

INDICATIONS AND CARE FOR PEDIATRIC TRACHEOSTOMY

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ABSTRACT

Tracheostomy in children is an extremely delicate procedure, which consists in the creation of a stoma between the trachea and the skin. Among the most frequent indications are neurological disorders, obstruction of the upper airway or prolonged mechanical ventilation. Pediatric versus adult airway differences should be considered during surgery. In the postoperative period, hemorrhage, pneumothorax, pneumomediastinum can occur. In the late postoperative period, accidental decannulation, false passage, infection of the tracheostomy, and later formation of peristomal or endotracheal granulomas may occur. Care for tracheostomy in the clinical unit must be performed with trained personnel and the family environment must be prepared for home care. As long as the tracheostomy persists, control of the upper and lower airway to the tracheostomy must be maintained by fiber optic. Patients with neurological compromise or cardiopulmonary damage have a lower decannulation rate and a longer hospital stay.

Key words: children, tracheostomy, cannula, complications.

INTRODUCTION

Tracheostomy is a procedure performed to ensure ventilation, in cases where the airway is compromised or due to the need for prolonged mechanical ventilation.

It consists of the opening of the anterior wall of the trachea through a surgical incision in the skin and the creation of a stoma through which a cannula is inserted for ventilation.

It is a procedure performed in a ward with general anesthesia, which must be performed by trained professionals, to avoid both intraoperative and postoperative complications, especially in children, since the infantile airway is different from that of the adult.

Tracheostomy care at the hospital room and at home is very important, since accidents such as decannulation,

false passage or hemorrhage can be fatal, as well as to avoid infections, and granuloma formation. When the patient can go home, the family must be instructed in their care.

The patient can be decannulated once the causes of their indication have been overcome, and have obtained adequate laryngeal and swallowing function.

HISTORY

Tracheostomy is a procedure described since ancient times. Already in the time of Ancient Egypt and Greece, quotes about this procedure are found in the Ebers papyrus, later it is recorded that Alexander the Great, Asclepiades, Aretaeus and Galen would have performed this surgery (1,2). In the middle ages, Avicenna in "Canon of Medicine" (980-1037 AD), describes in detail the tracheostomy technique. Subsequently there was a long period in which it was only performed in extreme cases, due to its uncertain results.

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The first documented pediatric tracheostomy was performed by Habicot in 1630, on a teenager with a foreign body. In 1833 Trousseau (3) made a report of 200 cases of tracheostomy for diphtheria therapy. Gradually, its frequency began to increase for the treatment of asphyxiation in patients with foreign airway bodies, neurological diseases and other diverse causes. Chevalier Jackson (4) in the 1900s, published the technique emphasizing the anatomical points to consider, what clearly decreases the associated complications. Currently there is a lot of consensus on its indications and management.

PEDIATRIC AIRWAY

A child's airway has important differences from that of the adult, which must be considered at the time of an endotracheal intubation or when performing a tracheostomy (5). Several studies have been carried out to evaluate the length and diameter of the trachea in its different areas, through fiber optics or by radiological study (Table 1) (6,7).

Table 1. Tracheal length evaluated by fiber optic endoscopy and chest radiography (n = 250 patients) (6).

Endoscopic evaluation		Radiological evaluation	
Age (years)	Tracheal length (mm)	Age (average years)	Tracheal length (mm)
0 a < 2	3,8-6,4	1	4,0-6,8
2 a < 4	4,3-8,1	3,2	5,4-7,4
4 a < 6	5,0-8,3	4,9	5,6-8,8
6 a < 8	5,5-8,9	6,5	6,8-9,6
8 a < 10	6,7-9,6	9,2	7,4-10,2
10 a < 12	7,3-10,4	11,2	8,2-11,8
12 a < 14	7,3-12,0	13,2	7,8-13,8
14 a < 16	8,2-13,5	15,1	8,8-13,6

