFT AVG].

Neonatal outcomes were evaluated in terms of 3 parameters – birth weight, APGAR score at 1 min, and 5 min. The observations didn’t show any definite pattern as the values were comparable in all 4 groups. Increased maternal BMI showed a rise in the requirement of neonatal Intensive care within the first 24 hours. While 0% of underweight mothers and 13.5 % of normal mothers had their neonates kept in NICU transiently, the percentages of NICU admissions among overweight and obese mothers were 25% and 33.3% respectively. This correlation, however, could not reach statistical significance. There was significant positive correlation between maternal abdominal SFT measurement and the requirement of neonatal Intensive care. The average SFT of mothers of those infants who did not require NICU admission was 11.72 mm while, the average SFT of mothers of those infants who were admitted in NICU was 14.94 with a standard deviation of 3.44 mm. This result was again comparable to the previous Australian study by Kennedy NJ et al.

When a final comparison of BMI and SFT was done as independent markers of the above outcomes, SFT showed higher correlation coefficients for these variables ie, 0.454[PIH], 0.432[GDM], 0.226[preterm], 0.101 [postdates] and 0.377 [NICU admission], hence implying a stronger positive correlation of SFT with adverse maternal outcomes. The p values were lower for correlation of SFT suggesting greater statistical significance. This paralleled with the study done by Suresh A et al , which substantiated that SFT was a better predictor than BMI for adverse maternal outcomes [13].

8. Strengths and Limitations
The strengths of this study were that it focused on measurement of SFT by USG which is a simple and routine procedure done in pregnancy. It was easy to perform and cost effective. FT is non-invasive, hence comfortable for the participants. MI and SFT have been studied separately but there is limited existing literature on a comparative evaluation of both. The limitations were – a long study period with a risk of patients being lost to follow up and observer variability in sonographic measurement of SFT. Also it would be challenging in a low resource set up.

9. Conclusion
We could draw a positive correlation between SFT and BMI hence establishing SFT was a maker of obesity. BMI showed a positive correlation with adverse pregnancy outcomes in mother as well as fetes, but SFT showed stronger and more statistically significant correlation for the same. Thus, we could rightly infer that SFT is a better independent predictor of obesity related adverse pregnancy outcomes. This opens huge possibilities for employing SFT as a surrogate marker for visceral obesity. Hence SFT can be used as a reliable, reproducible, and objective marker for obesity related risk modelling in pregnancies in the future.

References

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