A METHOD OF ANAESTHESIA FOR CAESAREAN SECTION

Evolution of a technique suitable for use in a country hospital

BY

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The practice of modern obstetrics has reached a high level of efficiency and requires equally efficient anaesthesia. Caesarean section is often performed to increase the baby's chance of survival and the anaesthetic should not appreciably decrease this chance. A maternal death due to anaesthesia is an unacceptable tragedy. Since there is no generally accepted "best" method of anaesthesia for this common operation, it may be of value to record an individual attempt made by the author, working single-handed in a country hospital, to devise a technique suitable for both mother and baby. The following observations are offered for the consideration of anaesthetists who may find themselves working in similar circumstances.

The two most important considerations in the design of a suitable technique are to reduce (1) the risk of maternal vomiting and (2) the effects of the anaesthetic on the foetus. In addition, however, several possible complicating factors may arise. For example, the patient may be toxæmic, shocked, or exhausted by a long unsuccessful labour. Sometimes, too, uterine relaxation may be necessary. Or again, for obstetric reasons, the operation may have to be performed speedily. Finally the obstetrician may use drugs which influence or limit the choice of agents available to the anaesthetist.

Most patients in this country prefer to be unconscious during the operation of caesarean section so that, while many advantages have been claimed for conduction techniques, only general anaesthesia will be discussed here. It is widely accepted that a skilled and experienced anaesthetist should be available for every obstetric anaesthetic, and in considering technique this is presumed to be the case.

VOMITING

In the past few years the increased awareness, largely due to the activities of the Committee of the Association of Anaesthetists on deaths under anaesthesia (Morton and Wylie, 1951) and the writings of Parker (1954), of the danger of vomiting during obstetrical anaesthesia has apparently reduced the maternal mortality from this cause, though fatalities still occur (Walker et al., 1960).

Various well recognized precautions have been advocated to diminish the risk of vomiting and subsequent aspiration. It seems, however, to be difficult or impossible to predict which obstetric patients are most likely to vomit. Therefore, if it is desired to ensure that the stomach shall be empty in all cases every patient must be subjected to pre-operative treatment to this end, and most obstetricians will protest if their patients are submitted routinely to procedures so uncomfortable or dangerous as gastric intubation or apomorphine administration. It would be easier to argue against such protests if these harsh measures invariably prevented vomiting during anaesthesia, but they do not. Therefore the anaesthetist should aim at a technique unlikely to cause vomiting or regurgitation during induction and one which prevents the aspiration of vomit for the remainder of the anaesthetic.

The trend of present opinion seems to favour induction with thiopentone and a relaxant followed by the passage of a cuffed endotracheal tube. Bourne (1956), however, prefers to use an inhalation agent instead of thiopentone in this sequence.

The chance of regurgitation of stomach contents following relaxant administration may be diminished by having the patient steeply tilted foot down during induction (Snow and Nunn, 1959). When the endotracheal tube is in place with the cuff inflated, complete security against aspiration has been achieved and maintenance of anaesthesia by any agent is made easy. Routine use of a cuffed endotracheal tube for caesarean
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anaesthesia has been strongly advocated by a number of writers (Armstrong, 1956; Coleman and Day, 1956; Bingham, 1957; Hodges et al., 1959a). A powerful argument for simpler methods has, however, been advanced by Dinnick (1957) who supports his view by the fact that in the Middlesex Hospital there has been no death from inhalation of vomit in the maternity department for a period of twenty-five years during which these simpler methods were in use. In spite of this fine record there is no doubt that opinion is moving towards routine intubation, and this is reflected in the "Report on Confidential Enquiries into Maternal Deaths 1955–1957" (Walker et al., 1960). This states: "It is striking that in ten cases, including three Caesarean sections, tracheal intubation does not appear to have been planned. Although in seven cases vomiting occurred before intubation could be completed, it is likely that more widespread use of tracheal intubation has avoided many fatalities from this cause."

Whatever method is to be employed the anaesthetist should be on the alert for vomiting, should use a tilting table, and have available an efficient suction apparatus and a bronchoscope.

