THE VACUUM EXTRACTOR — A SUPPLEMENT TO THE OBSTETRIC FORCEPS

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In the year 1848, James Young Simpson, of chloroform fame, read a paper before the Edinburgh Obstetrical Society entitled "The Air-Tractor as a Substitute for the Forceps in Tedious Labours". He made the observation that although the obstetric forceps were very valuable in treating cases of delay in the second stage, yet he was perturbed on account of the trauma every now and again inflicted on the maternal birth passage. It therefore occurred to him that if some contraption, similar to the suctorial discs of limpet shells and cuttle-fish, could be adapted to fix on to the exposed portion of the foetal scalp, an extractive force could be usefully applied to the foetal head. In Simpson's own words:

"If the opposed and adapted surfaces of two bodies have the air removed from between them, then the external atmosphere presses these bodies together, and consequently keeps them united with a force equal to about 15 lbs. upon each square inch. A round disk of two inches in diameter would thus, if the exhaustion of the air were complete, adhere to any proper surface to which it was adapted with a force of 47 lbs.; or, in other words, it would require a power of traction equal to a weight of 47 lbs. to separate it from the surface to which it was attached. A round disk of two and a half inches would adhere with a power amounting to 73 lbs.;....."

"The power that an air-tractor of two and a half or three inches in diameter, when fixed on the head of the child, should give us, is theoretically as much as is required in most, if not in all cases of tedious labour in which the forceps are at present employed..... In attempting to construct a proper obstetric air-tractor, a great variety of forms has been tried. The form which was found most effectual consisted of a slender short brass syringe, one and a half or two inches long, worked by a double-valved piston, like a breast-pump, having attached to its lower extremity a cup of half an inch in depth, and one and a half inches broad at its edge. Such an instrument, when fixed to the palm of the hand, lifted readily without detachment a weight of 30 to 40 lbs."

From the foregoing it is clear that Simpson was not the originator of the idea of employing vacuum suction to aid delivery. But his instrument (Fig. 1) is one among the great variety

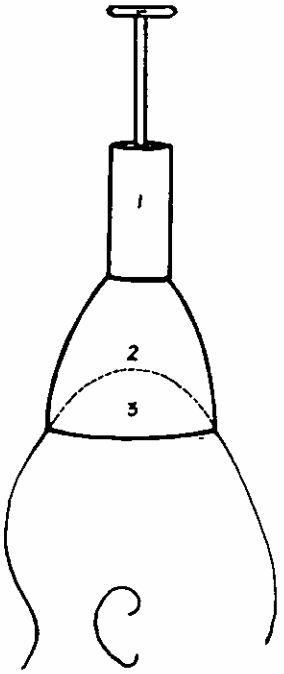

Fig. 1. James Y. Simpson's "Air-tractor", 1848.
Key:
(1) Metal syringe with double-valved piston.
(2) Suction cup.
(3) Artificial caput succedaneum.

invented which left its mark and helps to perpetuate the memory of one of the most versatile and inventive minds in obstetric history. Another proponent of the principle of vacuum extraction was McCahey (1890) who used a rubber cup (Fig. 2) with a solid handle, which, pressed

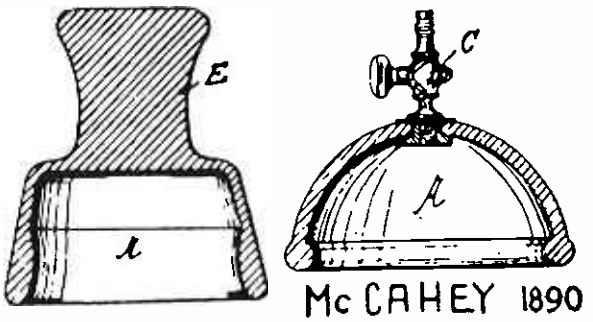

Fig. 2. McCahey's Vacuum Extractor.

firmly on to the foetal scalp created its own vacuum. In America, Torpin (1938) evolved a more elaborate instrument consisting of a rubber suction cup connected to a vacuum pump, with a loop attached to the suction cup for traction.

