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## OBSTETRICS

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# Risk Factors for the Occurrence of Scalp Hematoma in Term Neonates in King Chulalongkorn Memorial Hospital

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### ABSTRACT

**Objectives:** To determine the incidence and associated factors of neonatal scalp hematoma.

**Materials and Methods:** This prospective case-control study included all term singleton live newborns that delivered in King Chulalongkorn Memorial Hospital during July 2016 to October 2016. All neonates were prospectively evaluated and divided into two groups: cases with scalp hematoma and controls. Diagnoses of neonatal scalp hematoma either cephalhematoma or subgaleal hemorrhage were confirmed by the experienced neonatologist. Medical records of these neonates and their mothers were reviewed to collect demographic data and information regarding their processes of labor and delivery. Logistic regression analysis was used to identify the risk factors associated with presence of neonatal scalp hematoma.

**Results:** A total of 938 term neonates were included in this study. The incidence of neonatal scalp hematoma was 3.19% (30/938). Operative obstetrics (vacuum and forceps extraction) were found to have the highest rate (15.38%) of scalp hematoma when compare with other routes of delivery. Factors associated with neonatal scalp hematoma were primiparity (adjusted OR 4.86, 95% CI 1.61-14.58) and prolonged second stage of labor (adjusted OR 4.31, 95% CI 1.08-17.25). When analysis was done in only vaginally delivered neonates, the significant factors were primiparity (adjusted OR 3.84, 95% CI 1.26-11.71) and artificial rupture of membranes (adjusted OR 2.93, 95% CI 1.24-6.97).

**Conclusion:** Neonatal scalp hematoma was common. Primiparous women significantly increased risk of neonatal scalp hematoma regardless of route of delivery.

**Keywords:** birth injury, cephalhematoma, subgaleal hemorrhage, term neonate

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## ปัจจัยเสี่ยงที่สัมพันธ์กับการเกิดก้อนเลือดออกในชั้นหนังศีรษะของทารกแรกเกิดคลอดครบกำหนดในโรงพยาบาลจุฬาลงกรณ์

ชัยวุฒิ ไพบูลย์บริรักษ์, อนงค์นาถ ศิริทรัพย์, ญาดา คุณผลิน, สุรสิทธิ์ ชัยทองวงศ์วัฒนา

### บทคัดย่อ

**วัตถุประสงค์:** เพื่อศึกษาอุบัติการณ์และปัจจัยที่สัมพันธ์กับการเกิดภาวะก้อนเลือดออกในชั้นหนังศีรษะของทารกที่คลอดครบกำหนด

**ระเบียบงานวิจัย:** การศึกษานี้เป็นการศึกษาไปข้างหน้าแบบมีกลุ่มควบคุม ที่รวบรวมทารกคลอดครบกำหนดทุกรายที่เกิดในโรงพยาบาลจุฬาลงกรณ์ ตั้งแต่เดือนกรกฎาคม พ.ศ.2559 ถึงเดือนตุลาคม พ.ศ.2559 ทารกที่คลอดครบกำหนดทุกรายจะถูกแบ่งออกเป็น 2 กลุ่ม ได้แก่ กลุ่มที่มีภาวะก้อนเลือดออกในชั้นหนังศีรษะ และอีกกลุ่มคือกลุ่มควบคุม โดยทารกที่มีภาวะก้อนเลือดออกในชั้นหนังศีรษะไม่ว่าจะเป็นภาวะ Cephalhematoma หรือ Subgaleal hemorrhage ได้รับการยืนยันการวินิจฉัยจากแพทย์ผู้เชี่ยวชาญด้านทารกปริกำเนิด มีการเก็บรวบรวมข้อมูลจากเวชระเบียนในส่วนของประวัติการตั้งครรภ์ และรายละเอียดของการคลอดบุตร ใช้การวิเคราะห์ Logistic regression เพื่อหาปัจจัยที่มีผลต่อการเกิดภาวะก้อนเลือดออกในชั้นหนังศีรษะของทารกแรกเกิด

