AN HISTORICAL REVIEW OF ANAESTHESIA FOR ENDOSCOPY OF THE UPPER RESPIRATORY TRACT
The T. and A. Controversy

Revised Second Edition

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Please note, that the new main section ‘Wait!’ (pp. 18–19) was added to the revised second edition 2017.
Foreword

Advances in medical and surgical practice do not appear automatically or by accident.

They always result from focussed and progressive application of knowledge, skills, techniques and equipment. Although often driven by an individual practitioner, they almost always reflect the support and teamwork of a group.

The first author of this short historical review, Bruce Benjamin is a thoughtful and industrious surgeon who has devoted himself to the development and refinement of techniques for study of the airway in infants and children. John Overton is one of an outstanding group of paediatric anaesthetists acknowledged in the paper who supported Benjamin in his quest for ever better and safer paediatric endoscopy. Not the least of their collaborators were the German engineers and technicians who built refined equipment to Benjamin’s specifications.

As an occasional partner with Bruce Benjamin in the care of his patients, it was my privilege to observe the fine teamwork between him, his anaesthesiologist and nursing assistants and wonder at his unhurried gentle artistry in managing these challenging problems.

This booklet makes only passing reference to Benjamin’s use of photography to document this specialised branch of surgery. Many of his extraordinary collection of photographs have already been published in earlier papers, chapters and books.

A sidelight is a brief account of the arguments surrounding the waxing and waning popularity of tonsillectomy and adenoidectomy during the 20th century.

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Introduction

Citation in the Hindu literature shows that tonsillectomy has been practiced as long as 3,000 years ago. The Roman medical doctor, Aulus Cornelius Celsus, is recorded as the first to describe a tonsillectomy. It is said that he used his own finger for dissection and removal. Andreas Vesalius, physician, in 1543 was the first to describe the tonsils in anatomical detail. In the 16th century tools and instruments were made for tonsillectomy, which, at first, was performed by general surgeons but by the end of the 19th century the E.N.T. surgeons, who had the best illumination, took over the operation. The tonsils were thought to be the focus of chronic infection and toxaemia in many diseases of doubtful aetiology and were consequently removed but often without benefit – so then the teeth were blamed and they were removed. Both operations got a bad reputation when the results were not convincing and many fewer were done.

This historical review was prompted by our experiences when we worked together at the Royal Alexandra Hospital for Children Camperdown (R.A.H.C.) and the changes that have occurred in the indications for removal of Ts and As and the methods of anaesthesia and endoscopy in the last 30 years or so. John Overton was Director of Anaesthesia from 1977 until 1999, more or less the same time that Bruce Benjamin was Chairman of the Department of E.N.T.

It is surprising to find that the same method of anaesthesia used for Ts and As was, and is still now also used for endoscopy of the upper airways, i.e., insufflation of gasses and spontaneous respiration (but of course using no topical anaesthesia for the Ts and As). Hence, as a side issue, but an interesting one their inclusion in the title of this review.
Specialisation in Medicine and Surgery

Do you remember when there were general surgeons and general physicians? Years ago if your mother seemed to have gall bladder trouble, or your uncle had piles, you could refer them on as patients to your colleague who was the best general surgeon you knew. There were general physicians then too, but they now become cardiologists, neurologists, renal physicians, immunologists and so on. The surgeons have become specialised orthopaedic surgeons (as often as not concentrating only on one joint), cardiovascular surgeons and/or plastic surgeons and so on. It has all changed. In the early 1960s the E.N.T. surgeons enhanced their own image by giving themselves an upmarket name; they became E.N.T./Head and Neck Surgeons, better describing their interests and capabilities.

Within this group a multitude of specialists sprang up: otologists, otoneurologists, base of skull surgeons, head and neck surgeons, and those practising phonosurgery and functional endoscopic sinus surgery. What about specialised care of infants and children with E.N.T. diseases? At the time many considered it unnecessary because ‘aren’t they only small adults anyway?’ – Nothing will annoy a paediatrician more than this glib statement.

My own interests followed congenital and acquired conditions of the larynx, pharynx, tracheobronchial tree and oesophagus but I am not sure how or why this came about but I soon found that I needed to learn about a number of rare and unusual diseases.

In December 1961, I, Bruce Benjamin was pleased to be appointed an honorary E.N.T. surgeon at R.A.H.C. and directed to do my first operation ‘list’ which had been pre-arranged; six children recommended by another E.N.T. surgeon to have their Ts and As removed. I had never met the children or their parents. Today’s medico-legal minefield would never have tolerated this situation!

About this time when I culled two paediatric textbooks and one otolaryngologic textbook, all three respected for their teaching expertise, for the indications given for removal of Ts and As (the tonsils and adenoids operation), I was staggered to find mention of a total of more than 40 indications (many quite ridiculous) including, bad behaviour, congenital heart disease, epistaxis, cyclical vomiting, bed wetting, poor school achievement, loss of concentration, bad appetite, pyrexia of unknown origin, ill-temper etc. To add to the strange thinking about the indications for operation, we still hear gruesome stories of family members having had their operation at home on the kitchen table years ago.

The work seldom offered a surgical challenge and was boring and repetitive. Why were there so many Ts and As operations done not only in the hospital but also in the wider general medical community (i.e., at that time many GPs did the operation, often in small ‘private hospitals’)? Secondly, why was diagnostic examination of the upper respiratory tract and oesophagus and in particular of the larynx and pharynx not performed by E.N.T. surgeons but often by others not trained in anatomy or physiology of the region? In Europe and North America this work was the province of E.N.T. surgeons.

