Ref: Ro Med J. 2021;68(Suppl5)
DOI: 10.37897/RMJ.2021.S5.9

Neurological neonatal birth injuries caused by vacuum-assisted delivery

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ABSTRACT

Many complications can occur to a new-born during a vacuum-assisted delivery. Vacuum-assisted deliveries are considered to be safe and there seems to be insufficient evidence of long-term neurodevelopmental effects. There has always been a debate among clinicians about the risk of major neonatal injury using vacuum extraction. The major complications presented in this article are: intracranial haemorrhage, subgaleal haemorrhage, seizures, cerebral infarction, hypoxic-ischemic encephalopathy and permanent brachial plexus injury. We included several retrospective studies discussing these major complications. The incidence of vacuum related birth injuries was proven to be higher than the incidence of spontaneous birth injuries; however, the overall incidence was low.

Keywords: vacuum-assisted delivery, intracranial haemorrhage, brachial plexus injury, hypoxic-ischemic encephalopathy

INTRODUCTION

A birth injury is described as structural or functional impairment of a new-born as a result of a stressful incident during labour, delivery or both. Neonatal birth injuries have a diminished incidence, with a frequency of approximately 0.6-0.8 per 1000 of life births (1). When the second stage of labour must be shortened, vacuum extraction is the tool of choice. According to research, some practitioners prefer it to forceps application because it reduces the maternal genital tract trauma, the overall blood loss is low, requires less maternal analgesia and it is much simpler to use (2) (3). The vacuum-assisted delivery technique permits an external tractive force applied to the scalp through vacuum equipment communicating to the foetal head. The traction on the equipment allows increased delivery forces and easier passage of the foetus through the birth canal and as a result both compression of the skull and traction on the scalp develop (4).

In more than 12% of cases, complications throughout labour necessitate the use of assisted delivery. The "art" of forceps-assisted birth is slowly becoming obsolete because there are fewer clinicians available to teach the technique. However, some clinicians believe that the vacuum device requires less expertise, so there is less effort focused on learning the required skills for vacuum delivery, resulting in poor technique and worse neonatal and maternal outcomes (2). Generally, vacuum-assisted deliveries are mostly safe and have no long-term neurodevelopmental effects (5).

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Article History:
Received: 4 November 2021
Accepted: 29 November 2021

Operative vaginal birth is performed in 5% to 25% of nulliparous pregnant women. Since early 1800s the forceps was the main instrument for delivery; only after the 1950s vacuum extraction became much more popular. With the development of modern vacuum cups, the popularity of vacuum extraction has gradually risen (6). The risk of major neonatal injury by vacuum extraction has been the source of debate. Several studies have shown that soft vacuum extractors are safer than metal vacuum extractors or forceps (6).

The most common minor neonatal complications are represented by cephalohematoma, soft tissue trauma, transitory brachial plexus injury, hyperbilirubinemia with necessary intensive phototherapy and jaundice. The most common major complications under study are: intracranial or subgaleal haemorrhage, seizures, hypoxic-ischemic encephalopathy, permanent brachial plexus injury and skull fractures (7).

INTRACRANIAL HAEMORRHAGE

Haemorrhage can occur as a result of bleeding from the venous sinus, vein rupture in the subdural region or haemorrhage inside the cerebellum (8). Neurological signs usually manifest in the first few days following birth and are produced by the blood collection in the posterior fossa. The newborn can develop seizures, apneea, increased head circumference, bulging fontanelle, abnormal tone, and/or bradycardia (9). Because only a subset of infants with intracranial haemorrhage present clinical symptoms, the real incidence is likely to be greater than reported (10).

Intraventricular haemorrhage, subdural haemorrhage, cerebellar haemorrhage, primary subarachnoid haemorrhage and intraparenchymal haemorrhage are the five primary clinical types of neonatal intracranial haemorrhage. The prevalence of the intraparenchymal and subdural haemorrhage is greater in the term infant whereas the intraventricular, subarachnoid and cerebellar haemorrhage are more frequent in the preterm infant. There are many risk factors contributing to intracranial haemorrhage in the newborn, the most frequent are represented by forceps or vacuum assisted delivery, precipitous delivery, prolonged delivery and primiparity or extreme multiparity (10). After vacuum extractions, 0.1% to 0.8% of newborns experience symptomatic intracranial haemorrhage (11).

