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A fast method of surgical tracheostomy: A preliminary result of minimally invasive tracheostomy

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ABSTRACT

Introduction: Currently, the percutaneous puncture method is a popular method for performing tracheostomies. However, unexpected bleeding or organ injury is a concern with this method because the dissection or dilatation is blind. A conventional open surgical tracheostomy (COST) usually takes more time to complete, but the procedure has a lower risk of bleeding compared to blind method used in the percutaneous puncture approach. In this study, we evaluated a fast open surgical tracheostomy (FOST) procedure, which combines the advantages of both open and percutaneous methods.

Materials and Methods: From January 1, 2009, to December 31, 2010, our team performed surgeries on 259 patients in our institution that were indicated for tracheostomy. During this period, both COST and FOST methods were performed. These patients were not randomized with regard to method. No additional or specialized tools are required in the FOST method. All operations were performed by a single surgeon. The operative details and outcomes were analyzed.

Results: One hundred and fifty-six patients underwent COST, while 103 patients underwent FOST. There was no difference in gender distribution, age and indications for surgery in either group. The operative time was much faster in FOST than in COST. There was no acute or delayed bleeding in either group. Minor stoma infection was seen in five patients in the FOST group and 12 patients in the COST group.

Conclusion: The FOST provided a faster alternative to COST, while preserving the techniques of open dissection and resulting in comparable outcomes.

Key words: *Trachea, tracheostomy, minimally invasive surgery*

Introduction

Tracheostomy is a common surgical procedure. The conventional open surgical tracheostomy (COST) uses an open method for incision, dissection and creation of a tracheal stoma. The procedure is relatively safe because open dissection avoids unexpected injury to the vessels, thyroid gland, esophagus, etc. A potential problem is wound dehiscence, which can result in wound infection or delayed healing. Wound care for such problems is difficult and results in a lengthy secondary healing time [1]. In recent years, percutaneous tracheostomy has become very popular in many institutions [2]. This procedure is similar to the concept in placement of a central venous catheter. The method is usually quick and results in better wound healing than COST [1,2]. However, the method is partly blind. Palpation can confirm the surface anatomy, but it cannot confirm underlying structures, such as the thyroid isthmus in the pre-tracheal plane or an aberrant vessel in the soft tissues. With blind dissection or dilatation, the

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isthmus of the thyroid gland and vessels may rupture and cause unexpected bleeding. Another complication is that the tracheal stoma created may not be properly positioned in the trachea. To prevent such complications, some surgeons use a bronchoscope to ensure the stoma is created is in the proper location. However, bronchoscopes cannot exclude the possibility of pre-tracheal soft tissue injury [1-5].

In summation, the percutaneous tracheostomy is fast, easy to perform, results in better wound healing, but has the disadvantages of unexpected bleeding and greater likelihood of severe cardiovascular events. Although some studies showed percutaneous tracheostomy has comparable outcomes with COST, its reliance upon a blind dissection remains a concern [2-7].

In this study, we used the fast open surgical tracheostomy (FOST) method, which combines open dissection in the first step and a guiding method in the second step, to perform surgical tracheostomies.

Materials and Methods

From January 1, 2009, to December 31, 2010, there were 259 patients in our hospital that required tracheostomies, which were performed by our team. The inclusion criteria included all elective tracheostomies that were performed by our team. The indications for surgery included prolonged intubation for more than 2 weeks, poor weaning response in cases of respiratory failure, airway obstruction by cancer or planned surgical procedures and complete vocal palsy. We excluded cases of emergency tracheostomies and cases that required complex tracheal surgery, traumatic tracheal laceration and cases requiring concomitant surgery. Patients who had unexplained coagulopathy were not indicated for the surgery. But we included some patients with mild coagulopathy. An international normalized ratio (INR) of prothrombin time <2.0 was acceptable. When it was required, pre-operative correction of the coagulation profile was made. We did not routinely administer antiplatelet prior to the operations. There were 156 cases that underwent COST, while 103 cases underwent FOST. These cases were not randomized with regard to procedure. Instead, we attempted FOST in selected cases in early October 2009 and, gradually, this method became our procedure of choice. Some limited cases in which percutaneous methods were used also were excluded.

To avoid the bias from an individual surgeon's experience, all included patients were operated on by a single surgeon.

Procedure

COST method

The COST method begins with a horizontal incision around 1.5-2 cm in length. After using open dissection techniques to divide the strap muscles and elevate or divide the thyroid isthmus and the pre-tracheal fascia, we then made an inverted U-shaped tracheal opening. Then the tracheostomy tube was placed inside the trachea. The soft tissues were closed with braided absorbable sutures. The skin was closed with Nylon sutures. The operating time was recorded from skin incision to skin closure.

