THERAPY

Tracheostomy in critically ill patients

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Abstract

The authors made a retrospective analysis of results and complications of elective tracheostomies performed by percutaneous dilatational technique (PDT) as well as standard surgical procedure (ST) in critically ill patients in the ICU. The indication for tracheostomy was to facilitate long-term mechanical ventilation, to facilitate cleaning and management of the airway and to maintain upper airway patency. During a 5-year period there were 495 elective tracheostomies performed in the ICU setting, in 209 females and 286 males. From these, 408 were standard (82.4 %) and 87 percutaneous dilatational tracheostomies (17.6 %). Mean age of patients with tracheostomy was 63.3 years (range 17–93 years) and the mean duration of endotracheal intubation before tracheostomy was 7 days (range from 13 minutes to 21 days). During the monitored period 144 patients (29.0 %) were decannulated, out of which 34 patients (23.6 %) had PDT and 110 patients (76.4 %) ST. A total of 265 patients (53.5 %) with tracheostomy died and 86 patients (17.3 %) had the tracheostomy cannule in place at the study conclusion. Perioperative complications totaled 14 (2.8 %), the most serious being one cardiac arrest and death (0.4 %) both in ST as well as in PDT groups. Early postoperative complications totaled 46 (9.2 %). Late postoperative complications totaled 7 (1.4 %). Percutaneous dilatational tracheostomy is an alternative method to standard surgical tracheostomy in critically ill patients in the ICUs. Standard surgical tracheostomy is an irreplaceable procedure in patients with complex anatomic condition or in high-risk patients. ***(Tab. 3, Ref. 11.)***

Key words: tracheostomy, standard surgical tracheostomy, percutaneous dilatational tracheostomy, complications.

Tracheostomy is one of the oldest reported surgical interventions. First reports of tracheostomy were made in ancient Egypt arround 3500 B.C. The name of tracheostomy was introduced by German surgeon L. Heister in 1713 (1). In early 1800‘s, tracheostomy was introduced in clinical practice by Bretonneau and Trousseau. In 1909, Ch. Jackson performed a large study of patients with tracheostomy and his conclusions resulted in improvement in the surgical technique and a mortality reduction. The Jackson suggested procedure became a gold standard of surgical tracheostomy (1, 2). The first attempt to perform percutaneous dilatational tracheostomy was made in 1955 by Ch. Sheldon et al (2, 11). An improvement of percutaneous dilatational tracheostomy was made by using Seldinger method of wire!lead by P. Ciagla et al in 1985 (3, 8).

Recently, indications for tracheostomy have also changed. Whereas originally the main indication was laryngeal obstruction, recently the most frequent indication of tracheostomy is the requirement for airway access during long-term mechanical ventilation.

Patients and methods

Reotrospective data of patients with tracheostomy were analyzed from critically ill patients in the Intensive Care Units of the General University Hospital in Prague for period of 60 months (January 1998 through December 2002). The group includes 495 patients, 209 females (42 %) and 286 males (58 %).

Tracheostomy procedure was indicated to enable long-term mechanical ventilation, to facilitate cleaning and recovery of the

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Tab. 1. Indication groups for tracheostomy.

	Patients	%
Medical diseases	319	64.4
Neurology diseases	85	16.9
Malignancies	37	7.4
Intoxication, attempted suicide	22	4
Trauma	15	3
Laryngeal obstruction	10	2
Septic condition	7	1.4
Total	495	

Tab. 2. Demographic data of patients with ST in the 5-year period.

Total number of patients	495
Age (years)	63.3 (17-93)
Males	286 (58 %)
Females	209 (42 %)
Standard surgical tracheostomy (ST)	408 (82 %)
Percutaneous dilatational tracheostomy (PDT)	87 (18 %)
Endotracheal intubation (ETI)	7days (13 min-21days)
Mean duration of ST performance	14.5 min (9-30 min)
Mean duration of PDT performance	5 min (3-11 min)

airway and to keep patency of the upper air way. The indications for tracheostomy are shown in Table 1. A total of 11 otorhinolaryngologists performed the standard surgical tracheostomy. Percutaneous dilatational tracheostomy procedures were performed by 3 physicians – 2 intensivists and by 1 otorhinolaryngologist.

Techniques of elective tracheostomy procedure

In both techniques the patient lies supine on his back with a pad under his shoulders with his head slightly backwards, when this position is not contraindicated. Tracheostomy is performed with intravenous sedation using midazolam and fentanyl and the patients are relaxed. Immediately prior to the procedure, oxygenation with 100 % oxygen is performed and the area of skin incision infiltrated with topical anesthetic agent. The procedure is performed while monitoring ECG, pulse oxygenometry, capnometry and blood pressure.

A. Standard surgical technique (ST)

All cases begin with horizontal skin incision 3–5 cm long, in the middle of the line of cricoid cartilage – upper margin of the sternum. Access to the front surface of the trachea is used either under or above of thyroid gland isthmus. The trachea is opened between the second and third or the third and fourth tracheal ring. Incision of the caudal ring makes a modified Bjork lobe. Both the upper and lower edges of tracheostomy are fixed with 2 adaptation stitches on the top and 2 stitches on the bottom to the edge of the skin incision. Afterwards, the tracheostomy cannule is inserted, the balloon of the cuff is inflated and cannule connected to the ventilation circuit.

