

## TRACHEOSTOMY: INDICATION, TECHNIQUES AND MANAGEMENT

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Tracheostomy is a procedure practiced by the medical profession at least since the first century B.C. Up until the beginning of the present century, the operation was carried out solely for the relief of laryngeal obstruction. Today, tracheostomy is still performed frequently for obstructive conditions, but this is but one of the many indications for the operation.

### Indications:

"If in doubt, do it". This saying has much to commend it; all too often, the operation is carried out on a moribund patient, as an emergency, and under far from ideal conditions. If the patient is ill enough to warrant consideration of the procedure - this is the time to do it.

Conditions which might necessitate tracheostomy are innumerable, but may be grouped:

- (a) Respiratory obstruction - at any site above that at which tracheostomy may be performed, from any cause not rapidly amenable to medical treatment.
- (b) To provide a safe airway - where surgery of the neck or face is contemplated.
- (c) Inability to clear bronchial secretion - by reason of C.N.S. depression, injury or other disease.
- (d) Respiratory insufficiency -

(a) **Respiratory Obstruction:** Lesions of the base of the tongue, pharyngeal tumors, septic pharyngitis, retro- and para-pharyngeal abscesses, inoperable laryngeal tumors, oedema of the larynx - whether of allergic, cardiac or renal origin. Bilateral abductor palsy, inhalation of corrosive vapors, stenosis of the larynx or trachea, e.g. following injury or from pressure by tumors external to the larynx or trachea.

Infections such as laryngo-tracheo-bronchitis, epiglottitis and even acute laryngitis may all necessitate tracheostomy, particularly in children. The urgency of the problem is realized when it is appreciated that an infant with a subglottic airway measuring 6 mm. in diameter has a normal airway; 5 mm. represents a reduced airway and 4 mm. a definite stenosis. Dealing with such small measurements; one can easily see the effect of mucosal swelling involving the larynx or trachea in children.

There are many other conditions of respiratory obstruction which may necessitate tracheostomy. The distinguishing factor is often not the degree of obstruction, but the rapidity of onset. A tumor of the larynx, for example, may obstruct 80 - 90% of the airway without distress to the patient yet bilateral abductor palsy following thyroid surgery may be fatal with the same available airway. It is suggested that in chronic obstruction, the respiratory centre becomes gradually adapted to the higher CO<sub>2</sub> concentration in the blood.

The commonest obstructive causes indicating tracheostomy are: - laryngeal and pharyngeal carcinoma, then acute laryngo-tracheo-bronchitis, followed by occasional examples of bilateral laryngeal paralysis, acute oedematous laryngitis and laryngeal foreign bodies.

The symptoms and signs of respiratory obstruction include (1) Stridor - from a cause at or above the larynx; stridor is inspiratory in nature (c.f. asthmatic "wheezing" and the "asthmatoïd wheeze" of a foreign body in the bronchus). (2) Recession of the soft tissue spaces - the intercostal and subcostal regions, the supraclavicular fossae and in children, the lower costal cartilages, are indrawn with each inspiration. (c.f. asthma, where chest is expanded.) A "tracheal tug" may be felt and this is absent in other causes of dyspnoea, e.g. asthma and pneumonia. (3) Cyanosis

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and rapid respiration - restlessness is especially prominent in children and misguided efforts to quiet their apprehension by sedation or narcotics may have tragic results.

**(b) To Provide a Safe Airway:** For example, as a preliminary stage in certain operations on the larynx, tongue, pharynx and jaws to safeguard the airway and protect against the inhalation of blood. A cuffed tube will, in addition to providing an airway, prevent aspiration of saliva, mucus and vomitus.

In this instance, it should be noted that tracheostomy must never be attempted under general anaesthesia unless one can be sure intubation is feasible. If there is any doubt, the operation should be performed under local anaesthesia; otherwise the patient may die when given a muscle relaxant and the anaesthetist is unable to secure an airway. This situation presents in facio-maxillary injuries, advanced laryngeal carcinoma and laryngeal hyperkeratosis.

