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CASE REPORT

Intrauterine head stab wound injury resulting in a growing skull fracture: a case report and literature review

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Abstract
Introduction Penetrating injuries of the gravid uterus are rare complications of pregnancy with gunshot wounds most common than stab wounds. Fetal head injury is an unusual sequela of these penetrating traumas.
Materials and methods We describe the case of a 20-year-old pregnant woman stabbed at the lower abdomen at 30th weeks of gestation. She was nonsurgically managed by serial examination and continuous fetal monitoring.
Results Spontaneous vaginal delivery occurred at term with good maternal and fetal outcome. The newborn examination revealed a right temporal swelling interpreted as a subcutaneus hemangioma. At 2 years and 6 months of life, the child was led to our attention with a pulsating bulge in the right temporal region. Clinical examination and imaging were indicative of a typical growing skull fracture. The child underwent neurosurgical procedure for repairing of the dural tear and bone defect according to the senior author's personal technique, described in details, with a good neurological and esthetic outcome.
Conclusion Thirty-two cases of stab wounds to the pregnant uterus have been reported to date in medical literature with two cases of fetal head injury.Growing skull fractures are rare complications of head injury and only one case has been described in the perinatal period following blunt trauma to the mother's abdomen 2–3 weeks before birth.

Keywords Growing skull fracture · In utero · Penetrating head injury · Stab wound

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Introduction

Penetrating abdominal trauma is an uncommon complication during pregnancy, with gunshot wounds much more common than stab wound [1]. Although it is rare for a maternal death to occur from uterine injury since the uterus is not a vital organ and may be, after the first trimester, protective of other abdominal contents, the fetal death rate in both gunshot and stab injuries is appreciable: 71% and 42%, respectively [2, 3]. Intrauterine penetrating fetal head injury following gunshot wound has been reported and the outcome is usually lethal, depending upon the severity of the intracranial insult and the gestational period of the mother [4–8]. The fetus, if it survives, is at high risk of developing encephalopathy, cerebral palsy, and long term cognitive and developmental delay [9]. At our best knowledge, intrauterine penetrating direct fetal head trauma due to stab wounds has been described in literature two times only [10, 11].

We present here a case of fetal head-penetrating injury following a stab wound to the mother's abdomen during the 30th week of gestation resulting in a growing skull fracture. A complete review of the medical literature regarding stab wounds to the pregnant uterus has been done.

Case history

A 2.5-year-old child, adopted from Colombia, with a previous, referred, diagnosis of subcutaneous hemangioma, was led to our attention by pediatricians. He presented with a pulsating bulge in the right temporal region. Neurological examination disclosed, in addition, a mild left hemiparesis. A computed tomographic (CT) scan, including bone windows and 3D reconstruction, revealed a large right temporal bone defect (Figs. 1 and 2). Magnetic resonance

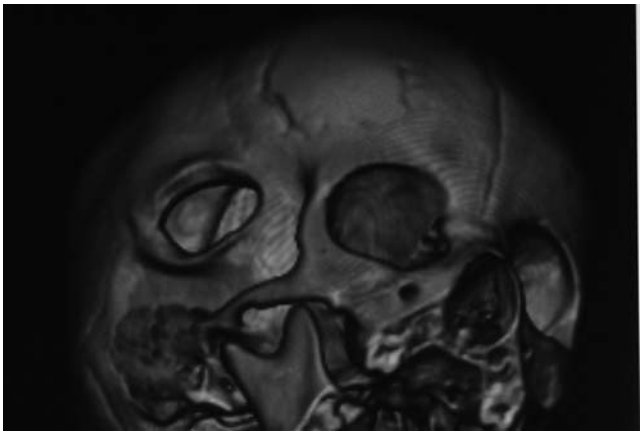

Fig. 1 A 3D CT scan that reveals a large right temporal bone defect

imaging (MRI) showed herniation of the cicatricial cerebral tissue through the skull defect and a mild "blow out" of the homolateral temporal ventricular horn (Figs. 3, 4 and 5). Neuropsichological evaluation and EEG were within normal limits.

As clinical examination and imaging were indicative of a typical growing skull fracture (GSF) and no history of head trauma was known to the adoptive parents, we asked the Colombian institution, where the child was born, more information about pregnancy and birth.

According to the Colombian institution's medical records, pregnancy was complicated, during the 30th week of gestation, by a knife stab wound in the lower abdomen, that the mother, a 20-year-old woman, received from her partner with the intention to harm the unborn child.