After careful study and experimentation, Torpin concluded that there was no advantage over the obstetrical forceps and abandoned his invention. A number of other contraptions have been described by Koller (1950), Gastaldo (1951), and Finderle (1952). But the one which was to capture the imaginations of accoucheurs and seriously challenge the Chamberlen family's time-honoured invention — the obstetric forceps — for pride of place on the current obstetrical scene, bears the name of a Swede.

In 1954, Tage Malmstrom described his vacuum extractor which he used to promote contact between the foetal head and cervix, thereby stimulating reflex contraction of the uterus in cases of uterine inertia. In 1957, he modified his instrument and published a monograph which constitutes the most extensive and authoritative article to date. His improved model is now widely used in many European countries, the British Isles. Russia, Africa, China, South America and Japan. The Japanese have brought out their own modification with the control valve incorporated into the traction bar, allowing the operator to control the vacuum at will.

THE VACUUM EXTRACTOR

The essential parts of Malmstrom's vacuum extractor are (a) metal suction cup, with a traction device (Fig. 3), (b) vacuum bottle and

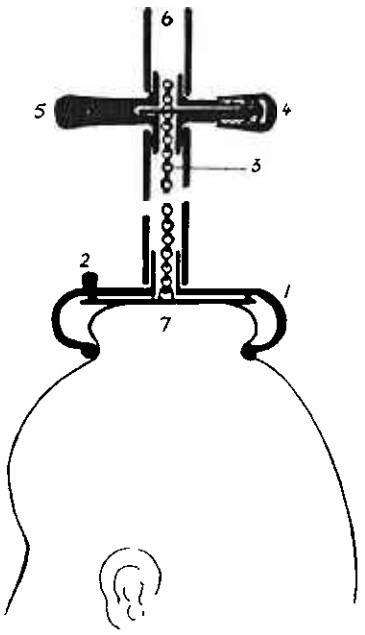

Fig. 3. Malmstrom's Vacuum Extractor.

Key:
(1) Metal cup.
(2) Indicator knob.
(3) Traction chain attached to disc in cup.
(4) Screw cap covering metal pin.
(5) Traction bar.
(6) Rubber tube connection with vacuum bottle.
(7) Artificial caput succedaneum.

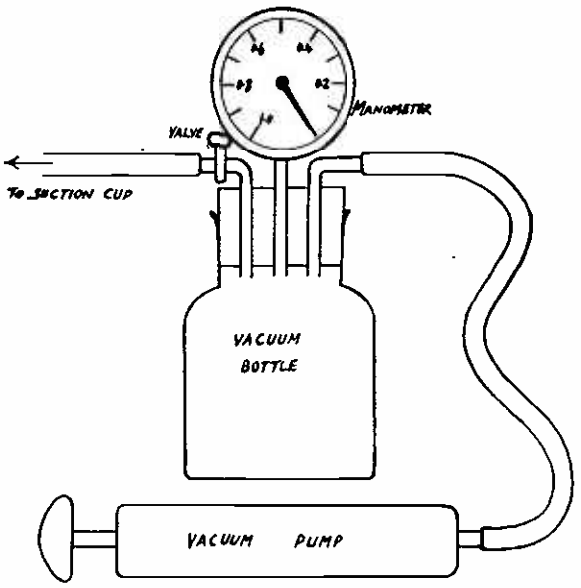

Fig. 4. The Vacuum Apparatus.

pump (Fig. 4). (a) The cup is round and flattened, with hemispherical sides and a flanged rim. The smaller diameter of the mouth gives the cup better sealing properties and thereby a stronger grip. The outside of the cup carries an indicator knob near the rim, while centrally is an opening with a connection for a rubber tube. A metal chain attached to a traction disc within the metal cup leads from the central opening to a traction bar. The traction bar carries a pin which is passed through the traction chain after the chain has been pulled taut before use. (b) The vacuum bottle has a rubber stopper which carries a manometer and two metal connections, one leading to the traction bar and the other to the vacuum pump. One of these connections incorporates a valve by which the vacuum may be controlled.

THEORY AND PRINCIPLES

When the cup is held in contact with the foetal scalp and air is evacuated by means of the vacuum pump, negative pressure acts on the scalp surface. This leads to the formation of an artificial caput succedaneum which together with the cup form a mechanical unit on which traction may be applied. The advantage to be derived is not merely that of the external traction force, but according to Malmstrom (1957) and Saunders (1960) there is the added mechanical stimulation of the cervix by the foetal head which reflexly stimulates uterine contractions. This phenomenon can be demonstrated by tocographic tracings.