The lymphoid tissue of the tonsils is strategically placed to enable them to ‘sample’ ingested and inhaled material on their spongelike surface: the tonsils to sample ingested food and fluid, and the longitudinal furrowed surface of the adenoids to sample inhaled material and so subserve their antibody: antigen function. Despite repeated searches as yet no detrimental effects after removal of the lymphoid tissue of the lymphoid tissue of the tonsils and adenoids has been identified.
Tonsillectomy and Adenoidectomy

Few medical issues were (and still are, even today) the subject of more controversy than surgery for removal of the tonsils and adenoids; opposite views were expressed not only in the medical literature but also in the lay press. Fifty years ago tonsils and adenoids were removed almost indiscriminately. Statistics purporting to show discrepancies in the incidence of the operation in different geographic areas, lack of uniform criteria for the operation and investigation of the economic aspects had focused attention on the morbidity and mortality of the operation. In contrast little was said about the benefits which might result from the operation. Opposing views led many observers to be poles apart and there were a large number of doctors with negative attitudes towards the operation. Paediatricians especially saw their responsible and conscientious role to denounce unscientific practice.

An almost opposite viewpoint was held by another group, mostly comprising E.N.T. surgeons, general practitioners and a small number of paediatricians, apparently convinced as a result of training, or experience, or both, that removal of the Ts and As could be beneficial.

Even now any recommendation for operation is viewed with suspicion by some paediatricians, physicians, and academics. The prevailing attitude to tonsil and adenoid surgery remains derogatory. It is accepted that the commonest indications for removal of the tonsils and adenoids are repeated attacks of acute tonsillitis and ‘an obstructive breathing pattern’.

Note: Unfortunately there are no scientific or objective criteria on which the success or failure of the operation can be judged; the need for operation to some extent remains a matter of opinion, although, in general terms, there is agreement upon repeated troublesome infections and partial airway obstruction. Scientific study of further controlled prospective trials is necessary. To this day there are no microbiologic or histopathologic changes to identify chronically infected ‘diseased’ tonsils even after they have been removed – no surgical audit is possible.

Indications for Tonsillectomy

Repeated attacks of acute tonsillitis. Usually children. It appears that besides streptococcus pyogenes, organisms such as adenoviruses, Epstein-Barr virus, herpes simplex virus, mycoplasma and others can be the causative microorganism and yet present clinically in the same manner.

Upper airway obstruction. Acute or acute on chronic. Obstructed breathing pattern but not necessarily any attacks of apnoea have varying degrees of upper airway obstruction caused by large tonsils and adenoids. In addition during the previous ten or twenty years it has been increasingly accepted that large Ts and As sometimes cause partial upper airway obstruction. In the 1950’s and 1960’s there was an unmistakable change in attitude in the part of circumspect members of the medical profession towards the advisability of the operation of Ts and As. The seminal papers by ENT surgeon C.D. Bluestone and paediatrician J.L. Paradise were careful and influential studies. However, since then, in reality, the advisability for removal of Ts and As has not changed and there should be little disagreement about the indications especially now that degrees of upper airway obstruction can be measured objectively by sleep studies. Although in an individual case, contrary opinions may be expressed; for instance, some invoke the philosophy that ‘they will grow out of it’.

The commonest indication for removal of the tonsils is repeated attacks of acute tonsillitis with or without peritonsillar abscess (quinsy). The combination of hypoventilation during sleep, noisy obstructed breathing, sleepiness during the day, and sometimes, strangely, pulmonary hypertension, cardiomegaly, pulmonary oedema and right heart failure may be unresponsive to medical treatment, and endotracheal intubation or removal of the tonsil and adenoid tissue to relieve the obstruction must be considered, occasionally as a matter of urgency.

From about the middle of the twentieth century, there was an unmistakable change in attitude on the part of responsible members of the medical profession towards the advisability for the operation partly due to ‘more conservative’ assessment: the most thoughtful and meticulous doctors still had diverse views.

- Chronic tonsillitis. Usually in adolescents or adults.
- Peritonsillar abscess. One attack, maybe. Two or more attacks, tonsillectomy is justified.
- Biopsy excision. A rare indication.
Indications for Adenoidectomy

**Adenoid hypertrophy**
Where nasal obstruction can be shown with reasonable certainty to be due to large adenoids, adenoidectomy is beneficial for at least two years.

**Infection of the adenoids**
Persistent nasal or postnasal discharge of mucopurulent material.

**Possible benefit in ear disease**
There have been no statistically significant valid trials showing whether adenoidectomy alone has any effect on the rate, severity or duration of recurrent middle ear infection, but some still regard adenoid disease as an important factor in otitis media.
Where there has been repeated infection in the pharyngeal lymphoid tissue, adenoidectomy is usually performed along with tonsillectomy, unless there is a contraindication to adenoidectomy (vide infra).

Contraindications to Tonsil and Adenoid Surgery

- Lack of staff or of facilities to recognise and manage the potential complications. This is by far the most important factor in the safety of the operation.
- Recent upper respiratory tract infection. To minimise bleeding and possible infection it is usual to postpone operation if there has been a respiratory tract infection within the previous two weeks.
- Systemic disorder, e.g. uncontrolled diabetes.
- A bleeding disorder.
- Adenoidectomy is contraindicated in cleft palate, repaired cleft palate, submucous cleft palate, when there is paralysis or paresis of the palate or anatomically ‘short’ palate because adenoidectomy may cause or worsen hypernasality with escape of air through the nose during speech: Insufficient attention has been given to this problem in the past.

There is no evidence that removal of tonsils or adenoids induces long term changes in the patient’s immune status.

