



Original Article

The changing indications and rates of cesarean section in one academic center over a 16-year period (1997–2012)

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ABSTRACT

Objective: To compare trends and rates of cesarean section delivery by indication in one academic center.
Materials and Methods: A retrospective analysis of the indications of all cesarean sections performed in Edith Wolfson Medical Center, Holon, Israel, a tertiary healthcare university facility, during 1997–2012 was done. Each delivery was assigned to the primary indication noted for that pregnancy, regardless of other indications reported. Whenever more than one indication was present, the principle indication chosen by the attending obstetrician was chosen for the analysis.

Results: The cesarean section rate gradually rose from 15.29% in 1997 to 21.10% in 2012, with an overall cesarean section rate of 20.66%. The cesarean section rate between 1997 and 2000 was 17.52%, between 2001 and 2004 was 18.5%, between 2005 and 2009 was 22.86%, and between 2009 and 2012 was 22.07% ($p < 0.001$). The five leading primary indications across the years were previous cesarean section (26.0%), non-reassuring fetal heart rate pattern (18.1%), malpresentation (16.9%), labor dystocia (8.8%), and suspected macrosomia (7.2%).

Conclusion: Previous cesarean section persistently increased and was the leading indication throughout the years. Any attempt to reverse this trend must be based on reduction of the primary cesarean section rate.

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Introduction

The indication of the first documented cesarean delivery dating to the 23rd year of King Hammurabi of Babylon (1795–1750 BC) was postmortem delivery of an alive child [1]. For centuries thereafter, the postmortem or perimortem was the principal indication for performing a cesarean section, although sporadic evidence during the course of history had suggested other indications. In modern times, it was François Rousset (1530–1603 AD), a French obstetrician, who suggested cesarean section on living women, and therefore proposed maternal (contracted pelvis) as well as fetal (macrosomia, malformation, malposition, or twins) indications [1]. During the 20th century, with the introduction of anesthesia, improved surgical techniques, asepsis, antibiotics, and modern transfusion techniques, cesarean section became safe for the health

and livelihood of both mother and child. Towards the end of the 20th century, the multiplicity of indications for cesarean section steadily increased and included maternal and neonatal safety objectives. The major “contributors” to the increasing cesarean section rates were maternal request, breech presentation, decreasing rate of trial of previous uterine scar, and electronic fetal heart rate monitoring [2].

During recent years, the attitude towards these and other indications has been modified [2]. Most of the “classic” indications such as cephalopelvic disproportion, placenta previa, labor dystocia, or high order gestation remained unchanged [2]. Side by side, “new” indications have emerged, such as planned cesarean section for term breech presentation [3] or maternal choice cesarean without a medical indication (i.e., cesarean on demand) [4]. The latter is a result of a motion to act in accordance with the mother's desire and preference, in addition to action on behalf of health and safety regulations of both mother and child [5]. Concurrently, improvements in definition and interpretation of common situations leading to cesarean section have taken place. More strict criteria for diagnosis of fetal distress were introduced and applied [6,7].

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Vaginal birth after cesarean delivery (VBAC) emerged from the 1980 National Institute of Health consensus report [8] as a mechanism to safely reduce cesarean section rates. After initial enthusiasm for trial of labor after cesarean birth (TOLAC), concerns about medical liability claims after catastrophic complications (uterine rupture and need for emergency hysterectomy) contributed to a sharp decline in VBAC rates in the beginning of the 2000s [9]. Thus, a “step back” was carried out towards the longstanding dictum suggested by Craigin in 1916 [10]: “once a cesarean always a cesarean”.

The objective of this study was to identify the main indications and to examine the trend of cesarean rate and indications over a 16-year period (1997–2012) in one university affiliated tertiary medical center.

Materials and methods

This retrospective study is based on data concerning method of delivery and indications for cesarean delivery at Edith Wolfson Medical Center, Holon, Israel, a university affiliated tertiary healthcare facility, in the years 1997–2012. The study protocol was approved by the Edith Wolfson Institutional Review Board Committee (protocol number WOMC 0151-12). There were a total of 55,390 deliveries between January 1, 1997 and December 31, 2012. Of those, 11,455 (20.66%) were accomplished by a cesarean section.

