THE USE OF MUSCLE RELAXANTS AT THE INDUCTION OF ANAESTHESIA OF PATIENTS WITH A FULL STOMACH

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SUMMARY

The use of a muscle relaxant after a rapid induction of anaesthesia will facilitate intubation and prevent vomiting when the patient is paralyzed. After paralysis, fluid may flow passively from the stomach and oesophagus if the patient be horizontal or tilted head-down, and will make rapid endotracheal intubation difficult, thus putting the patient in hazard from hypoxia. Tracheal aspiration is, however, unlikely. The passive movement of fluid is prevented by a foot-down tilt during induction, but, if any other factor cause fluid to reach the oropharynx in this position, tracheal aspiration is very likely, and has occurred in several instances. Possible factors are attempted vomiting before the onset of paralysis, abnormalities of the gastro-oesophageal junction, perhaps associated with respiratory trouble during induction, and changes in intragastric pressure during induction. The dangers of methods dependent on a muscle relaxant in the hands of inexperienced doctors are stressed, and the need to consider gastric decompression and to practice pre-oxygenation of the patient prior to anaesthesia are emphasized. It is concluded that insufficient evidence is available to favour one position more than another during induction. Cricoid pressure to occlude the oesophagus against the cervical vertebrae should be used, if the supine horizontal position be chosen.

The use of thiopentone immediately followed by a full dose of a muscle relaxant provides a pleasant induction and facilitates quick and easy intubation. Vomiting being defined as an active, co-ordinated process dependent on skeletal muscle activity, and regurgitation as passive, it seemed logical twelve years ago to advocate placing the patient in a foot-down tilt to prevent fluid flowing from the oesophagus or stomach towards the glottis (Morton and Wylie, 1951). The potential dangers of the technique, not least those to the circulation, were emphasized. The empiricism of this theoretical reasoning is now apparent from the wider knowledge available of gastro-oesophageal physiology and of the effects of anaesthetic drugs and techniques upon it. Despite this, clinical experience, both published and otherwise, suggests that, in suitable circumstances, this method has much to commend it, and that complications during it are in practice uncommon. These complications, or the fear of them, have, however, led anaesthetists to suggest alternative methods for a rapid induction associated with the use of a muscle relaxant. It is intended in this paper to review the factors concerned and the possible means for ensuring safety.

GASTRO-oesophageal PHYSIOLOGY

The upper end of the oesophagus is guarded by the cricopharyngeal sphincter, which is composed of striated muscle and is partly under voluntary and partly under reflex control. The muscle of the remainder of the oesophagus and of the stomach is smooth and under reflex control.

The gastro-oesophageal junction does not represent an exact point, but an area at the termination of the oesophagus which performs the functions of a valve and a sphincter (Dornhorst et al., 1954; Fyke et al., 1956). Fyke found a localized point in this area named the pressure barrier, since it seals off the sphincter area below it from changes in oesophageal pressure associated with normal conditions of respiration. Creamer and his colleagues (1959) have shown that, in normal people, the level of this pressure barrier coincides with
the level of the oesophageal hiatus of the dia-
phragm, and that, below it, there is a segment of
oesophagus of about 2 cm in length lying within
the abdominal cavity and subject to intra-
abdominal pressure. This abdominal part of the
oesophagus is kept as a narrow tube by virtue of
the sphincter area that surrounds it. Creamer
suggests that a flaccid tube (the oesophagus)
running from a chamber of low pressure (the
thorax) to one of high pressure (the abdomen)
would behave in the area of high pressure like a
“flap” valve and collapse, only opening to allow
forward flow when the pressure gradient has been
overcome.

