Percutaneus Tracheostomy in Anaesthetic and Intensive Care Practice

An Essay

Submitted for Partial Fulfillment of Master Degree
In Anaesthesia and Intensive Care

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ABBREVIATIONS

BP	Blood pressure
COPD	Chronic obstructive pulmonary disease
CPAP	Continuous positive airway pressure
CT	Computed tomography
ECG	Electrocardiogram
ENT	Ear, nose and throat
ET tube	Endotracheal tube
ETCO$_2$	End tidal CO_2
FG	French gauge
FiO$_2$	Fractional inspired oxygen
FRC	Functional residual capacity
Gl	Gastrointestinal
H	Hour
HDU	High dependency unit
HME	Heat moisture exchange
ICP	Intracranial pressure
ICU	Intensive care unit
ID	Internal diameter
INR	International normalised ratio
IPPV	Intermittent positive pressure ventilation
kg	Kilogram
LMA	Laryngeal mask airway
min	Minute
MRI	Magnetic resonance imaging
MRSA	Methicillin-resistant Staphylococcus aureus
NG	Nasogastric
PaCO_2	Partial pressure of carbon dioxide inarterial blood
PaO$_2$	Partial pressure of oxygen in arterialblood
PEEP	Positive end expiratory pressure
PcT	Percutaneous tracheostomy
s	Second
SaO$_2$	Arterial oxygen saturation
SLT	Spoken language translation
USS	Ultrasound scan

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Acknowledgement

In the name of **ALLAH** at first, praise must be presented to **ALLAH**, the most gracious and merciful for his help to complete this work.

The author wishes to express his sincerest gratitude to ***Prof. / Hala Amin Hassan Ali,*** Professor of Anaesthesia and Intensive Care, Faculty of Medicine, Ain Shams University for her sincere interest and expert advice.

I would like to extend may appreciation to***Dr./ Ahmed Nagah El Shaer***, Assisstant Professor of Anaesthesia and Intensive Care, Faculty of Medicine, Ain Shams University, for his efforts and support throughout the work.

Last but not least , I would like to thank ***My family*** for their support and encouragement that gave me the ability to complete this work and to all staff members who have given me hand during the progress of this work.

Mostafa Mohamed Mehanna

INTRODUCTION

The trachea is easily accessible at the bedside. As such it provides ready access for emergency airway cannulation (e.g, in the setting of acute upper-airway obstruction) and for long-term airway access after laryngeal surgery. The procedure can be done surgically or percutaneously, and with either technique the procedure can be performed in the operating room or at the bedside in the intensive care unit (ICU).

A tracheostomy is most commonly performed in patients who have had difficulty in weaning from mechanical ventilation, and less commonly in those who have suffered trauma or some catastrophic insult. Infections and neoplastic processes are less common diseases that require a surgical airway.

No absolute contraindication exists to tracheostomy, a strong relative contraindication to discrete surgical access to the airway is the anticipation that the blockage is laryngeal carcinoma.

In the last ٥ years, surgical tracheostomy is replaced by percutaneous dilatation tracheostomy, because the second one is a noninvasive technique that requires less equipments and it consumes less time with less complications.

Anaesthesia for percutaneous tracheostomy is mainly by local anaesthesiato avoidhazards of general anaesthesia and its complications.

HISTORY

The oldest known reference identifying a procedure akin to a tracheostomy is found in a sacred Hindu book from the second millennium before Christ. The first successful tracheostomy was recorded in ١٥٤٦ by an Italian physician *(Antonio MoussaBrasavola)* for a patient suffering from a laryngeal abscess. In the mid-١٨٠٠s, this procedure was performed on children with diphtheria. The technique was further refined and became widely accepted by the work of Chevalier Jackson who defined the indications and technique for performing the procedure ***(Jackson, ١٩٢٣)***.

Figure ١: Boy with tetanus in Leeds unit, ١٩٥٠s ***(Ablett, ١٩٥٦)***.

