Tracheostomy Complications

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Tracheostomy is a frequently performed procedure. The variety of indications and different characteristics of the patients makes attention necessary to avoid complications The decision regarding the performance of tracheostomy should consider the risks and benefits of this procedure [1].

More important than knowing the possible complications of the tracheostomy, making the diagnosis early, and treating them, is to identify in advance possible characteristics of the procedure that increase the chances of events, such as tracheostomies in obese patients or pediatric patients, and retracheostomy [2].

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Transoperative Complications

Bleeding

This is the most frequent complication, affecting between 1% and 37% of cases [3]. Most of the time the bleeding is minor, without hemodynamic repercussions for the patient (Fig. 1). it usually occurs due to failure of vessel exposure and exacerbated traction on these structures, especially the anterior jugular veins and inferior thyroid veins (Fig. 2).

The treatment of this kind of bleeding normally is done with hemostatic maneuvers with suturing or electrocauterization.

Pneumothorax

This occurs by inadvertent injury of the apical pleura (Fig. 3), which is more easily exposed in patients who are on mechanical ventilation. In addition, this pleural segment is more exposed in children, which increases the risk of this complication from 4% in adults to up to 17% in children [3, 4].

To diagnose this complication, it is necessary to perform a chest X-ray after the tracheostomy [3, 4].

Another cause of pneumothorax is the placement of the cannula on a false path anteriorly and laterally to the trachea (Fig. 4).

Fig. 1 A small bleeding posttracheostomy treated with surgical re-exploration and bleeding suture

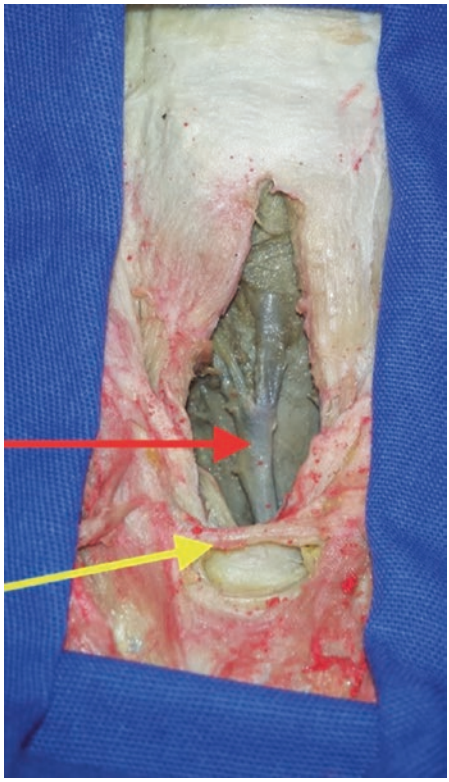

Fig. 2 *Red arrow:* inferior thyroid vein; *yellow arrow:* anterior jugular vein (anterior jugular arch)

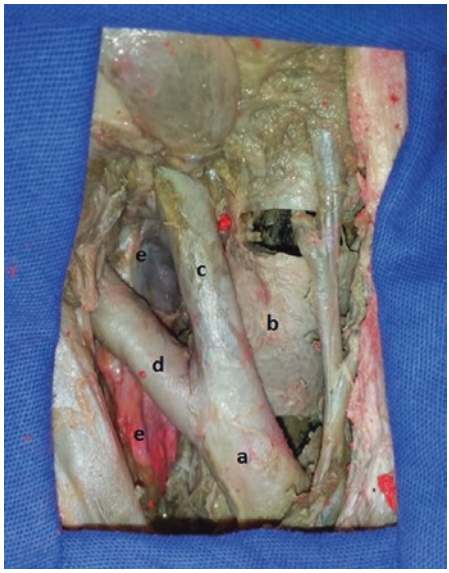

Fig. 3 (**a**) Brachiocephalic trunk. (**b**) Trachea. (**c**) Right carotid common artery. (**d**) Right subclavian artery. (**e**) Right apical pleura

