Maternal and Perinatal Morbidity Associated With Classic and Inverted T Cesarean Incisions

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OBJECTIVE: To estimate the maternal and perinatal morbidity associated with cesarean delivery involving the upper uterine segment compared with that of low transverse cesarean delivery.

METHODS: A 19-year review of a perinatal database and the relevant charts was used to determine the maternal and perinatal morbidity associated with low transverse cesarean, classic cesarean, and inverted "T" cesarean deliveries.

RESULTS: Over the 19 years, 1980–1998, there were 19,726 cesarean deliveries: low transverse cesarean, 19,422 (98.5%); classic cesarean, 221 (1.1%); and inverted T cesarean, 83 (0.4%). As a proportion of all cesarean deliveries, the rates of low transverse cesarean and classic cesarean have remained stable, whereas the rate of inverted T cesarean has risen from 0.2% to 0.9%. Maternal morbidity (puerperal infection, blood transfusion, hysterectomy, intensive care unit admission, death) and perinatal morbidity (stillborn fetus, neonatal death, 5 minute Apgar less than 7, intensive care) were significantly higher in classic cesarean compared to low transverse cesarean. Some maternal morbidity (puerperal infection, blood transfusion) and perinatal morbidity (5 minute Apgar less than 7, intensive care) were also significantly higher for inverted T cesarean compared to low transverse cesarean.

CONCLUSION: Classic cesarean section has a higher maternal and perinatal morbidity than inverted T cesarean and much higher than low transverse cesarean. There is no increased maternal or perinatal morbidity if an attempted low transverse incision has to be converted to an inverted "T" incision compared to performing a classic cesarean section. (Obstet Gynecol 2002;100:633–7. © 2002 by The American College of Obstetricians and Gynecologists.)

Improved survival in the very low birth weight infant between 25 and 28 weeks' gestation has led to increased intervention, including cesarean delivery, for both maternal and fetal indications at earlier gestational age.[1–3] As a result, there have been reports of increased use of classic cesarean delivery (Adams J. Classical caesarean section [letter]. Aust N Z J Obstet Gynaecol 1987;27: 266–7). Others have chosen the low vertical uterine incision,[4] although such incisions commonly extend into the upper uterine segment.[5] Over the last 30 years, there have been six studies in the English literature reviewing maternal morbidity associated with classic cesarean delivery.[6–11] Compared with low transverse cesarean, these reviews of classic cesarean have shown an increase in maternal puerperal infection,[6,8,11] hemorrhage,[11] blood transfusion,[6,9,11] and hysterectomy.[10,11] Three studies found an increase in perinatal morbidity and mortality associated with the earlier gestational age of infants delivered by classic cesarean compared with low transverse cesarean.[10–12] One report has compared the maternal morbidity of "T" and "J" vertical extensions of low transverse cesarean with uncomplicated low transverse cesarean incisions and found a significant increase in blood loss, broad ligament hematomas, and uterine artery laceration.[13] As all but two of the previous reviews involved less than 100 classic cesarean deliveries, and only one included inverted "T" cesarean delivery,[6,8] we have reviewed a large provincial database to assess the maternal and perinatal morbidity associated with upper uterine segment incisions compared with low transverse cesarean.

MATERIALS AND METHODS

The Nova Scotia Atlee Provincial Database was used to identify patients who had cesarean delivery at the Grace Maternity Hospital in Halifax, Nova Scotia, for the 19 years, 1980–1998. The Grace Maternity Hospital is the only tertiary care obstetric unit in Nova Scotia and is responsible for about half of the annual deliveries in the province. During the period of study there were about 5500 deliveries each year at the Grace Maternity Hospital, of which approximately 15% were high-risk, antenatal transfers from the rest of the province. The database was used to identify the types of cesarean section: low transverse cesarean, classic cesarean, inverted T cesar-

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ean, and low vertical cesarean. Because the number of low vertical cesarean deliveries was so low (20 over the 19 years and only one in the past 5 years), this group was excluded from the analysis. The charts of the patients delivered by classic cesarean and inverted T cesarean were reviewed to determine the indications for the cesarean delivery and for the type of uterine incision. In addition, the outcome of subsequent pregnancies was recorded for women delivered by classic cesarean and inverted T cesarean. Approval for this study and the hospital chart review was obtained from the Research Ethics Board of IWK Children's Hospital, Halifax, Nova Scotia.

Maternal morbidity was assessed as follows: wound infection, endomyometritis, septicemia, puerperal morbidity (temperature ≥ 38C on two or more occasions 4 hours apart in the first 48 hours), blood transfusion, hysterectomy, thromboembolism, intensive care unit admission, postpartum length of stay, and death. Perinatal morbidity was assessed as follows: stillborn fetus (≥500 g), neonatal death (≥500 g, 0–28 days), 5 minute Apgar score < 7, and intensive care.

