CASE REPORT

Non-traumatic depressed skull fracture in a neonate or 'ping pong' fracture

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SUMMARY

This is a case study describing the finding of a depressed skull fracture in a neonate who was delivered without instrumentation and with no history of trauma. Depressed skull fractures are described as being associated with forceps delivery both vaginally and with caesarean section but are much rarer without instrumentation. This obvious abnormality was very concerning for the parents as it was not picked up on antenatal scans and there was no clear cause. There were both cosmetic and neurological concerns and we found no clear consensus on appropriate treatment and prognosis in the literature we had available.

BACKGROUND

The finding of a depressed skull fracture in a neonate is a rare occurrence estimated at between 4 and 10 in every 100 000 live births in western countries. These can be grouped into spontaneous occurrences or more commonly those associated with instrumental deliveries. There is a wide range of possible causes for spontaneous depressed skull fractures and these have a very good prognosis. Both surgical and non-surgical treatments are available and should be guided by the severity of the fracture and any underlying intracerebral injury. Full resolution has been shown with conservative treatment in selected cases and is the recommended first line of management where possible.

CASE PRESENTATION

The female patient was born to a 28-year-old Caucasian Australian. The mother's medical history included gastric reflux, polycystic ovary syndrome and has a body mass index of 37. Parents were non-consanguineous. Mother was a G1P0, group 0 rhesus positive, rubella immune, serology negative, non-smoker with no history of alcohol or drug use. There is no significant family history of note.

The pregnancy was conceived using in vitro fertilisation. The mother developed pregnancy-induced hypertension which evolved into pre-eclampsia by the end of pregnancy for which she was treated with labetolol 200 mg three times a day. During her antenatal course, she had a period of vomiting and a urinary tract infection which was treated with oral antibiotics. The mother had five ultrasounds throughout pregnancy all with normal morphology and biophysical profiles. The estimated fetal weight at 32 weeks was 2099 g. Ten days before delivery, the mother tripped while walking landing heavily on both knees. There was no change in fetal movements or vaginal bleeding and she needed no medical attention for the accident and only remembered the event when being questioned following delivery.

She attended hospital at 38+4 for induction of her labour. The first day she received intravaginal dinoprostone which failed to induce labour, so on the second day she received balloon dilation which also failed, so on the third day, at 38+6, she was given syntocin and had her membranes artificially ruptured. She progressed as normal, until there was a fetal bradycardia and a scalp lactate of 2.9. She was taken to theatre for an emergency caesarean section. The new born had a careful, uneventful delivery with no extraction instruments utilised. At birth, the patient cried, but required suctioning and CPAP for 25 min. APGAR scores were 6^{1}, 7^{5} and 9^{10}. Birth weight was 3.24 kg (25–50th centile), length 47.5 cm (25th centile) and head circumference 33.5 cm (3rd–10th centile).

At birth, she was noted to have a depression in the right temporoparietal region, posterior to the coronal suture, approximately 3 cm, by 3 cm with 2 cm depth (figures 1 and 2). There was a hard base suggesting the presence of bone. Otherwise, her skull was normally shaped and proportioned with patent fontanelles and regular sutures. There was no softening of the skull and skeletal survey was normal except for clicking of the right hip. There were no dysmorphic features and the eyes,

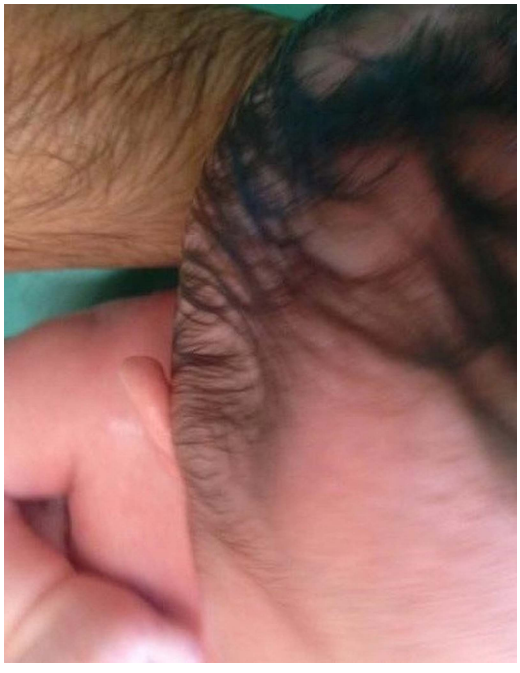

Figure 1 Inferior view of cranial indentation.