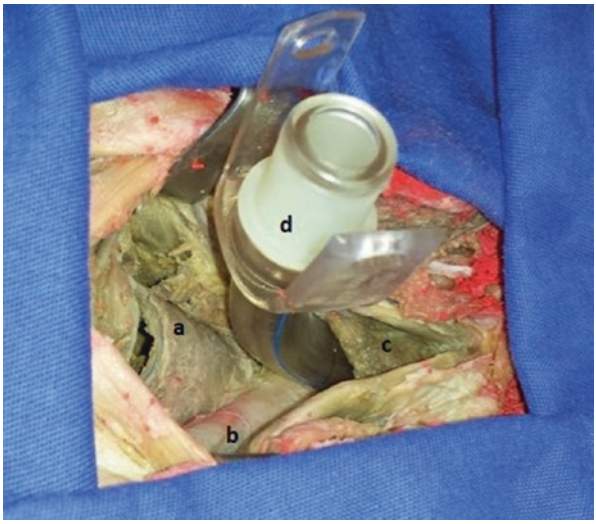

Fig. 4 (**a**) Trachea. (**b**) Brachiocephalic trunk. (**c**) Brachiocephalic vein. (**d**) Tracheal cannula (false path between brachiocephalic trunk and brachiocephalic vein)

Esophageal Perforation

This iatrogenic lesion is rare, occurring in fewer than 1% of cases, and should be treated immediately, with suturing in two planes, in addition to diversion of food intake with nasoenteric feeding. Late diagnosis of this complication significantly worsens the prognosis, based on the risk of mediastinitis [3, 4].

Normally it happens with lateral traction of the trachea, exposing the anterior wall of the esophagus, confusing the muscular esophagus wall with the strap muscles, which could resulting in a surgical esophagus injury (Figs. 5 and 6).

Recurrent Laryngeal Nerve Injury

This occurs during lateral dissection of the trachea, and happens more easily when it is deviated. This complication usually is diagnosed after decannulation, with significant dysphonia and changes in swallowing with aspiration of varied intensity, and is confirmed by laryngoscopy examination. This neural deficit may be definitive or temporary [5, 6].

Cardiopulmonary Resuscitation

Several factors can result in cardiorespiratory arrest during the performance of a tracheostomy: delay in airway clearance, cardiac arrhythmia, vagal stimulation, hypertensive pneumothorax, postobstruction pulmonary edema, and excessive inhalation of oxygen in patients with chronic hypercarbia [3, 7].

Fig. 5 Normal exposure during a tracheostomy. The trachea is in a central position

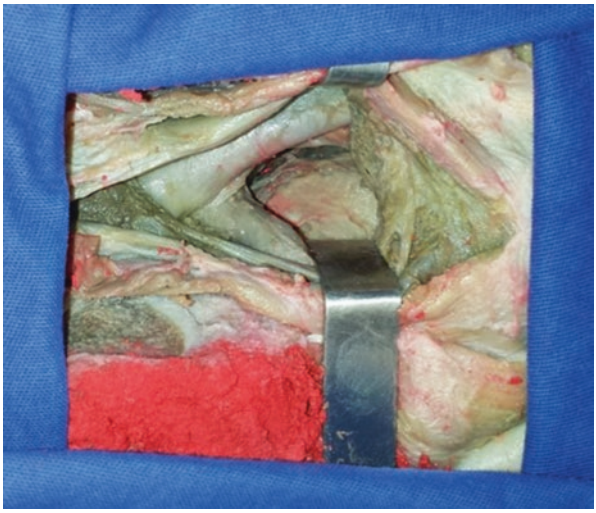

Fig. 6 Lateral tracheal retraction with anterior esophagus wall exposure

Pneumomediastinum

This occurs more often in children and is usually diagnosed on routine chest X-rays. This complication can be caused by dissection of the paratracheal soft tissues, especially in cases of excessive respiratory effort and also when accompanied by cough.

In most cases, pneumomediastinum is asymptomatic and does not require treatment [8].

Combustion

This rare complication can be a catastrophic event. The use of electrocautery on a surface that has received an alcoholic solution, in the presence of oxygen in a high concentration, may result in ideal conditions for the occurrence of severe burns.

Care should be taken to avoid this complication; however, if it occurs, treatment should be instituted to minimize the complications of airway burns, such as antibiotics, intravenous fluids, and corticosteroids [8].

Late debridement will be necessary in the following days to avoid secondary infection of the burned tissue.

