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Comparison of Feto-Maternal Outcomes Between Emergency and Elective Cesarean Deliveries in Patients with Gestational Diabetes

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ABSTRACT

Aim: To compare fetal and maternal outcomes between elective and emergency cesarean sections in patients with gestational diabetes mellitus (GDM).

Material and Methods: Data from patients with GDM delivered by cesarean section between January 2015 and July 2020 were retrospectively reviewed. Patients were grouped according to whether the cesarean section was elective (n=129) or emergency (n=158).

Results: The cesarean section rate was higher in patients with GDM (31.16%) than in patients without GDM. There were more patients with inadequate maternal care in the emergency cesarean section group than in the elective cesarean section group (p=0.003). One neonate in the elective group and six in the emergency C/S group died, but the rates of neonatal mortality were similar (p=0.198). Maternal morbidity (wound infection, fever, blood transfusion, and maternal intensive care) and fetal morbidity (birth asphyxia, respiratory morbidity, and neonatal intensive care) were higher in the emergency C/S group (p<0.05).

Conclusion: Emergency C/S results in a higher rate of adverse fetal and maternal outcomes in GDM. Adequate maternal care and early identification of GDM pregnancies likely to require cesarean section may increase the frequency of elective cesarean sections, favoring good fetal and maternal outcomes.

Keywords: *Diabetes mellitus, Gestational, Complications, Adverse birth outcomes, Surgery*

Gestasyonel Diabetes Mellituslu Hastalarda Acil ve Elektif Sezaryen Doğumların Feto-Maternal Sonuçlarının Karşılaştırılması

ÖZ

Amaç: Gestasyonel diyabetes mellituslu (GDM) hastalarda elektif ve acil sezaryen doğumlar arasındaki fetal ve maternal sonuçları karşılaştırmak.

Gereç ve Yöntemler: Ocak 2015-Temmuz 2020 tarihleri arasında sezaryen (C/S) yapılan GDM'li hastaların verileri geriye dönük olarak değerlendirildi. Hastalar C/S'nin elektif (n=129) veya acil (n=158) olmasına göre gruplandırıldı.

Bulgular: GDM'li hastaların sezaryen oranı (%31.16) ve GDM'li olmayanlara göre daha yüksekti. Acil sezaryen grubunda elektif sezaryen grubuna göre daha fazla anne bakımına sahip hasta vardı (p=0,003). Elektif grupta bir yenidoğan ve acil C/S grubunda altı yenidoğan öldü, ancak yenidoğan ölüm oranları benzerdi (p=0.198). Acil C/S grubunda yara enfeksiyonu, ateş, kan transfüzyonu ihtiyacı ve anne yoğun bakım ünitesi morbiditesi, doğum asfiksisi, solunum morbiditesi ve yenidoğan yoğun bakım gereksinimi fetal morbidite oranları daha yüksekti (p<0.05).

Sonuç: Acil C/S, GDM vakalarında daha yüksek oranda olumsuz fetal ve maternal sonuçlara sahiptir. Yeterli anne bakımı ve sezaryen olması muhtemel GDM gebeliklerinin erken tanınması, iyi fetal ve maternal sonuçları destekleyen elektif sezaryen insidansını artırabilir.

Anahtar Sözcükler: *Diabetes mellitus, Gebelik, Komplikasyonlar, Olumsuz doğum sonuçları, Cerrahi*

