Article
Fracture of the clavicle in the newborn following normal labor and delivery

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Abstract

\textit{Objective:} Earlier works have associated neonatal clavicular fracture (0.2−3.5\% of all deliveries) with a range of procedural, fetal and maternal risk factors; more recent studies, however, have failed to firmly identify any one or a combination of them. In the present work we sought to determine possible ante/intra-partum risk factors for this condition. \textit{Study design:} Using a retrospective case-controlled approach, we examined a series of maternal, fetal and pregnancy or delivery-related variables in 87 cases out of 403 of fractured clavicle of the newborn diagnosed in our department from 1986 to 1994. All infants were delivered vaginally (in the occipito-anterior position) at term by a specialist obstetrician and underwent peripartum sonographic fetal weight estimation. All variables were compared with those of an equal number of infants born immediately before or after each affected infant and delivered by the same obstetrical team. \textit{Results:} Fractured clavicles were found in 1.65\% of the total number of deliveries during the study period. Neonatal clavicular fracture was significantly and directly related to the duration of the second stage of labor, peripartum sonographic fetal weight estimation, and neonatal length, and inversely related to maternal height; nevertheless, all values in both the study and control groups were within normal range. Logistic regression analysis showed that these antenatal variables significantly affect the chances of clavicular fracture, but due to the high false-positive rate they cannot serve clinically as a comprehensive antenatal prediction index. \textit{Conclusions:} The majority of clavicular fractures occur in normal newborns following normal labor and delivery. The risk factors we identified statistically do not offer a method for clinical prenatal prediction. This work provides statistical evidence of the nature of this complication of early newborn life. © 1998 International Federation of Gynecology and Obstetrics

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1. Introduction

Newborn bone fractures are a known complication of parturition [1,2], with neonatal clavicular fracture being the most frequent, at a rate of 0.2–3.5% of all deliveries [3]. Though early reports implicated a range of fetal (high birth weight, shoulder dystocia) [4,5], procedural (induction of labor, post-term pregnancy, prolonged labor and instrumental vaginal delivery) [6–13] and maternal variables (older age, obesity, diabetes and short stature) [6–9], more recent studies [1–3,14] have suggested that no one or a combination of risk factors can be firmly identified. Today, clavicular fracture is generally considered an unpredictable and unavoidable complication of normal birth.

To test this assumption, we conducted a retrospective case-controlled study of newborns with clavicular fracture.

2. Material and methods

The computerized database of the Department of Neonatology was reviewed for all cases of neonatal clavicular fracture in singleton-term deliveries from August 1986 to July 1994. During this period, there were no changes in the institutional policy regarding management of delivery or the criteria for diagnosis of neonatal clavicular fracture. Of the 403 cases identified, 87 were included in the study. We included only those delivered by spontaneous vaginal delivery in the occipito-anterior position by an experienced specialist in obstetrics. Furthermore, only those who also underwent peripartum during the last 3 days of pregnancy to immediately before delivery) sonographic fetal weight estimation (all estimations were performed by an experienced technician and when compared to the actual birth weight were found to be accurate within a 5% range in average) were analyzed. For each infant with a clavicular injury, the records of the baby born immediately before or after and delivered by the same obstetrical team were examined as well (provided it, too, had all the inclusion criteria).

Every newborn in our department undergoes routine physical examination twice: during the first 24 h of birth and later, before discharge (56–72 h postpartum). Diagnostic criteria for neonatal clavicular fracture are: by inspection — asymmetry of the clavicular bones, absence of the supraclavicular notch and local edema or hematoma; by palpation — crepitations and local tenderness (reflected by the baby’s cry). X-ray films are not performed unless Erb’s palsy or other brachial plexus injury is suspected.

The variables evaluated for the study and control groups were:

1. Maternal: age, ethnic origin (Asian, African, Russian, Ethiopian, American, European or Arabic), parity, height, time elapsed since previous delivery, previous maximal birth weight, presence of gestational diabetes or diabetes in a first-degree relative, and weight gain during current pregnancy.

2. Fetal: peripartum sonographic fetal weight estimation (already specified), birth weight, birth length, head circumference, sex, intrapartum fetal well being (fetal heart rate monitor, cord blood pH < 7.20, Apgar score or the need for intubation), presence of neonatal paralysis and the side of the fracture.

3. Pregnancy and delivery: high or low risk pregnancy course (normal or significant complications, such as hypertension, major maternal infection and premature rupture of the membranes), gestational age and reason(s) for admission to the delivery room (rupture of the membranes, contractions, bleeding or induction of labor), duration and progress of labor by stages (duration of second stage defined as the time from full dilatation to delivery), the need for oxytocic augmentation of uterine contractions, use and type of analgesia or anesthesia, presence of meconium, performance of episiotomy.

