



Research

Newly Identified Preventable Risk Factors for Neonatal Clavicle Fractures

Yenidoğan Klavikula Kırıkları için Yeni Önlenebilir Risk Faktörleri

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ABSTRACT

Objective: Despite its excellent prognosis, neonatal clavicular fracture often leads to complaints regarding the proficiency of the delivery process and increased obstetrician frustration. It is considered an unavoidable complication of birth because most risk factors are uncontrollable. This retrospective study aimed to determine the obstetric and neonatal characteristics associated with neonatal clavicular fracture at our institution.

Methods: The data that obtained from the medical records of newborns delivered by spontaneous vaginal delivery and clinically diagnosed with clavicular fracture along with an x-ray confirmation were retrospectively evaluated. For each infant with a clavicular fracture, a healthy infant delivered by the same obstetrical team was enrolled as the control. Fetal, maternal, and delivery factors were evaluated in the fracture and control groups.

Results: Among the 106 newborn clavicle fracture cases, only 75 met the inclusion criteria and were enrolled in this study. Following the inclusion criteria, 75 healthy newborns were enrolled as controls. Birth weight and fetal distress were identified as fetal risk factors. Smoking during pregnancy, maternal hypothyroidism, and complications during pregnancy were maternal risk factors. Epidural anesthesia and instrumental delivery were identified as delivery risk factors

Conclusion: Smoking during pregnancy, maternal hypothyroidism, and epidural anesthesia have not been identified as risk factors for neonatal clavicle fracture. The risk factors that are mostly mentioned are uncontrollable. However, smoking and epidural anesthesia are risk factors that can be prevented.

Keywords: Neonatal clavicle fracture, ribosomal factors, epidural anesthesia, maternal smoking, maternal hypothyroidism

ÖZ

Amaç: İyi prognozuna rağmen, neonatal klavikula kırığı genellikle doğum sürecinin yeterliliği hakkında şikayetlere ve kadın doğum uzmanları için artmış strese neden olur. Bu kırıklar normal doğumun kaçınılmaz bir komplikasyonu olarak düşünülür, çünkü risk faktörlerinin çoğu kontrol edilemez. Bu retrospektif çalışmada, kuruluşumuzdaki neonatal klavikula kırığı ile ilişkilendirilen obstetrik ve neonatal özellikleri belirlemeyi amaçladık.

Gereç ve Yöntem: Spontan vajinal doğum (SVD) ile doğan ve klinik olarak klavikula kırığı tanısı konulan ve Röntgen ile konfirme edilen bebeklerin tıbbi kayıtlarından elde edilen veriler retrospektif olarak değerlendirildi. Klavikula kırığı olan her bebek için, aynı obstetrik ekibin doğurduğu sağlıklı bir bebek kontrol olarak alındı. Fetal faktörler, maternal faktörler ve doğum faktörleri kırık ve kontrol grupları için değerlendirildi.

Bulgular: SVD'ler arasında, 106 yeni doğan klavikula kırığı olgusunun sadece 75'i kriterleri karşıladı ve çalışmaya dahil edildi. Kriterleri karşılayan 75 sağlıklı yenidoğan kontrol olarak alındı. Doğum ağırlığı ve fetal sıkıntı fetal risk faktörleri olarak bulundu. Gebelik sırasında sigara içme, maternal hipotiroidizm ve gebelik sırasında komplikasyonlar yaşama maternal risk faktörleri olarak bulundu. Epidural anestezi ve enstrümantal doğum doğum risk faktörleri olarak bulundu.

Sonuç: Bildiğimiz kadarıyla, gebelik sırasında sigara içme, maternal hipotiroidizm ve epidural anestezi neonatal klavikula kırığı için risk faktörleri olarak şimdiye kadar belirlenmemiştir. Daha önce bahsedilen risk faktörlerinin çoğu kontrol edilemezdi. Ancak sigara içme ve epidural anestezi önlenebilir risk faktörleridir.

