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Brief communication (Original)

Predictors of severity of subgaleal hemorrhage

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Background: Subgaleal hemorrhage (SGH) from birth injury can be a lethal complication in severe cases.
Objectives: To compare risk factors and outcomes of SGH between neonates with serious complications (SC) and nonserious complications (NSC).
Methods: We conducted a descriptive retrospective study in a neonatal intensive care unit. All neonates were born between January 1982 and December 2014. The SC group was defined as neonates who had either shock or blood transfusion, whereas those in the NSC group did not.
Results: The incidence of SGH was 3.4 per 1,000 live births and 20.5 per 1,000 vacuum-assisted deliveries. We included 208 neonates in our study: 119 (57.2%) in the SC group and 89 (42.8%) in the NSC group. The mean (standard deviation) gestational age of the SGH neonates was 38.7 (1.6) weeks and their birth weight was 3275 (441.9) g. Univariate analysis showed gestational age, preterm, body length, Apgar score at 1 minute, and birth asphyxia in the SC neonates were significantly different from the NSC neonates. Multivariate analysis showed the SC neonates were significantly associated with preterm birth ($P < 0.001$) and birth asphyxia ($P = 0.03$) compared those in the NSC group. Anemia, jaundice, intensive phototherapy, length of hospital stay, and costs were higher in the SC neonates than in the NSC neonates ($P < 0.001$); however, only one neonate in the SC group died.
Conclusions: Preterm birth and birth asphyxia are risk factors for SC in neonates with SGH, who need early detection, prompt treatment, and frequent monitoring.

Keywords: Birth injuries, hematoma, newborn, subaponeurotic hemorrhage, subgaleal hemorrhage

Birth injury occurs in neonates during delivery. The incidence of birth injury is 25.9–41.2 per 1,000 births [1-3]. Subgaleal hemorrhage (SGH) is a rare condition; however, it is a lethal complication in severe cases. Serious complications of scalp injury need frequent monitoring of the hematocrit, early and prompt restoration of blood volume, and commencement of cardiac inotropes. Moreover, the sequelae of SGH are blood transfusion, hypovolemic shock, total blood exchange because of severe unconjugated hyperbilirubinemia [4], sepsis because of infected hematoma [5], and peritoneal dialysis because of acute renal injury [6].

To our knowledge, there are few published studies of factors to predict the severity of SGH in neonates. We performed a retrospective study of neonates who had SGH and born in Songklanagarind Hospital over a 33-year period. This study aimed to identify risk factors for SGH between neonates with serious (SC) and nonserious complications (NSC).

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Methods

Setting

Songklanagarind Hospital is part of a university-affiliated teaching hospital at Prince of Songkla University, Songkhla, Thailand and is a tertiary-level perinatal center with approximately 3,000 live births per year. The neonatal intensive care unit has approximately 450 admissions per year and receives referrals from the whole Southern Region of Thailand.

Patients

After approval of this study by the Ethics Committee of Faculty of Medicine, Prince of Songkla University (approval No. 56-068-01-3-3), the records of all neonates born at Songklanagarind Hospital between January 1, 1982 and December 31, 2014 were screened for inclusion in this study and were considered eligible if they included SGH. Exclusion criteria included major anomaly and missing medical record data.

Data collection

Data in medical records, including charts, daily flow sheets, and laboratory results, were collected by the investigators. The collected data included demographics, potential risk factors, including serious versus nonserious complications, and outcomes of SGH.

Definitions

Neonates with SC were defined those who had either shock or blood transfusion, whereas those with NSC did not. Preterm was defined as an neonate born alive before 37 weeks of pregnancy were completed. Low birthweight was defined as the birth weight of a live born neonate <2500 g. Birth asphyxia was defined as an Apgar score of ≤7 at 1 min. In-hospital mortality was defined as an infant that died at any time during the entire course of hospitalization. For prolonged second stage of labor, the 95th percentile for second-stage duration was defined as complete dilatation of the cervix to delivery of the neonate >2 h in nulliparous women and >1 h in multiparous women. Anemia (hematocrit less than 45% in the first day of life) and jaundice were diagnosed from the physician's record. The total length of stay (LOS) was defined as the duration of admission until discharge from Songklanagarind Hospital.

Statistical analysis

The R program [7] and Epicalc package [8] were used to develop a database of categorical and continuous variables. Categorical variables are presented as frequency and percentage, and compared using a χ^2 test or Fisher's exact test. Continuous variables are presented as mean (standard deviation, SD) and median (range), and compared using the Mann–Whitney *U* or Student *t* test. All *P* values were 2 tailed and $P < 0.05$ was considered to indicate significant difference. Multivariate analyses were conducted using a stepwise logistic regression model. Variables with $P < 0.2$ in the univariate analyses were then entered into the multivariate regression analysis.

