Subgaleal Hematoma: The Need for Increased Awareness of Risk

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Subgaleal hematoma, also known as subaponeurotic hemorrhage, is a serious complication of birth that is associated with vacuum-assisted delivery. Despite a high rate of mortality associated with subgaleal hematoma, it has received relatively little attention in the medical literature. Lack of awareness may lead to delayed diagnosis and serious consequences for infants. This paper is a report of six cases and a literature review. Prevention and early recognition and treatment of the condition can occur only with increased practitioner awareness of this entity.

Key words. Subgaleal hematoma; subaponeurotic hemorrhage; hematoma; infant, newborn; vacuum extraction, obstetrical; disseminated intravascular coagulation.
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Subgaleal hematoma results from injury to the scalp with subsequent bleeding into the potential space between the galea aponeurotica and the pericranium. This potential space is vast and can easily accommodate up to half of the blood volume of a neonate. Estimates of blood loss range from 38 mL per centimeter of increased head circumference[1] to 260 mL per centimeter increase in scalp thickness.[2] Once bleeding into this space starts, it can be difficult to control because of a subsequent coagulopathy.

The major reported risk factor for subgaleal hematoma is use of a vacuum extractor to assist with the delivery of the infant.[2] Both metal- and soft-cup extractors have been implicated in the formation of subgaleal hematomas.[2,3] Other risk factors include primiparity, macrosomia, prolonged labor, cephalopelvic disproportion, prematurity, sex (male), and birth in Africa.[2] The incidence has been reported to range from 4 to 59 per 10,000 deliveries.[2] The reported mortality is 22.8%.[2]

We report six consecutive cases of subgaleal hematoma in infants cared for at the Doernbecher Neonatal Intensive Care Unit (NICU) between November 1991 and June 1995. None of the patients in our series were born at Oregon Health Sciences University.

Case Reports

Case 1

A 3.3-kg female infant was born to a 24-year-old G_2P_{1011} woman. Pregnancy was uncomplicated. Delivery was assisted with a Malmström (metal) vacuum apparatus. A scalp pH done 1 hour prior to delivery was 7.38. On delivery, the baby was limp and pale, with Apgar scores of 5 and 4 at 1 and 5 minutes, respectively. Umbilical catheters were placed, 20 mL/kg of Plasmanate given for volume expansion, and dopamine started. A rapidly enlarging scalp hematoma was noted. After 45 mL of red cells were administered, prothrombin time (PT) and partial thromboplastin time (PTT) were obtained, both of which were >100 seconds. Fresh-frozen plasma (FFP) and cryoprecipitate were not readily available. Signs of

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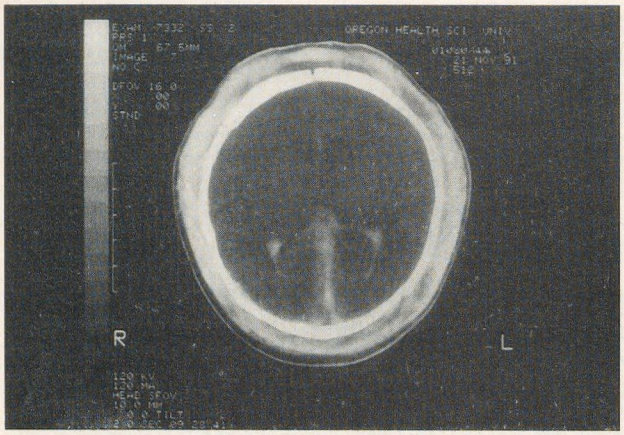

Figure 1. Computerized tomographic head scan of the infant in case 1, demonstrating extensive blood within the extracranial soft tissues and mild intraventricular and subarachnoid hemorrhages.

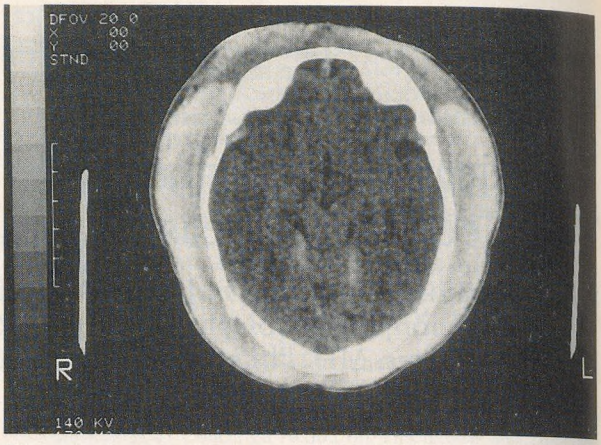

Figure 2. Computed tomographic head scan of the infant in case 2, demonstrating extensive scalp swelling resulting from subgaleal hematoma.

