



Percutaneous or surgical tracheotomy when, why, and selection criteria

Perkütan veya cerrahi trakeotomi, ne zaman? neden? ve seçim kriterleri

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Abstract

Aim: Tracheotomy is one of the most frequent procedure especially in the intensive care units (ICU). And the major indication is prolonged respiratory support. Tracheotomy is a procedure for patients who need prolonged mechanical ventilation support or airway protection. By this way, the respiratory care and weaning from mechanical ventilatory support become easier and comfortable. Tracheotomy improves patient tolerance, reduces the need for sedation, avoids laryngeal irritation, enhances nursing care, reduces dead space. Among the ICU patients, 8-24% of all, undergo tracheotomy procedure. This decision is individually based on the risk and benefits of tracheotomy versus prolonged intubation and also the consent of the patient's relations and expected clinical outcomes. But there is still no consensus about the timing of the procedure. Classically, the most considered opinion for tracheotomy in patients that are unable to wean from invasive ventilation within 10-14 days of intubation and should be planned under optimal conditions. The tracheotomy range increased over the last decade. But there is still no consensus about the optimal timing for procedure, criterias for selection of patients, type of technique and timing of decannulation. The most common, traditional method is open surgical approach; performed in the operating room. Percutaneous technique is relatively simple to perform. And has a shorter procedure time.

Percutaneous tracheotomy has become a popular, cost-effective, quick, simple and safe alternative to surgical tracheostomy. There is not an optimal tracheostomy, the physician should choose the best technique according to the patient and at the right time.

Keywords: Open Surgical Tracheotomy; Percutaneous Tracheotomy; Respiratory Failure; Tracheotomy.

Öz

Amaç: Trakeotomi; özellikle yoğun bakımlarda en sık uygulanan prosedürlerden biridir. Ve en temel endikasyonu uzamış entübasyondur. Trakeotomi uzamış mekanik ventilasyon desteği veya hava yolunu korumak için uygulanan bir prosedürdür. Bu yolla akciğerleri koruma ve mekanik ventilasyondan uyanma daha kolay ve konforlu olacaktır. Trakeotomi hasta toleransını arttırır, sedasyon ihtiyacını azaltır, laringeal irritasyonu engeller, hemşirelik bakımını kolaylaştırır ve ölü boşluğu azaltır. Yoğun bakım hastalarının yaklaşık %8-24 üne trakeotomi prosedürü uygulanmaktadır. Bu karar, uzamış entübasyona karşı trakeotominin yararına, hastadan beklenen klinik sonuçlara ve riske göre bireyseldir. Ancak prosedürün zamanlaması hakkında hala tam bir konsensus bulunmamaktadır. Klasik olarak trakeotomi prosedürü ventilasyondan 10-14 günde uyanamayacak hastalarda ve optimal koşullarda planlanmalıdır. Trakeotomi oranı son dekada artış göstermiştir. Ama prosedür için optimal zaman, hasta seçim kriterleri, teknik tipi ve dekanülasyon zamanı hakkında hala bir konsensus bulunmamaktadır. En yaygın, geleneksel trakeotomi yöntemi, operasyon odasında gerçekleştirilen açık cerrahi trakeotomi yaklaşımıdır. Perkütan teknik ise nisbeten daha kolay bir tekniktir. Ve daha kısa süreye sahip bir prosedürdür.

Perkütan trakeotomi cerrahi trakeotomiye alternatif, maliyet etkinliği olan, hızlı, kolay, güvenli ve popüler bir yöntem haline gelmiştir. Optimal bir trakeotomi yöntemi yoktur, klinisyen en iyi tekniği hastaya ve uygun zamana göre seçmelidir. Ama; optimal prosedür zamanı, hasta seçim kriterleri, teknik tipi ve dekanülasyon zamanı hakkında hala tam bir konsensus bulunmamaktadır.

Anahtar Kelimeler: Açık Cerrahi Trakeotomi; Perkütan Trakeotomi; Solunum Yetmezliği; Trakeotomi.

