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Original Research Article

Pattern of neonatal birth injuries among deliveries conducted at Kamla Nehru hospital, Shimla: a prospective cross-sectional study

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ABSTRACT

Background: Neonatal birth injuries refer to anatomical or functional harm sustained during childbirth and encompass a broad clinical spectrum. This study aimed to evaluate the pattern of neonatal birth injuries on physical examination among deliveries conducted at Kamla Nehru Hospital, Himachal Pradesh.
Methods: A prospective cohort study was conducted over 12 months on 376 live neonates. A standardized physical examination was performed within the first 2 hours of life to detect injuries such as caput succedaneum, cephalohematoma, fractures and soft tissue trauma. Associations with maternal, intrapartum and neonatal risk factors were analysed.
Results: The overall incidence of neonatal birth injuries was 20.7% (78 out of 376 neonates). Head and neck injuries were the most common (89.7%), followed by limb and joint injuries (7.7%). A statistically significant association was observed between the mode of delivery and birth injuries ($p<0.001$); 62.8% of injured neonates were delivered via normal vaginal delivery. Prolonged labor was a highly significant predictor of birth trauma (OR: 33.94, $p<0.001$). Neonatal sex, maternal comorbidities and gravida status showed no statistically significant association with the occurrence of birth injuries.
Conclusions: Birth injuries remain a prevalent clinical challenge that is predominantly influenced by intrapartum mechanical factors, particularly prolonged labor and mode of delivery, rather than maternal demographics.

Keywords: Birth injuries, Intrapartum monitoring, Neonate, Prolonged labor, Physical examination

INTRODUCTION

The term "neonatal birth injury" refers to functional or anatomical harm sustained by an infant during the process of childbirth.[1] These injuries typically result from mechanical forces, such as compression, traction, shearing, or torsion exerted as the fetus navigates the birth canal, or from complications arising during obstetric interventions. Neonatal health remains a critical global public health priority, with an estimated 2.5 million deaths occurring annually within the first 28 days of life.[1] Neonatal birth injuries significantly contribute to this burden of early mortality, as well as short- and long-term morbidity. The etiology of these injuries is highly multifactorial, encompassing a complex interplay of fetal, maternal and intrapartum variables.[2] Fetal risk factors include macrosomia, abnormal presentations and extreme prematurity. Maternal factors influencing injury risk involve parity, extremes of maternal age, structural pelvic abnormalities and chronic conditions such as hypertension or diabetes mellitus.[3] Furthermore, intrapartum dynamics, including prolonged labor, obstructed descent and the use of instrumental deliveries like forceps or vacuum extraction heavily modify the risk profile. Notably, while cesarean sections are often perceived to mitigate mechanical trauma, neonatal injuries can still occur during difficult or emergency extractions.[3,4] Despite significant advancements in

prenatal diagnostics, enhanced intrapartum monitoring, and refined obstetric techniques, neonatal birth injuries persist across various healthcare settings. In resource-constrained settings like India, the challenge is amplified by disparities in healthcare infrastructure, high patient volumes and limited access to timely, skilled obstetric interventions. Currently, existing Indian literature on neonatal birth injuries is relatively limited in scope and variations in institutional protocols and population characteristics restrict direct comparability across different regions. Therefore, conducting an institution-specific evaluation is clinically essential. Understanding the specific pattern of neonatal birth injuries through systematic physical examinations immediately after birth allows for early detection, precise classification and prompt clinical management.[5] Identifying the localized interplay of maternal, fetal, and intrapartum risk factors will provide critical empirical data and facilitate targeted evidence-based improvements in obstetric care and inform preventive strategies to optimize maternal and newborn health outcomes in hospitals.

METHODS

This prospective cross-sectional study was conducted in the Department of Paediatrics at tertiary care hospital in North India, over a 12-month period. A total of 376 live-born neonates were recruited based on prevalence-derived sample size calculations utilizing a 95% confidence interval. Inclusion criteria comprised live neonates born within institute, stillborn and those with congenital malformations were excluded from the study. Following approval from the Institutional Ethics Committee and obtaining written informed parental consent, data were prospectively collected in real time. Each neonate underwent a structured, detailed physical examination within the first two hours of life. This clinical assessment systematically evaluated for head and neck injuries (such as caput succedaneum and cephalohematoma), limb and joint fractures, soft tissue trauma (including abrasions and lacerations) and nerve palsies. Data were compiled in Microsoft Excel and statistically analyzed using Epi Info Version 7. Descriptive statistics were calculated and associations between maternal, fetal, or intrapartum risk factors and birth injuries were evaluated using Chi-square tests, Fisher's exact tests, and logistic regression to determine odds ratios.