**(c) Inability to Clear Bronchial Secretions:** This may occur in cases of head injury, coma from any cause, respiratory and bulbar paralysis, fractured ribs, when pain prevents coughing and promotes stagnation of respiratory secretions.

Intubation for a limited period is being practiced with comatose patients as an alternative to tracheostomy. This would be particularly useful in barbiturate poisoning where one could reasonably expect improvement or a fatal outcome within twenty-four hours. Endotracheal tubes are left in position on occasion up to a week, but the general opinion is that the time should not exceed three days - reports are coming in of complications from this mode of treatment.

**(d) Respiratory Insufficiency:** Even in the absence of obstruction, respiration may be insufficient to meet the demands of the patient. In such circumstances tracheostomy may improve efficiency by reducing dead space, reducing resistance to airflow, and allowing positive pressure ventilation.

In a patient with rapid shallow breathing, the tidal volume may be almost half normal yet the dead space remains the same. Tracheostomy can reduce dead space from 150 to 50 cc.

In reducing resistance to airflow, a wide bore tracheostomy tube is used (c.f. that required for aspiration of secretions, which may be of small bore).

In cases of coma (e.g. head injury, or barbiturate poisoning), respiration may be inadequate, tracheostomy and intermittent positive pressure respiration being required.

#### Anatomy

Although the anatomy of this region is generally well known, some comment on the surgical anatomy is in order.

Anteriorly, the cricoid cartilage is the prominent ring felt just below the lower border of the thyroid cartilage. The midline of the neck is relatively avascular but trouble may be experienced, with a jugular venous arch, which connects the anterior jugular veins of either side, and with anastomosing vessels between the two superior thyroid arteries immediately above the isthmus. The innominate artery and vein cross obliquely in front of the trachea at or just above the upper border of the manubrium sterni in children. (lower in adults). All manner of anomalous vessels may be found - e.g. the right subclavian artery may take origin from the left side and, on crossing over, form a dangerous anterior hazard at the third tracheal ring.

The sternohyoid and sternothyroid muscles lie on either side and, being attached to the deep cervical fascia, constitute with it a plane for the propagation of surgical emphysema. The thyroid isthmus crosses the second, third and fourth rings of the trachea usually, but it may be higher or lower.

Posteriorly, the oesophagus inclines to the left and with the recurrent laryngeal nerve is more vulnerable on this side. Laterally, the relations are the lobe of the thyroid gland down to the sixth tracheal ring, common carotid artery and internal jugular vein with vagus nerves, and far down near the manubrium sterni, the apices of the lung may be in danger and pneumothorax could occur.

From the anatomy, one can see that in no circumstances should tracheostomy be considered lightly.

It matters little whether a midline vertical or a collar incision is made; the resultant scar depends upon the length of time the tracheostomy tube is in place. It is however, fractionally easier to divide the thyroid isthmus using the vertical incisions, and also there is less likelihood of haemorrhage as the midline is relatively avascular. This, with the better exposure possible, would favour the use of the vertical incision, particularly if any difficulty is anticipated. If the procedure forms part of another operation (e.g., laryngec-

tomy) then of course the incision would be modified as required. For the sake of uniformity, the collar incision will be described.

In children, the airway should always be safeguarded, either by endotracheal anaesthesia or, the passage of a bronchoscope or endotracheal tube without anaesthesia. Operation under general anaesthesia is to be preferred, the exception being when the condition of the airway is such that difficulty with intubation is anticipated (e.g. facio-maxillary injuries, laryngeal carcinoma, laryngeal hyperkeratosis or papillomatosis.) The danger in this and similar conditions is that the patient may become, under pentothal and relaxants, apnoeic and with the anaesthetist unable to secure an airway, death results.

#### **Tracheostomy Operation:**

Wherever possible, the patient should be well informed as to the nature of the operation, as his subsequent co-operation is of vital importance.

The patient is placed in a moderately extended position with a sand bag or rolled sheet under the shoulders. The head and trachea should be exactly in the midline and the surface anatomy identifiable.