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The tracheotomy is one of the oldest surgical procedures. The history of this procedure based on Egyptian tablets dated back to 3600 BC. Asclepiades of Persia is accepted as the first person to perform a tracheotomy in 100 BC. Also in the 15th century Prasovala performed the first successful tracheotomy. In the 16th century, Guidi described an original method for tracheotomy. But in medical literature tracheotomy reports are sporadically from the second to the eighteenth centuries.

In 1932, operative technique for tracheotomy was defined and standardized by Chevalier Jackson and also emphasized the side effects of the high tracheotomy (5). And the technique remains basically same today (6).

In 1985 Ciaglia described a technique of performing percutaneous dilatational tracheotomy over a guidewire. Ciaglia's method has been modified over the years. The common feature of the all kinds of techniques is requiring puncture of the trachea and insertion of a guidewire into the trachea. The puncture level should be between the first and second or between the third or fourth tracheal rings. The lower level may cause accidental injury to aberrant vessels and other structures (7).

Tracheotomy is a procedure for patients who need prolonged mechanical ventilation support or airway protection. By this way, the respiratory care and weaning from mechanical ventilatory support become easier and comfortable. Tracheotomy improves patient tolerance, reduces the need for sedation, avoids laryngeal irritation, enhances nursing care, reduces dead space. Approximately 5 to 13% of patients on mechanical ventilation will require prolonged mechanical ventilation (>21 days). And tracheotomy procedure will be required to this group of patients. This decision is individually based on the risk and benefits of tracheotomy versus prolonged intubation and also the consent of the patient's relations and expected clinical outcomes. But there is still no consensus about the timing of the procedure. Classically, the most considered opinion for

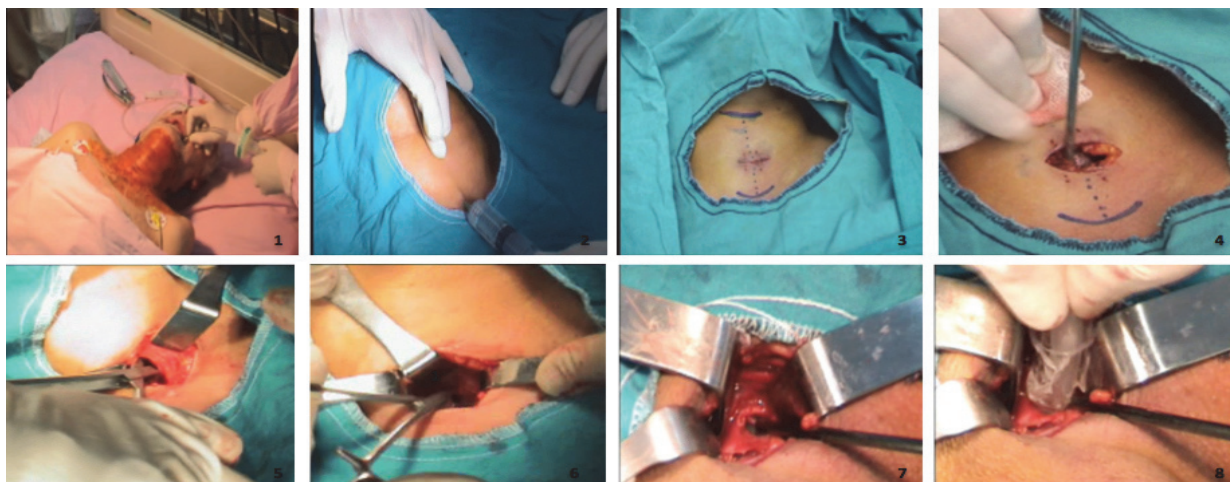
tracheotomy in patients that are unable to wean from invasive ventilation within 10-14 days of intubation and should be planned under optimal conditions.

