VACUUM EXTRACTION

A REVIEW AND ASSESSMENT

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It is seldom that obstetricians are presented with a radically new instrument to facilitate vaginal delivery. Such an instrument, however, is the vacuum extractor, which, with minimal instrumental interference, can effect delivery by traction on the foetal scalp. A completely new concept arises, since this instrument can be applied before full dilatation of the cervix. Should this method of delivery prove to be safe for the baby, a more physiological approach than, for instance, caesarean section, will have been attained. A few years ago a vacuum extractor was designed by Malmström, but the principle is not new.

Historical

A traction apparatus attached to the foetal scalp was first described by Yonge[1] in 1706. His instrument consisted of a glass funnel with an attached suction bulb; however, this innovation aroused no enthusiasm among obstetricians and fell into oblivion. The first subsequent mention of a similar device was made by Saemann[2] in 1794.

The potential value of the principle was recognized by Arnott,[3] who recommended his 'suction tractor' in 1829 as a substitute for obstetrical forceps. He expressed his views as follows:

> 'I suggest the suction tractor as a substitute for the steel forceps in the hands of men who are deficient in manual dexterity, whether from inexperience or natural inaptitude.'

The famous James Simpson[4,5] similarly devised a vacuum apparatus which he named an 'air-tractor'. He constructed it in 1849 and also thought of it as a possible substitute for forceps.

In 1890 McCahey[6] designed his 'atmospheric tractor'. It consisted of a short, straight, rigid handle attached to a cup made of elastic material. He later added a pump to create the required negative pressure. In 1938 Torpin[7] modified this apparatus by substituting a rubber suction cup for the one of elastic material.

Couzigou,[8] in 1947, was the first to devise metal cups connected to a suction pump. The cups were made of aluminium and their diameters ranged from 40 to 65 mm. This apparatus functioned at a negative pressure of 0·8 atmospheres.

Koller[9] reverted to a device without a pump in 1950. He was in favour of less forceful, but continuous, traction. Finderle,[10] in 1952, experimented with a metal funnel, the edge of which was covered with rubber. His negative pressure was also effected by an exhaust pump.

De Montague[11] found the artificial caput caused by the suction a disquieting phenomenon and devised his 'suction plates' in an attempt to obviate it. The concept was a failure.

The 'vacuum extractor' as we know it today owes its existence to Tage Malmström[12] of Sweden, whose experiments started in 1952. He did not have an extraction apparatus in mind initially, but was seeking an artificial means whereby the presenting part of the foetus could be firmly applied to the cervix and lower uterine segment in an attempt to stimulate and intensify the expulsive forces of labour. Extraction of the baby was, originally, only a secondary benefit of the device.

Malmström's first suction cups were made partially of rubber and were not very successful. The final design of the all-metal suction cups of different sizes, with the flanged rim, came in 1956 and has given the best results to date. Credit is also due to Malmström[13] for the elucidation of the mechanics underlying vacuum extraction. The forces involved were calculated with mathematical precision.

DESCRIPTION OF THE MALMSTRÖM APPARATUS

There are four metal cups which are 20 mm. deep and have diameters of 30, 40, 50 and 60 mm. respectively. The cups have rims which are flanged with a slight inward inclination. The sides of the cups have an outward convexity, so that the diameter of the body of the cup exceeds that of the opening. A length of chain connects a metal disc in the floor of the cup to a traction rod. The chain is housed in a length of firm rubber tubing and is coupled to the traction bar by a removable pin. The rubber tubing fits firmly over one end of a hollow metal cylinder which traverses the traction bar crosswise. A longer rubber tube courses from the other end of this cylinder to a vacuum jar with a screw valve. This glass jar is contained in a protective wire basket and carries a manometer calibrated to record a maximum negative pressure of 1 kg. per sq. cm. The vacuum is accomplished by a hand-operated suction pump.

Each of the two cups with the largest diameter has a small node on the convex surface. This serves to mark the direction of the foetal occiput during application, and may also facilitate manual rotation of the foetal head by providing an elevation against which pressure may safely be applied.

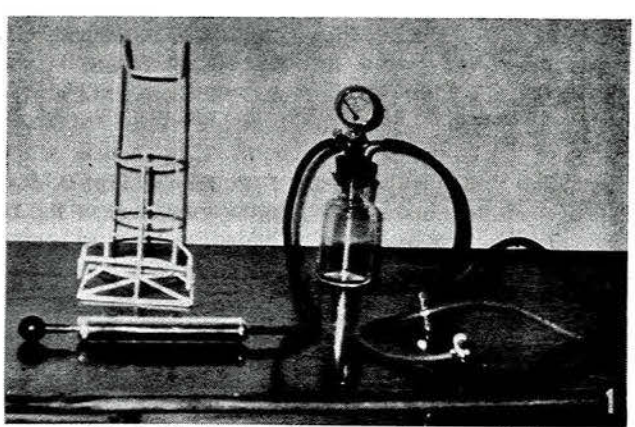

Fig. 1. The Malmström apparatus assembled.

The apparatus is light, compact, easy to transport and simple to assemble (Fig. 1). Sterilization of the extraction unit (i.e. the whole apparatus excluding the vacuum jar, manometer and pump, which need not be sterile) is accomplished by autoclaving or boiling for 15 minutes.

Principles and Technical Aspects

The basic principle is the application of an extraction apparatus to the foetal scalp by means of a vacuum.