The proportion between the size of the head and the body is different between a child and an adult, being in the child a higher percentage, so the tongue is proportionally larger than in the adult, the neck in turn is shorter and therefore, the larynx is in a higher position, at the level of C2 - C3 versus C5 - C6 in the adult. The larynx of children, up until about 10 years old, has a conical shape with its narrowest part at the level of the cricoid cartilage and not cylindrical as in adults. The vocal cords

have a lower inclination in the anterior area, which sometimes during intubation can make the tube collide with the lower area of the anterior commissure and make it difficult. The trachea has an oblique direction towards the back and not straight as in adults, so when performing an intubation, the Sellick maneuver can be performed (8), which consists in pressing the cricoid cartilage towards the back, which allows a better visualization of the glottis. Although this maneuver was described to avoid bronchoaspiration (9) during intubation, controversy remains (10) about its use. Another maneuver that is performed frequently is the BURP (Backward, Upward, Rightward Pressure) maneuver, which consists of the mobilization of the thyroid cartilage backwards, upwards and to the right (11). It is not recommended to perform both maneuvers together because intubation is difficult.

Once the tracheostomy is performed, great care must be taken in the placement of the cannula, since the child's trachea is very short and the distance from the vocal cords to the carina can be of just 4 cm in the newborn, reaching 9.5 cm in children of about 12 years old (5).

INDICATIONS FOR TRACHEOSTOMY

With advances in medicine, especially in intensive care units, which have significantly improved airway management, the role of tracheostomy has changed significantly. Currently, infants and very young children can be maintained with endotracheal intubation for long periods without complications, although it is recommended to maintain fiber optic control frequently. This is not the same in older children or adults, where the period of prolonged intubation can lead to subglottic stenosis, vocal cord pseudoparalysis, etc.

When analyzing the most frequent causes (12-14) for a tracheostomy (Table 2), those that stand out are patients with neurological disorders that are reported to be between 40% (12), 26% (15), in pathologies such as paralysis, cerebral, ischemic hypoxic encephalopathy, neuromuscular disorders, brain tumors, spinal cord atrophy and others. Upper airway obstruction is the second leading cause of tracheostomy (19%): laryngomalacia, subglottic hemangioma, tracheoesophageal fistula, tracheomalacia, vocal cord paralysis (12,14). Another group of patients who require tracheostomy are those with craniofacial malformations, an indication that ranges from 23% to 13% (14,15). These patients generally require tracheostomy at earlier ages, or when surgical repair of part of their malformation is required and there is difficulty in intubation, cases such as Pierre Robin Syndrome, Treacher Collins Syndrome, CHARGE, Goldenhar Syndrome, and other malformations that contain a micrognathia. Prolonged mechanical ventilation is reported in 26% of cases (14), due to prematurity, cardiac malformations, pulmonary hypertension, severe bronchopulmonary dysplasia. A less frequent cause is the post-traumatic sequelae such as laryngotracheal trauma, cervical spine fractures and maxillofacial fractures (16). There are some very rare emergency situations but no less serious, as in the extraction of a very large foreign body that has managed to pass through the vocal cords to the trachea, during its extraction it is advisable to perform a transient

tracheostomy to remove it through the stoma. On other occasions, intubation is unsuccessful due to the inability to visualize the glottis due to an infection of the floor of the mouth (Ludvig's angina), tongue-based tumors or a massive and late hemorrhage after tonsil surgery, or a massive epistaxis in some cases of Nasopharynx cancer. Many other causes for a tracheostomy exist and will always, at the request of the intensive care team or the pediatric emergency department.

At the ENT Service of the Hospital San Juan de Dios, in Santiago, Chile, 22 tracheostomies have been performed, between 2014 and February 2019, of which 14 have been performed in children under one year of age, and 9 of them are under 6 months. In most cases the reason was due to airway obstruction, subglottic stenosis, craniofacial malformation or prolonged ventilation.