B. Percutaneous dilatation technique (PDT)

After a short horizontal skin incision about 1–1.5 cm long in the midline between cricoid cartilage and upper rim of the sternum, the anatomical layers are dissected with dissectors. Afterwards the endotracheal tube is slightly pulled up so that its lower tip is just below or at the glottic ligaments. A needle attached to a syringe with normal saline solution with a plastic cannule is used to punctur between the second and third or the fourth tracheal ring. By air bubble aspiration into the syringe with normal saline, proper needle position in the trachea is confirmed. Through the plastic cannule a "J"-shaped guide wire is inserted into the trachea. Over this wire the puncture is dilated by plastic dilator and afterwards a special dilator forceps (GWDF) is inserted into the trachea. Following its insertion under the intercartilagineous space and the forceps is used to dilate the intercartilagineaous space first in the horizontal and then in the vertical direction. Afterwards dilatational tracheostomy cannula with plastic lead is inserted over the guide wire. Then the guide wire as well as the forceps is pulled out, the balloon cuff is inflated and the cannula is connected to the ventilation circuit. While performing tracheostomies we have monitored the time necessary for the procedure. The beginning of the procedure was set as performing skin incision and the end was set as insertion of a tracheostomy cannule.

Complications that emerged during the procedure or afterwards were considered to be perioperative complications when they emerged during the procedure or within 24 hours after the procedure. Early postoperative complications included those that emerged after 24 hours but no later then 7 days after the procedure. Late postoperative complications were those that emerged 7 days or later after the procedure.

Results

During the 5-year period we performed 495 tracheostomies: 408 (82.4 %) using standard surgical technique (ST) and 87 (17.6 %) using percutaneous dilatation technique (PDT). Demographic data of patients are shown in Table 2. Mean age of patients was 63.3 years (range 17–93 years), the largest was age group 61–81 years that formed 53.1 % of the group. The mean time from endotracheal intubation to tracheostomy was 7 days (range 13 minutes – 21 days). Only in 10 patients (2.0 %) was tracheostomy indicated due to laryngotracheal obstruction and in 5 of those (1.0 %) the procedure was performed without securing the airway by endotracheal intubation. In 3 cases the indication for tracheostomy was tumorous obstruction of the larynx, in 2 patients an urgent tracheostomy was necessary due to extensive edema of the larynx and bleeding following repeated unsuccessful attempts for endotracheal intubation. During the study period 144 patients (29.1 %) were decannulated. Out of these 34 patients had PDT (23.6 %) and 110 patients had ST (76.4 %). The mean age of decannulated patients was 55.2 years (range 17–83 years). A total of 265 patients (53.5 %) died while having tracheostomy. Their mean age was 64.2 years (range 19–93 years). During the study period, tracheostomy cannule were still in 86 patients (17.3 %). The mean time necessary to perform PDT was 5 minutes (range from 3 to 11 minutes), mean time necessary to perform ST was 14.5 minutes (range from 9 to 30 minutes).

Complications

The complication rate is reviewed in Table 3.

Perioperative complications in standard surgical tracheostomy (ST): cardiac arrest and death once, foreign body aspiration into the left main bronchus once (broken needle), misplacement of tracheostomy cannula with a temporary drop in oxygen saturation below 90 % once, minor bleeding once. Incidence of perioperative complications in ST was 0.9 %.

Perioperative complications in percutaneous dilatational tracheostomy (PDT): cardiac arrest and death once, injury of the posterior wall of the trachea once, misplacement of tracheostomy cannule with temporary drop in oxygen saturation below 90 % once, major bleeding 3 times, minor bleeding 4 times. The overall complication incidence in PDT was 11.4 %.

Early postoperative complications in ST: major bleeding 6 times and minor bleeding 3 times, 21 cases of inflammatory wound complications and suture or wound dehiscence, mediastinitis once, subcutaneous emphysema twice. The incidence of early postoperative complications in ST was 8 %. Early postoperative complications in PDT were: major bleeding 6 times, minor bleeding 4 times, wound infection twice, pneumomediastinum once. Incidence rate of early postoperative complications in PDT was 14.9 %.

Late postoperative complications. Following ST, tracheoesophageal fistula occurred twice. Both patients had a nasogastric tube inserted one week before tracheostomy. In the first patient the tracheoesophageal fistula appeared after 7 days, in the other 82 days after tracheostomy while the nasogastric tube was permanently inserted. Following ST, 4 patients (3.6 %) ended up with tracheal stenosis and clinical symptoms manifested within 14 to 166 days after decannulation. The incidence rate of late complications in ST was 1.5 %. Following PDT, 1 patient (2.9 %) had tracheal stenosis that became symptomatic 95 days post decannulation. The incidence rate of late complications in PDT was 1.1 %.