Deaths and near deaths occur from:
- Anaesthetic and surgical ‘accidents’.
- Unskilled anaesthesia.
- ‘Hidden’ blood loss.
- Inadequate post-operative observation.
- Delayed replacement of blood volume.
- Delay and indecision.
- Indiscriminate use of opiates.
- Unfamiliarity with paediatric nursing, especially with regard to intravenous infusion and drug dosage.

The death rate is highest in small, usually ‘private’ hospitals where nursing facilities, postoperative care and medical supervision may be less than satisfactory. Fatal complications are more likely in children aged five years or younger. Observation in a post-operative recovery ward and continued monitoring after return to the general ward together with the availability of 24 hour a day resident medical attention leads to a minimum of morbidity. Analysis of the morbidity and mortality statistics from the operation show very clearly that the operation can be very safe in large teaching hospitals, especially paediatric hospitals which provide skilled, specialised anaesthesia and surgery.
Improved Safety in Tonsil and Adenoid Surgery

There is now a greater awareness of the possible dangers of the operation among both medical and lay people. Parents are better informed, yet there is still a need for explanation of, and preparation for, the operation by the physician. It is, of course, quite erroneous and misleading to regard the operation as ‘minor’.

Careful pre-operative assessment by the surgeon and especially the anaesthetist is essential. Chloroform has been completely discarded as an anaesthetic agent. Various tonsil gags have been developed for the operation in a range to fit children of all ages; thus requiring co-ordination between the surgeon, the anaesthetist and the nursing staff. Both the Boyle-Davis tongue blade and the Doughty tongue gag with a split tongue blade were advances; the wide split in the latter is able to accommodate a peroral endotracheal tube under the length of the blade, allowing a relaxant anaesthetic to be used, making the procedure safer, ensuring control of the airway and minimising aspiration of blood and other tissue. Surgical exposure of the inferior pole of the tonsil remained satisfactory.

Improved surgical techniques include
- Abandonment of the guillotine operation.
- Better illumination.
- Consideration to maintain a postoperative intravenous infusion in all cases.
- General anaesthesia with peritonsillar infiltration of a measured amount of supplementary local anaesthesia with or without adrenaline of appropriate minimum concentration for analgesia and to decrease blood loss.
- Diathermy control of bleeding.
- Meticulous haemostasis, by diathermy or ligatures.
- Measurement of blood loss in selected cases.
- Appropriate resident and registrar training in paediatric otolaryngology.
- Better understanding by the surgeon of the problems of anaesthesia.
- Both anaesthetist and endoscopist must be constantly alert during the procedure with appropriate monitoring of vital functions during and after anaesthesia.

Facilities for recognising and managing the potential complications should now be optimal especially in paediatric hospitals. Routine intravenous fluids, avoidance of aspirin, observation of pulse-rate for 24 hours, early recognition of blood loss, prompt replacement of lost circulating blood volume and immediate availability of medical attention are essential.

In addition, even though they are ‘written up’, opiates (because of their respiratory depressant effect), should not be given to children unless the patient is first seen by a doctor and a thorough assessment of the need for opiates has been made.

Anaesthesia for ‘the bleeding tonsil’ requires great expertise. This or any other serious complication demands immediate specialist consultation. Morbidity and mortality are less when transfer to a paediatric hospital is undertaken early.

It can be conjectured, but it is hard to prove, that some operations continue to be performed without adequate justification, under less than satisfactory conditions.

The dreary, mundane nature of E.N.T. surgery in the 1930’s found more interesting fields. While some general E.N.T. surgeons concentrated on Ear Nose and Neck, others, like myself, found themselves enjoying the challenges of laryngeal and airway problems not only in infants and young children, but because I managed to keep a sizable adult practice, also in adult patients. So these changes happened quite quickly and almost unnoticed. About this time George Lomaz (then director of Anaesthesia) returned from Europe with two new German instruments, a laryngoscope and a bronchoscope, which he kindly asked me to trial. Both were designed for illumination using light transmitted by a flexible fibre optic lighting cable either to a prism (proximal) or to a rigid fibreoptic rod (distal) so the field at the distal end of the instrument received even ‘white’ light, an advance on the old fashioned little electric globes of the time which had an unnerving tendency to burn out or shatter (a potential hazard in the oxygen rich ether atmosphere of the lower airways).

We realised immediately that the principles of this system would replace existing old fashioned endoscopes. Improvement and expansion of the system of light delivery and illumination for different instruments of different sizes was under development at first, for both laryngoscopes and bronchoscopes, later for oesophagoscopes and finally for instruments for nasendoscopy.

Eventually nearly every body cavity could be explored.

A graduated set of oesophageal JACKSON-BENJAMIN bougie-dilators 33 mm long (based of course on the original JACKSON bougies) of my design was made – besides being dilators especially for small patients with oesophageal stenosis, the narrowest is 2 mm, they were excellent for measurement of the subglottic and upper tracheal diameter. Most equipment, originated and was supplied by KARL STORZ GmbH of Tuttlingen, Germany, and was necessary for different applications and for favoured methods of anaesthesia; my involvement was mostly in research and development and my own designs for paediatric and some adult instruments were created. Those for truly small patients were most popular. I was fortunate to have a working relationship with KARL STORZ who made fine surgical instruments. Dr Sybill Storz was always encouraging to me.
**General Anaesthesia Technique**

