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REVIEW ARTICALE
TRACHEOSTOMY: REVIEW OF LITERATURE

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Abstract

Tracheotomy is a surgical procedure in which a tracheocutaneous airway is created in the anterior neck. It is routinely done in critically ill patients requiring prolonged mechanical ventilatory support or in emergency cases of upper airways obstruction. Both open surgical tracheostomy and percutaneous dilatational tracheostomy are methods used to perform tracheostomy in select individuals. The best technique for performing tracheostomy remains a matter of debate. Each method has his advantages and disadvantages. The determining factors in deciding whether to use an open surgical or percutaneous dilatational tracheostomy in a particular situation depends on patient anatomical and physiological factors and as well on surgeon experiences and prefers. The basic technique and variations are described.

Keywords: *Tracheostomy; tracheotomy; percutaneous dilatational tracheostomy; airway obstruction*

Introduction

Tracheostomy is a surgical procedure in which a tracheocutaneous airway is created in the anterior neck. It is routinely done in critically ill patients requiring prolonged mechanical ventilatory support. It has a number of advantages including improved lung mechanics, easier oral hygiene, diminished nociceptive stimuli on the larynx or trachea, decreased need for sedatives, enhanced communication, and the fact that the head and neck are free of equipment ^{1, 2}. Tracheostomy might facilitate weaning by reducing dead space and airway resistance, and by improving secretion clearance ³. It has been associated with improved mobility and decreased length of intensive care stay ^{4, 5}.

Besides being one of the most frequently performed procedures today, tracheostomy is one of the oldest

described surgical procedures. It has been performed for over 3,500 y.b.c. by the ancient Egyptians ⁶. Asclepius, Hippocrates, and Galen each refer to tracheotomy in their ancient writings and Asclepius is given the first procedure description in 124B.C. ^{7, 8}. Initially tracheotomy was performed for the purpose of relieving upper airway obstruction in emergency settings. A major interest in tracheostomy developed during the 19th century. Chevalier Jackson standardized the indications for tracheostomy, the technique itself, and the instruments used around the turn of the 20th century. He developed anatomically correct tracheostomy tubes, recommended a “high” tracheostomy location (ring 2 or 3), and condemned cricothyroidotomy because of its high complication rate⁶. Percutaneous dilatational tracheostomy (PDT) over a guidewire was invented by Ciaglia in 1985 ⁹.

Over the last few years, the original Ciaglia PDT technique has undergone modifications, and multiple other techniques have also evolved¹⁰. Both open surgical tracheostomy (ST) and percutaneous dilatational tracheostomy (PDT) are methods used to perform tracheostomy in select individuals. The best technique for performing tracheostomy remains a matter of debate^{1, 11, 12, 5}. Each method has his advantages and disadvantages. The determining factors in deciding whether to use an ST or PDT in a particular situation depends on patient anatomical and physiological factors and as well on surgeon experiences and prefers. The aim of this study is to present the meta-analysis of tracheostomy methods.

Open surgical tracheostomy technic

Open surgical tracheostomy (OST) is indicated in emergency cases and for elective patients with anatomical and functional contraindications for PDT. The main advantage of open tracheostomy is visual control during the operation. In the routine, anesthetized, elective tracheotomy, a patient is positioned supine. Surgical landmarks, from superior to inferior, include the thyroid notch, the cricoid cartilage, and the sternal notch.

Anatomic landmarks for tracheostomy:

- Thyroid notch - a palpable landmark to identify the superior aspect of the larynx in the midline
- Cricothyroid membrane - a palpable depression between cricoid and thyroid cartilages. This is the location for an emergent cricothyrotomy
- Cricoid cartilage - a palpable landmark to identify the junction of the larynx and trachea. The skin incision is typically placed 1-2cm inferior to the cricoid
- Sternal notch - a palpable landmark to identify the thoracic inlet. It is important to palpate here to the possibility of a high-riding innominate artery that may be encountered during tracheostomy

The traditional method of upper tracheostomy involves a 3-5 cm vertical or horizontal skin incision from the middle of the cricoid cartilage to the jugular notch, or a horizontal skin incision 1.5 cm below the level of the cricoid cartilage or midway between the cricoid cartilage and the notch of the sternum⁶⁻¹³.

Then, tissue dissection is performed by blunt dissection. The incision is extended through the platysma muscle to expose the strap muscles (sternohyoid and sternothyroid), identifying the

median raphe. The strap muscles are then retracted laterally, exposing the cricoid cartilage and thyroid gland. The thyroid isthmus is identified and ligated, if necessary, depending on its location along the trachea. Hemostats can be utilized to cross-clamp the isthmus, subsequently oversewing each stump with a silk suture to ensure hemostasis of thyroid tissue. A cricoid hook is then placed under the cricoid cartilage to elevate the larynx and trachea into the operative field. The second and third tracheal rings are identified^{6, 14-17}.