EFFECT ON THE FOETUS

Some anaesthetic drugs given to the mother pass into the foetal circulation and may delay the onset of respiration in the newborn infant. This is generally assumed to be a harmful effect but it could be advantageous if the infant's first breath were delayed just long enough to allow the pharynx to be cleared of liquor, whose inhalation by an active baby is a danger in abdominal delivery. Anaesthetic depression is not the only factor which may delay neonatal respiration, though others have not yet been very clearly defined. James (1960) mentions biochemical changes and birth trauma, while Hodges and his colleagues (1960a) regard pre-operative foetal distress, pre-operative administration of sedative drugs to the mother, and a prolonged interval (associated with obstetric difficulties) between induction of anaesthesia and delivery as the main nonanaesthetic causes of delayed respiration in the baby. Because of the existence and the indeterminate nature of these additional factors the clinician naturally finds it difficult to discover a regular correlation between depth of maternal anaesthesia and recovery time of the baby. It is therefore surprising to read of a recent series of operative deliveries in which all the babies cried within 2 minutes of delivery (Kane and Stephens, 1959). It is impossible deliberately to use the anaesthetic to produce just enough delay in onset of respiration to ensure that the baby's first breath will not occur until the head has been delivered, but it should be possible to design for the mother an anaesthetic technique which has a negligible effect on the baby's recovery, and this should be the aim of the anaesthetist. The problem of inhalation of liquor must be solved in some other way.

OTHER FACTORS

Usually uterine relaxation is neither necessary nor desirable in Caesarean section but occasionally it may be a great help to the obstetrician. To achieve it, the chosen anaesthetic technique should be capable of modification by the addition of halothane or ether. A relaxed uterus, however, will then be attained only at the price of some depression of the baby.

Exhausted or shocked patients require suitable reduction in dose of the agents used and in very severe shock some anaesthetists prefer to avoid thiopentone. It is the author's experience that severe pre-eclamptic toxaemia seems to make the patient unusually intolerant of blood loss and it is wise to be fully prepared to give a blood transfusion to toxaemic patients.

Oxytocin may be used by the obstetrician to induce labour or to cause contraction of the uterus after delivery. Lesser and Eason (1954) have reported a death from ventricular fibrillation following the combination of oxytocin and cyclopropane, which should therefore be avoided when oxytocin is used. Hodges and his co-workers (1959b) have observed that intravenous infusion of oxytocin may modify the action of suxamethonium so that the normal depolarizing effect is replaced by neuromuscular block of a nondepolarizing type. They suggest that it is reasonable to expect that oxytocin might cause an increased susceptibility to a nondepolarizing relaxant such as tubocurarine, although they have no clinical evidence that this is so. At this stage it can only be said that when an oxytocin drip precedes Caesarean section the
anaesthetist should beware of abnormal reactions to any of the relaxant drugs.

**CHOICE OF DRUGS**

Thiopentone might be considered an unpromising drug for obstetric anaesthesia because it is a respiratory depressant which crosses the placental barrier. Formerly it was held that the placenta delayed maximum transmission of barbiturates for at least 5 minutes (Dundee, 1956), but it now appears that this is not so (Dundee, 1959). According to Crawford (1959a), when thiopentone is given to the mother the level of the drug in the foetal circulation quickly equals that in the maternal circulation and thereafter both fall in an exponential manner. Presumably, if the single induction dose of thiopentone is kept sufficiently small, and if the interval between its injection and delivery of the baby is long enough, then the level in the foetal blood will be so low that it will not cause any appreciable depression of respiration. Opinions vary regarding the permissible size of the induction dose, quantities ranging from 200 mg (Hodges et al., 1959a) to 300 mg (Crawford, 1959b) being mentioned. There is no general agreement on the relationship between thiopentone and the vomiting risk. On one hand, it is claimed that the risk of vomiting is decreased by the tranquil induction usual with thiopentone. On the other hand, the danger of sudden massive regurgitation following thiopentone is stressed.

Nitrous oxide, with at least 20 per cent oxygen, given to the mother appears to cause no delay in respiration of the newborn baby. The uterus can be relaxed, but the depth of ether anaesthesia required to do this may take 15 or 20 minutes to attain.

Hydroxydione produces a remarkably tranquil induction, and its use for Caesarean section has been advocated by Galley and Lerman (1959). It is thought to be a promising agent in obstetric anaesthesia (Ransom, 1959).