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INTRODUCTION

Gestational diabetes mellitus (GDM), defined as glucose intolerance, is a common pregnancy-related complication first identified in the second or third trimester of pregnancy. The pathophysiologic mechanism underlying this condition is due to various hormones or cytokines secreted by the gestational conceptus that affect the autoregulation of maternal blood glucose levels (1-3). GDM poses two main groups of risks to fetal and maternal well-being: short-term and long-term (1,2). Short-term complications include those that affect feto-maternal health during or shortly after the current pregnancy. Known short-term risks to the mother include severe perineal tears, postpartum hemorrhage, cesarean delivery, and preeclampsia. For the newborn, these include macrosomia, shoulder dystocia and birth trauma, hyperbilirubinemia, hyperinsulinemia, and postpartum hypoglycemia. Fetuses of mothers with GDM have an abnormal distribution of body fat that accumulates more around the fetal shoulder, increasing the risk of fetal shoulder dystocia (2,4). The recommended threshold of estimated fetal weight for cesarean delivery is lower in affected fetuses than in fetuses in pregnancies without GDM (4000 or 4500 vs. 5000 grams). Nevertheless, patients with GDM are at increased risk for cesarean delivery, even in the absence of fetal macrosomia or pregnancy-related complications (5,6). Cesarean delivery can be lifesaving for both the fetus and the mother when indicated. Cesarean delivery can be performed electively or as an emergency procedure (5). In an emergency cesarean section, the mother is not well prepared for anesthesia and surgery, and trained medical personnel are generally not readily available (7,8). Accordingly, emergency cesarean delivery has been shown to have more surgical and anesthesia-related complications than elective cesarean delivery (9-11).

There are many studies comparing the outcomes of emergency C/S with elective C/S in cases without GDM. However, there is no study comparing them in GDM cases. The aim of this study was to compare fetal and maternal outcomes between elective and emergency C/S in patients with GDM.

MATERIAL and METHODS

This retrospective case-control study examined patients with GDM who delivered by cesarean section at our tertiary referral center between January 2015 and July 2020. The local ethics committee approved the study (2.14.2020-3/15). Patients with fetal structural and chromosomal abnormalities, multiple pregnancies, and pregestational diabetes were excluded. In addition, patients were excluded, if their fasting plasma glucose > 125 mg/dL 48 hours after delivery (12), if their last menstrual date was unknown, or if they had positive results on a previous screening test before 22 weeks of gestation. Patient data were obtained from the hospital's computerized database and from patient records. These data included the patients' demographic, prenatal, intraoperative, and postoperative characteristics. Indications for C/S and neonatal data were also recorded. According to our clinical protocol, patients with one or more risk factors for GDM, including an age older than 35 years, patients with obesity, glycosuria, a family history of DM, previous GDM, previous fetal macrosomia, and previous unexplained fetal demise were offered early screening for GDM, which was performed between 14 and 20 weeks of gestation with the 75-g-oral glucose tolerance test (OGTT). The diagnosis was made if one or more plasma glucose levels were equal to or higher than the fasting value of 100 mg/dL, 180 mg/dL after one hour, and/or 140 mg/dL two hours after drinking a glucose solution. With the exception of those who had a positive result on previous testing and had pregestational diabetes mellitus, all patients were routinely screened with a 50-g glucose challenge test (GCT). In patients who had a plasma glucose level of 140 mg/dL or more on the first 50-g GCT, an oral 100-g glucose tolerance test was performed after an 8-to 12-h overnight fast, and the diagnosis was made using Carpenter and Coustan's criteria (13). Delivery was offered to patients who had well-controlled blood glucose at the 40th gestational week. Patients who could not achieve glucose control and had fetal macrosomia or comorbid diseases such as hypertension and preeclampsia were offered earlier delivery.

The choice of method of labor induction depended on the patients' Bishop score, with oxytocin infusions administered when the Bishop score was equal to or higher than six, and a Cook cervical ripening balloon or double Foley catheter chosen as the method of labor induction when the score was lower than 6 (14). Oxytocin infusion was started at a standard dose of 5 mIU/min and then gradually increased by 5 mIU/min every 15 minutes until seven contractions were achieved within 15 minutes or up to the maximum dose of 30 mIU/min. The Cook cervical ripening balloon and double Foley catheter were left in place for 12 hours, and both the uterine and cervicovaginal balloons were inflated with 80 ml of saline. Shortly after spontaneous expulsion or removal of the balloon, the Bishop score and uterine contractions were assessed. If uterine contractions were inadequate, an oxytocin infusion was initiated.

Failed induction of labor was diagnosed when a patient failed to induce active labor despite at least 10 hours of oxytocin infusion or amniotomy.

