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FETAL SONOGRAPHIC PARAMETERS BETWEEN GESTATIONAL DIABETIC AND NORMAL PREGNANT WOMEN.

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ABSTRACT **Background–** Gestational diabetes mellitus (GDM) is defined as intolerance of glucose seen during pregnancy and is associated with fetal and maternal morbidity. The aim of our study was to measure various fetal sonographic parameters such as fetal biometry, fetal liver length (FLL), amniotic fluid deepest pocket (AFDP), placental thickness, inter ventricular (IV) septum thickness, Wharton's jelly area and fetal abdominal fat thickness (FAFT) during 21-24 weeks of gestation and comparison of these parameters between Gestational diabetic and normal pregnant women. **Methods:** Total patients selected in our study were 100 in number, of which 50 had GDM and 50 were normal pregnant women. Fetal standard biometry with additional parameters were measured on transabdominal scan from 21-24 weeks. Fetal sonographic measurements and patients characteristics were measured and compared between two groups. P-value was evaluated along with mean, standard deviation, mean difference and confidence interval **Results:** Patient characteristics and standard fetal biometric parameters were comparable except for femur length (FL), mean femur length was significantly greater in GDM women compared to normal pregnant women (39.20 ± 0.70 vs. 38.36 ± 1.20, p = 0.001). Mean values in GDM vs. normal pregnent women were, fetal placental thickness in mm (42.28 ± 2.09 vs. 33.24 ± 1.70, p = 0.001), amniotic fluid maximum vertical pocket in mm (54.96 ± 1.24 vs. 44.46 ± 1.06, p = 0.001), fetal abdomen fat layer thickness in mm (3.59 ± 0.17 vs. 3.46 ± 0.15, p = 0.001), inter ventricular septum thickness in mm (3.71 ± 0.13 vs. 3.63 ± 0.16, p = 0.001), fetal liver length in mm (36.48± 1.15 vs. 31.86 ± 0.90, p = 0.001), Wharton jelly area in mm2 (115.26 ± 1.96 vs. 109.34 ± 4.81, p = 0.001), **Conclusion:** Fetal sonographic parameters are significantly increased in GDM women compared to normal pregnant women even before 24 weeks. Measurements of these parameters in routine practice could be used to monitor fetal growth and hence can prevent fatal complications.

KEYWORDS : Gestational diabetes mellitus, fetal liver length, amniotic fluid deepest pocket, inter ventricular, femur length

1. INTRODUCTION

Gestational diabetes mellitus (GDM) is defined as intolerance of glucose seen in pregnancy[1]. GDM diagnosis can be made during pregnancy by: fasting plasma glucose (92-125 mg/dl), 1-h post 75 gm oral glucose load (>= 180 mg/ dl) and 2-h post 75 gm glucose load (153- 199 mg/dl)[2]. Screening test are performed in 2nd trimester between 24-28 weeks of gestation. Maternal hyperglycemia during pregnancy causes fetal and maternal morbidity. Macrosomia is the common effect seen in fetus, which can complicate in fetus as Large for gestational age, shoulder dystocia. In addition there is increase risk for birth trauma, neonatal morbidity and perinatal mortality. Fetal ultrasound biometry early detects macrosomic changes even before detection of GDM in pregnant females by various methods. There are number of studies done to measure fetal ultrasonographic parameters, but none of the studies have evaluated all fetal parameters in one study and mostly were done after 24 weeks. Literature on early detection of macrosomic changes in fetus US parameters are not much available. So in our study we had included all separate fetal US parameters viz; fetal biometry, fetal abdominal wall thickness, fetal liver length, Interventricular septal thickness, whartons jelly area and their significance is evaluated with non-GDM fetal parameters. Aim of our study is to measure all parameters (fetal biometry, fetal liver length, amniotic fluid deepest pocket, placental thickness, inter ventricular septum thickness and fetal abdominal fat layer) on US in 21-24 weeks, and compare these findings with comparable non- GDM patients for significance.