FOST method

The FOST method begins with a tiny vertical incision around 4-5 mm in length [Figure 1a]. Then we used either a pair of hook retractors or mini-retractors to assist in the dissection of the strap muscles and pre-tracheal fascia [Figure 1b]. Next, we created an inverted U-shaped tracheal opening. Because the skin and soft tissues in the neck are very flexible, we created a tracheal opening of the proper size by retraction with a pair of mini-retractors without a large incision. After confirmation of the tracheal opening in the 3rd tracheal ring, we placed a suction tube, which functioned as a guidewire, into the distal trachea [Figure 1c]. Then, the tracheostomy tube was guided by the suction tube and placed into the trachea [Figure 1d]. After confirmation of the presence of an adequate end-tidal CO2 curve, the procedure was completed [Figure 1e]. Because the incision was very small, suturing of the soft tissues and skin was not required [Figure 1f].

Post-operative Care

Wound care included daily changing of dry gauzes, cleaning the stoma with saline and inspection of the tracheostomy wound. Minor infection was defined as an increasing frequency of wound care due to excessive discharge around the stoma. Major wound infection was defined as conditions that required wound debridement, wet dressing for secondary healing or severe wound dehiscence due to local infection.

Minor bleeding was defined as some bleeding epi-

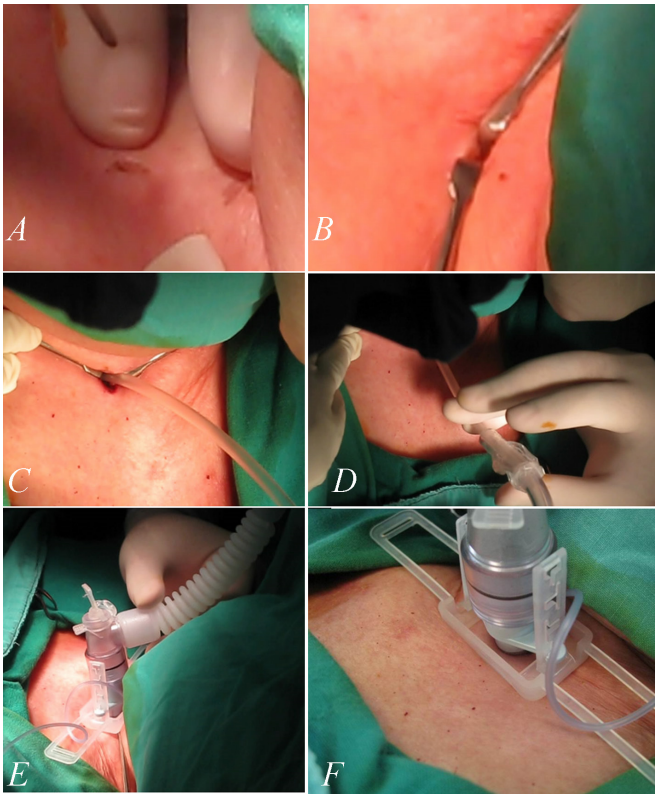

Figure 1. The procedure of fast method of open tracheostomy. The procedure is straightforward. Initially we made a tiny vertical incision measuring around 4-5 mm in length. **A:** Then we divided the strap muscles, pre-tracheal fascia and we opened the trachea with an inverted U-shape. **B:** We placed a segment of plastic suction tube into the distal part of the trachea. **C:** The tracheostomy tube was guided by the suction tube and placed into the trachea. **D:** After the adequate position was obtained, **E:** the procedure was completed. The appearance of the stoma was similar to that of percutaneous sutureless tracheostomy. **F:** Suturing was not required to close the wound.

sodes in the tracheostomy wound that required gauze compression during the post-operative course. Major bleeding was defined as reduced hemoglobin levels, lower blood pressure, or conditions that required surgical exploration to check for a bleeding source.

Conversion was defined as an initial attempt at the FOST method, but in which we enlarged the incision to perform the COST method.

Statistics

The patients' characteristics and outcomes were analyzed by Statistical Package for the Social Sciences 14.0 IBM SPSS inc. The Student's t-test and chi-square test were used to compare the categorical and numeric data. A $P < 0.05$ was considered significant.

Results

There were 259 patients included in this study. There were 137 men and 122 women. The average age was 63.5 years. The results are listed in Table 1.

In the COST group there were 76 men and 80 women. Re-do tracheostomy accounted for seven cases and emergency tracheostomy accounted for seven cases. The mean duration from intubation to performing tracheostomy was 26.1 days. The mean time required to complete the procedure was 32.6 min. Twelve patients had minor wound infections and one patient had a severe wound infection. After wound care and treatment for systemic infection, all patients' tracheostomy wounds healed. There was no acute and delayed bleeding episode seen in the COST group. 2 weeks after the operation, we changed to a new tracheostomy tube and did not encounter any difficulty in replacement of the tracheostomy tube.

In the FOST group, there were 61 men and 42 women. There was no significant difference in gender distribution between the FOST and COST methods ($P = 0.097$). Re-do tracheostomy was found in five cases and emergency operation in three cases. The mean duration between intubation to performing tracheostomy was 27.3 days, which did not differ from that of the COST group. The average operating time was 6.3 min, which was significantly faster than that for the COST group ($P < 0.001$). Minor infection was observed in five cases and there were no cases of severe wound infection. The incidence of wound infection did not differ from that in the COST group. There was no acute or

Table 1. Summary of clinical data and the results of both groups.

