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Original Article

DETERMINANTS OF MECHANICAL BIRTH TRAUMA AMONG LIVE BORN NEONATES ADMITTED AT UNIVERSITY OF GONDAR COMPREHENSIVE SPECIALIZED HOSPITAL NEONATAL INTENSIVE CARE UNIT, NORTHWEST ETHIOPIA: A CASE-CONTROL STUDY

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ABSTRACT

Background*: The occurrence of birth trauma varies according to the fetal factors, labour and delivery processes and maternal factors. However, there is limited data on the possible factors associated with neonatal birth trauma in our setup. This study aimed to identify the associated factors of birth trauma among live-born neonates in the University of Gondar Comprehensive Specialized Hospital (UoGCSH) Neonatal Intensive Care Unit.*

Method*: An unmatched case-control study was conducted among live-born neonates admitted neonatal intensive care unit of UoGCSH over a year from February 1, 2020 to February 1, 2021 G.C. Data was analyzed by SPSS version 20. Descriptive statistics and adjusted Odds Ratio (AOR) with a 95% confidence interval and a p-value of <0.05 was used to identify determinant factors.*

Result*: A total of 300 neonates were included with 1:2 ratio of case and controls. The determinant factors of mechanical birth trauma were head circumference (AOR=1.76, 95% CI: 1.26, 2.46), instrumental delivery (AOR=10.65, 95%CI: 2.83, 40.04), malpresentation (AOR=6.31, 95%CI: 1.01, 40.08) and prolonged labour (AOR=1.45, 95%CI: 2.04, 4.49).*

Conclusion*: Instrumental delivery, malpresentation, >37cm head circumference, and prolonged duration of labour had statistically a significant association with mechanical birth trauma.*

Keywords: - mechanical birth trauma, live born neonate, determinants, Ethiopia

Background

Scholars define birth injury as the impairment of neonatal body function or structure due to adverse influences of the birth process (1-4). Generally, birth-related injuries are classified into birth injuries due to hypoxia or mechanical injuries (5-8). According to few researches and the International Classification of Diseases-10, birth trauma incorporates the mechanical / physical birth injuries (ICD-10) (6, 7).

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Birth injuries occurred due to the mechanical pressure created by the birth canal and traction forces applied by a birth attendant during the labour and delivery processes (4, 9-11). It is usually associated with the size of the foetus, presentation, mode of delivery, duration of labour, maternal chronic diseases, maternal nutritional status, parity, genital anomalies and the skill of the birth attendant (1, 4, 9). Birth injury includes the soft tissue and musculoskeletal injuries (4, 5, 12). In conclusion, birth trauma is related to the foetal presentation, delivery mechanisms and maternal factors (13).

The prevalence of birth trauma can vary depending on the foetal presentation, mode of delivery and birth weight. The prevalence of birth trauma is 0.02% in uncomplicated spontaneous vaginal delivery (SVD) with cephalic presentation and 0.011 % among caesarean section (3). On the other hand, the rate of birth trauma was 30/1000 live birth and 1/1000 live births for vaginal delivery and caesarean delivery in a referral hospital of Iran, respectively (11). In Indonesia (Cipto general hospital), the rate of birth trauma was 29.9/1000 live births (8). In a teaching tertiary hospital of Nigeria, the incidence of birth trauma in vaginal and caesarean delivery was 43/1000 live births and 14/1000 live births for the former and latter (2). Generally, the overall incidence of birth trauma is decreasing due to the improvement of obstetrics care and prenatal diagnoses, due to early recognition and elective C/S (3, 10, 14). In Ethiopia, Jimma specialized hospital mechanical birth trauma was 8.14% live born neonates which is a relatively higher rate of mechanical birth trauma compared to other studies (5). Despite optimal obstetric care globally, birth trauma still affects neonates especially in low-income countries like Ethiopia (3).