Conditions for extraction are optimal when the suction cup and foetal scalp become a single mechanical unit. This ideal condition can only exist if the suction cup is entirely filled by the foetal scalp—only this condition will allow sufficient traction force to be of practical value. This mechanism requires the formation of a marked *caput succedaneum artificiale* in the foetal scalp. This caput is obviously of the same shape and dimensions as the cup with which it was moulded. The French very aptly describe it as a *chignon*.

However ominous this lesion may appear, it need give rise to little concern. Malmström[12] has proved that when a caput succedaneum forms, a functional division takes place between the scalp and the galea aponeurotica, so that a 'scalp membrane' and 'skull ball' come into existence. This potential plane of division was well demonstrated by the injection of air between the scalp and the galea of fresh stillborn infants. He also proved that the application of a suction cup to the foetal scalp (even at excessive negative pressure) has no effect on the pressure of either the inner or the outer surface of the cranium.

Achieving an effective artificial caput succedaneum requires gradually decreasing pressure over a certain minimum period of time. Malmström[12] has proved that the optimal pressure for ordinary traction is —0·6 kg. per sq. cm. He has found that this should be reached by progressively reducing the pressure by 0·1 - 0·2 kg. per sq. cm. every 2 - 3 minutes. It should thus require 10 - 15 minutes to acquire this degree of vacuum. A pressure of —0·8 kg. per sq. cm. is only employed during rotation or manipulation, and then only temporarily.

When the suction cup is applied to a scalp which already has a well-developed natural caput succedaneum, a speedier application is permissible.

Malmström's policy that the caput succedaneum should be formed slowly is supported by Chalmers and Fothergill[14] and Snoeck,[15] but the time factor is ignored by Berggren,[16] who nevertheless claims excellent results.

We have on occasion, in the presence of foetal distress, resorted to fast application without apparent detriment to mother or child.

Adhesion of the suction cup is directly proportional, and pressure increase in the layers deep to the scalp inversely proportional, to the size of the area over which traction is applied. It is therefore of practical importance to use the largest possible cup that a particular case will allow. This must not lead one to conclude that the application of the small suction cup gives rise to excessive increase of intracranial pressure. Both Rosa[17] and Snoeck[15] have conclusively proved that the application of the smallest suction cup only increases the intracranial pressure by 5% of the total pressure increase that a perfect cephalic application of forceps brings about.

Vacuum extraction has a most important additional aspect. It expedites delivery not only by mechanically withdrawing the foetus from the birth canal, but also by exerting a significant and important influence on the forces of labour. It has been found that traction on the foetal head stimulates uterine contractions. This beneficial response is elicited particularly when traction is intermittent and synchronized with the normal, rhythmic uterine contractions.[18] Reflex stimulation of uterine contractions by pressure brought to bear on the cervix and lower uterine segment underlies this phenomenon. Huber[18] suggested that the cervix may act as a 'pacemaker' for uterine contractions.

The posterior segment of the cervix is especially sensitive to this stimulation.[12] It is thus beneficial to apply the head firmly to the posterior part of the birth canal during vacuum extraction.

It is important to bear in mind that successful vacuum extraction demands adequate concomitant uterine contraction and that this is achieved by coordinated traction on the foetal head.

Dilatation of the cervix normally depends on a good application of the presenting part against it. The first stage of labour can therefore be hastened by pulling the head against the cervix by means of the vacuum extractor.

INDICATIONS FOR VACUUM EXTRACTION

The indications for forceps delivery and vacuum extraction coincide, but where the indication for delivery is a matter of urgency preference should be given to the forceps. Optimal application of the vacuum extractor requires at least 5 - 10 minutes, and delivery with this instrument is seldom accomplished in less than 15 minutes. The indications differ in yet another respect — the vacuum extractor may be employed before full dilatation of the cervix, whereas a completely dilated cervix is, for practical purposes, an absolute prerequisite for forceps delivery. The vacuum extractor may also be used with greater impunity than the forceps on the high head. It is accepted that there is no place for the high forceps delivery in modern obstetrics.

TABLE I. INDICATIONS FOR VACUUM EXTRACTION—A REPRESENTATIVE SERIES* (CHALMERS AND FOTHERGILL[14])

Indication	*Cases*	
	Number	*%*
Prolonged first stage	33	16·5
Prolonged second stage	100	50
Foetal distress	38	19
Abruptio placentae	1	0·5
Elderly primipara	1	0·5
Placenta praevia	2	1
Uterine scar	4	2
Respiratory insufficiency	1	0·5
Recent abdominal operation	2	1
Maternal distress	1	0·5
Hysteria	3	1·5
Cardiac disease	3	1·5
Pre-eclampsia	11	5·5
Total	200	100·0

* 24·5% of these were first-stage extractions.

The indications for use of the vacuum extractor in a representative series are given in Table I.

Foetal Indications

1. Threatened foetal asphyxia — excluding cases of marked foetal distress.[14]
2. Occipito-posterior position and deep transverse arrest of the foetal head.
3. Prematurity.
4. Abruptio placentae.
5. Placenta praevia (1st and 2nd degree).
6. Brow presentation.[14]
7. Delay in the birth of the second twin.[19,20]
8. Transverse lie.[14,16]
9. Breech presentation.[14,21,22]
10. Prolapse of the cord.[23]
11. Delivery of the head at caesarean section.[24,25]

Maternal Indications

1. Obstetric Factors

(*a*) Poor uterine contractions with delay in the first or second stage. The inertia may be primary or secondary.

(*b*) Previous caesarean section or a uterus 'scarred' in any other way.
(*c*) Fulminating pre-eclampsia and eclampsia.
(*d*) Minor degrees of contracted pelvis.