**ผลการศึกษา:** จากทารกคลอดครบกำหนดทั้งหมด 938 ราย พบว่า อุบัติการณ์การเกิดก้อนเลือดออกในชั้นหนังศีรษะเท่ากับร้อยละ 3.19 (30/938) เมื่อเปรียบเทียบกับวิธีการคลอดวิธีอื่น พบว่าการใช้สูติศาสตร์หัตถการ (vacuum and forceps extraction) มีอุบัติการณ์การเกิดก้อนเลือดออกในชั้นหนังศีรษะสูงสุด คือ ร้อยละ 15.38 โดยปัจจัยที่สัมพันธ์กับการเกิดก้อนเลือดออกในชั้นหนังศีรษะในการศึกษานี้ ได้แก่ การคลอดบุตรครั้งแรก (adjusted OR 4.86, 95% CI 1.61-14.58) และภาวะการคลอดระยะที่สองนานกว่าปกติ (adjusted OR 4.31, 95% CI 1.08-17.25). เมื่อวิเคราะห์ข้อมูลในกลุ่มที่คลอดทางช่องคลอดเท่านั้น พบว่า การคลอดบุตรครั้งแรก และการเจาะถุงน้ำคร่ำ สัมพันธ์กับการเกิดภาวะก้อนเลือดออกในชั้นหนังศีรษะอย่างมีนัยสำคัญทางสถิติ (adjusted OR 3.84, 95% CI 1.26-11.71 และ 2.93, 95% CI 1.24-6.97 ตามลำดับ)

**สรุป:** ภาวะเลือดออกใต้ชั้นหนังศีรษะเป็นภาวะที่พบได้บ่อย โดยการคลอดบุตรครั้งแรก เพิ่มความเสี่ยงในการเกิดภาวะก้อนเลือดออกในชั้นหนังศีรษะโดยไม่จำเป็นการคลอดโดยช่องทางใดก็ตาม

**คำสำคัญ:** การบาดเจ็บจากการคลอดบุตร, ภาวะก้อนเลือดในชั้นใต้เยื่อหุ้มกะโหลกศีรษะ, ภาวะก้อนเลือดระหว่างพังผืดของกะโหลกกับเยื่อหุ้มกะโหลกศีรษะ, ทารกแรกเกิดคลอดครบกำหนด

## Introduction

Neonatal birth injury is defined as the structural or functional damage of the neonate's body due to traumatic events during labor and delivery<sup>(1)</sup>. It does not only cause infant morbidities, but may also lead to various consequences such as prolonged hospital stay, increased cost of treatment, parental emotional effects, child disability, and perinatal death. The incidence of neonatal birth injury has decreased over time with advancement of obstetric care; however, it has still been estimated to appear in 2-7% of all deliveries<sup>(2)</sup>. The most frequently diagnosed birth injury was injuries to the scalp and causing neonatal scalp hematoma<sup>(2,3)</sup>.

Neonatal scalp hematoma or extracranial hematoma is the blood collection outside the calvarium and categorized as cephalhematoma or subgaleal hemorrhage. Cephalhematoma is a subperiosteal collection of blood between the dense fibrous periosteal tissue covering the skull and the skull<sup>(1,4)</sup>. It is usually benign condition which resolves spontaneously without any treatment<sup>(5)</sup>. Differently, subgaleal hemorrhage is bleeding between the galea aponeurotica and periosteum of skull<sup>(1,4)</sup>; 25-33% of cases may be severe and life-threatening<sup>(6)</sup>.

Most of the previous studies regarding neonatal birth injury reviewed the databases or medical records for diagnosing the injuries<sup>(2,3,7)</sup> that may lead to underestimate or overestimate the number of neonates complicated with scalp hematoma. This study was conducted to determine the incidence and associated risk factors of scalp hematoma in term neonates with prospective and validated evaluation of all recruited infants.

## Materials and Methods

The study was approved by ethic committee of The Institutional Review Board of the Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand, in compliance with the International guidelines for human research protection as Declaration of Helsinki, The Belmont Report, The Council for International Organizations of Medical Sciences (CIOMS) Guideline and International Conference on Harmonization in

Good Clinical Practice (ICH-GCP). This prospective case-control study included term ( $\geq 37$  weeks of gestation) singleton live-born neonates that delivered in King Chulalongkorn Memorial Hospital between July and October 2016. Newborns who either non-vertex delivered, had major anomalies, bleeding disorders, or born before arrival were excluded. All recruited neonates were examined by neonatologists and divided into two groups either case with scalp hematoma or control. Because the hematoma could develop a few days after birth, the neonates were reexamined before they were discharged from the hospital. Cases with scalp hematoma were evaluated and confirmed by experienced neonatologist.