Anahtar Kelimeler: Neonatal klavikula kırığı, risk faktörleri, epidural anestezi, maternal sigara içme, maternal hipotiroidizm

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INTRODUCTION

Clavicle is considered the most common bone fracture occurring during the delivery process, accounting for 0.2-2.9% of all births (1, 2, 3, 4). Newborn clavicular fracture generally has a good outcome, and it almost always heals spontaneously without any intervention (1, 2, 5, 6). Although it has an excellent prognosis, clavicular fracture is a cause of anxiety among parents and often leads to complaints regarding the proficiency of the delivery process and increased obstetrician frustration. In addition, it may be a source of medico legal problems for doctors, midwives, or other medical staff, considering the increasing trend of litigation in obstetrics practice.

It is thought that difficult deliveries requiring considerable traction can result in neonatal fractures (7). In addition, it is suggested that this fracture results from the compression of the fetal shoulder against the maternal symphysis pubis (2). Although the exact mechanism of clavicular fracture during delivery remains unclear, a consensus is birth trauma.

Risk factors for neonatal clavicular fracture during delivery have been previously reported. Among these risk factors; birth weight, gestational age, Apgar score, prolonged labor, shoulder dystocia, instrumental vaginal delivery, maternal age, and obesity were well documented (1-3, 5, 8). Neonatal clavicle fracture is an unpredictable and unavoidable complication of normal birth because most risk factors are uncontrollable (9, 10). This retrospective study aimed to determine the obstetric and neonatal characteristics associated with neonatal clavicular fracture at our institution.

METHODS

The present study retrospectively evaluated data for all neonates who had a clavicle fracture during delivery at İstanbul Medicine Hospital, Turkey, between March 2012 and March 2018. The study was approved by the medical İstanbul Atlas University Non-Interventional Scientific Research Ethics Committee of the affiliated university and was conducted in accordance with the principles of the Declaration of Helsinki (date: 03.05.2024, number: E-22686390-050.99-41975).

Data were obtained from the medical records of a computerized database. The variables evaluated for the study and control groups were;

Fetal factors: Sex, birth weight, head circumference, length, fracture side (right-left), Apgar score at 1 and 5 min, presence of neurovascular damage or other birth fractures, fetal distress findings (asphyxia, sepsis, respiratory distress syndrome...).

Maternal factors: Age, parity, gravidity, weight at birth, weight gain during pregnancy, comorbidities [such as diabetes mellitus (DM), thyroid problems, epilepsy...], drug treatment during pregnancy, smoking or alcohol consumption during pregnancy, pregnancy complications (gestational DM, preeclampsia, infection, hypertension...).

Delivery factors: Gestational age, mode of delivery (vaginal or caesarian section), epidural anesthesia, performance of episiotomy, need for oxytocic induction, presentation (vertex or Breech), and presence or absence of instrumental delivery.

A cross-check was made with the discharge notes from the obstetric records, newborn baby room or (neonatal intensive care unit) NICU and discharge notes from the orthopedic department.

All newborns were examined by attending staff in the delivery suite and again by neonatologists before discharge from the hospital. The diagnosis of clavicular fracture was established by physical examination (pseudoparalysis of an extremity, asymmetry or crepitation of the clavicular bones, edema, agitation by palpation) and confirmed radiologically (clavicular anteroposterior x-ray).

The inclusion criteria consisted of newborns delivered by spontaneous vaginal delivery and those clinically diagnosed with clavicular fracture along with an x-ray confirmation.

Newborns with brachial plexus injury, birth fractures other than clavicular or pathologic fractures, such as those observed in osteogenesis imperfecta, incomplete medical recordings, missed x-ray recordings, and those delivered by Caesarian section were excluded.

Among the spontaneous vaginal deliveries, of the 106 newborn clavicle fracture cases identified, only 75 met the inclusion criteria and were enrolled in the study. For each infant with a clavicular fracture, a healthy baby born immediately before or after surgery and delivered by the same obstetrical team was selected as the control.