Failure of labor was defined as unchanged cervical dilation within four hours or no descent during the second stage of labor within an hour despite adequate uterine contraction and oxytocin augmentation.

Weeks of gestation were calculated from the first day of the mother's last menstrual period (LMP) and early ultrasonography, when available. Gestational age was corrected if there was a discrepancy between the LMP and the ultrasound-based calculation according to the American College of Obstetrics and Gynecology (ACOG) guidelines (15).

A preterm birth was defined as a child born before 37 weeks of gestation. A postterm birth was defined as a birth after completion of 42 weeks of gestation. Suspected fetal macrosomia was defined as an estimated fetal weight (EFW) greater than 4500 g detected during ultrasound screening (16). According to our clinical protocol, which is consistent with the ACOG guideline, all women with GDM or gestational diabetes DM and an EFW > of 4500 g are offered cesarean delivery (17).

A cesarean delivery has been defined as the delivery of a fetus through the abdomen with an incision in the abdominal and uterine wall. Patients who underwent planned cesarean delivery and had preoperative preparation to ensure the best possible quality of obstetric, neonatal, anesthesiologic, and nursing services were included in the elective cesarean delivery group. All other patients delivered by emergency cesarean section were included in the emergency cesarean section group.

Statistical analysis was performed using the statistical package IBM Statistical Package for the Social Sciences (SPSS) version 23. Frequency, percentage, mean, and standard deviation were used to describe the data. The variables were investigated using visual (histogram, probability plots) and analytic methods (Kolmogrov-Simirnov/Shapiro-Wilk's test) to determine whether or not they are normally distributed. Student's t-test was used for continuous variables. For categorical variables, Pearson's chi-square test was used to determine the relationship between the variables studied. Before starting the study, we calculated that there should be 85 patients in each group for a power value of 0.90. At the end of our study for the t-test with the patients included in the evaluation, its power was calculated as 0.98 with 0.45 effect size. G*Power 3.1.9.7 (2021, Düsseldorf, Germany) program was used for these calculations. The effect of maternal age, gravidity, and parity variables on cesarean delivery groups was tested using logistic regression analysis. Differences were considered significant if the p value < 0.05.

RESULTS

During the study period, there were a total of 74,844 deliveries, of which 3218 patients had GDM (4.29%). A total of 287 patients with GDM underwent cesarean delivery, of which 129 (44.94%) were elective and 158 (55.04%) were emergency, all of which were included in the study. The follow-up diagram of the study is shown in Figure 1. The mean age of patients in the elective C/S group was significantly higher than in the emergency C/S group (31.3±5.9 years vs. 27.9±5.7 years, respectively; p=0.002). Gravidity and parity were lower, and the proportion of primiparous women was higher in the emergency C/S group than in the elective C/S group (p<0.05). Nulliparous pregnancies were more likely to have emergency C/S (p=0.004). The proportion of patients with inadequate prenatal care was higher in the emergency group than in the elective group (28.48% vs. 8.52%, respectively; p=0.003). More patients in the emergency group had post-term pregnancy and preterm delivery (p<0.05). There was a significant association between preterm and late births and inadequate prenatal care (p=0.001). There were no differences between the elective and emergency cesarean groups in maternal chronic diseases and gestational hypertension (p>0.05). There was no maternal mortality in women with GDM. Chorioamnionitis occurred more frequently in the emergency cesarean section group; however, this was not statistically significant (p=0.063). The proportion of patients requiring general anesthesia rather than regional anesthesia was higher in the emergency C/S group (p=0.012), and this was especially true for patients with fetal distress. The rate of postoperative morbidities, including wound infections, fever, blood transfusions, need for maternal intensive care, and urinary tract infections, was higher in the emergency C/S group than in the elective C/S group (p>0.05). The distribution of fetal sex was similar in the elective and emergency C/S groups. The mean fetal birth weight was higher in the elective group than in the emergency group (3385±622 g vs. 3092±679 g, respectively; p=0.011). As expected, birth weight was significantly lower in women who had a preterm delivery, and the rate of emergency cesarean section for preterm deliveries was also higher than for nonpreterm deliveries in this study. Compared to elective pregnancies, 1st minute fetal Apgar scores were lower in the emergency cesarean section group (p=0.045); 5th minute Apgar scores were lower in the elective group (p=0.056). Although perinatal mortality rates were similar (p=0.198), other fetal outcomes such as birth asphyxia, admission to the neonatal intensive care unit, and respiratory morbidity were statistically better in the elective cesarean

section group than in the emergency cesarean section group (p<0.05).The effect of maternal age, gravidity, and parity variables on the cesarean section groups was tested using logistic regression analysis, and no statistically significant effect was found (Table 1).