In his monograph, Malmstrom (1957), justified the form of his instrument on mathematical grounds. Rosa (1955) and Snoeck (1960) de-

monstrated that under clinical conditions the vacuum extractor was less dangerous than the forceps. In a lengthy exposition supported by complex mathematical equations, Snoeck (1960) stated that "..... the intracranial tension created by the vacuum extractor in the least favourable circumstances (i.e. the smallest cup size) is only one-twentieth of that created by the forceps used under the most favourable conditions.....".

PRACTICAL CONSIDERATIONS

Before embarking on the operation, it is essential to perform a careful clinical examination and assessment of each case so as to eliminate unsuitable cases and minimise failures. As in forceps delivery, emptying of the bladder and bowels should be ensured, as these in themselves may hinder progress in labour. There should be no material disproportion, the head should be engaged or engageable, and the membranes ruptured.

DILATATION OF THE CERVIX

Although some authorities advise against vacuum extraction before full cervical dilatation, the majority opinion (Malmstrom, 1957; Berggren, 1959; Chang, 1958; Snoeck, 1960; Chalmers, 1960) and our own experience support the view-point that the instrument may be profitably employed in the first stage. This is especially true of the case where labour is delayed towards the latter part of the first stage and maternal distress threatens. In such a situation Caesarean section usually provides the solution, although a few would employ Durhrssen's incisions and forceps delivery — now considered by most to be an unduly risky operation. An escape from either procedure is now provided by the vacuum extractor in those cases where physical conditions permit.

POSITION OF THE HEAD

Ideally, the occiput should be anterior and the head well flexed so that the vertex or the region of the posterior fontanelle presents. If the head is deflexed or in an unfavourable position, Meinrenken and Scheiferstein (1957) consider the method valueless. It is true that incomplete or posterior rotation of the occiput may be a cause of failure and if the anterior fontanelle presents, application of the suction cup can be dangerous (Rossel and Champod, 1958). These unfavourable factors are regarded by some as contra-indications to vacuum extraction.

On the other hand, the vacuum extractor takes up none of the available space in the vagina and therefore more room is available for spontaneous rotation of the head as traction and descent take place. Indeed, this gives the instrument a decided advantage over forceps. Evelbauer (1956) refers to this phenomenon as "autorotation" which is a frequently observed occurrence. Malposition, therefore, should not be regarded as a contra-indication to vacuum extraction. Even if autorotation should fail to occur delivery may be effected "face-to-pubes".

THE ANAESTHETIC

It is generally agreed that no general anaesthetic is required. In fact by abolishing maternal co-operation it makes extraction more difficult and protracted. In primiparas and some multiparas, local infiltration with 1 per cent solution of lignocaine is sufficient if the head is low in the pelvis. In multiparas, often no anaesthetic is needed at all. As a complement to local infiltration Malmstrom advises the use of short inhalation anaesthesia just as the instrument is introduced and applied to the foetal head. Where more extensive analgesia is indicated, a formal pudendal block may be given. For nervous or unco-operative patients an intravenous sedative cocktail of 12.5 mg. chlorpromazine and 50 mg. pethidine in 10 ml. normal saline may be used (Smedley, 1960).

THE APPLICATION

Having ascertained the dilatation of the cervical os, an appropriate sized cup — usually the largest permissible — is selected. Lubricated with a surgical antiseptic cream, it is inserted edgeways with strong pressure against the perineum. The cup is held in contact with the foetal scalp and the finger swept round its rim to ensure that no part of the cervix or vagina is included. The site on the scalp chosen should preferably be the portion of the vertex adjacent to the posterior fontanelle over the saggittal suture in order that traction would also encourage flexion. With the cup in place, an assistant creates a vacuum of 0.1-0.2 kg/cm^2. To quote from Malmstrom (1957): "Thereafter this is increased by 0.1 at 2-3 minute intervals. The author usually takes 10-15 minutes over this important phase of creating the instrument's capacity. The importance of this time factor has been underlined by Evelbauer (1956). The final vacuum can be chosen according to the cup's capacity". This usually varies between 0.6 to 0.8 kg/cm^2.

