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ORIGINAL ARTICLE

There is Only a Modest Increase in Neonatal Respiratory Morbidity Following Early Term Elective Cesarean in a South Indian Population

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Abstract

Objectives Elective cesarean deliveries (ECD) are still performed prior to 39 weeks. This study aimed to identify risk of neonatal respiratory morbidity (NRM) following ECD near term, in a South Indian population. Specifically, study aimed to measure the additional healthcare burden due to large number of ECDs performed prior to 39 weeks, in this local population.

Methods We analyzed NRM among 1329 deliveries (584 ECD and 745 spontaneous vaginal delivery, SVD) in a tertiary hospital over 2 years. Neonates were grouped into: A: 35^{+0}–36^{+6} weeks, B: 37^{+0}–38^{+6} weeks, and C: ≥39 weeks. NRM was compared between ECD versus SVD.

Results Majority (433/584) of ECDs were performed between 37^{+0} and 38^{+6} weeks. Overall, 32% received steroid prophylaxis. Of 1329 newborns, 18/584 (3.82%) in ECD and 6/745 (0.8%) in SVD group developed NRM

(p value of 0.004, OR 3.9, CI 1.54–9.93). Need of respiratory support among ECD was 4.28% compared to 0.53% in SVD ($p < 0.001$, OR 8.28; CI 2.86–23.94). However, comparing neonates born by ECD between groups B Vs C; there was only a modest increase in NRM (2.07 vs 0.9%; p 0.48, OR 2.3 with CI 0.29–18.4) and in need of respiratory support (2.54 vs 0.9%; p 0.47, OR 2.84; CI 0.36–22.2).

Conclusion NRM following early term ECD continues to be a healthcare burden in India. Interestingly in this South Indian population, early term ECDs caused only modest increase in NRM, and this ethnic variation requires further evaluation to determine ideal time for ECD in local population.

Keywords Neonatal respiratory morbidity · Transient tachypnoea of newborn · Respiratory distress syndrome · Persistent pulmonary hypertension · Elective cesarean at term · Elective cesarean near term

Background

Elective cesarean delivery (ECD) rates have increased over past three decades, due to several factors [1]. Risk of neonatal respiratory morbidity (NRM) due to ECD prior to 39 weeks of gestational age (GA) is well recognized [2], leading to standard recommendations on timing of ECD by international organizations [3, 4]. A course of maternal corticosteroids are recommended, to reduce the risk of NRM if ECD is deemed necessary prior to 39 weeks. However, in developing countries, this risk is underestimated by both patients and caregivers, leading to liberal attitude toward earlier ECDs. The resulting NRM leads to heavy burden on healthcare resources. This study aimed to investigate the association between ECD and NRM in late preterm and term infants in a South Indian population, in comparison with those born by spontaneous vaginal delivery (SVD), thus aiming to know the ideal timing for ECD in this population.

Methodology

This prospective observational study included all ECDs and SVDs in a tertiary obstetric unit over 2 years. Liveborn singletons without congenital malformations of GA $\geq$ 35 weeks (Fig. 1) were included. Deliveries (both ECD and SVD, $n = 1329$) were grouped into three: group A: deliveries between 35^{+0} and 36^{+6} weeks; group B: 37^{+0}–38^{+6} weeks; group C: $\geq$39 weeks. ECD defined as cesarean delivery before the onset of labor/rupture of membranes. GA was calculated using menstrual history/first trimester ultrasound data, as appropriate.

Information was extracted from neonatal intensive care unit (NICU) records and neonatal discharge summaries. The diagnosis of NRM was established by senior neonatologists based on clinical signs—tachypnoea, retractions, nasal flaring, grunting, cyanosis, and classic radiographic findings of transient tachypnea of newborn (TTN) or reticulogranular pattern of respiratory distress syndrome (RDS).

Birth weight, APGAR score, delivery room treatment, postnatal assessment of GA, neonatal morbidity/mortality, and type of respiratory support were recorded. Newborns with meconium aspiration syndrome, congenital pneumonia, congenital cystic adenomatoid malformation of lung, and congenital diaphragmatic hernia were excluded because these conditions may cause symptoms unrelated to delayed transition from fetus to newborn.