Statistical Analysis

Number Cruncher Statistical System 2007 (Kaysville, Utah, USA) program was used for statistical analysis. While evaluating the study data, Student's t-test was used in the comparison of descriptive statistical methods (Mean, Standard Deviation, Median, Frequency, Ratio, Minimum, Maximum) for two groups of variables that showed normal distribution, and Mann-Whitney U test in two group comparisons of variables that did not show normal distribution. Logistic Regression Analysis was also performed to identify risk factors associated with clavicle

fracture. Pearson's chi-square test was used to compare qualitative data. Significant differences were evaluated at least at $p < 0.05$ level.

RESULTS

Of 3747 spontaneous live vaginal deliveries at our medical center during the study period, 106 infants were diagnosed with clavicular fracture, with an incidence of 2,8%.

Following the inclusion criteria, the study comprised a total of 150 infants (75 with clavicular fractures and 75 health newborns. Fifty-two infants ($n=78$) were female, and 48 % ($n=72$) were male.

The fracture group included 36 males (48%) and 39 females (52%). Of these, 31 (41.3%) had left side involvement, 44 (58.7%) had right side involvement, and no bilateral cases. The fetal factors in the fracture and control groups are summarized in Table 1.

The factors that were not statistically significant ($p > 0.05$) were gender, height, head circumference, and Apgar scores at 1 and 5 minutes.

A statistically significant intergroup difference was observed regarding the mean birth weight. Mean birth weight was higher in the fracture group than in the control group ($p=0.001$; $p < 0.01$). Furthermore, statistical risk analysis showed that a 500-g increase in infant weight increased the risk of clavicular fracture by 1,924- fold [95% confidence interval (CI): 1,269-2,918]. Another significant fetal factor was fetal distress ($p=0,003$; $p < 0,01$). The presence of fetal distress complication was associated with

an increased risk of fracture of the clavicle 7,653 times (95% CI: 1,663-35,227).

Maternal factor analysis: The maternal factors for the fracture and control groups are showed in Table 2.

The maternal characteristics that were not statistically significant ($p > 0.05$) were age, weight, weight gain during pregnancy, parity, and gravidity.

Smoking was found to be a statistically significant risk factor for newborn clavicle fracture ($p=0,003$; $p < 0,01$). Statistical risk analysis showed that smoking during pregnancy increased the risk of clavicular fracture by 4.421-fold (95% CI: 1,546-12,643).

Considering the comorbidities of mothers; there was a statistically significant difference between two groups ($p=0,026$; $p < 0,05$). The presence of comorbidities increased the risk of clavicle fracture by 2,847- fold (95% CI: 1,104-7,343). In the additional disease group, statistical analysis showed that hypothyroidism increases the risk considerably by 4.571 times ($p=0,014$; $p < 0,05$, 95% CI: 1,234-16,935).

The statistical analysis of the two groups showed that having complications during pregnancy was also a risk factor for fracture ($p=0.003$; $p < 0.01$). Pregnancy complications increase the risk by 2,977-fold (95% CI: 1,438-6,163).

Delivery factor analysis: Delivery factors for neonatal clavicle fracture and control groups are showed in Table 3.

The delivery factors that were not statistically significant ($p > 0.05$) were gestational age, oxytocic induction, episiotomy, and presentation.

Table 1. Assessment of newborn cruciate fractures according to fetal characteristics