Statistical analysis was performed with Pearson $\chi^2$-tests for categorical variables and one-way analysis of variance for continuous variables, using the BMDP statistical software [15]. Variables with $P$-values $\leq 0.05$ were considered significant.
Logistic regression analysis was performed on variables proven to be statistically significant for discriminating between the study and control groups.

3. Results

During the period under study, there were 27,386 singleton-term deliveries in our center. The 403 cases of neonatal clavicular fracture represented 1.65% of all vaginal deliveries and 0.2% (7/3391) of all cesarean deliveries. Erb’s/brachial palsy was noted in 4% of the clavicular fracture group (16/403); all recovered within 1 year. Maternal age (average 30.7 ± 5.5 years; range 20–46 years) and parity (average 2.1 ± 1.8 deliveries) were similar in both groups.

Four of the analyzed variables were demonstrated to be significantly different for the two groups: maternal height; the duration of second stage of labor; peripartum sonographic fetal weight estimation; and neonatal birth length (Table 1). Nevertheless, all values were still within the normal range.

The first three variables, being documented antepartum data and having a significant relationship to the occurrence of neonatal clavicular fracture, were further analyzed in a stepwise logistic regression analysis. All three were significant at the 0.01 level. On this basis, we formulated a combined index, which we believed would be useful for ante/intra-partum identification of individual parturients predisposed to deliver an infant with a fractured clavicle, as follows:

\[
\text{Index} = \frac{e^{(5.9 - 0.082H + 1.765W + 1.22T)}}{1 + e^{(5.9 - 0.082H + 1.765W + 1.22T)}}
\]

where the index is the probability (between 0 and 1) of a fractured clavicle, \(H\) is the height (cm) of the mother, \(W\) is the peripartum sonographic fetal weight estimation (in kg) and \(T\) is the base 10 logarithm of the duration (min) of the second stage of labor.

Ideally, this formula could serve as a clinical diagnostic tool. Mothers whose index values exceed a predetermined threshold would be advised not to proceed with a vaginal delivery. For given threshold values, clinicians could also use the data to estimate the proportion of mothers among those whose infants suffered a fracture who would be referred for a cesarean section (sensitivity) and the proportion of mothers among those whose infants did not suffer a fracture who would be advised to continue with a vaginal delivery (specificity). Table 2 lists the estimated sensitivity and specificity for a variety of thresholds.

Unfortunately, the clinical usefulness of our formula is undermined by the high false-positive and false-negative rates for the different threshold values (Table 3). The false-positive rate is the proportion of mothers recommended for cesarean section whose infants would not have had a clavicular fracture (i.e. mothers incorrectly classified as high risk), and the false-negative rate is the proportion of mothers advised to have a vaginal delivery whose infants would be born with a clavicular fracture. Our calculation assumes that the overall fracture rate is 2% of all births (average of the range of prevalences in the literature) [3].

<table>
<thead>
<tr>
<th>Variable</th>
<th>Study group (n = 87)</th>
<th>Control group (n = 87)</th>
<th>Significance of difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal height (cm)</td>
<td>162.4 ± 6.6</td>
<td>164.5 ± 5.5</td>
<td>0.025</td>
</tr>
<tr>
<td>Second stage duration (min)</td>
<td>32.8 ± 34.6</td>
<td>21.9 ± 26.4</td>
<td>0.025</td>
</tr>
<tr>
<td>Estimated fetal weight* (g)</td>
<td>3620 ± 394</td>
<td>3311 ± 49</td>
<td>0.0001</td>
</tr>
<tr>
<td>Neonatal length (cm)</td>
<td>50.5 ± 1.7</td>
<td>49.3 ± 1.9</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

*Peripartum (3 days before to the delivery day) sonographic fetal weight estimation.
Table 2  
Estimated sensitivity and specificity for different calculated thresholds of the proposed neonatal clavicular fracture index

<table>
<thead>
<tr>
<th>Threshold</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3</td>
<td>0.931</td>
<td>0.269</td>
</tr>
<tr>
<td>0.4</td>
<td>0.816</td>
<td>0.538</td>
</tr>
<tr>
<td>0.5</td>
<td>0.724</td>
<td>0.654</td>
</tr>
<tr>
<td>0.6</td>
<td>0.609</td>
<td>0.756</td>
</tr>
<tr>
<td>0.7</td>
<td>0.402</td>
<td>0.885</td>
</tr>
<tr>
<td>0.8</td>
<td>0.195</td>
<td>0.949</td>
</tr>
</tbody>
</table>

