ANAESTHESIA IN A MAXILLO-FACIAL SURGICAL UNIT WITH THE BRITISH LIBERATION ARMY

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AFTER the First World War the anaesthetic problems arising in the cases at The Queen's Hospital for Facial and Jaw Injuries, Sidcup, were described by Magill and Rowbotham (1). The methods then evolved, although subject to considerable modification in the intervening years, still remain the basic means of dealing with maxillo-facial cases.

In recent times comprehensive reports on anaesthesia for maxillo-facial surgery have been published by Shackleton and others (2). Although these authors deal adequately with the less acute type of case they do not cover all the anaesthetic problems which have been encountered by Maxillo-Facial Units working in this theatre of operations.

The recently injured man, who often reaches the Maxillo-Facial Unit only a few hours after being wounded, differs in many respects both from those patients who were dealt with by the plastic surgeons and anaesthetists of the last war and from those who are being treated at Plastic Centres after their return to England.

Special Maxillo-Facial Units working as near as is practicable to the actual fighting line first came into being with the M. E. F. in June 1941. This paper is based on 1,687 patients with maxillo-facial injuries anaesthetised during the present campaign; it is an account of the problems encountered and of the methods employed to meet them in one Maxillo-Facial Surgical Unit. It may, however, be said that we by no means consider that all problems of anaesthesia for these patients have been solved satisfactorily.

CLASSIFICATION OF CASES

Cases dealt with by the maxillo-facial anaesthetist have been classified as follows: (1) the "blow-out" injury; (2) through and through injury to maxilla with disorganisation of nasal passages; (3) retained foreign body in the tongue; (4) the "brawny-neck"; (5) oedema of the glottis, often associated with comparatively trivial injuries of the neck in the laryngeal region; (6) direct involvement of the glottis and lar-

ynx, and (7) injuries involving soft tissues alone. Numbers 1, 3, 4 and 5 are more fully described.

1. *The "blow-out"* injury has acquired this descriptive title by reason of the apparently explosive origin of the injury. It is a gross injury of the face involving considerable loss of both bony and soft tissue and constitutes by far the most severe type of facial wound with which Maxillo-Facial Units have to deal. The patient's appearance suggests a violent disruption in an outward direction of the mandible and often of the maxilla and adjacent soft tissues as well. It is apparently caused by a high-velocity missile passing directly or indirectly into the mouth in a forward or upward direction. It is possible that air or fluid pressure, suddenly developed, and the projection of secondary missiles (teeth, bone, etc.) are responsible for the outward disruption of the tissues. Any of the structures of the pharynx, or even of the larynx, may be involved.

3. *Retained foreign body in the tongue.*—Large foreign bodies in the tongue, especially in the posterior portion, cause serious difficulty in laryngoscopy. Similar difficulties may occur in patients who have developed reactionary oedema from a foreign body in the tongue, or who have a large lingual haematoma.

4. *The "brawny neck"* (involving the floor of the mouth).—This type of case is seen as a late result of an injury in or near the floor of the mouth, possibly where submental drainage may have been inadequate. The brawny oedema of the pharyngeal tissues has been aptly compared to an inflated tyre; adequate exposure of the larynx is frequently impossible because of the unyielding nature of the involved tissues.

5. *Oedema of the glottis.*—This is often associated with comparatively trivial injuries of the neck. Laryngoscopy in a large number of cases has shown that oedema of the glottis exists in a high proportion of patients with minor wounds of the neck in the laryngeal region; the oedema of the perilaryngeal tissues is frequently of such degree that the glottis can be seen only with the greatest difficulty. Stridor is not always present. In such cases intubation must be carried out with great gentleness; attempts at "blind" intubation may result in increased oedema or in further damage to the tissues.

ANAESTHETIC PROCEDURE

Premedication.

For the average case an injection of omnopon grain 1/3 and scopolamine grain 1/150 is given one hour before operation. The presence of shock, debility or the fact that the patient has received morphine during the previous six hours must of course be taken into account and the dose adjusted accordingly.

Once a patient with injury to the lower jaw and pharynx has received morphine he should not be left and means should be at hand to intubate in the event the airway becomes obstructed. Because of this danger it has been our practice with such cases to give premedication intravenously, in the theatre, only a short time before induction of anaesthesia; but it has the great disadvantage that depression of respiration is maximal during induction and liable to cause difficulties in the early part of the anaesthesia.

Cocainisation.

Preliminary cocainisation of the nose with 20 per cent solution of cocaine hydrochloride by means of a fine spray minimises haemorrhage when a tube is passed through the nose. Some of the solution reaches the larynx and tends to reduce laryngeal sensitivity. In the presence of severe intra-oral damage the danger of absorption from an abraided surface must, however, be borne in mind. It is our practice to cocainise the nose just prior to induction of anaesthesia, and the larynx, under direct vision, prior to passing a tracheal tube.