Results

During the study period, a total of 78,589 neonates were born and 6,482 of these births were vacuum-assisted deliveries. There were 265 neonates with SGH (3.4 per 1,000 live births) of those 133 were born by vacuum-assisted delivery (20.5 per 1,000 vacuum-assisted deliveries). We excluded data from 57 neonates: 55 had missing data, and 2 were identified as having genetic syndromes. We included data from 208 neonates who met the study criteria. The mean (SD) gestational age (GA) of all the neonates with SGH were 38.7 (1.6) weeks and their birth weight was 3275 (441.9) g.

We identified 119 neonates (57.2%) to be in the SC group. The other neonates (42.8%) were in the NSC group. By univariate analysis, GA, preterm, body length, Apgar score at 1 min, and birth asphyxia of the neonates in the SC group were significantly different from those in the NSC group; however, there were no differences in the maternal obstetric factors or other neonatal characteristics, such as sex, birth weight, and head circumference (**Table 1**).

Variables with $P < 0.2$ in the univariate analyses were put into the multivariate regression analysis, except for the GA, body length, Apgar score at 1 min (statistical significance, but no clinical significance), and preterm (no preterm in the NSC group). Finally, antepartum pethidine, vacuum-assisted delivery, duration of the second stage of labor, sex, low birth weight neonate, and birth asphyxia were entered into the multivariate regression analysis (**Table 2**). By multivariate analysis, neonates in the SC group were more likely to have birth asphyxia (**Table 2**).

The clinical complications and outcomes are shown in **Table 3**. By univariate analysis, anemia (odds ratio (OR) = 3.3, 95% CI 1.9–6.0), jaundice (OR = 5.9, 95% CI 3.1–11.2), intensive phototherapy (OR = 31.3, 95% CI 11.6–83.3), length of hospital stay (LOS) >7 days (OR = 32.3, 95% CI 4.33–250), hospital cost, hospital cost >200.00 USD (OR = 11.9, 95% CI 5. 1–27.9), daily hospital cost and daily hospital cost >35.00 USD (OR = 5.3, 95% CI 2.7–10.5) in the SC group were significantly greater than the NSC group ($P < 0.001$). Two neonates had shock at birth and the maximum onset of shock was 24 h of age. Only one neonate in the SC group died (1/208, 0.5%) on day 7 of life as a result of severe sepsis and septic shock.

Table 1. Comparison of population characteristics between neonates with serious complications (SC) and those without (NSC)

Characteristics	SC (n = 119), n (%)	NSC (n = 89), n (%)	*P*
Maternal characteristics			
Maternal age, y*	28.8 ± 5.7	28.1 ± 6.3	0.40
Primigravidae	83 (70)	69 (78)	0.21
Labor induction	14 (12)	13 (15)	0.55
Antepartum pethidine	46 (39)	43 (48)	0.16
Staff who delivered a baby			
Clinical instructors	69 (58)	53 (60)	0.82
Residents/fellows	47 (40)	35 (39)	0.98
Midwife	3 (3)	1 (1)	0.47
Mode of delivery			
Normal labor	26 (22)	16 (18)	0.49
Forceps extraction	11 (9)	5 (6)	0.33
Vacuum assistance	71 (60)	62 (70)	0.14
Caesarian section	11 (9)	6 (7)	0.52
Duration of the second stage of labor, min†	33 (39)	30 (32)	0.16
Prolonged second stage of labor	25 (21)	16 (18)	0.59
Neonatal characteristics			
Male	78 (66)	47 (53)	0.06
Gestational age (GA), week*	38.4 ± 1.8	39.0 ± 1.1	0.008
Preterm <0.001	20 (17)	0	
Birthweight, g*	3241.8 ± 476.8	3318.5 ± 388.6	0.22
Low birthweight neonate	8 (7)	2 (2)	0.14
Birthweight compared with GA			
Small for GA	2 (2)	1 (1)	0.74
Appropriate for GA	90 (76)	73 (82)	0.27
Large for GA	27 (23)	15 (17)	0.30
Body length, cm*	49.4 ± 2.4	50.1 ± 1.9	0.02
Head circumference at birth, cm*	34.3 ± 1.6	34.2 ± 1.4	0.61
Head circumference (maximum), cm*	35.4 ± 1.6	35.2 ± 1.3	0.34
Apgar score†			
at 1 minute	8 (3)	9 (2)	0.004
at 5 minute	9 (2)	9 (1)	0.17
Birth asphyxia	58 (49)	29 (33)	0.02

*mean ± SD, †median (IQR)

Table 2. Multivariate analysis of risk factors between neonates with serious complications (SC) and those without (non-SC)

