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Vacuum extraction for non-rotational and rotational assisted vaginal birth

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A B S T R A C T

Vacuum-assisted birth is a safe mode of birth in the presence of a skilled provider. Vacuum extraction can avoid prolonged second stage of labour, birth asphyxia in the presence of foetal distress or maternal pushing where contraindicated. Vacuum-assisted births – particularly those in midpelvic rotational births – have been increasingly traded for caesarean births, although the latter are generally associated with potentially a greater risk to women and (future) children. In this article, (contra)indications and the basics of vacuum technique are elaborated. A specific section is dedicated to vacuum extraction for rotational birth. If these techniques are known, trained and practiced by obstetric care givers, then vacuum extraction has tremendous potential to make childbirth safer.

Introduction: unmet need for assisted vaginal birth

While caesarean sections have increased at an alarming pace throughout the world, assisted vaginal births have generally decreased and, in some countries, even disappeared [1]. There is plenty of literature suggesting that assisted vaginal births prevent caesarean sections. Temporal data indicate that reductions in assisted vaginal birth rates have been inversely related to increased caesarean section rates [2]. Midpelvic rotational assisted births, in particular, are increasingly traded for second-

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stage caesarean sections [3]. This has led to dwindling experience with vacuum extraction in some settings, for instance, in North America, which may increase chances of adverse outcome [4]. These developments should be reason for concern, particularly so in those settings where peri-caesarean maternal and perinatal mortality is high [5–7].

Preventing prolonged second stage of labour by assisted vaginal birth has been shown to reduce post-partum haemorrhage, sepsis and – in the presence of foetal monitoring – birth asphyxia [8,9]. Moreover, women who give birth vaginally and their future offspring do not run the risks associated with pregnancies in scarred uteri. Despite these clear advantages, the proportion of assisted vaginal birth remains low in many countries (Table 1) [1,10].

Within the European Union, there are also tremendous differences in the use of assisted vaginal birth (vacuum extraction or forceps) and caesarean section [11].

To reduce unnecessary caesarean sections and increase the vaginal birth rate, vacuum extraction is probably superior to forceps-assisted birth because it is relatively easy to perform and teach [8]. Here, I present an overview of (contra)indications and some general rules with regard to the vacuum technique. A special section is dedicated to vacuum extraction for rotational birth.

Indications, contraindications and prerequisites for vacuum extraction

Maternal indications for assisted vaginal birth include prolonged second stage of labour, exhaustion, heart disease or placental abruption. Presumed foetal distress – as a result of a maternal condition or independently – comprises foetal indication [9]. Non-cephalic and face presentations are contraindications for vacuum extraction. Foetal demineralisation (e.g. osteogenesis imperfecta), connective tissue disorder and bleeding tendency due to haemophilia or thrombocytopenia are rare and relative contraindications. Risks of vacuum extraction in these cases will have to be balanced against the considerable risk of delivering a deeply impacted foetal head [9].

Because premature infants are at a higher risk of cephalhaematoma, neonatal jaundice and intracranial and subgaleal haemorrhage, vacuum extraction is not recommended below a gestational age of 34 weeks, and it is unclear whether it is as safe as forceps below 36 weeks [9].

Good clinical practice entails that vacuum extraction should only be tried when a woman consents to the procedure, the cervix is fully dilated, membranes have ruptured and the foetal head is engaged, meaning that the largest circumference of the presenting bony part of the foetal head has passed the pelvic inlet. In the occiput anterior position, this implies that the bony part of the skull is at or below the level of the ischial spines (station 0, Hodge-plain 3). Note that the significant caput or moulding may misleadingly cause one to think that descent is lower than it actually is. Therefore, abdominal palpation may be less misleading and should always complement internal examination [9,12].

Other prerequisites are an empty bladder and availability of staff (including the maternity care provider) competent to perform neonatal resuscitation. Access to an operating room is preferred but not always possible in low-income countries. Adequate uterine contractions reduce the chance of failure of vacuum extraction. Augmentation with oxytocin may help establish effective contractions and there should be a low threshold to start oxytocin when performing vacuum extraction [9,12].