Differences in categorical data were tested using Chi-square test, whereas Student's t test used for continuous variables. The incidence of NRM, odds ratio, and 95% confidential interval (CI) were calculated for two groups (ECD and SVD). p value <0.05 regarded significant. Statistical analysis was performed using SPSS version 16.0.

Study was approved by institutional ethical committee (IEC 326/2013).

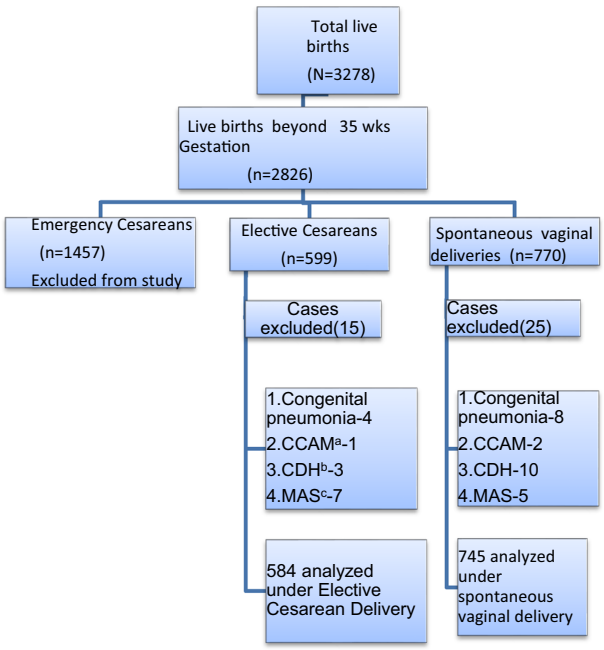

Fig. 1 Flow diagram showing the cases involved in the study, exclusions and the analysis. [a]CCAM—congenital cystic adenomatoid malformation. [b]CDH—congenital diaphragmatic hernia. [c]MAS—meconium aspiration syndrome

Table 1 Characteristics of study population (elective cesarean delivery—ECD)

Characteristic (maternal)	35^{+0}–36^{+6} weeks ($N = 41$)	37^{+0}–38^{+6} weeks ($N = 433$)	≥39 weeks ($N = 110$)	Total ($N = 584$)
Mean age at delivery in years	28.39 (± 4.12)	29.97 (± 4.02)	28.67 (± 3.80)	29.61 (± 4.02)
Booked				
Yes	21 (51.21%)	319 (73.67%)	37 (32.72%)	412 (70.37%)
No	20 (48.79%)	113 (26.09%)	74 (67.27%)	172 (29.45%)
Parity				
Primi	19 (46.34%)	100 (23.09%)	63 (57.27%)	182 (31.16%)
Multi	22 (53.65%)	333 (76.90%)	47 (42.72%)	402 (68.83%)
Preexisting hypertension	3 (07.31%)	9 (02.78%)	1 (00.90%)	13 (02.22%)
Preeclampsia	7 (17.07%)	6 (01.38%)	3 (02.72%)	12 (3.9%)
Gestational hypertension	4 (09.75%)	26 (06.00%)	3 (02.72%)	33 (05.65%)
Gestational diabetes	10 (24.39%)	51 (11.77%)	5 (04.45%)	66 (11.30%)
Hypothyroidism	2 (04.87%)	21 (04.84%)	3 (02.72%)	26 (04.45%)
Bad obstetric history	4 (09.75%)	50 (11.54%)	2 (01.81%)	56 (09.58%)
Steroid prophylaxis	23 (56.09%)	141 (32.56%)	26 (23.63%)	190 (32.53%)
Indication for ECD				
Maternal	32 (78.04%)	395 (91.22%)	102 (92.72%)	529 (90.58%)
Fetal	9 (21.95%)	38 (08.77%)	8 (07.27%)	55 (09.41%)
Previous cesarean	8 (19.51%)	245 (56.58%)	29 (26.36%)	282 (48.28%)
Breech	0	25 (05.77%)	6 (05.45%)	31 (05.30%)
CPD	3 (07.31%)	41 (09.46%)	59 (53.63%)	103 (17.36%)
Mean birth weight (Kg)	2.35 (± 0.60)	2.92 (± 0.46)	3.20 (± 0.39)	2.9 (± 0.49)

