RESEARCH ARTICLE

Maternal Subcutaneous Fat Thickness by Ultrasonography and Its Effect on Maternal and Perinatal Outcomes

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Received on: 17 October 2023; *Accepted on:* 25 June 2024; *Published on:* 23 October 2024

Abstract

Objectives: This study was done to determine the mean maternal abdominal subcutaneous fat thickness (SFT) by ultrasound during 18–24 weeks of gestation and to study its association with maternal outcomes (hypertensive disorders of pregnancy, gestational diabetes, gestational age at delivery, mode of delivery) and the perinatal outcomes (birth weight, APGAR score, and intensive care admission rates).

Materials and methods: A prospective longitudinal study was conducted on 158 patients in the Department of Obstetrics and Gynaecology at ESIC Medical College and PGIMSR, Rajajinagar, Bengaluru, from January 2020 to June 2021. A detailed history of patients was obtained using general, systemic, and obstetric examinations and they were followed up with regular antenatal checkups. The abdominal SFT was measured by ultrasonography at 18–24 weeks and correlated with maternal and perinatal outcomes.

Results: The mean value of SFT measured at 18–24 weeks was 16.4 mm. The correlation between SFT and the risk of gestational diabetes, hypertensive disorders, preterm birth, cesarean section, large for gestational age, NICU admissions, and low APGAR score was found to be statistically significant with *p*-value < 0.05.

Conclusion: Subcutaneous fat thickness represents maternal central obesity, a more vital risk factor than general obesity in pregnancy. Hence, sonographic assessment of SFT is an excellent, noninvasive, and cost-effective method for safely predicting both maternal and perinatal adverse outcomes.

Keywords: Abruptio placenta, Antepartum hemorrhage, Cesarean section, Fetomaternal outcomes, Gestational diabetes mellitus, Placenta previa, Preeclampsia, Preterm birth.

Journal of South Asian Federation of Obstetrics and Gynaecology (2024): 10.5005/jp-journals-10006-2486

Introduction

The adipose tissue, a storehouse for energy, affects the body's physiology and releases signals like endocrine and immune organs. Hence excess of adipose tissues leads to chronic inflammatory reactions and disturbs metabolic homeostasis causing obesity-related diseases.[1] Pregnancy is characterized by natural inflammatory and metabolic reactions, which are more prominent in obese women, resulting in specific obesity-related complications.[2]

Obesity is an abnormal condition with distribution of body fat leading to metabolic consequences and cardiovascular risks than total body weight and visceral abdominal fat accumulation is a significant risk for gestational diabetes mellitus.[2]

Along with urbanization and improvement in the standard of living, the affordability of food products with refined carbohydrates and saturated fats has increased exponentially. At the same time, a reduction in physical activity due to the increasing use of automated transport, technology at the fingertips at the comfort of home, and more passive leisure pursuits potentiates obesity.

Obesity causes a range of adverse maternal and fetal outcomes such as gestational diabetes mellitus, Preeclampsia, early and recurrent pregnancy loss, venous thromboembolism, increased operative deliveries,[3] fetal growth disorders, macrosomia, stillbirth, low APGAR score, hypoglycemia, postpartum hemorrhage, and surgical site infection.[1,4] Obese women are less likely to breastfeed and they have weight retention after delivery. Lacoursiere and Varner found increased postpartum depression in obese women.[5]

Clinicians generally use BMI to estimate maternal adiposity. However, BMI does not reflect fat distribution.[6] Central abdominal obesity predisposes to cardiovascular problems, hypertension, and diabetes mellitus. Peripheral adiposity is safe. Computed tomography, MRI, and waist-to-hip ratio are preferred markers for central obesity than BMI, but cannot be used in pregnancy.

Maternal abdominal subcutaneous fat thickness (SFT) measurement by ultrasound is a quick, safe method to measure central obesity in pregnancy. It does not require ionizing radiation. We hypothesized that central obesity is a more vital risk factor than total obesity in pregnancy. In the present study, abdominal SFT was measured between 18 and 24 weeks and correlated with maternal and perinatal outcomes.[1,4]

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How to cite this article: Sathish CH, Nanaiah SP, Ramaiah R, *et al*. Maternal Subcutaneous Fat Thickness by Ultrasonography and Its Effect on Maternal and Perinatal Outcomes. J South Asian Feder Obst Gynae 2024;16(5):491–495.