As described, general anaesthesia is preferable. If local anaesthesia is being used, 2% Xylocaine with or without adrenaline is satisfactory. The anaesthetic - about 15 cc.- is injected after sterile preparation and draping. The field injected is a diamond shaped one extending from the thyroid cartilage to the supra-sternal notch and on either side.

A collar incision is made over the third tracheal ring about 3-4 inches wide. This is deepened through the platysma to the deep cervical (investing layer) fascia. Skin flaps are freed sufficiently to convert the operative field into a vertical one - the flaps are retracted superiorly and inferiorly by an assistant.

Dissection is now carried out in the midline, avoiding as far as possible too much lateral dissection as this will encourage subsequent surgical emphysema. The deep fascia is incised vertically, the strap muscles identified and retracted laterally. This should expose the thyroid isthmus bound to the trachea by the pretracheal fascia. In many cases, the thyroid isthmus may be freed and retracted superiorly - if any difficulty is encountered the isthmus is divided and the cut edges secured with transfixion ligatures.

The cut ends of the isthmus are retracted laterally, exposing the trachea. The trachea may be partly obscured by the pretracheal fascia and if so, this is also divided. By using a skin hook as a retractor on the cricoid ring, the trachea may be brought forward. (It is surprising how deep the trachea may seem particularly in short thick-necked individuals).

The stage has now been reached where the trachea is about to be entered. Before doing this, the following checks are essential: - (1) all bleeding points properly controlled and ligated. (2) suction available and working. (3) an endotracheal tube of correct size available and if cuffed, both cuffs working.

The airway is injected through the trachea with 1 cc. of 5% Cocaine or 1% Pontocaine. This reduces the risk of coughing when the trachea is opened and the tube inserted.

The trachea is incised over the third and fourth tracheal rings and a wide based flap hinged inferiorly is fashioned. A retaining suture of black silk is passed through the tip of the lower skin flap, the ends of the suture left long. The use of a flap as opposed to cutting a window is debatable, but it does ease the task of early tube change.

The airway is gently suctioned and the selected tube inserted. If of the cuffed variety, the tube is inflated. The assistant is responsible for ensuring that the tube is not coughed out before it is secured and he also keeps the airway clear of blood or secretions.

The skin flaps are then approximated and sutured taking care not to close them in the immediate vicinity of the tracheostomy. If the closure is too snug, emphysema may result. Whilst the skin is being sutured, the tapes are secured behind the neck.

As soon as the operative procedure is over, the tapes securing the tube are again secured, this time with the head in a semi-flexed position.

The patient is returned to the floor and has with him a duplicate of his tracheostomy tube, tracheal dilators and is nursed by a special nurse. As he is unable to speak, a bell or buzzer should be available to him and his bed near the nursing station.

#### **Management:**

The aim of good management is to avoid complications by: - preventing obstruction to the patient's airway, avoiding introduction

of pathogens into the respiratory tract and, maintaining asepsis and cleanliness of the tracheostomy.

Mucus leads to diminution of air exchange; this causes crust formation and may result in death. How often suctioning is required is a matter of experience, but in the immediate post-operative period may be very frequent indeed, e.g. every fifteen minutes or less. Suction catheters are introduced into the trachea with suction *off* then withdrawn steadily whilst suctioning. Suctioning should not be for more than fifteen seconds at a time as it distresses the patient with the fear of suffocation. Remember the patient cannot talk. Suctioning should be done under sterile or as near sterile conditions as possible.

Humidification with a cupola and Puritan humidifier is essential. Remember, the airconditioning effect of the nose has been bypassed.

Patients are usually most comfortable in the semi-upright position.

As has been mentioned, it is the aim of management to avoid complications. Such complications may be early or late, mention of them will indicate how they may be avoided.

**Early Complications - (1). Respiratory arrest or depression** - Immediately post-operatively, there may be respiratory arrest or depression. This is more likely to occur following relief of long standing obstruction and is due to the sudden reduction of  $p\text{CO}_2$  when the respiratory centre has become adapted to a high  $\text{CO}_2$  concentration. Correction may be obtained by giving the patient oxygen with 7%  $\text{CO}_2$  for a few hours.