The trachea is either dissected longitudinally, or a window is formed between 2-3 cartilages. Stay ligatures may be placed laterally to facilitate traction on the trachea for tube placement, as well as tube security in the postoperative period. An incision is made between the second and third rings, and tracheostomy tube placed. Various modifications have been proposed including removal of an anterior window of cartilage (often removing a segment of 2 to 3 rings), the use of a vertical anterior incision across 1-2 rings (used in pediatric tracheostomy), or the creation of a Bjork flap, in which an inferiorly-based cartilage flap is created and secured to the subcutaneous tissues^{6, 13-15}.

Percutaneous dilatational tracheostomy technic

For the procedure, a flexible conductor and dilators (expansion tubes) were used, which replaced each other in order to expand the percutaneous inlet into the trachea. This technique has since undergone three significant changes in terms of the level of tracheal cannulation, the use of a bronchoscope, and the use of a single conical dilator. PDT soon became the standard in intensive care units and in most cases replaced open tracheostomy, although in any case, the open method remained preferable in certain clinical cases¹⁰.

In recent years, the Ciaglia PDT method has undergone various modifications and many other PDT techniques have appeared. In clinical practice, the Ciaglia Blue Rhino kit (Cook Critical Care, Bloomington, IN, USA) is widely used for PDT. It was produced in 1999, more than a decade after Ciaglia's description of the PDT method. This is a simple set with a single chamfer curved cone reamer. The use of a single dilator reduced the loss of tidal volume during the procedure because no dilator replacement was required. Similar to Blue Rhino, the Portex Ultraperc one-stage dilator was developed by

Smith Medical. The percutaneous tracheostomy method was developed by Griggs et al. in 1990¹⁸. It is also known as the extension clamp technique. The Seldinger method was used to introduce the conductor. Having determined the area of the tracheal rings, a horizontal skin incision of about 1.5-2 cm was made. A syringe filled with water was attached to the Seldinger needle and inserted into the selected tracheal space. The needle is advanced forward by slowly pulling the piston back until bubbles of air appear, indicating entry into the trachea. The position of the needle is checked with a bronchoscope. Next, a conductor is inserted through the cannula and the syringe is removed. A small dilator is inserted for a few seconds through the wire into the trachea and then removed. A special dilatation clamp is put on the conductor, moves into the trachea and opens to expand the anterior tissues. Opening the dilatation clamp expands the anterior tracheal wall to the size of a tracheostomy tube. After the tracheostomy tube is put on the conductor and moves into the trachea.

However, in recent years, this technique has lost its popularity due to a large incident of soft tissue injury with dilatation forceps¹⁰. In 1997, Fantoni and Ripamonti¹⁹ proposed the method of translaryngeal tracheostomy.

Then, a reinforced flexible tracheal cannula and a special cone soldered to it from a flexible plastic material are installed retrogradely from the oral cavity along a metal conductor on the anterior wall of the trachea by moving through the vocal cords. The metal cone penetrates the wall of the trachea; the operator's fingers exert a counter pressure on the front surface of the neck from the outside, around the hole created, facilitating the passage of the cone through the soft tissues and preventing its displacement. After the canal is formed, the dilator tip is removed, and a tracheostomy tube is placed in the canal. The technique has not been widely adopted due to its relative complexity.

In 2002, Frova and Quintel²⁰ proposed a percutaneous tracheostomy technique using a single-pitch screw dilator commercially available as the PercuTwist kit (Rusch, Kern, Germany). The dilator was rotated clockwise using a lifting motion over the conductor. The negative side of this method was the frequent damage to the tracheal rings and the posterior wall of the trachea, and therefore the method was not widely used. Although it was

believed that the control of tissue expansion with this method was better. The balloon dilatation method (Ciaglia Blue Dolphin, Cook Medical) is by far the most common method of PDT. It is the second generation of the Ciaglia method. The initial stages of the operation are similar to percutaneous dilated triotomy according to the P. Ciaglia technique. After making a skin incision and inserting the first dilator, a special conductor with a balloon is inserted into the lumen of the trachea, which is positioned in such a way that it fills the future tracheostomy canal as much as possible along the entire length. After that, the balloon is inflated with liquid using a special syringe, while stretching the soft tissues of the neck and tracheal semi-rings. Next, the balloon is deflated and a tracheostomy tube is inserted into the formed channel. This step is considered to be the main advantage of the balloon technique over other PDT methods, where the dilator is removed prior to insertion of the tracheostomy tube. There is also a suggestion that balloon dilatation minimizes pressure on the tracheal wall compared to other techniques^{9, 10, 19-22}. So, each PDT technique has its own special characteristics, advantages and disadvantages. Many comparative studies have been carried out to this day, but all of them differed significantly and had a small sample size. Conducted meta-analyses on the comparative technique of different PDT methods did not find a significant difference between them, with the exception of the Fantoni method, which had more serious complications with the need to switch to an alternative PDT method. The Ciaglia Blue Rhino technique performed better than other PDT techniques such as PercuTwist, Blue Dolphin or Griggs technique^{3, 10, 23-26}.