Marchand (1957) demonstrated that the pres-
sure within the resting stomach is a measure of
the general intra-abdominal pressure, but that
significant intragastric pressure changes may result
from the muscular activity of the stomach. It
seems important to recognize this differentiation
when discussing the possible effects of a raised
intragastric pressure on the competence of the
valve mechanism at the gastro-oesophageal
junction. As Creamer suggests, a general rise in
the intra-abdominal pressure should act against
reflux from the stomach to the oesophagus by
closing the “flap” valve mechanism, while a
rise in the intragastric pressure above intra-
abdominal pressure would overcome the valve
action, unless the sphincter area of the oesophagus
is caused to constrict by the same forces as affect
the stomach. Thus, although a rise in intra-
abdominal pressure will lead to a rise in intra-
 gastric pressure, it should not, in a normal person,
lead to reflux.

Abnormalities.

Marked malfunction at the gastro-oesophageal
junction may be associated with an anatomical
distortion such as that caused by hiatus hernia,
a distended stomach (Robson and Welt, 1959),
the presence of an oesophageal tube, or with a
physiological abnormality produced during the
induction of anaesthesia. Airway obstruction during
induction will reduce the intrathoracic pressure
considerably during each attempted inspiration,
and may make the valve mechanism incompe-
tent (O'Mullane, 1954; Sinclair, 1959), and
attempted inflation of the lungs by positive pres-
sure following paralysis, before intubation of the
tracea, can precipitate reflux from the stomach
or oesophagus through the relaxed cricopharyngeal
sphincter. Coughing and straining may precipitate
reflux, if the mechanism to prevent it be weak or
abnormal (Marchand, 1957).

Dinnick (1961) has drawn attention to the part
that inspiratory obstruction during the induction
of anaesthesia may play in causing regurgitation
from the stomach of a patient with a previously
unsuspected hiatus hernia, a condition which is
common in pregnant women. It is tempting to
speculate on the part that progesterone may play
at the gastro-oesophageal junction during preg-
nancy. A high level of this hormone is present
in the body during late pregnancy, and the relax-
ing effect that this produces on smooth muscle
might conceivably affect the efficiency of the
sphincter mechanism, and hence the functioning
of the “flap” valve even when the diaphragma-
tic hiatus is normal.

Posture.

Although changes in position from supine to
foot-down or to head-down produce alterations in
intragastric pressure, they do not in a normal,
unanaesthetized person, affect the proper function-
ing of the gastro-oesophageal junction. The effects
of the position of a patient during the induction
of anaesthesia and paralysis must be considered
in relation to the action of the drugs administered
at the time and to the possible responses of that
patient. All that can be said with any degree of
objectivity is as follows: a steep foot-down tilt
prevents the passive flow of fluid towards the
oropharynx once paralysis is complete, but it
renders tracheal aspiration probable should gastric
or oesophageal contents reach the oropharynx by
any other means, either before or during the onset
of paralysis. A foot-down tilt lowers intragastric
pressure, and enhances any adverse effects that the
drugs used may have on the patient's circulation.
A steep head-down tilt raises intragastric pressure
and encourages the passive flow of fluid toward the
oropharynx, but makes tracheal aspiration
improbable in the presence of total paralysis. The
supine, horizontal position combines in some
measure the disadvantages of the two positions
described, while the lateral position (normally, the
left) used with a head-down tilt assists fluid to
drain away from the area of the glottis, but
hampers laryngoscopy.
Emptying the stomach immediately before anaesthesia.

If it were possible to guarantee an empty stomach for several minutes immediately prior to anaesthesia by the passage of an oesophageal tube, then most of the problems associated with the induction of anaesthesia would disappear. In practice, this guarantee cannot be given, although at least that of a reduction in intragastric tension can.

Premedication.
The only essential is an adequate degree of parasympathetic block by atropine sulphate or an equivalent drug.

ANAESTHESIA FOR INDUCTION

When the use of a muscle relaxant is intended primarily to make vomiting impossible, then the anaesthetic agent for induction must be chosen to avoid vomiting while awaiting the onset of paralysis. Thus it is usual to select an agent that will produce unconsciousness rapidly. Either thiopentone or cyclopropane is suitable for this purpose.