**2. Cardiac arrest or failure** - This may also occur after relief of long standing obstruction as the anoxia brings about myocardial degeneration. The heart may collapse with the first unaccustomed exertions made possible by the adequate ventilation.

**3. Obstruction to left main bronchus** - If the tracheostomy tube is too long, it will pass the carina and enter the right main bronchus thus obstructing the left. Regular auscultation, the selection of a proper size tube and post-operative X-ray will avoid this complication.

**4. Respiratory obstruction** - This may also arise if an overinflated cuff on a James tube rides down over the inner lumen of the tube. This is a danger in the practice of cutting the tube - it may be better to build up

the neck dressing.

**5. Haemorrhage** - This may occur and require opening the original incision but this is rarely necessary.

**6. Surgical emphysema** - If the wound is closed too tightly, air may be drawn into the soft tissues during inspiration but remain trapped in expiration. Also when the patient coughs, air escapes around the tracheostomy tube and again enters the soft tissues, both circumstances leading to emphysema.

**7. Displaced tube** - The tracheostomy tube may enter the soft tissues of the neck during a bout of coughing. This is prevented by having the proper size of tube, skilled nursing care, the use of a tracheal flaps as described and most important, ensuring that the tapes securing the tube are adjusted with the head in the semi-flexed position.

**Later Complications - 1. Crusting** - This may be avoided by the use of humidifiers, mucolytic agents and adequate suctioning. Should crusts enter the lungs, bronchoscopy through the trachea will be required. Particular care is indicated in this respect with comatose patients who are unable to raise secretions by coughing.

**2. Respiratory infection** - This and infection of the tracheostomy will be avoided by attention to sterile techniques during suctioning, change of tubes or dressings.

**3. Stenosis of the trachea** - This may result from using too high a tracheostomy opening, using a tube too large for the window which has been cut thus leading to pressure necrosis and later stenosis, using a tube with incorrect curvature leading to pressure on the tracheal wall.

**4. Aspiration of foods** - When the larynx is out of use (tracheostomy) the vocal cords become insensitive and no longer protect the upper airway. Neuromuscular inco-ordination may also result and thus foods or liquids may appear around the tracheostome and possibly be aspirated. The situation may lead one to suspect tracheo-oesophageal fistula.

**5. Granulation tissue** - This may form around the tracheostome. This should be examined and cauterized around the base of the wound.

**6. Failure of tracheostomy to close** - This would appear to be more frequent when the tracheal flap with collar incision is utilized. Excision and secondary closure may be required.

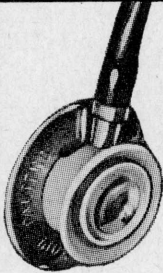
7. **Obstruction** - This may result from a tracheal flap breaking at the "hinge" and impinging on the airway. Fatalities have been recorded.

8. **Dysphagia** - This may occur as a complication of the tracheal flap, where the flap has been sutured to the soft tissue, this may be impairment of the normal sliding mobility of the larynx during the second stage of deglutition.

8. **Decannulation** - Difficulty may be experienced, usually in children. Children rapidly become accustomed to the unham-

pered airway provided by tracheostomy and will not tolerate decannulation. This can be overcome by using progressively smaller tubes or by corking the tracheostomy tube with corks from which progressively smaller segments have been removed.

In conclusion, tracheostomy may be a life-saving procedure but it is not without risk. The surgeon who undertakes this procedure should personally supervise the post-operative care and assist the nursing staff, otherwise, with the best will in the world, fatalities will occur.