shock and metabolic acidosis were treated with sodium bicarbonate and fluid boluses. On arrival at the NICU, the infant had gasping respirations and was immediately intubated. She had a hematocrit of 21%, fibrinogen of 54 mg/dL, platelets of 168,000/mm^3, and D-dimers of 2 to 4 ng/mL. Fresh-frozen plasma, cryoprecipitate, and red blood cells (RBCs) were administered. A computed tomographic (CT) scan of her head revealed extensive blood within the extracranial soft tissues, and mild intraventricular and subarachnoid hemorrhages (Figure 1). By the second day of life, transcranial Doppler and nuclear medicine flow scan revealed an absence of cerebral blood flow. On the third day, an electroencephalogram (EEG) confirmed the absence of cortical activity, and brain death was determined. This baby had received 476 mL of RBCs, 8 U of cryoprecipitate, and 140 mL of FFP with normalization of coagulation studies by 24 hours of age. All bacterial and viral cultures were negative and liver function tests were normal. Autopsy was remarkable for extensive subgaleal hematoma, and moderate subarachnoid and subdural hemorrhage.

Case 2

A 3.32-kg female infant was born at term to a 17-year-old primigravida following an uncomplicated pregnancy. She was born vaginally with vacuum assistance following a 35-minute second stage of labor. The vacuum device used was a soft-cup type and was applied repeatedly. An attempt at forceps delivery also failed, and delivery was finally accomplished by a sixth application of the vacuum extractor. The infant had Apgar scores of 3, 5, 6, and 7 at 1,5,10, and 15 minutes, respectively. Initial physical examination revealed her to be pale and limp with a large caput. Thereafter, she appeared to improve until 3.5 hours of age, when she was again noted to be pale and lethargic. Shortly thereafter, she became apneic and bradycardic. She was intubated and given epinephrine with good response. Laboratory studies revealed a profound metabolic acidosis with a bicarbonate level of 2 mEq/dL, and severe anemia with a hemoglobin of 4.7 mg/dL. It was noted at that time that her scalp hematoma was enlarging. Resuscitation was begun with sodium bicarbonate, FFP, packed RBCs, and dopamine. No coagulation studies were done before beginning this therapy. Following transport to the NICU, a cranial CT scan revealed a small subdural hematoma and extensive subgaleal hematoma (Figure 2). The ultimately unsuccessful struggle to maintain her intravascular volume and maintain the integrity of her organ systems lasted for 10 days. She received 223 mL/kg of blood products (RBCs, FFP, and platelets) during her first day, 80 mL/kg the second, and 50 mL/kg on subsequent days. Her scalp swelling was so extensive (Figure 3) as to render EEG, brain stem auditory evoked response (BSAER), and somatosensory evoked potential (SSEP) tests uninterpretable. She developed renal and hepatic failure with marked hyperkalemia. On the 10th day intermittent cardiac arrhythmias began, and on the morning of the 11th day she became bradycardic and died.

Case 3

A 4.3-kg female infant of 39 weeks' gestation was born vaginally with the assistance of a soft-cup vacuum device at a birth center with a naturopathic physician in attendance. The mother was a 19-year-old primigravida whose pregnancy had been uncomplicated. Delivery was compli-