Source of support: Nil

Conflict of interest: None

Materials and Methods

This study was conducted on 158 pregnant women who were visiting the Antenatal clinic in the Department of Obstetrics and Gynaecology, ESIC Medical College and PGIMSR, Rajajinagar, Bengaluru, between January 2020 and June 2021 with the following objectives.

- To determine the mean maternal abdominal SFT measured by ultrasound during 18–24 weeks of gestation.
- To determine the association of maternal abdominal SFT on maternal outcomes (hypertensive disorders of pregnancy, gestational diabetes, period of gestation at delivery, mode of delivery) and the perinatal outcomes (birth weight, APGAR score, and intensive care admission rates).

Inclusion Criteria

- Patients who are willing to participate in the study.
- Pregnant women aged between 18 and 40 years.
- Singleton pregnancy.

Exclusion Criteria

- Chronic hypertension.
- Prepregnancy diabetes mellitus.
- Multiple pregnancy.
- Congenital fetal anomalies.
- Uterine anomalies like bicornuate, septate, arcuate, and uterine didelphys.

Methodology

Following the ethical clearance from the ethical committee of ESIC Medical College and PGIMSR, Bengaluru, 158 pregnant women aged 18–40 years with viable singleton pregnancies were selected from the antenatal clinic. A detailed history regarding maternal age, period of gestation, obstetric history, and history of various co-morbidities was taken, and antenatal examination was done. Antenatal investigations like CBC, HIV, HbsAg, VDRL, blood grouping and typing, oral glucose tolerance test, thyroid function test, urine for proteinuria, sugars, and microscopy were done.

The measurement of SFT by USG was done at 18–24 weeks. The SFT was measured at the cervix placenta view, taken along the linea alba by keeping a standard convex ultrasound transducer, mid-sagittal and above the symphysis pubis. The landmarks demonstrated on the image were the bladder, cervix, and uterus, ensuring that the image contained the skin line and that the tissue in the near field was easily demarkable. These landmarks ensure that the measurement of the subcutaneous fat is reproducible. Three measurements were recorded to obtain a mean SFT measure. The first measure was done close to the midline and two measures were taken 5 mm on each side to account for the curvature from the ultrasound transducer face, so that the measurements were done perpendicular to the anterior border.[1,4,7] The SFT measurements were noted and these women were followed up with regular antenatal checkups. Maternal outcomes were studied regarding hypertension disorders, gestational diabetes, mode of delivery, gestational age at delivery, and perinatal outcome regarding birth weight, APGAR score, and NICU admission. Abdominal SFT was correlated with maternal and neonatal outcomes (Fig. 1).

Sample Size

Based on the previous literature, we hypothesized that the proportion of pregnant women with high maternal abdominal SFT (>18.2 mm) is about 50%. The calculated sample size had a relative precision of 8%, power of 80%, and confidence interval of 95%. The estimated sample size was found to be 151. Considering the attrition rate of 5%, the sample size was fixed at 158.

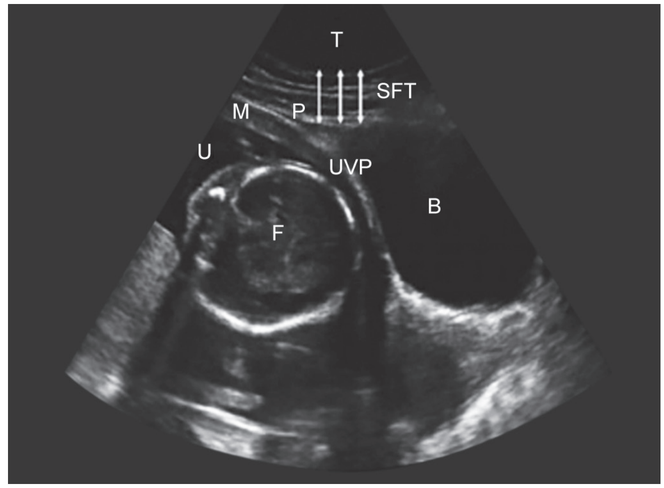

Fig. 1: Ultrasound image of subcutaneous fat thickness measurement

B, bladder; F, fetus; P, peritoneum lining the uterus; SFT, subcutaneous fat thickness taken from an average of three measurements 0.5 cm apart; T, transducer face; U, uterus; UVP, ureterovesical pouch

