Factors contributing to failure of vacuum delivery and associated maternal/neonatal morbidity

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Objective: To determine factors contributing to the failure of vacuum delivery and to compare the neonatal and maternal morbidity associated with failed and successful procedures.

Methods: A retrospective case-control study was undertaken at Aga Khan University Hospital, Nairobi, Kenya, by review of medical charts from the period of January 2007 to December 2010. In total, 31 cases of failed vacuum delivery were compared with 124 controls where extraction was successful. The primary outcome measure was fetal malposition. Secondary outcome measures included a composite score of maternal complications, a 5-minute Apgar score below 7, an umbilical arterial pH below 7.1, and a base excess below –12. Multiple logistic regression analysis was undertaken to identify factors associated with failure of vacuum delivery.

Results: Demographic and labor characteristics were similar in both groups. Fetal malposition significantly contributed to the failure of vacuum delivery (odds ratio 12.7, 95% confidence interval 1.5–14.8). Failure of vacuum delivery was not associated with clinically important neonatal or maternal morbidity.

Conclusions: Vacuum extraction is a safe mode of delivery where indicated, with minimal maternal and neonatal morbidity even in the event of procedural failure.

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1. Introduction

Operative vaginal delivery is used to expedite childbirth while avoiding cesarean delivery and its associated morbidities. However, the practice has largely fallen out of use in health facilities in most low-income countries because it is believed to be associated with increased maternal and neonatal morbidity and mortality. In the small number of facilities that have the required equipment, the equipment tends not to be used because of adverse medical, midwifery, and management opinion about the procedure and/or because of the equipment being inaccessible or in a nonfunctional condition [1,2]. If this trend is left unchecked, the end result will be a generation of midwives and midwives lacking this essential obstetric skill [3].

It is unfortunate that the same low-income countries that have seen a decline in the use of instrumental delivery, especially countries in Sub-Saharan Africa, bear the biggest burden of perinatal morbidity and mortality, with a significant number of stillbirths occurring intrapartum [4]. Typically, access to immediate cesarean delivery in emergencies such as fetal bradycardia is lacking in some of these countries [5]. Access to instrumental delivery in preference to cesarean delivery is essential in certain second-stage emergencies, considering that cesarean delivery, when performed in the second stage of labor, is associated with increased rates of maternal and neonatal morbidity [6,7].

In the few institutions where instrumental delivery is practiced, vacuum extraction is preferred to the use of forceps. Johanson and Menon [8] affirmed that vacuum delivery is associated with a higher risk of delivery failure than forceps delivery. Failure of instrumental delivery in turn increases the risks of intracranial hemorrhage, convulsions, birth asphyxia, and neonatal transfer to a special care unit [9,10].

These findings may not be encouraging if instrumental delivery is to be used more widely. However, a number of studies [11,12] have established the safety and efficacy of vacuum delivery, with a primary failure rate of approximately 10% being reported. Analyses of factors leading to failure have yielded diverse results and there are few data from low-income countries on the perinatal and maternal outcomes associated with failed instrumental deliveries.

Many obstetricians consider vacuum delivery to be the first choice when instrumental delivery is contemplated and the procedure is recommended in evidence-based guidelines [13]. In preparation for a potential failure to complete the procedure, a management plan should be established on the basis of local and international data and communicated to the patient.

The present study analyzed factors contributing to the failure of vacuum delivery by reviewing chart data and assessed the associated neonatal and maternal morbidity.
2. Materials and methods

A retrospective case–control study was undertaken by review of the medical charts of all attempted vaginal deliveries at Aga Khan University Hospital, Nairobi, Kenya, that occurred between January 1, 2007, and December 31, 2010. At the study hospital, the vacuum device is the instrument of choice if delivery is to be expedited in the second stage of labor. All maternity care providers at the hospital, including midwives, residents, and attending faculty, are trained in the procedure as part of their credentialing programs.

All cases in which vacuum extraction had failed – defined as the requirement for a cesarean delivery or the application of forceps to achieve delivery – were included in the present study. Cases were excluded if any of the following information was omitted from the charts: indication for assisted delivery, descent and station of the fetal head, position of the occiput, type of instrument used, number of attempted “pulls” before delivery, birth weight, 5-minute Apgar score, and results of umbilical cord gas analysis (including pH value and base excess status). Patients were not excluded from the study on the basis of fetal or maternal risk factors such as gestational diabetes mellitus, pre-eclampsia, previous cesarean delivery, or prepartum hemorrhage.

The cases were matched for age and parity to controls in whom vacuum extraction had been successful, at a ratio of 1:4. The control records were randomly selected using a computer-generated random number sequence.