Scalp hematoma in this study was diagnosed clinically and categorized as a cephalhematoma or subgaleal hemorrhage. Cephalhematoma was diagnosed when presence of a firm tense mass with a palpable rim that localized over one area of the skull and not across the suture<sup>(8)</sup>. Subgaleal hemorrhage was diagnosed when presence of a fluctuating mass that straddles cranial sutures or fontanelles<sup>(8)</sup>. Skull radiography or Computerized Tomography scan would be used if neonate had neurological symptoms or depressed skull fracture was suspected.

To determine risk factors associated with scalp hematoma, maternal and neonatal medical records were reviewed to collect demographic and clinical data. Baseline maternal characteristics included maternal age, parity, body mass index (BMI), total weight gain (TWG), gestational age and neonatal characteristics included neonatal birth weight, neonatal head circumference and neonatal sex. Information regard to labor and delivery included route of delivery, artificial rupture of membranes, intrapartum oxytocin infusion and duration of second stage of labor. Neonatal outcomes in cases with scalp hematoma were collected.

Statistical analysis was performed using SPSS version 22.0 software (IBM Corp., Armonk, NY, USA). Mean, standard deviation (SD), median, interquartile range (IQR), percentage were used to describe the maternal and neonatal demographic and outcome data. Incidence of neonatal scalp hematoma was presented

as percentage. Chi-square test or Fisher exact test were used to test of association between factors and occurrence of scalp hematoma. Adjusted odds ratios (OR) of the associated factors were determined using logistic regression model adjusted for covariates that found significant association from univariate analysis. P value of less than 0.05 was considered statistically significant.

## Results

Between 1<sup>st</sup> July and 31<sup>th</sup> October 2016, 1400 neonates delivered in King Chulalongkorn Memorial Hospital. Of all, 462 neonates were excluded: 249 neonates due to implausible data on gestational age;

137 preterm neonates; 29 non-vertex delivered neonates; 13 neonates with major anomalies, 1 neonate with bleeding disorder, 3 neonates born before arrival and missing medical records in 30 neonates. A total of 938 term neonates were included in this study.

Thirty cases were confirmed of having scalp hematoma, yielding an incidence of neonatal scalp hematoma was 3.19% (30/938). Cephalhematoma was found in 14 cases and subgaleal hemorrhage was found in 16 cases. There were 2 neonates having both cephalhematoma and subgaleal hemorrhage and complicated with hypovolemic shock. None was admitted in neonatal intensive care unit or dead.

**Table 1.** Baseline and clinical characteristics of cases with scalp hematoma and controls.

Variables	Scalp hematoma (n = 30)	Control (n = 908)	p value
Maternal age (year) <sup>a</sup>	29.5 ± 4.8	30.1 ± 6.1	0.59
Gestational age (weeks) <sup>a</sup>	39.0 ± 0.9	38.8 ± 1.0	0.28
Primiparity <sup>b</sup>	26 (86.7%)	480 (52.9%)	< 0.001
Height (cm) <sup>a</sup>	159.6 ± 4.0	158.3 ± 5.7	0.22
BMI (kg/m <sup>2</sup> ) <sup>a</sup>	22.7 ± 5.4	22.2 ± 4.5	0.55
TWG (kg) <sup>a</sup>	14.8 ± 5.3	13.7 ± 5.1	0.25
Duration from membrane rupture to delivery more than 4 hours <sup>b</sup>	17 (56.7%)	277 (30.5%)	0.005
Prolonged second stage of labor <sup>b</sup>	4 (13.3%)	22 (2.4%)	0.007
Artificial rupture of membranes <sup>*b</sup>	19 (67.9%)	206 (41.9%)	0.012
Intrapartum oxytocin infusion <sup>*b</sup>	13 (46.4%)	149 (30.3%)	0.11
Female neonate <sup>b</sup>	14 (46.7%)	459 (50.6%)	0.82
Neonatal birthweight (g) <sup>a</sup>	3180 ± 349	3125 ± 385	0.44
Neonatal head circumference (cm) <sup>a</sup>	33.8 ± 1.2	33.7 ± 1.2	0.65

\* Only vaginal delivered women: neonatal scalp hematoma (n=28); control (n=492)

<sup>a</sup> presented as mean ± SD, <sup>b</sup> presented as number (%)