Table 1
Per cent distributions of vacuum extraction, forceps and caesarean section in selected countries [1,10].

Country	Vacuum	Forceps	Caesarean Section
Congo-Brazzaville, 2012	<0.1	0.2	6.9
Cyprus, 2010	2.5[a]		52.2
Ghana, 2010	0.5	<0.1	12.3
Italy,2010	3.4[a]		38.0
Laos, 2010/2011	3.4	0.1	7.3
Poland, 2010	1.4[a]		34.0
Romania, 2010	0.5[a]		36.9
Zambia, 2015	0.5	0.1	5.0
WHO Global Survey	2.6[a]		25.7

[a] Vacuum and forceps combined.

Materials and technique

There is paucity of data with regard to the optimal instrument for vacuum extraction. The Cochrane review on this topic may be considered outdated because it largely pre-dates trials applying the Kiwi Omnicup. In essence, the same principles apply to all types of vacuum extractors with regard to the technique, but chances of failure and complication rates do vary (Box 1).

Cups that allow for high traction force (O'Neil, Bird) may also have a higher chance of damaging the foetus. Using cups that allow for medium traction force (Malmström, Kiwi Omnicup) may be more sensible, although some prefer the Bird OP cup in case of an anticipated difficult rotational birth. Generally, 50 mm cups are used, and larger cups are seldom necessary (the Kiwi Omnicup comes only in one size). Softcups should generally be avoided [8,9,12].

It is essential to prepare the procedure before beginning the procedure (Box 2).

The cup should be placed when there is no uterine contraction. There are several ways to insert the cup into the vagina. One important way is to spread the labia, and care is taken not to damage the vaginal wall. One technique is to insert the cup sideways and then tilt the outside of the cup towards the posterior vaginal wall. A softcup may also be folded in [12].

The most essential part of the procedure is that the cup is placed on the flexion point (Fig. 1). The flexion point is located at 3 cm from the centre of the posterior fontanel. If a 5 cm cup is used, then the edge of the cup will be at the edge of the posterior fontanel. Correct placement of the cup on the flexion point will promote flexion of the foetal head and therefore results in a favourable position [14].

The Kiwi Omnicup has marks on the tube at 6 and 11 cm from the vacuum cup. In combination with the length of one's fingers, these marks may be used to guide the placement of the cup on the flexion point [15].

After placing the cup, palpation should verify that no maternal tissue is trapped between the cup and the foetal scalp. Vacuum should then go up at once to 0.8 kg/cm^2 [16,17]. Traction should occur during contractions whilst the woman pushes to enhance outward force. The fingers of the dominant hand do the pulling, whilst the fingers of the non-dominant hand are placed on the foetal head and the

Box 1
Most commonly used vacuum cups*

- Malmström: contains one elevated attachment point that holds both vacuum tubing and traction chain, prone to slipping off if the direction of traction is not perpendicular to the surface;
- O'Neil: separate attachment points for both a *flexible* traction chain and eccentric vacuum tubing, lower chance of slipping off up to 30-degree deviation from the perpendicular line;
- Bird: separate attachment points for a central *inflexible* traction chain and eccentric vacuum tubing, with a variant for the occiput posterior (OP) position that has the tubing attached at the side of the cup enabling deep sacral placement in rotational birth; the traction chain is placed right on the cup, without elevation, thereby allowing for higher traction force in case of deviation from the perpendicular line;
- Softcups: clock-shaped cup made up of soft plastic; low traction force possible, higher chance of failure, low risk of damage to the foetal skin; only to be used for outlet births with the head in the occiput anterior position;
- Kiwi Omnicup: disposable plastic handheld cup with a short connector that holds the centrally placed tube allowing for traction; good traction force can be developed and can be used for both rotational and non-rotational births with the foetal head in all positions; this cup seems to require some experience and technique to prevent slippage and keep the failure rate low. Unnecessary manoeuvres outside the desired line of traction will cause slippage.