Fetal factors		Fracture group (n=75)	Control group (n=75)	p-value	OR (%95 CI)
Sex	Female	39 (52%)	39 (52%)	^b 1,000	1,000
	Male	36 (48%)	36 (52%)		0.527-1,898
Weight (gr)	Min-max (median)	2300-4600 (3600)	2370-4230 (3350)	^c 0,001**	1,924
	Mean±SD	3543,73±450,67	3321,53±375,90		1,269-2,918
Height (cm)	Min-max (median)	45-57 (52)	45-56 (51)	^c 0,166	1,101
	Mean±SD	51.17±2.53	50.63±2.27		0.961-1,261
Head circumference (cm)	Min-max (median)	31-38 (34)	32-38 (34)	^c 0,477	1,090
	Mean±SD	34.48±1.42	34.32±1.33		0.861-1,379
APGAR= 1 min	Min-max (median)	4-9 (8)	7-9 (8)	^a 0,427	1,000
	Mean±SD	8.03±0.68	8.03±0.37		0.553-1,807
APGAR= 5 min	Min-max (median)	7-10 (9)	8-10 (9)	^a 0,529	1,158
	Mean ±SD	9.08±0.49	9.05±0.36		0.546-2,458
Fetal distress/complication	Yes	62 (45.9)	73 (54.1)	^b 0,003**	7,653
	No	13 (86.7)	2 (13.3)		1,663-35,227

^aMann-Whitney U Test, ^bPearson chi-square test, ^cStudent t-test, ** $p < 0.01$, SD: Standard deviation, OR: Odds ratio

Table 2. Assessment of newborn cruciate fracture according to maternal characteristics

Maternal factors		Fracture group (n=75)	Control group (n=75)	p-value	OR (%95 CI)
Age (year)	Min-max (median)	20-44 (29)	18-40 (27)	^c 0.181	1,043
	Mean±SD	28.92±5.12	27.77±5.33		0.980-1,110
Weight (kg)	Min-max (median)	55-113 (77)	62-109 (76)	^c 0.285	1,017
	Mean ±SD	78.73±10.96	76.92±9.69		0.986-1,050
Weight gain (kg)	Min-max (median)	8-33 (16)	8-31 (14)	^c 0.177	1,041
	Mean ±SD	16.71±5.99	15.48±5.05		0.982-1,105
Gravidity	Min-max (median)	1-6 (2)	1-6 (2)	^a 0.496	1,078
	Mean ±SD	2.08±1.11	1.99±1.13		0.808-1,437
	1	28 (46.7)	32 (53.3)		
	2	24 (50.0)	24 (50.0)		
	≥3	23 (54.8)	19 (45.2)		
Parity	Min-max (median)	1-5 (2)	1-4 (1)	^a 0.387	1,075
	Mean±SD	1.91±0.90	1.84±1.03		0.770-1,501
	1	29 (43.3)	38 (56.7)		
	2	28 (59.6)	19 (40.4)		
	≥3	18 (50.0)	18 (50.0)		
Additional medical diseases	No	58 (46.0)	68 (54.0)	^b 0,026*	2,847
	Yes	17 (70.8)	7 (29.2)		1,104-7,343
Hypothyroidism	No	63 (84.06)	72 (96.0)	^b 0,014*	4,571
	Yes	12 (16.0)	3 (4.0)		1,234-16,935
Smoking	No	57 (44.9)	70 (55.1)	^b 0,003**	4,421
	Yes	18 (78.3)	5 (21.7)		1,546-12,643
Pregnancy complications	No	43 (41.7)	60 (58.3)	^b 0,003**	2,977
	Yes	32 (68.1)	15 (31.9)		1,438-6,163

^aMann-Whitney U test, ^bPearson chi-square test, ^cStudent t-test, ^dFisher's exact test, *p<0.05, **p<0.01, SD: Standard deviation, OR: Odds ratio, kg: Kilogram

Table 3. Assessment of newborn cruciate fracture according to delivery factors

		Fracture group (n=75)	Control group (n=75)	^b p-value	OR (%95 CI)
Epidural anesthesia	No	39 (39.8)	59 (60.2)	0.001**	3,404
	Yes	36 (69.2)	16 (30.8)		1,666-6,954
Oxytocic induction	No	29 (60.4)	19 (39.6)	0.080	1,858
	Yes	46 (45.1)	56 (54.9)		0.925-3,733
Episiotomy	No	8 (47.1)	9 (52.9)	0.797	1,142
	Yes	67 (50.4)	66 (49.6)		0.415-3,139
Instrumental delivery	No	67 (47.9)	73 (52.1)	0.048*	4,358
	Yes	8 (80.0)	2 (20.0)		0.894-21,256
Presentation	Vertex	63 (48.1)	68 (51.9)	0.220	1,850
	Breech	12 (63.2)	7 (36.8)		0.685-4,995
Gestational week	Min-max (median)	35-41 (39)	36-41 (39)	^c 0,718	1,055
	Mean±SD	38,93±1.22	39.00±1.03		0,792-1,402