2. *Concomitant and Extra-genital Factors*

(*a*) Maternal fatigue and distress.
(*b*) The 'elderly' primipara.
(*c*) Cardiac lesions—with or without congestive failure.
(*d*) Respiratory insufficiency and pulmonary tuberculosis.
(*e*) Diabetes mellitus.
(*f*) Recent abdominal operation with a 'fresh' scar.
(*g*) Hysteria.

As a matter of interest, it deserves to be mentioned that the vacuum extractor also has a use outside obstetrics. De Boer[26] found it of much help in gaining a purchase on large ovarian cysts during laparotomy.

Discussion of Certain Indications

A number of these indications require closer inspection and discussion:

Occipito-posterior Position and Deep Transverse Arrest of the Foetal Head

This indication enjoys the recommendation of Berggren,[16] Malmström,[13] Chalmers and Fothergill,[14] Martius,[27] and Willocks.[28]

E. W. Lillie of Dublin,[23] however, blamed occipito-posterior presentations for 20 failures in his 70 cases of vacuum extraction.

When the vacuum extractor is well applied to the head it provides a grip for digital rotation, without the danger of displacing the head upwards. This is a distinct advantage over conventional manual rotation.[14]

TABLE II. INITIAL POSITION OF FOETAL HEAD IN RELATION TO OUTCOME OF VACUUM EXTRACTION*[14]

Position	*No. of cases*	*Outcome*
Occipito-anterior	57	Occipito-anterior delivery
Occipito-transverse	26	24 autorotation to occipito-anterior 1 Kielland rotation to occipito-anterior 1 occipito-transverse delivery
Occipito-posterior	17	10 occipito-posterior deliveries 7 autorotation to occipito-anterior
Brow	2	1 delivered as brow 1 spontaneous flexion, autorotation through 140°, occipito-posterior delivery

* This series included 16 first-stage extractions and 13 primigravidae.

It is however seldom necessary to employ active manual rotation in these cases, since vacuum extraction *per se* more often than not leads to 'autorotation' of the foetal head (Table II). If it is borne in mind that, in the absence of complicating factors, the anterior rotation of the foetal occiput is normally dependent upon the firm application of a well-flexed foetal head against the trough of the pelvic floor with its forward inclination, then it is easily understood how and why the vacuum extractor will enhance this mechanism.

In the anthropoid type of pelvis or in cases with pre-existent moulding of the foetal head with much natural caput succedaneum formation, it is often least deleterious to mother and child to deliver the baby's head in the persistent occipito-posterior position. The same principle applies in forceps delivery.[29]

We subscribe to this view ourselves. A major proportion of the cases in our series were of this category and we are very favourably impressed with the way in which delivery is facilitated by vacuum extraction *in cases of malrotation of the foetal head*. We relied entirely on autorotation, so that our deliveries were never preceded or accompanied by attempts at manual rotation. It is our firm conviction that proper application and handling of the vacuum extractor allows the foetal head to adopt an optimal position in relation to the specific pelvis concerned, and furthermore we believe that, if autorotation is allowed to take place unimpeded, such rotation will occur at a level best suited to both the type and size of the pelvis and the size and shape of the foetal head. We have often observed how rotation of the occiput in the anterior direction takes place immediately before crowning of the head during vacuum extraction. It is conceivable that mid-pelvic rotation of the head in these cases, whether manually or by means of the Kielland forceps, could be difficult, dangerous and possibly undesirable.

From the practical point of view it is important to mention that in cases of malposition of the foetal head it is permissible initially to apply the vacuum extractor to a part of the foetal head other than the optimal and then later to make an ideal re-application when the position has been corrected. During such a manoeuvre one must be particularly wary of the inclusion of maternal tissue into the suction cup during the second application.

Prematurity

The use of the vacuum extractor on premature babies is a contentious matter. Those who advocate the routine use of forceps delivery in premature labour do so because they believe that the blades of the forceps actively protect the baby's head from compression by the birth canal, and that sudden decompression of the premature baby's head may be prevented as it escapes through the vulval ring.[30,31]

Rosa[17] and Snoeck[15] considered the above contentions to be based on purely imaginary grounds. They championed the use of the vacuum extractor on premature babies, since they experimentally proved that it only gives rise to 1/20th as much increase in intracranial pressure as does 'optimal' forceps application. Snoeck[15] has completely discarded the use of forceps in premature delivery.

Chalmers and Fothergill[14] mentioned 9 babies with a birth weight of less than 5½ lb. in their 1960 series of vacuum extractions. One of these babies succumbed after a relatively easy delivery. It weighed 4 lb. 8 oz. and died of a lacerated tentorium cerebelli.

Considering the vulnerability of the premature infant, one would do well to bear in mind that the vacuum extractor is a relatively new instrument, and that although it seems to be much less dangerous than forceps, it has been known to injure the full-term infant seriously and

even on occasion fatally. Our own attitude on this matter is at present a conservative one.

Delay in the Birth of the Second Twin

Owing to the fact that the vacuum extractor can be applied safely to a high head, the judicious use of the vacuum extractor could well obviate internal version and breech extraction in some cases of delivery of the second twin. Vacuum extraction obviously entails much less risk for mother and child.

Transverse Lie after Rupture of Membranes

Here again vacuum extraction may replace difficult and dangerous internal manipulations. Cases have to be well chosen and will only be those in which the uterus relaxes well between contractions. The foetal head is brought over the cervix and the vacuum extractor applied. This method will be of especial value in those cases where the cord and/or an arm prolapses before full dilatation of the cervix and where there are either contraindications or lack of facilities for immediate caesarean section.