The woman was managed nonsurgically by serial examinations and continuous fetal monitoring. Spontaneous

Fig. 2 CT scan (bone's window) showing a large right temporal bone defect

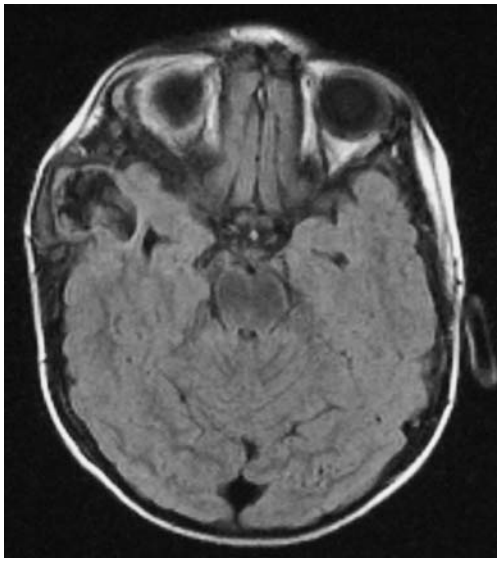

Fig. 3 MRI showing herniation of the cicatricial cerebral tissue through the skull defect and a mild "blow out" of the homolateral temporal ventricular horn

vaginal delivery occurred at 40th week of gestation, with good maternal and fetal outcome.

The newborn examination revealed a right temporal swelling that was interpreted as a subcutaneous hemangioma. This diagnosis was confirmed when the child was adopted in Italy.

At our institution, the child underwent neurosurgical procedure for repairing of the dural tear and bone defect. In the operating room, while positioning the patient, a very thin scar was noted on the bulging skin on the right temporal region (Figs. 6 and 7).

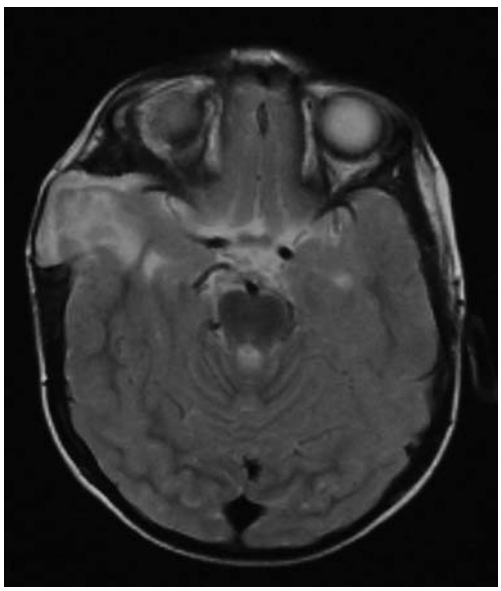

Fig. 4 MRI showing herniation of the cicatricial cerebral tissue through the skull defect and a mild "blow out" of the homolateral temporal ventricular horn

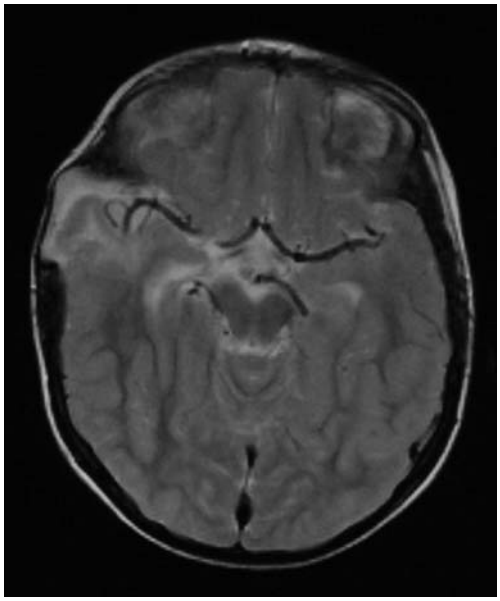

Fig. 5 MRI showing herniation of the cicatricial cerebral tissue through the skull defect and a mild "blow out" of the homolateral temporal ventricular horn

Skin incision was designed to allow for complete access to the edges of the dura mater that, as they usually happens, were retracted for some distance back from the bone edges that were involved with intense and white cerebro-meningeal scarring (Fig. 8). After a careful dissection of these adhesions, bone was removed piecemeal from the edges of the cranial defect until the dural edge was identified. Hence, we made a watertight duroplasty with deproteinized equine pericardium affixing fibrin glue on dural boundaries (Fig. 9). Cranioplasty was finally performed using hydroxyapatite granules mixed with autologous blood between two meshs of absorbable material, in a sandwich fashion (Figs. 10 and 11). Follow-up skull X-rays 1 year after surgery showed a good regrowth of the skull to fill the bony defect (Fig. 12). Neurological examination was within limits.