But there are different outcomes about the benefits of tracheotomy timing. Late tracheotomy defines the procedure that performed within one or two weeks, whereas at three weeks recommended on traditional definition. And early tracheotomy defines the procedure that performed between 2-14 days (9). Tracheotomy reduces resistive and elastic work of breathing (10,11). Conventional or Surgical tracheotomy technique includes dissection of the pretracheal tissues and insertion of the tracheotomy tube into the trachea under direct visualization (12).

Conventional or Surgical Tracheotomy Procedure

Surgical Tracheotomy (ST) can be performed in various situations and/or environments; such as an elective or emergency surgery, under general or local anesthesia, either in the operating room or by the bedside. The ideal approach in elective ST carried out in the operating room under general anesthesia with sufficient equipments such as; light, suction and electrocautery system, different size tracheotomy tubes. The first step for the ST is positioning of the patient; supine position with the head extended by using a roll placed under shoulders. By this position trachea would have been more anterior position in the neck. In second step local anesthesia with Xylocain 1% (with Ephinephrine 1/100.000) to the cutaneous and subcutaneous tissue on the incision line. A horizontal or vertical cutaneous incision (4-5 cm) is made. Usually horizontal incision is preferred and the incision is made at the midpoint between the cricoid cartilage and the sternal notch. Dividing the subcutaneous tissue, separating the strap muscles, identifying and ligating the thyroid isthmus and cauterizing and ligating the relevant anterior jugular and thyroid veins. A vertical or horizontal incision or a window was then open between the second and third tracheal rings to allow the insertion of a tracheotomy tube (Figure 1) (13).

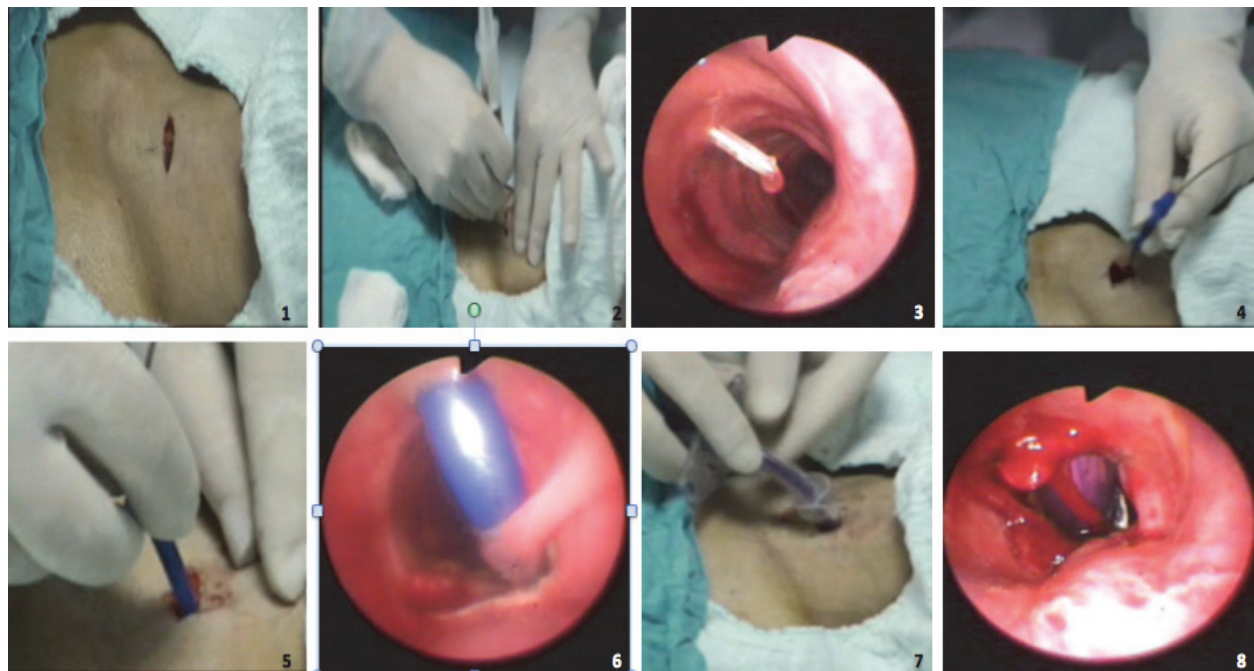
Figure 1. Basic steps of conventional or surgical tracheotomy procedure