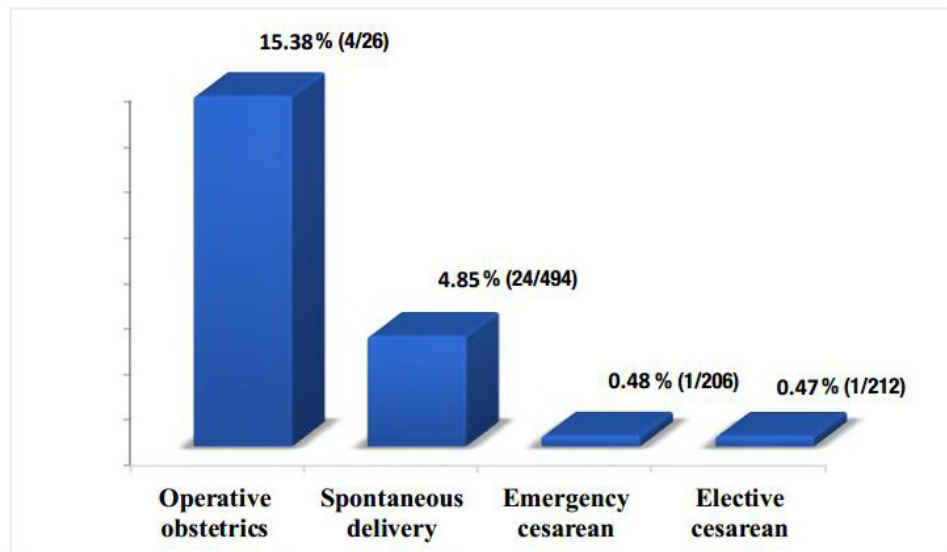
Maternal and neonatal characteristics and clinical data were shown in Table 1. No difference in maternal age, gestational age, height, BMI and TWG between case and control was found. However,

proportions of mothers with primiparity, duration from membranes rupture to delivery more than 4 hours, and prolonged the second stage of labor among cases with hematoma were significantly higher than

those among controls. In women who vaginal delivered, percentages of mothers having artificial rupture of membranes were higher among cases with hematoma when compared with controls, but proportions of women having intrapartum oxytocin infusion were not different. There was no difference in sex, mean birthweights and mean head

circumference of neonates between case and control.

Fig. 1. demonstrates the percentages of neonatal scalp hematoma in any route of delivery. Operative obstetrics (vacuum and forceps extraction) were found to have the highest rate (15.38%) of hematoma when compare with other routes of delivery.



**Fig. 1.** Percentages of neonatal scalp hematoma by route of delivery.

**Table 2.** Factors associated with scalp hematoma in total neonates.

Factors	OR	95%CI	AOR*	95%CI
Primiparity	5.79	2.01-16.74	4.86	1.61-14.58
Duration from membrane rupture to delivery more than 4 hours	2.98	1.43-6.22	1.56	0.70-3.48
Prolonged second stage of labor	6.19	1.99-19.27	4.31	1.08-17.25
Route of delivery				
Spontaneous vertex delivery	1		1	
Operative obstetrics	3.56	1.14-11.15	1.32	0.34-5.09
Emergency cesarean delivery	0.09	0.01-0.72	0.08	0.01-0.59
Elective cesarean delivery	0.09	0.01-0.69	0.12	0.02-0.92

\* Adjusted for parity, duration from membrane rupture to delivery, second stage of labor, and route of delivery.

Factors associated with scalp hematoma in total neonates were shown in Table 2. From multivariable

analysis, factors that significantly increased risk for neonatal scalp hematoma included primiparity

(adjusted OR 4.86, 95%CI 1.61-14.58) and prolonged second stage of labor (adjusted OR 4.31, 95%CI 1.08-17.25). Both emergency and elective cesarean delivery were significantly reduced risk of neonatal scalp hematoma (adjusted OR 0.08, 95%CI 0.01-0.59 and adjusted OR 0.12, 95%CI 0.02-0.92, respectively).

When analysis was done in only neonates who vaginal delivered (Table 3.), the significant risk factors associated with scalp hematoma were primiparity (adjusted OR 3.84, 95%CI 1.26-11.71) and artificial rupture of membranes (adjusted OR 2.93, 95%CI, 1.24-6.97).

