Correlation of birth injuries with maternal height and birthweight

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Abstract

Background Infant or maternal injury during vaginal delivery is a constant threat to all involved, but difficult to predict.

Objective To estimate the risk of birth injuries in an institution favouring trial of vaginal birth when there was doubt of the best mode of delivery.

Design A retrospective cohort study.

Setting University Hospital.

Population Singleton 14,359 vaginal deliveries in cephalic presentation during 5½ years.

Methods The total caesarean section rate during this period was 9%. The likelihood of injury was evaluated by logistic regression analysis with injury as the dependent variable and maternal height and child birthweight as explanatory variables in birth injury risk estimation.

Main outcome measures Infant injury defined as one of the following: shoulder dystocia, clavicle fracture or brachial plexus injury; and maternal injury as anal sphincter rupture (ASR).

Results There were a total of 318 infant injuries in 282 infants and 423 ASRs. A strong correlation was found between injury and both fetal macrosomia and short maternal stature, but macrosomia was a stronger indicator of injury. Birth injury risk estimation curves were constructed based on maternal height and birthweight.

Conclusions The present results confirm a strong correlation between fetal macrosomia and short maternal stature and the likelihood of injury during vaginal birth. Risk estimation curves were constructed that might be of great value for the obstetrician in choosing the mode of delivery in these cases.

Introduction

The macrosomic fetus is at increased risk of traumatic injuries at birth.[1,2] The main complications such as shoulder dystocia, clavicular fracture and brachial plexus injury in the infant and anal sphincter rupture (ASR) in the mother are significant birth injuries. Predicting and preventing these complications is difficult. However, if macrosomia can be diagnosed antenatally, it might be possible to reduce these complications.

The obstetrician managing a pregnancy with expected fetal macrosomia tries to estimate the risk of injuries during vaginal birth. The primary factors in the evaluation of risk are maternal height and fetal size estimated by palpation and by ultrasound. There are also a number of other factors that can further influence the risk of injury such as previous vaginal birth and the need for induction of labour. Apart from the information on maternal height and fetal size, the evaluation by the obstetrician during the consultation is a subjective evaluation based on clinical experience. This might explain the great variation in caesarean section rates between institutions. Presently, no risk-scoring system is available. However, such an instrument would improve risk assessment for vaginal delivery, both for the obstetrician and for the parents.

The aim of the present study was to analyse the relationship between birth injury and maternal height and infant birthweight. Furthermore, we aimed to construct risk estimation curves that could be used in the clinical setting.

Methods

The material consists of a total cohort of all infants born at the University Hospital in Malmö, Sweden, during 5.5 years from 1990 to 1996. During this period, a trial of vaginal labour was recommended when there was a doubt as to which mode of delivery was the best. The average caesarean section rate at the institution during this period was 9%. In this retrospective analysis, the perinatal database at the clinic was used as a source. Ultrasound examinations are routinely performed at the clinic at 18, 32 and 42 weeks of gestation. The aim of the two latter examinations is mainly to identify fetal growth discordancy.

During the study period, 17,885 infants were born. Of these, 17,390 were singletons and 495 were products of multiple births. Of the singleton deliveries, 16,743 (96.3%) were in cephalic presentation, 607 (3.5%) in breech position and 40 (0.2%) in a transverse presentation. Of the cephalic presentations, 15,594 (93.1%) were delivered vaginally and 1149 (6.7%) by caesarean section. Corresponding figures for breech presentations were 285 (47.0%) and 322 (53%), respectively. Of the cephalic presentations delivered vaginally, information on maternal height was available on 14,359 women from the Central Maternity Registry in Stockholm.

