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Association between rates of second-stage Caesarean section and instrumental delivery

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Objective: The increasing Caesarean section (CS) rate is a global public health concern, as is the second-stage CS rate at full cervical dilatation. This study aimed to study the temporal trends of the increased second-stage CS rate and the reduced instrumental delivery rate in a regional obstetric unit over 20 years.
Methods: Records of all CS and instrumental deliveries in a single obstetric unit between 1997 and 2016 were reviewed. Data were stratified into five 4-year intervals to analyse any significant trends.
Results: During the study period, there were a total of 87 413 deliveries, with 17 600 (20.1%) CS and 6502 (7.4%) instrumental deliveries. Although the overall CS rate increased modestly from 15.8% in 2001 to 24.6% in 2014, the rise in second-stage CS was significant ($p<0.001$) and culminated at 7.33% of all emergency CS in 2005-2008. Simultaneous to this increase was a trough in instrumental delivery rate of 5.3% ($p<0.001$) and a high failed instrumental delivery rate of 9.37% ($p<0.001$).
Conclusion: The increase in the second-stage CS rate was related to reluctance to attempt instrumental delivery together with failure of instrumental delivery. Introduction of training requirement in forceps delivery by Hong Kong College of Obstetricians and Gynaecologists resulted in an increasing use of forceps.

Keywords: Cesarean section; Delivery, obstetric; Labour stage, second

Introduction

The increasing Caesarean section (CS) rate is a global public health concern. From 1990 to 2014, the CS rate increased 12.4% globally, with an average annual rate increase of 4.4%, and in western European countries, it increased from 14.8% to 24.5%[1]. In Hong Kong, the secular trend of CS rates over 20 years also increased from 15.4% to 24.6%[2]. As the overall CS rate increases, so does the CS rate at full cervical dilatation, which is often coupled with a decline in the instrumental delivery rate. Up to 5% to 6% of intrapartum CS for singleton pregnancies were performed in the second stage of labour[3-5], and in 55% of these cases, no attempt was made to achieve vaginal birth with forceps or vacuum extraction[3]. There are concerns that resorting to second-stage CS after failed instrumental delivery is associated with increased risks of fetal trauma. Although failed instrumental delivery is a risk factor for birth trauma[6], the perception that second-stage CS is less traumatic to the mother and baby than a successful instrumental delivery is not supported by published data. Meta-analyses have demonstrated that second-stage CS is associated with a significant increase in maternal and fetal morbidity, including higher maternal admission to intensive care unit, transfusion rates, neonatal death rates, admission to neonatal unit, and rate of Apgar score of <7 in 5 minutes[6,7]. The rising number of CS at full dilatation not only increases the maternal risks for the delivery in question, but also has a negative impact on the woman's future pregnancies and deliveries[8]. Therefore, we aimed to study the temporal trends of the increased second-stage CS rate and the reduced instrumental delivery rate in a regional obstetric unit over 20 years.

Materials and Methods

This study was approved by the Kowloon Central / Kowloon East Cluster Research Ethics Committee. Data from the obstetric unit at United Christian Hospital from 1997 to 2016 were retrieved from the Hospital Authority Obstetrics Clinical Information System. Data on CS such as elective versus emergency CS, CS during the second stage of labour, and instrumental delivery (vacuum extraction versus forceps) were reviewed. Trends and changes in CS rates over the 20 years were examined.

The protocol for instrumental delivery was in accordance with Royal College of Obstetricians and

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Gynaecologists guidelines, and decision was made by obstetrician following evaluation of head station, position, and pelvis adequacy[9]. Prerequisites of instrumental delivery include vertex-presenting fetuses at full cervical dilatation and fully engaged head with no known suspicion of cephalopelvic disproportion. Forceps is preferred for deliveries <34 weeks of gestation. Indications for instrumental delivery include prolonged second stage of labour, fetal compromise, and shortening second stage for maternal benefit. Every detachment of the vacuum cup prior to delivery is considered as deviation from proper procedure and defined as slipped cup. Instrumental delivery is abandoned when no progression after three pulls of vacuum or forceps, or disengagement of vacuum cup for three times. The total number of failed instrumental deliveries was the summation of failed vacuum extraction or forceps. CS is performed within 30 minutes of failed instrumental delivery when further attempts at instrumental delivery were deemed inappropriate.