The most common indication for elective cesarean section was previous cesarean delivery, which was significantly higher than in the emergency cesarean section group (48.88% vs. 16.46%; p=0.001), followed by fetal macrosomia. However, the rate of fetal macrosomia was similar in both groups (p=0.702). The most common indication for emergency C/S was fetal distress, followed by failure to progress to term, and both were higher than in the elective C/S group (p<0.05). While there were no differences between groups in hypertensive gestational disorders, including gestational hypertension, preeclampsia, eclampsia, or HELLP syndrome (p=0.212), they were more common in the emergency C/S group than in the elective C/S group in terms of indication for emergency C/S (p=0.021). Most cases of placenta previa occurred in the elective C/S group (n=12, 9.31% vs. n=3, 1.89%; p=0.032). The other dystocia indications were as follows: in the elective group, there were two cases of vulvar varices, three cases of lower uterine fibroid, and one case of condyloma acuminata, and in the emergency group, there were two cases of vulvar varices, one case of lower uterine fibroid, and three cases of condyloma acuminata that obstructed the delivery route (Table 2).

The effects of the variables that were significant in the cesarean section groups in Table 2 were tested using logistic regression analysis, and a statistically significant effect was found for previous cesarean deliveries. The risk of emergency cesarean section was 4.84 (95% CI: 2.813-8.350) times higher for those who did not have a history of cesarean section.

DISCUSSION

To our knowledge, this is the first study in the English-language literature comparing fetal and maternal outcomes of pregnancies with GDM in relation to elective and emergency C/S. Our results show that elective C/S resulted in better