^bPearson Chi-Square Test, ^cStudent t Test, *p<0.05, **p<0.01, SD: Standard deviation, OR: Odds ratio

Epidural anesthesia was found to be a statistically significant risk factor for clavicle fracture ($p=0.001$; $p<0.01$). Statistical risk analysis showed that epidural anesthesia during delivery has an increased risk of clavicular fracture by 3,404- fold (%95 CI: 1,666-6,954).

Among the delivery factors, instrumental delivery was another significant factor was instrumental delivery ($p=0.048$; $p<0.05$). Our data showed that instrumental delivery significantly increased fracture risk by 4,358- fold (%95 CI: 0.894-21,256).

DISCUSSION

Clavicular fractures are the most frequently encountered neonatal bone fractures (10, 11). The long-term prognosis of a fractured clavicle is very good and heals without any complications, so it is not considered a significant birth injury (2). However, in addition to increasing physician and parental anxiety, it can also create a potential risk of medicolegal issues. Therefore, it is important to identify potential preventive factors.

The mechanism underlying clavicle fracture during delivery remains unclear. It was previously suggested that fetal shoulder compression on the maternal symphysis pubis could be the reason or it may be fractured while attempting to relieve shoulder dystocia (12). However, in most cases, the fracture occurs spontaneously during vaginal delivery.

Most of the studies reported previously supported that most of the risk factors were either related to fetal physical characteristics or difficult prolonged delivery, so it was acknowledged as an inevitable complication of labor (13, 14). However, some studies have claimed that the majority of affected infants did not undergo difficult labor or delivery processes (13, 15). The current consensus is that most neonatal clavicle fractures are unavoidable complications of labor (3, 9, 10, 13, 14).

The reported incidences of neonatal clavicle fracture range between 0.2 and 4.4% (8, 11, 13-16). In our institution, we found the incidence as 2.8% and it is within the acceptable range reported previously.

In the past, many reports have investigated the potential risk factors for fetal, maternal, and delivery in neonatal clavicle fractures. The most frequently cited risk factors are birth weight, shoulder dystocia, instrumental delivery, maternal age, maternal height, maternal diabetes, prolonged labor, and low Apgar score (3, 4, 8, 9, 10, 13, 14, 15, 17). However, some of the suggested risk factors and some potential risk factors that have not been investigated have still remained controversial. This study was developed to analyze the risk

factors for neonatal clavicular fractures and to compare the data with those of previous studies to clarify specific risk factors and the precautions to avoid them.

In this study, we divided possible risk factors into three groups; fetal factors, maternal factors, and delivery factors.

In the analysis of fetal factor, sex, height, head circumference, and Apgar scores at 1 and 5 min were not identified as risk factors. Although some studies suggested that lower Apgar scores at 1 st minute is associated with higher fracture risk (4, 10), most of the reports could not find any statistical significance between Apgar scores and fracture, similar to our study (3, 8, 13, 14, 16). The two fetal risk factors that we found to be significant were birth weight and fetal distress after birth. In the literature, almost all reports have shown that increased fetal weight is a risk factor for neonatal clavicle fracture (3, 4, 8, 14, 15, 17). Our statistical risk analysis showed that a 500- g increase in infant's weight increased the risk of clavicular fracture by 1,924- fold. Fetal distress was another significant fetal risk factor that reached significance in the present study. In the fracture fetal distress group, 10 patients were diagnosed with dyspnea and interned to the NICU, and 4 patients were diagnosed with sepsis and interned to the NICU. Beall et al. (17) claimed that meconium aspiration was significantly related to clavicle fractures, but we did not have any patient diagnosed with meconium aspiration in the fetal distress group.