There are different types of mechanical birth trauma. Among these, bleeding in the head is the leading one. Bleeding in the head is grouped into intracranial and extra cranial bleeding (haemorrhage) (5). Intracranial bleeding includes subdural, subarachnoid, intraparenchymal, and intraventricular hemorrhage (15, 16). The extracranial bleeding encompasses the subgaleal haemorrhage, cephalohematoma and bleeding into the caput succedaneum (17). Traumatic injury of the scalp causes subgaleal hemorrhage, cephalohematoma, or caput succedaneum. In cases of forceps-assisted deliveries, the prevalence of cephalohematoma reached up to 0.95-2.3%. In extracranial hemorrhage hypovolemic shock, heart failure, acute bilirubin encephalopathy and coagulopathy were the killers (7, 17). Death rate and Complications were more common in neonates with subgaleal haemorrhage (SGH) than neonates with other mechanical birth injuries (17).

Most neonatal brachial plexus palsy occurred in women with normal labour and delivery processes (18). The risk factors associated with brachial plexus injury were maternal diabetes

fetal distress, meconium-stained liquor, vaginal delivery, shoulder dystocia, perineal laceration or episiotomy, high birthweight and depressed one-minute Apgar score (19). Instrumental assisted and emergency caesarean delivery were also associated with facial nerve palsy (19, 20). In addition, facial nerve palsy occurred in Primiparity, birth weight more than 3500gm and prematurity (13). The prevalence of Erb's/brachial palsy was 0.4% in a newborn with a clavicular fracture (21).

Musculoskeletal injury comprised both bony and soft tissue trauma (16, 21). Some studies described the clavicular fracture as the most common musculoskeletal injury type. It accounted for about 2.7-5.7/1000 live births to as high as 6-16.5/1000 live births (16, 21, 22).

The magnitude of birth trauma is lower in developed countries. However, the reverse is true in developing countries where there is poor health care service provision and quality of care. To our knowledge, few studies were done on risk factors of mechanical birth trauma in Ethiopia. Thus, this study aimed to investigate the determinants of mechanical birth trauma among live-born neonates in the university of Gondar Comprehensive Specialized Hospital neonatal intensive care unit.

Methods and materials

Study design and setting

An unmatched case-control study was conducted at the University of Gondar Comprehensive Specialised Hospital (UoGCSH) Neonatal Intensive Care Unit (NICU) from February 1, 2020 to February 1, 2021 G.C.

The UoGCSH neonatal intensive care unit has 40 beds; Fourteen beds for preterm and twenty -six for term neonates. There are six beds reserved for kangaroo mother care services. Two pediatricians are working in the neonatal ICU during working hours. In addition to the pediatricians, there are three residents, six intern doctors and three BSc nurses. The labour ward and neonatal intensive care unit are adjacent to each other.

Study participants

The target population was all live birth neonates admitted to the NICU ward from February 1, 2020, to February 1, 2021. The study population was all live-born neonates whose gestational age was ≥37 completed weeks and admitted to NICU within the study period. Neonates with congenital anomalies, admitted after seven days of postnatal age and referred from other health facilities after seven days of stay at the hospital they have been initially admitted were excluded. Both out born and newborns born in UoGCSH who came after 7 days were excluded because, most signs and symptoms of birth trauma disappeared with in this period. A case was defined as a neonate with physical injury during labour and delivery which was diagnosed by the resident or pediatrician during clinical evaluation. Control was defined as neonates admitted to NICU on the same days as the case and with other diagnosis other than birth trauma. The cases and controls were selected by simple lottery method.

Sample size estimation and sampling

The sample size was calculated by using the 80% power and 95% confidence. The ratio of controls to cases was 2. The proportion of the controls was 8.1% and the proportion of cases exposed was 20%. We calculated the sample size using the above points, and the final sample size became around 300. Therefore, the cases and controls became 100 and 200, respectively. All cases were included in the study and the controls were selected by simple lottery method.