The theoretic requirements for ideal anaesthesia (which, of course cannot be achieved in practice) include rapid induction, smooth maintenance, maximum safety, simplicity, reasonable cost, control of the airway and ventilation, an immobile operative field during microsurgery, safe use of the diathermy or laser, continuous monitoring of the patient’s cardiovascular and pulmonary responses, little, if any, restriction on time, unobstructed access to the airway, protection against undesirable autonomic and somatic reflexes, minimal patient discomfort, minimal contamination by anaesthetic gasses of room air in the operating theatres and prompt patient recovery, especially of cough and other protective reflexes. Anaesthesia for tonsil and adenoid examination or manipulation around the larynx and in the airways has exercised the ingenuity of anaesthetists for years and new and innovative techniques are regularly proposed; the method of anaesthesia favoured by each practitioner depends upon traditional techniques taught in their teaching hospital and on teaching experience by the individual anaesthetist. Paediatric anaesthesia continued to develop as a specialty from the 1940’s (following the Second World War) when every field in medicine and surgery prospered and matured, including otolaryngology.

When spontaneous respiration anaesthesia using a face mask reaches the appropriate depth, anaesthetic solution (6 mg/kg of body weight xylocaine) is sprayed on the larynx and the subglottic region by the anaesthetist (Fig. 2). A supplement such as methoxyflurane may be chosen for additional anaesthesia to smooth out the course of the procedure. Each member of the team requires a sound knowledge of the anatomy, physiology and pathology in patients from low birth-weight babies to older children.
Airway Physiology and Symptomatology in Infants

Certain differences in the infant compared to an older child should be remembered.

Size. The infant larynx is about one third of the size of an adult larynx which usually reaches its maximum about 12–14 years of age. The arytenoid cartilages are relatively very large so that the vocal processes of an infant are at about the midpoint of the vocal cords making the membranous folds about the same length as the cartilaginous posterior edge of the vocal cord. The posterior aspect of the cricoid cartilage is a shallow V-shape, whereas the inferior part is circular: this shape of the subglottic lumen is significant in determining the site of pressure necrosis caused by long-term intubation.

Stridor indicates at least partial airway obstruction, but not necessarily emanating from the larynx, so diagnostic endoscopy may need to include the tracheobronchial tree (vascular compression, duplication cyst, oesophagus (assessment and/or biopsy of gastroesophageal reflux).

Other presenting clinical features. Clinical features in paediatric patients include not only stridor, often present from birth or shortly after but airway obstruction; partial or severe; Other features include repeated aspiration; cyanotic or apnoeic attacks; weak or absent cry in infants, husky voice in older children; atypical or repeated croup and, of course, inhaled or ingested foreign bodies. Preoperative fasting should be adequate to minimize the risk of aspiration; for infants the last milk feed should be restricted to about two hours and to have clear fluids only for three hours. Be aware if there is a history of gastroesophageal reflux and the possibility of regurgitation of fluid or food during induction and maintenance of anaesthesia.

Subglottic stenosis. An acceptable definition of subglottic stenosis is a diameter within the cricoid cartilage of 4 mm or more in a full term infant, and 3 mm or more in a preterm infant of approximately 32 weeks. Because the infant airway is smallest within the non-distensible cricoid cartilage, most acute obstructions in infants and children occur in this vital subglottic regions where oedema on the loose areolar tissue from inflammation (e.g. croup) or trauma (e.g. irritation from an endotracheal or a bronchoscope) can rapidly cause swelling at the expense of the airway. An oversized, tight, endotracheal tube or bronchoscope should never be forced through the subglottic region.

Physiology and Symptomatology in Infants

Certain differences in the infant compared to an older child should be remembered.

A practical classification of anaesthetic techniques depends on whether respiration remains spontaneous or whether controlled intermittent positive pressure ventilation with a muscle relaxant is used.

The accepted methods are:

- Spontaneous respiration inhalational technique. Oxygen, nitrous oxide and sevoflurane are insufflated into to the larynx via a side metal tube built in during manufacture or fixed inside the proximal rim of the laryngoscope by a small gnurled knob tightened in place by the endoscopist. A second simple method of delivering the gasses is by a shortened pernasal endotracheal tube passed into the pharynx so that the space of the laryngopharynx is filled with sufficient concentration of gas to maintain stable anaesthesia.

- Total intravenous anaesthesia has not been favoured by us. Techniques of general anaesthesia using a combination of agents given solely by the intravenous route, with absence of all inhalational agents including nitrous oxide are gaining popularity for otolaryngological surgery but, as yet, we have not used them for endoscopic procedures, especially because we prefer to preserve and observe the dynamics of the respiratory tract. With high pressure jet ventilation in infants or small children the reported high incidence of airway rupture in the airways is not acceptable.

- A muscle relaxant technique with jet ventilation depends on regular bursts of high-pressure oxygen, oxygen/nitrous oxide mixture or oxygen/helium mixture delivered via a plastic distal jet tube such as the purpose-designed BENJET tube positioned in the mid trachea or alternatively proximal ventilation via a metal, slightly malleable cannula to permit adjustment of the direction of the jet to be aimed at the glottic opening. The infant larynx is about one third of the size of an adult larynx which usually reaches its maximum about 12–14 years of age. The arytenoid cartilages are relatively very large so that the vocal processes of an infant are at about the midpoint of the vocal cords making the membranous folds about the same length as the cartilaginous posterior edge of the vocal cord. The posterior aspect of the cricoid cartilage is a shallow V-shape, whereas the inferior part is circular: this shape of the subglottic lumen is significant in determining the site of pressure necrosis caused by long-term intubation.
General anaesthesia using ether as a volatile agent for surgical procedures is usually thought to have been in use in the 1860s about when the American civil war broke out; ether became more widely used while other forms of anaesthesia became favoured by individual anaesthetists. During diagnostic endoscopy the upper airway has to be shared between the anaesthetist and the endoscopist and close co-operation and understanding is always vital. However, at times, a relatively inexperienced team may feel more in control, safer and more comfortable using a small diameter endotracheal tube (which can be partly squashed to one side) rather than no tube at all.