2. MATERIAL AND METHODS :

2.1. Study groups:

Total 100 singleton pregnant females with and without GDM between gestation age from 21-24 weeks, attending antenatal clinic for routine anomaly scan assessment were selected. Of these, 50 pregnant females were proven GDM cases and 50 pregnant females were non GDM taken for comparison with similar gestational age, BMI, Hemoglobin (Hb) and age. The exclusion criteria were twin or multiple pregnancy, chronic maternal disease, major congenital abnormalities.

2.2. Fetal ultrasound Scan assessment :

Institutional ethical clearance was obtained prior to beginning of study. The grey scale real time ultrasound examination performed between 21-24 weeks using 3-5 MHz curvilinear transabdominal transducer. Fetal biometry parameters were measured as per standard protocols. BPD and HC measurement was taken at the level of thalami in axial section. AC measurement was also taken in the axial section at the level of fetal stomach and intrahepatic part of umbilical vein. FL was measured in a longitudinal plane as diaphysis length excluding epiphysis. Fetal gestational age was estimated using Hadlock tables and using regression equations. Fetal parameters were taken as following:

1. Fetal abdominal fat thickness (FAFT): Measurement was taken in the axial section and echogenic subcutaneous fat was measured.
2. Interventricular septal thickness : Four chambered heart view was obtained with the septum in horizontal position. Measurement was taken at the midpoint of IVS.
3. Fetal liver length: Coronal section of fetal abdomen was taken and measurement was taken from dome of right hemidiaphragm to the tip of right lobe of liver below.
4. Wharton's Jelly area: Cross- section view of umbilical cord was obtained and total vessel area was subtracted from umbilical cord area.
5. Placental thickness : Placental thickness was measured in vertical plane where the umbilical cord was seen inserting in the placenta. The uterine myometrium and the retroplacental veins are excluded.
6. Amniotic fluid deepest pocket: the vertical depth of the largest cord-free amniotic fluid pocket was taken.

2.3. Statistical Analysis:

IBM SPSS software was used to analyse data. We summarized continuous variables as mean ± SD and categorical variables as percentages. The independent samples t-test was used to evaluate the means of continuous variables. P values < 0.05 was taken as statistically significant.

3. RESULTS

3.1. Characteristics of study groups:

Participants' demographic and clinical features are shown in tables 1-4 and figure 1-8. Mean maternal age was 25.76 ± 1.57 years in GDM group and 25.70 ± 1.89 years in non- GDM group (Table1,Figure1 and Figure 2). Mean gestational age was 23.20 ± 0.72 weeks in GDM group and 22.98 ± 0.79 weeks in non-GDM group, with mean difference of 0.220, which was not statistically significant (Table 2, Figure 3 &

Figure 4). Mean maternal BMI in GDM group was 27.24±1.69 kg/m^2 and in non-GDM group was 26.80±1.48 kg/m^2, with mean difference of 0.44, which was seen to be statistically insignificant (Table 3, Figure 5 and Figure 6). Mean Hb level in GDM group was 11.52 ± 1.50 gm and non-GDM group was 11.12 gm, not statistically significant.(Table 4, Figure 7and Figure 8)

3.2.Comparison between fetal sonographic parameters between GDM and non- GDM groups: fetal parameters are shown in tables 5-10 and Figure 9-18.

Fetal biometric parameters were comparable(Table 5, Table 6 and Table 7 and Figure 9, Figurte 10 and Figure 11) except for femur length (FL), mean femur length was significantly higher in GDM women compared to non-GDM women (39.20 ± 0.70 vs. 38.36 ± 1.20, p = 0.001)(Table 8 and Figure 12). The mean fetal sonographic parameters were significantly higher in GDM women compared to normal pregnant women (p = 0.001). Mean values in GDM vs. Non – GDM women were, fetal placental thickness in mm (42.28 ± 2.09 vs. 33.24 ± 1.70, p = 0.001)(Table 9 and Figure 13), amniotic fluid maximum vertical pocket in mm (54.96 ± 1.24 vs. 44.46 ± 1.06, p = 0.001)(Table 10 and Figure 14), fetal abdomen fat layer thickness in mm (3.59 ± 0.17 vs. 3.46 ± 0.15, p = 0.001)(Table 11 and Figure 15), inter ventricular septum thickness in mm (3.71 ± 0.13 vs. 3.63 ± 0.16, p = 0.001)(Table 12 and Figure 16), fetal liver length in mm (36.48± 1.15 vs. 31.86 ± 0.90, p = 0.001)(Table 13 and Figure 17), Wharton jelly area in mm2 (115.26 ± 1.96 vs. 109.34 ± 4.81, p = 0.001)(Table 14 and Figure 18)respectively.