*The Mityvac system (a more or less conventional vacuum system to which different types of plastic disposable cups may be applied depending on position of the foetal head) is less commonly used and its presumed benefits over other cups will need to be evaluated more robustly. The Odon device (a newer device using a plastic sleeve developed under auspices of the World Health Organization) is being evaluated in a trial and its benefits are currently unknown.

Box 2
Preparation for vacuum extraction.

1. Inform the woman and her partner about the procedure and acquire consent. Be sensitive to their worries and answer questions they might have.
2. Check the equipment for completeness. In case a metal cup is used, connect it to the vacuum machine.
3. Always perform an abdominal examination. Critically re-assess fetal size and determine the level of descent by abdominal palpation. Station 0, with only the sinciput felt, and the head one-fifth above the pelvic brim correspond to the lowest part of the bony skull being at the level of the ischial spines.
4. Remove the lower end of the bed to ensure that a downward direction of traction may be achieved.
5. Catheterise the bladder and remove an indwelling catheter.
6. Infiltrate the perineum with a local anaesthetic (or give a pudendal block).
7. Perform a careful vaginal examination and make sure to assess the level of descent and position of the foetal head. Perform an ultrasound scan when in doubt of position of the foetal head*.
8. Check whether the equipment works, whether vacuum can be created (some do so by applying the cup to their own non-dominant hand and creating vacuum).
9. Consider applying lubricant to the outside of the cup.

*Some clinicians propose performing translabial or transperineal ultrasound scanning to predict failure of assisted vaginal birth, using the angle of progression' between pubic symphysis and foetal head, but this technique requires more robust evaluation [13].

Box 3
After the procedure.

1. The third stage should be managed as after physiological vaginal birth, recognising that in case vacuum was performed for prolonged second stage of labour, the risk of post-partum haemorrhage due to uterine atony is increased [4,9,12].
2. Immediate care for the neonate (drying, stimulating and assessment of condition) should happen as after any birth. The baby should be placed on the mother's chest and only be taken to a resuscitation table if the condition of the baby requires additional care. As a type of self-examination, assess whether the cup was placed correctly over the flexion point. Examine and observe the neonate without hindrance to the initial mother–child bonding. Neonatal complications usually occur within the first 10 h.
3. Always carefully inspect the perineum and assess for damage to the sphincter. Repair any tears meticulously, resorting to regional or general anaesthesia if tears are large or complicated, or if the anal sphincter is involved.
4. Always debrief after the procedure and preferably also the day after. Feelings of failure were found to be common in women after vacuum extraction and could contribute to the instrument becoming less popular in some settings [19]. At the same time, vacuum extraction may be considered a normal birth' in other settings, particularly in some parts of the world where women are afraid to undergo caesarean section because of associated risks [20].

cup, typically in a three-finger fashion, with the thumb placed on the cup, and the index and middle fingers on the foetal head [12].

Traction should be smooth and manoeuvring or jerking movements avoided at all times. Direction of traction should always follow the axis of the birth canal. The first traction should generally be directed towards the floor of the labour room. A common error is to pull too horizontally, in which case

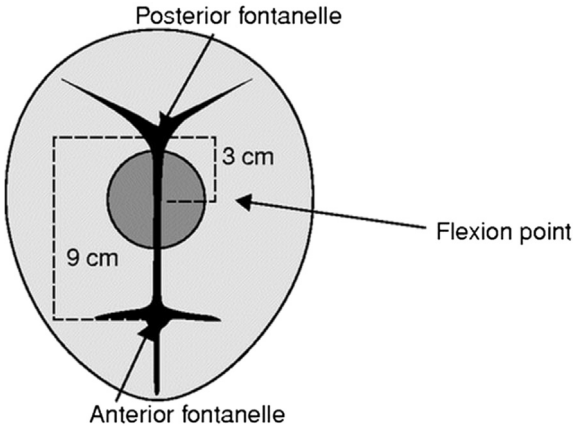

Fig. 1. Schematic representation of the flexion point.

the head is pulled against the pubic symphysis and chances of slippage increase. If adequate traction force can be developed, there should be progress in the descent of the foetal head, with the first pull dislodging/disimpacting the foetal head and correcting position and the second pull leading to considerable descent. After the third pull, the head should (almost) be born [9,12].