The false-positive rate may be high either because fractured clavicle is not a common outcome or because the logistic regression equation does not sharply discriminate between mothers whose infants will have a fracture and mothers whose infants will not. As the great majority of births do not result in a clavicular fracture regardless of the threshold chosen, most of the mothers with index values exceeding the threshold will come from the large no-fracture group. For example, for every 10 mothers whose neonates have a fracture, there are 500 whose infants do not. Thus, even if the sensitivity and specificity are both 0.7, seven mothers from the first group will exceed the threshold vs. 150 from the second. The low-false negative rate also reflects the low prevalence of clavicular fractures. That is, if no attempt was made to classify mothers on the basis of our data, the false-negative rate would be 0.02 — the accepted overall rate of clavicular fracture. Using a threshold of $\geq 0.6$ would screen out at least half the mothers whose infants would have a fracture — as the false-negative rate is approx. $\leq 0.01$ — but at the expense of performing unnecessary cesarean sections for many mothers — as the false-positive rate is $> 0.95$.

4. Discussion

Newborn infants with clavicular fracture rarely have symptoms [16] and most have no long-term problem [17]. Nevertheless, this complication is important because of the concern it raises in parents and the occasional associated neurologic trauma [8,18].

In our study, the neonatal clavicular fracture rate was 1.65%, about mid-range of the reported figures in the literature [16,19,20]. Although we found that several variables — duration of second stage of labor, peripartum sonographic fetal weight estimation and neonatal birth length — were positively correlated with neonatal clavicular fracture, and maternal height was inversely correlated with neonatal clavicular fracture, all these values were still within normal range. In addition, statistical analysis proved that despite their significance, the application of these criteria for the prenatal identification of mothers predisposed to a delivery complicated by clavicular fracture is impractical owing to the high false-positive rate, which indeed, approached the prevalence rate of clavicular fracture in the general population.

How can a relationship be statistically significant but the diagnostic value so weak? Statistical significance depends on two factors: strength of the relationship between the outcome and the explanatory variables, and sample size; diagnostic ability depends only on the strength of the relationship. The relationship in this study was not sufficiently strong to yield a sharp discrimination between the two groups of mothers, as shown by the considerable overlap in the predicted values from the logistic regression equation. However, coupled with sample size, it was strong enough to enable us to conclude beyond a reasonable doubt (i.e. with a low $P$-value) that the explanatory variables are related to the outcome.

Thus, our results bridge the earlier studies showing associations between clavicular fracture...
in the newborn and different risk factors [4–13] and the newer ones which failed to pinpoint any risk factors [1–3,14] and which emphasized the elusive nature of this obstetrical complication. As our statistical conclusion that neonatal clavicular fracture cannot be predicted antenatally is independent of the sample size, we must accept that the fractured clavicle of the newborn is most probably unpredictable and unavoidable.

Additional findings in our study were the absence of sex predominance among affected neonates and the elimination of traumatic delivery, Apgar score, need for postpartum resuscitation or for instrumental delivery as important variables. Our data also did not support the reported relationship between clavicular fracture and shoulder dystocia [5]. Finally, despite the relatively high proportion of diabetic mothers in both groups — because our department serves as a referral center for diabetic pregnancies — we detected no association between gestational diabetes and macrosomia, which may lead to shoulder dystocia [21], and clavicular fracture. The rate of neurologic sequelae such as Erb’s/brachial palsy in the neonates with fractured clavicles was only 4%, less than the reported 7–13%, and all the affected newborns were found to be healthy at 1-year follow-up. No other neonatal or maternal problems (meconium, episiotomy, and perinatal morbidity) were noted. Therefore it seems that clavicular fracture is a transient event that normally leaves no sequelae.

Finally, our findings preclude the human factor in neonatal clavicular fracture, not mentioned in earlier works, as all our deliveries were managed by expert obstetricians.

In conclusion, the majority of clavicular fractures in our series were noted in normal newborns following normal labor and delivery. The three antenatal risk factors identified statistically do not offer a practical method for clinical prenatal prediction because of high false-positive rate, due to the low prevalence of this complication in the obstetrical population. Yet, it seems justified to determine the two statistically significant antenatal variables (i.e. peripartum sonographic fetal weight estimation and the duration of the second stage of delivery) in women of short stature in the context of a trial to prevent clavicular fracture of the newborn. This work offers statistical evidence of the ‘stealthy’ nature of fractured clavicle in the neonate, as proposed in several recent studies.

References