Schot et al., from Máxima MC Eindhoven General Hospital, Netherlands, conducted a retrospective study, which spanned for 8 years in which 14,562 deliveries (14%) were terminated by means of vacuum extraction. They found 25 infants who had symptomatic intracranial haemorrhage following vacuum extraction. Seven patients born elsewhere were referred to their newborn critical care unit. According to the findings of the study, only 48% of children with symptomatic intracranial haemorrhage following vacuum extraction experienced normal growth. From the 25 patients that were studied, 12 showed normal development for motor and mental functions. However, 13 patients had developmental impairment, 11 for motor functions and 10 for mental functions. In symptomatic patients, the location of the intracranial haemorrhage is important for prognosis. It was identified that intraparenchymal lesions are a risk factor for increased prevalence of impaired motor outcome, however only 43% individuals showed motor impairment (11).

Brouwer et al., from Department of Neonatology, Wilhelmina Children's Hospital, University Medical Centre Utrecht, conducted a 17 years retrospective study in which 53 term neonates were admitted in the neonatal intensive care unit. They were diagnosed with intracranial haemorrhage that was associated with parenchymal involvement. 12 infants (22.6%) were given birth using vacuum assisted delivery. The research shows a significant death rate among vacuum-assisted deliveries (24.5%), but 83.8% of the children that survived had normal neurodevelopmental outcome. (10). Compared to Schot's study, it can be observed that the neurological damage occurs less since not all the infants were born using the vacuum extraction. In addition, the studies are spanned over different periods (17 years vs 8 years) and different scales of infant development were used.

SUBGALEAL HAEMORRHAGE

Subgaleal haemorrhage is an uncommon but possibly fatal complication associated with vacuum-assisted vaginal delivery (7). Subgaleal haemorrhage is caused by the amassment of blood between the periosteum of the skull and the galea aponeurotica (12). If the emissary veins conjoining scalp veins and dural sinuses are ruptured, disseminated intravascular coagulation occurs, followed by hypovolemic shock if 20-40% of the circulating blood volume is lost. Over 20% mortality rates have been observed (13). Hypotension, tachycardia, pallor and a decrease in the haematocrit are all symptoms of circulatory collapse in a newborn (14). Subgaleal hematomas are uncommon complications, which usually occur in one of every 2,500 births, and are roughly ten times more probable following vacuum-assisted deliveries (4). Subgaleal haemorrhages' outcome is progressive after birth, it resolves within 2 or 3 weeks after substantial amounts of blood

products are administered and can be deadly if left untreated (15).

In a neonatal care hospital in Portugal it was conducted a study over 4 years in which 12,463 infants at 24 weeks or more were delivered and only 2068 (17%) were vacuum-assisted vaginal deliveries. The research included two groups of 1,802 full-term infants each: vacuum assisted vaginal births and spontaneous deliveries. The incidence of the subgaleal haemorrhage was 1.1 per 1000 infants born with vacuum assisted delivery (7).

Another research from Australia, Monash Medical Center, included 29,708 infants with 2,238 vacuum assisted deliveries over a 9-year period. The study found 21 cases of subgaleal haemorrhage and only 12 infants were delivered using vacuum extraction with an incidence of 7.6 per 1000 vacuum extracted infants. The research showed a lower mortality rate (14%) than the usual average of 20%, and the incidence of subgaleal haemorrhage in live births was found 0.5 per 1000 infants (13).

RETINAL HAEMORRHAGES

Retinal haemorrhages are caused by the pressure exerted on the foetal head during the passage through the birth canal, causing the rupture of the blood vessels on the surface of the retina (15). If a fundoscopic exam is performed within the first 24 hours of life, a retinal haemorrhage can be found. After the first day of life, retinal haemorrhages can still be observed up to three to four weeks (1). Usually, the resolution is between 24 hours and 6 weeks, more likely to recover in 5 days if it's shaped like a flame or a splinter; if it presents as a severe haemorrhage then it can last up to 21 days (15). 19% to 50% of newborns develop retinal haemorrhages. The data from research shows that vacuum assisted births are the most common factor for retinal haemorrhages, whereas using forceps may protect the newborn (4). The incidence of retinal haemorrhages, at infants delivered by vacuum extraction is 75%; 33% of infants from spontaneous vaginal deliveries develop retinal haemorrhage whereas in case of infants delivered by caesarean sections only 6.7% develop retinal haemorrhages (16). There are other factors related with neonatal retinal haemorrhage such as short second stage labour, intrauterine growth retardation and/or acidosis (4).