Continuous variables (mother's age, gestational age, birth weight, and postpartum length of stay) were analyzed with one-way analysis of variance and Tukey post hoc pairwise comparisons. Categorical variables were analyzed with χ^2 tests (SPSS 9.0, SPSS Inc., Chicago, IL). A total of 42 between-group comparisons were made using χ^2 tests. Bonferroni corrections would dictate that only P values of less than .001 would therefore be considered statistically significant for these comparisons. Logistic regression was used to evaluate the contribution of maternal and neonatal variables to the incidence of neonatal mortality (SAS 8.0, SAS Institute Inc., Cary, NC). χ^2 tests for trend were also conducted (Epi Info 2000 1.1, Centers for Disease Control and Prevention, Atlanta, GA).

RESULTS

Excluding the 20 low vertical cesarean cases, there were 19,726 cesarean deliveries, of which 19,422 (98.5%) were low transverse cesarean, 221 (1.1%) classic cesarean, and 83 (0.4%) inverted T cesarean. These rates are shown in Table 1 for the four times 1980–1984, 1985–1989, 1990–1994, and 1995–1998. As a proportion of all cesarean deliveries, the low transverse cesarean and classic cesarean showed no trend over the 19 years. The inverted T cesarean showed a trend to increase over the 19 years (χ^2 test for trend, $P < .001$).

The maternal and neonatal characteristics are shown in Table 2. Classic cesarean and inverted T cesarean were significantly more likely to be performed in parous women, compared with low transverse cesarean. Both the gestational age and neonatal birth weight were significantly lower in classic cesarean compared with both low transverse cesarean and inverted T cesarean. Gestational age and birth weight in the inverted T cesarean group were also significantly lower than in the low transverse cesarean group. The primary indication for cesarean delivery in the three groups is shown in Table 3. In the low transverse cesarean group, dystocia and previous cesarean delivery combined to form the primary indication in 61.3%. In contrast, in the classic cesarean and inverted T cesarean groups, malpresentation and antepartum hemorrhage account for approximately one half of the primary indications. The indications for the type of uterine incision in the classic cesarean group were as follows: inadequate lower uterine segment, 157 (71.0%); malpresentation, 27 (12.2%); inaccessible lower segment, 23 (10.4%); and other, 14 (6.4%). The indication for the inverted "T" incision was, in all cases, inadequate access to safely deliver the infant

Table 1. Cesarean Delivery Rates

	LTC	CC	TC
1980–1984	4514 (98.3)	62 (1.3)	8 (0.2)
1985–1989	5321 (98.8)	47 (0.9)	15 (0.3)
1990–1994	5547 (98.2)	71 (1.3)	25 (0.4)
1995–1998	4040 (98.1)	41 (1.0)	35 (0.9)
Total	19,422* (98.5)	221† (1.1)	83‡ (0.4)

LTC = low transverse cesarean; CC = classic cesarean; TC = inverted T cesarean.
Data are presented as *n* (%).
* χ^2 test for trend: $P = .23$.
† χ^2 test for trend: $P = .41$.
‡ χ^2 test for trend: $P < .001$.

Table 2. Maternal and Neonatal Characteristics

	LTC	CC	TC	*P*
Maternal age (y)	28.2	29.0	30.3	.04* .01† .31‡
Parity ≥ 1 (%)	49.0	65.2	61.4	<.001* .02† .48‡
Neonatal				
Gestational age (wk)	38.8	31.6	33.9	<.001* <.001† <.001‡
Birth weight (g)	3310	1596	2118	<.001* <.001† <.001‡

Abbreviations as in Table 1.
All values are mean.
* LTC compared with CC.
† LTC compared with TC.
‡ CC compared with TC.

Table 3. Primary Indication for Cesarean Delivery

	LTC	CC	TC
Malpresentation	3428 (17.7)	77 (34.8)	36 (43.4)
Antepartum hemorrhage	526 (2.7)	39 (17.6)	12 (14.5)
Non-reassuring FHR	2365 (12.2)	26 (11.8)	8 (9.6)
Severe preeclampsia	310 (1.6)	20 (9.0)	5 (6.0)
Dystocia	6662 (34.3)	11 (5.0)	6 (7.2)
Previous cesarean	5252 (27.0)	10 (4.5)	7 (8.4)
Severe IUGR	118 (0.6)	10 (4.5)	3 (3.6)
Cord prolapse/presentation	120 (0.6)	6 (2.7)	2 (2.4)
Others	641 (3.3)	22 (10.0)	4 (4.8)
Total	19,422	221	83

FHR = fetal heart rate; IUGR = intrauterine growth restriction; other abbreviations as in Table 1.