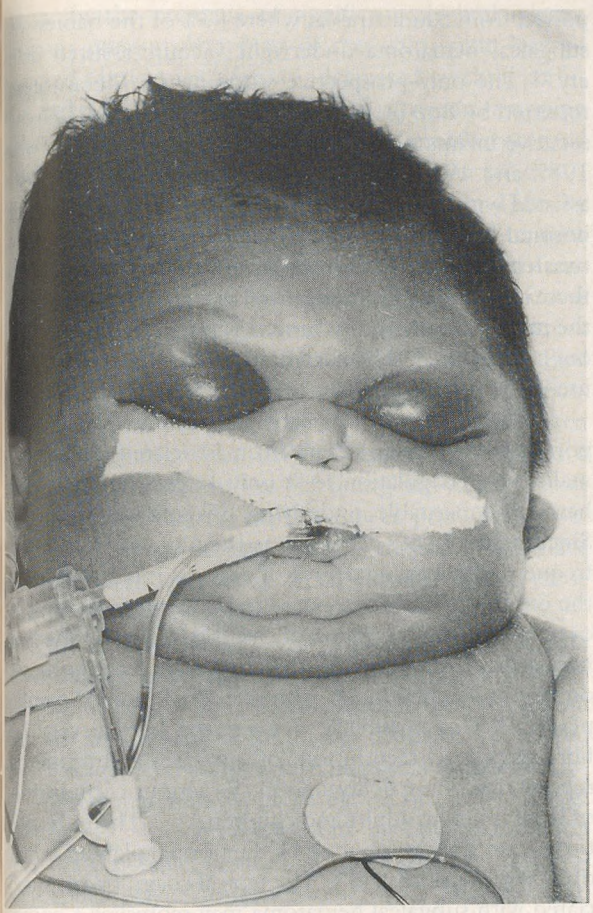

Figure 3. Photograph of the infant in case 2, showing marked extracranial swelling and orbital ecchymosis.

cated by a 5-minute shoulder dystocia and meconium-stained amniotic fluid. The infant had Apgar scores of 0 and 0 at 1 and 5 minutes, respectively. She was intubated and given epinephrine by an endotracheal tube. At 8 minutes of age, she had a heart rate of 60 to 80 beats per minute, and the NICU transport team was called. On arrival of the team, she was completely flaccid, her pupils were 4 to 5 mm and fixed, and she had no corneal or gag reflex. Cranial ultrasound obtained shortly after admission to the NICU showed marked cerebral swelling with loss of subarachnoid space and lateral ventricles. An enlarging head circumference was noted at 4 hours of age. Coagulation studies revealed PT and PTT >100 seconds, plasma fibrinogen concentration <15 mg/dL, D-dimers 8 to 16 μg/mL, and platelets of 169,000/mm^3. The infant's neurologic status did not improve, and the baby was removed from life support at her parents' request on the second day of life. An autopsy revealed a large (200 g) subgaleal hematoma, bilateral renal necrosis, and meconium and amniotic fluid squames in the alveolar spaces.

Case 4

A 3.685-kg male infant of 41 weeks' gestation was born vaginally with soft-cup vacuum assistance to a 20-year-old primiparous woman. The vacuum was applied at least six times over the course of an hour. He had Apgar scores of 3, 4, and 4 at 1, 5, and 10 minutes, respectively. He was tachypneic with good oxygen saturations. He was given Plasmanate for hypotension. His scalp was noted to be ballotable by 5 hours of age. His coagulation studies included PT 21.3 seconds, PTT 39 seconds, fibrinogen 39 mg/dL, D-dimers 4 to 8 μg/mL, platelets 172,000/mm^3, and a normal factor VIII level. Fresh-frozen plasma was administered. He was intubated, pressure dressings were applied to his head, a transfusion was given, and he was transported to the NICU. Cranial Doppler studies revealed good blood flow with the pressure dressing in place at admission. He began to have clinical seizure activity by 8 hours of age and was treated with high doses of phenobarbital. On day 2 of life, his coagulation studies were normal, and the pressure dressing was removed without evidence of further hemorrhage. He continued to have good cerebral blood flow by Doppler measurement on day 2. His neurological status, however, deteriorated progressively, and by day 3 he had no systolic blood flow in his right middle and anterior cerebral arteries by Doppler measurement. Forward diastolic flow was absent in all his cerebral arteries. His pupils were fixed and dilated, his EEG was markedly depressed, and he failed to initiate respirations. Because of the dismal neurologic prognosis, mechanical ventilation was discontinued and he died. An autopsy revealed a large subgaleal hematoma.

Case 5

A 3.8-kg male infant of 41 weeks' gestation was born to a 20-year-old primiparous woman following an uncomplicated pregnancy. An attempt at forceps delivery was unsuccessful, and the baby was delivered vaginally without instrumentation 2 hours following the attempt with forceps. The fluid was meconium stained. Apgar scores were 1 and 4 at 1 and 5 minutes, respectively. He was intubated and meconium was suctioned from his trachea. His first arterial blood gas revealed a pH of 6.92, with a bicarbonate of 5.0 mEQ/dL. After he was stabilized at the referring hospital, he was transported to the NICU, where an enlarging ballotable scalp was noted. His initial head CT scan revealed subgaleal fluid and a small hemorrhage near the tentorial incisura. Over the first 2 days of life, he received multiple transfusions of RBCs, FFP, and Plasmanate. He received one platelet transfusion. He also received infusions of dopamine and dobutamine. Phenobarbital and dilantin were administered for seizure con-

trol. Cranial swelling decreased on day 4. He was extubated on the fifth day. He was discharged at 2 weeks of age. Head CT scan at discharge revealed increased ventricular size, which was felt to be consistent with cerebral atrophy. His condition has subsequently been diagnosed as cerebral palsy.

