TRACHEOSTOMY

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ALTHOUGH tracheostomy is an operation which has been practised since the days of Asclepiades in the first century B.C., profound changes have occurred during the last 30 years in the variety and relative frequency of the conditions for which the operation is performed. This article attempts to assess the role of tracheostomy at the present time and to discuss the modern views of why and when a tracheostomy is indicated and, briefly, how it should be performed and managed subsequently.

Indications for Tracheostomy

The most obvious indication for tracheostomy is to relieve an obstruction to the airway. This is such a well established and understood procedure that there is no need to consider it in any detail here, but mention might be made of the fact that the changing pattern of disease has altered the frequency of the operation in various conditions. Diphtheria provides the most striking example.

Apart from relieving an obstruction in the upper airway a tracheostomy provides easy access for aspiration of bronchial secretions in patients who cannot adequately eliminate them by coughing; it allows the air passages to be shut off from the digestive tract, thus preventing anything except air from entering the lower respiratory tract; it reduces the dead space by approximately a half; and it also allows the lungs to be aerated by intermittent positive pressure. In many patients it may be advantageous for more than one of these reasons and often it is impossible to single out any one of them as *the* indication for a tracheostomy. Aspiration of secretions and reduction of the dead space can both play a part in helping patients with acute or chronic respiratory insufficiency, while elimination of pharyngeal secretions from the respiratory tract and intermittent positive pressure respiration both help in the treatment of patients with respiratory and laryngeal paralysis.

Some of the conditions, other than respiratory obstruction, which may require a tracheostomy need to be considered in more detail.

Poliomyelitis and Polyneuritis

Most patients with a paralysis of the muscles of respiration can be managed perfectly well in a tank respirator without recourse to tracheostomy—except in large epidemics where sufficient respirators may not be available, as happened in Denmark in 1952 (Lassen, 1954). However, where paralysis of the protective laryngeal sphincter mechanism is added, saliva and mucus will be aspirated into the tracheo-bronchial tree with each respiration and infection will soon supervene. A tracheostomy allows a cuffed tube to be inserted into the trachea to exclude these unwanted secretions from the airway. It is possible, with the aid of special fittings around the neck, to respire artificially such a patient in a tank respirator, but once a tracheostomy is available it is much better and easier to aerate the lungs by intermittent positive pressure through the tracheostomy tube.

Simple loss of the laryngeal sphincter, without respiratory paralysis, may allow aspiration of saliva or food, but the cough reflex may well be adequate to keep the airway clear.

Pharyngeal paralysis by itself will lead to pooling of secretions in the hypopharynx with overflow into the larynx causing choking attacks. After a time tolerance may set in and there is no longer sufficient reflex response to clear the airway. Infection will occur unless the air passages are separated from the pharynx. Whenever laryngeal and pharyngeal paralysis are present together a tracheostomy is essential from the start.

The best time for operating is a matter of judgment in every individual patient but, in most cases seen early, inhalation of secretions can, and should, be anticipated rather than awaited and a tracheostomy established so that pharyngeal secretions are excluded before they can be aspirated. In this way many cases of respiratory infection will be prevented. If infection has already occurred by the time the patient is seen it is recommended that a tracheostomy should be done as soon as possible.

Coma

In many cases of coma, even when it is prolonged, skilled nursing and physiotherapy will ensure a satisfactory airway and elimination of sputum and will prevent the development of respiratory insufficiency or lung infection. However, in some patients, infection develops in spite of these precautions and once it is established a vicious circle can be started in which infection leads to hypoventilation, which reduces the venous return, with a consequent fall in cardiac output resulting in a further increase in the secretions. A tracheostomy can succeed in breaking this chain of events by allowing removal of the secretions with improved ventilation. Obviously, it is desirable to anticipate the onset of this infection and prevent it with a tracheostomy rather than await its development and then attempt to treat it.

A patient with a good physique may be able to withstand conditions which would be fatal to one who is emaciated or weak, and this must be considered when a decision about tracheostomy is being made. Chest disease with a degree of respiratory failure will, in the presence of coma, usually need a tracheostomy except where unconsciousness is very brief.

Coma due to a head injury requires special consideration because the case is sometimes complicated by the existence of other injuries which may involve the airway or may interfere with the proper posturing and physiotherapy which are such a necessary part of the patient's management. Injuries of the mouth and pharynx may demand an urgent tracheostomy for obstruction or to exclude blood from the respiratory tract and also to allow adequate surgical treatment of the injuries. Coincident chest injuries may interfere with coughing and with posturing to such an extent that infection is almost inevitable without a tracheostomy. Fractures of the limbs (especially the femur) may require continuous traction with the patient maintained in the supine position and prevent any possibility of adopting the prone or semi-prone position which is so helpful in maintaining a clear respiratory tract. For a patient in coma who needs to remain continuously in a supine position a tracheostomy is a necessity.