Data are presented as *n* (%).

following an initial attempt at low transverse uterine incision.

Maternal morbidity is shown in Table 4. Infection and the need for blood transfusion were significantly higher in the classic cesarean and inverted T cesarean groups compared with low transverse cesarean. Blood transfusion, emergency hysterectomy, need for intensive care, and maternal death were all significantly higher for classic cesarean compared with low transverse cesarean. There were two maternal deaths in the classic cesarean group: one due to pulmonary embolism in a woman who had both antepartum and postpartum deep vein thrombosis, and the other due to hemorrhage and disseminated intravascular coagulation (DIC) in a woman who refused blood products. There was one maternal death in the low transverse cesarean group due to postpartum hemorrhage and DIC associated with thrombotic thrombocytopenia.

Perinatal morbidity is shown in Table 5. Stillbirth, 5 minute Apgar score < 7, and need for intensive care were all more common in the classic cesarean and inverted T cesarean groups. Neonatal death was significantly higher in the classic cesarean group compared with both the inverted T cesarean and low transverse cesarean groups.

After infants with lethal anomalies were excluded, the factors of gestational age, birth weight, intrauterine growth retardation, abruptio placentae, parity, maternal age, multiple gestations, placenta previa, antepartum hemorrhage, pyrexia in labor, insulin-dependent diabetes mellitus, nonlethal anomalies, severe preeclampsia, and maternal DIC were assessed for their effect on the relationship between classic cesarean delivery and neonatal death. The logistic regression model contained those factors that altered the contribution of classic section to neonatal death by 5% or more. The model included gestational age, intrauterine growth restriction, abruptio placentae, birth weight, and type of cesarean delivery (Table 6). The results of the analysis indicated that, of the variables in the model, gestational age had the greatest impact on the risk of neonatal death, followed by intrauterine growth restriction, abruptio placentae, and classic cesarean. Birth weight did not have a significant impact on the risk of neonatal death once these variables were considered.

Sixty women who had classic cesarean or inverted T cesarean had 79 subsequent pregnancies at the Grace Maternity Hospital. Seventy-six (96.2%) were delivered by repeat cesarean, and three (3.8%) were delivered vaginally. Forty-three women with previous classic cesarean had 61 subsequent deliveries: 53 by elective cesarean (50 low transverse cesarean, three classic cesarean); five by low transverse cesarean in labor; two by emergency classic cesarean—one uterine rupture (all layers of uterine wall), one uterine dehiscence (muscle separated but visceral peritoneum intact); and one vaginal

Table 4. Maternal Morbidity

	LTC	CC	TC	*P*
Infection				
Wound infection	549 (2.8)	12 (5.4)	7 (8.4)	.02* <.01† .34‡
Endometritis	391 (2.0)	12 (5.4)	4 (4.8)	<.001* .09† 1.00‡
Septicemia	23 (0.1)	3 (1.4)	2 (2.4)	<.01* <.01† .61‡
Puerperal morbidity	909 (4.7)	22 (10.0)	13 (15.7)	<.001* <.001† .16‡
Transfusion	428 (2.2)	24 (10.9)	11 (13.3)	<.001* <.001† .56‡
ICU admission	39 (0.2)	5 (2.3)	1 (1.2)	<.001* .16† 1.00‡
Postpartum thromboembolism	5 (0.03)	1 (0.5)	0 (0)	.07* 1.00† 1.00‡
Hysterectomy	39 (0.2)	4 (1.8)	0 (0)	<.001* 1.00† 0.58‡
Maternal death	1 (0.01)	2 (0.9)	0 (0)	<.001* 1.00† 1.00‡
Length of stay (d)	5.5	6.7	6.0	<.001* .12† .03‡

ICU = intensive care unit; other abbreviations as in Table 1.

Data are presented as *n* (%).

* LTC compared with CC.

† LTC compared with TC.

‡ CC compared with TC.

Table 5. Perinatal Morbidity

	LTC	CC	TC	*P*
Stillborn fetus	54 (0.3)	5 (2.0)	2 (2.4)	<.001* .02† 1.00‡
Neonatal death	147 (0.7)	42 (17.2)	1 (1.2)	<.001* .46† <.001‡
Apgar score <7 at 5 min	489 (2.4)	49 (20.5)	15 (15.9)	<.001* <.001† .36‡
ICU admission	5707 (28.5)	210 (86.1)	65 (77.4)	<.001* <.001† .06‡

Abbreviations as in Tables 1 and 4.
Data are presented as *n* (%).
* LTC compared with CC.
† LTC compared with TC.
‡ CC compared with TC.

delivery. Seventeen women with previous inverted T cesarean had 18 subsequent deliveries: 14 by elective cesarean (13 low transverse cesarean, one classic cesarean); two by low transverse cesarean in labor; and two vaginal deliveries without incident.