The proportions of those with advanced maternal age of >35 years, previous CS or other uterine scars, induction of labour, and multiple pregnancies were calculated. The total number of patients in each mode of delivery was stratified into five 4-year intervals, and the five intervals were compared using 5 × 2 contingency tables and Mantel-Haenszel Chi squared tests for linear trends for each category. A p valve of <0.05 was considered statistically significant.

Results

From January 1997 to December 2016, there were a total of 87 413 deliveries, with 17 600 (20.1%) CS and 6502 (7.4%) instrumental deliveries (Figure and Table 1). The annual number of deliveries ranged from 3371 in 1998 to 5648 in 2011. The CS rate increased modestly from 15.8% in 2001 to 24.6% in 2014. The rate of instrumental deliveries peaked at 10% in 1998-1999 and then troughed during 2005-2010, with the lowest rate of 4.92% in 2005, rising to 10% in 2015. Forceps delivery became more frequent after 2008, with the highest rate of 2.5% in 2013.

A total of 646 (3.67%) CSs were performed at full cervical dilatation, ranging from 19 cases in 1999 to 52 cases in 2008 (Table 1). The number of second-stage CS

Table 1. Major epidemiological risk factors and rates of Caesarean section (CS) and instrumental delivery from 1997 to 2016

	1997	1998	1999	2000	2001	2002	2003	2004
Total no. of deliveries	3501	3371	3534	3850	3522	3806	3787	4558
Crude perinatal mortality, %	3.16	3.25	3.56	3.87	3.68	2.59	3.98	3.63
Adjusted perinatal mortality, %	2.25	1.89	2.78	2.16	2.52	2.0	2.8	2.16
Women age >35 years, %	14.5	15.4	15.7	15.2	16.7	14.4	14.9	13.3
Previous CS, %	10.4	11.7	5.7	6.0	6.7	11.3	10.2	10.0
Induction, %	9.8	11.0	12.5	11.6	13.2	9.9	9.2	11.4
Multiple pregnancies, %	1.3	1.6	1.6	1.2	1.8	1.9	1.8	2.0
Total CS rate, %	18.1	19.5	16.6	16.5	15.8	17.4	18.2	19.5
No. (%) of emergency CS	424 (66.9)	384 (58.4)	437 (74.4)	457 (71.9)	389 (69.9)	387 (58.4)	421 (61.1)	596 (67)
No. (%) of second-stage CS	23 (5.42)	20 (5.20)	19 (4.34)	27 (5.90)	29 (7.45)	27 (6.97)	33 (7.83)	28 (4.69)
No. (%) of second-stage CS without trial of instrumental delivery	8 (35)	6 (30)	7 (36.8)	8 (29.6)	10 (34.5)	12 (44.4)	16 (48.5)	13 (46.4)
Instrumental delivery rate, %	8.99	10.3	10.5	10.2	8.88	8.14	7.26	6.34
No. of vacuum extraction	288	325	350	379	305	302	269	280
No. of forceps delivery	27	21	20	13	8	8	6	9
No. (%) of failed instrumental delivery	15 (4.76)	14 (4.04)	12 (3.24)	19 (4.84)	19 (6.07)	15 (4.84)	17 (6.18)	15 (5.19)
No. of failed vacuum extraction with slipped cup	8	10	6	14	15	8	13	10
No. of failed vacuum extraction with no slipped cup	6	4	6	5	4	7	4	5
No. of failed low forceps	1	0	0	0	0	0	0	0

peaked in 2005-2010, with a corresponding trough in the rate of instrumental deliveries, with the lowest at 4.85% in 2009. Of a total of 6502 attempted instrumental deliveries, 6139 (94.4%) were successful. The peak rate of failed instrumental delivery occurred in a period when fewer instrumental deliveries were performed, with the highest at 11.2% in 2008.