Percutaneous tracheotomy (PT) procedure is accepted as a safe and simple alternative technique against traditional tracheotomy. The procedure can be performed under local or general anesthesia. But the safety of the technique in children, patients in difficult airway management and emergency situations still remains controversial. So that a detailed evaluation (coagulation profile: INR<1.3, PLT>100.000) and anatomical suitability for PT must be determined preoperatively (14). And recommendation for this technique is to perform the procedure under direct

vision with flexible fiberoptic with a good airway control, ideally. Otherwise initial steps are similar to ST and the next steps should all be performed under direct vision. Flexible fiberoptic vision can provide through the endotracheal tube and tube pull back below the level of glottic opening under vision. Bleeding, infection and hypoxia are rare complications of PT. Paratracheal insertion of the tracheotomy tube, posterolateral tracheal wall laceration, even death are infrequent complications (Figure 2) (7).

Figure 2. Basic steps of percutaneous tracheotomy procedure



Types of percutaneous tracheotomy:

Even though, a number of various systems and approaches have been described, two techniques; serial dilatational technique described by Ciaglia et al (15) in 1985 and a guidewire dilating forceps method (GWDF) described by Griggs and colleagues in 1990, are the most commonly used methods. All these techniques comprise minor differences such as the methods of airway control during the procedure, identifying the trachea, forming the tracheal stoma and inserting the tracheostomy tube, from each other.

1. GWDF (Guide Wire Dilating Forceps): Griggs introduced this tracheotomy method. Tracheostoma is opened by using blunt-tipped forceps (16).
2. Ciaglia Blue Rhino: Byhahn et al modified Ciaglia technique by introducing the Blue Rhino by a single dilatation (17).
3. Translaryngeal Technique (Fantoni and Ripamanti): The stoma is made by exteriorizing a dilator from within the trachea, by a specially designed tracheotomy cannula and a rigid bronchoscope (18).
4. Percu Twist technique (Frova and Quintel): Tracheostoma is made by a rotation system (19).

5. Ciaglia Blue Dolphin: A dilatational method by insufflating a balloon (20). Tracheostomy Indications.

The tracheostomy decision should be individualized according to balance the patient's wishes, recovery or survey expectancy, risk of elongated translaryngeal intubation, and also surgical risks for tracheostomy.

Table 1. Medical indications for tracheostomy (21,22).

| Indications for Tracheostomy |
|---|
| Upper airway obstruction |
| ○ Swelling resulting from burns, |
| ○ Anaphylaxis, |
| ○ Trauma |
| ○ Infection |
| ○ Direct result of facial trauma or fractures |
| ○ Tumour |
| Prolonged ventilation (to facilitate weaning from ventilation |
| To provide pulmonary toilet and/or to protect the airway |
| As part of head and neck surgeries |

Tracheostomy Contraindications

There is no absolute contraindications exist for ST. A strong relative contraindications for ST are the blockage of the airway depending to a laryngeal carcinoma that

discrete surgical access, bleeding diathesis, active pulmonary tuberculosis, pregnancy, rarely vascular giant mass prevents to reaching the trachea and unstable cervical spine fractures (21,22).

Table 2. Contraindications for tracheotomy (21,22)

| Contraindications | |
|--|---|
| Surgical Tracheostomy | Percutaneous Tracheostomy |
| There is no absolute contraindications | <ul style="list-style-type: none"> ○ Obesity (BMI> 27 kg/m2) ○ Short neck ○ Gout and/or neck deformities ○ Coagulation disorders (INR>1,5) or trombopenia (plt<50.000/mm3) ○ Children under 16 years old ○ Need for emergence airway ○ Cervical spine damage ○ Previous neck surgery or tracheotomy ○ Infection in the surgical zone |

Obesity may cause a difficult anatomical identification, longer tracheotomy cannulas may be required. The degree of obesity is also important (23).

