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ORIGINAL PAPER

Perinatal features and rate of cesarean section in newborns with non-syndromic sagittal synostosis

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Abstract
Purpose The purpose of this study was to evaluate perinatal features and the rate of cesarean section in children with non-syndromic sagittal synostosis and to compare these with the official statistics.
Methods The birth data of 36 consecutive children (25 boys) operated on using cranial vault remodeling because of primary sagittal synostosis were analyzed retrospectively from hospital records. The children were born between 2007 and 2011, and the surgery was performed before the age of 1 year. The official statistics of all Finnish newborns from the year 2010 (n = 61 371) were used as a reference. Chi-square and Fisher's exact tests were used in statistical analyses.
Results The average gestational age of the newborns with sagittal synostosis was 39.8 weeks (reference 39.7 weeks). The average birth weight was 3565.8 g (3540 g) for boys and 3197.2 g (3427 g) for girls, and the average lengths at birth are 51 cm (50.4 cm) and 49.4 cm (49.6 cm), respectively. The average head circumference was 36 cm for both sexes (35.2 and 34.6 cm for reference boys and girls). The mean age of mothers was 30.5 years (30.1 years). The rate of cesarean section was significantly increased 30.5 % (reference 16.6 %), and the rate of suction cup delivery was increased 13.9 % (9 %). In addition, a prolonged or difficult delivery was reported in three childbirths.
Conclusion Newborns with non-syndromic sagittal synostosis appear to be of average birth size and gestational age. The incidences of perinatal complications and cesarean sections were increased with problems occurring in more than half of the childbirths.

Keywords Sagittal synostosis · Cesarean section · Gestational age · Birth size

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Introduction

Premature fusion of sagittal suture, scaphocephaly, is the most common type of non-syndromic isolated craniosynostosis, with an estimated prevalence between 1:2000 and 1:5000 live births [1]. Most of the cases are sporadic [1, 2], although in 6 % familial occurrence has been reported [1, 3]. Interestingly, sagittal synostosis is over three times (3.5:1) more common in boys than in girls [1].

The timing of sagittal suture fusion is variable; it can occur anytime from late first trimester to the early postnatal period [4]. The suture synostosis can begin anywhere along the interparietal junction, and once initiated, fusion extends anteriorly and posteriorly [4]. The characteristic sign of sagittal synostosis is abnormal head shape, with elongation of the cranial vault, prominent forehead and occiput, variable ridging of the sagittal suture, and increased head circumference. As a result, the cephalic index (CI, the ratio of biparietal to occipito-frontal diameters reported as a percentage) is generally decreased relative to children with a normal head.

Corrective surgery is preferably performed within the first year of life but can be performed later. The goal of surgical correction of sagittal craniosynostosis is to remodel the cranial vault to allow unimpeded brain growth and to avoid elevated intracranial pressure. Thompson et al. [5] reported borderline or elevated intracranial pressure, ≥10 mmHg, in six (24 %) of 25 patients with sagittal synostosis. Untreated progressive

sagittal craniosynostosis may also be associated with an increased risk of learning disabilities [6] and language impairment [7, 8].

Cranial sutures serve as the major sites of bone expansion during early postnatal craniofacial growth. During labor, they allow molding of the cranium. Children with premature craniosynostosis have been found to have an increased rate of perinatal complications [9]. These include a higher rate of fetal malpresentations at birth, a higher rate of secondary emergency cesarean deliveries, and lower pH values and Apgar scores than the control population [9]. In addition, an emergency cesarean section after labor lasting for 16 h has been reported [10].

The aim of this study was to evaluate perinatal characteristics and the rate of cesarean section in children with nonsyndromic sagittal synostosis and to compare these with the official statistics.

Material and methods

The birth data of 36 consecutive children (25 boys) operated on by cranial vault remodeling because of primary sagittal synostosis was analyzed retrospectively from hospital records. The children were born in several maternity hospitals between 2007 and 2011, and had been operated on in Helsinki University Central Hospital before the age of 1 year. Patients with syndromes were excluded. The birth data of the children with primary sagittal synostosis were compared with the official statistics of all Finnish newborns from all (n = 61,371) from the year 2010 [11]. A chi-square test and compare the rate of cesarean section and a Fisher's exact test to compare the rate of suction cup delivery in children with sagittal synostosis to the official statistics.

The research protocol was approved by Helsinki University Central Hospital. Principles outlined in the Declaration of Helsinki were followed.

Results

The gestational age and birth size of the newborns with sagittal synostosis were comparable with the official statistics (Table 1). One twin pregnancy and one preterm delivery (less than 37 weeks of gestation) were observed. Two boys were born with birth weights of more than 4000 g and one girl with a birth weight of less than 2500 g. The mean age of the mothers was average (30.5 years).

The rate of cesarean section was significantly higher (p = 0.001) in the group with sagittal synostosis (30 %) than in the reference group (16.6 %) whereas the difference in the rate of suction cup delivery between the group with sagittal synostosis (13.9 %) and the reference group (9 %) was not significant. In addition, a prolonged or difficult delivery was reported in three childbirths. One mother had a fourth-degree perineal tear during delivery.

Of the 36 children with sagittal synostosis, cesarean section was needed mostly for first children (5/12, 4 singleton and 1 twin pregnancy), also for second (5/19) and third children (1/3), but not for fifth (0/1) or seventh children (0/1).