Table1: Descriptive statistics

Parameter	*Mean*	*SD*	*Min*	*Max*
Weight (kg)	62.0	14.0	35.0	100.0
Height (cm)	155.0	5.9	140.0	170.0
BMI (kg/m^2)	25.7	5.9	13.2	44.7
Gestational age at SFT measurement (weeks)	21.4	1.8	18.0	24.0
SFT values (mm)	16.4	6.1	8.0	38.0

SFT, subcutaneous fat thickness

Results and Observations

One hundred fifty-eight pregnant women were studied for 18 months (January 2020 to June 2021) concerning demographic features, and maternal and fetal outcomes.

The mean distribution age in our study is 27.9 years; 96 (60.8%) were primigravida and 62 (39.2%) were multigravida.

The mean BMI was 25.7, and the gestational age at which SFT was measured ranged from 18 to 24 weeks with a mean of 21.4 weeks.

Sonographically measured SFT ranged from 8 to 38 mm with a minimum of 8 mm, maximum of 38 mm, mean value of 16.4 mm, and SD of 6.1 mm (Table 1).

In the present study out of 158 women, 138 (87.3%) had term deliveries and 20 (12.7%) had preterm deliveries; 101 (63.9%) delivered vaginally, 3 (1.9%) had instrumental delivery, and 54 (34.2%) cesarean section. In the present study out of 158 babies, 22 babies (13.9%) were shifted to NICU.

Out of 93 pregnant women with SFT <16.4 mm, 12 (12.9%) women developed gestational diabetes. Of 65 pregnant women with SFT >16.4 mm, 38 (58.5%) had gestational diabetes. The correlation between SFT and gestational diabetes mellitus (GDM) is statistically significant (p-value < 0.001) (Table 2).

Table 2: Correlation between subcutaneous fat thickness and gestational diabetes

	No GDM		GDM		
SFT	*n*	*%*	*n*	*%*	*p-value*
<16.4 (*n* = 93)	81	87.1	12	12.9	<0.001
>16.4 (*n* = 65)	27	41.5	38	58.5	
Total	108	68.4	50	31.6	

SFT, subcutaneous fat thickness

Table 3: Correlation between SFT and GHTN

	No GHTN		GHTN		
SFT	*n*	*%*	*n*	*%*	*p-value*
<16.4 (*n* = 93)	77	82.8	16	17.2	0.005
>16.4 (*n* = 65)	41	63.1	24	36.9	
Total	118	74.7	40	25.3	

SFT, subcutaneous fat thickness

Table 4: Correlation between SFT and GA at delivery

	Term		Preterm		
SFT	*n*	*%*	*n*	*%*	*p-value*
<16.4 (*n* = 93)	91	97.8	2	2.2	<0.001
>16.4 (*n* = 65)	47	72.3	18	27.7	
Total	138	87.3	20	12.6	

SFT, subcutaneous fat thickness

Table 5: Correlation between SFT and mode of delivery

	INSTR		LSCS		VD		
SFT	*n*	*%*	*n*	*%*	*n*	*%*	*p-value*
<16.4 (*n* = 93)	0	0	22	23.7	71	76.3	<0.001
>16.4 (*n* = 65)	3	4.6	32	49.2	30	46.2	
Total	3	1.9	54	34.2	101	63.9	

SFT, subcutaneous fat thickness

Table 6: Correlation between SFT and low APGAR at 1 minute (<6)

	APGAR ≤ 6		APGAR > 6		
SFT	*n*	*%*	*n*	*%*	*p-value*
<16.4 (*n* = 93)	4	4.3	89	95.7	0.002
>16.4 (*n* = 65)	13	20.0	52	80.0	
Total	17	10.8	141	89.2	

SFT, subcutaneous fat thickness

Table 7: Correlation between SFT and LGA babies

	No LGA		LGA		
SFT	*n*	*%*	*n*	*%*	*p-value*
<16.4 (*n* = 93)	93	100	0	0	0.001
>16.4 (*n* = 65)	57	87.7	8	12.3	
Total	150	94.9	8	5.1	