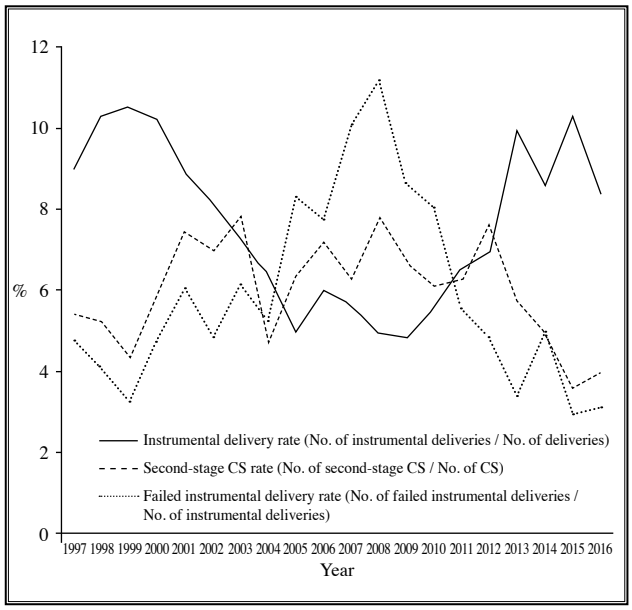

Figure. Rates of instrumental delivery, failed instrumental delivery, and second-stage Caesarean section (CS) from 1997 to 2016

The crude perinatal mortality rate ranged from 2.6 to 6 per 1000 deliveries; the adjusted perinatal mortality rate (excluding those with major congenital malformations and birth weight of <750 g) varied from 1.9 to 4.6 per 1000 deliveries. Owing to the small number of variations, no obvious trends were identified. The maternal mortality rate was <5 per 100 000 pregnancies, with many years recorded as zero so no trends could be observed. The incidence of significant birth trauma (including fractures and intracranial haemorrhage) and the incidence of maternal trauma (including third- and fourth-degree perineal tears) remained <0.5% of all deliveries and hence no obvious trends could be discerned.

Data were then stratified into five 4-year intervals for trend comparison (Table 2). The CS rate of 17.1% in 1997-2000 increased significantly to 22.9% in 2013-2016 ($p<0.001$). There was a progressive trend towards a higher

2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
5122	4295	4754	5234	5009	5315	5648	5039	4128	4429	4253	4258
5.27	3.96	2.95	3.09	4.99	3.95	3.28	2.58	3.39	2.94	6	4.46
3.52	3.49	1.89	2.32	3.39	2.82	2.42	1.6	1.70	2.48	4.62	2.78
13.2	16.1	18.1	22.4	27.3	21.5	22.9	23.5	25.5	24.5	26.3	26.9
9.5	10.7	12.8	12.7	12.0	12.4	14.0	14.5	15.2	16.1	15.6	17.1
11.0	8.4	14.7	10.8	12.7	11.4	12.5	14.3	15.7	15.9	16.3	17.7
1.7	2.3	3.0	2.5	2.3	2.4	3.4	2.8	2.3	3.6	1.34	1.86
18.2	18.6	18.8	22.1	20.9	23.1	23.1	23.4	23.6	24.6	22.0	23.5
676 (72.5)	541 (67.7)	558 (59.5)	665 (60)	596 (59.9)	689 (58.6)	732 (57)	604 (55)	507 (54.8)	549 (53.7)	557 (55.7)	528 (54.9)
43 (6.36)	39 (7.20)	45 (6.27)	52 (7.81)	40 (6.7)	42 (6.09)	46 (6.28)	46 (7.61)	29 (5.72)	27 (4.92)	20 (3.59)	21 (3.97)
22 (51.1)	19 (48.7)	18 (45)	23 (44.2)	19 (47.5)	18 (42.8)	25 (54.3)	29 (63)	15 (51.7)	18 (66.7)	7 (35)	10 (47.6)
4.92	6.01	5.62	4.93	4.85	5.58	6.55	6.97	9.98	8.60	10.3	8.33
246	256	260	226	228	258	336	290	308	330	402	316
6	2	7	32	15	38	43	61	104	51	36	39
21 (8.33)	20 (7.75)	27 (10.1)	29 (11.2)	21 (8.64)	24 (8.05)	21 (5.54)	17 (4.84)	14 (3.39)	19 (4.98)	13 (2.96)	11 (3.09)
12	11	17	20	12	16	12	9	9	14	8	4
9	8	10	8	8	7	9	8	4	4	4	5
0	1	0	1	1	1	0	0	1	1	1	2