Induction.

Induction is the greatest problem of maxillo-facial anaesthesia. In many patients it is not possible to fit on a mask because either the face is covered by bandages or the presence of a wound makes close apposition impossible.

In forward areas chloroform on an open mask must sometimes be used, but it is to be avoided whenever possible because of its inherent dangers.

Often a patient with injury to the lower jaw can keep a free airway only by lying on the face or when traction is exerted on a stitch through his tongue. In such a case the difficulty of maintaining the airway is much increased during induction of anaesthesia.

The most serious hazard of induction is the tendency to laryngeal spasm which is present in so many patients who have sustained injury to the lower jaw, base of tongue or larynx. It is, however, noteworthy that in very severe injuries the reverse is often the case; e.g., the "blow-out." In such cases the laryngeal reflexes are so depressed that intubation may often be carried out under very small doses of pentothal (e.g., 0.2–0.5 Gm.) and sometimes even without an anaesthetic at all. In other cases, however, laryngeal spasm may be so severe and persistent that, once it has developed, a patient may die before the spasm has passed unless a tube can be forced between the cords or an emergency tracheotomy be performed.

Pentothal.

As induction of anaesthesia by inhalation is so often difficult, an intravenous anaesthetic, such as pentothal, is the obvious alternative. Anaesthesia of sufficient depth to permit intubation must be produced,

and in the majority of cases pentothal has proved adequate. It has, however, two great drawbacks: (1) a tendency to cause laryngeal spasm, even in normal patients, and (2) the fact that in order to produce sufficiently deep anaesthesia for intubation it must be given quickly and in moderately large dose. This not only produces great depression of respiration but also considerably weakens the action of the heart, with consequent depression of the blood pressure.

In order to overcome these drawbacks to the use of pentothal one may: (1) cocainise the larynx, which to a large extent lessens the need for deep pentothal anaesthesia, and (2) produce an excessive stimulus to the respiratory centre by giving carbon dioxide at the same time as the pentothal. This artificial air-hunger will usually cause the patient to open his glottis widely with each breath and so partially overrides the tendency to laryngeal spasm.

Premedication, given intravenously just before induction of anaesthesia, not only considerably depresses the respiration but may, we think, be an important factor in the production of laryngeal spasm. Holmes (3) working with a Maxillo-Facial Surgical Unit observed in a small series of patients receiving pentothal that whereas spasm of the glottis occurred in 45 per cent of those who had been given atropine as a premedication, only 15 per cent had laryngeal spasm when this drug was omitted. On the other hand, Lundy (4) quoting Burstein and Rovenstine says, "Atropine is effective for prophylaxis and treatment of laryngospasm which frequently follows the use of intravenous barbituric acid derivatives." In a small number of our cases induction was attempted without premedication. As it is not easy to judge the single dose of pentothal necessary to allow intubation the injection apparatus was arranged so that several small measured doses could be given until the required effect was produced. To start with, a dose of 0.5 Gm. to 0.75 Gm. of pentothal was given, and after a period of one or two minutes further doses of 0.1 Gm. were added until the jaw became relaxed. A laryngoscope was then introduced and cautiously advanced towards the epiglottis. At the slightest sign of gagging or spasm a few more cubic centimetres of pentothal were given and this procedure was repeated until intubation was possible. Before intubation the cords were again sprayed with cocaine under direct vision. Although in all these cases spasm was not altogether absent, it did appear to be definitely less severe.

Bromethyl (*syn. Avertin*).

With the object of avoiding the laryngeal spasm so often encountered with pentothal, we have, in a series of 264 cases, induced anaesthesia with bromethyl and have found it to possess several great advantages over the former drug.

Bromethyl may be given intravenously; its use by this route was first reported by Kirschner in 1929 (5). Using a 3 per cent solution of

bromethyl fluid in 5 per cent calorose or physiologic salt solution, it was injected in predetermined doses by means of a specially contrived syringe. Macintosh and Pask (6) reported the use of a 1 per cent solution at Oxford in 1941.

We have found that with a 1 per cent solution in 5 per cent glucose the bromethyl dissolves and remains in solution more easily at room temperature than when normal saline solution is used as solvent. The weaker solution appears less likely to produce venous thrombosis, the incidence of which Adam (7) states is 2 to 3 per cent. In the present series of cases this complication has not occurred, although if a small amount of the solution is allowed to leak out into the tissues there is a very definite inflammatory reaction.

The solution is warmed to blood heat and tested with Congo red before use. It is given by a transfusion apparatus and the standard Army set proved very satisfactory. The large needle is introduced through a small intradermal wheal of procaine. Induction is quick and pleasant and it has never in our experience produced either struggling or laryngeal spasm; in fact, the early relaxation of the jaw and the ease with which a laryngoscope can be introduced without causing spasm or cough make it ideal for this purpose.