In the analysis of maternal factors, our results were consistent with those of most of the previously reported studies that there was not any significant relationship between clavicle fractures and age, weight, weight gain during pregnancy, parity, and gravidity (3, 8-10, 13, 15, 16). Contrary to our findings, Beall et al. (17) and Ahn et al. (4) argued that advanced maternal age is significantly associated with fracture. However, most studies showed similar results regarding maternal age (3,8,10,13,15,16).

In the present study, two new maternal risk factors were: Smoking during pregnancy and maternal hypothyroidism. Our statistical analysis showed that babies to mothers who smoke during pregnancy have an increased risk of clavicular fracture by 4.421- fold, and hypothyroid maternal hypothyroidism increases the risk by 4.571- fold. To our knowledge, these two risk factors have not been shown to be related to neonatal clavicle fracture in the literature.

Maternal smoking during pregnancy is a known cause of low birth weight, perinatal mortality, and disturbances in neurodevelopment (18, 19). The chemical toxins in tobacco, particularly nicotine, reach the fetus through the placenta and are concentrated in fetal blood at levels 15% greater than those of the mother (20). Today, nicotine has numerous

effects on the musculoskeletal system, including stimulating the sympathetic nervous system, causing vascular disturbances, inducing cell death, and decreasing bone mineral density, causing fracture-healing complications (21-23). A systematic review showed that congenital birth defects (digit anomalies, limb reduction defects, clubfoot) are associated with maternal smoking during pregnancy (18).

Many studies have shown that subclinical maternal hypothyroidism is associated with adverse obstetric outcomes and pregnancy complications, such as increased prevalence of spontaneous abortion, anemia, preeclampsia, gestational hypertension, placental abruption, postpartum hemorrhage, and adverse neonatal outcomes, such as premature delivery, low birth weight, and neonatal respiratory distress (24-26). Thyroid hormone is required for normal neuronal migration and myelination of the brain during fetal and early postnatal life, and hypothyroxinemia during these critical periods causes irreversible brain damage, with mental retardation and neurological abnormalities (27). In this entity, we investigated mothers diagnosed with pre-pregnancy hypothyroidism but not gestational hypothyroidism. Statistical analysis showed that hypothyroidism considerably increases the risk of developing hypothyroidism. To our knowledge, this is the first study to report the relationship between neonatal clavicle fractures and maternal hypothyroidism. Even if we can deduce that maternal hypothyroidism can be related to neonatal clavicle fractures through fetal distress and other pregnancy complications, we believe that further investigation is required to enlighten this new finding.

Encountering complications during pregnancy was also found related to clavicle fractures and pregnancy complications, increasing the risk by 2,977- fold. This entity included Rh or ABO hemolytic disease, gestational DM, gestational HT, preeclampsia, infectious diseases, and gestational hypothyroidism. Most studies did not investigate this relationship. Beall et al. (17) showed that gestational DM increases the risk, whereas Roberts et al. (9) and Chez et al. (13) showed the opposite. With a more general point of view, Kaplan et al. (14) and Peleg et al. (15) did not find any relationship between maternal complications and neonatal clavicle fracture.

Results of delivery factor analysis showed that gestational age, oxytocin induction, episiotomy, and presentation did not have an effect on neonatal clavicle fracture ($p > 0.05$). Our results were comparable to others, but when we looked at the literature, we saw that, like us, some authors did not find any significant relationship for gestational age (8, 15,

17). However, contrary to our findings, Chez et al. (13) and Roberts et al. (9) found that advanced gestational age (40th week) was related to neonatal clavicle fracture.

Among the delivery factors, instrumental delivery (vacuum and forceps) significantly increased fracture risk by 4.358-fold. This factor has been studied previously many times, and many studies supported our result (4, 8, 10), whereas some have reported reversals (3, 9, 10, 14).