Table 2. Comparison of five 4-year intervals in terms of rates of total Caesareans section (CS), instrumental delivery, failed instrumental delivery, and second-stage CS

Variable	1997-2000	2001-2004	2005-2008	2009-2012	2013-2016	p Value (Mantel-Haenszel Chi square for linear trends)
Total no. of deliveries	14 256	15 673	19 405	21 011	17 068	
Total no. (%) CS	2444 (17.1)	2816 (18.0)	3884 (20)	4546 (21.6)	3910 (22.9)	<0.001
No. (%) of emergency CS	1702 (69.6)	1793 (63.7)	2440 (62.8)	2621 (57.6)	2141 (54.8)	<0.001
No. (%) of second-stage CS	89 (5.23)	117 (6.52)	169 (6.92)	174 (6.63)	97 (4.53)	<0.001
No. (%) of second stage CS without trial of instrumental delivery	29 (32.6)	51 (43.6)	82 (45.8)	91 (52.3)	50 (51.5)	<0.001
No. (%) of instrumental delivery	1423 (9.98)	1187 (7.57)	1035 (5.33)	1269 (6.04)	1586 (9.29)	<0.001
No. (%) of failed instrumental delivery	60 (4.21)	66 (5.56)	97 (9.37)	83 (6.54)	57 (3.59)	<0.001

proportion of elective CS as compared to emergency CS, probably related to the ever-increasing proportion of patients with elective repeat CS for previous CS. The rate of emergency CS among all CS dropped from 69.9% to 54.8%. Among all emergency CS, the proportion of second-stage CS increased from 5.23% in 1997-2000 to 7.33% in 2005-2008, and then decreased to 4.53% in 2013-2016 (p<0.001). Simultaneous to this increase in second-stage CS was a significant trough in the instrumental delivery rate of 5.3% in 2005-2008 (p<0.001), during which the rate of failed instrumental delivery was highest (9.37%). As instrumental delivery rates gradually rebounded to 9.29% in 2013-2016, the rate of failed instrumental delivery decreased to 3.59%. The proportion of women undergoing second-stage CS without a trail of instrumental delivery increased gradually from 32.6% in 1997-2000 to 60% in 2009-2012 and 50% in 2013-2016 (p<0.001).

Discussion

In our study, the CS rate increased modestly from 15.8% in 2001 to 24.6% in 2014. The second-stage CS rate reached 7.33% of all emergency CS during 2005-2008. Simultaneous to this increase in the second-stage CS rate was a significant trough in instrumental delivery rates. Even as instrumental delivery rates rebounded in later years, >50% of women who had a second-stage CS did not attempt at instrumental delivery.

The global CS rates increased 12.4% from 1990 to 2014[1]. Along with the rising CS rate, there is an increasing trend to CS at full cervical dilatation[4,10,11]. In a population-based study of US births, from 2005 to 2013 vacuum delivery reduced from 5.8% to 4.1% while forceps delivery decreased from 1.4% to 0.9%[12]. In 55% of second-stage CS, no attempt at instrumental delivery was made[3].