Case 6

A 4.0-kg male infant of term gestation was born to a 23-year-old G_3P_2 woman who was receiving magnesium sulfate during labor for treatment of hypertension. Her first child had been delivered by a cesarean section, and the second vaginally, with the assistance of a vacuum extractor. The third infant was delivered with the assistance of a soft-cup vacuum device. The vacuum was applied at zero station following 2 hours of pushing without progress. Vacuum was used for 55 minutes and 13 uterine contractions. Multiple reapplications were performed. A nuchal cord was reduced at delivery. The baby was pale and flaccid at delivery. His Apgar scores were 1, 3, and 3 at 1, 5, and 15 minutes, respectively, and the first umbilical vein pH was 6.9. Scalp swelling was noted; vigorous fluid resuscitation was started at the referring hospital and continued in the NICU. The first PT was 24.4 seconds, and the PTT was 72.5 seconds. His fibrinogen level was 55 mg/dL and the initial hematocrit was 21%. He responded to fluid resuscitation and was discharged at 12 days of age.

Discussion

A description of subgaleal hematoma in the medical literature dates to 1819, when it was referred to as false cephalohematoma.[4] Despite this long history, many practitioners are not aware of this entity and its frequently devastating outcome for neonates. Although an association with vacuum extraction was described in the early literature,[1,5] Ahuja and colleagues[6] clarified this association in 1969. They reported 13 cases associated with vacuum extraction. There were no cases in over 12,000 infants delivered by other methods. Since then, several authors have substantiated this association.[2,3,7–9] In 1980, Plauche reviewed 123 cases of subgaleal hematoma from the literature and found that 48.8% had a vacuum device applied, 13.8% had forceps applied, and 28.4% occurred with spontaneous delivery.[2] A retrospective study of cases occurring between 1989 and 1991 from a single hospital in Belgium reported 27 cases.[10] Twenty-six of the infants had undergone vacuum-assisted delivery. All the infants had reportedly received vitamin K at delivery. A similar group of patients with subgaleal hematoma has been reported from Saudi Arabia, where 85% of the babies with subgaleal hematoma underwent vacuum-assisted delivery.[11] The only prospective study in the literature was reported by Boo in 1990.[9] The study included 101 consecutive infants born with subgaleal hematoma between 1987 and 1989; in 66.3% of these cases, delivery was assisted with a vacuum device. The devices in use at the hospital were both the metal- and soft-cup type. Unfortunately, the author did not report which was used with these cases. Many of the reported cases involved the use of the metal (Malmström) vacuum device, but, as in four of our cases, subgaleal hematoma also can be associated with use of the soft-cup vacuum extractors.[3]

Although many cases of subgaleal hematoma reported in the literature have been associated with abnormalities in coagulation,[2,6,12] only a few were found to have an inheritable underlying coagulation defect.[3,12] Since infants whose delivery is assisted by a vacuum device frequently have some degree of distress, it is possible that the coagulopathy is secondary to perinatal asphyxia,[13–15] or to massive consumption of clotting factors by the large hematoma.[2] Alternatively, the coagulopathy may be secondary to cerebral injury with release of brain thromboplastin.[16] This possibility is suggested by the very low fibrinogen level seen in four of our cases and numerous reports describing defibrination as a serious complication of head injury in adults and children.[16–23] Thromboplastin release is also supported by the normal platelet counts observed in cases 1 and 4. The typical coagulopathy associated with subgaleal hematoma may represent a combination of the suggested causes.

Prompt diagnosis of subgaleal hematoma with treatment of the associated shock and coagulopathy is important.[2,3,9,24] While the death of the patient in case 3 most likely was related to intrapartum asphyxia rather than subgaleal hematoma, we believe the other three infants died secondary to the consequences of postnatal shock or primary cerebral injury. Early signs include pallor, hypotonia, tachycardia, tachypnea, and increasing head circumference.[2,9,24] Late signs include anemia and a boggy, ballotable cranium.[7] These signs may be present at birth[8] or delayed up to 72 hours of age.[8] Plauche[2] recommended close observation of infants following difficult instrumented deliveries, and for at-risk infants, Florentino-Pineda and colleagues[3] recommended hourly head circumference measurements, with a minimum of 8 hours of close observation.