Epidural anesthesia has been evaluated as a risk factor in some previous studies, but it was not considered a risk factor (3, 4, 9). However; in our study, epidural anesthesia was found to be a statistically significant risk factor for clavicular fracture and increased the risk of clavicular fracture by 3.404- fold. Epidural analgesia is associated with prolonged labor, decreased rates of spontaneous vaginal delivery, increased instrumental delivery, and fetal malposition (28, 29). We accept the instrumental delivery as a risk factor. In addition, some studies showed that prolongation of labor was related to clavicle fracture (9, 14). However, it has not been identified as a risk factor in most studies (1, 3, 4, 9). In the literature, only one report showed epidural anesthesia as a risk factor for birth trauma, but not for clavicle fracture (30).

Study Limitations

The major limitation of this study was its retrospective design. Although our study population can be considered adequate, to assess the newly identified risk factors in this paper, prospective studies with larger sample sizes are required.

CONCLUSION

To our knowledge, smoking during pregnancy, maternal hypothyroidism, and epidural anesthesia have not been identified as risk factors for neonatal clavicle fracture. The risk factors that are previously mentioned mostly were uncontrollable or unpredictable. However, smoking and epidural anesthesia are risk factors that can be prevented. Therefore, these two risk factors should be examined in further studies. The elimination of these factors can decrease neonatal clavicle fracture incidence.

ETHICS

Ethics Committee Approval: The study was approved by the medical İstanbul Atlas University Non-Interventional Scientific Research Ethics Committee of the affiliated university and was conducted in accordance with the principles of the Declaration of Helsinki (date: 03.05.2024, number: E-22686390-050.99-41975).

Informed Consent: Since this study was retrospective, error confirmation was not required.

FOOTNOTES

Authorship Contributions

Surgical and Medical Practices: S.E.B., M.T.D., Concept: S.E.B., O.B., Design: S.E.B., M.T.D., O.B., Analysis or Interpretation: M.T.D., Literature Search: S.E.B., Writing: S.E.B., M.T.D., O.B.