HISTORY OF PERCUTANEOUS TRACHEOSTOMY:

There were devices available historically to facilitate rapid percutaneous tracheostomy but without the benefit of guidewires and flexible dilators/introducers. Such devices were inherently unsafe and never achieved widespread usage. The Italian surgeon SanctorioSanctorius (١٥٦١-١٦٣٦), a professor at the University of Padua, was probably the first surgeon to describe percutaneous tracheostomy***(Shelden et al., ١٩٥٥)***.

Sanctorius described the procedure in his book but does not seem to have performed it himself ***(Shelden et al., ١٩٥٥)***.

The term percutaneous tracheostomy was first used by Shelden in ١٩٥٥.Tominimize the risk of damaging vital structures,Shelden first introduced a slot-needle into the tracheal lumen. He loaded the cannula onto a cutting trocar, slid it along the slot and then introduced it into the tracheal lumen***(Toyeand Weistein, ١٩٦٩)***.

In ١٩٦٩, Toye and Weinstein used a Seldingerguidewire to allow the safe introduction of a cannula, providing a vital step towards popularisation of percutaneous techniques ***(Toye and Weistein, ١٩٦٩)***.

Pasquale Ciaglia, a thoracic surgeon at St Elizabeth Hospital, New York, was concerned about tracheal stenosis from surgical tracheostomy.Encouraged by work done by

Brantigan and Grow in ١٩٧٦ on crico-thyroidotomy, Ciaglia first developed subcricoid fingertip tracheostomy before moving on to full percutaneous tracheostomy, where the only incision needed is to the skin to admit the index finger for palpation of the cartilages ***(Brantigan and Grow, ١٩٧٦)***.

He reported the first percutaneous progressive dilatational technique in June ١٩٨٥ on a series of ٢٦ patients. He used a modified percutaneous nephrostomy set to perform the tracheostomy ***(Ciaglia et al, ١٩٨٥)***.

ANATOMY OF THE TRACHEA

The lower respiratory tract starts at the vocal cords. Inferior to the vocal cords, the rigid cricoid cartilage encases a ١,٥–٢,٠-cm region known as the subglottic space. Access to this space is possible via the crico-thyroid ligament, a membrane that runs from the thyroid cartilage inferiorly to the cricoid cartilage. Inferior to the cricoid cartilage is the trachea, a cylindrical tube that extends inferiorly and slightly posteriorly. The trachea is made up of ١٨-٢٢ C-shaped rings consisting of rigid cartilage anteriorly and laterally, and a membranous posterior portion ***(Epstein, ٢٠٠٥)***.

In the average adult, the distance from the cricoid to the carina is approximately ١١ cm in length, with a range of ١٠-١٣ cm. On average, the trachea is ٢,٣ cm in width and ١,٨ cm from posterior membrane to the anterior cartilaginous aspect. The trachea is wider in men than in women ***(Rood, ١٩٨٥)***.

In examining the landmarks of the neck, it is evident that the trachea is protected by strap muscles (sternohyoid,sternothyroid and sternocleidomastoid) and bony structures (manubrium sterniand body of sternum) **(Fig. ٢)** ***(Heffner andSahn, ١٩٨٧)***.

Furthermore, the trachea is positioned posterior to a number of blood vessels and the thyroid isthmus. Branches of

the bronchial, inferior thyroid, innominate, and subclavian arteries provide the blood supply to the trachea ***(Streitzand Shapshay, ١٩٩١)***.