We have successfully delivered one such case.

Breech Presentation

Vacuum extraction has seldom been described in breech presentation.[14,21,22] Where it was employed the suction cup was fitted to the anterior buttock and traction was applied until standard procedures could be adopted. No harm came to the babies in the small series.

Prolapse of the Cord

Lillie[23] successfully employed this technique in the case of a primipara in whom cord prolapse took place with the cervix only half dilated. Vacuum extraction obviously has no place in those cases of cord prolapse with a fully dilated cervix and a well-descended presenting part. In such cases a quick forceps delivery or breech extraction remains the treatment of choice. When the cervix is not fully dilated, caesarean section remains the treatment of choice. Where facilities for immediate caesarean section are not available, vacuum extraction may possibly be a better alternative than bipolar version.

Weak or Incoordinated Uterine Action

Attention must be given particularly to the use of the vacuum extractor before full dilatation of the cervix. Should vacuum extraction in the first stage of labour be effective and not involve additional risks for mother and/or foetus, then the obstetrician has gained an instrument of inestimable value. It could and would be the alternative to caesarean section in many cases. Caesarean section is often resorted to in a prolonged first stage of labour in a primigravida. The pregnancy is often postmature, the presentation is occipito-posterior, uterine action is inadequate and the cervix fails to dilate. Traction with the vacuum extractor in such cases accelerates the first stage of labour and makes vaginal delivery possible. Dilatation of the cervix often progresses at an incredible rate without harming the mother.[12,14,16,32] If vacuum extraction fails to bring about delivery in such cases, it is usually because of undiagnosed cephalo-pelvic disproportion.[33]

Traction on the foetal scalp in the first stage of labour is apparently not always harmless to the baby. Obstetricians have been cautioned, in connection with the increased risk to the foetus in first-stage vacuum extraction, by Greenhill,[34-36] Martius,[37] Boon,[38] and Huntingford.[39]

Huntingford[39] reported an alarming series in this category, where 11 cases were treated. Four of the infants showed signs of cerebral irritation, but recovered. Two infants died (neonatal deaths).

Brey and his co-workers[40] recently reported abnormal electro-encephalographic (EEG) tracings in 21 of 213 babies who had been delivered by vacuum extraction. In 6 of these the changes were specific (hyperactivity), and these workers found that the incidence of abnormal EEG patterns was directly related to the use of the vacuum extractor on the 'high head'. (In this same series 7 babies were lost, although only 1 died of intracranial haemorrhage.)

It would be unwise to draw final conclusions at this early stage, but we should be well advised to exercise caution and restraint in the use of vacuum extraction in the first stage of labour. Data are still too limited and, in particular, the possible long-term results on the children have not yet been sufficiently elucidated.

In our own series there was 1 neonatal death. This was a case of vacuum extraction during the first stage. The baby was of normal size (6 lb. 4 oz.), presented with jaundice in the early neonatal period, and died of a subdural haemorrhage.

Chalmers[41] was not perturbed by the possibility of increased foetal risk as a result of first-stage vacuum extraction. His optimism was based on the fact that no babies were lost during the past 250 vacuum extractions in his department, despite the fact that a prolonged first stage was the indication for vacuum extraction in at least one-sixth of his cases. He did not regard the fact of extraction beginning in the first stage as significant, but pointed out that the danger in this type of extraction lies in the fact that the duration of application and traction often has to exceed the permissible maximum of 40 minutes.

Contracted Pelvis

A severe degree of contracted pelvis is a contraindication for either vacuum extraction or forceps delivery. In borderline cases of disproportion, where forceps delivery would have been attempted, the vacuum extractor is recommended instead of forceps because it offers certain advantages:

(*a*) Because the instrument is applied against and not around the foetal head, it does not further diminish the dimensions of an already contracted parturient canal.

(*b*) Blind instrumentation beyond the palpable part of the foetal head, with all its attendant dangers, is avoided. Where disproportion is involved in forceps delivery, the incidence of maternal injury is higher than with any other indication for forceps.

(*c*) In forceps delivery the forces of labour are often ignored, whereas vacuum extraction accentuates and utilizes this very important factor.

(*d*) Vacuum extraction never requires general anaesthesia, so that the uterine contractions are not depressed. There is also the advantage of the mother being able to participate actively and cooperate.

(*e*) A 'trial vacuum extraction' is permissible, and potentially less dangerous for mother and foetus should it fail.[21] Excessive traction on the foetal head is easy with forceps, but impossible with the vacuum extractor. Detachment follows if too much force is employed during vacuum extraction and little harm is done to the child and none to the mother. Mishell and Kelly[42] have established that vacuum extraction in any event requires 40% less traction force than forceps delivery.

CONTRAINDICATIONS TO VACUUM EXTRACTION

1. Where immediate delivery is imperative. Proper application

of the vacuum extractor requires time (10 - 15 minutes), as does the extraction process proper (a further 5 - 40 minutes).

2. Absolute disproportion.

3. The aftercoming head in breech delivery. The vacuum extractor cannot be employed here, firstly because it would take too much time and secondly because the foetal head does not offer a site for application in such cases.