The need for episiotomy should be considered when the head crowns to reduce the risk of anal sphincter rupture. When the head is born, vacuum is stopped (e.g. by pushing the release button on the Kiwi Omnicup). The birth of shoulders and rump occurs in the same manner as that in physiological vaginal birth. It is suggested to be aware of the risk of shoulder dystocia. In multiparous women, vacuum extraction is indicated in case of foetal distress in the presence of favourable position but should be carefully considered in case of prolonged labour particularly with a poorly descending foetal head [9,12].

Although in most settings this is currently considered obsolete, some clinicians apply fundal pressure to be combined with vacuum extraction, particularly in areas where caesarean sections carry higher risks. In some low-income settings, where caesarean section is inaccessible or very unsafe, symphysiotomy could be performed if vacuum extraction fails and resorting to theatre is impossible or undesired [18]. Providing aftercare is of great importance following every vacuum extraction Box 3.

Rotational birth

The OP position often results from a deflexed foetal head. The direction of traction after the cup is placed on the flexion point promotes flexion, after which the foetal head will most often rotate by itself and come out with the occiput anteriorly but may also come out with the occiput posteriorly. It is even more important in rotational compared to non-rotational birth that the cup is placed on the flexion point. The flexion point is often located further back than one thinks in occiput transverse and OP positions [15,21,22]. Despite what some forceps-adepts proclaim, the need for rotation should be one of the main reasons to perform a vacuum. When the correct line of traction is applied, the head will rotate by itself. One should not attempt to manually rotate the cup. This is unnecessary and increases the chance of lacerations to the woman and the baby.

The softcup should not be used for rotational birth, but the Kiwi Omnicup or any metal cup can be used. Both the Kiwi Omnicup and the Bird OP-cup were specifically designed to be able to put the cup on the flexion point in case of a deflexed OP position with the flexion point located deep posteriorly in the pelvis.

Abandonment and complications

Common sense rather than solid evidence has it that the procedure should be abandoned if there is no progress with subsequent pulls; birth is not imminent after the third pull (one pull equals one

Box 4
Reasons for failure of the procedure

1. Placement of the cup outside the flexion point: a larger circumference of the foetal head will have to pass through the birth canal.
2. Incorrect direction of traction. Frequently, inexperienced operators have a tendency to pull too soon too horizontally. Generally, the direction of traction should be dorsally/downwards for most of the procedure.
3. A large caput succedaneum can prevent the development of vacuum in rare cases.
4. Insufficient uterine contractions: oxytocin augmentation is often necessary to achieve good contractions.
5. Cephalopelvic disproportion.
6. Failing equipment.

contraction during which adequate traction force could be applied) or within 20 min from onset [9]. One could question the 'rules of thumb': Are five pulls at relatively low traction force more dangerous to the baby than three strong pulls? Few data are available to answer such questions, which underlines the need for intrapartum research on assisted vaginal birth.

Reasons why vacuum extraction may fail are given in Box 4. Higher rates of failure occur in obese women, large babies, OP position and midpelvic or high vacuums [9]. In several slightly older studies, the Kiwi Omnicup was found to have a high failure rate, of up to 30% [23,24]. However, such high failure rates could not be confirmed in more recent studies, and it appears that failure rates are low in experienced hands [25]. Of note, failure rates of vacuum extractor are also inherent to their safety mechanism: excessive traction force or wrong technique, particularly jerking movements deviating from the pelvic axis, could cause damage to a woman and her child if the cup does not give way.