Early Complications

Cannula Obstruction

The presence of mucous secretions or blood clots can occur frequently and immediately after performing the tracheostomy. This can be avoided by using proper humidification and frequent aspiration of the tracheostomy. To avoid complete obstruction of the cannula, the use of a prosthesis with an inner cannula is essential, otherwise replacement is indicated [8].

Displacement of the Tracheostomy Tube

The earlier this occurrence happens, the more serious a complication it can be. In the immediate postoperative period, the peritracheal soft tissue does not present fibrosis. Then there is no defined path between the skin and the trachea, and immediate recannulation could be difficult to perform. Decannulation more frequently occurs in patients without favorable anatomy such as obesity, agitated patients, or those with a severe cough. Incorrect cannula fixation and inappropriate dressing may also facilitate the occurrence of this complication.

One of the clear signs of cannula displacement is the possibility of the patient speaking even with a tracheostomy.

For the repositioning of the cannula, a suture in the tracheal ring can help in the exposure of the tracheal orifice. In cases where repositioning of the cannula is not

possible, the orotracheal tube should be replaced, following by posterior repositioning of the tracheostomy cannula [8].

Bleeding

In the early postoperative period the source of bleeding would be the same as that in the transoperative period (see Sect. 1.1). Cases of major bleeding should be surgically re-explored [8].

Surgical Wound Infection

Colonization of the tracheal wound occurs within the first 48 h after surgery. The main colonizing germs are Gram positive bacteria, *Pseudomonas,* and *Escherichia coli*. Because it is an open operative wound, colonization is inevitable, but some maneuvers are important for reducing the risks of major infectious complications, such as frequent cannula replacement, removal of the tracheal ring suture, and minimal devascularization of peritracheostoma and tracheal tissue, avoiding lateral tracheal dissection.

Necrotizing stoma infection is an uncommon complication; however, it presents a high rate of serious complications such as exposure of large vessel ruptures (Fig. 7). Treatment should be performed with antibiotic therapy whenever possible, guided by cultures and debridement of devitalized tissue [8].

Subcutaneous Emphysema

Accumulation of air in the subcutaneous space usually is not very serious, requiring no treatment at all. The cause of this complication may be excessive cough, a cannula without a cuff, or near-total obstruction of the skin around the cannula. Usually the treatment is cannula replacement with a cuffed cannula or correct cuff inflation [8].

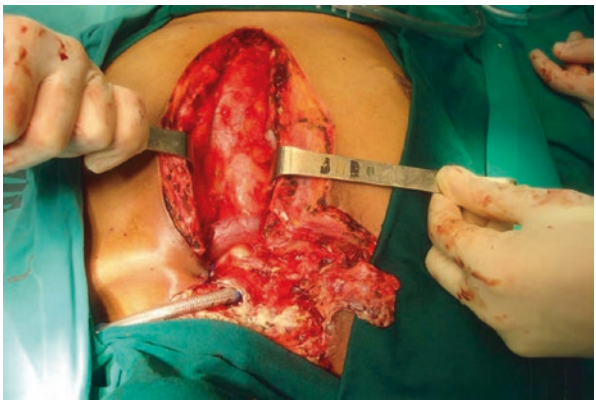

Fig. 7 Sternotomy approach for a brachiocephalic trunk rupture due to tracheostomy infection

Late Complications

Tracheal Stenosis

After tracheostomy, tracheal narrowing occurs more frequently at the stomal level, but this also can occur in a lower incidence in the suprastomal region [9, 10, 11], in the region of contact with the cuff, and in the contact region between the tip of the cannula and the tracheal wall [12]. Some factors such as local infection favor weakening of the tracheal walls, facilitating the occurrence of this stenosis.

Although a large number of patients show a certain degree of tracheal caliber reduction after a tracheostomy, only 3–12% of patients present with stenosis symptoms that require treatment [11].

At first, granulation tissue formation occurs, which can lead to decannulation difficulties. Later, fibrous tissue formation begins at the site of granulation, followed by epithelization of this tissue and stenosis.

Some factors are indicated as risk factors for developing tracheal stenosis, such as sepsis, stoma infection, hypotension, elderly patients, steroids, cannula size, excessive cannula mobility, prolonged cannulation, or disproportionate excision of the anterior wall of the trachea during the surgical procedure [9].