Of the commonly used relaxants, gallamine is the only one which has been shown to pass the placenta in amounts which might be harmful to the foetus (Crawford, 1956). Suxamethonium (Wylie and Churchill-Davidson, 1960) and d-tubocurarine (Gray, 1947; Crawford, 1956) do not appear to reach the foetal circulation and can be used freely without fear of causing apnoea neonatorum. It may be that the danger of regurgitation of stomach contents is slightly increased by the period of muscle twitching which often follows suxamethonium administration.

**EVILOUTION OF PRESENT METHOD**

In 1957 the author believed that his standard of anaesthesia for Caesarean section could be improved by applying the methods of induction then in use for general abdominal surgery. The technique chosen was as follows:

Anaesthesia was induced with a full dose of thiopentone (400 to 500 mg) and was followed by a relaxant (gallamine 80 mg or tubocurarine 15 mg or suxamethonium 50 mg). After a short period of inflation of the lungs with oxygen, endotracheal intubation was carried out with a cuffed tube and thereafter anaesthesia was maintained using cyclopropane and oxygen in a closed circuit. Anaesthesia was induced on the operating table; an electrical suction
apparatus was tested and kept running. If vomiting occurred before intubation, the table was tilted steeply head down and the pharynx promptly cleared by suction. No special effort was made to minimize the time between induction of anaesthesia and delivery of the baby.

A record was kept of each anaesthetic, and the intervals between induction and delivery and between delivery and onset of continuing respiration of the baby were timed. The latter interval was chosen because, as Ozinsky and Harrison (1956) have pointed out, it gives a more accurate indication of the state of the baby than "breathing time" or "crying time".

Forty patients undergoing Caesarean section were anaesthetized in this way. Of these, two mothers vomited between induction and intubation but fortunately aspiration was avoided and the patients suffered no sequelae.

Of the forty babies, only ten were breathing satisfactorily within 2 minutes of birth, and the average time between delivery and continuing respiration was 5.4 minutes. No correlation could be found between the induction to delivery interval and the speed of recovery of the baby. The undue depression of the babies in the group was attributed to the generous induction dose of thiopentone. The dose was therefore reduced to a maximum of 250 mg for the next group of fifty Caesarean sections, the technique being otherwise unchanged. Of these patients, one mother vomited between induction and intubation, without aspiration or other sequelae.

Of the fifty babies, satisfactory respiration was established in twenty-six within 2 minutes of birth, and the average time between delivery and continuing respiration was 3.5 minutes. While this represented a decided improvement on the previous group, it seemed that the anaesthetic still delayed unduly the onset of respiration in many babies. Another rather serious disadvantage of this technique was that such dosage of thiopentone and relaxant gave far from ideal conditions for intubation. A struggle to intubate is dangerous to the patient and humiliating for the anaesthetist.

Since, according to Apgar and her colleagues (1957), cyclopropane given to the mother has an adverse effect on the recovery of the baby, it was decided to exclude this agent from the next technique to be used, which was as follows:

The patient, premedicated with atropine 0.6 mg is placed on the operating table which is tilted steeply foot down (Snow and Nunn, 1959). The suction apparatus is tested and kept running. Through a Gordh needle a test dose of d-tubocurarine 5 mg is injected intravenously (Gray, 1959). If there is no abnormal reaction, thiopentone 100 mg in 24 per cent solution is injected, followed immediately by d-tubocurarine 25 mg. After a short pause a further dose of 150 mg of thiopentone is added. It is felt that this sequence of injection allows the relaxant to develop most of its effect before that of the thiopentone wears off. A short period of gentle inflation of the lungs with nitrous oxide and oxygen is carried out and when the jaw is relaxed auffed endotracheal tube is introduced. The patient is then hyperventilated with a mixture of 80 per cent nitrous oxide and 20 per cent oxygen, following the technique of Geddes and Gray (1959). On delivery of the baby, ergometrine maleate 0.5 mg is given through the Gordh needle and the obstetrician places the baby on a table where there is a pillow covered by a sterile towel, allowing a head-down tilt. The anaesthetist clears the baby's pharynx by mechanical suction and, assisted by the midwife, carries out whatever resuscitation is thought necessary. This arrangement allows endotracheal intubation of the baby to be carried out quickly if it is considered advisable. The author agrees with the view of Hodges and his colleagues (1960b) that endotracheal intubation and ventilation with oxygen is far more effective than that available by suction during delivery.