The solution is introduced rapidly. First plane anaesthesia, with roving eyeball, is well marked. We have found that the laryngoscope may be safely introduced and intubation effected in the early second plane, i.e., when the eyes have just come to rest in the central position and the pupils have contracted well down. Patients vary considerably in the dose they require to produce this stage, just as they do with other anaesthetics; although an average case may easily be intubated on 300 cc., one occasionally meets a patient who requires double this amount.

It is probable that the manner in which the introduction of the laryngoscope is tolerated under very light anaesthesia and the absence of laryngeal spasm are due to the high degree of analgesia which is produced by bromethyl. Of the immediate advantages possessed by bromethyl for induction of anaesthesia in maxillo-facial cases there is little doubt, but the question of its complete safety is not altogether certain. We have had no cause whatever for anxiety in the cases in which it has been used with the exception of one:

Case 1. G. (Belgian F. I.). Proposed operation for excision of scars on face and bone graft to mandible.

Condition on admission.—A well-developed and apparently healthy man aged 28. (Previous history of anaesthesia with chloroform.)

Premedication.—Omnopon, grain 1/3, and scopolamine, grain 1/150, intravenously followed in fifteen minutes by *induction of anaesthesia* by intravenous infusion of 1 per cent bromethyl in 5 per cent glucose solution. Induction proceeded normally, but rather more (350 cc.) than the average amount of solution was required to produce relaxation of the jaw. *Intubation* was performed without difficulty via the mouth, under direct vision. Immediately following intuba-

tion, the colour became pale, the pulse feeble and rapid, and respiration "gasping" at the rate of 4 per minute. The lungs were immediately inflated with oxygen (via the endotracheal tube) and the bromethyl infusion stopped.

Cardiac arrest occurred a few seconds later. The abdomen was opened, and *cardiac massage* (through the diaphragm) was instituted within approximately twenty seconds after it was clear that the heart had stopped beating. "Gasping" respiration continued, and was supplemented by rhythmical inflation of the lungs with oxygen during the cardiac massage.

Intracardiac injections of coramine were followed by feeble myocardial fibrillatory movements. The colour commenced to improve but no definite heart beat occurred. Twenty-four minutes after cardiac arrest the *diaphragm was incised* and direct cardiac massage was followed in four and one-half minutes by strong cardiac contractions at the rate of 120 per minute. *Normal respiration* soon returned at the rate of 20 to 30 per minute. The colour became good and the pulse strong. *Diaphragm and abdomen* were *closed* and the patient returned to bed with an endotracheal tube in place. He was given continuous oxygen. The pulse rate later dropped to 80 to 100 per minute, and respiration, 20 to 30 per minute. He *died* forty-four hours later without recovering consciousness. At necropsy nothing abnormal was discovered except areas of collapse at both pulmonary bases.

The cause of death in this patient is not certain. Was it a case of primary cardiac failure similar to that which may occur with chloroform? Hewer (7) drew attention to a death after bromethyl "suspiciously like ventricular fibrillation" reported by Beecher in 1938. In this patient the pharynx was not cocainised and another possibility suggested by Hewer which must be considered is that of a reflex vagal stimulation having been caused by the endotracheal tube. Abnormal sensitivity to bromethyl as far as we know does not occur.

In those cases in which intravenous induction of anaesthesia is especially preferable, particularly when time is needed for suction toilet of the air passages prior to intubation, we consider the potential hazards of bromethyl less than those of pentothal. Whether its use in other cases is justified we are not at present in a position to say.

It would appear, however, that when bromethyl is used it is advisable to cocainise the larynx (possibly under direct vision) before passage of the tube.

Intubation.

As most cases require intra-oral surgery and intermaxillary fixation, the nasal route for intubation is the most commonly chosen. As large a tube as possible is used (usually size No. 9 or 10 Magill), sufficiently long to reach 1½ to 2 inches beyond the vocal cords.

Intubation is carried out under direct vision in almost all cases for the following reasons: (1) maxillo-facial injuries so frequently involve the soft tissues of the pharyngeal and glottic region that attempts at "blind" intubation may result in damage to pharynx or larynx; (2) spasm of the larynx is likely to occur if the laryngeal reflex is stimu-

lated by the tube touching the perilaryngeal structures as it frequently does during attempts at "blind" intubation; (3) an assessment of the intra-oral condition by laryngoscopy is of value to the surgeon, and (4) adequate and effective suction and removal of debris prior to intubation can be effected only under direct vision.

ENDOTRACHEAL TUBES AND CONNECTIONS

Plastic Tubes (8).