Results

Table 1 summarizes the characteristics of study population, under ECD group. 402/584 (68.8%) were multigravidae, among whom 282 (70%) underwent previous cesarean delivery, which contributed as indication for repeat ECD. Among ECD group, 66 (11%) had gestational diabetes. Majority (61 of 66 gestational diabetics) among them underwent ECD prior to 39 weeks, due to various other indications. Overall, 190 (32.53%) received steroid prophylaxis, at some point in their pregnancy within a month of delivery. Steroid coverage was given for 56 and 32% women undergoing ECD in group A and B, respectively. Of the 190 who received antenatal steroids, 183 (96.31%) had 1 course and 7 (3.69%) had 2nd course as rescue course. Majority (529; 90.58%) underwent ECD for maternal indications (medical complications, bad obstetric history, precious pregnancy, placenta previa, scarred uterus, etc.). Fetal indications were malpresentation, fetal growth restriction, and compromised fetal well being tests. Out of 282 women with previous cesarean scar, 245 underwent ECD between 37^{+0} and 38^{+9} weeks. Also, 25 of 31 pregnancies with breech presentation underwent ECD between 37^{+0} and 38^{+9} weeks. There were 103 women with a diagnosis of CPD at term, out of whom significant proportion (39%) underwent ECD between 37^{+0} and 38^{+9} weeks. Major indication for ECD was preeclampsia and IUGR in group A, previous cesarean delivery in group B (56.58%), whereas CPD in group C (53.63%).

Number of infants with NRM (RDS and TTN) associated with ECD and SVD between the three groups at different gestational weeks is shown in Tables 2 and 3. The overall incidence of NRM (RDS, TTN, and Air leak syndrome) was significantly higher after ECD than following SVD, 18/584 (3.82%) and 6/745 (0.8%), respectively. Odds ratio—3.9; 95% CI 1.54–9.93; p value = 0.004. Infants born by ECD showed a significant progressive reduction in NRM as GA progressed from group A 8 out of 41 (19.5%), group B 9 out of 433 (2.07%), and group C 1 out of 110 (0.9%), respectively.

Among the causes for NRM, majority of newborns were affected by transient tachypnoea 15/18 (83.33%) in ECD and 4/6 (66.66%) in SVD. Majority of TTN in ECD group occurred prior to 39 weeks (14/15).

Analyzing the risk of NRM in group B (37^{+0}–38^{+6} weeks) in which majority of ECDs were done, there was no significant difference between the two groups of ECD and SVD (Table 3).

Table 4 describes the respiratory support needed by the neonates, following ECD and SVD in the three groups. All those who required respiratory support in some form were admitted to NICU. Overall, neonates born by ECD were

Table 2 Respiratory morbidity in newborns delivered by elective cesarean delivery (ECD) and spontaneous vaginal delivery (SVD)

Respiratory morbidity	Elective cesarean ($N = 584$)				Vaginal delivery ($N = 745$)			
	35^{+0}–36^{+6} weeks ($n = 41$)	37^{+0}–38^{+6} weeks ($n = 433$)	≥39 weeks ($n = 110$)	Total	$35 + {}^{0}$–$36 + {}^{6}$ weeks ($n = 78$)	37^{+0}–38^{+6} weeks ($n = 315$)	≥39 weeks ($n = 352$)	Total
RDS[a]	0	2	0	2	2	0	0	2
TTN[b]	7	7	1	15	0	4		4
Airleak syndrome	1	0	0	1	0	0	0	0
Overall	8 (19.51%)	9 (02.07%)	1 (00.90%)	18 (03.82%)	2 (07.69%)	4 (01.26%)	0	6 (00.80%)

[a] Respiratory distress of newborn; [b] transient tachypnea of the newborn

significantly more likely to need some form of respiratory support, versus SVD group (4.28 vs 0.53%; p value <0.001, OR 8.28 with CI 2.86–23.9). This difference between ECD Vs SVD was highly significant in group A (31.5 vs 2.56%; p value <0.001; OR 17.64 CI 3.74–83.1). In group B, although the need of respiratory support was more among ECD group Vs SVD group, this difference was not statistically very significant (2.54 vs 0.63% with a p value of 0.08, OR of 4.07; CI 0.89–18.5). Also, comparing need of respiratory support and NICU admission for the neonates born by ECD in group B (37–38^{+6} weeks, 2.54%) Vs group C (beyond 39 weeks, 0.9%), group B had only a modest increase in need, compared to those in group C (p value 0.47; OR 2.84 CI 0.36–22.2). Among 11 neonates requiring respiratory support following ECD in group B, 10 received free flow oxygen and one needed invasive ventilation. Beyond 39 weeks, only one neonate in ECD group needed free flow oxygen.