The identification of the indications for cesarean delivery was through the Edith Wolfson Medical Center registry in accordance with International Classification of Disease (ICD-9) codes. The selection of the underlying reason or indication for cesarean delivery was based on the primary indication for cesarean delivery as stated by the attending obstetrician. Each delivery was assigned to the primary indication noted for that pregnancy, regardless of other indications reported. All cesarean deliveries were allocated to one of 10 categories: previous cesarean section, labor dystocia, fetal distress [non-reassuring fetal heart rate pattern (NFHRP)], malpresentation, hemorrhage, multiple gestation, macrosomia (and/or cephalopelvic disproportion), failed induction, cesarean on demand (i.e., maternal-choice) and “other.”

In our department, labor is managed by standard departmental protocols, with direct supervision by the senior obstetric faculty. In 2000, refreshment courses of the criteria of indications of cesarean deliveries were undertaken in our department. It was followed by quality control program assessment of indications of cesarean deliveries in 2001 and 2002. In 2001, a policy of labor induction at 41 weeks' gestation instead of 42 weeks for otherwise uncomplicated singleton pregnancies was introduced.

The category previous cesarean section includes all repeated cesareans, i.e., post one, two, three, and more previous cesareans. The category labor dystocia includes all types of obstructed or nonprogressive labors. In our department, the diagnosis of failure to progress was made in accordance with the guidelines of the American College of Obstetricians and Gynecologists. NFHRP (i.e., fetal distress) was defined as severe variable decelerations, late decelerations, prolonged decelerations (3–10 minutes), or baseline bradycardia of < 100 beats/min. The category malpresentation includes singleton breech presentation or transverse lie. Since 2001, a policy of planned cesarean section for term breech presentation was introduced in our department in accordance with recommendations of the Term Breech Trial Collaborative Group study [3]. The category hemorrhage includes placental abruption and placenta previa. Until the end of 2005, parturient women with complete placenta previa were delivered by a cesarean section, while those with partial or marginal were allowed to have a trial of vaginal delivery [11]. Since 2006, all women with prelabor diagnosis of either complete, or partial or marginal placenta previa

were scheduled for a cesarean section. Until 2011, suspected macrosomia was defined as ultrasonographic or clinical estimation of fetal weight of > 4250 g, and since then as > 4500 g. Women who requested a cesarean section on demand were interviewed by a senior obstetrician and if after they have received and understood all the necessary information and still maintained the request for a cesarean section, their wish was granted. The category “other” includes all other indications for cesarean delivery.

Statistical analysis was performed by Chi-square calculations. Significance was set at $p < 0.05$.

Results

Table 1 summarizes the rate of cesarean sections in the years 1997–2012 in Edith Wolfson Medical Center. The lowest rate (15.29%) was in 1997, while the highest (24.12%) was in 2007. The cesarean section rate between 1997 and 2000 was 17.52% (1858 out of 10,606), between 2001 and 2004 was 18.5% (2252 out of 11,630), between 2005 and 2009 was 22.86% (3431 out of 15,008), and between 2009 and 2012 was 22.07% (4004 out of 18,146) ($p < 0.001$). The cesarean section rate between 1997 and 2004 was 18.03% (4010 out of 22,236) as compared to the 22.43% (7435 out of 33,154) rate between 2005 and 2012 ($p < 0.001$).

Table 2 summarizes the distribution of indications for cesarean sections in the years 1997–2012 in Edith Wolfson Medical Center. In total, the five leading primary indications were previous cesarean section (26.0%), NFHRP (18.1%), malpresentation (16.9%), labor dystocia (8.8%), and suspected macrosomia (7.2%). The leading primary indication for cesarean delivery differed across the years: it was previous cesarean in 1997–2000 and 2006–2012 (68.7%); malpresentation in 2001–2004 (25.0%); and NFHRP pattern in 2005 (6.3%). Malpresentation contribution to cesarean section rate was 14.3% (76/530) and 24.5% (114/464) in 2000 and 2001, respectively ($p < 0.05$). Malpresentation contribution to cesarean section rate was 14.1% (262/1858) between 1997 and 2000, and 17.5% (1674/9587) between 2001 and 2012 ($p < 0.05$).