Endotracheal tubes moulded in plasticised polyvinyl chloride (Portex) have been used in preference to the standard rubber tube in all cases. They have proved satisfactory for a number of reasons, not the least of which is their remarkable durability: most of the tubes which were in use at the beginning of the present campaign are still serviceable and appear likely to remain so for many more months.

Other advantages are: (1) Ease of sterilisation by boiling (which does not affect the tube). (2) Freedom from kinking (particularly noticeable in orotracheal tubes). (3) The particular properties possessed by this plastic material which enable the curve of the tube to be modified to individual requirements after it has been softened by boiling. If metal connecting pieces are inserted into the tube while hot they remain firmly held. (4) Plastic tubes appear to be less irritating to the laryngeal and tracheal mucous membrane than those made of rubber, allowing the lightest possible plane of anaesthesia to be maintained without coughing.

Wide-Bore Endotracheal Connections (9).

In order to reduce resistance to breathing to a minimum, Thornton has devised a wide-bore endotracheal connection for both nasal and oral tubes. One end fits into the endotracheal tube; the other is rapidly and evenly expanded to 1.7 cm. and is connected directly to the anaesthetic apparatus by a short length of wide-bore tubing without further constriction or joints. A shallow beading at either end of the metal connection ensures against accidental detachment of the tube when in use.

Packing Off the Pharynx.

After intubation, the pharynx is carefully packed off in all cases. This prevents blood and other material from entering the larynx and trachea during the operation and reduces leakage of the anaesthetic gases to a minimum. We have adopted the pharyngeal pack in preference to a tube with inflatable cuff as we believe it to be safer and more certain. With the latter there is always the possibility of the cuff becoming deflated in the course of the operation and allowing foreign matter to pass into the trachea before the fault is discovered. Another danger is that blood may "pool" on top of the cuff and enter the larynx or trachea as the tube is removed.

We find the most satisfactory pack to be a 3-inch open-woven bandage soaked in liquid paraffin, excess of which has been removed before use. Packs soaked in saline or other watery solutions quickly become saturated with blood and will act as wicks, actually conducting blood to the larynx.

The pack should be introduced with gentleness for any trauma to the pharyngeal mucous membrane may result in the most severe sore throat postoperatively.

It is best to introduce the pack under direct vision using a laryngoscope or illuminated spatula. The Macintosh curved laryngoscope (10) is especially useful for this purpose; it gives adequate exposure with minimum obstruction of the field. Packs are limited as far as possible to the deep pharynx, leaving the mouth free for the surgeon. When dental impressions are taken, it must be remembered that the impression trays extend back beyond the last molar teeth and this region must therefore be left free of packing.

TECHNIC IN SPECIAL CASES

1. *The "blow-out."*—This type of injury may produce the most urgent problems of maxillo-facial anaesthesia; for the most part they are difficulties of induction and intubation, sometimes in the presence of intra-oral haemorrhage, disorganisation of the upper respiratory tract, concussion and shock. It is fortunate, however, that shock is not so frequently encountered in severe maxillo-facial injuries as is perhaps to be expected. The condition of a patient may remain surprisingly good despite the most severe and mutilating injuries, *provided his airway is not obstructed.*

From a practical point of view severe cases of this class may be divided into two main groups: those in which *anoxia* is the urgent problem, and those in which haemorrhage and shock outweigh other considerations.

The anoxic emergency. In cases in which the anterior attachments of the tongue are involved in the injury, the patient loses all voluntary control of his airway. This state of affairs is commonly present in "blow-out" wounds of the lower face involving the middle third of the mandible. The patient's condition may be aggravated by haemorrhage and by the inspiration of blood or other foreign matter, for the laryngeal reflexes are rendered inactive by injury, shock and anoxia, or by a combination of all three.

When haemorrhage and shock are present they must be treated by transfusion and other methods of resuscitation before operation is undertaken. Generally speaking, it is unwise to start an operation until the patient's systolic blood pressure has become stabilised at 100 mm. of mercury or above, except in those cases in which urgent measures are necessary to deal with haemorrhage. No amount of resuscitation will improve a patient's condition if his airway remains impaired,

or if the aerating surface of his lung is reduced because of inspired foreign material. In such cases intubation and tracheobronchial suction without anaesthesia nearly always produce considerable improvement in the patient's condition. In practice the anoxic emergency takes precedence over all others.*

Restoration of the airway is the primary consideration in dealing with the "blow-out" injury so that in this sense these preliminaries to anaesthesia may be regarded as part of the resuscitation treatment. Intubation and tracheobronchial suction as a purely life-saving measure must often precede operation by some hours, but in an asphyxiated or semiconscious patient such improvement is sometimes produced by these measures that operation may be safely undertaken sooner than his original condition had led one to expect. In the most severe type of case intubation fortunately can almost always be accomplished without difficulty.