**Table 3.** Factors associated with scalp hematoma in neonates who vaginal delivered.

Factors	OR	95%CI	AOR	95%CI
Primiparity	5.02	1.72-14.67	3.84	1.26-11.71
Artificial rupture of membranes	2.93	1.30-6.61	2.93	1.24-6.97
Duration from membrane rupture to delivery more than 4 hours	2.48	1.14-5.36	2.07	0.88-4.89
Prolonged second stage of labor	5.69	1.74-18.60	3.66	0.81-16.44
Operative obstetrics	3.56	1.14-11.15	1.18	0.28-4.91

\* Adjusted for parity, rupture of membranes, duration from membrane rupture to delivery, second stage of labor, and route of delivery.

## Discussion

The present study found that 3.19% of term neonates delivered in King Chulalongkorn Memorial Hospital had scalp hematoma. It seem to be higher incidence when compared to previous studies<sup>(2,3,9)</sup> that reported the injury between 1.28-2.01%. Prospectively surveillance for the hematoma in this study may explain this phenomenon; however, the excess numbers mostly come from the cases with subgaleal hematoma. The incidence of cephalhematoma in this study was 1.49%. It was in the range 1-2% that mostly cited by the literatures<sup>(1,4,10)</sup>. Although incidence of subgaleal in this study was quite high, the severe cases were found only in 0.21% of neonates.

It is not surprising that neonates vaginal delivered by operative obstetrics had the highest proportion (15.38%) of scalp hematoma while those delivered by elective cesarean section had the lowest proportion (0.47%). Cases indicated for operative obstetrics usually have other risks for scalp injury; in addition, traction force direct to neonatal scalp either by forceps or vacuum cup at contact site may result in rupture of the beneath vessels. Cephalhematoma occurs in 4% of

neonates delivered by forceps extractions and the proportion may as high as 26% among neonates delivered by vacuum extractions<sup>(10)</sup>. However, delivery by operative obstetrics did not significantly associate with neonatal scalp hematoma after multivariable analysis to adjust the covariates was performed.

Regardless route of delivery, the factors significantly increased risk of neonatal scalp hematoma were primiparous women and cases having prolonged second stage of labor. Primiparity was still an important factor that increasing risk of hematoma after analysis was done only in vaginal delivered neonates. The result supported findings from the retrospective case series<sup>(7)</sup>, in which 95% of infants with subgaleal hemorrhage delivered by primiparous mothers.

Similarly to previous reports, cesarean delivery was a protective factor of birth injury<sup>(9,11,12)</sup>. Interestingly, this study showed that reducing risk of hematoma was found both in neonates delivered by elective cesarean section and those delivered by emergency operation. Although cesarean delivery could reduce risk of a scalp injury, it may increase maternal morbidities and other nonspecific birth trauma<sup>(12)</sup>. Judicious decision making



on route of delivery should be practiced to approach the favorable maternal and neonatal outcomes.

Among vaginal delivered neonates, artificial rupture of membranes or amniotomy, a common procedure for induction or augmentation of labor, was found to increase risk of neonatal scalp hematoma. An exact mechanism for this event is unknown; however, it may relate to increase of duration from ruptured membranes to delivery or may increase the usage of oxytocin which may result in malposition. It was found that prolonged rupture of membranes (>12 hours) was found in 43% of cases with subgaleal hemorrhage<sup>(9)</sup>. According to results from a Cochrane review, amniotomy alone did not shorten the duration of spontaneous labor or lower the incidence of cesarean births<sup>(13)</sup>. The routine practice of artificial rupture of membrane in women with normally labor progression and reassuring fetal status is not needed<sup>(14)</sup>.

The strength of this study was that the scalp injury was prospectively surveillance and diagnosis was validated by experienced neonatologist. However, one of our limitations included the diagnosis of neonatal scalp hematoma was done only by clinical examination. Skull imaging was indicated if there were neurological symptoms and when concomitant depressed skull fracture was suspected, but no neonate in our study was needed.

## Conclusion

In conclusion, the incidence of neonatal scalp hematoma in this study was 3.19%. Primiparous women and prolonged second stage of labor were the factors significantly increased risk of neonatal scalp hematoma while cesarean delivery was a protective factor. In vaginal delivered neonates, factors significantly increased risk of neonatal scalp hematoma were primiparity and artificial ruptured of membranes. Proper counseling and judicious decision making on method of delivery should be practiced to reduce the incidence of this birth injury. Further study is warranted to identify intrapartum management protocol that could prevent neonatal scalp injury.

## Potential conflicts of interest

The authors declare no conflict of interest.

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