Discussion

During the 16-year study period (1997–2012) the overall cesarean section rate at Edith Wolfson Medical Center was 20.66%. The cesarean section rate in Israel in the 1960s was 1.8% [12]. Since then, the national cesarean section rate steadily increased and was

Table 1
Cesarean section rates in the years 1997–2012.

Year	Deliveries (n)	Cesareans (n)	Cesareans (%)
1997	2688	411	15.29
1998	2691	476	17.69
1999	2607	441	16.92
2000	2620	530	20.23
2001 *	2669	464	17.38
2002 *	3000	530	17.67
2003	2951	562	19.04
2004	3010	596	19.80
2005 **	3463	794	22.93
2006	3630	738	20.33
2007 ***	3785	913	24.12
2008	4130	986	23.87
2009	4308	967	22.45
2010	4363	1008	23.10
2011	4522	984	21.76
2012	4953	1045	21.10
Total	55390	11,445	20.66

* $p < 0.05$ when compared to the rate in 2000.

** $p < 0.05$ when compared to the rate in 2004.

*** $p < 0.05$ when compared to the rate in 2006.

Table 2

Distribution of indications for Cesarean section the years 1997–2012. NRFHRP stand for non-reassuring fetal heart rate pattern. Grey shadowing represents the most frequent indication for each year. The differences between the years are statistically significant ($p < 0.001$).

Year	Cesareans (n)	Indications for cesarean section									
		Previous cesarean	NRFHRP	Malpresentation	Labor Dystocia	Macrosomia	Multiple gestation	Hemorrhage	Cesarean on demand	Failed induction	“Other”
1997	411	78 (19.0)	68 (17.0)	53 (12.0)	37 (9.0)	46 (11.0)	46 (11.0)	31 (8.0)	0 (0.0)	7 (2.0)	45 (11.0)
1998	476	111 (23.3)	58 (12.1)	65 (13.6)	47 (9.8)	53 (11.1)	60 (12.6)	29 (6.0)	0 (0.0)	5 (1.0)	48 (10.0)
1999	441	104 (23.5)	70 (15.8)	68 (15.4)	47 (10.6)	36 (8.1)	38 (8.6)	40 (9.0)	0 (0.0)	7 (1.5)	31 (7.0)
2000	530	123 (23.7)	60 (11.3)	76 (14.3)	51 (9.6)	65 (12.2)	45 (8.5)	23 (4.3)	1 (0.2)	5 (0.9)	78 (14.6)
2001	464	64 (13.8)	83 (17.8)	114 (24.5)	57 (12.2)	53 (11.4)	16 (3.4)	29 (6.2)	4 (0.8)	2 (0.4)	42 (8.9)
2002	530	82 (15.5)	120 (22.6)	134 (25.3)	23 (4.3)	69 (13.0)	7 (1.3)	39 (7.3)	5 (0.9)	10 (1.9)	41 (7.6)
2003	562	98 (17.4)	123 (21.9)	149 (26.5)	8 (1.4)	69 (12.2)	21 (3.7)	42 (7.4)	4 (0.7)	17 (3.0)	31 (5.5)
2004	596	118 (19.8)	96 (16.1)	148 (24.8)	41 (6.8)	72 (12.0)	30 (5.0)	23 (3.8)	20 (3.3)	16 (2.6)	32 (3.2)
2005	794	165 (20.1)	174 (21.9)	127 (16.0)	73 (9.0)	116 (15.0)	47 (5.9)	23 (2.9)	26 (3.2)	14 (1.7)	29 (3.6)
2006	738	205 (27.7)	160 (21.6)	126 (17.0)	15 (2.0)	44 (5.9)	29 (3.9)	71 (9.6)	36 (4.8)	23 (3.1)	29 (3.9)
2007	913	237 (25.9)	193 (21.1)	135 (14.7)	60 (6.5)	48 (5.2)	62 (6.8)	81 (8.8)	48 (5.2)	19 (2.0)	30 (3.2)
2008	986	304 (30.8)	165 (16.7)	145 (14.7)	127 (12.8)	29 (2.9)	64 (6.4)	34 (3.4)	49 (4.9)	33 (3.3)	36 (3.6)
2009	967	273 (28.2)	187 (19.3)	150 (15.5)	116 (11.9)	38 (3.9)	54 (5.5)	17 (1.7)	37 (3.8)	30 (3.1)	65 (6.6)
2010	1008	345 (34.2)	179 (17.7)	149 (14.7)	109 (10.8)	38 (3.7)	72 (7.1)	18 (1.7)	33 (3.2)	25 (2.4)	40 (3.8)
2011	984	328 (33.3)	165 (16.7)	124 (12.6)	103 (10.4)	22 (2.2)	78 (7.9)	23 (2.3)	56 (5.7)	39 (3.9)	46 (4.6)
2012	1045	345 (33.1)	173 (16.6)	173 (16.6)	91 (8.7)	29 (2.8)	47 (4.5)	31 (3.0)	67 (6.4)	30 (2.9)	59 (5.7)
Total	11,445	2980 (26.0)	2074 (18.1)	1936 (16.9)	1005 (8.8)	827 (7.2)	716 (6.3)	554 (4.8)	386 (3.4)	282 (2.5)	682 (6.0)