In our data, there was a close temporal relationship between rising second-stage CS rates, decreasing instrumental delivery rates, and increasing failed instrumental delivery rate. The decline in instrumental delivery was replaced, in whole or in part, by the increase in second-stage CS. This trend is multifactorial. First, junior doctors are better trained in performing CS than instrumental delivery. Junior doctors regularly perform elective CS under supervision, whereas instrumental deliveries are usually performed only under emergency settings. A lack of confidence could lead to reluctance to attempt instrumental delivery. Second, the medicolegal concerns over maternal and neonatal morbidities with failed instrumental delivery fuel earlier recourse to CS, which is perceived to be safer. Third, failed instrumental delivery may trigger a vicious cycle of reluctance to attempt instrumental delivery. Avoidance of primary CS may minimise risks in subsequent pregnancies and increase the chance of a normal vaginal birth thereafter. Women are more likely to aim for and to have vaginal delivery if they have a previous instrumental delivery rather than CS[13].

In the United Kingdom, 10% to 13% of women underwent instrumental delivery[9]. In our cohort, the rate halved to 4.9% in 2008-2009. Unlike CS, the World Health Organization has not defined an optimal rate of

instrumental delivery. Nonetheless, instrumental delivery is one of seven basic emergency obstetric care services[14]; it potentially increases the expelling force, decreases resistance of birth canal such as soft tissue obstruction, and modifies the perimeter of fetal head in cases of malposition, asynclitism, or deflection. CS should be reserved for genuine cephalopelvic disproportion at the brim. Instrumental delivery has a role in optimising obstetric care and reducing the CS rate. Both the American College of Obstetricians and Gynecologists (ACOG) and Royal College of Obstetricians and Gynaecologists (RCOG) reiterated the need for better training for instrumental delivery. ACOG Obstetric Care Consensus 2014 recommends with moderate-quality evidence that: "Operative delivery in the second stage of labour by experienced and well-trained physicians should be considered as a safe, acceptable alternative to CS delivery. Training in, and ongoing maintenance of, practical skills related to operative vaginal delivery should be encouraged"[15]. In the RCOG curriculum, completion of Objective Structures Assessment of Technical Skills for operative vaginal delivery is one of the prerequisites to enter higher training[9]. Moreover, simulation and teamwork training in Advanced Life Support in Obstetrics course provides structured clinical training in a supportive environment. In Hong Kong, training in forceps delivery has decreased in the past 20 years. Since 2008, the Hong Kong College of Obstetricians and Gynaecologists has required all trainees to perform a minimum of 30 forceps deliveries under supervision within their 6-year specialist training[16]. This may have resulted in an increase in forceps delivery rates from 2008 onwards. Indeed, the need for adequate training in forceps delivery also encouraged trainees to perform more vacuum deliveries. Therefore, the overall instrumental delivery rate gradually returned from the trough years in 2005-2008 to that in 1997-2000.

Vacuum extraction is preferred over forceps because of lower incidence of maternal trauma. A Cochrane review supports the use of vacuum extraction as first-line method if there is no clear clinical indication for any specific instrument[17]. However, we found a trend that the vacuum-to-forceps ratio increased more than tenfold from 1:0.02 in 2001 to 1:0.34 in 2013. This shift closely reflects the re-introduction of forceps training by the Hong Kong College of Obstetricians and Gynaecologists[16]. The College saw the need to reinvigorate forceps training as forceps may be the safest option of delivery in certain clinical situations, such as delivery of a preterm baby <34 weeks' gestation, face presentation, poor maternal effort, expedient delivery for fetal distress, and after-coming head in vaginal breech delivery.