Only singleton pregnancies with a fetus presenting cephalic, resulting in a live birth, were analysed. Vaginally delivered intrauterine deaths (n= 50) were excluded during analysis, none of these was an intrapartum death. Diabetic pregnancies were included in the analysis. Maternal height was available in 14,359 cases and newborn birthweight was noted in all cases (n= 15,594). The pregnancies were divided into eight groups depending on maternal height (in centimeters): (1) <150, (2) 150–154, (3) 155–159, (4) 160–164, (5) 165–169, (6) 170–174, (7) 175–179 and (8) >180. The pregnancies were also divided into seven groups based on newborn birthweight (in grams): (1) <2500, (2) 2500–2999, (3) 3000–3499, (4) 3500–3999, (5) 4000–4499, (6) 4500–4999 and (7) $\geq$5000.

The outcome variables were infant injuries defined as shoulder dystocia, clavicular fracture, brachial plexus injury and maternal injuries, which were defined as ASRs both partial (third degree) and total (fourth degree). The diagnosis of shoulder dystocia was made if, after delivery of the fetal head, additional manoeuvres other than gentle downward traction and episiotomy were required. Diagnosis of a clavicular fracture or brachial plexus injury was made by the attending paediatrician in the postpartum ward or neonatal intensive care unit (NICU). The attending obstetrician made the diagnosis of ASR.

Fisher's exact test and χ^2 test were used for statistical analysis; $P< 0.05$ was regarded as significant. The Gauss statistical package, Aptech Systems, Maple Valley, Washington, USA, was used for logistic regression analysis and constructing risk estimation curves with varying cutoffs.

Results

In the entire sample of 14,359 infants, 282 suffered injuries: shoulder dystocia in 56, clavicular fracture in 211 and brachial plexus injury in 51, for a total of 318 infant injuries. In addition, 423 third- and fourth-degree perineal lacerations (partial or total ASRs) were recorded. The great majority of injuries were in cases of normal maternal height. Infant injuries increased with shorter maternal height but decreased again in the shortest groups due to elective caesarean section. The relationship between birthweight group and injury is illustrated in Fig. 1.

The best curve fit by logistic regression analysis was when birthweight (g) was divided by maternal height (in centimeters) using the following formula:

$$\frac{e^{\left(-11.437756 + \frac{\text{Birthweight}/100}{\text{Maternal height}/10} \times 3.277439\right)}}{1 + e^{\left(\frac{\text{Birthweight}/100}{\text{Maternal height}/10} \times 3.277439\right)}}$$

Figure 2 illustrates the risk of infant injury in percent in relationship to birthweight and maternal height. Figure 3 gives the same information after adding infant and maternal injury.

In the 56 deliveries with shoulder dystocia, there was no association with any other infant injury in 34 (60.7%) cases. In 7 (12.5%) and 19 (28.5%) of the deliveries, the infants had a fractured clavicle and a brachial plexus injury, respectively. Four infants (7.1%) had all three complications.

A fractured clavicle was the only complication in 196 (92.9%) of the 211 infants with this injury. Four cases with both clavicular fracture and brachial plexus injury occurred in deliveries with shoulder dystocia, while both these injuries were found in 11 (5.2%) deliveries without this complication. Of the 51 infants with brachial plexus injury, this was the only complication in 22 (43%) cases.

Eighteen (32%) of the newborns with shoulder dystocia were admitted to NICU. Comparable figures for clavicular fractures and brachial plexus injuries were 13 (6.2%) and 8 (15.7%), respectively. The general frequency of admissions to NICU during this period was 6%.

Epidural analgesia was used for pain relief in 12 (21.4%) of the cases of shoulder dystocia. Comparable figures for clavicular fractures and brachial plexus injuries were 24 (11.4%) and 6 (11.8%), respectively. The general epidural rate in relationship to vaginal delivery was 10.8% during this period.

The percentage of operative extractions including vacuum or forceps was 4.4% during this period. ASR occurred in 81 in relationship to an operative extraction (18.2%, OR 3.67, 95% CI 2.86–4.7). Furthermore, 124 extractions (17.1%) were performed in association with any one of the four complications (OR 3.53, 95% CI 2.87–4.34).