PDT is usually performed using a bronchoscope to verify the location of the cannula and ensure the safety of the procedure^{10, 11}. However, some authors note that PDT using a bronchoscope has limitations due to the difficulty of accurately identifying the anatomical structures of the neck and preventing complications such as vascular damage^{26, 27}.

Several studies suggest that ultrasound-guided PDT has potential benefits, including portability, safety, identification of cervical vascularity and localization of the tracheal puncture site, reduced procedure time and complications²⁶⁻³⁰. Kang HT et al (2022) concluded in their study that ultrasound-assisted PDT could be offered as an alternative to surgical tracheostomy in high-risk patients³⁰. Protocols

proposed in May 2020 for the management of Covid-19 infected patients in the ICU recommend OT as less safe in terms of aerosol spread of the virus compared to PDT, and therefore reduces the potential risk of transmitting a viral infection to medical staff³¹.

Practical aspects

The key aspects of preoperative planning of PDT are the correct selection of the patient after a thorough anatomical and physiological examination. Anatomical landmarks should be easily palpable and the distance between the cricoid cartilage and the notch of the sternum should be at least 3-4 cm. Anticoagulants should be suspended¹⁰. PDT is the method of choice for elective tracheostomy. For emergency tracheostomies, the advantage is clearly given to the open surgical method. Coagulation abnormalities favor ST over PDT, since bleeding vessels are more easily controlled under direct vision. High levels of support need for oxygenation would favor ST over PDT. Patients with unstable or fragile cervical spines would favor ST over PDT. Patients with “unfavorable” neck anatomy would favor ST

over PDT (ie, previous surgery, neck masses, poor neck mobility, or obesity may be more complicated for PDT)¹³.

Conclusion

Tracheotomy is a surgical procedure which is routinely done in critically ill patients requiring prolonged mechanical ventilatory support or in emergency cases of upper airways obstruction. Varieties of techniques are used to perform this operation with the same basic surgical principles for performing of a tracheocutaneous opening. New percutaneous techniques offer advantages over standard open ST. However, novel technic or modifications could reduce the intraoperative and postoperative complications.

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ՏՐԱԽԵՈՍՏՈՄԻԱ: ԳՐԱԿԱՆՈՒԹՅԱՆ ՏԵՍՈՒԹՅՈՒՆ

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¹ Սուրբ Գրիգոր Լուսավորիչ բժշկական կենտրոն, պլաստիկ և դիմաձնոտային վիրաբուժության բաժանմունք

Ամփոփում

Տրախեոստոմիան վիրաբուժական վիրահատություն է՝ շրջակա միջավայրի հետ շնչափողի խոռոչի կայուն անաստոմոզի ձևավորման համար: Տրախեոստոմիան կատարվում է շտապ հիմունքներով՝ առողջական նկատառումներով վերին շնչուղիների խցանմամբ կամ պլանավորված կերպով՝ թոքերի երկարատև արհեստական օդափոխությամբ հիվանդների մոտ: Մինչ օրս տրախեոստոմիայի երկու հիմնական մոտեցում կա՝ բաց վիրաբուժական և պունկցիոն-լայնացման մեթոդներ: Տրախեոստոմիայի լավագույն մեթոդի հարցը մինչ օրս քննարկման առարկա է: Մեթոդի ընտրության վրա ազդող հիմնական գործոններն են հիվանդի անատոմիական և ֆիզիոլոգիական բնութագրերը, ինչպես նաև վիրաբույժի փորձն ու նախասիրությունները: Հոդվածում նկարագրված են տրախեոստոմիայի հիմնական մեթոդներն ու փոփոխությունները:

ТРАХЕОСТОМИЯ: ОБЗОР ЛИТЕРАТУРЫ

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Резюме

Трахеостомия-хирургическая операция образования стойкого соустья полости трахеи с окружающей средой. Трахеостомия выполняется в экстренном порядке по жизненным показаниям при обструкции верхних дыхательных путей либо, в плановом порядке у пациентов находящихся на длительной искусственной вентиляции легких. На сегодняшний день имеется два основных подхода к проведению трахеостомии: открытый хирургический и пункционно-дилатационный методы. Вопрос наилучшего метода трахеостомии является предметом дебатов по сей день. Основными факторами, влияющими на выбор метода являются анатомические и физиологические особенности пациента, а также опыт и предпочтения хирурга. В статье описаны основные методы и модификации проведения трахеостомии.