With the advent of newer endoscopic instruments many anaesthetists adopted more versatile anaesthetic methods. The choice of anaesthetic technique depends on the experience of the anaesthetist and the endoscopist, the age and general health of the patient, the suspected site of the lesion, the degree, if any, of airway obstruction and the demands of endoscopy. Each member of the team requires a sound knowledge of the anatomy, physiology and pathology in patients ranging from low birth weight, pre term babies to older children and should also be familiar with various fall-back strategies if one approach is ineffective: equally the laryngologist should be conversant with the principal of delivery of insufflation anaesthesia, the pharmacology of anaesthetic drugs and the likely difficulties the anaesthetist may face in the management of the airway and in maintaining oxygenation.

The most common method of anaesthesia for diagnostic examination is spontaneous respiration with nitrous oxide, oxygen, and a volatile component such as halothane, or more often now sevoflurane. This method is only a step forward from the principles of the method used for Ts and As with insufflation via a metal tube in the mouth gag itself. When spontaneous respiration anaesthesia using a face mask reaches the appropriate depth (Fig. 2) topical anaesthetic solution (6 mg/kg of body weight xylocaine) is sprayed on the larynx and subglottic region by the anaesthetist. This technique is particularly suitable as it allows the opportunity for careful, unhurried assessment of the respiratory cycle and vocal cord movement and of the dynamic changes seen, for instance, in laryngomalacia. In laryngomalacia, as the depth of anaesthesia progresses, the stridor often lessens and may be completely abolished apparently by positive pressure ‘splinting’ of the supraglottic tissue.

No endotracheal tube is necessary. Oxygen, nitrous oxide and halothane are insufflated into the larynx via a side, metal tube fixed in the laryngoscope or by a pernasal tube into the pharynx, so that the space of the laryngopharynx is filled with sufficient concentration of gas to maintain stable anaesthesia.

- For sundry different procedures modifications of the standard spontaneous respiration technique may be necessary, e.g. bronchogram (for which we were careful to use a minimum of contrast material), removal of a difficult foreign body (use of a relaxant is occasionally needed), or testing for an H-type or recurrent trachea-oesophageal fistula. However this is not the place to go into these and other techniques.
- In the case of an ill child, oxygen only, with halothane, is used.
Laryngoscopy

A systematic technique of diagnostic endoscopy of the laryngopharynx requires firstly preliminary naked eye examination with a hand-held laryngoscope, secondly a more detailed evaluation with rigid telescopes for image magnification, thus providing diagnostic information for the third stage which depends upon use of the operating microscope.

- **Hand-held laryngoscopy.** Preliminary examination with naked eye or with telescopes.
- **Suspension laryngoscopy.** For detailed examination telescopes leaving two hands available.
- **Microlaryngoscopy.** Magnification provided by the operating microscope for micro- and laser-surgery.

Except in an emergency, laryngoscopy is normally performed under general anaesthesia in a fully equipped operating theatre. Laryngoscopes, ventilating bronchoscopes and a selection of endotracheal tubes with introducers must be ready for resuscitation in unexpected circumstances. Laryngoscopy to restore an airway may occasionally be necessary other than in controlled conditions, i.e. in the field or, more often in the Emergency Department or I.C.U.

**One group** of laryngoscopes is intended for routine, general purpose examination. Some may favour one or another design for the preliminary examination, but I certainly prefer the simple BENJAMIN (formerly known as the KARL STORZ design) general purpose original (four sizes, K.S. Cat. 8574 G to 8574 E) with a slot on the right to assist in introduction of an endotracheal tube, or maybe of a bronchoscope. Others may prefer as an alternative, say, the Parsons design (three sizes).

**A second group** of laryngoscopes includes those for special purposes, microlaryngoscopy, microsurgery, laser surgery, and the ‘difficult airway’.

By using a well-chosen, most helpful laryngoscope, and using gentle downward external pressure from a finger or the flat of a hand with even upward internal counterpressure from the beak of the laryngoscope, all anatomical detail of the larynx should be accessible to the examiner (Fig. 3). This principle of manual pressure for better visualisation is used frequently by anaesthetists to assist intubation.

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**Fig. 3** Improved visualisation. The larynx may need to be manipulated by pressure on the neck from a finger (as shown here in an infant) or fingers or a hand (in adults) of the examiner or an assistant. Internal counterpressure with the laryngoscope will augment exposure of the anterior larynx.
Bronchoscopy

A paediatric ventilating bronchoscope of appropriate diameter and length is selected and introduced either directly or, if necessary, with the aid of a slotted (Fig. 4) laryngoscope and the connection for anaesthesia is attached to the proximal end of the ventilating circuit so the patient continues to breathe anaesthetic gases; a glass cap seals the proximal end of the bronchoscope while the patient continues to breathe spontaneously. The bronchoscope can be gently advanced or withdrawn and moved into the left or right main bronchus.