In a review article by Watts el al., thirteen trials with a total of 1,777 babies were included. Retinal haemorrhage was found in 25.6% of newborns delivered by spontaneous vaginal delivery according to the research. Infants born using vacuum extraction had a 42.6% rate of retinal haemorrhages, whereas infants delivered using forceps and vacuum had a 52% rate of retinal haemorrhages. The haemorrhages are often bilateral (59%) and of diverse intensity, ranging from "mild" (between 22% and 56%) to "severe" (between 18% and 37%), with the majority occurring in the posterior and the intraretinal pole (17).

In another cohort study by Hughes et al., from University of Sheffield, 53 infants between 33 and 42 weeks were examined. 9 infants were born using vacuum assisted delivery, 9 with forceps, 12 by caesarean section. 77.8% of the infants born with vacuum delivery presented retinal haemorrhages while 30.3% delivered with forceps respectively 30.4% of the infants born spontaneously presented retinal haemorrhages. There were substantially more cases of retinal haemorrhages after vacuum delivery compared to spontaneous births, while there were fewer produced by caesarean section (8.3%) (16).

SEIZURES

The most common neurological abnormalities symptom in newborns is represented by seizures. The prevalence of clinical seizures in newborns is estimated between 1 and 3 per 1,000 infants (18). Seizures in newborns are mostly an indication of an underlying neurologic disease. Common effects include behavioural issues, post neonatal epilepsy, mental impairment and death (19).

In a retrospective population-based cohort study from Gardella et al., neonatal seizures presented an incidence of 0.8 per 1,000 among infants delivered using a vacuum extractor compared to 0.5 per 1,000 infants delivered by forceps application, respectively 0.2 per 1,000 infants delivered spontaneously. In addition, neonatal seizures complicated 1.3 of 1,000 infants born assisted by a vacuum extractor and forceps (20). A slightly higher incidence was discovered by Towner et al. in a study where neonatal seizures occurred in 1.17 of 1,000 vacuum assisted delivered infants compared to 0.98 per 1,000 infants born using forceps application, 0.64 per 1,000 infants born spontaneously and the sum of 2.49 per 1,000 infants born assisted by both vacuum extractor and forceps (6).

CEREBRAL INFARCTION

Cerebral infarction represents a rare complication that appears on the side where the vacuum is applied and is frequently accompanied by a cephalohematoma after a vacuum-assisted birth (21). Newborns with cerebral infarcts are frequently asymptomatic at birth, but they can suffer long-term effects such as seizures, cerebral palsy and developmental delay as they mature (5).

A case report from Kumar et al. presents an infant born with an Apgar score of 7 at 1 minute and

9 at 5 minutes. The newborn developed at 18 hours of life two minutes of generalized tonic-clonic seizures. Afterwards the infant developed five more episodes of lateralized clinical seizures on the right side, ranging in length from 20 seconds to 5 minutes (21). Regarding paraclinical investigations, a computed tomography was performed which revealed a cerebral infarction in the left anterior parietal region, the origin being most likely arterial. To confirm, a magnetic resonance imaging was performed and the cerebral infarction was identified in the left posterior frontal lobe. The baby recovered without complications. At the time of release home and at 3 months of age, the neurological evaluation was normal (21).

HYPOXIC-ISCHEMIC ENCEPHALOPATHY

Neonatal encephalopathy is defined for a term newborn who presents with either isolated seizures or any two of the following symptoms lasting more than 1 day during the first week of life: abnormal reflexes or tone, abnormal consciousness, difficulty maintaining respiration and difficult feeding (22).

Ferraz et al. reported in a study over 5 years that hypoxic-ischemic encephalopathy has an incidence of 1.1 per 1,000 infants in vacuum assisted vaginal deliveries (7), which is a lower incidence compared to the work of Walsh et al., who discovered an incidence of 4.7 per 1,000 (22). The discrepancy can be explained by a certain number of cases that are undiagnosed. Infants with stage 1 hypoxic-ischemic encephalopathy have subtle symptoms. Ferraz et al., in the 5-year study that was conducted, had no stage-1 cases (7). The incidence is lower for spontaneous vaginal delivery 1.1 per 1000 as Walsh et al. demonstrated (22).