Data collection

A structured English version questionnaire was developed by the investigators. A preliminary review of 15 neonatal charts were done to test the tool before the actual data collection. Training was prepared for two nurses, two interns and one resident. Then, these trained data collectors extracted the maternal and neonatal sociodemographic factors, mode of delivery, duration of labour, birth attendant, presence/ absence of malpresentation, neonatal anthropometries and maternal factors from the neonatal and maternal charts as well as by face-to-face interview of mothers or caregivers from February 1, 2020 to February 1, 2021. The principal investigator supervised the data collection and checked the data completeness daily. In addition, the data was handled in safe places to keep confidentiality.

Statistical analysis

The collected data was entered into Epinfo 4.1 and analysed using SPSS software version 20. Investigator checked errors, outliers, inconsistencies, and missing observations before the data analysis. Frequency tables, range, mean, and standard deviations were used. The association of birth trauma with different variables was analysed using bivariate logistic regression. The adjusted odds ratio (OR) within the 95% confidence interval (CI) and a p-value of <0.05 guided us to know the associations between the independent and outcome variables.

Study variables

Dependent variables: neonatal mechanical birth trauma

Independent variables:

Neonatal variables: gestational age, sex, Birth weight, Length, head circumference, foetal presentation.

Maternal variables: age, address, parity, duration of labour, duration of rupture of membrane, mode of delivery, obstructed labour, ANC follow up, maternal illness and the birth attendant.

Operational definition

Birth trauma- Physical injury like bone fracture and joint dislocation, bruising, nerve palsy, bleeding, happened to the newborn during labour and delivery process.

Macrosomia- A newborn whose birth weight was ≥ 4000gm.

Prolonged labour- Duration of all stages of labour lasting ≥24hours.

Precipitated labour-Labour duration < 3hours

Prolonged PROM- Duration of rupture of membrane stayed >18hr.

Post term baby- Baby delivered after 42 completed weeks of pregnancy

Term baby- Baby delivered within 37 and 42 completed weeks of pregnancy

Antenatal care- Mother who had at least one health institutional visit for the pregnancy

Foetal malpresentation- Any foetal presentation other than vertex.

Referral baby- Baby brought with referral sheet out of UoGCSH.

Results

Socio-demographic characteristics of neonates and mothers

A total of 300 neonates were included in the study; One hundred cases and 200 controls. The sex ratio was 1:3 and 1:1.8 for cases and controls, respectively. The overall sex ratio of the study population was 1:2. The mean age of mothers of the cases was 25.6±4.8SD, and for controls was 25.8±5.1SD. Among the three hundred mothers, 8.7% and 4.7% were younger than 20 and older than 34 years respectively. Most mothers of cases (83%) and controls (70.5%) attended primary education and above. The other 17% of mothers of the cases and 29.5% of controls were not attending formal education.

The mean head circumference of the cases and controls was 36.52±1.6SD and 35.31±1.2SD, respectively. The weight of the cases was 49-34 grams higher than the weight of the control groups. The mean birth weight of cases and control was 3118.67±451.7SD and 3022±499.3SD, respectively. The birth weight laid between 2500 and 4000grams in 90% of the cases and 86.5% of the controls. Among the three hundred neonates, 7.7% and 3% of them had low birth weight and macrosomia respectively (Table 1).

Table 1: Sociodemographic characteristics of neonates and their mothers to NICU in UoGCSH, 2020

Variables		Birth trauma	
		Cases (n=100(%)	Controls (n=200(%))
Age of the mother	Mean maternal age	25.64±4.77SD	25.84±5.11SD
	<20yr	8(8)	19(9.5)
	20-34yr	89(89)	168(84)
	35-49yr	3(3)	13(6.5)
Level of education	Not attending	17(17)	59(29.5)
	Primary	27(27)	29(14.5)
	Secondary	35(35)	91(45.5)
	College	21(21)	21(10.5)
Newborn's gender	Males	76(76)	128(64)
	Females	24(24)	72(36)
Birth weight [gm]	Mean birth weight	3118.67±451.7SD	3022±499.3SD
	<2500	3930	20(10)
	2500-4000	93(93)	173(86.5)
	≥4000	4(4)	5(2.5)
Gestational age (weeks)	Mean GA	39.3±1.45	39.3±1.49
	37-41WKS	92(92)	181(90.5)
	≥42wks	8(8)	19(9.5)

Obstetric and other maternal health related characteristics

Forty-three percent (43%) of cases and 128 (64%) controls were born via SVD. However, about 39% of the cases and 6% of the control were delivered by instrument. But, 18% and 30.5% of mothers of the cases and controls underwent C/S, respectively.

