Maternal and Fetal Outcomes in Extremely Urgent Caesarean Delivery in Relation to the Decision-to-delivery Interval

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Objectives: To evaluate whether there were any differences in the maternal and fetal outcomes for extremely urgent Caesarean deliveries having shorter decision-to-delivery interval (DDI) versus those with longer DDI (i.e. >20 minutes), and to explore the reasons for longer DDI.
Methods: Retrospective data were retrieved between 1 January 2011 and 30 June 2013 from all women with singleton pregnancies delivering at >24 weeks of gestation by extremely urgent Caesarean sections for fetal distress. Data including the causes of fetal distress, DDI and the breakdown, perinatal outcomes (Apgar scores, cord blood pH, need for neonatal intensive care unit admission) and maternal outcomes (operative complications, wound infection, need for intensive care unit admission) were collected.
Results: Of 171 extremely urgent Caesarean deliveries, 159 (93%) and 100 (58%) were delivered within 30 and 20 minutes after decision, respectively. Compared with the group with DDI of ≤20 minutes, the antenatal characteristics, gestational age, and birth weight were not significantly different in those with DDI of >20 minutes. No significant differences in the maternal outcomes of fever, endometritis, wound infection, bladder injury, hysterectomy, and the need for special postoperative care were found between these two groups. Besides, the mean cord blood pH was significantly lower in those with DDI of ≤20 minutes (7.19 ± 0.14 vs. 7.23 ± 0.09, p=0.04), however, no significant differences in the Apgar scores at 5 minutes as well as the need for admission to neonatal intensive care unit were noted between these two groups. No hypoxic ischaemic encephalopathy was found in those with DDI of >20 minutes. When compared with those with DDI of ≤20 minutes, more time was required in the preparation and transfer of patient to the operating theatre (15.9 vs. 7.9 mins, p<0.001), induction of anaesthesia (6.9 vs. 6.0 mins, p=0.01), and from skin incision to delivery of the baby (3.4 vs. 2.7 mins, p=0.01) for those with DDI of >20 minutes.
Conclusion: The cord blood pH was lower in the group with DDI of ≤20 minutes than that with DDI of >20 minutes. The reason for delayed DDI was mainly related to the longer time required for preparation and transfer of patient to the operating theatre.
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Keywords: Cesarean section; Decision making; Emergencies; Pregnancy outcome

Introduction

'Crash' Caesarean section (extremely urgent Caesarean delivery) was defined by MacKenzie and Cooke[1] as an abdominal operation to achieve immediate delivery when life-threatening fetal distress occurs. It is regarded as the immediate resort for saving the fetus and/or the mother when instrumental delivery is not achievable or imminent delivery is not expected, with an aim to protect maternal and neonatal well-being. Under the classification system proposed by Lucas et al[2], it is considered as grade 1 emergency Caesarean section. Extremely urgent Caesarean delivery also belongs to the most urgent type of Caesarean section in the continuous spectrum suggested by the Royal College of Obstetricians and Gynaecologists[3]. The global incidence of extremely urgent Caesarean delivery is estimated to be 0.6% to 0.7%[4,5].

Hypoxic ischaemic encephalopathy (HIE), stillbirth or neonatal death may result from delay in delivery, and this has serious implications in litigation. The results of early primate studies demonstrated an increased risk of brain injury with an increased interval of anoxia[6]. In a study of severe placental abruption complicated by fetal bradycardia, a decision-to-delivery interval (DDI) of >20 minutes was associated with substantially increased neonatal morbidity and mortality[7]. Significant neonatal morbidity was also

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observed in uterine rupture with complete fetal extrusion when >18 minutes elapsed between the onset of prolonged deceleration and delivery[8]. Therefore, to obtain the best fetal and maternal outcomes, it seems prudent to achieve a delivery as quickly as possible when severe fetal distress or serious maternal conditions occur.

The guidelines established by several national consensus panels such as the Royal College of Obstetricians and Gynaecologists, American College of Obstetricians and Gynaecologists, as well as Canadian National Consensus Conference recommend that obstetrical services should be capable of performing a Caesarean section within a time interval of 30 minutes[9-11]. The German Society of Gynaecology and Obstetrics advocates a time interval of 20 minutes[4]. However, the literature revealed limited evidence to support this standard, and all these recommendations were established by a consensus of experts.

This study was undertaken to evaluate the maternal and fetal outcomes in extremely urgent Caesarean deliveries with respect to their DDI in the local setting. It aimed to search for evidence concerning the appropriate standard on the time limit for DDI in this locality. The study also explored the reasons for delayed DDI (i.e. >20 minutes) in extremely urgent Caesarean deliveries to estimate the achievability of a shorter DDI.