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## Mechanism of action analogous to that of chlorothiazide Prolonged diuretic action

According to numerous clinical trials carried out in Europe and in Canada, its main indications are the following:

### EDEMA OF VARIED ETIOLOGY — CARDIAC FAILURE — HYPERTENSION (used alone or with other antihypertensive drugs)

#### dosage and administration

**Oral route** — single dose or divided doses. Adjust dosage, frequency and duration of administration according to patient's needs. Dosage guide for adults:

#### Various edemas and cardiac failure:

25 to 50 mg daily on alternate days or on 3 consecutive days per week; in rare cases, daily dosage may reach 100 mg. Maintenance doses: 10, 20 or 25 mg daily may be adequate.

**Water retention of a mild degree** (as in premenstrual syndrome): 10 mg daily or 25 mg three times a week.

**Hepatic cirrhosis:** 25 to 75 mg, occasionally increased to 100 mg daily, for 3 to 4 days. **A potassium supplement should always be given.**

**Hypertension:** in mild or moderately severe cases, Nefrolan often exerts a hypotensive action when used alone: 10 mg daily should be tried initially and the dose increased to 20 mg if the response is inadequate. In some cases, a dose of 10 to 20 mg on alternate days or three times a week may be sufficient. Higher dosage may be used if necessary or other antihypertensive drugs added to the treatment.

#### supportive treatment

a) **Potassium supplement** — Nefrolan may cause potassium depletion. The daily ingestion of fruits rich in potassium is suggested. **A daily potassium supplement of 1 to 3 g is recommended; in hepatic cirrhosis — when a digitalis preparation is being administered — during prolonged corticosteroid therapy.** In patients treated with Nefrolan for periods exceeding 2 to 3 weeks, frequent monitoring of serum potassium, chloride and bicarbonate levels should be performed. Supplements of potassium should be given when indicated.

b) **Spironolactone** may be associated with Nefrolan when the urinary output of sodium chloride is low and there is reason to suspect aldosteronism.

#### references:

1. Simpson, F. O.: Clinical trial of a new oral diuretic, M & B 8430. *Current Therap. Res.*, **6**, (1), 21-26, January 1964. — 2. Baba, W. I. *et al.*: Studies on the mechanism and Characteristics of action of a new phthalimidine diuretic, clorexolone. *Clin. Pharmacol. Therap.*, **7**, (2), 212-223, March-April 1966. — 3. Nenna, A. and Mariambourg, A.: *Appréciation des résultats obtenus dans la pratique médicale courante par l'utilisation du diurétique 12, 833 R.P. Gaz. Méd. France*, **73**, (9th suppl.), 48-51, May 10, 1966. — 4. Mary, P. and Mirouze, J.: *Essai clinique de la clorexolone salidiurétique 12-833 R.P. (flonatriil)*. *Semaine Thérap.*, **42**, (9), 529-532, November 1966.

#### side effects

**The only relatively frequent side effects are nausea (more rarely vomiting) and anorexia (particularly in ambulant patients).**

Symptoms associated with hypotension and low serum potassium may be encountered when anti-hypertensive and/or diuretic drugs are used, and are not specific for Nefrolan. So far, the drug has had no demonstrable adverse action on the liver, kidneys, blood-forming organs or blood-sugar levels. At diuretic doses, a few cases of urticaria have been reported. Nefrolan may give rise to a lowered serum potassium and, in rare instances, to a hypochloremic and hypokaliemic alkalosis proceeding to tetany. The drug may increase blood uric acid and precipitate an attack of gout in predisposed patients. The loss of body fluid may cause thirst, frequency of micturition, constipation and dryness of the lips.

#### contra-indications and precautions

Those of the thiazide diuretics in general: **adrenal insufficiency; renal impairment; severe hepatic disease; in heart disease,** it must be borne in mind that a lowered blood potassium increases the sensitivity of the myocardium to digitalis. If the urinary output is insufficient treatment should be discontinued as accumulation in the body may occur. Nefrolan should be used with caution in patients predisposed to gout. There is no clinical evidence that fetal abnormality has resulted from treatment with Nefrolan during the first trimester of pregnancy; however in the present state of our knowledge, it is recommended that the drug be withheld in early pregnancy. Nefrolan has been very little used in pediatrics; data available is insufficient to recommend its use in children.

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