Fig. 7 The bulging on the skin in the right temporal region

Discussion

The incidence of trauma occurring during pregnancy has been reported to be about 6% to 7% and increasing [12, 13]. Most pregnancy injuries are due to blunt trauma as the result of motor vehicle accidents, accidental falls, and violence. In this case, the most common cause of fetal death is maternal death [14] although direct injury to the fetus in the absence of uterine injury has been reported [15]. The occurrence of fetal skull's fracture following blunt trauma to the mother's abdomen is the most common fracture encountered [12, 16] and is well described in the literature, starting from the end of the 19th century [17–19].

Alexander and Davis in 1969 provided an exhaustive review of older and recent reports on intrauterine depression fractures of the skull in infants [20]. When the position of the fetal head was documented, they found that the depressed fracture occurred as the result of the contact of

Fig. 6 A very thin scar was noted on the skin in the right temporal region

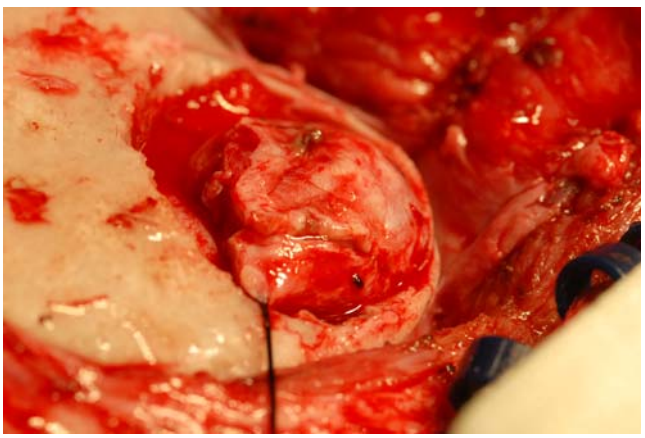

Fig. 8 The edges of the dura mater, as they usually happens, were retracted for some distance back from the bone edges that were involved with intense and white cerebro-meningeal scarring

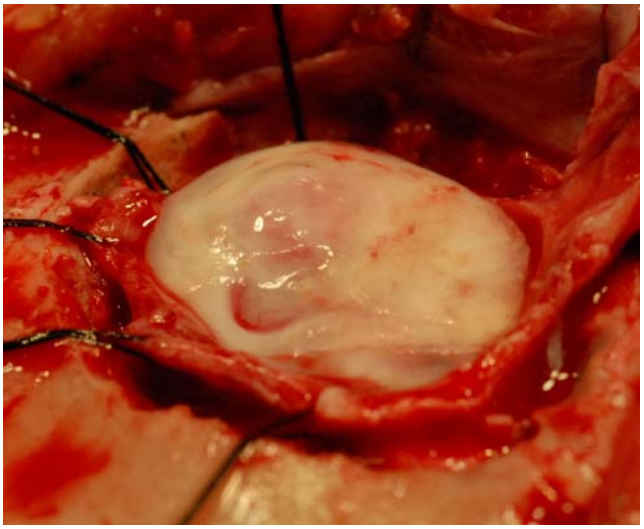

Fig. 9 Identification of the dural edges after a careful dissection of the adhesions and piecemeal removal of the bone. After that, a watertight duroplasty with deproteinized equine pericardium affixing fibrin glue on dural boundaries was made

the skull against the promontory of the sacrum in all except one of the cases reported in their series, as previously supposed by others [17–19].

Less frequent than blunt trauma, penetrating wounds of the abdomen during pregnancy are usually manifestations of gunshot and stab wounds. Other causes are extremely rare. They have higher risk of injury both to the maternal viscera and the fetus [21]. Bullet wounds are the most common type of penetrating injuries during pregnancy [3]. Stab wounds have a better maternal prognosis due to the absence of shock waves, the ability of visceral organs to slide away from the advancing knife blade, and the protective shield of the uterus.