Respiratory Insufficiency

Cases of chronic respiratory disease, such as emphysema and bronchitis, may suffer acute respiratory inadequacy by the development of an acute infection, and a tracheostomy can be life-saving at such a time. Even in the chronic state the operation can prevent some patients from becoming respiratory cripples by allowing the

easy and frequent removal of secretions which cannot be coughed up.

Similar conditions occur after some thoracic and abdominal operations, when pain and weakness may depress respiratory movements and coughing to a dangerous extent. Anxiety and the rapid shallow respiration which often accompanies this state may be an added factor in some cases. In such people, especially those with a poor respiratory reserve before operation, a tracheostomy is indicated as part of the post-operative management.

Tetanus

In this condition the combination of trismus and excessive salivation with dysphagia and laryngeal spasm produces a state of affairs where a tracheostomy is the only possible solution. There are, of course, mild cases of tetanus which do not require this aid, but experience has shown the necessity for tracheostomy in all severe and fulminating cases, especially as control of the spasms may require paralysing doses of muscle relaxants or sedatives and require positive pressure ventilation.

Myasthenia gravis

In severe cases of this disease with difficulty in breathing and with little or no response to large doses of neostigmine there is almost always associated difficulty in swallowing and a tracheostomy is just as necessary as in cases of bulbar poliomyelitis or polyneuritis.

Operative Technique

Fortunately it is very uncommon for an extreme emergency to demand an immediate tracheostomy as in most cases the difficulty can be overcome faster and more easily by passing an endotracheal tube through the larynx, or by making a stab laryngotomy between the thyroid and cricoid cartilages. When the sudden need for a tracheostomy does arise the cricoid cartilage should be felt below the prominence of the thyroid cartilage and a vertical incision made downwards from it. The incision will immediately flood with blood, but this must be ignored and the trachea located by feel and incised vertically. A slight twist of the scalpel after the incision has been made will separate the two cut edges and establish an airway. After that the blood can be removed, hæmostasis secured and a more satisfactory tracheostomy opening made.

When there is not this compelling need for immediate action the operation can be undertaken in more deliberate stages. In severe cases of respiratory obstruction with stridor and cyanosis, and also in cases of respiratory insuffi-

ciency, it may be advisable to use only a local anaesthetic, but in most cases for which a tracheostomy is required it is possible to administer a general anaesthetic through an endotracheal tube. This has the very considerable advantage of allowing an unhurried operation without the surgeon having to concern himself with constantly allaying the patient's natural anxiety and distress. In cases of coma, of course, no anaesthetic is required, but in delirious patients a general anaesthetic is highly desirable.

The site of the skin incision is determined by the level at which the tracheal opening is to be made and it seems best to discuss this point first. An opening in the trachea which is too high is apt to produce stenosis. Probably it is necessary to impinge on the cricoid cartilage itself before this complication arises, but in order to avoid any risk in this matter *the first tracheal ring must always be left intact* and the second ring should also be spared whenever possible. However, there is no merit in making a tracheostomy as low as is possible and a very low tracheostomy may leave too short a distance between the stoma and the carina to accommodate the tube without blocking one bronchus. This is especially important when a cuffed tube is being used. Also, if the opening is too low the flange of the tube may press uncomfortably on the manubrium. Accordingly, the most satisfactory position for the tracheostomy is usually at the level of the third or fourth tracheal ring.

A short collar incision 2 cm. below the cricoid cartilage in adults will give access to the trachea at the correct level. The incision is carried down to the sternohyoid muscles and then the skin and subcutaneous tissues are dissected upwards and downwards a short distance and the flaps held apart with a self-retaining retractor. The right and left sternohyoid and sternothyroid muscles are separated and held apart with retractors, exposing the isthmus of the thyroid and the trachea above and below it. The isthmus varies greatly in size and if it is at all in the way it is divided in the midline and the cut surfaces sewn over. The trachea is then exposed and at this stage it is wise to check the position of the head.

Exposure of the trachea is made easier by extending the neck and at the start of the operation it is usual to extend the neck as much as possible. There is no objection to this at that stage, but in some patients the neck can be extended considerably and as a result the trachea is raised some distance in the neck. If the opening in the trachea is made when the neck is hyperextended it can be made very low, but it will descend in the neck when flexion occurs and will no longer correspond to the skin incision. For this reason,

before opening the trachea it is wise to see that the neck is not unduly extended and is in a position approximating to that in which the patient will be lying subsequently.