RESULTS

Baseline neonatal and maternal characteristics

During the 12-month study period, a total of 376 live-born neonates meeting the inclusion criteria were enrolled in the study (Table 1). The gender distribution revealed a slight male predominance, comprising 198 (52.9%) males and 178 (47.1%) females. The majority of the pregnancies resulted in term deliveries, accounting for 304 (80.9%) of the cases, whereas preterm deliveries constituted 72 (19.1%) of the cohort. Maternal gravida status indicated more than half of the mothers were primigravida (215, 56.6%), followed by gravida 2 (99, 26.1%), gravida 3 (39, 10.1%), gravida 4 (12, 3.2%), and gravida 5 to 7 comprising the remaining 4%. The vast majority of pregnant women had adequate liquor (366, 97.3%), with oligohydramnios and polyhydramnios equally distributed at 5 cases (1.3%) each. A comprehensive evaluation of maternal medical comorbidities revealed that hypothyroidism was the most prevalent affecting 42 (25.30%) of the mothers. This was followed by gestational diabetes mellitus (30, 18.10%), hypertension (17, 10.20%), prematurity (16, 9.60%), and twin pregnancies (16, 9.60%).

Obstetric and delivery characteristics

Normal vaginal delivery (NVD) was the most common delivery method, utilized in 204 (54.3%) of the cases. Lower segment cesarean section (LSCS) was performed in 162 (43.1%) of the deliveries, while assisted vaginal delivery (AVD) using instruments was required for 10 (2.7%) of the neonates. Evaluation of specific pregnancy complications demonstrated that 9 (2.4%) of the mothers experienced prolonged labor, 19 (5.1%) had fetal malpresentations and 11 (2.9%) presented with fetal anomalies.

Incidence and pattern of neonatal birth injuries

The primary outcome of the study upon physical examination, 78 out of the 376 neonates sustained a birth injury, translating to an overall incidence rate of 20.7%. There was a strong anatomical predilection for the cranial and cervical region trauma, 70 neonates (89.7%) sustained head and neck injuries. Injuries involving the limbs and joints were observed in 6 (7.7%) of the affected newborns. Superficial skin injuries, as well as genital and anal injuries, were rare, each documented in only 1 case (0.3% respectively) (Table 2).

Associations and predictors of neonatal birth injuries

Bivariate statistical analysis was performed to determine the association between various maternal, fetal and intrapartum variables and the occurrence of birth injuries (Table 3). The mode of delivery emerged as a highly significant determinant ($p<0.001$). Among the 78 injured neonates, 49 (62.8%) were delivered via NVD, 20 (25.6%) via LSCS and 9 (11.5%) via AVD. Notably, 9 out of the 10 total AVDs in the study resulted in a birth injury, highlighting the pronounced risk associated with instrumental deliveries.

Prolonged labor was another highly significant intrapartum risk factor. Of the mothers who experienced prolonged labor, 88.8% (8 out of 9) delivered neonates with birth trauma. Neonates subjected to prolonged labor had a dramatically increased risk of sustaining birth injuries (OR 33.94, 95% CI 4.17-275.8, $p<0.001$).

Conversely, several demographic and clinical variables did not demonstrate a statistically significant relationship with the occurrence of birth injuries. While males exhibited a slightly higher absolute rate of injury (24.2%) compared to females (16.9%), this association was not statistically significant (OR 0.63, 95% CI 0.38-1.05, p=0.09).

Table 1: Comparison of continuous parameters among study participants (n=376).

Variables	Birth injury present (n=78) mean (SD)	Birth injury absent (n=298) mean (SD)	P value
Birth weight of child (kgs)	2.65 (0.66)	2.63 (0.52)	0.78
Height of mother (cms)	156.59 (5.8)	155.69 (6.6)	0.22
Weight of mother (kgs)	56.88 (6.3)	57.95 (6.8)	0.21

Table 2: Incidence and anatomical distribution of neonatal birth injuries (n=376).

Variables	Category	Number (n)	Percentage (%)
Overall incidence	Injury present	78	20.7
	Injury absent	298	79.3
Type of injury (n=78)	Head and neck	70	89.7
	Limb and joints	6	7.7
	Skin	1	0.3
	Genital and anal	1	0.3

Table 3: Bivariate analysis of factors associated with neonatal birth injuries.