Data are presented as n (%).

13.1% in 1997 and 19.4% in 2011 [13]. These rates are parallel to those in our department: 15.29% in 1997 and 21.10% in 2012. Gibbons et al [14] performed a worldwide analysis of cesarean section rates for the year 2008. The analysis included 137 countries out of 192 United Nations member states which represented 95% of global births in that year. Fifty-four countries had cesarean section rates of $< 10\%$, whereas 46 countries showed rates of $> 20\%$; the highest cesarean section rate was in Brazil (45.9%) and the lowest was in Chad (0.4%). For comparison, in that year, our departmental cesarean section rate was 23.87%, while the Israeli national rate was 19.1%.

In 2001 and 2002, we had a statistically significant decline in cesarean section rates from 20.23% in 2000 to 17.38–17.67% (Table 1). We believe that this decline in cesarean section rate is a result of educational influence of refreshment courses of the criteria and the quality control program assessment of indications of cesarean deliveries that took place in our department. A similar influence was demonstrated previously by other authors [15,16]. The statistically significant increase in cesarean section rate in 2005–2012 as compared to that in 1997–2004, from 18.03% to 22.43%, could be attributed to the “Landon effect”. In December 2004, Landon et al [17] published data from 19 academic medical centers belonging to the National Institute of Child Health and Human Development Maternal-Fetal Medicine Units Network in the *New England Journal of Medicine*. In that publication, they concluded that a trial of labor after prior cesarean is associated with a greater perinatal risk than elective repeated cesarean without labor. As a result of this fundamental paper, a more liberal approach for elective repeated cesarean was introduced in our department. We do not have an explanation for the statistically significant increase in cesarean section rate in 2007 (24.12%) as compared to that in 2006 (20.33%), and this can be attributed to merely chance.

During the 16-year study period (1997–2012) at Edith Wolfson Medical Center, the overall leading primary indication was previous cesarean section (26.0%). It was also the leading primary indication in 11 out of the 16 study period years (68.8%). Previous cesarean was shown to be the major contributor to cesarean section rate in industrialized as well as developing countries, as reported in many previous studies [18–21]. Because a cesarean is usually obligatory after two previous cesarean sections, it was suggested by some authors that reducing the rate of cesarean section after one

previous cesarean section would reduce the total cesarean section rate [9]. This is particularly important in countries with high order pregnancies. However, there is insufficient evidence that these merits are effective [9]. Currently there is a tendency in decreasing rate of attempts of VBAC because of increased risk of uterine rupture during TOLAC [17]. If this notion is true, than future efforts in reduction of total cesarean section rate should be directed towards lowering the rates of primary cesarean section rate.