Case 2. Pte. F. Accidental injury. Maxilla was separated from base of skull, with shearing away of soft tissues of face from low down on left cheek across bridge of nose, to left side of forehead. Whole of soft tissue was turned down as a flap. Left eye was destroyed. Patient arrived in ward with trachea and bronchi full of blood, almost pulseless, breathing in occasional gasps, and unconscious.

Treatment.—Patient was placed in a steep Trendelenburg position in bed and intubated through the mouth under direct vision, without anaesthesia. Airway was cleared of blood by tracheobronchial suction via endotracheal tube. Pharynx was packed to prevent entrance of blood around tube. Oxygen was administered and blood transfusion commenced.

The patient's condition improved sufficiently within one hour to permit long operation (about three and a half hours) under light cyclopropane-oxygen anaesthesia. Subsequent recovery was complete and there were no postoperative pulmonary complications.

Case 3. Pte. S. Gun shot wound of face. Compound fracture of mandible.

This patient was brought from the ambulance car to the operating theatre literally drowning in blood as a result of his having lain on his back during the journey to hospital. He was unconscious, and the right lung was collapsed.

Treatment.—Nasotracheal intubation was carried out under direct vision without anaesthetic, and tracheobronchial suction performed. Much blood and mucus were removed from trachea and bronchi, especially from the right bronchus. Oxygen therapy and blood transfusion were instituted.

Pulse and colour were much improved but patient was still unconscious at end of thirty minutes. There were restless movements of the limbs. About one hour later operation was performed under cyclopropane-oxygen anaesthesia.

* It is not always appreciated that proper positioning of a patient who has lost voluntary control of his airway will avert the development of an asphyxial crisis during his transit from a forward area. Many emergencies would not arise if patients with fractures of the mandible were transported in the semiprone position with a traction-suture through the tongue which can be controlled by a medical orderly or by the patient himself.

Immediately after operation.—Condition was still serious. Right lung partially re-expanded; moist sounds were heard throughout chest. Respiration rate was 40. *Seven hours later:* Patient was still unconscious. Jerky movements of limbs and generalised uncontrolled movements were suggestive of cerebral damage. Temperature was 106 F. Cold water per rectum was given frequently, which eventually maintained the temperature between 100 F. and 101 F. During the next eight hours there was dramatic improvement. Consciousness was fully regained. Right chest was fully expanded. Respiration rate and temperature became normal.

Thereafter the patient made an uneventful recovery and when seen two months later showed no signs of cerebral damage.

Comment.—This case illustrates the disastrous results which may follow on placing patients in wrong position with face and jaw injuries during transit to hospital. It also shows the effect on the brain of prolonged anoxia. In this case the damage to the brain was not permanent but catastrophe was avoided only by a very narrow margin.

Induction of anaesthesia in a case in which previous intubation has not been carried out is as follows:

The patient is placed on the operating table in the position in which he finds that he can best maintain his airway (on the side, semiprone or sometimes sitting up). An assistant stands ready to control the tongue if necessary. Premedication is given intravenously (1/2 to 2/3 of an ampoule containing omnopon grain 1/3 and scopolamine grain 1/150 according to the condition and physique of the patient). An interval of about five minutes is now allowed to pass in order that the anaesthetist may ascertain the effect of the injection; the intravenous anaesthetic then follows. As the technic required for induction of anaesthesia differs materially with pentothal and bromethyl the separate procedures are described.

Pentothal.

This was employed in most cases before bromethyl came into use. The technic calls for a nice judgment in dosage. An initial "sleeping dose," usually 0.2 to 0.3 Gm., is given slowly. This is intended to abolish the fear of suffocation that the patient may experience by being placed on his back. As soon as he has lost consciousness the tongue is secured by tongue forceps or by the tongue suture and held by the assistant in such a way that the airway remains free, and he is turned on his back for laryngoscopy. In most cases a total of 0.7 to 0.8 Gm. will be required for laryngoscopy and intubation. Generally the injection syringe is left in the hands of an assistant who is directed to give further doses of pentothal until a degree of relaxation of the jaw which will permit laryngoscopy has been achieved. (As a rule inspection, toilet, spraying with cocaine and intubation under direct vision are now performed.)

Intravenous Bromethyl.

When using this drug the anaesthetist may transfer his attention to the patient's airway immediately the transfusion is seen to be running satisfactorily, and the tongue may be controlled with the blade of the laryngoscope as soon as consciousness has been abolished. A deliberate exposure of the glottis, assessment of intra-oral damage, suction toilet and intubation may be performed within a few minutes of the onset of unconsciousness. Relaxation of the jaw muscles and lack of laryngeal sensitivity make laryngoscopy a simple and unhurried manoeuvre. The intravenous infusion is terminated as soon as the endotracheal tube is well tolerated.