4. Face presentation. There is grave danger of injury to the baby's eyes.

5. Transverse lie with a 'tonic' uterus. Any form of manipulation may have a fatal outcome.

6. Where the application has already exceeded the 40-minute time limit the attempt at vacuum extraction should be abandoned, since there is a steep increase in the incidence of necrosis of the scalp and even intracranial injury if this period is exceeded.[13]

7. Should detachment of the instrument occur twice, it is unlikely that a third application will result in successful delivery with the vacuum extractor.[14]

TECHNIQUE

After the intended procedure has been explained to the mother she is prepared in the labour room. The patient lies in the lithotomy position, the vulva and surrounding skin are antiseptically cleaned in the customary fashion, and sterile draping is carried out.

The instrument is mounted and tested.

Catheterization and vaginal examination follow. Attention is given to all those factors usually considered before forceps delivery, viz. pelvic type and dimensions, station and presentation of the foetus, moulding, caput, etc. The degree of cervical dilatation is particularly noted (to ascertain which suction cup is to be used) and the membranes are felt for. The membranes should be ruptured during this examination if they have not broken spontaneously beforehand, since it is essential that there should be no intact membranes between the suction cup and the foetal scalp.

The largest suction cup that the cervix (and introitus) will admit is now chosen and lubricated. The obstetrician's left hand separates the labia as far posteriorly as possible, while his right hand introduces the cup into the vagina edgeways. It is carefully and gently pushed upwards to make contact with the foetal scalp. Manipulation now ensures a snug fit of the mouth of the cup against the foetal head over the posterior fontanelle or as near to it as possible. This has been found to be the optimal point to which to apply traction, since flexion of the foetal head is thereby enhanced.

An insufficiently dilated cervix may be gently dilated digitally to allow passage of the suction cup, but under no circumstances should the cervix be incised. If this is done the edges of the incision will be drawn into the suction cup and will prevent effective application.

After satisfactory contact between suction cup and foetal scalp has been achieved, a finger is moved round the cup's perimeter to make sure that no maternal tissue is included.

An assistant now operates the hand pump to decrease the pressure in the apparatus by 0·2 kg. per sq. cm. every 2 minutes until a negative pressure of 0·6 - 0·8 kg. per sq. cm. has been attained. A further 2 minutes are then allowed to elapse before extraction commences. It is not advisable to work with a vacuum greater than −0·8 kg. per sq. cm., and it is essential to create the negative pressure gradually, in order to allow sufficient opportunity for the formation of the *caput succedaneum artificiale*, on which successful adhesion of the suction cup is dependent.

Should manual rotation of the foetal head be deemed necessary, it is undertaken at this stage.

The index and middle fingers of the left hand are now inserted into the vagina to press the foetal head dorsad and to control the attachment of the cup. These fingers are applied to the most anterior part of the foetal head and remain there during the whole extraction (Fig. 2).

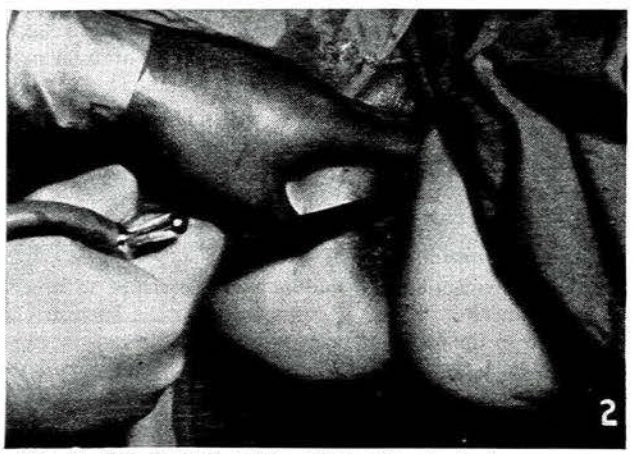

Fig. 2. Coordinated action of the hands during vacuum extraction. Note the left hand applying backward pressure on the foetal head.

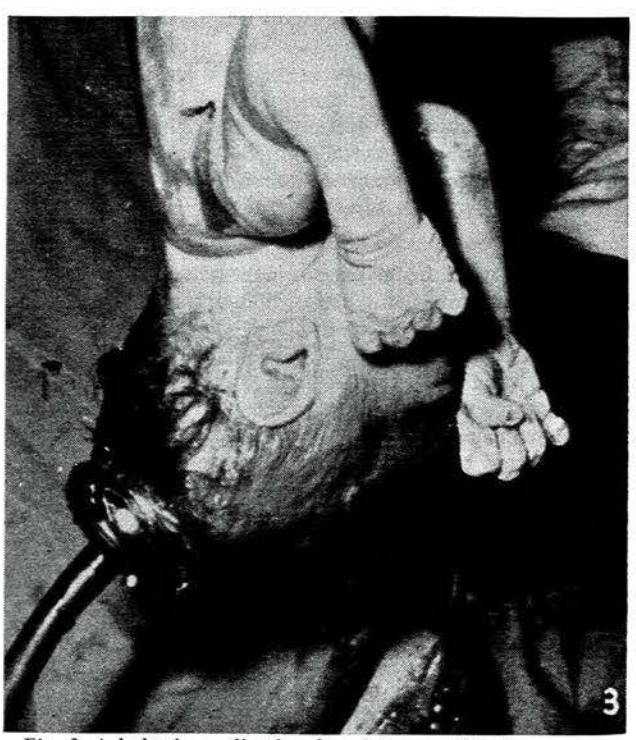

Fig. 3. A baby immediately after delivery with the vacuum extractor. Note the occipital application.