DISCUSSION

As a proportion of all cesarean sections, the rates of low transverse cesarean and classic cesarean have remained stable over the past 20 years in our hospital, whereas the rate of inverted T cesarean has risen. The most common indication for making the cesarean incision in the upper uterine segment is when inadequate formation of the lower uterine segment precludes safe and atraumatic delivery of the fetus through that site. It may also be necessary when access to the lower uterine segment is prohibited by uterine fibroids, extensive adhesions, or massive vascularity associated with some cases of placenta previa. This was borne out in our study, with the majority of cases requiring upper uterine incision being due to preterm delivery, often associated with malpresentation and inadequate development of the lower uterine segment. Because a number of studies have shown increased maternal morbidity associated with classic cesarean delivery,[6,8–11] as well as the implications for scar rupture in a subsequent pregnancy, most obstetricians will try and perform a low transverse cesarean incision if at all possible. We feel this probably accounts for the stable incidence of classic cesarean but rising incidence of inverted T cesarean in our series. In the majority of cases with a partially formed lower segment, the obstetrician can plan and perform a low transverse cesarean incision, thus avoiding the potential risks of upper uterine segment incision. This approach has been emphasized by Jovanovic.[14]

Table 6. Regression Analysis

Factor	Odds ratio	95% confidence interval	*P*
Gestational age (wk)			
22–27	659.1	170.6, >999.9	<.001
28–31	95.8	28.2, 325.1	<.001
32–35	3.7	1.1–12.4	.03
≥36 (ref)	1.0		
IUGR	2.5	1.4, 4.4	.002
Abruptio placentae	2.2	1.2, 4.2	.01
CC	1.9	1.0, 3.4	.04
Birth weight (g)			
<1000	0.5	0.1, 2.0	.32
1000–1999	0.4	0.1, 1.5	.18
2000–2999	2.0	0.8, 5.2	.16
≥3000 (ref)	1.0		

Ref = referent group; other abbreviations as in Tables 1 and 3.

This is also reflected in the perinatal morbidity in our series. The increased perinatal morbidity associated with classic cesarean largely represents the low gestational age at which intervention was carried out. The fact that the perinatal morbidity is less for inverted T cesarean compared with classic cesarean also reflects the greater gestational age in women delivered by inverted T cesarean when, although preterm, there is some development of the lower uterine segment, such that the obstetrician started the cesarean with a low transverse incision. The other complications associated with neonatal mortality and classic cesarean were intrauterine growth restriction and abruptio placentae, both of which are more likely to occur preterm and with a poorly formed lower uterine segment. Of all the factors that contributed to the risk of neonatal death, classic cesarean had the smallest impact (odds ratio 1.8, $P = .04$).

The maternal morbidity for classic cesarean was significantly increased compared with low transverse cesarean. Although the infectious morbidity and need for blood transfusion in the women with inverted T cesarean was comparable to that of classic cesarean, other measures, such as intensive care unit admission, thromboembolism, emergency hysterectomy, and length of stay were not significantly higher in inverted T cesarean than with low transverse cesarean. Thus, whereas the maternal morbidity of inverted T cesarean is increased compared with low transverse cesarean, it is not raised to the same extent as classic cesarean. The two maternal deaths that occurred in the classic cesarean group could not be attributed to the method of delivery: one was due to pulmonary embolus following both antepartum and postpartum deep vein thrombosis and the other to hemorrhage in a woman who refused blood products. The number of pregnancies following classic cesarean and

inverted T cesarean was relatively small, with the majority (84.6%) being delivered by repeat elective cesarean; however, one uterine rupture and one uterine dehiscence in the seven women with previous classic cesarean not delivered by elective repeat cesarean confirms the risk of the classic cesarean incision.

This study confirms the increased maternal morbidity associated with classic cesarean delivery and that the higher perinatal morbidity and mortality is a reflection of preterm delivery. The fact that, compared with classic cesarean, inverted T cesarean carries a slightly lower risk of maternal and perinatal morbidity (in part due to higher gestational age) reassures the obstetrician that it is reasonable in cases with a marginally developed lower uterine segment to start with a transverse incision and, if this proves inadequate to safely deliver the fetus, convert to an inverted T cesarean without increasing the risk to the mother or fetus. In this way, many lower-segment cesarean deliveries will be safely accomplished without the need for the "T" portion of the incision, thereby reducing the risk for the mother in the puerperium and in any subsequent pregnancy.

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