The maternal death rate from gunshot wounds to the abdomen is reported to be two thirds less than in

Fig. 10 Cranioplasty is performed using hydroxyapatite granules mixed with autologous blood between two meshs of absorbable material, in a sandwich fashion

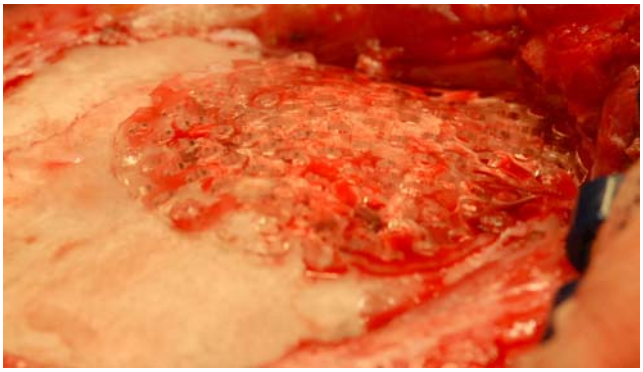

Fig. 11 Cranioplasty is performed using hydroxyapatite granules mixed with autologous blood between two meshs of absorbable material, in a sandwich fashion

nonpregnant victims (3.9% vs 12.5%). The death rate from abdominal stab wounds is also diminished by the so-called protective effects of the uterus.

A detailed review of the literature disclosed 32 cases of stab wounds of the uterus in pregnancy, 33 if we consider our case (Table 1). Guadagnini reported the first case of stab wound of the gravid uterus in 1930 [22]. Several authors reported isolated cases [2, 10, 11, 23–29]. The typical patient stabbed in pregnancy is between 18 and 28 years of age. She is usually in the early or late part of the third trimester (26 out of 30 cases). All of the patients who were stabbed in the abdomen had uterine wounds varying from 2 to 5 cm in length. The angle of penetration and the length of the knife have a direct correlation to the depth of the inflicted injury. A stab wound of the gravid uterus with proper intervention has a good prognosis for the mother (only one died, but she received about 25 knife injuries in her head, neck, thorax, and extremities in addition to the

Fig. 12 Follow-up skull X-rays 1 year after surgery showed a good regrowth of the skull to fill the bony defect

Table 1 Review of the literature regarding stab wounds to the uterus in pregnancy