Third-degree lacerations occurred in 423 (2.9%) of the 14,359 vaginal cephalic deliveries. An episiotomy had been performed in 177 (41.8%). The average episiotomy rate in vaginal deliveries during this period was 21.1%. There were no ASRs in deliveries of infants weighing below 2500 g. The frequency rose with increasing infant birthweight to 8% of mothers giving birth to infants weighing 5000 g or more. However, the deliveries of the five largest infants were not complicated with these lacerations. Lacerations of the sphincter in combination with the rectum were found in

34 (0.23%) cases. There were no such lacerations among women delivering infants with birthweights below 2000 g or above 4499 g. Among the 282 deliveries with shoulder dystocia, clavicular fracture or brachial plexus injury, 18 perineal lacerations occurred (6.4%). Sixteen (5.7%) of these were third-degree lacerations and 2 (0.7%) fourth-degree lacerations.

Discussion

A highly significant relationship was found between newborn birthweight and maternal height and the frequency of complications. By logistic regression analysis based on actual birthweight and maternal height, a formula could be constructed for the likelihood of injury during vaginal delivery. The risk estimation curves (Figs. 2 and 3) based on maternal height and expected birthweight of the baby could greatly improve clinical prelabour evaluation of term pregnancy, where the mother is short and/or the fetus macrosomic.

Shoulder dystocia cannot be predicted accurately antepartum using routinely available clinical measurements. The risk of shoulder dystocia in cases of macrosomia is known to be highest in cases where a large fetus was unknown prior to delivery. [3] The odds ratio for birthweight >5000 g in the present material was 38 (95% CI 16.7–88). The occurrence of shoulder dystocia in fetal macrosomia is also related to prolonged pregnancy, prolonged second stage of labour and midcavity extractions [4,5]. Shoulder dystocia is also strongly related to diabetic pregnancies, [6] forceps delivery and vacuum extraction in macrosomic infants.

Shoulder dystocia is associated with brachial plexus injury. The difference between the Erb palsy occurring in the absence of shoulder dystocia and those occurring after shoulder dystocia has been evaluated.[7] Brachial plexus injury in spontaneous vaginal delivery without shoulder dystocia was more likely to occur in the posterior arm. These brachial plexus injuries may therefore be unrelated to manipulations performed at the time of delivery, occurring in the absence of shoulder dystocia and might be caused by forceful uncontrolled pushing. Brachial plexus injury in relationship to shoulder dystocia is characteristically in the anterior arm and probably related to traction of the head to deliver the anterior shoulder. According to the literature, brachial plexus paresis occurs in 0.019–0.25% of live births, of which 70–92% improve with conservative management. [8] The only option for those not improving is to undergo surgical procedures including neurolysis,

neurotisation, nerve grafting and combinations of these as well as secondary muscle/tendon transfers. [9]

Clavicular fractures usually heal without misalignment. Many of the cases of shoulder dystocia are also delivered without any future sequelae. The same appears true for the great majority of ASRs; however, long term sequelae like incontinence of flatus have been reported. [10] Although many of the complications in this survey heal without sequelae, efforts should be made to avoid them, as they can have lifelong physical and psychosocial consequences for the patient.

There is an urgent need for risk estimation curves for infant or maternal injury during labour. These estimates may increase anxiety in the parents-to-be who might, as a result, request an elective caesarean section. Instead of recommending vaginal birth, the new risk chart might then result in more work for the obstetrician, both in explaining the chart and the risk related to the alternative—the caesarean section. As a result, the caesarean section rate would increase in most instances, but the increase might differ between institutions due to local policies for indication for caesarean section. In our case, the frequency of delivery by caesarean section would increase by 2.55% if the indication for abdominal birth was set at estimated fetal weights of 4500 g and above. This would imply that six caesarean sections would have to be performed to prevent one injury. If the indication for abdominal delivery was set at 5000 g, the corresponding figure would be four caesarean sections to prevent one injury. Although the risk score will help the obstetrician in evaluating mode of delivery in the case of a macrosomic fetus and/or short maternal stature, the large majority of injuries occur in normal cases and therefore are hard to predict.