Discussion

Although infants with primary sagittal synostosis were of average birth size and gestational age, they had high rates of cesarean sections. Perinatal complications were associated with more than half of the deliveries. However, it must be kept in mind that this material is small.

Only a few previous studies have dealt with newborns with sagittal synostosis or birth complications in connection with premature craniosynostosis. An American study including 670 infants with craniosynostosis and 5928 controls found that sagittal (n = 357) and metopic synostosis (n = 116) were associated with preterm delivery [12]. On the other hand, an Austrian survey with 102 infants with different types of isolated craniosynostosis and 57,317 controls showed that the birth weight and duration of pregnancy (39.09 weeks) of infants with craniosynostosis were average [9], but the rate of secondary cesarean delivery (including emergency procedures) was 17 % higher in the craniosynostosis group than in the control group. In addition, only 29.5 % of the vaginal births were spontaneous vaginal deliveries, and the rates of induction of labor preceding delivery were high (38.5 versus 13.1 % in the control group) [9].

In general, abnormal labor (dystocia) is the result of problems with one of the 3 P's: Passenger (infant size, fetal presentation), Pelvis or passage (size, shape, and adequacy of the pelvis), and Power (uterine contractility). During spontaneous vaginal delivery, the two widest points of the fetus, the head and the shoulders, need to pass through the birth canal. In a longitudinal lie and cephalic presentation, the head enters the pelvis in the right or left occipito-transverse position. Uterine contractions cause the head of the fetus to flex (chin towards chest), allowing the minimum head diameter to be presented during delivery. In newborns with premature sagittal synostosis, the longitudinal head shape with an increased head circumference or a variation of the flexed posture may present a progressively larger fetal head to the bony pelvis for labor and delivery. According to Weber et al. [9], one third of children diagnosed with premature scaphocephaly (n = 50) had fetal malpresentations. These included abnormal cephalic presentation (20 %), breech presentation (12 %), and transverse position (2 %).

A limitation of our study is that no detailed information was available about the maternal or fetal reasons for cesarean

Table 1 Perinatal features and rates of cesarean section and suction cup deliveries in newborns with non-syndromic sagittal synostosis and in controls

	Sagittal synostosis $n = 36$	Range	Controls $n = 61{,}371$
Mean age of mothers (years)	30.5	20.4–41.5	30.1
Gestational age (weeks)	39.8	35–42.7	39.7
Plurality (%)			
Singleton	97 (35/36)		97
Twin or higher order	3 (1/36)		3
Birth weight (g)			
Boys	3565.8	2800–4260	3540
Girls	3197.2	2375–3960	3427
Birth length (cm)			
Boys	51	47–54	50.4
Girls	49.4	47–52	49.6
Head circumference (cm)			
Boys	36	31–38	35.2
Girls	36	32.5–39	34.6
Cesarean section (%)	30.5 (11/36)		16.6
Suction cup (%)	13.9 (5/36)		9

sections, prolonged or difficult deliveries, and previous pregnancies. Cesarean sections carry a higher risk of maternal complications than vaginal deliveries and should be performed only when the operation offers a clear benefit to either the mother or the neonate [13, 14]. The ideal rate of cesarean section in a high-resource country is contentious. The World Health Organization consensus conference [15] agreed that the rate of cesarean sections should not exceed 10–15 %. The rate of cesarean section in Finland has remained between 15.8 and 16.7 % since 1995 [16]. In Finland, the maternal and perinatal mortality rates are among the lowest in the world. Maternity services are free, and deliveries take place at municipal or tertiary level referral hospitals with highly standardized care.

Early detection of craniosynostosis may decrease complications during delivery and facilitate postnatal management. The premature closure of sagittal suture is characterized by a disproportionately large occipito-frontal and short biparietal diameter [17]. The prenatal ultrasound diagnosis of craniosynostosis in utero may be difficult and may be suspected when the cephalic index, the cranial shape, or the fetal face shape are abnormal [17]. Reports on prenatal ultrasound diagnosis of fetal sagittal synostosis are controversial [9, 10, 18, 19]. Weber et al. [9] reported prenatal suspicious sonographic findings only in 10.8 % of the 220 children with craniosynostosis. The antenatal detection was usually based on the abnormal shape of the fetal skull in ultrasound screening during the third trimester between 28 and 32 weeks of gestation. The rate of cesarean section in infants with prenatally diagnosed craniosynostosis was high (45.5 %) relative to those with postnatally diagnosed craniosynostosis (22.6 %) [9]. On the other hand, there were no major complications in the cesarean deliveries of prenatally diagnosed infants whereas vaginal deliveries were associated with several perinatal complications, such as cephalhematomas (16.7 %), dystocia (16.7 %), and perinatal ruptures (33.3 %) [9].

The longitudinal head shape of the newborn is sometimes explained to be a result of the molding of the head during prolonged delivery. Instead in newborns with sagittal synostosis, the longitudinal shape of the head may be the cause of the prolonged delivery. If sagittal synostosis is suspected in the routine prenatal ultrasound, another ultrasound screening with high-technology equipment during the third trimester of pregnancy could be considered.

Although newborns with non-syndromic sagittal synostosis of this study were of average birth size and gestational age, problems occurred in more than half of the childbirths. The incidences of perinatal complications and rates of cesarean sections were increased.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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