No.	Author	Year	Age	Gestational age at injury	Weapon	Mode of delivery	Time to delivery	Fetal injury	Perinatal outcome	Maternal wound	Maternal outcome
1	Guadagnini	1930	N/A	34	Dagger	Spontaneous vaginal	Same day	Right calf	Stillborn 34 weeks	Abdomen and uterus	Survived
2	Badia and Charlton	1940	20	28	Knife	Spontaneous vaginal	9 weeks	None	Living term	Abdomen and uterus	Survived
3	Flamrich	1941	N/A	N/A	Knife	Cesarean	Immediate	Wound to scrotum	Living term	Abdomen and uterus	Survived
4	Steele	1941	N/A	N/A	Knife	Spontaneous vaginal	N/A	None	Living term	Abdomen, uterus, and bowel	Survived
5	Wright	1954	20	18	Knife	Spontaneous vaginal	19 weeks	None	Living term	Abdomen and uterus	Survived
6	Bolot	1957	27	Term	Knife	Spontaneous vaginal	N/A	None	Living term	Abdomen, uterus, left arm, bowel, and chest	Survived
7	Hammar	1960	25	32	Knife	Spontaneous vaginal	6 weeks	Right tight wound	Living term	Abdomen and uterus	Survived
8	Bochner	1961	21	29	Knife	Spontaneous vaginal	38 days	None	Stillborn	Left chest	Survived
9	Gropianov	1961	22	8 months	Shaving razor	Spontaneous vaginal	3 days	N/A	Neonatal death	Ten wounds of ileum and jejunium and uterus	Survived
10	Dyer and Barclay	1962	28	14 weeks	Knife	Hysterectomy	Immediate	N/A	Aborted	Abdomen, ileum perforated, and uterus	Survived
11	Dyer and Barclay	1962	28	40 weeks	Knife	Cesarean	Immediate	Partially severed cord	Stillborn	Abdomen and uterus	Survived
12	Moss et al.	1962	N/A	16 weeks	Knife	Spontaneous vaginal	N/A	N/A	Aborted	Abdomen, uterus, and hematometra	Survived
13	Quast and Jordan	1964	N/A	6 months	Knife	Spontaneous vaginal	3 months	None	Survived	Abdomen, and uterus	Survived
14	Gordon	1966	28	36 weeks	File blade	Cesarean	Immediate	Liver laceration and stomach perforation	Neonatal death on 3rd day	Abdomen, uterus, and left chest	Survived
15	Shaftan	1968	N/A	8 months	Knife	Spontaneous vaginal	N/A	None	Living term	Abdomen	Survived
16	Knapp and Drucker	1972	27	39 weeks	Knife	Cesarean	Immediate	Back and flank lacer	Survived	Abdomen, uterus, and liver laceration	Survived
17	McNabney and Smith	1973	23	N/A	N/A	Cesarean	Immediate	Live rand ileum contusions	Survived	Abdomen and uterus	Survived
18	Malinovsky	1974	24	37 weeks	Knife	Cesarean	Immediate	None	Survived	Abdomen and uterus. Sigmoid and mesentery	Survived
19	Amine	1976	24	8 months	Barbecue fork	Spontaneous vaginal	7 days	T6–T7 spine wounds	Survived	Abdomen and uterus	Survived
20	Golan et al.	1980	25	32 weeks	Knife	Spontaneous vaginal	3 days	None	Survived	Abdomen and uterus	Survived
21	Jacobson	1983	18	24	Knife	Cesarean	8 weeks	None	Survived	Abdomen and uterus	Survived
22	Jacobson	1983	25	38	Knife	Cesarean	Immediate	None	Survived	Chest, abdomen, and uterus	Survived
23	Degefu et al.	1986	20	38	Knife	Cesarean	Immediate	Both extreme	Stillborn	Abdomen and uterus	Survived
24	Sakala	1987	18	26 weeks	Knife	Cesarean	Immediate	Bowel evisceration and left tight wound	Stillborn	Abdomen and uterus	Survived
25	Raginia	1966	42	7 months	Knife	Spontaneous vaginal	5 days	Amniotic bag. Scapular region	Living term	Abdomen and uterus	Survived
26	Mukaramov and Mukaramova	1987	27	36	Knife	Spontaneous vaginal	Immediate	Lumbar region	Living term	Abdomen and uterus	Survived
27	Shapkin and Mel'nikov	1988	N/A	36-37	Knife	Cesarean	Immediate	Chest–pneumothorax 7 ml	Survived	Abdomen and uterus	Survived
28	Belousov and Romanova	1977	23	32	Knife	Cesarean	Immediate	Right lumbar region	Living term	Abdomen and uterus	Survived
29	Grubb	1991	26	30	Steak Knife	Spontaneous	Immediate	Left parietal bone	Living term	Abdomen, uterus, and	Survived

Table 1 (continued)

No.	Author	Year	Age	Gestational age at injury	Weapon	Mode of delivery	Time to delivery	Fetal injury	Perinatal outcome	Maternal wound	Maternal outcome
						vaginal				upper extremities	
30	Schultz et al.	1993	19	29	Knife	Cesarean	Immediate	Right parietal region	Living term	Abdomen and uterus	Survived
31	Fleming et al.	2001	29	32	N/A	Cesarean	Immediate	Radial nerve injury, lower leg, and left anterolateral chest	Living term	Abdomen, uterus, and multiple stab wounds	Survived
32	Yildirim et al.	2003	27	34	Knife	Post-mortem Cesarean	Immediate	None	Survived	Abdomen, head, neck, thorax, and extremities	Dead
33	This case	2008	20	30	Knife	Spontaneous vaginal	10 weeks	Right temporal region	Living term	Abdomen and uterus	Survived

abdomen) [29]. However the fetus suffers. Twenty-four out of the 33 fetus survived (72.7%). Seventeen out of 33 patients had vaginal delivery with 76.4% fetal survival [Table 1].