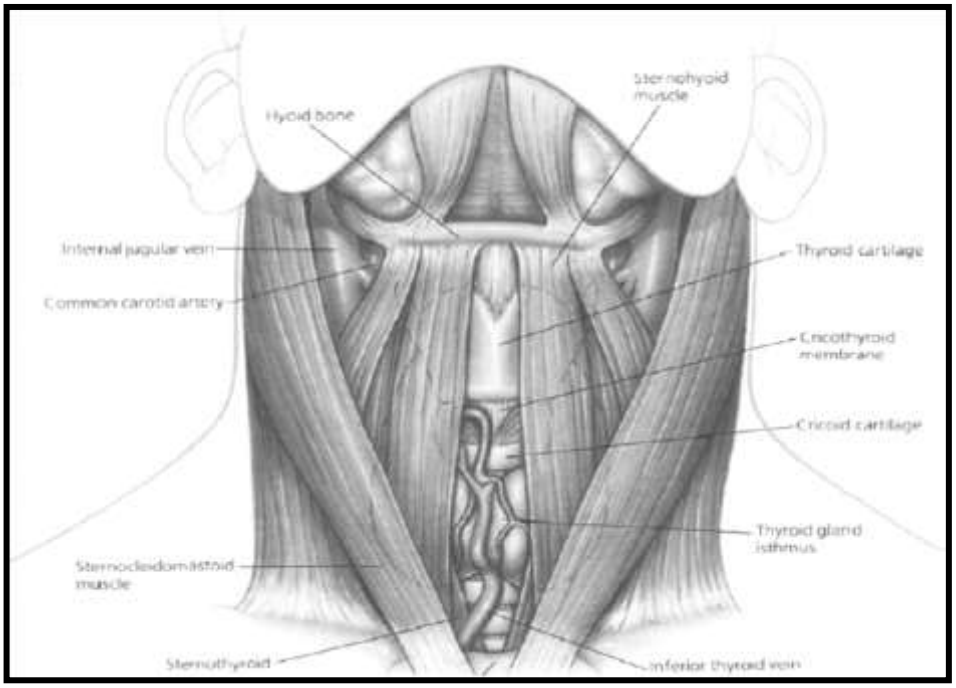

Figure ٢: Major landmarks in the neck***(Moore, ٢٠١٠)***.

Knowledge of neck and tracheal anatomy is essential for understanding the various approaches to establishing a tracheostomy. As an example, surgical tracheostomy tubes are typically placed in the region of the ٢nd to ٤th tracheal rings and may entail removal of tracheal cartilage or the creation of a cartilaginous flap. Percutaneous tracheostomy tubes are typically placed between the ١st and ٢nd or between the ٢nd and ٣rd tracheal cartilages **(Fig. ٣)*(Silvestri and Colice, ١٩٩٣)***.