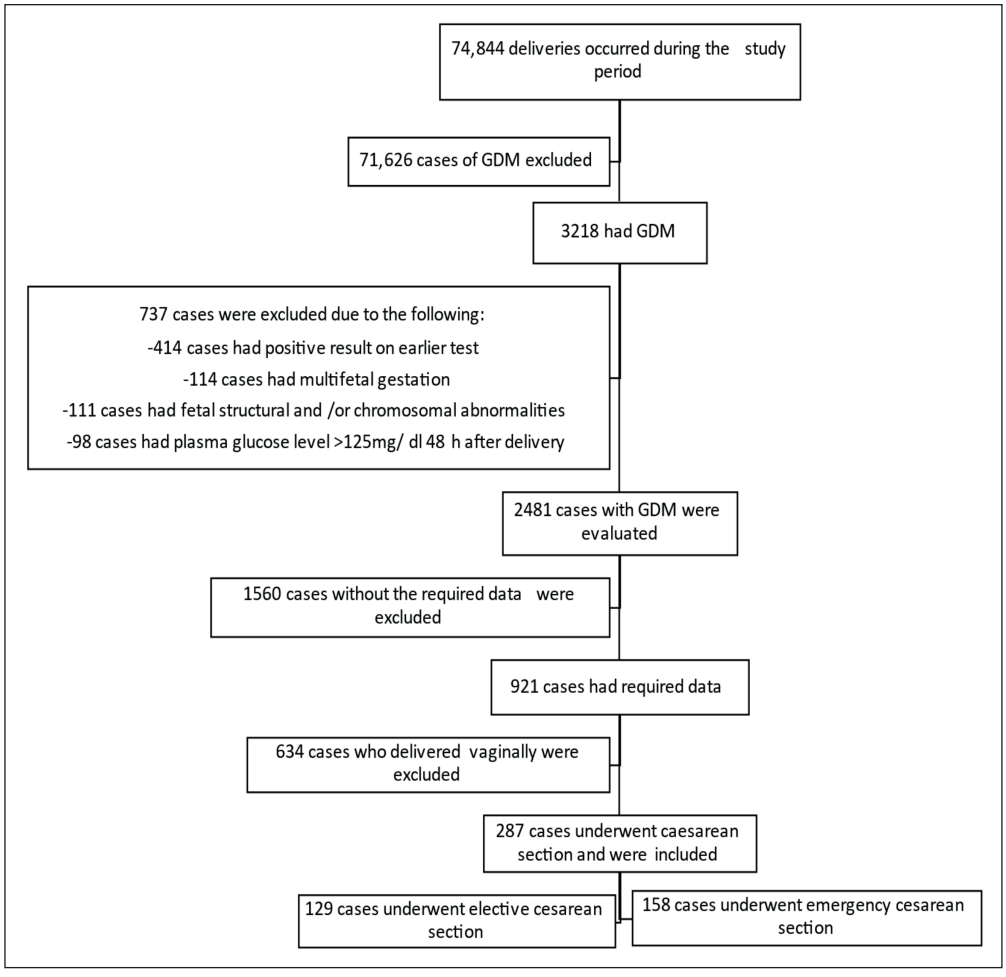

Figure 1. Description of the study cohort

Table 1: Maternal, delivery, postoperative and fetal characteristics.

Characteristics *	Elective caesarean (n=129)	Emergency cesarean (n=158)	p
Maternal characteristics			
Maternal age (year)	31.3±5.9	27.9±5.7	**0.002**
Gravida	4.18±1.72	2.26±1.42	**0.009**
Parity	2.51±1.62	1.68±1.22	**0.018**
BMI (kg/m^2)	30.9±5.8	29.4±5.2	0.132
Nulliparous mother	34 (26.3)	66 (41.8)	**0.004**
Gestational weeks at delivery	38.62±1.02	38.16±2.16	0.652
Post term pregnancy	0 (0.0)	16 (10.12)	**0.009**
Preterm delivery	17 (13.17)	30 (18.98)	**0.014**
Gestational hypertension	15 (11.66)	22 (13.92)	0.212
Insufficient prenatal care	11 (8.52)	45 (28.48)	**0.003**
Maternal chronic disease	15 (11.62)	13 (8.22)	0.342
Pre-labor rupture of membranes greater than 18 hours	14 (10.85)	23 (14.56)	0.272
Delivery characteristics			
Chorioamnionitis	1 (0.77)	6 (3.79)	0.063
General anesthesia	2 (1.55)	15 (9.46)	**0.012**
Post-operative morbidity			
Wound infection	5 (3.87)	31 (19.62)	**0.002**
Need for blood transfusion	9 (6.97)	23 (14.55)	**0.024**
Fever	4 (3.10)	31 (19.62)	**0.002**
Urinary tract infection	3 (2.32)	27 (17.02)	**0.002**
Need for MİCU admission	3 (2.32)	15 (9.49)	**0.025**
Newborn characteristics			
Female	66 (51.16)	80 (50.63)	0.561
Male	63 (48.84)	78 (49.37)	0.549
Fetal weight	3385±622	3092±679	**0.011**
Prematurity	3 (2.32)	14 (8.86)	**0.025**
1.min APGAR	8.86±0.63	8.12±0.58	**0.045**
5.min APGAR	9.90±0.81	9.56±0.78	0.056
Birth asphyxia	3 (2.32)	12 (7.59)	**0.039**
Admission in neonatal intensive care unit	8 (6.20)	20 (12.65)	**0.028**
Respiratory morbidity	5 (3.87)	19 (12.02)	**0.019**
Perinatal mortality	1 (0.77)	6 (3.80)	0.198

*Values are given as mean ±standard deviation and as number (percentage).

outcomes for both the mother and the fetus. However, we could not exclude the role of adherence to prenatal care, which was higher in patients in the elective group.