Two modifications of the technique might be necessary in certain circumstances, which did not in fact arise in any of the thirty cases recorded. First there are instances where an examination under anaesthesia is necessary to decide whether or not to proceed with Caesarean section. In these, suxamethonium is more effective than thiopentone which is given later if necessary. Second, the obstetrician may request uterine relaxation. Here halothane vapour should be added to the gas mixture for a few minutes before the uterus is opened. A most careful watch being kept on the maternal blood pressure during the halothane administration.

**COMPARISON OF RESULTS**

Records were kept during the three stages of development of the anaesthetic technique, and the results are grouped as follows:

**Group I.** Induction with thiopentone 400 to 500 mg, relaxant (tubocurarine 15 mg or gallamine 80 mg or suxamethonium 50 mg), and maintenance with cyclopropane and oxygen.

**Group II.** Induction with not more than 250 mg of thiopentone, relaxant (tubocurarine 15 mg or suxamethonium 50 mg), and maintenance with cyclopropane and oxygen.

**Group III.** Induction with not more than 250 mg thiopentone, relaxant (tubocurarine 30 mg), and maintenance with a nitrous oxide and oxygen mixture.

The results are summarized in table I, and the
histograms (fig. 1) compare the recovery times of the babies in the three groups. It is evident that each successive change in technique brought an improvement in the state of the babies. While 30 per cent of the babies in group I were severely depressed, it must be remembered that the endpoint of continuing respiration was not recorded until the baby’s respiration was fully established, and before this point was reached intermittent breathing took place. None of the babies in any group failed to establish respiration.

Slightly more than half of the babies in group II were considered satisfactory, and here it is felt that cyclopropane was an important factor causing neonatal depression. Its exclusion led to a marked improvement in group III. While the results seem to indicate that the technique used in group III is an acceptable one, the ideal of negligible anaesthetic depression of the baby has not yet been reached.

Finally, no correlation could be found between the induction-to-delivery interval and the speed of recovery of the baby in any group, nor in the results of the three groups taken together.

DISCUSSION

In this series of cases no account has been taken of the nonanaesthetic factors, such as pre-operative foetal distress, which are known to lead to neonatal depression.

While no firm conclusions may be based on such a small series, the results obtained indicate that techniques using thiopentone for induction and cyclopropane for maintenance are unsuitable for Caesarean section because of the depressant effect on the babies. A technique consisting of a limited dose of thiopentone for induction, a muscle relaxant, and nitrous oxide and oxygen for maintenance, is acceptable but not ideal.

A routine assessment of the state of the baby delivered by Caesarean section is almost certainly valuable to indicate the success (or otherwise) of the anaesthetic technique used. The baby’s condition can be simply gauged by recording the time between delivery and onset of continuing respiration, or by scoring on the Apgar system (Apgar, 1953). A healthy dissatisfaction with the anaesthetic method may result.

SUMMARY AND CONCLUSIONS

The requirements of anaesthesia for Caesarean section are discussed.

| Table I | Results obtained in three groups of patients undergoing Caesarean section. |
|--------|-------------------------------------------------|-----------------|-----------------|-----------------|
|         | Group I (40 patients)                          | Group II (50 patients) | Group III (30 patients) |
| Average interval between delivery and continuing respiration (min) | 5.4 | 3.5 | 1.8 |
| Satisfactory babies (delivery to continuing respiration interval not over 2 minutes) | 10 (25%) | 26 (52%) | 20 (67%) |
| Severe neonatal asphyxia (delivery to continuing respiration time 8 or more minutes) | 12 (30%) | 6 (12%) | 1 (3.3%) |
| Mother vomited | 2 (5%) | 1 (2%) | 1 (3.3%) |
| Baby inhaled liquor | 1 (2.5%) | 3 (6%) | 4 (13.3%) |
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Following a decision to apply the induction methods in use for general surgery to Caesarean section, an anaesthetic technique was used which consisted of a large induction dose of thiopentone, a relaxant, endotracheal intubation and maintenance by cyclopropane. Recordings of the time between delivery and onset of continuing respiration of the baby revealed that this technique produced severe depression in many babies. Reduction of the dose of thiopentone led to an improvement. When, in addition, nitrous oxide was substituted for cyclopropane, a further improvement resulted. It was concluded that large induction doses of thiopentone and cyclopropane should both be avoided in Caesarean anaesthesia because of their effects on the baby.

An opinion was expressed that routine assessment of the baby delivered by Caesarean section is a valuable indication of the success of the anaesthetic technique used.

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REFERENCES