Lack of cervical spine clearance is a difficult situation for PT. Ultrasound-guided PT is determined as safe as surgical tracheotomy in these cases.

In trombocytopenia the patient may be supported by platelet transfusions before the procedure (7).
Complications of Tracheotomy:

Before performing a tracheotomy; it is important to evaluate the baseline conditions of the patient. Complication range reduces according to the experience of the surgeon. Fistula of the innominate artery is too mortal nearly 100%. To avoid this complication the tracheotomy may not be low level. Tracheoesophageal fistula may be a result of posterior tracheal wall damage (23).

There is a wide variation in the complication rates following percutaneous tracheotomy; ranging from 7-19% (24-26).

Table 3. Tracheotomy Complications (21,22)

| Complications | |
|---|---|
| Surgical Tracheostomy | Percutaneous Tracheostomy |
| <p>Intraoperatively</p> <ul style="list-style-type: none"> ○ Hemorrhage ○ Cardiopulmonary arrest <p>○ Inferior laryngeal nerve injury</p> <p>○ Cricoid cartilage destruction</p> <p>○ Damage of the surrounding tissues</p> <p>Early postoperative (intermediate)</p> <ul style="list-style-type: none"> ○ Postoperative hemorrhage ○ Wound infection (Temporary tracheitis, Stomal cellulite) ○ Severe Infections (Mediastinitis, Clavicular osteomyelitis, Necrotizing fasciitis) ○ Subcutaneous emphysema ○ Pneumomediastinum / pneumothorax ○ Cannula obstruction <p>Late postoperative</p> <ul style="list-style-type: none"> ○ Delayed hemorrhage ○ Tracheoesophageal fistula ○ Tracheal and subglottic stenosis (Prolonged intubation, High tracheotomy, Cricothyrotomy) ○ Airway trauma ○ Tracheocutaneous fistula | <ul style="list-style-type: none"> ○ Hemorrhage ○ Fistula of the innominate artery ○ Tracheomalacia ○ Tracheoesophageal fistula ○ Tracheal stenosis ○ Tracheocutaneous fistula ○ Hoarseness and/or voice changes ○ Esthetic alterations |

The tracheostomy is a procedure to maintain an open airway and to by-pass upper airway obstruction. By this way, it is possible to prevent the laryngeal and upper airway structures from prolonged translaryngeal intubation. Also for an easy lower airway suctioning, tracheostomy is a safety procedure. The most common, traditional method is open surgical approach; performed in the operating room. Surgical tracheostomy may be

performed for difficult or emergency cases, when there is a contraindication for percutaneous tracheostomy or percutaneous tracheostomy has failed.

Complication ratio decreases according to the increasing operator experience and use of imaging adjuncts (bronchoscopy, ultrasound imaging of neck) (4).

Percutaneous technique is relatively simple to perform. And has a shorter procedure time.

PT can be performed in 5 minutes and this time is shorter than surgical method. Surgical method can be performed in average 10 minutes (8). PT has a reduced wound infection risk (27).

In surgical tracheostomy the incidence of local hemorrhage or stomal infection is approximately 37% (8). The bleeding and long-term complications were similar to surgical tracheostomy (27,28).

Coagulopathy causes difficult situation for tracheostomy. Coagulopathy is a relative contraindication for PT. But recent studies has shown that there is no significant difference between the percutaneous technique and surgical method (29).

Bronchoscopy assisted PT has been popular. To reduce the risks bronchoscopy appears safer. It provides direct visualization and avoids posterior tracheal wall damage and tube misplacement. However, fiberoptic scope may impair ventilation and this may cause an increased risk of hypoxia and hypercarbia.