Profile of study groups

Table 1: Profile of Maternal age (years) between GDM group and Non GDM group

Group	Mean (years)	Standard deviation	Mean difference	95% CI	p Value
GDM (n=50)	25.76	1.57	0.060	-0.632-0.752	0.864
Non GDM (n=50)	25.70	1.89			

Maternal age in GDM group as compared to Non GDM group shows no statistically significant difference.

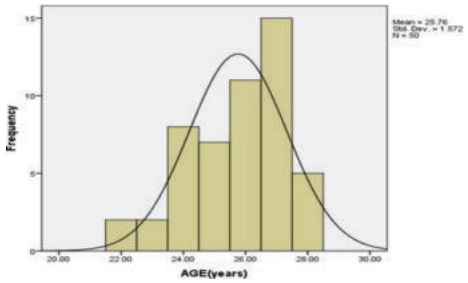

Figure 1 Histogram Showing Distribution Of Maternal Age (years) Among GDM Group

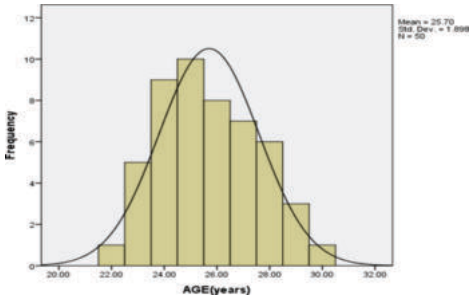

Figure 2 Histogram Showing Distribution Of Maternal Age (years) Of Non GDM Group

Table 2 Profile Of Gestation Age (weeks) Between GDM Group And Non GDM Group

Group	Mean (weeks)	Standard deviation	Mean difference	95% CI	p Value
GDM (n=50)	23.20	0.72	0.220	-0.083-0.523	0.152
Non GDM (n=50)	22.98	0.79			

Gestation age in GDM group as compared to Non GDM group shows no statistically significant difference.

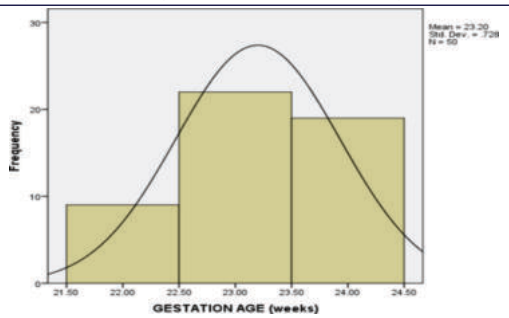

Figure 3 Histogram Showing Distribution Of Gestation Age (weeks) Of GDM Group

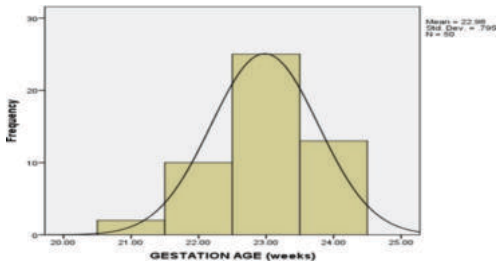

Figure 4 Histogram Showing Distribution Of Gestation Age (weeks) Of Non GDM Group

Table 3 Profile Of BMI (kg/m2) Between GDM Group And Non GDM Group

Group	Mean (kg/m2)	Standard deviation	Mean difference	95% CI	p Value
GDM (n=50)	27.24	1.69	0.44	-0.193-1.073	0.171
Non GDM (n=50)	26.80	1.48			