The backward pressure on the foetal head stimulates uterine contraction and ensures that the obstetric pelvic axis is followed by the head. In this connection it should be borne in mind that the foetal head occupies more of the posterior than the anterior segment at the pelvic inlet, and that the 'birth canal' lies closer to the posterior than to the anterior pelvic wall throughout its course.[44] The upper section of the canal is slightly curved and the lower part, which is straight, meets this at right angles. During normal labour the sub-occipital part of the foetal skull does not impinge on the pubic symphysis.[45]

Traction is now applied with the right hand. This traction must be such that the foetal head is encouraged to follow the direction of the pelvic axis. Traction is synchronized with uterine contractions and should under no circumstances be continuous. Care should be taken that the suction cup does not injure the posterior vaginal wall.

When the suction cup reaches the perineum it is carefully guided through. Delivery of the foetal head now follows with or without episiotomy (Fig. 3). Immediately after the head is born, the valve on the vacuum jar is opened so that the suction cup is released. The rest of the delivery is managed in the usual manner.

Vacuum extraction as such is not an indication for episiotomy. Whether or not the patient has an episiotomy depends on the standard indications for this procedure.

A major advantage of vacuum extraction is that it never requires full general anaesthesia.[46] Local infiltration of the vulva and vagina, or pudendal block (with or without inhalation of gas and oxygen during application of the suction cup) are generally regarded as adequate anaesthetic measures by those who regularly use the vacuum extractor.[13,19,47]

We have found pudendal block adequate and agree with Blackman *et al.*,[48] Dexeus,[49] Bruniquel and Israël,[21] and Goldberg and Levy[50] that in the multiparous patient with a patulous vagina anaesthesia may be unnecessary.

CAUSES OF FAILED VACUUM EXTRACTION

The following factors may cause a failure of vacuum extraction:

1. Intact membranes.
2. Interposition of maternal tissue between suction cup and foetal scalp.
3. Insufficient vacuum.
4. Vacuum produced too quickly.
5. Incorrect direction of traction and especially lack of coordination between the 'vaginal hand' and the 'traction hand'.
6. Excessive force during traction.
7. Absolute cephalo-pelvic disproportion.
8. Mechanical defects in the apparatus.

THE CONSEQUENCES OF VACUUM EXTRACTION

A. On the Mother

There can be no doubt that there is but little danger for the mother in vacuum extraction. In this respect it is much safer than forceps.[12,14-16,39,51] Garcia Gamboa,[52] Huntingford,[39] and other workers have stated that vacuum extraction entails no more risk for the mother than does normal vaginal delivery.

Pigeaud[47] regarded the instrument as safe enough to be used as a routine in primiparae, with the sole aim of shortening labour.

Because the vacuum extractor may be used before full dilatation of the cervix and where the foetal head is still high, it may in some cases reduce the incidence of caesarean section and therefore prevent the possible sequelae of this operation.

The benefits the mother derives from not having to have general anaesthesia are obvious.

The only possible maternal complications of vacuum extraction are injury to the birth canal and the results of such injury. The incidence of first-degree perineal lacerations is identical with that in normal delivery, and more serious lacerations occur much less frequently than in forceps delivery. Vaginal rupture and laceration of the cervix do occur, but are not common.

We have been unable to find any reports in the literature of injury to the bladder or rectum or of fistula formation as a result of vacuum extraction. This can be ascribed to the following: (*a*) Continuous traction is not employed, (*b*) forceful traction is impossible, and (*c*) there is no blind instrumentation.

Because general anaesthesia is excluded and the incidence of trauma is so low, vacuum extraction does not predispose to postpartum haemorrhage.

Genital infection in the puerperium is obviously less than after any other form of delivery with instruments. Berggren[16] followed-up the mothers in his series for up to 13 months, and could detect no deleterious after-effects in them.

Huntingford[39] mentioned that it is possible that the use of the vacuum extractor to accelerate the first stage of labour may subsequently lead to incompetence of the internal cervical os, but this question can obviously not be answered before some of the patients who have had first-stage vacuum extractions become pregnant again.

In our series there have been no maternal injuries. We are, however, concerned about the possibility that traction on the foetal head before full dilatation of the cervix may throw undue strain on the supports of the uterus and so injure them that they may become weakened. If this happens it may predispose to genital prolapse in later years. We have, however, seen no such cases of prolapse as yet, but our first vacuum extractions were performed only 17 months ago.

B. On the Child

1. *Caput Succedaneum Artificiale*

The creation of a 'chignon' is essential for optimal application of the vacuum extractor. When seen for the first time this phenomenon is almost alarming — but it is not in itself harmful to the baby (Fig. 4). The size of the swelling rapidly diminishes after birth, and the affected area is flush with the surrounding scalp within 6 hours. Small contusions, petechiae and abrasions commonly occur around the periphery of the application area, but are of little significance and usually disappear within 48 hours (Fig. 5). The site of application is usually no longer recognizable after a week.

Fig. 4. *Caput succedaneum artificiale* lesion immediately after delivery.

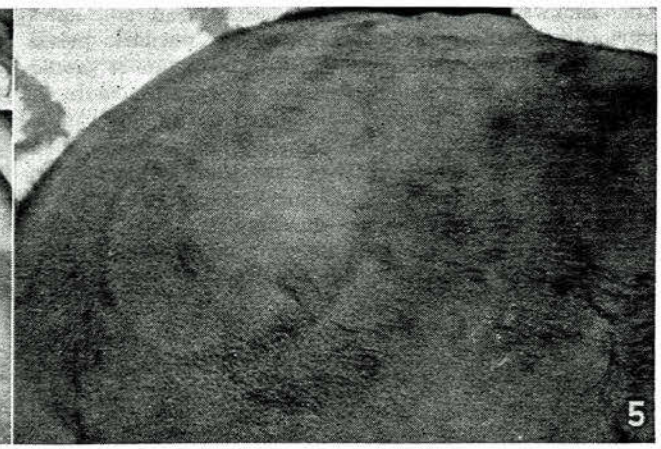

Fig. 5. Application area 48 hours after birth (same baby as in Fig. 4).