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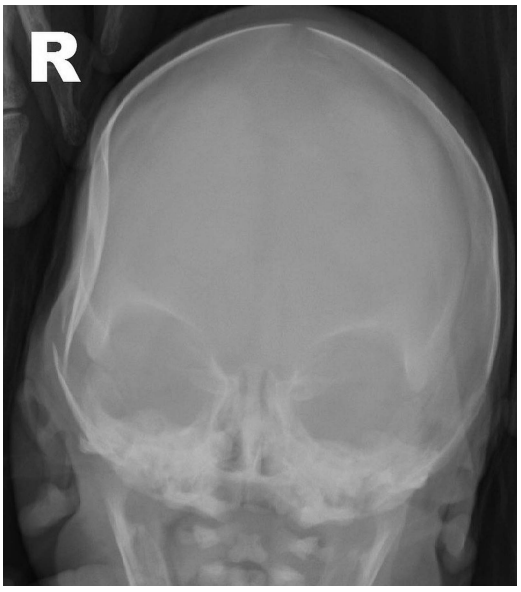

Figure 2 X-Ray of patient skull showing right temporoparietal region indentation.

neurology, respiratory, abdominal and skin examination were normal. Her observations, blood sugar and oral feeding were normal.

INVESTIGATIONS

Neonatal depressed skull fractures can be identified clinically at delivery by an abnormal concavity or moulding of the skull. Plain radiographs of the skull can demonstrate the degree of deformation and cranial ultrasound can be used to identify intracerebral bleeds and haematomas.[1] Using CT scanning to detect fractures and haematomas is more sensitive and reduces the likelihood of misinterpreting suture lines and vascular markings as fractures but has the disadvantage of higher doses of ionising radiation and the need for sedation to avoid movement artefact.[2] The radiation dose from plain skull X-rays is 0.3–2.0 mGy compared with the much higher dose of 40–130 mGy delivered by CT.[2]

The patient had an anterior-posterior X-ray which showed a depression in the right temporoparietal region with associated diastasis of the squamosal suture and no region with an absence of skull. The skull bones were otherwise of normal size, shape and appearance. Her cranial ultrasound scan demonstrated no underlying haematoma, midline shift or bleed. Follow-up radiographs at 3 and 6 months of age showed remodelling with no increase in size of the depressed section of the temporoparietal region (figure 3).

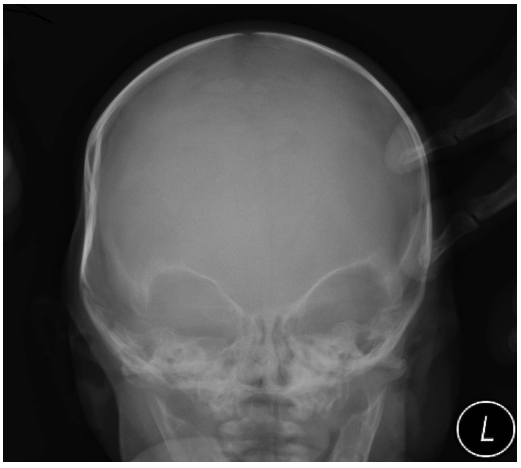

Figure 3 Follow up X-Ray of patient skull showing improved skull remodelling.