BRACHIAL PLEXUS INJURY

Excessive traction on the brachial plexus during delivery causes obstetrical brachial plexus damage (23). According to some sources, the incidence rate is around 0.15% in the United States, however it can range between 0.04% and 0.6% (1). Brachial plexus damage is detectable at birth and can cause permanent neurological impairment in 10% to 20% of newbors with this birth pathology (20). When compared to all other delivery options, neonates born by forceps-assisted vaginal delivery had a greater rate of facial nerve and brachial plexus damage (24).

Werner et al. reported in their study that brachial plexus injuries have an incidence of 4.3 per 1,000 infants born using vacuum-assisted delivery compared to 5.6 per 1,000 infants born by forceps delivery (24). This is comparable with Gardella et al. study where the incidence of brachial plexus injury is 3.7 per 1,000 infants born assisted by vacuum delivery compared to 5.3 per 1,000 infants born assisted by forceps and 1.5 per 1,000 infants born spontaneously (20). A lower incidence was reported by Towner et al where brachial plexus injuries have an incidence of 1.76 per 1000 infants born with vacuum assisted delivery compared to 2.5 per 1000 infants born with forceps deliver and 0.77 per 1,000 infants born spontaneously (6). Brachial plexus injuries have a higher incidence when forceps or vacuum is used, however there are other risk factors to be considered such as macrosomia, excessive maternal weight gain or shoulder dystocia (1,25).

OTHER COMPLICATIONS

Scalp oedema, cephalohematoma and non-depressed fracture are other complications that are not normally considered clinically significant because they cure on their own. Growing skull fractures are a rare complication of cranial fractures and usually appear in newborns (3). A cephalohematoma is defined by the accumulation of serosanguinous fluid, caused by the compression of the neonate's presenting part of the head, which collects under the periosteum of the skull bones. Because the bleed is restricted to the periosteum's limits, cephalohematoma has a minor clinical significance (2) and it resolves usually in 3 to 4 weeks (1). In a study from Werner et al., the incidence of cephalohematoma is 2.7 per 1,000 infants born with vacuum assisted delivery compared to 0.7 per 1000 infants born with caesarean delivery (24). However, another study from Ferraz et al. reported much higher incidences for cephalohematoma: 19 per 1,000 infants born with vacuum assisted delivery compared to 4 per 1,000 infants born spontaneously (7). The standard accepted incidence in literature is between 15 and 200 per 1000 infants (4). However, there are many cases that are not reported due to the low severity of cephalohematoma, so many studies on this matter are underreported.

VACUUM-ASSISTED BIRTH COMPLICATIONS

It is very important for obstetricians to understand the variety of complications that can occur to a newborn during a vacuum assisted delivery (1). The future of vacuum assisted deliveries depends on the willingness of practitioners to be trained and to train those who come after them. In this paper we documented several complications that are associated with vacuum assisted deliveries. We included several studies that document these complications and in most cases the incidence rate is low, however it's higher than the incidence of a compli-

cation during spontaneous delivery. Vacuum-assisted vaginal delivery rates are difficult to compare since various researches utilize different methods and medical practices differ across nations. It's difficult to pronounce whether vacuum-assisted deliveries have long-term neurological outcomes, since there are few long-term prospective studies on this subject. Most of these studies are retrospective and document the incidence of the injuries and not the long-term neurological outcome.

The research from Schot et al. (11) demonstrates a 52% incidence of poor neurodevelopmental outcome in intracranial haemorrhage caused by vacuum-assisted delivery. Though, the study is retrospective in nature and whether vacuum extraction associated intracranial haemorrhage does have a poorer outcome than non-vacuum extraction associated intracranial haemorrhage should be studied in further (prospective) studies. Brower et al. (10) studied the neurodevelopmental outcome in 53 infants with intracranial haemorrhage, regardless of their delivery type.

The other complications are researched in retrospective studies and only the incidence of the injury itself is documented. In addition, many of these studies have some limitations caused by the undiagnosed cases, some of the hospitals are high-risk pregnancies centres resulting in more deaths and older studies are hard to be compared to the recent ones since these have better equipment and technologies.

CONCLUSIONS

The studies show a correlation between vacuum-assisted deliveries and neonatal birth injuries despite the fact that there is not enough proof associating vacuum-assisted deliveries and long-term neurological damage. Even in asymptomatic neonate, a thorough evaluation, including brain ultrasound, should be performed shortly after birth.

Conflict of interest: none declared
Financial support: none declared

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