Risk factors	Birth injury present (n=78) N (%)	Birth injury absent (n=298) N (%)	Odds ratio (95% CI)	P value
Sex of newborn				
Male	48 (24.2)	150 (75.8)	0.63 (0.38-1.05)	0.09
Female	30 (16.9)	148 (83.1)		
Mode of delivery				
NVD	49 (62.8)	155 (52.0)	3.62 (1.35-9.23)	<0.001*
LSCS	20 (25.6)	142 (47.7)		
AVD	9 (11.5)	1 (0.3)		
Risk factors in mother				
No risk factor	43 (55.1)	178 (59.7)	0.73 (0.48-2.15)	0.33
Single risk factor	27 (34.6)	79 (26.5)		
Amniotic fluid				
Adequate	74 (94.9)	292 (98.0)	1.08 (0.62-3.41)	0.12
Oligohydramnios	3 (3.8)	2 (0.7)		
Polyhydramnios	1 (1.3)	4 (1.3)		
Maternal obesity				
Yes	2 (2.6)	3 (1.0)	2.58 (0.42-15.76)	0.27
No	76 (97.4)	295 (99.0)		
Prolonged labor				
Yes	8 (10.3)	1 (0.3)	33.94 (4.17-275.8)	<0.001*
No	70 (89.7)	297 (99.7)		
Fetal malformations				
No	76 (97.4)	281 (94.3)	2.29 (0.52-10.16)	0.2
Yes	2 (2.6)	17 (5.7)		
Fetal anomalies				
No	75 (96.2)	290 (97.3)	0.69 (0.17-2.66)	0.4
Yes	3 (3.8)	8 (2.7)		
Gravida status				
Primigravida	47 (60.3)	168 (56.4)	1.17 (0.70-1.95)	0.6
Multigravida	31 (39.7)	130 (43.6)		

*Statistically significant (p<0.05).

Similarly, the presence of maternal risk factors and comorbidities did not significantly alter the injury risk profile (p=0.33); in fact, the majority of the injured neonates (43 out of 78, 55.1%) were born to mothers with no identified risk factors. Other factors that failed to reach statistical significance included maternal gravida status (p=0.60), amniotic fluid abnormalities (p=0.12), maternal obesity (OR:2.58, p=0.27), fetal malformations (OR:2.29, p=0.20), and fetal anomalies (OR:0.69, p=0.40). Furthermore, a comparison of continuous anthropometric variables revealed no significant mean differences between the injured and non-injured groups regarding neonatal birth weight (2.65±0.66 kg vs. 2.63±0.52 kg, p=0.78), maternal height (156.59±5.8 cm vs. 155.69±6.6 cm, p=0.22), or maternal weight (56.88±6.3 kg vs. 57.95±6.8 kg, p=0.21). In the bivariate analysis, only two factors, mode of delivery and prolonged labor were found to be statistically significant predictors, hence multivariable regression analysis was not performed.

DISCUSSION

The present prospective cross-sectional study was conducted to systematically evaluate the incidence, pattern, and underlying determinants of neonatal birth injuries among deliveries at a tertiary care teaching hospital. The overall incidence of neonatal birth injuries in our cohort was determined to be 20.7%, with 78 out of 376 neonates sustaining some form of mechanical trauma during the birthing process. This finding highlights a substantial clinical burden and underscores the reality that despite modern advancements in prenatal diagnostics and intrapartum monitoring, mechanical birth trauma remains a persistent challenge in contemporary obstetric practice.[2]

The incidence rate observed in our study aligns with the higher prevalence rates reported in several other hospital-based cohorts. For instance, Tibebu et al documented a birth injury prevalence of 24.7% among newborns delivered in public hospitals in Addis Ababa, while Tolosa et al reported a magnitude of 16.9% among neonates admitted to public hospitals in eastern Ethiopia.[6,7] Similarly, Misganaw et al observed a 15.6% magnitude of birth injuries in neonatal intensive care units.[8] In contrast, our incidence is substantially higher than the rates reported by Uchenna et al (2.4%), Senthil Prabhu et al (2.22%) and Shanthi et al (0.32%).[9-11] This discordance is likely attributable to methodological differences. Our study utilized a prospective design featuring systematic, standardized physical examinations conducted within the first two hours of life. This rigorous early assessment captures minor, subclinical and self-limiting soft tissue injuries that are often underreported or omitted entirely in retrospective chart reviews or studies restricted strictly to severe NICU admissions. Furthermore, the pooled cumulative incidence of neonatal birth trauma across low- and middle-income countries was estimated by Woldegeorgis et al at 34 per 1,000 live births, emphasizing that tertiary centers managing high-risk and complicated pregnancies naturally observe concentrated rates of mechanical trauma.[1]

Regarding the anatomical distribution of birth trauma, our data demonstrated a striking predilection for the cranial and cervical regions. Head and neck injuries constituted the overwhelming majority, accounting for 89.7% of all documented injuries.[4] This pattern is strongly corroborated by the existing literature. Yemane et al reported that the scalp was involved in 86.4% of cases, with subgaleal hemorrhage and cephalohematoma being the most frequent manifestations.[12] Senthil Prabhu et al also identified head and neck injuries in 88% of their mechanical trauma cases.[10] This anatomic vulnerability is intrinsically linked to the biomechanics of normal labor. In vertex presentations, the fetal head acts as the leading wedge dilating the birth canal, absorbing the brunt of maternal expulsive efforts, sustained uterine contractions and pelvic bony compression.