On the other hand, 56% and 64% of the mothers of the cases and control were multiparous, respectively. Ten-point five percent of mothers of the case and four percent of the controls had malpresentation. Five percent of the cases was born from mothers who had obstructed labour. Ninety-one and ninety-three percent of mothers of the case and control had ANC follow-up (Table 2).

Table 2: Obstetric and other maternal health related characteristics of neonates admitted to NICU in UoGCSH, 2020

Variables		Birth trauma	
		Cases (n=100(%))	Controls (n=200(%))
Parity	Primiparity	44(44)	72[36.0]
	Multiparty	56(56)	128(64.0)
Mode of delivery	SVD	43(43)	128(64.0)
	Caesarean section	18(18)	61(30.5)
	Instrumental	39(39)	11(5.5)
Duration of labour	Mean DOL	15.79±8.1SD	12.27±8.8SD
	<24hr.	84(84)	144972)
	≥24hrs.	16(16)	56(28)
Duration of ROM	Mean ROM duration	10.57±40.4SD	5.29±6.8SD
	<18hrs.	87(87)	169(89.5)
	≥18hrs.	13(13)	21(10.5)
Mal-presentation	Yes	11(11)	8(4)
	No	89(89)	192(96)
Obstructed labour	Yes	5(5)	0(0)
	No	95(95)	200(100)
ANC follow up	Yes	91(91)	187(93.5)
	No	9(9)	13(6.5)
Maternal illness	Yes	13(13)	35(17.5)
	No	87(87)	165(82.5)
Birth attendant	Skilled	97(97)	197(98.5)
	Traditional	3(3)	3(1.5)

Types of birth trauma

The identified mechanical birth trauma were scalp, musculoskeletal and peripheral nerve trauma, and bruising, described from the commonest to the least common one. Scalp trauma encompassed 80% of the mechanical trauma in which subgaleal hemorrhage and Cephalohematoma contributed 56% and 24% respectively. Among the 100 cases, nine had musculoskeletal trauma, which accounted 9% of mechanical birth trauma. Among the musculoskeletal trauma four of them had humeral shaft fractures and one femoral shaft fracture, one skull fracture, and another one shoulder dislocation. Five of the neonates with long bone fractures had a breech presentation. There were four newborns with peripheral nerve trauma. Three had facial nerve palsy; one had brachial plexus palsy (Figure 1). Four neonates with Scalp trauma had concomitant facial bruising in one neonate, facial nerve palsy in two neonates and a depressed skull fracture in another neonate. Seventy-nine percent of neonates delivered by forceps had scalp injuries. Among these, 66.5% had subgaleal hemor-