2. Necrosis of the Scalp

This is a complication of continuous and/or prolonged traction (more than 40 minutes).[13,14,43,53] This complication need not occur if the basic principles are followed.

3. Cephalhaematoma

The incidence of cephalhaematoma varies from 0·9% to 10% in representative series (we have had no such case to date). This complication is not regarded as very important. All reported cases have undergone spontaneous resolution.

4. Jaundice

In Lauridsen's[54] recent series of 69 cases, jaundice occurred in 2 babies, who both recovered. We have also noted jaundice in those few babies who had extensive contusion of the scalp. Our one neonatal death (subdural haematoma) presented with jaundice. Agüero and Alvarez[55] reported a neonatal jaundice rate of 12%! This is far greater than the rate reported by anyone else.

5. Oedema of the Eyelids and Sub-conjunctival Haemorrhage

Furstenburg and Söderhjelm[56] reported two such cases. Both babies recovered quickly and completely.

6. Fractured Skull

Isolated cases are reported. The worst figures are those of Boon[38] (4 in 160 vacuum extractions), but the incidence of all complications is extremely high in his particular series.

7. Intracranial Haemorrhage

In spite of proof that the vacuum extractor increases the intracranial pressure much less than forceps, cases of intracranial haemorrhage caused by this method of delivery have been reported.[14,16,33,38-40,55-57] Workers like Lauridsen[32] are still reluctant to blame the vacuum extractor for this complication, but even if it is responsible, the vacuum extractor (ventouse) carries much less risk of intracranial haemorrhage than forceps (Table III).

It would appear that first-stage vacuum extraction increases the risk of intracranial haemorrhage.

TABLE III. A COMPARISON OF PERCENTAGE FOETAL MORTALITY IN FORCEPS AND VENTOUSE DELIVERY

Author	*Forceps*	*Ventouse*
	%	%
Bergman and Malmström[58]	4·1	1·5
Holtorff[59]	6·3	0·8
Zilliacus and Sjostedt[60]	8·6	3·5
Chalmers[41]	—	0·3
Average	6·3	1·5

We have had one case of subdural haematoma, which occurred when extraction commenced before complete cervical dilatation.

8. Cerebral Irritation

Boon,[38] Chalmers and Fothergill,[14] and Huntingford[39] described this complication in a small proportion of babies born by vacuum extraction.

The symptoms are irritability, photophobia, a 'cerebral' cry, neck rigidity and a positive Moro sign. The reported cases recovered without exception within 2 - 5 days.

Chalmers and Fothergill[14] and Saunders[61] have employed electrophonocardiography to prove that vacuum extraction does not influence the foetal heart rate. On the other hand Greenhill[36] has had a personal communication from the Russian authority on foetal asphyxia, Persianinov, to disprove the above statement. Foetal electrocardiography showed changes during vacuum extraction — they were temporary, however, and resembled those occurring during forceps delivery.

Facial palsy and injuries to the eyes and ears are well-known possibilities with forceps delivery, but cannot be caused by vacuum extraction.

Because general anaesthesia is neither desirable nor necessary during vacuum extraction, the foetus is not subjected to this additional risk, small as it is with modern anaesthesia.

An important aspect of vacuum extraction which requires more research and elucidation is the question of late sequelae on the child.

Berggren[16] followed-up babies for periods of 1 - 13 months and the only sequelae he found were patches of alopecia in some of them. Smedley[57] examined 22 babies after a year and

could find no local signs nor any deviation from the normal developmental pattern. Evelbauer[62] saw 100 children one year after delivery with the vacuum extractor and could detect no abnormalities.

Lauridsen *et al.*[54] followed-up 65 children from a series of 69 vacuum extractions for 2 - 26 months. The development both mentally and physically was normal in all but one (who was atonic and born to a mentally retarded mother). Three children had pigmentation of the scalp, 2 had areas of alopecia and 1 had a scar on the scalp.

Boon[38] reported permanent damage to the brain in 2 cases in a series of 160. (The incidence of all complications was alarmingly high in this isolated series from Singapore.)

For the sake of comparison the results of two recent series of forceps deliveries are given:

(*a*) Müller and Treiber[63] reported the following results in a series of 43 forceps deliveries. There were 9 early neonatal deaths, 6 of which were due to injury to the brain as established at autopsy. In the later neonatal period a further 3 babies died. Of the survivors there are 8 who have signs of birth injury and, of these, 6 show electro-encephalographic disturbances.

In all fairness it must be stated that the indication for all these deliveries was prolonged labour, and much of the damage was probably caused by the intrapartum foetal anoxia.

(*b*) Ijzerman,[64] of the Netherlands, reported as follows on 224 consecutive forceps deliveries at term: The perinatal mortality was 3·5%; 100 of the survivors were followed-up for periods of 7 - 16 years and the electro-encephalographic pattern was abnormal in 50 of them—in 26 the changes were diffuse and in 24 they were focal.