Methods

Our study comprised women who delivered in Queen Elizabeth Hospital of Hong Kong from 1 January 2011 to 30 June 2013. All singleton births delivered by extremely urgent Caesarean sections at a gestation of >24 weeks were included.

Routine continuous cardiotocograph monitoring was used as standard intrapartum management in the study unit. When there was persistent fetal bradycardia (i.e. <110 beats per minute) for 3 minutes, the use of oxytocin would be routinely discontinued. The decision for extremely urgent Caesarean delivery would be made if the bradycardia showed no sign of recovery, or if it was associated with irreversible causes such as placental abruption or cord prolapse. The woman would be prepared for extremely urgent Caesarean delivery (shaving, insertion of urinary catheter) once the decision was made. On-site emergency anaesthetist support was available for 24 hours. The operating theatre was located in close proximity to the delivery suite, which facilitated the transfer of the patients.

Data were retrieved from the Clinical Data Analysis and Reporting System (CDARS) of the Hospital Authority, supplemented by the hospital's electronic records from the Clinical Management System, the OBSCIS (Obstetric Specialty Clinical Information System), and hospital records. Deliveries by Category A1 emergency Caesarean sections which were formally required to be performed within an hour of decision for Caesarean sections were first selected using CDARS. Those having extremely urgent Caesarean deliveries because of fetal distress were, in turn, selected from the group and included in this study. The definition of extremely urgent Caesarean delivery used in this study was equivalent to the grade 1 emergency Caesarean section under the classification system proposed by the Royal College of Obstetricians and Gynaecologists[3]. Women with multiple pregnancies were excluded.

Medical notes of all eligible cases were retrieved. The causes of fetal distress were reviewed, with the DDI and the corresponding time required in each step collected (preparation and transfer of patient to the operating theatre, induction of anaesthesia, skin incision to delivery of the baby, and uterine incision to delivery of the baby). Demographic data such as age, gravidity, parity, and gestational age were collected. Maternal outcomes including postoperative fever, wound infection, endometritis, injury to bladder, ureter or bowels, hysterectomy and requirements for special care after Caesarean section in addition to routine postoperative care were evaluated. Special care in addition to routine postoperative care included blood transfusion, antihypertensive treatment, use of anticonvulsants in pre-eclampsia, diuretic treatment for renal failure, and surgical management for severe postpartum haemorrhage. Data on neonatal outcomes including Apgar scores at 1 and 5 minutes, cord blood pH, need for intubation or cardiopulmonary resuscitation after birth, need for admission to neonatal intensive care unit, presence of HIE, and neonatal death were retrieved from the neonatal discharge summaries.

The collected data were categorised into two groups: those with DDI ≤20 minutes and those with DDI >20 minutes. Contributory factors for DDI and the corresponding time required as well as the reasons for delayed DDI were analysed. These included: (1) preparation and transfer of the patient to the operating theatre; (2) induction of anaesthesia; (3) skin incision to delivery of the baby; and (4) uterine incision to delivery of the baby.

The collected data were analysed using the IBM Statistical Package for the Social Sciences software, version

22.0 (SPSS Inc., Chicago [IL], US). Baseline characteristics of the study were compared using percentages and a variety of statistical tests. Differences in categorical variables were analysed with Pearson Chi-square test. When the cell counts were less than 5, the differences in categorical variables were analysed with Fisher's exact test. Differences in continuous variables were analysed with independent *t* test. p Values of <0.05 were used as the cutoff point for statistical significance.

The research protocol was approved by the Ethics Committee of the study hospital.

Results

During the study period, extremely urgent Caesarean deliveries accounted for 4.0% of all Caesarean deliveries and 1.1% of all deliveries in the study unit. The subjects' median maternal age was 32 (interquartile range [IQR], 29-36) years. Overall, 123 (72%) women were nulliparous. The median gestational age at delivery was 39 (IQR, 36-40) weeks, and the median birth weight was 3110 g (IQR, 2690-3410g). The median pH of the cord blood was 7.24 (IQR, 7.16-7.29). All the 171 extremely urgent Caesarean deliveries at our hospital were performed under general anaesthesia. A total of 159 (93%) cases were performed within a DDI of 30 minutes. The DDI in our cohort ranged from 11 to 69 minutes, with a median of 19 (mean ± standard deviation, 21 ± 7) minutes.