Flexible Fibreoptic Bronchoscopy

Anaesthetists may employ delicate flexible endoscopes as small as 2.4 mm diameter which can be used through a 3.0 mm internal diameter endotracheal tube to check the lumen of the trachea and main bronchi or to facilitate intubation through a laryngeal mask, in a difficult airway. Diagnostic bronchoscopy with a larger diameter steerable instrument is undertaken in some institutions by paediatric otolaryngologists and pulmonologists (with specific training) in the Intensive Care Unit or operating room, usually using intravenous sedation and supplementary oxygen with continuous monitoring of vital signs; facilities for resuscitation must be readily available. Flexible fibreoptic examination is a safe and effective visualisation method with a use complementing the rigid bronchoscopy method, with certain limitations, but rigid endoscopy remains the gold standard.
Oesophagoscopy

We prefer open-tube, rigid oesophagoscopes, with a wide, almost round lumen and bright distal lighting, as provided by the Benjamin paediatric pattern KARL STORZ NEGUS instruments as shown here demonstrating antegrade dilatation of an oesophageal stricture and gradual dilation to a satisfactory size. Successively larger gum elastic bougies are passed from a graduated set of BENJAMIN-JACKSON pattern dilators ranging in size from 6 F to 30 F diameter with a shorter more convenient, working length of 33 cm. They are made to be used in conjunction with the new BENJAMIN paediatric oesophagoscopes, both KARL STORZ Germany and both designed specifically for paediatric use.

The oesophagoscope is passed through the right side of the mouth (Fig. 5), beside the tongue, guided to the right piriform fossa and moved to the midline, lifting and displacing the larynx to identify the cricopharyngeus muscle and then down and into the lumen of the oesophagus.

Mortality and Morbidity

We know of no mortality associated with our endoscopies. There were several instances of post endoscopic croup-like stridor requiring either nursing in a moist air atmosphere and/or steroid treatment.

Documentation

Photography of the pharynx, larynx and trachea has exercised the ingenuity of laryngologists and photographers for over 100 years – there have been many successful and partly successful methods. Telescopes can be used to give precise and comprehensive information about the airway from the nasal cavities down to the carina and bronchi. A single lens reflex camera can be readily attached to the proximal end of the telescope for single-frame photography. Suspension laryngoscopy allows the use of two hands.

Years ago I started using the small purpose-made light-weight motorised KARL STORZ Endocamera but now I would prefer, and be confident of, the reliable and versatile modern KARL STORZ, Germany’s remote electronic flash generator model 600 computer flash unit which not only allows excellent vision but also yields consistently reliable photographs. Currently digital pictures are conveniently ‘lifted’ from a digital movie recording and the hard copy is simply filed in the patient’s records.

Fig. 5  Commencement of oesophagoscopy. We prefer an open-tube, rigid oesophagoscope, with a wide, almost round lumen and bright lighting – a NEGUS pattern instrument is shown here. It is passed through the right side of the mouth, guided to the right piriform fossa and moved to the midline, lifting and displacing the larynx, to identify the cricopharyngeus muscle, then the oesophagoscope is gently directed into the lumen of the oesophagus. At this stage it may be helpful to have an assistant’s hand under the shoulders to lift them.
Laryngoscopic, Bronchoscopic and Oesophagoscopic Instruments

It was not difficult to realise the almost limitless possibilities offered by the advent of transmission of light through fibreoptic rods. It soon became apparent that the acquisition of endoscopes with fibreoptic lighting in a range of sizes from newborn to teenage would become a major budget item.

**Laryngoscopes – One group** is intended for routine, general-purpose routine examination.

**A second group** includes those for special purposes, microlaryngoscopy, microsurgery, laser surgery and the ‘difficult airway’.

From time to time colleagues who wish to do some pediatric airway work in in their hospital ask me to recommend just a few instruments but not a ‘full set’. This is clearly impossible, when our patients insist on coming in all sizes – we advise that the patients be transported to a paediatric hospital; each year we had to sort out patients eventually referred but with undue instrumental trauma through use of ill-fitting instruments.

We have attempted to show the importance of the union and interdependence of the E.N.T. surgeon and the Anaesthetist in surgery of the upper respiratory tract, including Ts and As in children and endoscopy of the upper respiratory tract of any age. We have emphasised and confirmed what always been obvious – that when an E.N.T. surgeon is working in the upper respiratory tract, he must be aware of, and cooperate with, the anaesthetist with whom he is working especially in the endoscopic investigation of abnormalities in the upper respiratory tract in infants and children.

Teamwork

As individuals we are all involved in teamwork in one way or another every day of our life; not just cricket or football team or the church choir but also, say, as a medical professional, as part of a specialised group such as the Burns Unit, Intensive Care, Cardiac Unit and so on – to be involved is to be part of a team. In paediatric airway work a multitude of complex medical and surgical issues require expert and specialised attention but is the person, who by long experience and grim determination collects, collates and assembles the x-rays for case discussion more or less than any other member of the team (Fig. 6).

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Fig. 6 Teamwork. Diagnostic endoscopy using a telescope for bronchoscopy in an infant under general anaesthesia in a fully equipped operating theatre. Note the overhead radiant heater, careful monitoring, the range of instruments available and the focus and concentration of the doctors and nursing team.

At this stage it may be helpful to have an assistant’s hand under the shoulders to lift them.

Fellow observer registrar (1); endoscopist (2); anaesthetist (3); anaesthetic assistant (4); instrument nurse (5).
Wait!

Would you believe that both authors omitted to include acute inflammatory obstructive airway disease and the changing place of tracheotomy? Intubation has all but replaced tracheotomy.

The major infectious diseases causing airway obstruction have been diphtheria, acute epiglottis and the diseases covered by the description ‘croup’.

**Diphtheria** was a feared, often fatal, disease up to the end of the 18th century. But now in developed countries, used at the right age, vaccination is effective and anti-toxin is available for treatment during the acute phase of the illness. The incidence of the disease has been dramatically reduced: nonetheless diphtheria remains a dreaded disease.