The most significant predictors of birth injuries in our study were entirely intrapartum mechanical factors, overshadowing baseline maternal demographics. Prolonged labor emerged as a profound risk factor; neonates subjected to extended labor had a nearly 34-fold increased risk of sustaining an injury (OR:33.94, p<0.001). This robust association is supported by Uchenna et al, who noted that 22.3% of their trauma cases were associated with prolonged labor and by Tolosa et al, who identified prolonged labor as a significant independent risk factor.[7,9] Prolonged labor exposes the fragile fetal skeletal and vascular structures to continuous, unrelenting compressive and shearing forces, dramatically increasing the likelihood of hypoxia-induced tissue fragility, cephalohematoma and skeletal fractures.

In parallel, the mode of delivery exerted a highly significant influence on the occurrence of birth trauma (p<0.001). While normal vaginal deliveries accounted for the absolute majority of injuries (62.8%), assisted vaginal deliveries utilizing instrumental extraction carried a disproportionately high risk. In our cohort, 9 out of the 10 neonates delivered via instrumental assistance sustained an injury. This mirrors the findings of Shrimathy et al, who reported a notably higher incidence of birth trauma in forceps deliveries, and Bacha et al, who documented a 19.8% injury rate across both vacuum and forceps deliveries.[13,14] Operative vaginal deliveries require precise technique and the direct application of mechanical traction inherently predisposes the neonate to scalp lacerations, facial nerve palsies and extracranial haemorrhages.

Interestingly, several demographic and anthropometric variables traditionally associated with difficult labor did not demonstrate statistically significant independent associations with birth injuries in our cohort. Although a slight male predominance was observed (males: 24.2% vs. females: 16.9%), the correlation was not statistically

significant. This aligns precisely with the conclusions drawn by Pius et al and Yemane et al suggesting that while male fetuses often have larger head circumferences, sex alone is not an independent determinant of trauma when mechanical factors are accounted for.[12,15] Similarly, anthropometric parameters such as neonatal birth weight, maternal height and maternal weight yielded non-significant mean differences. Misganaw et al also evaluated these maternal and neonatal anthropometric characteristics, finding that they did not demonstrate statistically significant associations with birth injuries after multivariate adjustment.[8]

Furthermore, maternal medical comorbidities., such as hypothyroidism, gestational diabetes mellitus and hypertension did not significantly elevate the risk of birth trauma (p=0.33). While Tolosa et al and Misganaw et al found maternal complications to be important contributors, the lack of significance in our study likely reflects the protective impact of rigorous antenatal screening.[7,8] At a tertiary care center, high-risk pregnancies complicated by conditions like gestational diabetes or hypertension are subjected to strict glycemic control, continuous fetal surveillance and proactive elective cesarean sections, thereby neutralizing the downstream mechanical risks associated with potential macrosomia or fetomaternal disproportion. The same mechanism explains why gravida status, particularly primiparity, did not reach statistical significance in our cohort, despite Senthil Prabhu et al and Pius et al identifying it as a major risk factor for difficult, untried labor.[10,15]

This study strength includes a primarily prospective design, which minimized recall bias, and the use of standardized, immediate postnatal physical examinations that ensured robust data capture. However, the limitations must be acknowledged. As a single-center study, the findings are influenced by the specific referral patterns of a tertiary teaching hospital, potentially limiting generalizability to primary community settings. Additionally, the reliance on clinical diagnosis without routine radiological imaging for minor cases may underestimate subtle internal trauma and the absence of longitudinal follow-up precludes the evaluation of long-term neurodevelopmental sequelae.

CONCLUSION

In conclusion, our study underscores that neonatal birth injuries remain a prevalent clinical challenge driven predominantly by intrapartum mechanical events, specifically prolonged labor and operative vaginal delivery rather than isolated maternal or fetal demographics. These findings highlight the critical importance of vigilant partographic monitoring, timely decision-making and skilled obstetric execution to minimize the incidence of preventable mechanical trauma and optimize perinatal outcomes.

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