Only two fetus, excluding our case, suffered head injury following intrauterine knife stab [10, 11]. Grubb reports a case of a 26 year-old Hispanic woman, at 30 weeks of gestation in her first pregnancy, brought to the hospital with multiple stab wounds to the abdomen and upper extremities inflicted by her husband with a steak knife. On the admission, the patient was hemodynamically stable and the fetal heart rate was 140 beats/min. Obstetric ultrasonography revealed a single fetus in a breech presentation, with an estimated fetal weight of 1,928 gm, and no evidence of fetal injury. The fetal head was directly below one of the wounds. There was a normal amniotic fluid volume, and the placenta was anterior with no evidence of retroplacental blood clot. Continuous fetal heart rate monitoring, serial hematocrit determinations, and serial abdominal examinations were undertaken. The patient was then observed in the hospital for an additional 48 h. No signs of infection developed, and she was discharged from the hospital. At 34 weeks of gestation, she was admitted to the hospital in labor. On rupture of the membranes, the fluid was noted to be dark brown with particulate matter present. A vigorous female infant weighing 2,540 gm with Apgar scores of 8 at 1 min and 8 at 5 min was delivered spontaneously. The uterus was explored manually and was intact. A poorly healed laceration, about 5 mm long, was noted over the infant's left parietal bone and closed spontaneously on the second day of life.

Schulz et al. describe a case of a 19-year-old woman in her 29th week of pregnancy who was stabbed in the lower abdomen during a robbery. Two hours later, an emergency cesarean delivery was performed. Blood was present in the amniotic fluid. The Apgar scores were 2/5/6 at 1.5 and 10 min, respectively. Above the right ear was a 2-cm-long bleeding wound. The neonate had stable respiratory and hemodynamic functions. The cerebral sonogram showed an extensive intracerebral hemorrhage in the region of the right thalamus and temporal lobe with a visible 5 to 6-cm long incision channel stretching about 1 cm beyond the midline. A large, right-sided subdural hematoma near the laceration site and intraventricular bleeding had occurred. Surgical evacuation of a subdural hematoma was undertaken. The child developed a left spastic hemiparesis.

Evaluation of the pregnant patient with either gunshot or stab wounds of the abdomen must take into consideration the physiologic changes of pregnancy while following the principles of trauma management. A patient with a gunshot wound generally requires surgical exploration, although Awwad et al. advocate conservative management in anterior abdominal entry wounds below the level of the uterine fundus

[30]. Otherwise, a patient with a stab wound to the abdomen may require exploratory laparotomy only if there is evidence of intraperitoneal hemorrhage or bowel perforation. Cesarean section may be required if fetal distress ensues [31].

GSF are reported to complicate less than 1% of all skull fractures. Most cases of GSF described in the literature have occurred in children under 3 years of age, one half occur in children under 1 year of age [32]. The first report of this condition was in 1816 by John Howship who noted "partial absorption of the (right) parietal bone, arising from a blow on the head" in a child aged 9 months [33].

GSFs require a head injury severe enough to include a skull fracture, a tear in the dura mater, and brain injury. The outward driving force, such as a normally growing brain, is the mechanism underlying the formation of the growing fracture. These elements explain why the vast majority of growing fractures occur in very young children and also the very occasional report of this entity in the adult age [34–36]. As with all skull fracture, the most common location for the development of a GSF is the parietal bone, although it can occur anywhere, including in the skull base [36, 37].

Only one case of intrauterine growing skull fracture has been described in medical literature by Moss et al. in 1990 in a full-term male infant with a mother's history of a blow to the abdomen 2 or 3 weeks before birth. Abdominal ultrasound at 36 weeks of gestation did not demonstrate intracranial lesions. The newborn examination revealed a right parietal caput succedaneum and cephalohematoma. Neurosurgical consultation at 2 weeks of age revealed a linear lesion measuring 3 cm × 7 cm in the parietal bone. In this case, surgery was performed at 4 weeks of age. The typical features of a GSF were encountered [38]. In our case, it appears that the strength of the stab wound was not capable of a deep brain injury such as the case reported by Schultz et al., but only of a bony interruption and a dural tear with parenchymal injury. From this, a GSF has slowly developed. We think it is unlikely, in view of the injury noted at delivery, that earlier delivery would have improved the outcome of the infant.

Conclusion

To our knowledge, this is the first reported case of intrauterine head injury following a stab wound of the gravid uterus, resulting in a GSF. Our intraoperative findings are totally in concordance with the pathogenetic mechanism formulated for this condition by Lende and Erickson in 1960 [32]. The goals of the operation for GSF are to completely identify all the dural defects, free the adhesions, decompress the cyst, provide a watertight dural closure, and fill the bony defect with a cranioplasty. This unusual case supports literature's recommendations that injuries known to penetrate the uterus may be managed with the fetus left in utero if there is no evidence of fetal distress or amniotitis, and that exploratory laparotomy can be deferred if there is no evidence of maternal or fetal hemorrhage or bowel injury.

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