The symptoms mostly present in young children 2 to 5 years of age but can occur older children and in adults. There is acute sore throat, fever, difficulty swallowing, difficulty breathing, and sometimes swollen neck. Examination may reveal a white or greyish-white membrane which bleeds on separation from the underlying mucosa. The circulating exotoxin may cause myocarditis and a surprisingly rapid tachycardia. Later complications include neuritis, myocarditis and cranial nerve dysfunction.

The causative organism is usually, but not always *Corynebacterium diphtheriae*, readily recognised on a smear as a club-shaped bacillus. It had been recognised for many years that tracheotomy could overcome the breathing obstruction in some patients and save their lives.

It is hard to discover when clinicians recognised the features of acute epiglottitis as a separate disease from diphtheria but we know that tracheotomy was also used to treat acute epiglottis patients at that time.

**Acute epiglottitis** (referred to by some as *acute supraglottitis*) should be a readily diagnosable condition rapidly causing acute airway obstruction. There is gross swelling, even abscess formation in the supraglottic tissues including the base of tongue, aryepiglottic folds and of course the epiglottis. The latter is sometimes seen, if the patient tolerates even a brief examination of the oropharynx, as a cherry-red swelling behind the tongue. The child is invariably very sick, the onset is sudden with severe pain and A lateral airways x-ray can reveal the swollen epiglottis (the so-called ‘thumbprint sign’). Care must taken to ensure that positioning for the x-ray does not further compromise the airway and precipitate complete obstruction.

The causative agent is usually *Haemophilus influenza*, found on smear of the supraglottic inflammatory tissue or from blood culture. Tracheotomy certainly saved many lives in diphtheritic patients but we now know that intubation can be employed with few complications even though the tube goes through or past the membrane in the nose or oropharynx on its way to the trachea and theoretically can spread the disease process. Pernasal endotracheal intubation is preferred by most but not all authorities.

**Croup** is a noun used to describe a fairly common condition of small children. It is also called laryngo-tracheo-bronchitis, a cumbersome better descriptive term. Other conditions such as acute tracheal bronchitis are variants. The latter forms plaques or a membrane in the trachea itself. These must be removed at direct endoscopy and removed again if they recur.

The disease croup is usually caused by a virus which initiates soft tissue inflammatory swelling in the larynx particularly in the subglottic larynx where it is the cause of partial airway obstruction and inspiratory stridor, of course accompanied by a ‘croupy’ cough. The adjective ‘croupy’ is commonly used to describe a harsh, barking cough, usually accompanied by inspiratory stridor.

Many cases do not require treatment but where airway obstruction is worrying, significant or progressive, close observation in hospital is mandatory. Cortisone by mouth or by injection resolves many cases seen in general practice and treated at home. The accepted management used to be tracheotomy, but now treatment with moist air, cortisone or nebulised adrenaline means that an artificial airway (intubation) is seldom needed.

Tracheotomy and Intubation

Intubation is now the preferred option for serious croup. Many milder cases need no treatment except observation, maybe moist air and steroids or nebulised adrenaline.

Until a few years ago it was considered by many that tracheotomy was mandatory for acute epiglottitis but now nasotracheal intubation is preferred. When possible an experienced anaesthetist should be attendance. The gross swelling of the supraglottic tissues makes visualisation difficult – a small bubble of secretions just behind the epiglottis sometimes indicates where the airway is. An ENT surgeon or a general surgeon should be standing by, also be prepared to do a ‘crash’ tracheotomy, in truly life-saving circumstances.

Although sometimes difficult to achieve, intubation will overcome the airway obstruction and with intravenous antibiotics, removal of the tube may be possible in one to three days. So intubation has now become the preferred artificial airway in acute epiglottis.

Thus intubation has largely replaced tracheotomy in the modern management of acute inflammatory airway disease.
Acknowledgements

I would like to acknowledge and pay tribute to certain members of the Department of Anaesthesia with whom I worked regularly, formed a special relationship with, and from whom I learned so much. Most brought back their expertise after study in overseas centres of excellence.

So, in no particular order:


The late Verlie Lines – emphasised the total care of the child. Verlie taught me (and many others) by example: the need to be gentle with very small patients, e.g., in and out of an incubator with careful awareness and attention to minimal handling, optimal oxygenation, body temperature and blood glucose. She introduced us to the Cass needle (Fig. 7).

John Overton – Director of Anaesthesia. John espoused the principle of the ‘dynamic respiratory tract’ for evaluation of movement by the endoscopist. And he encouraged the use of the Cass needle.

The late Graham Fisk – Cecil Gray, England. Graham introduced the technique of paralysis with further intermittent ventilation down the bronchoscope indicated by development cyanosis or bradycardia.

The late Gregory Wotherspoon – Toronto, Canada, cheerfully took over the Monday morning ‘airway list’, a valuable teaching list following Verlie’s sad demise.

Typing and Proof-reading

The typing was shared by Millie Constable and Sharlene Rainford to whom we owe a great debt.

Brian Shearman, F.R.A.C.S., proved to be an eagle-eyed proof-reader.

Greg Benjamin has also helped with typing early drafts, proof-reading and correcting final drafts.