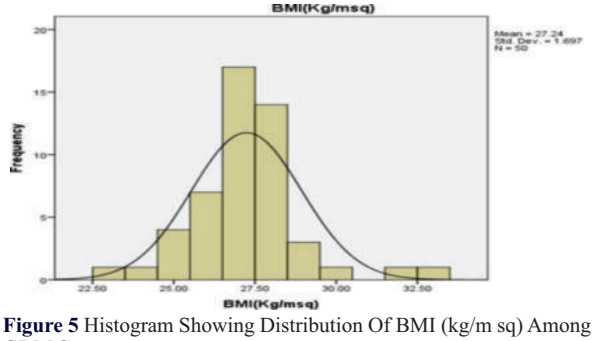

Figure 5 Histogram Showing Distribution Of BMI (kg/m sq) Among GDM Group

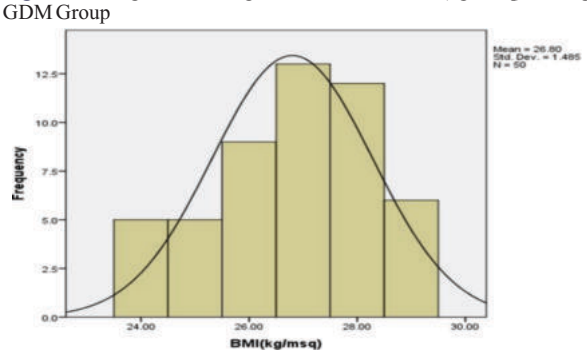

Figure 6 Histogram Showing Distribution Of BMI (kg/m sq) Among Non GDM Group

Table 4 Profile Of HB (gm) Between GDM And Non GDM Group

Group	Mean (gm)	Standard deviation	Mean difference	95% CI	p Value
GDM (n=50)	11.52	1.50	0.344	-0.244-0.932	0.248
Non GDM (n=50)	11.12	1.45			

HB in GDM group as compared to Non GDM group shows no statistically significant difference.

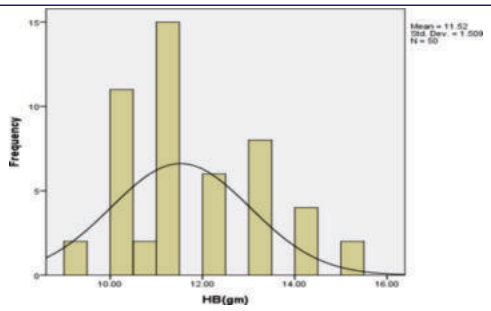

Figure 7 Histogram Showing Distribution Of HB (gm) Among GDM Group

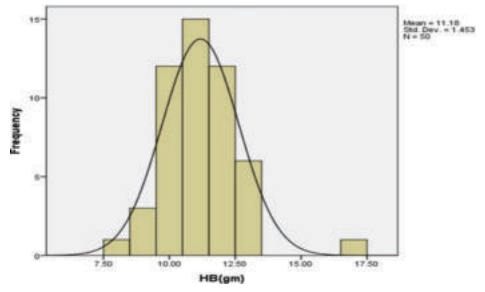

Figure 8 Histogram Showing Distribution Of HB (gm) Among Non GDM Group

Table 5 Comparison of BPD (mm) between GDM and Non GDM group

Group	Mean (mm)	Standard deviation	Mean difference	95% CI	p Value
GDM (n=50)	56.44	1.41	0.36	-0.18-0.90	0.192
Non GDM (n=50)	56.08	1.32			

BPD in GDM group as compared to Non GDM group shows statistically no significant difference.

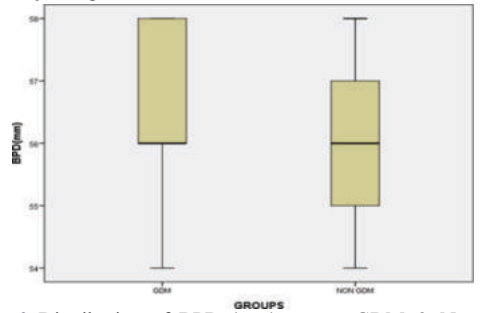

Figure 9 Distribution of BPD (mm) among GDM & Non GDM groups.