THE METHOD OF DELIVERY

When the desired vacuum has been obtained after the prescribed lapse of time, a tentative pull

may be made, bearing in mind two important principles: first, traction should be synchronized with the uterine contractions and secondly, the direction of pull should as far as possible be at right angles to the transverse axis of the traction cup. Observance of the first principle would ensure maximum effectiveness of the traction, while attention to the second would minimise any tendency for the cup to detach. Since the head follows the curve of Carus in its descent and exit, the direction of traction must describe a similar curve (Fig. 5). If traction has to be

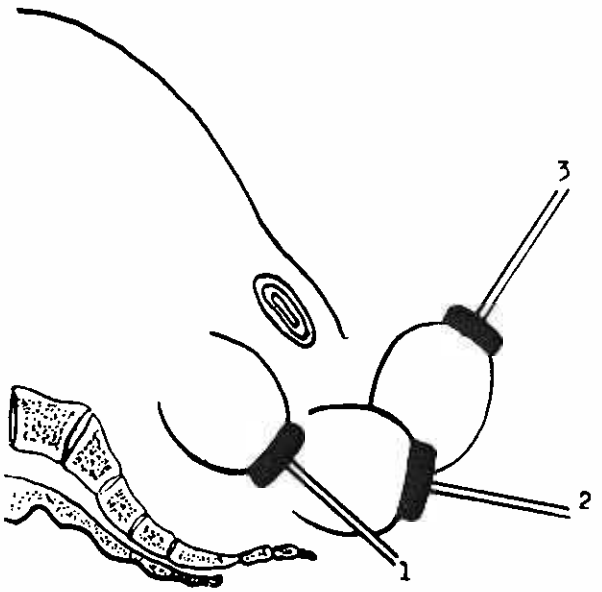

Fig. 5. Sketch showing the changing direction of traction.

exerted in an oblique direction in relation to the cup, there is a tendency for the rim opposite the direction of traction to detach. This tendency may be corrected by applying counter pressure with the fingers.

In order to lessen trauma to the foetal scalp, it is advisable to reduce the vacuum in between pulls, working up the vacuum just before each pull, at the first sign of a commencing uterine contraction. Where necessary, episiotomy may be performed as the head is about to crown. As soon as the head is born, the vacuum is released, the cup removed and delivery completed manually.

INDICATIONS — SCOPE AND LIMITATIONS

The indications for vacuum extraction include all the indications for forceps delivery except face presentation and the after-coming head in breech. It thus has a wide application in prolonged second stage, foetal and maternal distress, eclampsia and severe pre-eclampsia, maternal conditions such as cardiac and lung disease, previous Caesarean section — in order to shorten the second stage. In addition, it may be used to treat these various complications in the first stage, provided the cervix has dilated sufficiently to allow introduction of the small cup. For the control of haemorrhage in minor degrees of placenta praevia, the vacuum extractor is far superior to Willett's forceps.

The scope for the use of the vacuum extractor has so widened in recent years that in some clinics forceps have been completely discarded or nearly so (Snoeck, 1960; Blackman, Pierret and Dussart. 1956; Sohie, 1957; Bruniquel and Israel, 1958), but others consider the newcomer only as a valuable supplement to forceps and a useful addition to the obstetric armamentarium (Chalmers, 1960; Meinrenken and Schieferstein, 1957; Pigeaud, 1957, Dexeus, 1957). The latter point of view seems the more sensible one and is worthy of support.

As already mentioned, the vacuum extractor cannot be applied to the face or after-coming head in breech. Opinion is divided on its use in breech presentation although Chalmers and Fothergill (1960) report success with application to the anterior buttock.

Where foetal distress calls for immediate delivery, the vacuum extractor is at a disadvantage on account of the time-consuming process of building up the artificial caput. In the presence of material cephalo-pelvic disproportion the vacuum extractor would fail because detachment results when traction is excessive. In both these instances, reliance has still to be placed on the use of forceps. The vacuum extractor may prove useful only in securing full cervical dilatation and descent and rotation of the head in order to facilitate application of forceps in cases where more powerful traction is required. Premature infants whose skulls are soft are unsuitable for vacuum extraction for fear of disruption of the intracranial contents.