In all cases in which the presence of inspired blood is suspected tracheobronchial suction is performed after intubation by means of a small-bore, thick-walled catheter, introduced through the endotracheal tube. Usually the tube can be easily guided into the right bronchus with the head in a central position but to cause it to pass to the left of the carina is often difficult. It is recommended that the catheter be passed with the head turned to the right and the chin approximated to the clavicular region. When it touches the carina the catheter almost always provokes a cough which assists in the expulsion of inspired matter.

2. *Through and through wounds of the maxilla* (involving nasal passages).—In this type of injury it would at first sight appear best to pass the endotracheal tube via the mouth; but the mandible is also frequently involved and procedures become necessary within the mouth, e.g., extraction of teeth or impressions for cap splints, so that the nasal route is preferable and should if possible be used. When the maxilla is "floating," great difficulty may be experienced in passing the tube through the nose; it may even be impossible and the oral route, despite its disadvantages, must be used. On more than one occasion the distal end of the tube has been seen to have passed beneath the lacerated pharyngeal mucous membrane. In such cases it is sometimes possible to pick up the tube with Magill's forceps while it lies behind the soft palate and to guide it past the damaged area.

Often the nares are filled with blood clots or other débris which must be removed before the tube is passed through the nose. Great gentleness is necessary in performing laryngoscopy on these cases in order to prevent further haemorrhage and disorganisation of the dislocated structures.

3 and 4. *Foreign body in tongue; through and through wounds and haematomata of the tongue; "brawny neck"* present identical anaesthetic problems.

Haemorrhage may be severe in all such wounds and is likely to be aggravated during laryngoscopy. Positioning of the patient and the use of suction will usually permit safe intubation. If haemorrhage is

severe a steep Trendelenburg position is advisable for induction of anaesthesia.

Obstruction to laryngoscopy is one of the most commonly encountered difficulties associated with wounds in the region of the tongue and floor of the mouth. The obstruction may be caused by large *foreign bodies* embedded in the base of the tongue or floor of the mouth, by large *haematomata* of these structures (following through and through wounds) or by *brawny oedema* of the tongue, floor of mouth and neck. The latter condition is most commonly seen in untreated cases which have become infected or in cases having inadequate drainage. Whatever the cause, the anaesthetist's problem results from difficulty in exposing the larynx.

In the case of a foreign body in the tongue an impassable obstacle to the passage of the laryngoscope may be encountered; with brawny oedema of the floor of the mouth and neck the exposure of the larynx is prevented by the unyielding tissues which resist the lifting movement of the blade of the laryngoscope.

It is open to question whether tracheotomy should be performed under local anaesthesia as a routine procedure in all such cases prior to the induction of general anaesthesia; when there is doubt as to the ability of the anaesthetist to perform intubation, the safety of this step has much to recommend it. A deliberate tracheotomy is a far safer procedure than laryngotomy or tracheotomy performed as an emergency. The difficulty of maintaining a clear airway throughout the induction period has inclined us in the past towards the "safety first" policy of preliminary tracheotomy. More recent experience with intravenous bromethyl, however, has somewhat modified our views.

Case 4. Cpl. M. Compound fracture of mandible and wound of skull.

Anaesthesia.—Induced with 0.65 Gm. pentothal. When laryngoscopy was attempted a huge haematoma of the tongue and floor of the mouth made exposure of the larynx impossible. Strong pressure with the blade of the laryngoscope expressed some of the haematoma through the external wound and allowed a partial view of the larynx to be obtained. There was considerable oedema of the false cords. At the moment that intubation was performed the pulse failed. The lungs were rhythmically inflated with oxygen and cardiac puncture performed without result. Approximately one minute later the abdomen was opened and cardiac massage commenced. Spontaneous cardiac contractions started exactly one and a half minutes after opening the abdomen. Inflation of lungs with oxygen at the rate of 15 to the minute was continued for ten minutes, when automatic respiration commenced. The abdomen was closed and operation performed without any further anaesthetic. Pulse and colour were good throughout. The patient was returned to bed with an endotracheal tube in place. Oxygen was administered continuously.

The patient died seventy-one and three-quarters hours after cardiac resuscitation following hyperpyrexia and convulsions without regaining consciousness.

Comment.—If the difficulties of laryngoscopy had been fully appreciated preoperatively, the safest procedure would undoubtedly have

been a tracheotomy under local anaesthesia and the administration of a general anaesthetic via the tracheotomy. Fatal damage to the cerebral cortex following approximately four minutes of complete anoxaemia is well illustrated.

A technic extensively employed in this unit at one time was pentothal-cyclopropane sequence and in most cases it produced a smooth induction. Only sufficient pentothal was used to abolish consciousness, a nasopharyngeal airway was inserted and anaesthesia then deepened with cyclopropane to a degree sufficient for intubation. The advantage possessed by bromethyl over either pentothal or cyclopropane is its property of producing early analgesia, thus not only allowing an artificial airway to be tolerated from the moment consciousness is lost, but preventing spasm of the larynx when it is used.