Table 6 Comparison of HC(mm) between GDM and Non GDM group

Group	Mean (mm)	Standard deviation	Mean difference	95% CI	p Value
GDM (n=50)	22.12	2.29	0.13	0.705-0.965	0.758
Non GDM (n=50)	21.99	1.90			

HC in GDM group is more as compared to Non GDM group but the difference is not statistically significant.

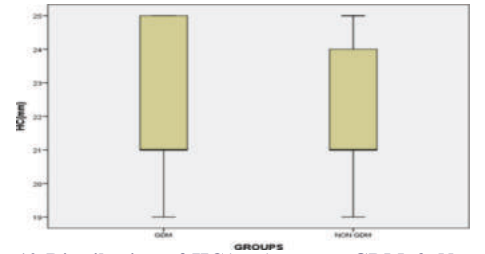

Figure 10 Distribution of HC(mm) among GDM & Non GDM groups.

Table 7 Comparison Of AC (mm) Between GDM And Non GDM Group

Group	Mean (mm)	Standard deviation	Mean difference	95% CI	p Value
GDM (n=50)	183.68	3.44	0.58	-0.646-1.806	0.350
Non GDM(n=50)	183.08	2.70			

AC in GDM group is more as compared to Non GDM group but the difference is not statistically significant

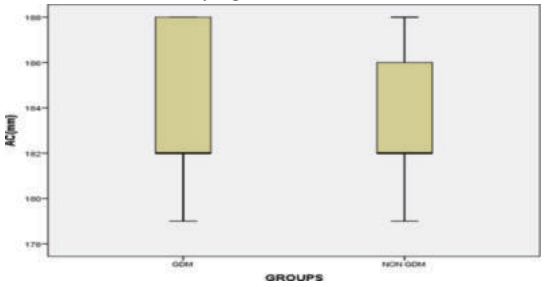

Figure 11 Distribution of AC(mm) among GDM and Non GDM groups.

Table 8 Comparison of FL (mm) between GDM and Non GDM group

Group	Mean (mm)	Standard deviation	Mean difference	95% CI	p Value
GDM (n=50)	39.20	0.70	0.84	0.447-1.225	0.001
Non GDM (n=50)	38.36	1.20			

FL in GDM group is more as compared to Non GDM group and the difference is statistically significant.

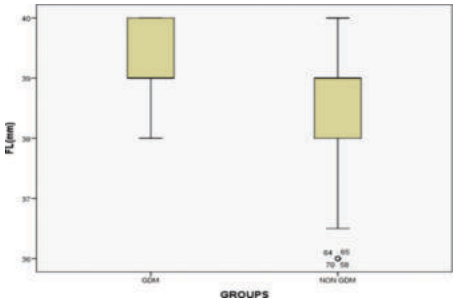

Figure 12 Distribution of FL (mm) among GDM and Non GDM groups.

Table 9 Comparison of Placental thickness (mm) between GDM and Non GDM group

Group	Mean (mm)	Standard deviation	Mean difference	95% CI	p Value
GDM (n=50)	42.28	2.09	9.04	8.284-9.796	0.001
Non GDM (n=50)	33.24	1.70			

Placental thickness in GDM group is more as compared to Non GDM group and the difference is statistically significant.

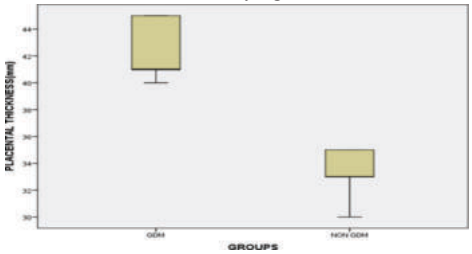

Figure 13 Distribution Of Placental Thickness (mm) Among GDM And Non GDM Groups.