Characteristics	aOR	95% CI	*P*
Antepartum pethidine	1.51	0.84–2.71	0.17
Vacuum-assisted delivery	1.49	0.81–2.74	0.20
Duration of the second stage of labor	1.00	1.00–1.00	0.14
Male	1.50	0.84–2.71	0.17
Low birthweight neonate	3.04	0.60–15.47	0.18
Birth asphyxia	1.93	1.07–3.48	0.03

aOR = adjusted odds ratio, CI = confidence interval

Table 3. Comparison of clinical complications and outcomes between neonates with serious complications (SC) and those without (NSC)

Complications	SC (n = 119), n (%)	NSC (n = 89), n (%)	*P*
Hematocrit level at birth*	46.4 ± 6.6	47.8 ± 11.8	0.30
Hematocrit level at nadir*	37.9 ± 3.8	36.1 ± 3.1	0.19
Anemia	86 (72.3)	39 (43.8)	<0.001
Jaundice	100 (84.0)	42 (47.2)	<0.001
Intensive phototherapy	77 (64.7)	5 (5.6)	<0.001
Length of hospital stay (LOS), d†	6 (3)	3 (1)	<0.001
LOS >7 days	32 (26.9)	1 (1.1)	<0.001
Hospital cost, USD†	202.6 (279.1)	77.5 (65.9)	<0.001
Hospital cost >200.00 USD	60 (50.4)	7 (7.9)	<0.001
Daily hospital cost, USD†	36.3 (52.5)	24.0 (15.8)	<0.001
Daily hospital cost >35.00 USD	61 (51.3)	17 (19.1)	<0.001

*mean ± SD; †median (IQR)

Discussion

The incidence of SGH was 0.6–3.0 per 1,000 live births [4, 9, 10] and 4.6–7.6 per 1,000 vacuum-assisted deliveries [9, 11]. In the present study, there was a high incidence of SGH (3.4 per 1,000 live births) compared with a previous study and especially in vacuum-assisted deliveries (20.5 per 1,000 vacuum-assisted delivery). Prolonged second stage of labor, fetal stress, vacuum-assisted delivery, forceps extraction, macrosomia, maternal nulliparity, placement of vacuum extraction cup over the sagittal suture at a distance too close to the neonate's anterior fontanel, and failed vacuum extraction were risk factors of SGH [10, 12]. Being preterm and birth asphyxia were the risk factors for serious complications in SGH in the present study. The case fatality rate of SGH was 11.9%–22.8% in previous studies [9, 10, 13, 14], but only one neonate (0.5%) died in the present study despite the higher incidence of SGH.

A dead neonate with SGH who had significant volume loss with anemia, coagulopathy, and shock requiring large volumes of blood and blood product transfusions in a previous study [15] was compatible with the criteria of the SC group in this study. Finally, the risk factors for neonates in the SC group for SGH were being preterm and birth asphyxia compared with the NSC group. No preterm neonate presented in the NSC group. The lower GA had a higher proportion of neonates who received therapy for hypotension [16] because the hemodynamics of the preterm neonates had an afterload/output imbalance. Hypotension in preterm neonates occurs from the combination of poor myocardium contractility, patent ductus arteriosus, and low systemic vascular resistance [17]. Moreover, birth asphyxia may cause myocardial ischemia that presents as impaired myocardial contractility, decreased cardiac output, and tricuspid insufficiency [18]. Perinatal asphyxia in preterm neonates was reported with cardiogenic shock [19]. Preterm neonates (poor cardiac contractility) with birth asphyxia (myocardial ischemia) and SGH (hypovolemic shock) have risks for shock and blood transfusion so the hemodynamics of these neonates should be closely monitored within 24 h of birth and crossmatched with blood products for prompt volume resuscitation. However, there was no statistically significant difference in the Apgar scores at 5 min between the SC and NSC groups.

A strength of this study is that data covering a long period (33 years) were collected. Although there was an increasing trend to perform cesarean section, there was no change in close monitoring and prompt resuscitation in all SGH patients in our unit, and there was a very low mortality rate. Moreover, most previous studies mentioned the risk factors for SGH, but very rarely identified the risk factors for SC and cause of death. There are some limitations to this study. It was retrospective with some missing data and records. Neither computerized tomography nor magnetic resonance imaging of the neonates with SGH was performed routinely to evaluate intracranial hemorrhage (ICH) and/or skull fracture. However, the presence of ICH was not correlated with the severity of SGH or mortality, whereas the severity of SGH (severe hypovolemia and coagulopathy) was associated with mortality [15]. Because only one neonate died, we could not identify the risk factors

for mortality in the neonates with SGH. Finally, there were no long-term neurodevelopmental outcomes in either group.

Being preterm and birth asphyxia predicted SC in neonates with SGH. Therefore, we should be quick to recognize the signs of SGH and promptly manage neonatal patients to reduce phototherapy requirements, length of hospital stay, and costs.

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Conflict of interest statement

The authors declare that there is no conflict of interest in this research.

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