Table 2. Indications for tracheostomy

Neurological disorders	Cerebral palsy Ische Hypoxic Ischemic Encephalopathy (HIE) Neuromuscular disorders Brain tumors Spinal cord atrophy
Upper airway obstruction	Laryngomalacia Subglottic hemangioma Tracheoesophageal fistula Tracheomalacia Vocal cord paralysis
Craniofacial malformations	Pierre Robin syndrome Treacher Collins syndrome CHARGE syndrome Goldenhar syndrome Micrognathia
Laryngotracheal trauma	
Prolonged mechanical ventilation	

TRACHEOSTOMY TECHNIQUE

The performance of tracheostomy in children is different from that of adults because of what is described above, in relation to the location of the larynx, which is in a higher position. Occipital prominence in children forces to put a support under the shoulders and a pad hollowed in the head to avoid movement during the procedure. The larynx and trachea should then be located, the incision will be midway between the cricoid cartilage and the sternal notch. There is no consensus on the skin incision, some surgeons perform it horizontally, for

cosmetic considerations, others vertically, in both cases when the tracheostomy is extended for a long time, the scar will take an umbilical appearance and require cosmetic surgery in the future, if the patient requests it, once all the reasons for its indication have been exceeded. The vertical incision is more comfortable and less traumatic, which extends for about two centimeters, the skin is then released, the planes are dissected, placing the platysma muscle that does not suffer trauma in the vertical incision, then the pretracheal muscles are separated, always locating the middle raphe and palpation of the trachea frequently to avoid leaving the midline, the planes are then released, until reaching the pretracheal fascia, palpation of the trachea is very important since it is sometimes found anterior the innominate artery or right of the brachycephalic trunk and must be clearly identified, since because of its thickness it can be confused and an accident in this case can be fatal. We will also find in this area the thyroid gland, which in rare cases is necessary to section in children since it is less bulky than in adults.

Finally, once the trachea is located, a vertical incision is made between the third and fourth tracheal ring with an extension to both sides at the upper and lower end, remaining in a horizontal H-shape, then fixation points are placed from the edges of the opening from the trachea to the skin with vicryl 2/0 or 3/0, on both sides, at the lower and upper level, these points can be left long allowing them to be opened by opening the stoma in case of requiring a change of the cannula in the first hours or days. After a week, they should be removed to avoid reaction to a foreign body and operative wound infections.

During the postoperative period, the patient should be closely monitored, usually in an intensive care unit, with cardiac monitoring and oxygen saturation. The correct position of the cannula should be checked and the possibility of pneumothorax or pneumomediastinum evaluated with a chest x-ray and the cannula secured with bands fitted to the neck to avoid accidental decannulation.

COMPLICATIONS

Complications can be very serious. The frequency is variable with rates of 41% (13), 44% (14) and 55% (15). They can occur during the same operative act and in the immediate or late post-operative period (Table 3).

During the procedure, hemorrhages can occur due to damage of the anterior jugular veins, especially in case of a horizontal skin incision, or damage of the unnamed artery that occasionally appears prior to the trachea 7% (17). The rupture of the pleural dome will be a serious complication, producing a pneumothorax that is reported in up to 17% in children under one year old(19). During an emergency procedure, with an untreated patient, it is possible to break the anterior wall of the esophagus if the tracheal incision is performed too deep, producing a tracheoesophageal fistula, which can worsen an already serious situation.

In the immediate postoperative period it is not uncommon for subcutaneous emphysema or pneumomediastinum to occur (18). Occasionally during the first changes of cannula, if it is not done with the proper technique, a false pathway can be formed, with serious complications such as asphyxiation or hemorrhage. The installed cannula should remain with a stable fixation that prevents its accidental expulsion, since in general one of the causes of tracheostomy mortality is accidental cannulation. Frequent cleaning should be performed since if there are too many secretions the lumen can be clogged and cause asphyxiation.

Stoma healing should be performed daily to avoid infections of the tracheostomy orifice and formation of periorificial external granulomas or towards the lumen, being the most frequent suprastomal granuloma (20), which can become extensive and fibrous and prevent decannulation once it is required (21).

Perhaps the most serious of the complications due to the dramatic presentation, is hemorrhage due to erosion of the anterior wall of the trachea and rupture of an unnamed artery, this can happen due to excessive manipulation of the tracheostomy, balloon cannulas with a lot of pressure or a tracheostomy performed below the third tracheal ring. In this case the presence of a thoracic surgeon and an otolaryngologist is required.

change should be made, there is no agreement in the various units, with recommendations to do so once a month and in others once a week. To avoid the formation of granulomas, change should be made once a week. The first change must be made by the surgeon who has performed the tracheostomy and the following changes by properly trained nurses and once at home by the caregivers, who must have training, an aspiration machine, probes, serum, gauze, and cannulas of the same size and smaller in case of presenting any difficulty at the time of change.