Maternal complications include post-partum haemorrhage and perineal tears, including anal sphincter ruptures. The latter, however, are less frequent than forceps-assisted births. Post-partum infections appear to be lower after operative vaginal birth than caesarean section [26].

The more common neonatal complications are generally self-limiting or without long-term consequences (cephalhaematoma, jaundice and retinal haemorrhage), but more rare complications can be severe and even life threatening, such as the case in intracranial (epidural, subdural, intraparenchymal and subarachnoid) and subgaleal haemorrhage. In case of the latter, a neonate may lose much of its blood volume in the space between the periosteum of the skull and aponeurosis. Shoulder dystocia may be more common after vacuum-assisted birth [9,12].

In 1998, the United States Food and Drug Administration distributed a public health advisory (May 21, 1998) that stressed the importance of applying the correct indication and technique when resorting to vacuum extraction, as well as the need to educate staff attending to the neonate about complications that may occur. It is important to stress that neonatal staff should at all times be briefed properly by the attending maternity care professional and particularly so in case of high-risk situations such as the sequential use of instruments or failed vacuum extraction with an impacted foetal head at caesarean section. In such situations, the risk of adverse neonatal outcome is increased.

Although, if performed correctly, vacuum extraction is associated with little damage to the mother and the baby, it should not be done if it can safely be avoided. With regard to this, it is important to note that continuous support during labour – which is under increasing pressure in the increasingly computerised labour rooms in many high-income countries – was shown to reduce the need for assisted vaginal birth [27]. Applying delayed pushing in women with neuraxial analgesia was recently found not to reduce the need for operative vaginal birth, and upright positions – previously thought to be beneficial – were found not to increase the chance of spontaneous vaginal birth [28,29].

Conclusions

Vacuum extraction is a technique used in the second stage of labour to facilitate vaginal birth in case of (need to avoid) prolonged second stage or foetal distress. If common sense and a number of safety

precautions are considered, the procedure carries low additional risks to physiological birth. Vacuum extraction is fairly simple to teach and learn.

On a personal note, from a perspective of having worked in both high- and low-income settings, I am convinced that we, obstetricians and guideline makers in high-income countries, have transferred some of our reluctance to perform assisted vaginal births to other parts of the world, in particular our reluctance to perform the more difficult rotational ones. The malpractice of not performing a vacuum-assisted birth if medically indicated and resorting to caesarean section instead is currently costing the lives of women and children. We must turn this tide, and vacuum extraction, a relatively simple procedure that can be taught to and practiced by any maternity care professional, given the context of the global human resources crisis, is probably the best way to perform this.

Practice points

- Do not resort to caesarean section in the second stage of labour without at least considering vacuum extraction.
- Always explain to a woman and her partner your reasons for intending to perform vacuum extraction and what the procedure entails, and debrief with them afterwards.
- Make sure to place the vacuum cup over the flexion point, which in occiput transverse and posterior positions may be located rather dorsally in the woman's pelvis.
- The first pull should generally be directed to the floor of the labour room, following the line of the pelvic axis. Do not pull too horizontally too soon.
- Abandon the procedure if no progress with subsequent pulls. Birth should be imminent after the third pull.
- Be aware of maternal and neonatal side effects of vacuum extraction.
- Train vacuum extraction regularly on models, and make sure that all staff members feel competent to perform vacuum extraction in practice. Ensure sufficient on-job supervision to junior staff.
- Only perform vacuum extraction if medically indicated and avoid unnecessary procedures by ensuring continuous support during childbirth.

Research agenda

- More research in the second stage of labour (e.g. optimal instrument for vacuum extraction, traction force and number of pulls) is needed to enhance safety of vacuum extraction.
- Easy-to-reuse, low-cost and autoclavable handheld extractors should be developed, particularly for use in low- and middle-income countries.
- There is a need for implementation research to overcome dwindling experience and reinstall vacuum extraction in its rightful place as an option for safe childbirth in the second stage of labour.

Conflict of interest

I have no conflict of interest to disclose.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bpobgyn.2018.12.002.

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