Table 10 Comparison Of Amniotic Fluid Maximum Vertical Pocket (mm) Between GDM And Non GDM Group

Group	Mean (mm)	Standard deviation	Mean difference	95% CI	p Value
GDM (n=50)	54.96	1.24	10.50	10.035-10.965	0.001
Non GDM (n=50)	44.46	1.06			

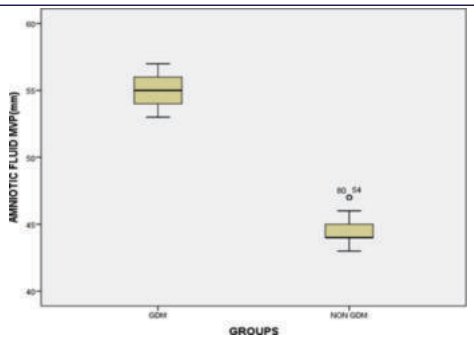

Figure 14 Distribution Of Amniotic Fluid Volume (mm) Among GDM & Non GDM Groups.

Table 11 Comparison Of Foetal Abdomen Fat Layer Thickness (mm) Between GDM And Non GDM Group

Group	Mean (mm)	Standard deviation	Mean difference	95% CI	p Value
GDM (n=50)	3.59	0.17	0.13	0.0698-0.1942	0.001
Non GDM (n=50)	3.46	0.15			

Foetal abdomen fat layer thickness in GDM group is more as compared to Non GDM group and the difference is statistically significant.

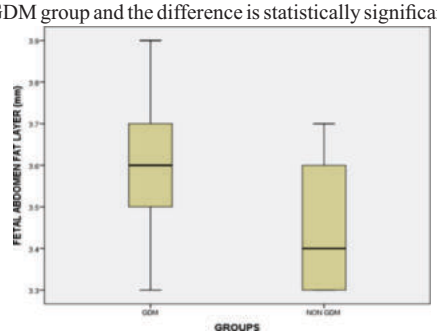

Figure 15 Distribution Of Fetal Abdomen Fat Layer (mm) Among GDM & Non-GDM Groups

Table 12 Comparison Of Inter Ventricular Septum Thickness (mm) Between GDM And Non GDM Group

Group	Mean (mm)	Standard deviation	Mean difference	95% CI	p Value
GDM (n=50)	3.71	0.13	0.08	0.0241-0.1399	0.006
Non GDM (n=50)	3.63	0.16			

Inter ventricular septum thickness in GDM group is more as compared to Non GDM group and the difference is statistically significant.

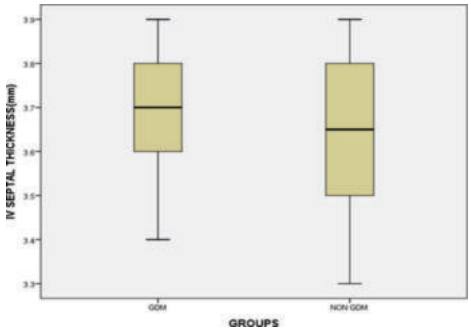

Figure 16 Distribution of IV septum thickness (mm) among GDM and Non GDM groups.

Table 13 Comparison of Foetal liver length (mm) between GDM and Non GDM group

Group	Mean (mm)	Standard deviation	Mean difference	95% CI	p Value
GDM (n=50)	36.48	1.15	4.62	4.21-5.03	0.001
Non GDM (n=50)	31.86	0.90			

Foetal liver length in GDM group is more as compared to Non GDM group and the difference is statistically significant.