Stenoses were localized 4 times in the place of tracheostomy incision and once at the site of the lower tip of tracheostomy cannule. The length of the stenoses ranged from 5 mm to 2 cm and the narrowest place of the trachea was 0.5–0.7 mm.

Tab. 3. Complication incidence rate.

Perioperative complications	ST (n=408)	PDT (n=87)	Total (n=495)
cardiac arrest, death	1	1	2
foreign body aspiration	1	0	1
trachea posterior wall injury	0	1	1
misplacement of tracheostomy cannule and transient hypoxia	1	1	2
major bleeding	0	3	3
minor bleeding	1	4	5
Total	4 (0.9%)	10 (11.4%)	14 (2.8%)
Early postoperative complications	**ST (n=408)**	**PDT (n=87)**	**Total (n=495)**
major bleeding	6	6	12
minor bleeding	3	4	7
infection and wound dehiscence	21	2	23
subcutaneous emphysema	2	0	2
pneumomediastinum	0	1	1
mediastinitis	1	0	1
Total	33 (8.0%)	13 (14.9%)	46 (9.2%)
Last operative complications	**ST (n=408)**	**PDT (n=87)**	**Total (n=495)**
tracheoesophageal fistula	2	0	2
tracheal stenosis	4	1	5
Total	6 (1.4%)	1 (1.1 %)	7 (13.5%)
Complications total	ST 43 (10.5%)	PDT 24 (27.5%)	67 (13.5%)

Postoperative major bleeding – required surgical wound management and electrocoagulation, ligature or suture of bleeding vessel. Postoperative minor bleeding – bleeding stopped after wound tamponade.

Discussion

Tracheostomy is one of the most frequently performed elective surgical interventions in critically ill patients in intensive care units (2, 4). These patients have a high risk of perioperative and postoperative complications, since besides serious underling condition these patients have other risk factors such as sepsis, multiorgan failure, blood clotting and hemopoetic disturbances, metabolic disturbances etc. (5). In our patient group the most frequent indication for tracheostomy was the need for long-term mechanical ventilation in 485 patients (98 %). Laryngotracheal obstruction was the indication for tracheostomy only in 10 patients (2 %). Infectious complications at the site of tracheostomy with resulting wound dehiscence were observed more frequently in standard surgical tracheostomy, which corresponds to the findings of Cheng et al. One of the possible causes is the size of surgical wound. The length of the skin incision is 3–5 cm in ST, which makes a wide gate for bacterial entry from both the area surrounding incision as well as oropharyngeal or bronchial fluid (3, 7).

On the other side PDT is a procedure with an elevated risk of injury of interfering anatomical structures in the operating field, which resulted in a higher incidence rate of postoperative bleeding (2).

In cases when clinical examination of the neck and the upper chest shows changes in anatomical structures such as trachea deviation, cervical and thoracic spine deformities, PDT may be a high-risk procedure. To verify anatomical structures of the anterior neck and trachea location, ultrasonographic examination is recommended. Based upon its results we may select the best technique to perform elective tracheostomy (6, 10). Advocates of the standard surgical procedure emphasize the maximum vi-

sualization of anatomic structures in the operating field and therefore prevention of complications. Bernard et al even recommends a short, 2.5 cm vertical skin incision in ST. This ensures maximum visibility of the operating field while minimizing the risk of complications, especially the risk of bleeding (2).

The most serious late complications of tracheostomy include tracheal stenosis. Its incidence rate is reported from 0.6 to 21 % (9). The stenosis incidence rate in our group was 3.6 %. Local factors that facilitate its occurrence are mechanically conditioned. First, it is the influence of excessive pressure of inflated balloon cuff at the tracheal wall that causes local ischemia. This pressure usually exceeds perfusion capillary pressure, i.e. 25–30 torr. Therefore, in patients with tracheostomy it is necessary to monitor the pressure in the cannule balloon cuff. Another cause is counter-pressure of nasogastric tube at site of tracheostomy cuff that may cause ischemic changes. Macroscopic and microscopic injury of the tracheal mucous membrane occurring during repeated suction, tracheostomy cannula replacement or undesired range of motion of tracheostomy cannule following connection to the ventilating machine (8, 9, 10) are other possible contributors to tracheal stenosis. The main clinical causes of stenoses include shortness of breath, first during physical exertion such as walking upstairs etc. Shortness of breath presents after an asymptomatic period (so-called free interval) ranging from several days to many weeks. When the stenosis progresses, the shortness of breath increases and presents also at rest. All our patients with tracheal stenosis were treated surgically by stenosis resection with end-to-end anastomosis.

The purpose of this article was to present the 5-year results and complications in critically ill patients with tracheostomy. Our experience is that PDT is a faster and easier procedure with lower rate of early and late postoperative complications. In the ICU setting, percutaneous dilatational tracheostomy is an alternative method to the standard surgical technique. However standard surgical tracheostomy is an irreplaceable procedure in conditions with complex anatomy of the neck in high-risk patients where maximum visualization and identification of interfering anatomical structures in the operating field is needed to avoid serious complications.

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