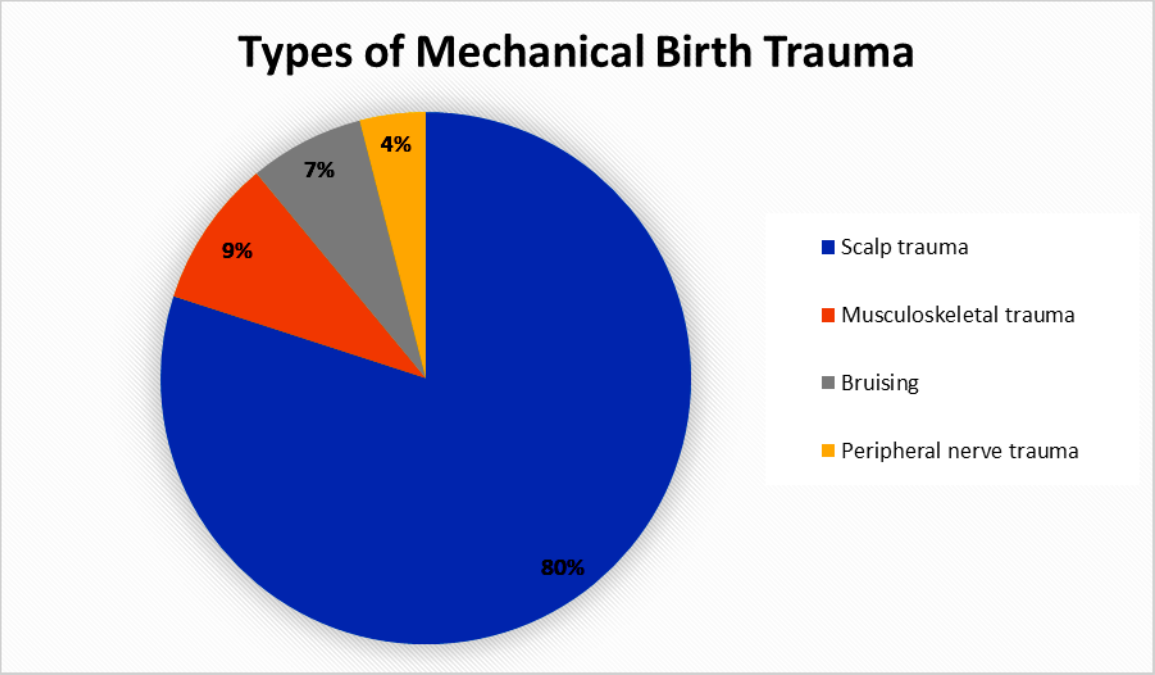

Figure 1: Types of mechanical birth trauma in UoGCSH, 2020

Factors associated with birth trauma

First, the association between the independent and outcome variables were checked by bivariate logistic regression. From bivariate analysis, male gender, malpresentation, head circumference >37 cm, maternal age ≥35 years, gestational hypertension, primiparity, labour ≥24 hours, ANC follow-up and forceps delivery were candidate variables. Then, the candidate variables were interred into a multivariable logistic regression to determine the determinant factors of mechanical birth trauma.

Accordingly, the head circumference >37cm, malpresentation, instrumental delivery and prolonged labour had a significant association with mechanical birth trauma. Instrumental deliveries were around 11 times more likely to have mechanical birth trauma compared to SVD and C/S deliveries (AOR=10.65, 95%CI: 2.83-40.04). The odds of having birth trauma in neonates born from a mother with malpresentation were about six times higher likelihood to have mechanical birth trauma than those infants born without malpresentation (AOR=6.31, 95%CI: 1.20, 40.08).

In neonates delivered after prolonged labour, the occurrence of birth trauma increased by 1.45 times compared to those born within no prolonged labour duration (AOR= 1.45, 95% CI, 2.04-4.49 (Table 3).

Table 3: Factors associated with birth trauma among neonates admitted to NICU in UoGCSH, 2020