It was estimated that a total of 135 charts, including 27 cases (failed vacuum delivery) and 108 controls (successful vacuum delivery) matched at a ratio of 1:4, were required to be able to reject the null hypothesis with a power of 80% and a type 1 error of 0.05.

The primary outcome measure was fetal malposition. Other outcome variables included maternal body mass index, duration of the first stage of labor, birth weight, use of analgesia during labor, time of delivery (AM versus PM), level of experience of the person conducting the delivery, composite score of maternal complications (i.e., anal sphincter injury, extension of episiotomy, postpartum hemorrhage, need for blood transfusion, admission to critical care unit, and post-delivery urinary incontinence or retention) in the first 24 hours, 5-minute Apgar score below 7, arterial pH value below 7.1, and arterial base excess below −12.

The data were analyzed using SPSS version 15 (SPSS, Chicago, IL, USA). The descriptive analysis included the calculation of means and standard deviations for continuous variables. The continuous variables were compared using the t test. The χ² test was used to compare categorical variables. Stepwise multiple logistic regression was undertaken to determine odd ratios and 95% confidence intervals (CI) for explanatory variables. P<0.05 was considered statistically significant.

3. Results

Of 5404 women who attempted vaginal delivery during the 4-year study period, 830 (15.4%) had a vacuum delivery (Fig. 1). In total, 31 (3.7%) vacuum deliveries failed; 6 (19.4%) of the affected women underwent sequential delivery with forceps and the rest had an emergency cesarean delivery. The control group included 124 women
Factors contributing to the failure of vacuum delivery.

Table 2

<table>
<thead>
<tr>
<th>Variable</th>
<th>OR</th>
<th>95% CI</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of 1st stage</td>
<td>0.9</td>
<td>0.7–1.1</td>
<td>0.299</td>
</tr>
<tr>
<td>Body mass index</td>
<td>1.0</td>
<td>0.8–1.2</td>
<td>0.897</td>
</tr>
<tr>
<td>Fetal malposition</td>
<td>12.7</td>
<td>1.5–14.8</td>
<td>0.018</td>
</tr>
<tr>
<td>Birth weight</td>
<td>1.0</td>
<td>0.9–1.0</td>
<td>0.046</td>
</tr>
<tr>
<td>Use of analgesia in 1st stage</td>
<td>0.9</td>
<td>0.5–1.8</td>
<td>0.77</td>
</tr>
<tr>
<td>Time of delivery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AM</td>
<td>1.1</td>
<td>0.2–5.0</td>
<td>0.933</td>
</tr>
<tr>
<td>PM</td>
<td>0.6</td>
<td>0.9–4.2</td>
<td>0.616</td>
</tr>
<tr>
<td>Induction of labor</td>
<td>1.1</td>
<td>0.4–2.7</td>
<td>0.923</td>
</tr>
<tr>
<td>Augmentation of labor</td>
<td>0.9</td>
<td>0.9–10.6</td>
<td>0.965</td>
</tr>
<tr>
<td>Level of training of operator</td>
<td>0.3</td>
<td>0.4–1.3</td>
<td>0.288</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; OR, odds ratio.

because of mild birth asphyxia, 1 (0.6%) infant had a cephalohematoma, and 2 (1.3%) newborns were admitted to the neonatal intensive care unit for over 24 hours owing to severe birth asphyxia.

The OR of having an adverse neonatal outcome following a failed vacuum delivery was 1.7 (95% CI 0.2–18.9, P = 0.679) if the 5-minute Apgar score was lower than 7; 1.9 (95% CI 0.3–10.6, P = 0.491) if the base excess was more than −12; and 1.3 (95% CI 0.3–6.5, P = 0.783) if the arterial pH was lower than 7.1.

4. Discussion

The present study demonstrates that failure of an attempted vacuum delivery is most likely to occur in the context of fetal malposition. Birth weight, duration of the first stage of labor, maternal body mass index, use of labor analgesia, and time of delivery did not significantly influence the chances of failure. Neither induction nor augmentation of dysfunctional labor affected the success of a vacuum delivery. The success was also not dependent on the level of training of the operator (Table 2).

The main indications for vacuum delivery were maternal exhaustion (39%), and fetal bradycardia (32%). The use of vacuum delivery because of maternal conditions such as cardiac disease and severe hypertensive crisis was rare (1%). These findings are similar to those reported by Nkwabong et al. [2] in their study in Cameroon.