The risk of this complication occurs equally with the surgical and percutaneous procedures [13, 14, 15].

One third of tracheal stenoses are located in the cuff region due to a pressure higher than the capillary perfusion, resulting in an ischemic lesion of the tracheal wall. These types of lesions decrease by ten times after standard cuffs, prioritizing high-volume and low-pressure cuffs [16, 17].

The position and contact of the distal cannula tip are important and can result in posterior tracheal wall trauma, especially in obese patients with a large distance between the skin and the tracheal orifice, allowing contact between its extremity and the posterior wall of the trachea [12].

For diagnosis of tracheal stenosis, a lot of signs and symptoms should be observed. The most frequent symptom is dyspnea, beginning weeks to months after decannulation. Half of the patients start experiencing symptoms before 6 weeks and two thirds before 2 months after decannulation [18]. Usually the symptoms start with a reduction in the tracheal lumen of greater than 50%.

A computed tomography (CT) scan and tracheoscopy are the most useful examinations to define the exact level and the extension of the stenosis, and help to define the treatment [12] (Fig. 8).

Laser resection of the granulation tissue (Fig. 9) formed in the tracheostomy is the treatment of choice [19]. Bronchoscopy dilation may also be an appropriate approach for this type of complication [20]. When stenosis of a short segment of the trachea occurs, resection with laser therapy achieves up to 60% success. When the laser approach does not achieve an adequate outcome, surgical segmental resection of the trachea and reanastomosis is the treatment of choice [11, 18, 21, 22].

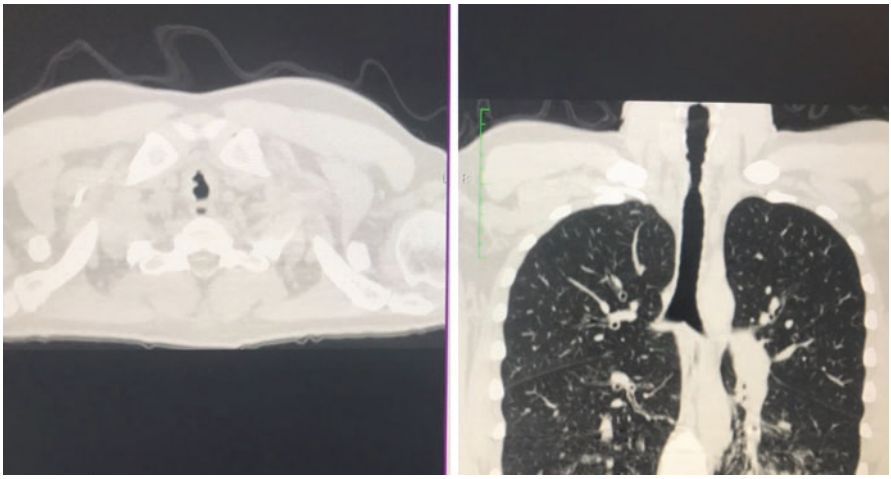

Fig. 8 Transversal and coronal section showing extensive tracheal stenosis due to cuff hyperinflation