Thiopentone is pleasant for the patient and simple to administer, but it must be used with caution, if at all, when the cardiovascular state of the patient is poor and the foot-down position is adopted. Hypotension in the foot-down position can be offset to some extent by raising the legs 10° above the horizontal (Sykes, 1960). Thiopentone is not contraindicated in obstetric practice (Crawford and Kane, 1956). Hodges and his co-workers (1959) consider that, in obstetric practice, the advantages of a smooth and rapid induction of anaesthesia with 150 to 200 mg of thiopentone offset any adverse effects that this drug may have on the foetus. A rapid induction can be achieved with a mixture of 50 per cent cyclopropane and 50 per cent oxygen delivered from a previously filled bag of 6 litres capacity (Bourne, 1954). This is a single-dose method of inhalational induction which requires from 6 to 20 breaths, taking from 20 to 60 seconds to become effective, and which produces anaesthesia for up to 1½ minutes with adequate oxygenation of the patient for that time. The total quantity of cyclopropane given has no adverse effects on the circulation and, in obstetric practice, does not depress the foetus, since it can be speedily washed out of the mother once she has been intubated and ventilation of the lungs has commenced. A rapid induction with cyclopropane in the manner described is remarkably free from vomiting, perhaps due to the predominance of the respiratory drive associated with rebreathing.

Should the use of a muscle relaxant be intended primarily to facilitate intubation rather than to prevent vomiting, then a more leisurely induction of anaesthesia with halothane and oxygen may be valuable. Vomiting is not common when halothane is administered, but, to prevent tracheal aspiration should it occur, the patient must be in a head-down position. If halothane be used only for induction of anaesthesia in an obstetric patient, then it seems improbable that any adverse effect would occur either on uterine tone or on foetal respiration, but evidence is still awaited on these points.

Whatever method of induction be chosen, inflation of the patient's lungs with oxygen must not be carried out until endotracheal intubation has been completed and a cuff inflated around the tube. Therefore, when thiopentone is administered, it must be immediately preceded by the patient inhaling 100 per cent oxygen for 2 to 3 minutes. Oxygen inhalation should be continued until paralysis is complete. Although the induction as described with cyclopropane will provide oxygenation of the patient for a limited period, pre-oxygenation should be practised also, since this extends the time after paralysis when oxygenation is adequate, and increases the safety of the technique should laryngoscopy and intubation prove difficult.

Muscle relaxants.

Active vomiting cannot occur after total muscle paralysis, but the cricopharyngeal muscle will now be paralyzed and the protection normally offered to the glottis by this sphincter is absent. No muscle relaxant has a direct effect on the gastro-oesophageal junction (O'Mullane, 1954), but the use of suxamethonium is associated with a rise in intragastric pressure in some patients (Andersen, 1962; Roe, 1962). Since there is no evidence available to suggest that suxamethonium has a direct effect on the smooth muscle of the stomach, this rise in intragastric pressure is presumably secondary to a rise in intra-abdominal pressure.
caused by the fasciculations of skeletal muscles during depolarization. Such an effect is not caused by either tubocurarine chloride or gallamine triethiodide, but both these relaxants take longer than suxamethonium to exert their full effect. A further advantage of suxamethonium is that profound paralysis of brief duration can be produced with a moderate dose.

In obstetric practice, transfer of the muscle relaxant across the placenta and a possible effect on the foetus must be considered. Tubocurarine, gallamine and suxamethonium can all pass through the placenta and reach the foetus. When equipotent clinical doses of the first two of these relaxants are used, only traces of tubocurarine can be found in foetal serum, compared with readily detectable and possibly significant amounts of gallamine (Crawford and Gardiner, 1956). It seems likely that maternal doses of the order of 300 to 500 mg of suxamethonium are needed before this relaxant can be detected in foetal serum, and even then there is no clinical effect on the infant at birth (Moya et al., 1960). A subsidiary point to note when considering placental transfer is that neonates are resistant to depolarizing relaxants such as suxamethonium (Stead, 1955).