Pregnancies complicated by GDM are at increased risk for cesarean delivery, even in the absence of additional complications such as fetal macrosomia or gestational hypertension (6). This is due in part to maternal and caregiver preoccupation with a higher risk of fetal and maternal morbidity or mortality than in pregnancies without GDM (18,19). During the study period, 921 women were diagnosed with GDM, of whom 287 (31.16%) underwent C/S, 129 (14.0%) had elective C/S, and 158 (17.11%) had emergency C/S. These rates were consistent with previous studies (10,11). However, they were higher than the cesarean section rates recommended by the World Health Organization (WHO).

Table 2: Cesarean section indications.

Indications*	Elective Cesarean (n=129)	Emergency Cesarean (n=158)	p
Maternal indications			
Previous cesarean delivery	63 (48.83)	26 (16.46)	**0.001**
Severe pre-eclampsia, eclampsia, or HELLP syndrome	0 (0.0)	9 (10.12)	**0.021**
Fetal indications			
Fetal distress	0 (0.0)	30 (18.98)	**0.001**
Breech presentation	14 (10.85)	13 (8.22)	0.543
Other malpresentations	5 (3.8)	3 (1.90)	0.214
Extraembryonic membranes indications and dystocia indications			
Placenta previa	12 (9.31)	3 (1.89)	**0.032**
Ablatio placenta	0 (0.0)	4 (2.53)	0.079
Cord prolapses	0 (0.0)	7 (5.70)	**0.041**
Dystocia indications			
Cephalopelvic disproportion	2 (1.55)	5 (3.16)	0.121
Failure to induce labor	0	11 (6.96)	**0.003**
Failure to progress	0	21 (13.29)	**0.001**
Fetal macrosomia	18 (13.95)	20 (12.66)	0.702
Other	6 (4.65)	6 (3.8)	0.349

*Values are given as number (percentage).

Earlier cesarean section rates tended to be higher with increasing maternal age. This may explain the higher gravidity and parity rates in the elective group. This fact was consistent with previous studies performed in patients without GDM (9,10). In addition, the rate of nulliparous pregnancy was higher in the emergency C/S group than in the elective C/S group (11). In our clinical procedure, labor is routinely induced at 39 weeks of gestation in patients with GDM. However, if pregnancy disorders such as hypertension and systemic lupus erythematosus are present or maternal serum glucose cannot be controlled, labor induction is performed at earlier weeks of gestation. However, in patients who do not receive prenatal care, labor is not induced as expected. This explains the absence of post term cases in the elective group compared with the 16 cases in the emergency group. The gestational weeks of both groups were similar, but there was a wide range between gestational weeks in the emergency cesarean delivery group. The preterm and post-term delivery rates were also higher in the emergency C/S group ($p<0.05$). Previous studies have shown that the complication rate in patients with GDM is highly dependent on whether there is good adherence to therapy and whether good glucose control has been achieved (6,11). In the present study, the rate of inadequate prenatal care was higher in the emergency cesarean section group than in the elective cesarean section group. Emergency cesarean section is more likely to be performed for life-threatening events to the fetus or sometimes to the mother. Accordingly, fetal morbidities in the emergency cesarean section group, including birth asphyxia, admission to the neonatal intensive care unit, respiratory morbidity, and low Apgar scores in the first minute, were higher than in the elective cesarean section group ($p<0.05$). These fetal outcomes are comparable to previous studies (6,9,11,20-22).

The time from decision to delivery is of critical importance, especially in cases of fetal distress (23). In these cases, general anesthesia is used instead of regional anesthesia to shorten the time from decision to delivery. Similar to previous studies examining cases without GDM, the rate of general anesthesia was higher in the emergency cesarean section group (9,20,23). On the other hand, the desire to shorten time in emergencies may compromise the quality of asepsis and antisepsis when preparing the skin for surgical incisions or bladder catheterization. In addition, uncontrolled maternal blood glucose levels may promote infectious morbidity. In this study, the rate of postoperative wounds, lower urinary tract infections, and fever was higher in the emergency catheterization group than in the elective catheterization group ($p<0.05$). GDM, especially in the presence of uncontrolled blood glucose, is a risk factor for polyhydramnios and fetal macrosomia, leading to uterine enlargement, which is one of the etiologic factors of uterine atony (24,25). In this study, the rate of patients requiring blood transfusion was higher