The vacuum extractor appears to be relatively safe, but we must await the results of more and larger series over a longer period. Table IV gives the perinatal mortality in

TABLE IV. PERINATAL MORTALITY (UNCORRECTED) IN VARIOUS VACUUM-TRACTION SERIES

Author	*Year*	*Size of series*	*Perinatal mortality %*
Berggren[16]	1959	100	6
Snoeck[15]	1960	410	2·9
Hochuli and Stoeckli[33]	1960	264	1·1
Lacombe *et al.*[65]	1959	60	5
De Azevedo[66]	1960	352	5·2
Chalmers and Fothergill[14]	1960	100	4
Hugon *et al.*[67]	1960	600	3·2
Huntingford*[39]	1961	11	18·2
Boon[38]	1961	160	3
Bergman and Malmström[58]	1961	1,389	1·5
Holtorff[59]	1961	?	0·8
Zilliacus and Sjostedt[60]	1961	?	3·5
Chalmers[41]	1962	297	2
Willocks[28]	1962	100	3
Brey *et al.*[40]	1962	213	3·3
Average		312	4·3

* Exclusion of this single series reduces average to 3·2%.

a number of series. We must agree with Huntingford,[39] Martius,[37] and Greenhill[34-36] that we are not yet equipped to judge the long-term consequences of vacuum extraction.

PRESENT SERIES

We began to use vacuum extraction in February 1962 and had delivered 53 babies by the end of 1962. We used this method of delivery only in those cases where delivery would have been by difficult forceps or by caesarean section. Routine substitution of the forceps by the vacuum extractor was deliberately avoided.

Twenty-nine (54·7%) of the patients were primiparae; in 23 (43·4%) there was first-stage intervention, and in 17 (32·1%) the head was not fully engaged.

Indications

The indications in most of the cases were a combination of factors and they can therefore not be tabulated on a percentage basis. The following factors played a role:

A. Foetal

1. Malpresentations — 27 cases. This constituted the major indication for vacuum extraction. Of the 27 cases, 16 presented as occipito-posterior, of which 8 were in the first stage; and 11 as occipito-transverse, of which 5 were in the first stage. Autorotation and successful delivery occurred in all the cases of occipito-transverse position. In 13 of the occipito-posterior positions vacuum extraction was successful after autorotation. In the 3 unsuccessful cases the cervix, fortunately, was fully dilated and forceps delivery, with the head unrotated, was performed. In no case was caesarean section necessary, since vacuum extraction was successful in every one of the 13 first-stage cases.

2. Foetal distress. In all cases foetal distress was a factor. In 6 of these the cervix was not fully dilated. Since delivery was successful, with live babies in all cases, we feel that vacuum extraction supplanted the conventional approach, namely caesarean section, in the 6 cases where the cervix was not fully dilated.

B. Maternal

1. Hypotonic first stage of labour. Although vacuum extraction was commenced in 23 cases where the cervix was not fully dilated, hypotonic inertia was a factor in only 13 of these. Vacuum extraction was successful in all these 13 (with no foetal loss).

2. Antepartum haemorrhage. This was a factor in 7 cases, 5 of them being in the first stage of labour. Delivery was successful in all, but 1 baby died in the neonatal period (intracranial haemorrhage).

3. Diverse factors. The following factors were less important in determining the choice of vacuum extraction as the means of delivery, and usually occurred in combination with one of the abovementioned primary factors. They were: Prolonged second stage (14), maternal distress (7), cardiac failure (4), toxaemia (4), previous caesarean section (3), minor disproportion (2), eclampsia (1), and pneumonia (1).

Anaesthesia

Pudendal block was the anaesthetic used in 33 cases, while 18 cases required no anaesthetic. One patient had the vulva and perineum infiltrated locally, and general anaesthesia was employed in one case owing to lack of maternal cooperation.

Results

Vacuum extraction was successful in all but 4 cases (7·5%). The forceps was used in 3 of these and caesarean section had to be resorted to in 1 patient in whom it was impossible to dilate the cervix beyond 7 cm. This patient had had Shirodkar stitches inserted on 3 occasions, with subsequent cervical fibrosis.

The weight of the babies ranged from 3 lb. 14½ oz. to 11 lb. 2 oz., with a mean of 7 lb.

Foetal Death

One child was lost as a result of vacuum extraction. The indication for intervention was intrapartum accidental haemorrhage in a patient with a history of 2 previous uncomplicated deliveries. The cervix was 7 cm. dilated. The extraction was very easy and the duration of traction only 5 minutes. The baby weighed 6 lb. 4 oz., developed jaundice and cerebral signs in the neonatal period, and died of a subdural haematoma.

Perinatal foetal loss is thus 1·9%.

CONCLUSIONS

The vacuum extractor offers some very real advantages. We have no doubt that it deserves a place in modern obstetric practice and can recommend its use in cases of prolonged labour caused by hypotonic uterine inertia irrespective of full dilatation, provided the head is engaging. It is also remarkably efficacious in cases of malrotation of the foetal head where its use obviates difficult rotations and potentially dangerous forceps deliveries.

We believe that the indications for vacuum extraction are as specific as those for other forms of instrumentation, and although we have found it a relatively safe procedure, would warn against its indiscriminate use.

The future of the vacuum extractor is regarded with enthusiasm, but opinion must be reserved on the possible long-term sequelae of this procedure on the mother and especially on the infant.

SUMMARY

A review of the various aspects of vacuum extraction is given. We report the use of the vacuum extractor in a selected series of 53 cases in the Karl Bremer Hospital during 1962. We conclude that the instrument is relatively safe, has specific indications, and is of particular value in hypotonic uterine inertia and malrotation of the foetal head.

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