RESULTS

(a) Maternal

Simpson had conceived of his air-tractor to eliminate maternal birth trauma. This hope has well been realized by all who have given the vacuum extractor a trial. Serious injuries to uterus, cervix, fornices, bladder and vagina which regularly attend the inexpert use of forceps are exploits completely beyond the vacuum cup. The only harm which may come about is inclusion of a portion of vagina or cervix in the rim of the cup, with consequent bruising or laceration. This can be

avoided by careful digital examination before and during the build-up of the vacuum. The need for episiotomy is probably less than in forceps delivery since the vacuum cup does not take up space within the birth canal as the forceps blades would. The episiotomy wound in fact is smaller and hospitalization time may be reduced. Its employment in the the first stage has lowered the incidence of Caesarean section (Berggren, 1959).

(b) Foetal

The thought of a baby being dragged into the world by its scalp must cause some anxiety and misgivings especially in the minds of paediatricians and the more conservative obstetricians. If the foetal skull were a rigid structure as in the adult, tension on the scalp would have no effect on the contents. But the foetal skull is relatively soft, easily compressed and displaced, and presents certain vulnerable spots at the suture lines and the fontanelles, particularly the anterior one. If in securing its grip the vacuum cup should compress the skull this would be reflected in a rise in intracranial pressure. Using an intraspinal manometer in a fresh stillborn baby, de Boer (1960) found that simple application of the suction cup without traction caused the cerebrospinal fluid to rise 25 cm. This shows that there is a considerable increase in the intracranial pressure during normal use of the vacuum extractor, which might prove harmful to the foetal brain.

Furthermore, if there is gross distortion of the skull bones and sutures lines, the meninges may be disrupted, with disastrous effects. What is the evidence available?

The artificial caput appears to be of little consequence. It subsides within a short time and leaves little trace after a few hours. The overlying skin may suffer superficial abrasion but this usually heals in a few days. Cephalhaematoma is a not infrequent occurrence but this as a rule subsides without complication.

A study of the causes of foetal deaths in the literature reveals a few disturbing reports. Intracranial lesions encountered include tear of the tentorium cerebelli (Snoeck, 1960), tentorial tear in the posterior cranial fossa and intracranial haemorrhage (Smedley, 1960). However, these are only a few isolated instances in a growing mass of literature reporting large successful series from many parts of the world.

The great majority of authors report favourably on the foetal results (Kolier, 1950; Malmstrom, 1957; Finderle, 1952; Blackman et al, 1956; Sohie, 1957; Bruniquel and Israel, 1958; Berggren, 1959; Chalmers and Fothergill, 1960). Malmstrom's personal series of 457 cases showed most convincingly that, in his hands, the instrument was absolutely safe for the foetus. His results were confirmed by Evelbauer's report of 250 deliveries without a death attributable to the extractor.

DISCUSSION

From the widespread enthusiasm with which it has been received in many teaching hospitals and conservative schools, it is certain that the vacuum extractor has come to stay. Its popularity has been ensured by a number of obvious advantages over the obstetric forceps. Little skill or experience is needed to operate this simple and practically harmless instrument. Maternal trauma is virtually abolished while foetal results are comparable to those obtained with forceps. Its applicability in the first stage of labour gives it a major advantage over forceps which can be of decisive value in avoiding more drastic operative procedures. The dispensibility of general anaesthesia removes a major hazard in present day obstetrics.

It is safe to say that the vacuum extractor can replace forceps in about 80 per cent of cases requiring assistance. There remain about 20 per cent who will need forceps, such as a cephalopelvic disproportion, occipito-posterior position, prematurity, the after-coming head in breech, and face presentation.

The value of the vacuum extractor in the local setting must be scientifically assessed by ourselves, who labour in conditions and among women in many ways vastly different from those of western communities, whose reports we have just considered. The University Obstetric Unit in conjunction with the Paediatric Unit is presently studying the results of babies extracted with the vacuum cup. The objective is to determine what cerebral damage may be caused by the extractor, and the factors responsible for it. Until we are completely satisfied that our employment of the instrument is within reasonable limits of safety, its use must be regarded as tentative and in the nature of a scientific trial.

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