In the present study, only two variables related to infant or maternal injury were evaluated (i.e. maternal height and birthweight of the newborn). There are other factors that might be taken into consideration such as parity, maternal body mass index, operative delivery and induction of labour. Parity is difficult to include in the risk formula as it has varying implications such as being delivered by caesarean section during the first pregnancy. Infant injuries in the present study were

more related to multiparity, but maternal injuries to primiparity. Operative extractions are strongly related to both infant and maternal injuries. All these factors must therefore also be taken into account when counselling the parents.

The risk estimation curves in Figs 2 and 3 are constructed by actual birthweight and not expected birthweight. This is obviously a disadvantage as the present estimation of fetal weight either by manual palpation or ultrasound fetometry has acknowledged measurement errors. A more precise prediction curve based on fetal weight close to term with results blinded to the clinician deciding on the labour must await a prospective trial.

In conclusion, the present study describes the likelihood of injury during vaginal delivery in a cephalic presentation in an institution recommending vaginal delivery when in doubt about the optimal mode of delivery. The results show a strong relationship between maternal height and infant birthweight and the likelihood of injury. Risk estimations based on maternal height and birthweight were constructed and might prove to be of value for the obstetrician in planning mode of delivery after further prospective evaluation.

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Legends to figures

Figure 1 The percent of shoulder dystocia, clavicle fracture, brachial plexus injury, and anal sphincter rupture in relationship to birthweight.

Figure 2 The risk of child injury in percent in relationship to maternal height and birthweight.

Figure 3 The risk of child and maternal injury in percent in relationship to maternal height and birthweight.

References

1. Spellacy WN, Miller S, Winegar A, Peterson PQ. Macrosomia - maternal characteristics and infant complications. Obstet Gynecol 1985;66(2):158-61.
2. Rydhstrom H, Ingemarsson I. The extremely large fetus - antenatal identification, risks, and proposed management. Acta Obstet Gynecol Scand 1989;68(1):59-63.
3. Gonen R, Bader D, Ajami M. Effects of a policy of elective cesarean delivery in cases of suspected fetal macrosomia on the incidence of brachial plexus injury and the rate of cesarean delivery. Am J Obstet Gynecol 2000;183(5):1296-300.
4. Baskett TF, Allen AC. Perinatal implications of shoulder dystocia. Obstet Gynecol 1995;86(1):14-7.
5. Turner MJ, Rasmussen MJ, Turner JE, Boylan PC, MacDonald D, Stronge JM. The influence of birth weight on labor in nulliparas. Obstet Gynecol 1990;76(2):159-63.
6. Langer O, Berkus MD, Huff RW, Samueloff A. Shoulder dystocia: should the fetus weighing greater than or equal to 4000 grams be delivered by cesarean section? Am J Obstet Gynecol 1991; 165(4 Pt 1):831-7.
7. Gherman RB, Ouzounian JG, Miller DA, Kwok L, Goodwin TM. Spontaneous vaginal delivery: a risk factor for Erb's palsy? Am J Obstet Gynecol 1998;178(3):423-7.
8. Sherburn EW, Kaplan SS, Kaufman BA, Noetzel MJ, Park TS. Outcome of surgically treated birth-related brachial plexus injuries in twenty cases. Pediatr Neurosurg 1997;27(1):19-27.
9. Berger AC, Hierner R, Becker MH. Early microsurgical revision of the brachial plexus in traumatic birth injuries. Patient selection and outcome. Orthopade 1997;26(8):710-8.
10. Haadem K, Gudmundsson S. Can women with intrapartum rupture of anal sphincter still suffer after-effects two decades later? Acta Obstet Gynecol Scand.1997; 76: 601-03.