Discussion

We are witnessing an increase in the rate of ECDs, especially in the private sector, where cesarean rates are approaching 50%. In the absence of standard protocols on the timing of ECD, many cesareans are being performed prior to 39 weeks. This study aimed to see the resulting neonatal healthcare burden, in a South Indian population.

Large majority of women with previous cesarean, breech presentation, and 39% of women with cephalopelvic disproportion, have undergone ECD between 37^{+0} and 38^{+6} week. Only a third of them received steroid prophylaxis. Therefore, we had an opportunity to assess the NRM following ECD between 37^{+0} and 38^{+6} week, without steroid prophylaxis.

Incidence of NRM following ECD at or near term varies in literature, from 1.8 to 30% [2, 5, 6]. However, there are differences in inclusion criteria, GA assessment, definition of term,, and in definitions for respiratory morbidity. In our study, overall risk of NRM following ECD was 3.08%, which is lower compared to most of the western literature. However, it is significantly more than the risk of NRM following SVD. The odds ratio of 3.9 is also modest compared to a wide range of odds ratios reported in the literature [7]. However, considering the large number of births by ECD in this part of the world, the neonatal healthcare burden would be huge. As previously reported [6, 8], there is a significantly decreasing trend of NRM as the GA advances from 35 to 39 weeks. Therefore, we propose that the practice of performing ECD prior to 39 weeks should be altered in this part of the world.

Table 3 Respiratory morbidity in ECD v/s SVD

Respiratory morbidity	Elective cesarean delivery ($N = 584$)	Spontaneous vaginal delivery ($N = 745$)	Odds ratio (OR)	95% CI	p value
37^{+0}–38^{+6} weeks	9/433 (02.07%)	4/315 (1.26%)	1.65	0.50–5.40	0.57
Overall	18 (03.08%)	6 (00.80%)	3.90	1.54–9.93	0.004

NRM is less frequent when cesarean is done in labor (1.2–11.2%) [9] and is least common among those born by term vaginal delivery (0.5–3.7% in the literature and 0.8% in our study) [10]. This is due to several mechanisms including release of catecholamines, increase in surfactant, changes in pulmonary vasculature, and changes in epithelial sodium channels.

In contrast to most of the western literature, our study did not show statistically significant difference in the risk of NRM following ECD between 37 and 38^{+6} weeks, as compared to SVD group born in the same GA, despite the fact that only a third among them received prophylactic steroids. This could be an ethnic difference causing earlier lung maturity in these early term fetuses in this part of the world. If we compare the risk of NRM following ECD in group B (2.07%) versus C (0.9%), odds ratio is 2.3 with CI 0.29–18.4 (p value 0.48). Hence, in our study, there was advantage of delaying ECD to 39 weeks and beyond, but the benefit was only modest. Very few studies have looked into NRM following ECD, in a South Asian population. A retrospective study [11], however, showed a much higher incidence of NRM following ECD between 37 and 38^{+6} weeks (15%) compared to beyond 39 weeks (6%). A recent study from India reported ECD to be the strongest risk factor for development of NRM [12]. However, there are several disadvantages of waiting at or beyond 39 weeks, in our setting where there may be significant delay before getting medical attention. A significant proportion of women may go into labor. There is increased risk of perinatal death or birth asphyxia/trauma, among women going into labor with a scarred uterus/breech presentation, especially beyond office hours. A study from South India reported a significantly higher neonatal morbidity following emergency cesareans compared to ECD [13], although there are several methodological limitations to assess the problem of NRM in this study. Overall neonatal complications were 85% less likely among those born by scheduled ECD Vs those born by emergency cesarean section. In this study, NICU stay (due to all causes) was needed much more often following emergency cesarean compared to ECD (39 vs 10%). A Canadian study [14] reported that a hospital policy of waiting beyond 39 weeks for low-risk planned ECDs did not show improved neonatal/maternal outcomes significantly, instead resulted in modest increase in out-of-hours delivery. While waiting for ECD beyond 39 weeks, we must consider the antepartum fetomaternal risks versus the risk of respiratory morbidity in the newborn. There are risks such as abruption/eclampsia/IUD, even with mild preeclampsia or mild fetal growth restriction. These problems may result in higher mortality and morbidity in low resource settings, due to suboptimal or delayed care. Hence, the convenience of scheduled ECD at about 38 weeks seems advantageous to both patients and care givers, in this part of the world. This will continue to influence the timing of ECD, unless there are large-scale population studies throwing light on the ethnic differences in NRM following ECD, from this region. We propose that such studies are the need of hour.