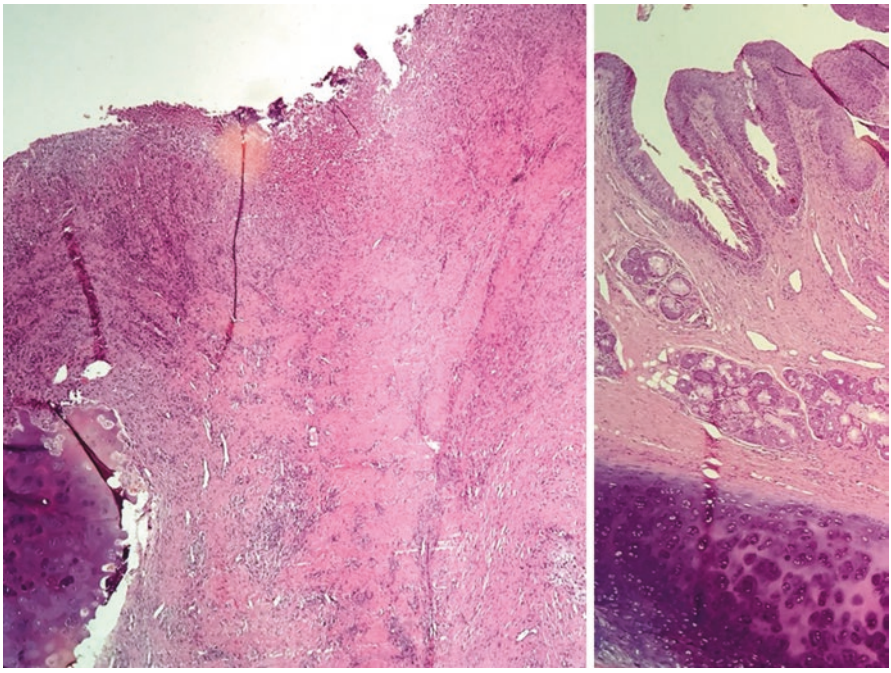

Fig. 9 *Left:* H&E staining, 40× magnification, granulation tissue fibrosis with tracheal cartilage destruction. *Right:* H&E staining, 40× magnification, normal tracheal tissue

Tracheomalacia

This is weakening of the walls of the trachea, which results in a decrease in caliber during expiration. It occurs secondary to chondritis and subsequent cartilage necrosis, resulting in loss of airway caliber support [9, 23].

It may arise acutely, resulting in failure to attempt withdrawal from mechanical ventilation, or in a more chronic manner, manifesting itself with dyspnea associated with a previous history of tracheostomy [12].

A high degree of suspicion is also required for diagnosis. Several complementary examinations may aid in diagnosis, such as tracheoscopy showing a decrease in the tracheal caliber during expiration, and spirometry with characteristics of intrathoracic flow obstruction, in addition to dynamic tracheal tomography [24].

The treatment depends on the severity of the symptom [25]. The options include retracheostomy, stent placement, and tracheal resection [12].

Tracheoinnominate Fistula

This is one of the most feared complications of tracheostomy [9]. The risk factors for the occurrence of this fistula are similar to those of other late complications and are related to local trauma secondary to excessive movement of the tracheal cannula, hyperinflation of the cuff, and inferior placement of the cannula [12].

The brachiocephalic trunk crosses the trachea approximately at the level of the ninth tracheal ring—a region easily reachable if the tracheostomy is performed below the third cartilaginous ring (Fig. 10).

Fig. 10 Relationship between the posterior wall of the brachiocephalic trunk, the anterior tracheal wall, and the cuff pressure

This complication occurs in fewer than 1% of tracheostomized patients, and approximately 75% of these occur between the third and fourth week of tracheostomy. Mortality is close to 100%, even in cases where surgical exploration is possible.

Clinically it presents with a bleeding prodrome by the tracheostomy, evolving to massive hemoptysis [12]. Immediate surgical exploration is mandatory to attempt to correct the fistula [26].

Tracheoesophageal Fistula

This is a rare complication, which occurs in fewer than 1% of cases [27]. This iatrogenic complication occurs due to trauma to the posterior wall of the trachea, which may occur acutely during a percutaneous tracheostomy procedure, or it may be due to chronic trauma causing ischemia of the posterior tracheal wall [12]. The presence of a nasoenteric catheter may also cause trauma to the esophagus, facilitating the formation of the fistula [24, 28].

The clinical manifestation of this complication occurs with aspiration pneumonia, increased dyspnea, and gastric distension [9]. The diagnosis is made with esophagography and a thoracic CT scan. The treatment is surgical, and, depending on the level of the fistula, a thoracic approach beyond the cervical one could be necessary [29].

Pneumonia

Old studies have reported that tracheostomy reduced the occurrence of pneumonia [30]. However, a study analyzing more than 3000 intensive care patients reported that tracheostomy increased the incidence of pneumonia by 6.7 times [31].

Aspiration

Placement of the tracheostomy alters the swallowing movement, predisposing the patient to aspiration, in addition to compression of the esophagus by the cuff of the cannula. Aspiration can occur in up to 50% of patients on mechanical ventilation and with an inflated cuff. Based on this high incidence, a swallowing study is recommended in all patients who remain tracheostomized for a long time before starting oral intake of food.

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