SECRETIONAL ANOXIA AND TRACHEOTOMY*

D. V. MAYTHAM, D.L.O., R.C.P. & S. (ENG.), *Cape Town*

The operation of tracheotomy was first mentioned by Galen and Areteus in the 2nd and 3rd centuries A.D. but they did not use the term tracheotomy.[1] Galen used a word meaning to cut the larynx or artery—he used artery, arteria aspera, and bronchus, all to mean the windpipe. Subsequently the terms laryngotomy and bronchotomy were used more or less indiscriminately by various writers, and it was Fabricius in the 16th century who was first to use the term tracheotomy. However, the terms laryngotomy and bronchotomy continued to be used by many until the 19th century, when Bretonneau and Trousseau firmly established the operation as a life-saving procedure in diphtheria and also firmly established the present name. The first tracheotomies and, for that matter, tracheotomies up until recent times were performed almost exclusively for obstructive laryngeal lesions of various aetiology.

With the development of the concept of secretional anoxia the role of the operation has been greatly extended. Echols *et al.*[2] report that, out of a total of 108 tracheotomies performed in a general hospital between January 1947 and July 1950, only 39 were for obstructive lesions, while 69 were for the prevention or treatment of respiratory complications. Between January and June of this year 45 tracheotomies were done by the Ear Nose and Throat Department of Groote

* Paper presented at the 42nd South African Medical Congress, East London, C.P. September—October 1959.

Schuur Hospital, Cape Town; of these only 14 were for obstructive lesions, while 31 were for the management of secretional obstruction and allied problems.

The ear nose and throat surgeon has thus become an integral part of the team in the management of this type of respiratory insufficiency.

The present-day role of tracheotomy owes much to the work of those concerned in the management of respiratory problems in poliomyelitis. With the recognition of the place of the operation in poliomyelitis it was logically inevitable that the indications would be widened to include a variety of disease states with similar respiratory problems. Wilson,[3] of Harvard, in 1931 recognized the relief afforded by direct removal of secretions from the respiratory tract. He considered tracheotomy a help in selected cases although a radical procedure. More experience convinced him, according to reports in 1941 and 1943, that sometimes tracheotomy was life-saving. More thought and study were given to the problem after Galloway[4] published an article in 1943 in whch he observed that tracheotomy had saved 2 poliomyelitis patients who otherwise would have succumbed to the disease. Epidemics in succeeding years gave American physicians more opportunity to recognize the respiratory obstruction early, when formerly it was frequently overlooked. Priest *et al.*[5] reported thus on the 1946 Minneapolis epidemic: 'Of 75 patients on whom tracheotomy was performed 29 survived and 19 of these left little doubt that tracheotomy directly saved their lives.' Reports such as these and subsequently others, notably those by Professor Lassen,[6] of Copenhagen, firmly established the place of tracheotomy in poliomyelitis and laid the foundations for further development.

Pathology of Secretional Anoxia

Normally between 1200 and 1500 c.c. of saliva is secreted daily by the average adult, and about 900 c.c. of fluid is produced in the respiratory tree. Over and above this it has been suggested that in conditions such as poliomyelitis actual hypersecretion of saliva takes place owing to autonomic dysfunction possibly caused by central stimulation of the salivary nuclei in the medulla due to anoxia or inflammation. In addition oedema of the lung and tracheobronchial inflammation produce increased fluid. Secretional obstruction is likely if (*a*) secretions, drink, food, vomit or blood spill over into the trachea because of disturbance of the swallowing mechanism, or (*b*) the patient is unable to expel secretions or inhaled material from the lungs because of the inability to cough. Either or both of these two grave disabilities may arise in a number of pathological conditions, viz., (i) acute poliomyelitis, (ii) polyneuritis of the Guillain-Barré and Landry type, (iii) coma of any aetiology, (iv) head injuries, (v) tetanus, and (vi) severe injury to the chest, neck, mouth, pharynx and larynx. Clinical observation warrants the conclusion that the immediate cause of death in many of these patients is progressive anoxia and accumulation of carbon dioxide from obstruction of the airway by mucus and other secretions and the resulting pulmonary complications—atelectasis and pneumonia. The clinical signs and symptoms of obstructed or inadequate respiration may be summarized as follows:

(*a*) A sustained diastolic and systolic hypertension due to the raised blood carbon dioxide.

(*b*) Apprehension and anxiety.

(*c*) Mental aberration.

(*d*) Signs of retained secretions in the tracheobronchial tree.

(*e*) Fever and tachycardia.

(*f*) Cyanosis, which, it should be observed, is a manifestation that should not be allowed to develop. Regardless of the disease entity, tracheotomy may be said to be indicated whenever this procedure alone will establish and maintain an adequate airway fror proper gaseous respiratory exchange.

Advantages and Disadvantages of Tracheotomy

The advantages are as follows:

1. It provides a free airway and at the same time, if necessary, the use of a cuffed tube prevents the entry of fluids and solids from the pharynx into the trachea.

2. Tracheobronchial toilet is greatly facilitated.

3. It makes it possible to use intratracheal positive-pressure respiration when indicated.

The disadvantages are the following:

1. Highly trained and experienced personnel are essential, particularly in cases requiring assisted respiration.

2. The weaning period may be difficult in patients making a poor respiratory recovery in poliomyelitis.

3. The tracheotomy tube in itself increases secretion and, if the inhaled air is not adequately humidified, viscous secretions and crust formation are likely.