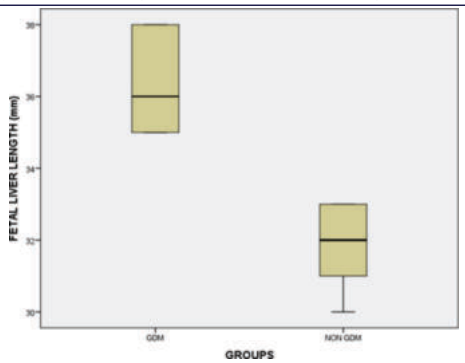

Figure 17 Distribution of Fetal liver length (mm) among GDM and Non GDM group

Table 14 Comparison of Wharton jelly area (mm2) between GDM and Non GDM group

Group	Mean (mm2)	Standard deviation	Mean difference	95% CI	p Value
GDM (n=50)	115.26	1.96	5.92	8.11-10.84	0.001
Non GDM (n=50)	109.34	4.81			

Wharton jelly area in GDM group is more as compared to Non GDM group and the difference is statistically significant

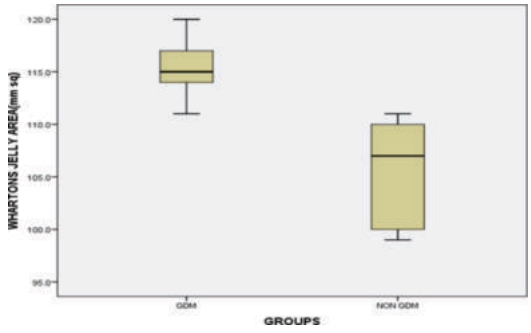

Figure 18 Distribution Of Wharton Jelly Area (mm2) Among GDM And Non GDM Groups.

4. DISCUSSION:

We enrolled 100 pregnant women in our study out of which 50 (50%) had GDM, and 50 (50%) were without GDM. On statistical analysis no significant difference was seen in mean maternal age, mean gestational age, mean blood hemoglobin level (HB) and mean body mass index (BMI) between the GDM and Non GDM groups. The mean fetal liver length, mean fetal abdominal fat layer thickness, mean placental thickness, mean maximum vertical pocket (MVP) of amniotic fluid, mean femur length, mean Wharton's jelly area and mean inter ventricular septum (IV) thickness showed statistically significant difference among GDM and Non GDM groups with p value <0.001 however the mean bi parietal diameter (BPD), mean head circumference (HC) and mean abdomen circumference (AC) showed statistically no significant difference among GDM and Non GDM groups.

The mean fetal liver length in our study was 36.48 mm in women with GDM and 31.86 mm in women without GDM with p value 0.001. The results of our study are partially comparable with the study conducted by **Mirghani H *et al.* (2006)**[3] who studied 123 patients with period of gestation between 21 & 24 weeks, out of which 19 (15.4%) women were diagnosed with GDM and 104 (84.6%) without GDM. Fetal liver length, fetal abdominal fat layer thickness,Wharton jelly and inter ventricular septum, were measured. Fetuses of GDM patients showed increased liver length (36 mm) and in non GDM (31 mm), which was statistically significant ($p < 0.01$), which is in concordant with our study. In our study sample size of GDM group was 50 (50%) as compared to their study in which only 19 (15.4%) had GDM. The most probable explanation of this could be the response of these tissues to maternal hyperglycemia.

The mean fetal abdomen fat layer thickness in our study was 3.59 mm in women with GDM and 3.46 mm in non-GDM women with p value of 0.001. The results of our study are in concordance with the study conducted by **Aksoy HS *et al.* (2016)**[4] conducted study measuring

standard biometric measurements which were BPD, FL, AC and anterior abdomen wall thickness (AAWT) in fetuses of 124 pregnant females, between 26 to 28 weeks of gestation. Of which 55 females had GDM and 69 were normal pregnant females. The basic parameters like BPD, AC & FL were not statistically significant among two groups, but the mean anterior abdomen wall fat layer thickness was significantly higher in the GDM group, 4.07 mm versus 3.28 mm in non-GDM group (p= 0.001). These results were in concordance with our study except that the mean FAFT was 3.59 mm in our study, likely contributed due to gestational age smaller than the said study group.