Transfusion with blood and FFP to maintain circulation and coagulation factors has been the cornerstone of therapy. Pressure wrapping of the head as soon as the diagnosis is made has been suggested as an adjunct to transfusion therapy.[7,24] This method may indeed be useful if applied in patients without evidence of cerebral

edema. In the presence of significant cerebral edema, however, pressure wrapping of the scalp could lead to increased intracranial pressure, decreased cerebral perfusion, and even herniation. Therefore, if pressure wrapping of the scalp is utilized, it may be useful to monitor cerebral perfusion with frequent transfontanel Doppler studies.

Vacuum extraction was first described in 1705 by James Yonge, a Royal Naval surgeon, who tried to draw out a fetus using a cupping glass fitted to the scalp combined with an air pump.[25] Interest in the technique was not widespread, however, until 1954 when Malmström published results using his metal cup.[26] In 1969, Bird published his modifications of the Malmström cup, putting the suction port to the side of the centrally located chain for traction.[27] In 1973, Kobayashi introduced a silastic cup, followed by the marketing of a variety of soft cups. Although the soft cups have been promoted as being "safe," ie, not causing any fetal trauma,[28] they have been associated with severe fetal injuries similar to those reported in our case studies.

Optimal obstetrical management and appropriate use of the instruments are keys to the prevention of subgaleal hematoma. The indications for the use of a vacuum extractor are the same as for forceps deliveries: prolonged second stage, fetal compromise, maternal disease requiring limited maternal expulsive efforts or elective outlet delivery.[25,29-31] Contraindications include presentation other than cephalic, gestational age <32 weeks, or absolute cephalopelvic disproportion.[25,29-31] The prerequisites for use are the same as for forceps: the fetal head must be deeply engaged (at least zero station), the cervix must be fully dilated, the membranes ruptured, the position and station of the fetal head identified with certainty, adequate maternal analgesia and facilities for neonatal resuscitation present, the maternal bladder empty, and cephalopelvic disproportion absent. The vacuum cup, regardless of type, should be applied as far posterior as possible over the posterior fontanel and in the midline.[25,29,31] After assuring that no maternal tissue of the cervix or vagina is trapped in the cup, suction is initiated. For the Malmström cup, suction is raised by 5 cm H_2O every 2 minutes until 20 cm of H_2O (0.2 kg/cm^3 every 2 minutes to 0.7 to 0.8 kg/cm^3) is reached. Suction is left on until delivery of the infant and traction started only after full suction has been reached.[29] This allows for the development of a caput succedaneum (chignon) to which the tractional force is applied. With the soft cups, suction is engaged to the desired level for traction and released between contractions. With all cups, traction should be exerted only with uterine contractions and maternal effort. Traction must be applied perpendicular to the cup. If traction is applied at other than 90° to the cup, the risk of slippage of the cup, "pop-offs," and scalp injuries increases.

To prevent fetal injury, vacuum extraction should be approached as a trial of vaginal delivery with the intent to abandon the trial and proceed immediately to cesarean section if the infant is not delivered within preset limits. Recommendations of the American College of Obstetricians and Gynecologists include the statement that "progress in descent should accompany each traction attempt. As with forceps procedures, there should be a willingness to abandon attempts at vacuum extraction if satisfactory progress is not made."[31] If there is no descent with traction, if the infant is not delivered after three or four tractions, if the cup pops off once or twice, or if the total time of the attempt is 15 to 30 minutes, the vacuum should be removed and the infant delivered by other means, preferably cesarean section.[25,29-31] Preparations to proceed to cesarean section should be initiated at the beginning of the trial of instrumented delivery to avoid any delay. This is particularly important in rural hospitals where operating room teams may have to travel from another site.

The vacuum extractor is technically easier to use than forceps, requires less maternal analgesia, and is associated with less maternal trauma. These factors make it an appealing method of instrumental vaginal delivery. However, all vacuum extractors, soft or metal cups, have the potential to cause extensive fetal trauma and therefore must be used carefully, adhering strictly to guidelines for initiating and abandoning a trial of vacuum-assisted delivery.

All practitioners who use vacuum extractors to assist with deliveries should be aware of subgaleal hematoma as a potential, although rare, complication of the procedure. They should also be aware of the indications for and recommendations applicable to the use of vacuum extractors. Health care practitioners who care for newborn infants should be alert to the potential for development of subgaleal hematoma, as prompt recognition and supportive care may improve outcome in some cases.

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