We consider the use of pentothal as the sole induction agent in this type of case to be uncertain and hazardous. Undoubtedly in cases in which the larynx cannot be seen blind intubation under pentothal anaesthesia has often been accomplished, but there is a likelihood of laryngeal spasm occurring if the attempt fails. In such a case the condition of the patient, whose respiratory centres may already have been depressed by partial asphyxia (in addition to the depressant action of the pentothal), becomes one of extreme danger. When a haematoma or oedema rendered the passage of a laryngoscope impossible, it was sometimes necessary to ask the surgeon to incise and drain the submental region. In a few cases, despite every precaution, intractable obstruction of the airway supervened before sufficiently deep anaesthesia could be attained and an emergency tracheotomy or laryngotomy had to be performed. The anaesthetist's problem in the lighter planes of anaesthesia is to maintain an airway by artificial means without provoking spasm of the larynx and it is very likely to occur if a pharyngeal or nasopharyngeal airway be introduced too early in induction, i.e., at the first sign of obstruction of the breathing, which usually follows immediately after loss of consciousness.

5. *Oedema of the glottis.*—In the absence of extreme dyspnoea, patients with oedema of the glottis can usually be intubated without difficulty. Induction with cyclopropane-oxygen or intravenous bromethyl will generally produce the relaxation necessary for the anaesthetist to obtain a full view of the glottis. In patients with urgent dyspnoea a preliminary tracheotomy under local analgesia is undoubtedly the safest procedure. In cases of glottic oedema following on wounds of the neck, the swelling for the most part is limited to the arytenoid region, and even if the cords themselves are obscured, a tube will easily pass between the folds of oedematous mucous membrane.

6. *Direct wounds of the larynx and trachea.*—Such cases usually require tracheotomy to put the larynx at rest. This should be performed under local analgesia. General anaesthesia may then be conducted by replacing the tracheotomy tube by a short length of endotracheal tubing

which is connected by an angle piece with the anaesthetic apparatus. This method permits a freer airway than one in which the inner tracheotomy tube is adapted to connect with the anaesthetic machine. The pharynx above is packed off.

Maintenance.

Once the larynx is intubated and packed off, the maxillo-facial anaesthesia is usually carried out without incident. Choice of agent is wide and individual preference may be indulged without materially affecting the patient's condition. It should be remembered, however, that the operations are often long and that relaxation, demanding deep anaesthesia, is not needed; but early recovery of the reflexes in a patient whose airway is uncertain is a very great advantage. "The less the better" is a useful rule of anaesthesia in such cases.

The closed (carbon dioxide absorption) technic has been used in the majority of cases. It offers very distinct advantages over other methods; the quiet respiration is less fatiguing to the patient, and reduction of heat and fluid loss is also a factor in the prevention of shock. Economy of the anaesthetic is likewise important in an overseas force when all supplies must be carried considerable distances. The most frequently used combination has been nitrous oxide-oxygen with, or more often without, minimal ether. In cases in which pentothal or bromethyl has been used for induction, ether is seldom necessary.

In certain patients cyclopropane appeared preferable. Usually these were men with an associated chest wound or whose lungs were involved in some pathologic condition. Occasionally we found it useful for cases requiring quiet induction and intubation without cough, e.g., patients with prolapsed iris.

In many of our cases anaesthesia was maintained by ether, using the Oxford vaporiser. We have found this apparatus excellent in every respect. It requires so little attention that, once set, the anaesthetist may devote his attention to another case, knowing that anaesthesia will go on unhampered and unchanged. It is remarkable how small a percentage of ether is required to maintain anaesthesia.

Many maxillo-facial patients arrive at the Unit suffering from both shock and concussion. Resuscitation is done in the ward; usually an operation is not undertaken until the systolic blood pressure reaches 100 mm. of mercury. Usually the patients have suffered severe trauma; the anaesthetist must therefore keep careful watch of the blood pressure and pulse during the whole operation. In some cases (especially large flesh wounds) there is considerable loss of blood during operation and resuscitative measures must be instituted when necessary.

Termination of Anaesthesia.

Before the patient is returned to bed every effort must be made to provide him with a free airway until he can take care of it for himself.

Packs are removed and the throat, postnasal space and, if necessary, the trachea and bronchi are cleared by suction. This is a most important procedure and the thoroughness with which it is done has a direct effect on the occurrence of postoperative pulmonary complications.