SFT, subcutaneous fat thickness

Table 8: Correlation between SFT and NICU admission

	No NICU admission		NICU		
SFT	*n*	*%*	*n*	*%*	*p-value*
<16.4 (*n* = 93)	87	93.5	6	6.5	0.001
>16.4 (*n* = 65)	49	75.4	16	24.6	
Total	136	86.1	22	13.9	

SFT, subcutaneous fat thickness

Table 9: Correlation between SFT and respiratory distress syndrome of the newborn

	No RDS		RDS		
SFT	*n*	*%*	*n*	*%*	*p-value*
<16.4 (*n* = 93)	92	98.9	1	1.1	<0.001
>16.4 (*n* = 65)	54	83.1	11	16.9	
Total	146	92.4	12	7.6	

SFT, subcutaneous fat thickness

Among 93 pregnant women with SFT <16.4 mm, 16 (17.2%) had hypertensive disorders of pregnancy.

Among 63 women with SFT >16.4 mm, 24 (36.9%) had hypertensive disorders of pregnancy. The correlation between SFT and gestational hypertension (GHTN) is statistically significant (Table 3).

In the present study, among 93 women with SFT <16.4 mm, 2 (2.2%) delivered preterm. Among 65 women with SFT >16.4 mm, 18 (27.7%) delivered preterm.

The correlation between SFT and preterm delivery is statistically significant (Table 4).

In the present study, out of 93 women with SFT <16.4 mm, 22 (23.7%) delivered by cesarean section and 71 (76.3%) delivered vaginally.

Out of 65 women with SFT >16.4 mm, 3 (4.6%) had instrumental delivery, 30 (46.2%) had vaginal delivery, and 32 (49.2%) delivered by cesarean section. This shows a significant correlation between SFT and cesarean section with a *p*-value < 0.001 (Table 5).

In the present study, among 93 babies of women with SFT <16.4 mm, 4 (4.3%) babies had low APGAR at 1 minute (≤6).

Out of 65 babies of women with SFT >16.4 mm, 13 (20%) babies had low APGAR at one minute (≤6).

There is a significant correlation between SFT and low APGAR score of newborn (*p*-value 0.002) (Table 6).

In the present study, out of 93 women with SFT <16.4 mm, none delivered large for gestational age (LGA) babies.

Among 65 women with SFT >16.4 mm, 8 (12.3%) had LGA babies.

The correlation between SFT and LGA babies is statistically significant with a *p*-value of 0.001 (Table 7).

In the present study, out of 93 babies of women with SFT <16.4 mm,6 (6.5%) babies were shifted to NICU.

Out of 65 babies of women with SFT >16.4 mm, 16 (24.6%) babies were shifted to NICU.

The correlation between SFT and the risk of NICU admission for newborns is statistically significant (*p*-value 0.001) (Table 8).

In the present study, out of 93 babies of women with SFT <16.4 mm, 1 (1.1%) had respiratory distress at birth.

Out of 65 babies of women with SFT >16.4 mm, 11 (16.9%) developed respiratory distress at birth. There is a significant correlation between SFT and the risk of developing respiratory distress syndrome (Table 9).[8–11]

Discussion

- In the present study, the mean SFT measured at 18–24 weeks was 16.4 ± 6.1 mm, comparable to the studies done by Budak et al.[6] (18.1 mm). However, Kosus et al.[11] (15 mm), Yang et al.[9] (19 ± 0.5 mm), De Souza et al.[7] (19 ± 0.8 mm), and Kennedy et al.[1] (20.2 ± 7.7 mm), but D'Ambrosi et al.[8] (9.3 ± 3.6 mm, non-diabetic, 10.7 ± 4.8 mm, diabetic) found lesser values and this could be due to geographical variation in height and weight.
- In the present study, the correlation between maternal sonographic SFT and gestational diabetes is statistically significant with a *p*-value < 0.001which is similar to the studies done by Kennedy et al.[1] (*p*-value 0.01), Suresh et al.[4] (*p*-value < 0.001), Budak et al.[6] (*p*-value < 0.002), D'Ambrosi et al.[8] (*p*-value 0.01) and Yang et al.[9] (*p*-value 0.001).
- In the present study, the correlation between SFT and the development of hypertensive disorders in pregnancy had a *p*-value of 0.005 and it was significant, similar to the studies done by Kennedy et al.[1] (*p*-value 0.042), Suresh et al.[4] (*p*-value 0.003), Kosus et al.[11] (*p*-value = 0.002) Gur et al.[10] (*p*-value <0.001) and Eley et al.[3] (*p*-value < 0.001). The risk of developing gestational diabetes increases as SFT increases.
- We found a statistically significant correlation between SFT and preterm delivery with a *p*-value < 0.001, which is similar to the findings in studies done by NJ Kennedy et al.[1] (*p*-value 0.09), Suresh et al.[4] (*p*-value 0.003), and Eley et al.[3] (*p*-value 0.43).
- In the present study, out of 93 women with SFT <16.4 mm, 22 (23.7%) delivered by cesarian section and 71 (76.3%) delivered vaginally. Out of 65 women with SFT >16.4 mm, 3 (4.6%) had instrumental delivery, 30 (46.2%) had vaginal delivery, and 32 (49.2%) delivered by cesarean section. The correlation between SFT and cesarean section is statistically significant with a *p*-value < 0.001, which is similar to the studies done by Kennedy et al.[1] (*p*-value < 0.001), Suresh et al.[4] (*p*-value < 0.001) and Eley et al.[3] (*p*-value < 0.001)
- None of the 93 women with SFT < 16.4 mm delivered large for gestational age (LGA) babies.