in the emergency group than in the elective group (p<0.05). The main risk factor for admission to the maternal intensive care unit (MICU) during cesarean delivery is maternal hemorrhage. In addition, infection, pregnancy-related hypertension, and other complications such as anesthesia pose a risk for admission to the MICU (21,24,26). Accordingly, the rate of patients requiring admission to the MICU in the current study was higher in the emergency C/S group than in the elective C/S group (p<0.05), which is consistent with previous studies performed on cases with a nonhomogeneous group in terms of GDM (10,22,24).

The most common indication for cesarean section in our study was previous cesarean delivery, which accounted for 21.95% of all indications. This was also the most common indication (48.83%) in the elective cesarean section group. However, in the emergency cesarean delivery group, previous cesarean delivery was the second most common indication after fetal distress, which is comparable to studies of cases without GDM (27).

Efforts are underway worldwide to reduce the rate of cesarean deliveries. Therefore, many centers offer vaginal delivery, especially for patients who have already had a cesarean delivery with transverse lower segment incisions and who have no other indications for cesarean delivery (28). However, the option of vaginal delivery remains controversial in women with GDM without prior cesarean delivery.

The rate of cesarean delivery between emergency and elective deliveries is highly variable. For example, a woman who has already had a cesarean section is more likely to return with labor pain and undergo an emergency cesarean section if she does not deliver as an elective delivery in a given week. This example is also valid for most indications. The rate of placenta previa was higher in the elective cesarean section group than in the emergency cesarean section group (p=0.032). According to our clinical protocol, a patient diagnosed with placenta previa is fully informed of the risk, which can be life-threatening. Therefore, these patients are more likely to adhere to prenatal care.

Patients with GDM are at increased risk for developing gestational hypertension (1,29). Rates of hypertensive pregnancy disorders, including gestational hypertension, preeclampsia, eclampsia, and HELLP, did not differ between groups. However, the indication for cesarean delivery was lower in the elective group. As expected, the rate of failed inductions and non-advanced deliveries was higher in the emergency cesarean section group than in the elective cesarean section group (p<0.05), which is consistent with the literature (9-11). Our study has some limitations. First, although we were able to assess the association between adequate prenatal care and emergency and elective cesarean section using our database, the degree of glycemic control and the ratio of elective to emergency cesarean section were not considered. It would be useful to evaluate the effects of glycemic control on the rates of these two types of cesarean deliveries. Second, the study could have included diabetes mellitus rather than GDM, because unrecognized diabetes mellitus may have been detected first during pregnancy and diagnosed as GDM.

Emergency C/S has a higher rate of adverse fetal and maternal outcomes in GDM. Adequate maternal care and early recognition of GDM pregnancies in which cesarean section is likely may increase the incidence of elective cesarean section, favoring good fetal and maternal outcomes.

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Author's Contributions

Idea/Concept: **Mehmet Obut, Neval Çayönü Kahraman,** Design: **Mehmet Obut, Özge Yücel Çelik, Ayşe Keleş,** Control/Supervision: **Dilek Şahin, Aykan Yücel,** Data Collection and/or Processing: **Mevlüt Bucak, Ayberk Çakır, Özgür Arat, Neval Çayönü Kahraman,** Analysis and/or Interpretation: **Sadun Sucu, Ayşe Keleş, Özge Yücel Çelik,** Literature Review: **Özgür Arat, Ayberk Çakır, Dilek Şahin,** Writing: **Mehmet Obut,** Critical Review: **Mehmet Obut, Aykan Yücel.**

Conflict of Interest

The author(s) have no conflicts of interest relevant to this article.

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Ethics Committee Approval

This study was approved the Etlik Zubeyde Hanım Womans' Health Training and Research Hospital Ethical Committee (2.14.2020-3/15).

Peer Review Process

Extremely peer-reviewed and accepted.

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