In cases who have suffered damage to the lower jaw or tongue it is often advisable to leave the endotracheal tube in place. It is usually well tolerated even when the patient has quite regained consciousness. It is later removed inch by inch (preferably by the anaesthetist himself) and if there appears to be any tendency for the tongue to fall forward and obstruct the airway it can be replaced and retained for a further period. In some cases a tracheotomy is performed after operation. It is open to discussion whether it is not often the better plan to do this beforehand, but usually an endotracheal tube will maintain the airway as long as it is necessary. In all such cases suction should be at hand in the ward to clear the tube should it become blocked with mucus.

In all other cases either a nasal pharyngeal or oral airway is used; the former is perhaps preferable because it is tolerated when an oral airway often is not.

A duty which sometimes falls to the anaesthetist is to insert a Ryle's tube for those patients who are unable to swallow and must be fed by this means for a week or more after operation. While the patient is still under the anaesthetic, the tube is passed through the nose and, with the anaesthetist looking through a laryngoscope, it is caught up in the pharynx with Magill's forceps, and pushed down the oesophagus, inch by inch, until it reaches the stomach.

Postoperative Care of the Patient.

Preservation of the airway is of first importance during the recovery period and supervision of the unconscious patient by ward staff experienced in maxillo-facial cases is essential for the prevention of respiratory accidents.

As the majority of patients who have undergone operations for injuries of the mandible have intermaxillary fixation, control of the airway in them presents difficulties not usually encountered in the postoperative care of general surgical cases. In most cases a postnasal tube, inserted after withdrawal of the endotracheal tube, will provide a safe airway during the recovery period. It must not, however, be assumed that because the patient is breathing freely through the tube when he leaves the operating theatre, he will continue to do so without interruption after return to the ward. Slight alterations in the position of the head or blocking of the tube with vomitus, mucus or other material may precipitate an asphyxial crisis if he be left unattended. Until fully conscious, the patient should be placed on the side with the head slightly extended. He may be supported in this position with bolsters or rolled-up blankets. This position will allow mucus, vomi-

tus, etc., to gravitate into the cheek of the dependent side. Means should be at hand for cutting the intermaxillary tie-wires should it be necessary to open the jaws in an emergency. A simple suction pump such as the standard foot-operated Army pattern should be available in the ward.

Early recognition of postoperative respiratory obstruction is a matter of great importance. Patients who have been subjected to lengthy operations and may have suffered preoperative anoxia are particularly susceptible to even partial anoxia in the recovery period. A fatal issue may follow with appalling suddenness if partial obstruction is allowed to persist in an unconscious patient whose respiratory centres have been depressed as a result of the combination of surgical shock, previous anoxia and anaesthetic. "He was breathing very deeply just before he collapsed" is a phrase not infrequently used by ward staff who do not realise that noisy respiration is synonymous with obstructed respiration and confuse the increased respiratory efforts made to overcome the obstruction with normal deep breathing.

Case 5. Pte. M. Through and through wound of face, involving maxilla, both antra and mandible. On admission the airway was clear. There was no serious haemorrhage. The pulse was 100. He was drowsy from morphia grain ½ given three hours previously.

Premedication.—Atropine, grain 1/100, intravenously.

Anaesthetic.—Intubation was performed under pentothal. A nasotracheal tube was inserted. Gas-oxygen-ether was employed.

Operation.—Debridement and intermaxillary fixation were carried out and per oral antral drainage instituted.

The postoperative condition was satisfactory. The patient was returned to ward with nasopharyngeal airway in place. There was no obstruction to the airway. He was found dead four hours later.

N.B. This death occurred in a tented ward which was very poorly lighted and during an exceptionally busy period. It was stated by the ward Sister that the patient had been "breathing deeply" just after his return from the operating theatre. At necropsy, a condition compatible with prolonged partial asphyxia was found.

Comment.—This patient's respiratory centre was depressed by morphine before operation. The operation was a long one, and there was considerable haemorrhage during the procedure. He should undoubtedly have been sent to the resuscitation ward, but owing to the rush of work this was not done. The "deep breathing" was almost certainly obstructed breathing, which finally led to respiratory failure.

From our experience with these cases the following principles have developed: (1) The recovery period should be as short as possible (light anaesthesia with rapidly eliminated drugs). (2) There should be individual skilled supervision while the patient is unconscious. (3) In all cases in which there is doubt as to the absolute freedom of breathing, the endotracheal tube should be left in position until such time as

the patient has full control of his airway. (4) A postoperative tracheotomy should be performed when it is considered that the nature of the injuries is likely to result in a permanently uncertain airway after recovery of consciousness. (5) In all other cases a nasal pharyngeal airway should be inserted after withdrawal of the endotracheal tube.

SUMMARY

The anaesthetic problems arising in a Maxillo-Facial Unit with the B. L. A. are discussed.

The cases are classified and the technic used for the several types is described.

The means of dealing with asphyxia both before and after operation are outlined.

Difficulties of induction are described and the use of intravenous bromethyl for this purpose is reported.

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