Majority of the NRM following ECD is due to TTN, known to have a benign clinical course. Severe complications such as respiratory failure, persistent pulmonary hypertension, pulmonary airleaks, and pulmonary hypoxemia have been described. Unfortunately, we did not have data on persistent pulmonary hypertension/other chronic lung problems from our neonatal records.

Compared to the literature, our study shows only a modest increase in the need for respiratory support/NICU admissions, following early term ECDs. Specifically looking at group B, need of respiratory support reported in the literature ranges from 5 to 36% [7, 8, 15, 16]. A study from South India [11] reports 10% NICU admission rate for neonates born between 37 and 38^{+6} weeks by ECD, which is much higher an incidence than in our study (2.54%). Also, most of our neonates only needed free flow oxygen in our study, for a few hours to 1 day. Obviously, larger sample size would be beneficial. A randomized controlled trial performed at Denmark, to study the neonatal and maternal outcomes following elective cesarean delivery at 38 versus 39 weeks of gestation [17], found no significant difference in NICU admission, serious neonatal respiratory depression, or oxygen requirement between the two groups.

Conclusion

In India, many ECDs are performed between 37 and 38^{+6} weeks. Undoubtedly, this causes significant neonatal healthcare burden. However, there seems to be some ethnic difference in respiratory maturity near term, as this study shows that ECD between 37 and 38^{+6} weeks did not result in significantly more NRM, compared to

Table 4 Respiratory support for the newborns delivered by ECD and SVD

Respiratory support	Elective cesarean ($N = 584$)				Vaginal delivery ($N = 745$)			
	35^{+0}–36^{+6} weeks ($n = 41$)	37^{+0}–38^{+6} weeks ($n = 433$)	≥39 weeks ($n = 110$)	Total ($n = 584$)	35^{+0}–36^{+6} weeks ($n = 78$)	37^{+0}–38^{+6} weeks ($n = 315$)	≥39 weeks ($n = 352$)	Total ($n = 745$)
Free flow oxygen	9 (21.95%)	10 (02.30%)	1 (00.90%)	20 (03.42%)	0	2 (0.63%)	0	2 (0.26%)
Noninvasive ventilation (Nasal CPAP)	3 (07.31%)	0	0	3 (00.51%)	2	0	0	2 (0.26%)
Invasive Ventilation (SIMV)	1 (02.43%)	1 (00.23%)	0	2 (00.34%)	0	0	0	0
Overall need of respiratory support	13 (31.70%)	11 (02.54%)	1 (00.90%)	25 (04.28%)	2 (2.56%)	2 (0.63%)	0	4 (0.53%)

ECD > 39 weeks. This requires further research as we need locally developed protocols to decide on the timing of ECD near term.

Compliance with Ethical Standards

Conflict of interest All authors have filled in the conflicts of interest form. All 4 authors declare that there are no conflicts of interest.

Ethical Statements Work described has not been published before; that it is not under consideration for publication anywhere else; that its publication has been approved by all co-authors, if any, as well as by the responsible authorities—tacitly or explicitly—at the institute where the work has been carried out. The publisher will not be held legally responsible should there be any claims for compensation.

Ethical Approval Ethical consent for the work has been given by the institutional ethical committee. This article does not contain any studies with human participants or animals performed by any of the authors.

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