DISCUSSION

Only a limited number of facts can be stated dogmatically. No technique of anaesthesia is foolproof, but the use of a muscle relaxant following a rapid induction of anaesthesia is particularly hazardous, in the presence of a full stomach, if the rationale of this method be not fully understood by the anaesthetist. None of the methods discussed is suitable for inexperienced or unskilled anaesthetists. It is particularly important that all apparatus (suction, anaesthetic, laryngoscope) be checked immediately before anaesthesia. The patient should be on the operating table, or a labour ward bed designed to tilt like an operating table, and a vein cannulated before the induction of anaesthesia, so that intravenous injection can be given without delay. Oxygenation should precede the induction of anaesthesia for 2 to 3 minutes. The choice of drugs and posture is more problematical.

Hodges and his colleagues (Hodges et al., 1959; 1960; Hodges, 1960) have successfully combined the foot-down tilt with thioptone and suxamethonium in 1,500 anaesthetic inductions for operative obstetric procedures without vomiting or regurgitation. Snow and Nunn (1959) report the use of thiopentone and gallamine with the foot-down tilt for 606 patients, 480 of them being induced for Caesarean section, all considered to be at risk from a full stomach. They did not encounter tracheal aspiration of gastric contents in any patient, but had one instance when fluid was forced into the oropharynx because of inadequate paralysis and an explosive cough at the moment of intubation. Snow and Nunn chose gallamine to ensure that the abdominal muscles were not stimulated to contract during induction. They positioned each patient 40° foot-down from the horizontal to raise the larynx 19 cm above the cardio-oesophageal junction, assuming a distance between these two points in an adult of 25 cm and a 10° inclination of this line to the vertical axis of the body. The calculation of the degree of tilt necessary is based on O'Mullane's (1954) finding that, even with distension of the abdomen, intragastric pressure did not rise above 18 cm of water. However, an intragastric pressure above this level may occur in certain circumstances, for instance, when suxamethonium is used, although whether or not it is able to upset the competence of the cardio-oesophageal valve in a normal person is unknown.

It seems certain that, despite a steep foot-down tilt, fluid may reach the oropharynx during induction and may enter the trachea. Active vomiting may take place before paralysis is complete (Sellick, 1961). In a recently reported series of 428 obstetric patients for whom a rapid induction of anaesthesia in the foot-down position was followed by paralysis with suxamethonium, three patients (0.7 per cent) were found to have fluid in the oropharynx at the time of laryngoscopy, and, in one of these, some fluid entered the trachea (Wylie, 1961). Whether this complication is initiated by an attempted vomit, partial respiratory obstruction, and abnormality at the gastro-oesophageal junction, the effects of the drugs administered, or to some other factor or factors, cannot yet be proved. It is, however, a risk which must be set against the advantages of the technique, and must be compared with the difficulties encountered when a passive flow of fluid follows...
the onset of paralysis in a patient placed either supine or in the left lateral position with a head-down tilt. In obstetric practice, it is particularly important to ensure full maternal oxygenation at all times. After paralysis is complete, any undue delay in intubating the mother and ventilating her lungs may be disastrous. Laryngoscopy and endotracheal intubation cannot always be carried out easily, even when the patient is fully relaxed. Rarely, intubation may be impossible. Difficulties of this kind are commonly associated with malformation of the jaws or teeth, and should therefore be visible to the discerning anaesthetist before this form of anaesthetic induction is chosen. Sometimes laryngoscopy is difficult in an obstetric patient simply because of the size of the tongue, a sort of temporary macroglossia of late pregnancy.