Ultrasound imaging of the neck prior to the procedure may help the surgeon about the anterior neck structures, the depth and angulation of trachea, big vessels and thyroid gland (4). Percutaneous tracheostomy appears to be a less traumatic procedure and requires a smaller skin incision than in surgical technique (8). The mean size of tracheostomy tube used in PT, is smaller than, used in surgical tracheostomy. Postoperative infection and mean length of scar tend to be less in PT. PT minimizes the local tissue damage and provides a fast wound healing (12). Tracheostomy associated risk for mediastinitis is lower in percutaneous tracheostomy. For this reason, in cardiothoracic patients, with mediastinal wounds, PT should be first choice. PT has lower late infection risk of the stoma and should be first alternation in patients with head trauma and neurological problems, who has a great risk for nosocomial infection (30). The classical tracheostomy method requires transport from the intensive care unit to the operating room. PT can be performed at bedside and has no need for patient transport to the operating room (27). PT is a bedside procedure, for this reason; it avoids the long waiting lists for operating room scheduling. PT has a low cost compared with surgical tracheostomy (7). In conclusion PT has become a popular, cost-effective, quick, simple and safe alternative to surgical tracheostomy. There is not an optimal tracheostomy, the physician should choose the best technique according to the patient and at the right time.

REFERENCES

1. Clec'h C, Alberti C, Vincent F, Garrouste-Orgeas M, de Lassence A, Toledano D, et al. Tracheostomy does not improve the outcome of patients requiring prolonged mechanical ventilation: a propensity analysis. *Crit Care Med* 2007;35(1):132-8.
2. Nathens AB, Rivara FP, Mack CD, Rubenfeld GD, Wang J, Jurkovich GJ. Variations in rates of tracheostomy in the critically ill trauma patient. *Crit Care Med* 2006;34(12):2919-24.
3. Cox CE, Carson SS, Holmes GM, Howard A, Carey TS. Increase in tracheostomy for prolonged mechanical ventilation in North Carolina, 1993-2002. *Crit Care Med* 2004;32(11):2219-26.
4. Bittner EA, Schmidt UH. The ventilator liberation process: update on technique, timing, and termination of tracheostomy. *Respir Care* 2012;57(10):1626-34.
5. Jackson C, Jackson CL. *The Larynx and its diseases*. Philadelphia, Pa:WB Saunders,1937.
6. Jackson C. Tracheostomy. *laryngoscope* 1909;19:285-90.
7. Al-Ansari MA, Hijazi MH. Clinical review: percutaneous dilatational tracheostomy. *Crit Care* 2006;10(1):202.
8. Yaghooobi S, Kayalha H, Ghafouri R, Yazdi Z, Khezri MB. Comparison of complications in percutaneous dilatational tracheostomy versus surgical tracheostomy. *Glob J Health Sci* 2014;20:6(4):221-5.
9. Esteban A, Anzueto A, Alía I, Gordo F, Apezteguía C, Páizas F, Cide D. et al. How is mechanical ventilation employed in the intensive care unit? An international utilization review. *Am J Respir Crit Care Med* 2000;161(1):1450-8.
10. Davis K Jr, Campbell RS, Johannigman JA, Valente JF, Branson RD. Changes in respiratory mechanics after tracheostomy. *Arch Surg* 1999;134(1):59-62.
11. Diehl JL, El Atrous S, Touchard D, Lemaire F, Brochard L. Changes in the work of breathing induced by tracheotomy in ventilator-dependent patients. *Am J Respir Crit Care Med* 1999;159(2):383-8.
12. Youssef TF, Ahmed MR, Saber A. Percutaneous dilatational versus conventional surgical tracheostomy in intensive care patients. *N Am J Med Sci* 2011;3(11):508-12.
13. Worthley LI, Holt AW. Percutaneous tracheostomy. *Crit Care and Resusc* 1999;1(1):101-9.
14. Hasanloei MAV, Mahoori A, Bazzazi AM, Golzari SE, Karami T. Percutaneous dilatational tracheostomy and surgically created tracheostomy in ICU patients. *J Cardiovasc Thorac Res*. 2014;6(1):43-6.
15. Ciaglia P, Firsching R, Syniec C. Elective percutaneous dilatational tracheostomy. A new simple bedside procedure; preliminary report. *Chest*. Jun 1985;87:715-9.
16. Griggs WM, Worthley LI, Gilligan JE, Thomas PD, Myburg JA. A simple percutaneous tracheostomy technique. *Surg Gynecol Obstet* 1990;170(6):543-5.
17. Byhahn C, Wilke HJ, Halbig S, Lischke V, Westphal K. Percutaneous tracheostomy: Ciaglia blue rhino versus the basic Ciaglia technique of percutaneous dilatational tracheostomy. *Anesth Analg* 2000;91:882-6.
18. Fantoni A, Ripamonti D. A non-derivative, non-surgical tracheostomy: the translaryngeal method. *Intensive Care Med*. 1997;23(4):386-92.
19. Frova G, Quintel M. A new simple method for percutaneous tracheostomy: controlled rotating dilation. A preliminary report. *Intensive Care Med*. 2002;28:299-303.
20. Gromann TW, Birkelbach O, Hetzer R. Balloon dilatational tracheostomy: initial experience with the Ciaglia Blue Dolphin method. *Anesth Analg* 2009;108(6):1862-6.
21. Keskin G. Erişkinlerde Yetersiz Hava yolunun Kontrolü. Bölüm: 106. Koc C. Çeviri Editörü: Cummings Otolaringoloji Baş ve Boyun Cerrahisi. Dördüncü Baskı. Ankara: Güneş Tıp Kitabevi; 2007:2441-54, Durbin CG