Identifiable causes for fetal bradycardia included placental abruption (n=16; 9%), cord prolapse (n=15; 9%), and uterine rupture (n=1; 1%). In the remaining 139 (81%) cases, the cause of fetal bradycardia was unknown (Table 1). There was no significant difference in the antenatal characteristics between the two (DDI ≤20 minutes and DDI >20 minutes) groups (Table 2). The proportions of extremely urgent Caesarean deliveries performed after midnight, during weekends or public holidays were similar between the two groups. No significant difference was noted in the experience of surgeons performing Caesarean sections or operative blood loss between the two groups (Table 3).

Regarding neonatal outcome, the birth weight was similar between the two groups. There was no significant difference in the Apgar scores at 5 minutes and the need for admission to the neonatal intensive care unit between the two groups. Also, there were no cases of HIE in the group with DDI >20 minutes (Table 4). The cord blood pH was significantly lower in the group with DDI within 20 minutes (Table 5).

Maternal outcomes including fever, wound infection, endometritis, and bladder injury had similar incidence in the two groups. There was no significant difference in the need for special postoperative care between the two groups. Two cases required hysterectomy, and there were no cases

Table 1. Causes of fetal distress

Cause	DDI ≤20 minutes (n=100)	DDI >20 minutes (n=71)	No. of cases	p Value
				0.39
Unknown cause	79 (79%)	60 (84%)	139 (81%)	
Placental abruption	10 (10%)	6 (9%)	16 (9%)	
Cord prolapse	11 (11%)	4 (6%)	15 (9%)	
Uterine rupture	0	1 (1%)	1 (1%)	

Abbreviation: DDI = decision-to-delivery interval

Table 2. Demographic data of patients who underwent extremely urgent Caesarean delivery

	DDI ≤20 minutes (n=100)	DDI >20 minutes (n=71)	p Value
Mean (± SD) age (years)	31.8 ± 4.7	32.4 ± 5.2	0.47
Median (IQR) gravida	2 (1-2)	1 (1-2)	0.69
Median (IQR) parity	0 (0-1)	0 (0-1)	0.87
No. of previous abdominal operation	9 (9%)	6 (8.5%)	0.56
Mean (± SD) gestational age (weeks)	37.8 ± 3.4	37.4 ± 3.2	0.54

Abbreviations: DDI = decision-to-delivery interval; IQR = interquartile range; SD = standard deviation

Table 3. Details of extremely urgent Caesarean delivery*

	DDI ≤20 minutes (n=100)	DDI >20 minutes (n=71)	p Value
Time of operation			
After midnight	14 (14)	14 (20)	0.40
Weekend / public holiday	36 (36)	17 (24)	0.10
Experience of surgeon (years)	2.8 ± 3.3	2.9 ± 2.7	0.85
Duration of anaesthesia (mins)	51.7 ± 25.9	46.8 ± 10.2	0.13
Operative blood loss (ml)	479.0 ± 642.1	414.1 ± 255.8	0.42

Abbreviation: DDI = decision-to-delivery interval

* Data are shown as No. (%) of subjects or mean ± standard deviation

Table 4. Neonatal outcomes*

	DDI ≤20 minutes (n=100)	DDI >20 minutes (n=71)	p Value
Birth weight (g)	2966 ± 648.1	2964 ± 816.2	0.99
Apgar score			
<4 at 1 min	11 (11)	9 (13)	0.81
<7 at 1 min	38 (38)	37 (52)	0.09
<4 at 5 mins	4 (4)	0	0.14
<7 at 5 mins	13 (13)	6 (9)	0.46
CPR	5 (5)	2 (3)	0.70
Intubation	19 (19)	14 (20)	0.53
NICU admission	34 (34)	27 (38)	0.63
HIE	4 (4)	0	0.14
Neonatal death	1 (1)	1 (1.4)	0.66

Abbreviations: CPR = cardiopulmonary resuscitation; DDI = decision-to-delivery interval; HIE = hypoxic ischaemic encephalopathy; NICU = neonatal intensive care unit

* Data are shown as mean ± standard deviation or No. (%) of subjects

Table 5. Cord blood pH*

	DDI ≤20 minutes (n=90)	DDI >20 minutes (n=67)	p Value
Cord blood pH	7.19 ± 0.14	7.23 ± 0.09	0.04
Cord blood pH <7.20	36 (40)	23 (34)	0.51
Cord blood pH <7.00	6 (7)	1 (1)	0.24

Abbreviation: DDI = decision-to-delivery interval

* Data are shown as mean ± standard deviation or No. (%) of subjects

of ureteric and bowel injury during the study period (Table 6).