The mean placental thickness in our study was 42.28 mm in GDM groups and 33.24 mm in Non GDM group with p value of 0.001. **Pala HG *et al*. (2015)**[7] studied 39 GDM patients & 42 non GDM women and found significantly higher placental volume in GDM (411.59 cm^3) versus non GDM (343.86 cm^3). This data hence reflects the changes in placental volume in GDM. In our study the difference in the mean MVP of amniotic fluid was 54.96 mm in GDM groups as compared to 44.46 mm in Non GDM group. The mean Wharton's jelly area in GDM group was 115.26 mm^2 and 109.34 mm^2 in Non GDM group with p value of 0.001and the mean femur length was 39.20mm in GDM group and 38.36 mm in Non GDM group with p value of 0.001 which is statistically significant. The most likely explanation of this is response of these tissue to fetal hyperglycemia.

The mean inter ventricular (IV) septum thickness in our study was 3.71 mm in GDM group and 3.63 mm in Non GDM group and the results are statistically significant with p value of 0.006. **Macklon NS *et al*. (1998)**[8] determined the fetal cardiac inter ventricular septum thickness measurement in matched pregnancies with and without GDM at 18-20 weeks of gestation. IV septum thickness was 2.1 mm in GDM group compared to 1.9 mm in non GDM (p= 0.01). The results of this study are comparable to the results of our study however difference in mean IV septum thickness in the two studies can be attributed to the difference in gestation age of two studies.The mean BPD, HC and AC showed statistically no significant mean difference among GDM and Non GDM group. This is in concordance with the results of **Raychaudhuri K *et al* (2000)**[9] who concluded that the standard biometric measurements (BPD, AC, HC) in second trimester do not differ between fetuses complicated with GDM and non-GDM group. **Ogata *et al*. (1980)**[10], noted that growth promoting effect of insulin showed no effect on fetal brain. This is in agreement with our finding of statistically no significant difference in mean bi parietal diameter and mean head circumference growth in fetuses of mothers with gestational diabetes and non-gestational diabetes mellitus group.

The study conducted by us allows to identify early the growth pattern in gestational diabetes mellitus and to detect high risk pregnancy complications and manage the complications early. The various fetal biometric parameters (BPD, FL and AC) does not change much in gestational diabetes in our study. In our study, fetal abdominal fat layer thickness, fetal liver length, amniotic fluid MVP, placental thickness are simple measurements that can be used to safely evaluate fetal growth during diabetic pregnancies.

5. CONCLUSION

There was statistically no significant difference between the GDM and Non GDM groups in biometric measurements like biparietal diameter (BPD) head circumference (HC) and abdomen circumference (AC).The GDM group had a significantly greater mean fetal liver length 36.48 mm as compared to Non GDM having a mean of 31.86 mm with p value of 0.001,significantly greater mean mean maximum vertical pocket (MVP) of amniotic fluid 54.96 mm as compared to Non GDM having a mean 44.46 mm with p value of 0.001. Significantly greater mean mean placental thickness 42.28 mm as compared to Non GDM having a mean of 33.24 mm with p value of 0.001,Significantly greater mean fetal anterior abdomen fat layer thickness 3.59 mm as compared to Non GDM having a mean 3.46 mm with p value of 0.001,significantly greater mean femur length of 39.20 mm as compared to Non GDM having a mean 38.36 mm with p value of 0.001,significantly greater mean Wharton's jelly area 115.26 mm^2 as compared to Non GDM having a mean value of 109.34 mm^2 with p value of 0.001,significantly greater mean inter ventricular septum thickness 3.71 mm as compared to Non GDM group having a mean of 3.63 mm with p value of 0.001.The statistically significant difference in mean femur length, mean placental thickness, mean MVP of amniotic fluid, mean fetal liver length, mean fetal subcutaneous fat layer thickness, mean Wharton's jelly area and mean IV septum thickness between GDM and Non GDM in gestation weeks between 21 to 24 weeks detect fetus with high risk for pregnancy complication. Clinicians and obstetricians will be benefited by knowing changes in fetal biometric parameters other than BPD, HC and AC in detecting early fetal growth changes in patients with GDM such as fetal abdomen fat layer, fetal liver length, placental thickness, MVP of amniotic fluid, IV septum thickness and Wharton's jelly area and one such parameter can be used to evaluate fetal growth during GDM.

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