DIFFERENTIAL DIAGNOSIS

Aetiology

Congenital skull fractures of all types are a rare occurrence in western countries and in most cases they are caused by trauma from delivery and most commonly due to instrumental delivery or pressure from the delivering doctor or midwife's hands during obstetric manoeuvres in a difficult delivery.[3] Associated intracranial injuries rarely occur but can lead to lifelong neurological problems if not detected and treated early.[1] A study of 34 946 live deliveries by Bhat *et al*[4] found 35 cases of neonatal fractures of all types at an incidence of 1 in 1000 and depressed skull fractures accounted for 4 of these.

An article by Dupuis *et al*[5] describes a retrospective case–control analysis in France and compared spontaneous and instrumental obstetric depressed skull fractures over a 10-year period. They found 75 cases of depressed skull fracture from 1 994 250 deliveries giving an incidence of approximately 1 in every 26 000 deliveries. Of the 68 cases, they analysed 18 were spontaneous and 50 were instrumental deliveries. Of the spontaneous group, 8 were delivered vaginally and 10 by caesarean section and of the 50 instrumental deliveries 34 were vaginal deliveries. Ben-Ari *et al*[6] found 3 cases in 8 years of congenital skull depression from 29 137 births or an incidence of 0.01% or 1 in 10 000 births. Of the three cases, they found only one was instrument related.

A depression of the skull cortex without maternal or obstetric trauma is very rare.[7] During vaginal delivery, the contracting forces of the uterus must overcome the resistive forces of the birth canal.[2] During this time, the fetal head is compressed by the mother's bony pelvis resulting in moulding of the cranium[2] and may lead to depression of the parietal or frontal bones of the skull.[3] A prolonged amount of pressure applied to a focal area of the skull in utero or during delivery may result in a localised depression or cause buckling and discontinuity of the cerebral cortex.[6] Pressure from the fifth lumbar vertebrae, ischial spines, sacral promontory and symphysis pubis or from an asymmetrical pelvis, uterine fibroid, the fetal hands or part of a twin are possible causes of depressed skull fractures in the absence of instrumental deliveries.[3 8] Other risk factors include external trauma to the mother's abdomen, multiple gestations, Ehlers-Danlos syndrome and congenital disorders of osteogenesis.[9]

One article has classified the finding of a depression of the neonatal skull into two main types being either a depression without a fracture or a depression with a fracture with plain film radiographs distinguishing between the two.[6] The difference between these types is whether the cause is related to trauma or a direct pressure effect of an external structure on the developing skull. The latter case has also been described as 'faulty fetal packing' or congenital vault depression.[8] Some authors compare skull depressions to a 'greenstick' fracture found in the long bones of children being that a traumatic event has left no discontinuity of the cortex.[6]

Another author describes three types of skull fractures in newborns being linear, depressed or 'ping pong' and occipital osteodiastasis.[3] A ping pong fracture is a type of depressed skull fracture that can occur in neonates and the very young due to the relatively soft and malleable nature of the newborn skull.[10] As a result of immature ossification, increased pressure on a

neonatal skull can cause the calvarial bones to buckle inwards resembling on radiographs an indentation commonly found in ping pong balls. This has led to these types of injuries being labelled as ping pong fractures or pond fractures.[11 12] The parietal bones are most commonly affected site followed by the frontal bones and very rarely in the occipital region.[3]

TREATMENT

A traumatic injury to the skull and brain in utero is an uncommon event and rarely results in permanent disability.[1] However, the choice of treatment used has been controversial and there are no clear guidelines as to when surgical intervention is warranted in cases where there is no evidence of cerebral injury.[11] Traditionally depressed skull fractures in neonates have been managed surgically but recently there has been good evidence of spontaneous elevation and good outcomes from non-surgical management. There are however no definite predictors to illicit which fractures will elevate spontaneously and which will not. Parental anxiety is common and cosmetic concerns may influence management.[11]