In the group with DDI >20 minutes, more time was required for preparation and transfer of patient to the operating theatre (mean difference, 8.0 minutes; p<0.001), induction of anaesthesia (mean difference, 0.9 minutes; p=0.01), and from skin incision to delivery of the baby (mean difference, 0.7 minutes; p=0.01) when compared with the group with DDI within 20 minutes. However, there was no significant difference in the time required from uterine incision to delivery between the two groups (Table 7).

Discussion

The incidence of extremely urgent Caesarean

Table 6. Maternal outcomes*

	DDI ≤20 minutes (n=100)	DDI >20 minutes (n=71)	p Value
Special care	10 (10)	4 (6)	0.40
Fever	7 (7)	6 (9)	0.78
Endometritis	1 (1)	0	0.59
Wound infection	5 (5)	2 (3)	0.70
Bladder injury	0	1 (1)	0.42
Hysterectomy	2 (2)	0	0.51

Abbreviation: DDI = decision-to-delivery interval
* Data are shown as No. (%) of subjects

Table 7. Comparison of the time for preparation in extremely urgent Caesarean deliveries*

	DDI ≤20 minutes (n=100)	DDI >20 minutes (n=71)	p Value
Preparation and transfer to operating theatre (mins)	7.9 ± 2.8	15.9 ± 6.3	<0.001
Induction of anaesthesia (mins)	6.0 ± 1.8	6.9 ± 2.8	0.01
Skin incision to delivery (mins)	2.7 ± 1.3	3.4 ± 2.1	0.01
Uterine incision to delivery (mins)	0.8 ± 0.9	1.1 ± 1.3	0.09

Abbreviation: DDI = decision-to-delivery interval
* Data are shown as mean ± standard deviation

delivery was 1.1% in this study, which was comparable to the rate (0.9%) reported in a local study[12] on extremely urgent Caesarean deliveries. There had been concern on liberal use of extremely urgent Caesarean deliveries in less urgent cases, leading to unjustified maternal and fetal complications. In a study by Bloc et al[13], the indications of 38 extremely urgent Caesarean deliveries were retrospectively reviewed by independent experienced obstetricians and they were confirmed in 12 but rejected in 13 cases (the opinions were discordant for the remaining 13 cases). Since only those cases that underwent extremely urgent Caesarean deliveries for fetal distress were included in this study, it was likely to be a reflection of the actual incidence of these interventions.

In our series, 93% of extremely urgent Caesarean deliveries were performed with a DDI of ≤30 minutes. This encouraging result was probably attributed to adherence to the emergency Caesarean section protocol, good team collaboration, and regular drills in our hospital. In the study by MacKenzie and Cooke[1], fewer than 40% of extremely urgent Caesarean deliveries for intrapartum fetal distress were achieved within a DDI of 30 minutes. Similarly, the 30-minute interval was only obtainable in 63% of emergency Caesarean sections in the case control study by Schauberger et al[14]. On the other hand, in an audit on extremely urgent Caesarean deliveries at a tertiary maternity hospital in Singapore, the mean DDI was 7.7 minutes with 100% of the deliveries accomplished within 17 minutes[15]. The study by Hillemanns et al[4] also showed similar results that all 109 extremely urgent Caesarean deliveries performed within a DDI of 30 minutes (median DDI, 10 mins).

The Royal College of Obstetricians and Gynaecologists, American College of Obstetricians and Gynaecologists, and Canadian National Consensus Conference recommend that extremely urgent Caesarean deliveries be performed within DDI of 30 minutes[9-11]. However, since the majority of extremely urgent Caesarean deliveries in this study were performed in a DDI of ≤30 minutes, the collected data were categorised into two groups using the standard of 20 minutes as recommended by the German Society of Gynaecology and Obstetrics for comparison[4]. Another reason for using the 20-minute cutoff was for a fairer comparison between the two groups.