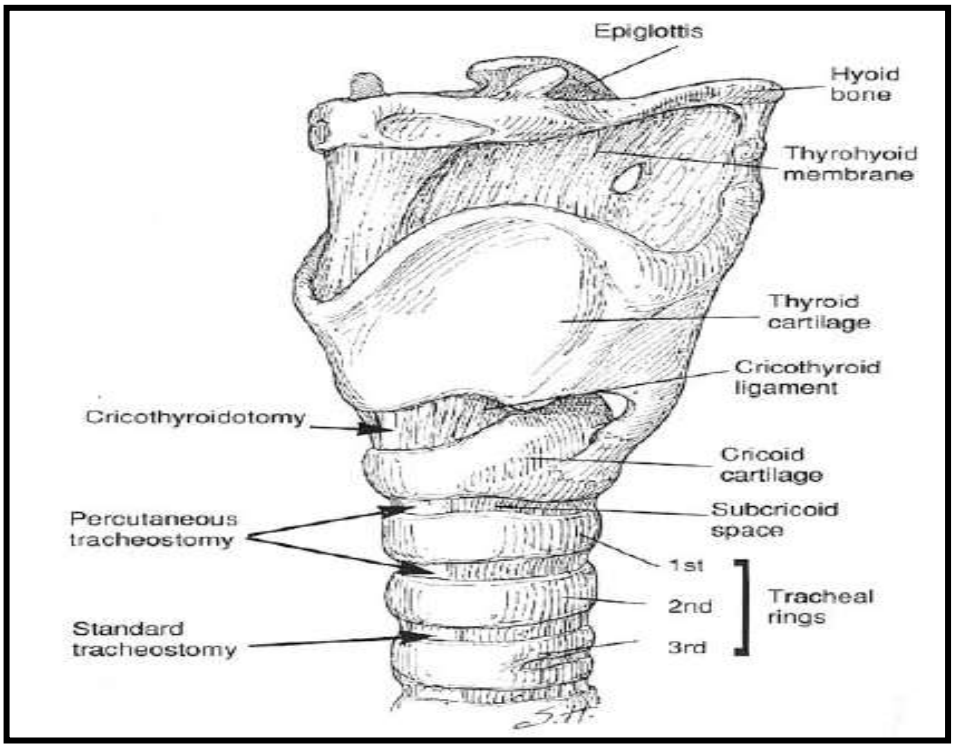

Figure ٣: Anterior oblique view of larynx and trachea. The preferred anatomic locations for placing standard tracheostomy, percutaneous tracheostomy, and cricothyroidotomy are indicated ***(Epstein, ٢٠٠٥)***.

There is a difference between tracheal position in youth and old people, so tracheal position is extended in youth in normal standing and flexed in old people in normal standing.

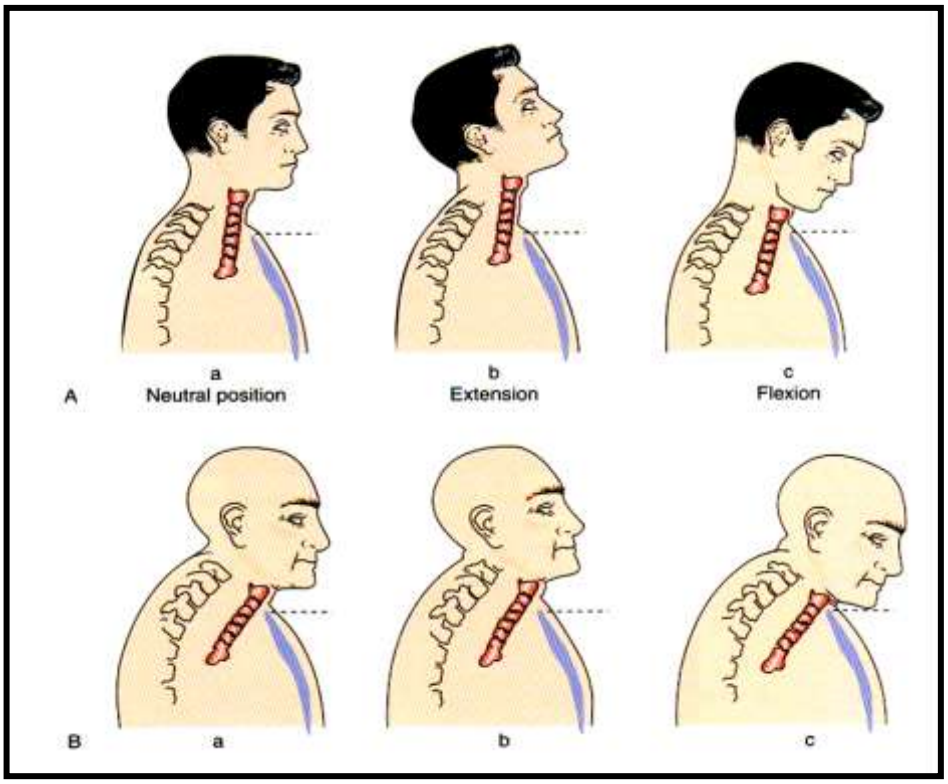

Figure ٤: Tracheal position in youth and old age with cervical extension and flexion.The trachea is much more vertical on lateral projection in youth (A) than in old age (B). A, (a) In youth, approximately one-third of the trachea is in the neck above the sternum *(dashed line)* in neutral position, (b) With cervical extension, one-half or more rises into the neck, (c) Most of the trachea devolves into the thorax on full flexion. B, In the aged, the level of the larynx (a) changes little with attempted cervical (b) extension and (c) flexion. Surgical implications are obvious. ***(Mathisen and Muniappan, ٢٠١١)***