NRFHRP was the second leading primary indication for cesarean section (18.1%) during the 16-year study period (1997 to 2012). This finding is in agreement with previous studies that have revealed that fetal distress is another major contributor to cesarean section rate in industrialized as well as developing countries [19,20,21]. Suspected fetal distress usually results in expedited delivery which is often a cesarean section. Unfortunately, fetal distress is often overdiagnosed using the tool of NRFHRP [2]. Moreover, the subsequent increase in cesarean section rate did not necessarily lead to improved perinatal morbidity or mortality [2]. It was previously shown that combined use of electronic fetal monitoring and fetal scalp blood pH estimation may reduce the diagnosis of fetal distress and resulting cesarean deliveries [22]. In 2011, Reif et al [23] showed that if one or more results of fetal scalp pH were within the normal range, a cesarean delivery could be avoided in 6.4% of cases in spite of the NRFHRP. We agree with this approach and believe that a more strict policy of interpreting fetal heart rate tracing and the liberal use of scalp pH may reduce the contribution of suspected fetal distress to cesarean section rate. By contrast, the use of fetal pulse oximetry [24] or fetal ECG ST segment analysis [25] were not shown to be beneficial in reducing cesarean section rate for non-reassuring fetal status.

Malpresentation was the third leading primary indication for cesarean section (16.9%) during the 16-year study period (1997–2012). It was the leading primary indication of cesarean sections in the years 2001–2004. Malpresentation contribution to cesarean section rate significantly rose from 14.1% between 1997 and 2000 to 17.5% between 2001 and 2012 ($p < 0.05$), with the largest increase between 2000 and 2001 (14.3% and 24.5%, respectively, $p < 0.05$). We believe that this change is a result of the introduction of policy of planned cesarean section for term breech presentation in accordance with recommendations of the Term Breech Trial Collaborative Group study. This randomized

multicenter trial performed by Hannah et al [3] was published in *The Lancet* in October, 2000. Hannah et al [3] concluded that planned cesarean section is better than planned vaginal birth for the term fetus in the breech presentation. These conclusions and recommendations were enthusiastically adopted by the obstetrical community. Vaginal breech delivery was always considered as problematic for both the mother and her fetus and of course demanded extensive experience and know-how. An elective safe cesarean section for breech presentation is much easier to execute and it requires less expertise and experience to do so [26]. Moreover, in the current medicolegal environment, in which litigation for a performed cesarean section is a rare event but vaginal delivery carries increased risks for litigation, obstetricians can easily be convinced not to take this risk [26]. We believe that a reduction of the breech presentation as a primary indication for cesarean section has the ability of an important contribution of reducing the cesarean section rates. A way to do so would be to increase the rate of external cephalic version in breech presentation through education and proper training [27].

The relative contribution of labor dystocia as a primary indication of cesarean sections during the 16-year study period (1997–2012) was relatively low and constant over the years. One of the explanations for that could be our policy of labor induction at 41 weeks' gestation for otherwise uncomplicated singleton pregnancies. This approach is supported by a meta-analysis that concluded that a policy of labor induction at 41 weeks' gestation for otherwise uncomplicated singleton pregnancies reduces cesarean delivery rates without compromising perinatal outcomes [28]. It demonstrated that, compared with women allocated to expectant management, those who underwent labor induction at 41 weeks' gestation had a lower cesarean delivery rate (odd ratio 0.88; 95% confidence interval 0.78, 0.99). The raise in cut-off of suspected macrosomia from 4250 g to 4500 g did not result in significant increase in contribution of this indication to cesarean section rate.

The study has few limitations, since it is a retrospective study in which the data were extracted from a registry. In that way, confounders cannot be excluded as possible explanations for the findings. The strength of the study is in its large cohort over a relatively long period (16 years) in a single medical center, a feature that maintained homogeneity regarding the attending obstetricians' attitudes towards cesarean section.

In summary, cesarean section rates steadily increased during the 16-year study period (1997–2012) and the distributions of contribution of each indication have changed across the years, although the principle contributor remained previous cesarean section. We therefore feel that if one wishes to lower the total cesarean section rate, the appropriate way would be to reduce the primary section rate by increasing the rate of external cephalic version for breech presentation (and safe breech vaginal delivery technique), tightening the criteria for NRFHRP (and liberal use of scalp pH) and labor induction at complete 41 weeks' gestation.

Conflicts of interest

The authors have no conflicts of interest relevant to this article.

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