Complete haemostasis should be secured before incising the trachea and then a circular opening is made in the anterior wall corresponding in size to the tracheostomy tube to be used. As has been said previously this will involve removing the central portion of the third or fourth (or, rarely, the second) tracheal ring. If an anaesthetic is being administered through an endotracheal tube this is now withdrawn until the tip is just above the tracheal opening and the tracheostomy tube is then introduced. The incision is closed with a few skin sutures. It is important not to sew the skin tightly around the tube as such a procedure is almost certain to lead to the development of surgical emphysema as a result of air leaking out of the trachea, especially during coughing and straining, and then being trapped beneath the tightly sutured skin.

A useful safeguard against the risk of emphysema is to suture the centre of the lower skin flap to the lower edge of the tracheal opening. Should the tube become dislodged out of the trachea it can be replaced much more easily and safely when this precaution has been taken.

The best type of tube to insert will depend on the condition for which the operation is being done and on the post-operative treatment needed. In order to exclude pharyngeal secretions from the bronchial tree and in order to permit positive pressure respiration a tube with an inflatable cuff is required and a plastic- or rubber-cuffed tube is most suitable. If the tube does not need to act as a seal a double-lumen metal tube is usually best. The outer tube can be retained in the neck while the inner one is removed for cleaning, thus avoiding any necessity for replacing the tube in the tracheostomy opening after cleaning. When the tracheostomy has become firmly sealed off, after 7-10 days, the double-lumen metal tube can be discarded and replaced by a single plastic or rubber tube.

When positive pressure ventilation is required it is preferable to use a tube with a fixed flange rather than one in which the position of the tube is adjustable. The pulsations transmitted from the pump tend to shift the tube and it may move up or down within the adjustable collar and become seriously displaced.

Management

It is impossible to discuss here the detailed post-operative management of patients with a tracheostomy, especially those requiring inter-

mittent positive pressure respiration. However, brief mention may be made of humidification and of pressure effects on the tracheal wall from the tube or its cuff.

It is important that crusting should not occur in the trachea or bronchi and this is liable to happen when the moistening action of the nasal mucosa is no longer available. In moist weather there may be only slight risk of this happening, but in dry weather the danger is considerable and humidification of the inspired air is essential. A steam kettle is beneficial but has considerable disadvantages and a special humidifier is better (Spalding, 1956). With intermittent positive pressure respiration a humidifier is always necessary. If infection has already developed before the tracheostomy is done the bronchial tree may be filled with tenacious exudate which will be difficult to clear by suction and where this occurs there may be a place for the use of aerosol enzymes or detergents (Steigman and Scott, 1952; Ravenel, 1953).

Necrosis of the tracheal wall has occurred as a result of pressure from the tracheostomy tube, but this can be avoided if tubes of the correct size and shape are available for every patient. Prolonged pressure from the inflated cuff can lead to necrosis of the mucosa, but in our experience this is not a danger if a fairly long cuff is used and if it is never inflated more than is necessary to produce an airtight seal. Under these circumstances the cuff can be left inflated for several days or even weeks without any necessity for periodic deflation.

Difficulties have arisen as a result of forcing the upper edge of the window into the lumen of the trachea when too small an opening has been made in the cartilage. After being depressed for days or weeks by the tube the cartilage becomes set in this position permanently and forms a bar limiting the lumen of the trachea and causing trouble when attempts to decannulate are made. On the other hand, removal of too much cartilage may leave unsupported so large an area of tracheal wall that the soft tissue collapses into the trachea when healing is taking place.

When the need for a cuffed tube is over, the tracheostomy will have to be maintained with an ordinary tube, fitting loosely in the trachea, until such time as decannulation may safely be attempted. This can usually be determined by gradually corking the tube until it is completely blocked and for this to be possible there must be sufficient air space in the trachea around the tube. When the patient is able to sleep all night with the tube corked he is ready to do without it although he may be very unwilling to do so. Much patience and persuasion may be called for to overcome his lack of confidence in his ability to breathe naturally again. The rima glottidis gives a feeling of lesser freedom than the tube and so it takes time for the patient to feel at ease on once more returning to the normal state.

Once the tube has been removed healing of the tracheostome occurs quickly without the necessity for secondary suture, even when the tracheal edge has been stitched to the skin. The scar soon becomes inconspicuous.

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