From time to time, which may be every 6 months, an endoscopic examination of the airway should be performed, with nasopharyngoscopy or with bronchoscopy, to evaluate mobility of vocal cords, subglottis status, presence of granulomas or eventual tracheal stenosis.

Ideally, protocols for the management of patients with tracheostomy should be generated, with very clear points, in terms of patient monitoring, stoma cleaning and cannula change.

Table 3. Tracheostomy complications.

Intra-operative complications	Hemorrhage Pneumothorax Tracheoesophageal fistula
Early post-operative complications	Subcutaneous emphysema Pneumomediastinum False passage Accidental decannulation Infection Hemorrhage
Late post-operative complications	Granulomas Innominate artery rupture Accidental decannulation

CANNULA

With regard to the choice of cannula for tracheostomy, it will depend on age and weight (22). In general, the sizes are constant among the different brands, some have a balloon, others depending on the number, will have an endo-holder cannula, various connection valves for mechanical ventilation, a T-tube, filters to keep the environment and voice valves for children that can speak. There is consensus that in neonates and children under one year of age, a 2.5-3 cannula number should be chosen, for infants from 6 months to 2 years it may be a 3.5 - 4.0, and for older children 3-4 a 4 -4.5 cannula. The age and size of the patient should be considered, when choosing the cannula and several cannulas must be available in the ward. Care must be taken in that the cannula is left with sufficient space in the tracheal lumen to avoid contact ulcers and secondary stenosis, the length of the cannula should be checked once in situ, since if it is too long it may be inserted in one of the bronchi. Various brands of tracheostomy cannulas exist in the market; however, many hospitals do not have all of them, the most used are Shiley, Rush, Portex, in some cases they have a balloon, which is especially indicated when there is a risk of persistent aspiration, however, it must be deflated from time to time, and control of the cuff pressure must be kept. In younger children, it is preferable to use without a balloon. Depending on the size of the patient, the use of an endo-holder cannula that allows daily cleaning or several times a day may be useful if necessary, when the patient is no longer connected to a ventilator. Filters are used in the hole of the cannula to prevent the entry of some particles during inspiration. When possible in older children, a voice valve can be used that allows language to be emitted at a better volume.

READMISSION

Once discharged, patients can return to the hospital for various reasons, usually within the next 30 days, and mainly due to acute respiratory diseases (23). Other causes of readmission are due to airway reassessment planning, or management of their basic pathology.

TRACHEOSTOMY CARE

Once the stoma is established, the cannula should be changed during the first week after the procedure. On a daily basis and if necessary more frequently, the stoma should be cleaned, keeping it as dry as possible.

To change the cannula, a cannula of the same dimensions and a smaller number must be available. The patient should be placed back dorsal with the head in hyperextension with a sheet rolled under the shoulders, secretion aspiration should be performed prior to extraction, removing the cannula and quickly cleaning the stoma with gauze with physiological serum and placing the new cannula, smoothly, orienting the tip of the latter towards the inside and laterally or upwards. Once the tip is inserted, it is turned to place it towards the bottom, in this way the false passage that could have occurred during the first days is avoided. The cannula is then reattached to the neck with ad hoc tapes.

Regarding the frequency with which the cannula

DECANNULATION

For the family of tracheotomized children, definitive decannulation is a primary objective, however, it will not always be possible.

According to some studies between 26% (24) and 31% (12) of children can be decannulated, which depends on the indication of the tracheostomy. Takahashi (24) reports that patients with only structural disorders are more likely to be decannulated, unlike patients with functional disorders. Funamura (12) reports that children who have as a cause a trauma have higher decay rates, 72% versus 36%, than those with upper airway obstruction. Patients with neurological damage and cardiopulmonary problems have a higher mortality (8.8%) and a greater number of days in the hospital (25).

CONCLUSION

Tracheostomy in children is a great challenge, since its indication, and needs in-hospital and home management, since it has complications that can be very serious. Health professionals should be trained in the care of pediatric patients who have this condition. Management protocols can reduce serious accidents such as accidental decannulation. Definitive decannulation is not always achieved, mainly due to neurological or cardiopulmonary conditions.

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