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REFERENCES

1. Levine MG, Holroyde J, Woods JR Jr, Siddiqi TA, Scott M, Miodovnik M. Birth trauma: incidence and predisposing factors. *Obstet Gynecol.* 1984;63:792-5.
2. Oppenheim WL, Davis A, Growdon WA, Dorey FJ, Davlin LB. Clavicle fractures in the newborn. *Clin Orthop Relat Res.* 1990;176-80.
3. Lurie S, Wand S, Golan A, Sadan O. Risk factors for fractured clavicle in the newborn. *J Obstet Gynaecol Res.* 2011;37:1572-4.
4. Ahn ES, Jung MS, Lee YK, Ko SY, Shin SM, Hahn MH. Neonatal clavicular fracture: recent 10 year study. *Pediatr Int.* 2015;57:60-3.
5. Gilbert WM, Tchabo JG. Fractured clavicle in newborns. *Int Surg.* 1988;73:123-5.
6. Cohen AW, Otto SR. Obstetric clavicular fractures. A three-year analysis. *J Reprod Med.* 1980;25:119-22.
7. Groenendaal F, Hukkelhoven C. [Fractures in full-term neonates]. *Ned Tijdschr Geneesk.* 2007;151:424.
8. Hsu TY, Hung FC, Lu YJ, Ou CY, Roan CJ, Kung FT, et al. Neonatal clavicular fracture: clinical analysis of incidence, predisposing factors, diagnosis, and outcome. *Am J Perinatol.* 2002;19:17-21.
9. Roberts SW, Hernandez C, Maberry MC, Adams MD, Leveno KJ, Wendel GD Jr. Obstetric clavicular fracture: the enigma of normal birth. *Obstet Gynecol.* 1995;86:978-81.
10. Ohel G, Haddad S, Fischer O, Levit A. Clavicular fracture of the neonate: can it be predicted before birth? *Am J Perinatol.* 1993;10:441-3.
11. Bhat BV, Kumar A, Oumachigui A. Bone injuries during delivery. *Indian J Pediatr.* 1994;61:401-5.
12. Joseph PR. Newborn clavicle fractures. *Clin Pediatr (Phila).* 1997;36:491.
13. Chez RA, Carlan S, Greenberg SL, Spellacy WN. Fractured clavicle is an unavoidable event. *Am J Obstet Gynecol.* 1994;171:797-8.
14. Kaplan B, Rabinerson D, Avrech OM, Carmi N, Steinberg DM, Merlob P. Fracture of the clavicle in the newborn following normal labor and delivery. *Int J Gynaecol Obstet.* 1998;63:15-20.
15. Peleg D, Hasnin J, Shalev E. Fractured clavicle and Erb's palsy unrelated to birth trauma. *Am J Obstet Gynecol.* 1997;177:1038-40.
16. Lam MH, Wong GY, Lao TT. Reappraisal of neonatal clavicular fracture: relationship between infant size and neonatal morbidity. *Obstet Gynecol.* 2002;100:115-9.
17. Beall MH, Ross MG. Clavicle fracture in labor: risk factors and associated morbidities. *J Perinatol.* 2001;21:513-5.
18. Hackshaw A, Rodeck C, Boniface S. Maternal smoking in pregnancy and birth defects: a systematic review based on 173 687 malformed cases and 11.7 million controls. *Hum Reprod Update.* 2011;17:589-604.
19. Ernst M, Moolchan ET, Robinson ML. Behavioral and neural consequences of prenatal exposure to nicotine. *J Am Acad Child Adolesc Psychiatry.* 2001;40:630-41.
20. Müller JS, Antunes M, Behle I, Teixeira L, Zielinsky P. Acute effects of maternal smoking on fetal-placental-maternal system hemodynamics. *Arq Bras Cardiol.* 2002;78:148-55.
21. Zevin S, Gourlay SG, Benowitz NL. Clinical pharmacology of nicotine. *Clin Dermatol.* 1998;16:557-64.
22. Lee JJ, Patel R, Biermann JS, Dougherty PJ. The musculoskeletal effects of cigarette smoking. *J Bone Joint Surg Am.* 2013;95:850-9.
23. Tong VT, Jones JR, Dietz PM, D'Angelo D, Bombard JM; Centers for Disease Control and Prevention (CDC). Trends in smoking before, during, and after pregnancy - Pregnancy Risk Assessment Monitoring System (PRAMS), United States, 31 sites, 2000-2005. *MMWR Surveill Summ.* 2009;58:1-29.
24. Allan WC, Haddow JE, Palomaki GE, Williams JR, Mitchell ML, Hermos RJ, et al. Maternal thyroid deficiency and pregnancy complications: implications for population screening. *J Med Screen.* 2000;7:127-30.
25. Su PY, Huang K, Hao JH, Xu YQ, Yan SQ, Li T, et al. Maternal thyroid function in the first twenty weeks of pregnancy and subsequent fetal and infant development: a prospective population-based cohort study in China. *J Clin Endocrinol Metab.* 2011;96:3234-41.
26. Abalovich M, Gutierrez S, Alcaraz G, Maccallini G, Garcia A, Levalle O. Overt and subclinical hypothyroidism complicating pregnancy. *Thyroid.* 2002;12:63-8.
27. Morreale de Escobar G, Obregon MJ, Escobar del Rey F. Role of the thyroid hormone during early brain development. *Eur J Endocrinol.* 2004;151.
28. Lieberman E, O'donoghue C. Unintended effects of epidural analgesia during labor: a systematic review. *Am J Obstet Gynecol.* 2002;186(5 Suppl Nature):31-68.
29. Anim-Somuah M, Smyth RM, Cyna AM, Cuthbert A. Epidural versus non-epidural or no analgesia for pain management in labour. *Cochrane Database Syst Rev.* 2018;5:CD000331.
30. Perlow JH, Wigton T, Hart J, Strassner HT, Nageotte MP, Wolk BM. Birth trauma. A five-year review of incidence and associated perinatal factors. *J Reprod Med.* 1996;41:754-60.