Variables		Birth trauma		COR (95% CI)	AOR (95% CI)
		Cases (n=100)	Controls (n=200)		
Gestational age	37-41wk	92(92)	181(90.5)	1	1.00
	≥42wk	8(8)	19(9.5)	1.3(0.43,5.0)	1.24(0.31, 4.92)
Head Circumference (cm)	≤37	80(80)	195(97.5)	1	1
	>37	20(20)	5(2.5)	14.19(3.19,63.14)	1.76(1.26,2.46) *
Age of the mother	< 20 years	8(8)	19(9.5)	1	1
	≥20 years	92(92)	181(90.5)	1.56(0.45,7.35)	1.49(0.34,6.56)
Parity	Primiparity	44(44)	72(36)	1	1
	Multiparty	56(56)	128(64)	0.65(0.35,1.43)	0.52(0.20, 1.36)
Level of education	Not attended	17(17)	59(29.5)	0.32(0.13,1.24)	0.25(0.06, 1.04)
	Primary	27(27)	29(14.5)	0.95(0.37,4.24)	1.05(0.27, 4.14)
	Secondary	35(35)	91(45.5)	0.25(0.08(1.20)	0.30(0.09, 1.03)
	College	21(21)	21(10.5)	1	1
Mode of delivery	SVD	43(43)	128(64)	1	1
	C/S	18(18)	61(30.5)	0.74(0.32-1.68)	0.62(0.23, 1.71)
	Instrumental	39(39)	11((5.5)	10.24(3.29,38.8)	10.65(2.83,40.0*
Duration of labour	<24hrs.	84(84)	144(72)	1	1
	≥24hrs.	16(16)	56(28)	1.41(1.21,1.80)	1.45(2.04,4.49)*
Duration of ROM	<18hrs.	87(87)	179(89.5)	2.34(0.54,5.34)	1.62(0.40, 6.56)
	≥18hrs.	13(13)	21(10.5)	1	1
Malpresentation	Yes	11(11)	8(4)	2.87(0.73-11.26)	6.31(1.20,40.08*
	No	89(89)	192(96)	1	1
ANC follow up	Yes	91(91)	187(93.5)	0.63(0.31,3.25)	0.55(0.20, 2.55)
	No	9(9)	13(6.5)	1	1
Maternal illness	Yes	13(13)	35(17.5)	2.12(0.38,4.38)	1.13(0.29, 4.38)
	No	87(87)	165(82.5)	1	1

Discussion

This study identified instrumental delivery, malpresentation, head circumference and prolonged labour as determinant factors of neonatal mechanical birth trauma. These factors were also identified as risk factor of birth trauma in different studies of many countries. In USA, Huge et al., birth weight, vaginal delivery, primiparity, forceps delivery, vacuum delivery, large for gestational age infant, and male infant sex were risk factors of birth trauma (6). In Indonesian, Cipto general hospital, a study revealed forceps extraction, vacuum ex-

As result of a set up and level of obstetrics care difference, prolonged labour and malpresentation were not risk factors in USA and Indonesian studies. In research done at Jimma University Specialized Hospital, the place of residence, parity, fetal presentation, fetal position and distress, vaginal delivery, and need for resuscitation were factors associated with birth trauma (5). Research done in Addis Ababa, Tikur Anbessa Specialized Hospital (TASH), also showed primiparity, vacuum delivery, forceps delivery and birth weight of ≥3.5 kilograms had strongly associated with birth trauma (23). So, the mode of delivery and presence of malpresentation was in line with the results of these studies. However, head circumference and duration of labour were not associated with birth trauma in the above researches.

One of the risk factors that had a significant association with neonatal birth trauma was the mode of delivery. In this study, the mode of delivery included spontaneous vertex delivery, instrumental assisted delivery and cesarean section delivery. Spontaneous vertex delivery was taken if the neonate was born without instrumental applications. Among these modes of delivery, instrumental assisted delivery had a significant association with birth trauma compared to others.

Contrary to this study, studies done in Saudi Arabia, India, and Iran showed that SVD was the main root of delivery for neonates who had birth trauma (3, 12). But the Indonesian Cipto general hospital study contradicted the Iranian, Saudi Arabian, and Indian studies; they showed that most neonates were born by C/S. In this study, instrumental delivery had a significant association with birth trauma (8). Descriptive study in one of the hospitals in Cameroon done for 11 years showed that 97.3% of neonates with birth trauma were born via SVD. A cross-sectional study in Jimma USH also showed SVD had a statistically significant association with birth trauma. This difference was due to the incorporation of instrumental assisted delivery into the SVD which made SVD riskier than C/S for mechanical birth trauma. In addition, C/S was done after a trial of instrumental application (i.e., forceps and vacuum trial failure).