Maternal and neonatal morbidity was minimal regardless of the outcome of the vacuum delivery, with no mortality reported in either group. Although the study was not sufficiently powered to detect a difference in mortality (this would have required a very large sample size), this finding provides some reassurance in the context of reluctance among health workers in the study region to perform instrumental delivery because they fear poor neonatal and maternal outcomes [1]. Given that access to immediate cesarean delivery is often not readily achievable in the regional setting, it is important that this safe and effective intervention be made available.

In previous studies [7,14–16], a primary failure rate of 10–23% for vacuum delivery has been reported. In the present study, only 4% of the attempted vacuum deliveries failed, with subsequent cesarean delivery being performed in all but 6 patients, who underwent successful sequential delivery with forceps. The discrepancy between the failure rates could be due to differences in the definition of failure of vacuum delivery. Variation in the criteria for attempting instrumental delivery may also explain differences in the failure rate. For example, in the study unit, the use of vacuum delivery to achieve rotation in an occipitoposterior position is not common, even though it has been used elsewhere [17].

Failure of an attempted vacuum delivery has been associated with a high birth weight (between 3500 g and 4000 g), absence of systemic or regional analgesia during labor, persistence of an occipitoposterior position, and reluctance to use an episiotomy [11]. Gopalan et al. [15] also found that increased maternal age, African American race, a high body mass index, maternal diabetes mellitus, polyhydramnios,
induction of labor, and dysfunctional and prolonged labor were associated with higher chances of failure. Other reported risk factors include fetal station of less than 0, nulliparity, and a history of cesarean delivery [16,18]. The present findings do not support these associations; this could reflect equipment factors, differences in the patient populations, and/or differences in the training and experience of health workers.

Failure is more likely to occur with soft than with rigid vacuum cups, with typical failure rates of 9% and 16% reported for rigid and soft cups, respectively [8], even though soft cups are associated with less trauma to the fetal scalp. The higher failure rate for soft cups is associated with the detachment rate, with detachment occurring in 10% of rigid cup applications and 22% of soft cup applications [8]. This may result from difficulty in maneuvering the soft cup in the birth canal, especially in occipitoposterior, deflexed, or asynclitic presentations, because of the central attachment of the suction tube or handle, compared with the posterior (occipital) attachment with rigid cups [18]. For the present study, a handheld disposable vacuum pump and the rigid plastic Kiwi Omnicup (Clinical Innovations, Murray, UT, USA) were used in 91% of the assisted deliveries. These devices are claimed to be easier to maneuver and can serve as both anterior and posterior cups. They are considered to be less cumbersome and intrusive, and with single use there may be a reduced risk of transmissible infections, although there is currently no strong evidence of their superiority to conventional vacuum devices [19,20].

Maternal complications were uncommon following vacuum delivery, with anal sphincter tears occurring in 2% of the deliveries in the present study. The most common complication was second-degree perineal tearing (9%). Naturally, perineal tears are not a feature of failed vacuum delivery followed by cesarean delivery. Anal sphincter tears are more prevalent in cases of fetal malposition, which is an independent risk factor for failure of instrumental delivery [12,21].

Neonatal morbidity in the present study was unaltered by the outcome of vacuum delivery. Similar findings have been reported by Al-Kadri et al. [16]. However, Sadan et al. [22] demonstrated a significantly lower umbilical cord pH in neonates delivered by cesarean delivery following failed ventouse delivery. The prevalence rates of a poor Apgar score and admission to the neonatal intensive care unit following vacuum delivery were also low in that report. Clearly, it is important for practitioners to maintain fetal monitoring and expedite delivery if instrumental delivery is unsuccessful. The design of maternity units should, therefore, facilitate the rapid transfer to theater, or instrumental deliveries should be undertaken in the theater suite to avoid delays.

The present study was limited by the small numbers of failed vacuum deliveries reported. Being retrospective in design, the study was prone to selection bias, which was overcome by random sampling of all matched records. It was not possible to explore maternal and neonatal complications in further detail because the study was underpowered to analyze these effects. Caution should therefore be exercised when interpreting the results. The CI for some variables are wide reflecting the small sample size. However, the study reflects true clinical findings that a prospective study may not easily reveal. A prospective study of this nature is prone to the Hawthorne effect because practice tends to change once the maternity care providers are aware that they are being studied; consequently, the results may be misleading when it comes to understanding outcomes in routine clinical practice. Stringent inclusion criteria were established and adhered to, so that only charts that were considered complete were randomized.

In summary, fetal malposition is likely to influence the failure rate of vacuum delivery. However, the overall maternal and neonatal morbidity associated with failure of vacuum delivery is minimal.

Conflict of interest

The authors have no conflicts of interest.

References