4. Infection may be introduced by the repeated suction if the suction technique is not kept as aseptic as possible.

5. Lassen reported 3 cases of tracheal stenosis in 250 cases of bulbospinal poliomyelitis treated by tracheotomy and intermittent-positive-pressure respiration.

Tracheotomy Technique

The majority of tracheotomies of this type can be performed under local anaesthesia and, of course, in unconscious patients without any anesthetic at all. General anaesthesia is preferred in the following 2 groups:

(*a*) In bulbospinal poliomyelitis cases, where the operation is being done to institute intermittent-positive-pressure respiration. These patients require assisted respiration, and many of them are mentally alert, distressed and anxious; tracheotomy is then less harrowing under general anaesthesia. For spinal cases in a respirator who require tracheotomy because of supervening bulbar paralysis, the operation is much more easily done with endotracheal anaesthesia and assisted respiration outside the respirator.

(*b*) Neonatal tetanus tracheotomies are also best done under general anaesthetic with endotracheal intubation.

The tracheotomy incision will depend on the personal preference of the operator. Those who favour the transverse incision claim better cosmetic results. In fact, the cosmetic deformity of any tracheotomy is the central puckered scar, and this may follow either the vertical or the transverse incision; its size and unsightliness depend on the duration of the tracheotomy and the degree of wound infection. The vertical incision is quicker and easier as regards haemostasis, and is, for the occasional operator at least, the one of choice.

Lassen and his associates recommend a high tracheotomy in cases for intermittent-positive-pressure respiration. This is to obviate the danger of the cuffed tube slipping down one or other main bronchus. In his 1952 series of 250 tracheotomies only 3% of the patients developed tracheal stenosis and, considering that many of these patients had a cuffed tube *in situ* for anything from 3 to 6 weeks, it is difficult to know

whether a low tracheotomy would have produced better figures. I performed a low tracheotomy on the first bulbospinal case to be treated by Lassen's method in the 1956 Cape Town polio epidemic and I must confess the tendency of the tube to slip down the right bronchus required constant watching. The right-angled tube designed by Crampton Smith eliminates this hazard, however, and with it I think this objection to a below-isthmus tracheotomy falls away.

If tracheotomy is being performed with a view to intermittent-positive-pressure respiration it is necessary to excise a window from the anterior tracheal wall. This should be oval in shape with its greatest diameter in the axis of the trachea. If the tracheotomy is for an obstructive lesion or for tracheobronchial toilet only, the excision of such a window would appear to be optional, and Mosher's cruciate incision or a simple vertical division of 2 or 3 tracheal rings is used.

Management of Patient

The following points are stressed:

(*a*) Secretions should be kept as fluid as possible by adequate humidification, alevaire therapy, or full hydration. When secretions are viscid and difficult to clear, preparations such as alevaire, tryptar and pancreatic desoxyribonuclease may be of help. Galloway[7] recommends irrigation with 1-5 ml. of normal saline and 3% sodium bicarbonate solution occasionally in preference to the above agents. If treatment is adequate bronchoscopy should rarely be necessary.

(*b*) If a cuffed tube is in use this should be deflated for a minute or two every 4 hours. Before the cuff is deflated the bed should be tilted and the stomach and pharynx aspirated.

(*c*) Suction technique should be as aseptic as possible to minimize infection.

(*d*) Regular turning, percussion and chest squeezing combined with gravity and suction are important in the prevention and management of pulmonary complications.

Detubation

The following criteria are given for closure of the tracheotomy:

1. There must be complete return of swallowing.
2. The laryngeal and chest muscles must permit an adequately forceful cough.
3. The laryngeal muscles must permit maintenance of an adequate airway.
4. The patient must be able to oxygenate adequately without assisted respiration.
5. There must be no evidence of any pulmonary complication indicating bronchial obstruction and atelectasis.

The difficulty in detubation which sometimes arises in infants who have had a tracheotomy for any length of time is a familiar problem. In the first instance a laryngoscopy and bronchoscopy should be carried out to ascertain whether there is any stenosis or whether granulations are present in the trachea. When such granulations have been encountered they have, in my experience, invariably been found to be prolapsing into the trachea from the margins of the stoma and not arising within the trachea itself. I have found that the most effective way of dealing with these is to remove them under endotracheal anaesthesia with a Hartman's granulation-tissue forceps through a Welsh Alleyn operating auriscope inserted into the tracheostome. In some cases neither stenosis nor granulations are found to account for the difficulty in detubation, and I should like to submit the following explanation for this group. The infant trachea can tolerate very little reduction of its lumen without seriously impairing its airway. With the removal of a tracheotomy tube which has been *in situ* for any length of time there is an established gap in the anterior tracheal wall and therefore some degree of prolapse of soft tissue into the trachea, which is further aggravated by inspiration through the tracheostome. The infant becomes distressed and the tube has to be replaced. The only treatment for these cases is to reduce the size of the tracheotomy tube to the smallest possible, and then wait for the trachea to acquire the necessary extra capacity required to compensate for the prolapse described above.

Conclusion

In view of the team-work and trained personnel required to obtain the best results in the management of these various types of respiratory insufficiency I think it is essential to provide specific centralized units in all our major hospitals.

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