  Among 65 women with SFT >16.4 mm, 8 (12.3%) had LGA babies. The correlation between SFT and LGA babies is statistically significant with a *p*-value of 0.001, and similar findings were reported by Kennedy et al.[1] (*p*-value 0.68), Suresh et al.[4] (*p*-value < 0.001), Lindberger et al.[12] (*p*-value 0.000) and D'Ambrosi et al.[8] (*p*-value 0.16).
- In the present study, APGAR at 1 minute ranged from 5–10 with a mean of 8.2 and APGAR at 5 minutes ranged from 4–10 with a mean of 8.8. Out of 93 babies of women with SFT <16.4 mm, 4 (4.3%) babies had low APGAR at one minute (≤6). Out of 65 babies of women with SFT > 16.4 mm, 13 (20%) babies had low APGAR at 1 minute (≤6). The correlation between SFT and low APGAR score of newborns is statistically significant with a *p*-value of 0.002, which is similar to Kennedy et al.[1] (*p*-value < 0.00), Suresh et al.[4] (*p*-value < 0.003), and Eley et al.[3] (*p*-value 0.016).
- Out of 93 babies of women with SFT <16.4 mm, 6 (6.5%) babies were shifted to NICU, and out of 65 babies of women with SFT >16.4 mm, 16 (24.6%) babies were shifted to NICU immediately after birth. The correlation between SFT and risk of NICU admission of newborns is statistically significant (*p* = 0.001) as in Kennedy et al.[1] (*p*-value < 0.00), Suresh et al.[4] (*p*-value < 0.003), and Eley et al.[3] (*p*-value 0.005).

Limitations of the Study

- Subcutaneous fat thickness may not give a correct estimation of the amount of fat in very obese women because compression of fat and the abdominal pannus is not included in the measurement.
- The study group had only 158 women, which could be due to the COVID pandemic at the time of the study period; a lack of transport facilities, and aversion to visiting hospitals due to fear of acquiring infection may have had confounding effects on utilizing the resources, where we had patient attrition, especially at 18–24 weeks gestation and hence sample number was less. Similarly, confounding factors like preterm, diabetes, and obesity could have skewed the maternal and neonatal outcomes.

Conclusion

This study has shown that measurement of maternal SFT by ultrasonography between 18 and 24 weeks of gestation (mean SFT is 16.4 mm with SD 6.1 mm) is an effective predictor for adverse effects on pregnancy like gestational diabetes, hypertensive disorders in pregnancy, cesarean section, preterm delivery, LGA babies, neonatal respiratory distress, low APGAR score, and NICU admissions.

Subcutaneous fat thickness is more representative of central obesity and a more vital risk factor than general obesity in pregnancy.

Hence, sonographic assessment of SFT in second trimester is an excellent, noninvasive and cost-effective method for safely predicting maternal and perinatal adverse outcomes. Early prediction and appropriate antenatal and intrapartum care will help to prevent adverse maternal and perinatal outcomes.

Acknowledgment

The authors thank all our patients for their cooperation. The authors thank all the department members for their contributions and support.

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