Bourne (1958) advocates the left lateral position with a head-down tilt and, more recently (Bourne, 1962), this posture coupled with induction of anaesthesia with halothane and oxygen, followed by suxamethonium for intubation. Sellick (1961) suggests an alternative to the use of posture: during the induction of anaesthesia with the patient supine and the head and neck fully extended, an assistant exerts backward pressure on the cricoid cartilage to occlude the oesophagus against the cervical vertebrae. Sellick warns that this technique may be dangerous in the presence of vomiting, since the oesophagus might be damaged under high pressure. An assessment of the value of these techniques must await further reports of their clinical use.

The lack of complications from vomiting in the two series reported by Hodges and his colleagues (1960) and by Snow and Nunn (1959) may be due to the fact that an oesophageal tube was passed on any patient thought to be particularly likely to have a distended stomach. This is a procedure that is more or less routinely carried out for surgical emergencies, but that is not recommended with any degree of unanimity in obstetric practice. For a patient in labour, the need for anaesthesia may be so urgent that no time can be spared for emptying the stomach. But even when time is available, the routine passage of an oesophageal tube can hardly be considered acceptable for a woman in labour. When such a tube is thought necessary a 7-mm (gauge 12) size is most suitable.

CONCLUSIONS

None of the methods discussed can be considered ideal in all circumstances, each having some disadvantage to offset its particular advantage. None is suitable for an inexperienced anaesthetist, and all demand technical skill for their safe accomplishment. There is insufficient evidence available to favour one position more than any other, but the choice seems to lie between the left lateral with a head-down tilt and the supine with a foot-down tilt. If the supine, horizontal position be adopted, it must be combined with pressure on the cricoid to occlude the oesophagus. The choice of drugs is less important in the lateral, head-down position than with a foot-down tilt. For the latter, a small dose of thiopentone followed by suxamethonium seems most suitable, having regard to all the circumstances, particularly in obstetric practice, but the patient's circulatory state must be satisfactory.

REFERENCES

USE OF MUSCLE RELAXANTS AT THE INDUCTION OF ANAESTHESIA


THE XIII FRENCH CONGRESS OF ANAESTHESIOLOGY

The XIII French Congress of Anaesthesiology will be held in Bordeaux at Whitsuntide, on May 31 and June 2 and 3.

The Congress is being organized jointly by the three French Societies of Anaesthesiology:
- The French Society of Anaesthesiology, Analgesia and Reanimation;
- The French Association of Anaesthesiologists;
- The National Syndicate of French Anaesthesiologists.

The Scientific Programme is as follows:
1. The delivery of two reports, followed by papers, on the subjects:
   - "Therapeutics of Respiratory Failure in Surgical Pathology outside the Operating Theatre", by Dr. M. Cara, Professor (Agrégé) L. Lareng, Dts. Echter, Gervais, Jolij, Poisvert.
   - "Anaesthesiology and Kidney Function", by Dr. Caillard.
2. Programmed discussions:
   - "Drowning", by Professor (Agrégé) Joly.
   - "Venous Irritation of a Chemical Origin", by Dr. P. Huguendard.
   - "Gastric Pathology and Acute Aggression", by Professor (Agrégé) du Cailar and Dr. P. Jaquesound.
   - "One Year's Experience of Intravenous Lipids", by Dr. P. Deligne.
3. Meetings for unscheduled reports.
4. A legal talk by Me. Fontaine on "Contracts in Anaesthesiology".
5. A meeting on professional and syndical matters.

The reports, in a separate volume, will be distributed at the beginning of the Congress together with, as far as possible, summaries of papers. The summaries (15 typewritten lines) received in the Secretariat by March 1, will be published in this book. The papers will, of course, be published in extenso in the French Journal of the author's choice.

An important non-scientific programme is planned for the participants and those accompanying them. It will consist, among other things, of visits, excursions and meals in various "Chateaux" and wine cellars of the Bordeaux wine country, around the Arcachon inlet and in the Basque country, and the "Chateaux" of the Dukes of Epernon and Montesquieu. More detailed information will be given in the advance programme of non-scientific activities which will also include visits to the theatre and other artistic events.

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