Head circumference >37cm had also statistically significant association with birth trauma. A 1cm increase in the head circumference resulted in a 1.8 times higher likelihood of birth trauma (AOR=1.76, 95% CI: 1.26-2.46). The increment in the head circumference was due to extracranial or intracranial bleeding. Sometimes head descent could not progress and forceps could be applied. As a result of the forceps application, there could be soft tissue injury like caput and bleeding into the caput that resulted in increased head circumference (1). Although there was significant set up difference, the retrospective case-control study in Israel supported head circumference as the independent risk factor of birth trauma. The research done at Tikur Abessa Tertiary Hospital (TASH) on extracranial bleeding in neonates

showed that subgaleal hemorrhage had a head circumference of above the 90th percentile in 87.9% (17). This result was consistent with ray and Masoumeh et al.; which identified large head circumference as a factor associated with birth trauma (3, 14).Malpresentation of the fetus was one of the determinant factors of birth trauma in this research. In most of the research on birth trauma, malpresentation was a risk factor for mechanical birth trauma. A prospective study in India showed malpresentation and obstructed labour as risk factors for birth trauma. In the same research, increased maternal age, shorter height, higher birth weight, instrumental delivery, prolonged labour and delivery during risk hours were the identified risk factors (14). The fetal presentation had a significant association with birth trauma, which is supported by Workneh et al. The reason for malpresentation as one risk for birth trauma could be due to the association of obstructed labour and prolonged duration of labour, which caused the newborn skull to stay long in contact with the maternal pelvis.

Prolonged labour had a significant association with mechanical birth trauma. The retrospective research in India on predictors of birth trauma showed that prolonged and obstructed labour were an independent predictor of birth trauma. The neonatal and maternal morbidities were more in the protracted second stage of labour. These could be due to prolonged contact of scalp tissue with sacral prominence, obstructed labour and as a result intervention.

The most common type of birth trauma identified was scalp injury, which accounted for about 84% of the total mechanical birth trauma. Although the percentage was lower in other research, the most common type of birth trauma was the injury to the scalp (5, 10, 12, 23). Among the scalp injuries, subgaleal hemorrhage was the leading scalp injury type, which comprised 56% of the injuries (23, 24). In contrast, a Georgetown University Medical Centre study showed that Cephalohematoma was the leading scalp injury type, 56.6%, (6). Cephalohematoma was also the most common scalp injury in India (38.7%) and Iranian (57.2%) (3, 4). The Jimma university hospital and TASH studies showed scalp injury was the commonest injury type. Among the scalp injury, subgaleal hemorrhage was the leading type identified in 20% and 61% for the former and the later studies, respectively (5, 23).

Limitations

The limitation of this study was the absence of trans-fontanel ultrasonography. It was not available to all neonates with birth trauma, especially newborns with scalp injuries which can contribute to missing intracranial bleeding in this study.

Conclusion

Instrumental delivery, malpresentation, >37cm head circumference, prolonged labour had statistically significant association with birth trauma. Birth trauma is associated with birth weight, prolonged duration of labour, malpresentation and instrument delivery.

Instruments are widely used for shortening the duration of labour with risk of birth trauma. Head circumference was found to be determinant factor of neonatal birth trauma.

Declarations

Ethical approval

All methods were performed following the relevant guidelines and regulations. Ethical clearance was obtained from institutional review board of Gondar University. It was funded by the University of Gondar for the master's program.

Consent

Written consent was given to parents or care giver of the neonates. Then, the data were filled in to the questionnaire by the data collectors.

Data availability

Underlying data supporting the result of the study can be made available on reasonable request.

Authors' contribution

All BAM, AS and BT conceptualized the idea. BAM wrote the concept, organized the data collection. All authors analyzed, interpreted, and drafted the manuscript, and had read and agreed to the final manuscript. All authors had read and approved the manuscript and that there are no other persons who satisfied the criteria for authorship. We further confirm that the order of authors listed in the manuscript has been approved by all of us. There had been no significant financial support for this work that could have influenced its outcome.

Conflict of interest

All authors declared that there was no conflict of interest.

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