Although there was no significant difference in the gestational age and birth weight between the two groups, the cord blood pH was lower in the group with DDI within 20 minutes. This finding was consistent with the previous study by Hillemanns et al[4]. In this retrospective

study on 109 extremely urgent Caesarean deliveries, a DDI within 20 minutes was found to be associated with lower cord blood pH[4]. Two possible explanations might account for this paradoxical result. First, clinicians tended to perform Caesarean delivery more promptly in cases with severe fetal distress. Second, a longer DDI may allow the condition to improve spontaneously in cases with reversible causes of fetal distress (e.g. uterine hyperstimulation)[16]. In this study, the causes of fetal distress were unknown in the majority (81%) of cases. There were no cases of fetal distress after regional analgesia. Although extremely urgent Caesarean deliveries were performed because of persistent bradycardia after discontinuation of oxytocin in some cases, the presence of reversible elements could not be totally excluded, as recovery of the fetal heart rate might not occur before making the decision of extremely urgent Caesarean delivery. The possible adverse effects related to prolonged DDI among cases with irreversible causes might be diluted by those cases with reversible elements, leading to this paradoxical result. The fact that the bradycardia-to-delivery interval was not included in the analysis might also affect the result, as fetal hypoxia does not start at the time of decision but around the time of onset of fetal bradycardia. This may give direction to further studies for evaluation.

On the other hand, a longer DDI did not seem to be associated with worse neonatal outcomes, and this finding was consistent with that in a previous study by Thomas et al[17]. In this national cross-sectional survey on emergency Caesarean sections, the odds for Apgar score of <7 at 5 minutes in cases with DDI <15 minutes was not significantly different from those with DDI between 16 and 75 minutes[17]. The odds for Apgar score of <7 at 5 minutes was increased in cases with a DDI of >75 minutes, but this could not be validated in our study because no extremely urgent Caesarean deliveries were performed with a DDI beyond 75 minutes.

In our study, there was no significant difference in complications related to Caesarean section including fever, wound infection, endometritis, bladder injury, hysterectomy, and need for special postoperative care between the two groups. Our findings were consistent with those from a previous study by Hillemanns et al[18] who suggested that extremely urgent Caesarean delivery with a shorter DDI did not have detrimental perioperative effects on the mother or neonate. In our series, 13 (8%) cases developed puerperal fever and two (1%) cases required hysterectomy. The rates were much higher than those reported in a local audit (1.1% and 0.1%, respectively) on the complication rates of Caesarean sections (including both elective and emergency operations)[19]. This finding is consistent with that reported by Pallasmaa et al[20] who opined that maternal morbidity was more frequent in crash than in emergency or elective Caesarean deliveries. Due to the fact that some complications of Caesarean sections are rare (e.g. bowel injury, hysterectomy), a larger-scale study may be able to further explore the relationship between DDI and maternal outcomes, so as to provide more evidence-based recommendations.

In the group with DDI >20 minutes, more time was required for preparation and transfer of patient to the operating theatre (mean difference, 8.0 mins), induction of anaesthesia (mean difference, 0.9 mins), as well as from skin incision to delivery of the baby (mean difference, 0.7 mins) when compared with the group with DDI within 20 minutes. In other words, the most significant contributory factor for the delay was time required for preparation and transfer of patient to the theatre. This was unexpected as the antenatal characteristics were not significantly different between the two groups. A limitation of our study was that data concerning pre-existing medical diseases were not collected. More time would be spent in optimisation of maternal condition in cases with pre-existing medical diseases.

When life-threatening fetal distress occurs, Caesarean sections should be performed swiftly, preferably within 30 minutes, but the well-being of the mother or fetus should not be compromised. In our present study, the most significant contributing factor to a delay in DDI was the time required for preparation and transfer of patients to the operating theatre (mean, 15.9 mins). Preoperative interventions can be carried out smoothly within a shorter period of time if an experienced operating team is available[21]. Earlier preparation in high-risk cases including blood typing and screening, fasting, control of hypertension or optimisation of maternal conditions will shorten the time required for preparation if emergency Caesarean section is needed. Epidural analgesia for pain relief can be considered so that a top-up can be offered if emergency Caesarean section is needed. Having an experienced in-house operating team has the advantage of allowing the intervention to take place within a shorter period of time[22]. The time required for transferring the patient to the operating theatre can be minimised if the operating theatre is located inside or within a short distance from the labour suite.

In our study, general anaesthesia was given to all cases for extremely urgent Caesarean delivery. General

anaesthesia is the method of choice for most anaesthetists in most urgent settings, but it can be more risky than regional anaesthesia[23]. While Dunphy et al[24] suggested that regional blockade was associated with longer DDI than general anaesthesia, Lim et al[15] found that there was no significant difference in the DDI regardless of the type of anaesthesia used.

The limitations of the present study included the retrospective nature and small sample size. A larger-scale prospective study is recommended to further evaluate the relationship between DDI and neonatal and maternal outcomes.

Conclusion

The cord blood pH was lower in the group with DDI within 20 minutes than those with DDI >20 minutes. The major reason for delayed DDI was related to the longer time required for preparation and transfer of patients to the operating theatre.

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