It has been demonstrated in adults that a section of depressed bone greater than 1 cm has a higher risk of dural and cortical laceration; however, a critical measurement in children and, in particular, neonates is not known.[11] In theory, a 5 mm depression of the neonatal skull could impinge on the cerebral cortex and cause a focal area of decreased blood flow leading to tissue hypoperfusion and cerebral oedema.[6] Owing to the malleable state of the neonatal skull, it is able to buckle under pressure but less compliant intracranial structures such as the major vessels and dural attachments may become torn or ruptured causing cerebral injury[5] which could cause an epileptic focus.[13]

There are many treatment types described in the literature and the choice is usually based on the severity of the fracture, underlying brain injury, clinical examination, imaging findings and the use of instruments during delivery.[14] Treatment types include watchful waiting, non-surgical reductions using suction from a vacuum extractor or breast pump, digital pressure on the edges of the depression and surgical treatment using standard methods of depressed skull fracture management.[11] Zalatimo *et al* describe the treatment of four patients between the ages of 2 days and 4 months who underwent surgical treatment of their skull fracture using a 4 or 5 mm microscrew typically used in neurosurgery for cranial plating to elevate the depressed segment of bone. Two of the patients were treated under general anaesthesia and two with local anaesthesia only. All patients had good cosmetic results and experienced no adverse events.

Dupuis *et al* found that the prognosis of a neonatal depressed skull fractures was always good in spontaneous cases and that the long-term neurological sequelae following instrumental-associated injuries could be severe but were very rare and only occurred in 4% of cases. Steinbok *et al*[15] reported that there was no difference in outcome between children with depressed fractures that were treated surgically and non-surgical with regard to seizures, neurological dysfunction or cosmetic appearance. A number of published cases have demonstrated spontaneous resolution of the depression within 4 months without any cosmetic or neurodevelopmental sequelae and recommend conservative management in cases without intracranial injury.[7 8 15 16]

OUTCOME AND FOLLOW-UP

The patient was transferred to a neonatal unit for consultation with the tertiary centre and following review a conservative management plan was finalised and the baby was transferred back to the peripheral hospital. In consultation with a paediatric radiologist, the diagnosis was concluded to be a depressed skull fracture of the 'ping pong' type.

The patient was discharged the following day and reviewed by a paediatrician after 3 and 6 months. She was developing normally and her parents had no concerns over her growth or behaviour. The indentation was still palpable but not as marked as when born and well covered by hair. Follow-up radiographs demonstrated a reduction in size of the depression with bony remodelling and otherwise normal skull growth and development.

DISCUSSION

A neonate born with a congenital depression of the skull is encountered rarely and there is no clear definition or agreement on the pathogenesis or significance of this finding, so it is of no surprise that there is no clear understanding of how to name this finding.

Skull fractures in neonates either depressed or linear are categorised in the literature as being either 'spontaneous' where no cause can be found for the abnormality or 'instrumental' following delivery using obstetric instruments such as forceps or vacuum extractors.[5] No distinction is made between affected neonates born by vaginal delivery or caesarean section with the use of instruments being the discriminating factor in the naming of these occurrences. Any depressed skull fracture diagnosed after delivery can be classified as an obstetric depressed skull fracture.[5]

The literature is not clear as to the naming of these neonatal skull depressions and the authors believe that a case with non-instrumental delivery and no history of trauma be called either faulty fetal packing or an idiopathic skull fracture with the latter used if there is radiographic evidence of a breach in the cortex. A case where there is documented trauma such as a forceps or difficult delivery would be best described as a traumatic skull fracture of delivery. The authors would welcome any further comments or experiences on neonates with this type of abnormality, the naming of such occurrences and the treatment that was implemented.

Learning points

- A neonatal depressed skull fracture is a rare occurrence with causes associated with either birth trauma or while in utero.
- Both conservative and surgical interventions have been described with watchful waiting found to be appropriate in cases with no clear traumatic cause.
- Prognosis for non-traumatic cases is excellent with very few cases of neurological abnormalities reported.

Competing interests None.

Patient consent Obtained.

Provenance and peer review Not commissioned; externally peer reviewed.

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