Deciding between a trial of instrumental delivery and a direct second-stage CS is a dilemma in obstetric practice. A UK study found that consultant assessment and decision is crucial in deciding whether a second-stage CS is the optimal mode of delivery[18]. There are substantial differences between consultant and specialist registrar opinions on factors affecting safe vaginal delivery such as the position of the fetal head and its proximity to the pelvic outlet. A consultant obstetrician is more likely to reverse the initial decision for CS and attempt instrumental delivery. In addition, intrapartum ultrasound can be used to assess labour progress. In particular, the angle of progression is an objective, accurate, and repeatable parameter to predict successful vaginal delivery and enable better decision-making on the optimal mode of delivery[19-21]. Furthermore, it provides an opportunity for experienced obstetricians to teach advanced skills such as manual rotation of fetal head. A retrospective study reported a vaginal delivery rate of 74% after successful manual rotation to occipital anterior position[22].

Instrumental deliveries are traditionally associated with increased risk of fetal trauma, ranging from brachial plexus injury to intracranial bleeding and skull fractures. Yet the risk of fetal trauma secondary to difficult disengagement of a deeply engaged head during CS should not be ignored. In 2012, the Cochrane Collaborative attempted to investigate outcomes of attempted instrumental delivery and direct CS for anticipated difficult births but failed to identify any randomised trials[23]. An observational cohort with 2531 women reported that in patients requiring second-stage delivery assistance with a station of +2 or below, attempted instrumental delivery was associated with fewer postpartum infection but more severe laceration than CS[24]. Another retrospective study of 2518 women demonstrated that a trial of forceps delivery from a low station was associated with decreased neonatal morbidity born to nulliparous women compared with CS[25]. These two studies examined the attempted (instead of ultimate) mode of delivery, thus minimising selection bias. Nonetheless, in the absence of randomised trials, the balance of risks between the two interventions remained unanswered.

When opting for a direct second-stage CS, obstetricians should be aware of the increased risk of massive postpartum haemorrhage requiring blood transfusion, and the impact of possible uterine tears on subsequent pregnancies[26]. Laparoelytrotomy (mistaking the upper vagina for lower uterine segment) is more common in second-stage CS[27]. CS at full dilatation is technically

challenging when the fetal head is deeply impacted into the maternal pelvis. The most common techniques for disengagement are the push and pull methods. In particular, the pull method may result in fewer hysterotomy extensions, lower blood loss, and shorter operating time[28]. Furthermore, second-stage CS is associated with a significant increase in the risk of spontaneous preterm birth <32 weeks of gestation in subsequent pregnancies[5,29].

Our overall rate of failed instrumental delivery was 5.5%, which is comparable to that reported in the Cochrane systematic review of 32 randomised controlled trials[17]. In our cohort, the peak of the failed instrumental delivery rate of 11.2% in 2008 coincided with one of the lowest instrumental delivery rates of 4.93%. Increasing failed instrumental delivery has been reported to be associated with reduced attempts at instrumental delivery (regression coefficient p=0.002)[4]. High instrumental delivery failure rate is often ascribed to malposition or erroneous assessment of fetal head position[23]. Defining fetal position is essential for appropriate choice of instrument and correct application. A large retrospective observational study involving 1291 full-term singleton cephalic birth with malposition of fetal head during second stage of labour suggested that in experienced hands, assisted vaginal birth by Kielland rotational forceps was the most effective and safe method. Births by Kielland forceps achieved comparable maternal and neonatal outcomes with rotational vacuum and primary emergency CS[30]. Therefore, phased re-introduction of rotational forceps should be considered should expertise and experience be available.

The strength of the current study is the large sample collected over 20 years for trend observance. However, data were limited to one single training centre. Although the trends should be similar in other centres, it would be interesting to extend the survey to include non-training private obstetric centres.

Conclusion

Instrumental delivery is important in optimising obstetric care and counteracting CS. It is imperative that residency training programmes continue to teach instrumental delivery skills as an alternative to CS. Experienced obstetricians should decide on the suitability and safety for trial instrumental delivery and provide supervision for technically challenging second-stage CS. The requirement from the Hong Kong College of Obstetricians and Gynaecologists for all trainees to perform a minimal number of forceps deliveries is the main reason to revive the forceps delivery rate. Our study highlights the need for continuous audits on instrumental delivery and second-stage CS as a useful measure of clinical standards.

Declaration

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