Caution. An endotracheal tube in the larynx can cause more injury than is generally appreciated, more so if the tissues are acutely inflamed and swollen as they are in the infectious diseases described above. Significant injury is mostly related to the duration of intubation and the diameter of the tube because prolonged pressure can cause ulceration of perichondrium and underlying cartilage. To minimise airway obstruction after extubation the diameter of tube must be selected so that it is not ‘tight’ but ‘loose-fitting’ within the larynx, and subglottis so that an air leak can be demonstrated by exerting positive pressure on the ventilation system. This is especially important in children intubated for croup.16 Benjamin and Holinger reviewed acute and chronic intubation sequelae and coined four new descriptive terms to cover some of the possible outcomes:

- Flaps of granulation tissue.
- Healed fibrous nodule.
- Healed furrows.
- Ulcerated trough.

Fig. 7 Local anaesthetic spray. A Cass needle has four side openings and one forward opening at the distal end to spray topical anaesthetic solution in the larynx. Alternatively, a pre-packaged delivery bottle with an integral spray can be used.
References

Articles


Textbooks

KARL STORZ Instruments Designed and Used by Bruce Benjamin
Laryngoscopes for Infants and Children

8587 P BENJAMIN-LINDHOLM Operating Laryngoscope, for newborn babies and infants, inner diameter proximal end 26 x 16 mm, distal end 14 x 11 mm, length 9.5 cm

8574 N HOLINGER-BENJAMIN Anterior Commissure Laryngoscope, for very low birthweight and newborn babies, slotted, length 9.5 cm, with fiber optic light carrier 8574 FD

8587 KK LINDHOLM Operating Laryngoscope, for children, inner proximal end 30 x 20 mm, distal end width 16 mm, length 11 cm

8574 G BENJAMIN Slotted Laryngoscope, lateral opening, especially appropriate for introducing pediatric bronchoscopes, length 13.5 cm

It is recommended to check the suitability of the product for the intended procedure prior to use.
8574 C  **Slotted Laryngoscope**, lateral opening, length 11 cm

8574 D  **Slotted Laryngoscope**, lateral opening, length 9.5 cm

8574 E  **Slotted Laryngoscope**, lateral opening, length 8 cm

8574 F  **HOLINGER-BENJAMIN Anterior Commissure Laryngoscope** for newborn, length 9.5 cm, with fiber optic light carrier 8574 FD
8574 B  HOLINGER-TUCKER  
**Anterior Commissure Laryngoscope**,  
lateral opening, length 11 cm

8574 JB  BENJAMIN  **Operating Laryngoscope**,  
for children, small size, length 11.5 cm

8574 RB  BENJAMIN  **Subglottiscope**,  
for infants a few weeks of age,  
for diagnostic inspection and LASER  
surgical treatment in the subglottic  
and upper trachea, e.g. congenital  
hemaginoma, acquired stenosis of  
ductal retention cysts, length 11 cm,  
inner diameter proximal: 26 mm x 13 mm,  
inner diameter distal: 3.5 mm

8574 J  BENJAMIN  **Operating Laryngoscope**,  
for children, length 15 cm
8574 RA  **BENJAMIN Subglottiscope,**
for infants a few months of age, for diagnostic inspection and LASER surgical treatment in the subglottic and upper trachea, e.g. congenital hemanginoma, acquired stenosis of ductal retention cyst, length 11 cm, inner diameter proximal: 26 mm x 13 mm, inner diameter distal: 4.7 mm

8574 R  **BENJAMIN Subglottiscope,**
pediatric size for diagnostic inspection and LASER surgical treatment in the subglottic and upper trachea, e.g. congenital hemanginoma, acquired stenosis or ductal retention cysts, length 11 cm, inner diameter proximal 33 mm x 18 mm, inner diameter distal 7 mm x 9 mm
Laryngoscopes for Adults

8574 SL  BENJAMIN Slimline Operating Laryngoscope and Subglottiscope, for adults, slender, length 17 cm, for use with Clip 497 AC

8574 SSL  BENJAMIN-PARSONS Super-Slimline Operating Laryngoscope and Subglottiscope, for adults, extra slender, flat model, for particularly difficult anatomical circumstances, length 17 cm, for use with Clip 497 AC

Other Laryngeal Instruments

8574 GZ  BENJAMIN Injection Cannula, for positive pressure assisted ventilation, malleable, diameter 3 mm, working length 13.5 cm

8574 GY  BENJAMIN Injection Cannula, for positive pressure assisted ventilation, malleable, diameter 2 mm, working length 13.5 cm
8575 KW  BENJAMIN-PARSONS **Support Rod**, movable, with metal ring, diameter 12 cm and 2 lateral set screws, length 34 cm

497 AB  BENJAMIN-HAVAS **Clip** for proximal illumination

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**Oesophageal Instruments**

12063 A  BENJAMIN **Esophagoscope**, adult long, length 47 cm, size 18 x 20

10393 A  JACKSON-BENJAMIN **Neonate Esophageal Bougie**, working length 33 cm, 6 Fr. (2 mm)
12064 A  BENJAMIN Esophageal Speculum, distal end flat, with long bevelled end, outer diameter proximal 35 x 22 mm, distal width 20 mm, length 24 cm

12064 B  BENJAMIN Esophageal Speculum, distal end flat, with long bevelled end, outer diameter proximal 29 x 18 mm, distal width 18 mm, length 23 cm

12068 A  HOLINGER-BENJAMIN Double-End Diverticuloscope, outer diameter proximal 35 mm x 22 mm, distal 20 mm x 15 mm, length 24 cm

12068 B  HOLINGER-BENJAMIN Double-End Diverticuloscope, slender, for difficult anatomical circumstances, outer diameter proximal: 35 mm x 22 mm, distal 17 mm x 13 mm, length 24 cm
Notes:
with the compliments of
KARL STORZ — ENDOSKOPE