- Jr.. Tracheostomy: why, when, and how?. *Respir Care*. 2010;55(55):1056-68).
22. Kost KM. Advanced Airway management Intubation and Tracheotomy. In: Johnson JT, Rosen CA, eds. *Bailey's Head and Neck Surgery-Otolaryngology Volume 1*. Fifth Edition. 2013. p.908-45.
 23. Anon JM, Araujo JB, Escuela MP, Gonzalez-Higueras E. Percutaneous tracheostomy in the ventilated patient. *Med Intensiva* 2014;38(3):181-93.
 24. Veenith T, Ganeshamoorthy S, Standley T, Carter J, Young P. Intensive care unit tracheostomy: a snapshot of UK practice *Int Arch Med* 2008;25(1):21.
 25. Yuca K, Kati I, Tekin M, Yilmaz N, Tomak Y, Cankaya H: Fibre-optic bronchoscopy-assisted percutaneous dilatational tracheostomy by guidewire dilating forceps in intensive care unit patients. *J Otolaryngol Head Neck Surg* 2008;37(1):76-80.
 26. Silvester W, Goldsmith D, Uchino S, Bellomo R, Knight S, Seevanayagam S, Brazzale D, McMahon M, Buckmaster J, Hart GK, Opdam H, Pierce RJ, Gutteridge GA. Percutaneous versus surgical tracheostomy: A randomized controlled study with long-term follow-up. *Crit Care Med* 2006;34(8):2145-52.
 27. Delaney A, Bagshaw SM, Nalos M. Percutaneous dilatational tracheostomy versus surgical tracheostomy in critically ill patients: a systematic review and meta-analysis. *Crit Care* 2006;10(2):R55.
 28. Higgins KM, Punthakee X. Meta-analysis comparison of open versus percutaneous tracheostomy. *Laryngoscope* 2007;117(3):447-54.
 29. Pandian V, Vaswani RS, Mirski MA, Haut E, Gupta S, Bhatti NI. Safety of percutaneous dilatational tracheostomy in coagulopathic patients. *Ear Nose Throat J* 2010;89(8):387-95.
 30. Pelosi P, Severgnini P. Tracheostomy must be individualized! *Crit Care* 2004;8(5):322-4.