	COST	FOST	*P* value
Case	156	103	
Sex			
M	76	61	0.097
F	80	42	
RDT	7	5	0.891
EMT	7	3	0.52
Intubation to operations (days)	26.1	27.3	0.95
OP time (min)	32.6	6.3	<0.001
Wound healing			
Mild	12	5	0.367
Severe	1	0	0.421
Bleeding			
IOP	0	0	
POP	0	0	

FOST: Fast open surgical tracheostomy, COST: Conventional open surgical tracheostomy, M: Male, F: Female, RDT: Re-do tracheostomy, EMT: Emergency tracheostomy, OP: Operation, IOP: Intraoperative period, POP: Post-operative period

delayed bleeding in the FOST group. However, we did encounter a single case that exhibited in which there was a problem in changing the tracheostomy tube for the first time 2 weeks after the operation. The tube was misplaced in the pre-tracheal space and resulted in a marked subcutaneous emphysema. The problem was immediately identified and corrected.

In the FOST group, there were only two cases converted to COST. Both cases were converted because pre-tracheal soft tissues were very thick and, therefore, we had to enlarge the incision for better inspection and dissection. The two conversion cases were in the first 10 cases when our experience was still limited. Subsequently, there were no conversions in 93 consecutive cases.

The use of anti-platelets and an abnormal INR were not associated with bleeding and infection events in either group.

Discussion

Tracheostomy is still a commonly used procedure in many institutions. The current trend is to use the percutaneous puncture method, which is similar to that in placement of a central venous catheter. The procedure may be performed by physicians, anesthesiologists, and some surgeons. The impression is that this procedure is fast, easy to perform, exhibits better wound healing and can be a bedside procedure [1-4]. The indications are basically the same as with the COST approach.

In most studies, the outcome of the percutaneous puncture method is more favorable, or at least comparable, to COST. However, in some studies, the percutaneous tracheostomy may carry the additional risk of more severe bleeding episodes [5]. Airway maintenance is essential for the safety of the percutaneous puncture tracheostomy. Without sufficient experience of surface anatomy and surgical techniques, the procedure can sometimes be dangerous and may cause life-threatening bleeding [6,7]. A major consideration is the use of blind dissection or dilatation in the course of non-surgical percutaneous tracheostomies [8-10]. An ultrasound-guided method has been proposed to prevent the injury [11]. Although many tools may help to decrease the incidence of lethal bleeding, open surgical techniques are a more promising method. This is the reason why there are still surgeons who still favor surgical tracheostomy.

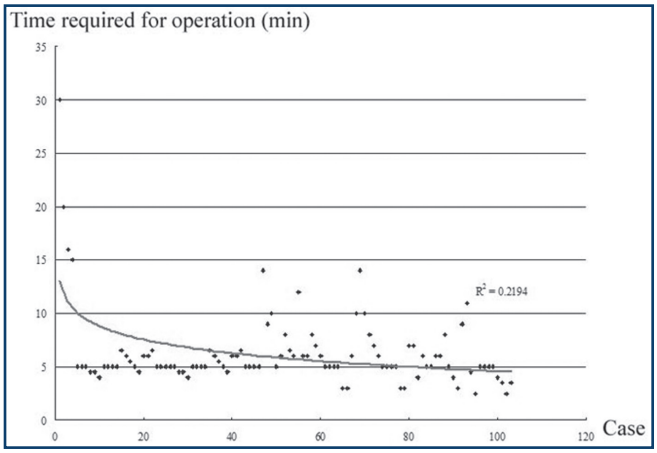

Figure 2. Learning curve for the fast open tracheostomy. In the initial four cases, the time required for the operation took more than 10 min. After that, the time significantly decreased to around 5 min. The learning curve was easier to overcome for surgeons.

In the method we proposed here, a mini-wound for open dissection is used to avoid unnecessary injury to the vital organs or vessels. We used conventional surgical techniques but, with a very small incision. After opening a small tracheal stoma, the next step was to safely place the tube into the trachea. Because it is very cheap and usually available in the bedside, we used a segment of plastic suction tube as a guide-wire to place the tube correctly. Making a tiny incision is easy for any surgeon who has experience performing tracheostomies, but the pitfall here is that the tube is prone to be placed into the pre-tracheal false lumen without any guidance. In the proposed techniques, the procedure is very straightforward and easy to perform. In most circumstances, the whole procedure takes around 5 min and is much faster than that of COST and is even faster than percutaneous tracheostomy. Additional merits are that it does not require a bronchoscope to confirm the anatomy since the dissection is open and the wound is fit to the size of the tracheostomy to be placed. Therefore, the surgical site infection is low. In all cases, there was no bleeding episode encountered during the post-operative period.

The cost of the proposed procedure is lower than that of both COST and percutaneous tracheostomy. Suturing is not required in the FOST and, because it is fast, the turnover rate of the operating table is increased. In some conditions, we can perform the fast open method as a bedside procedure while avoiding the necessity of bronchoscope inspection.

The FOST proposed here did have a learning

curve. Initially, when we attempted the procedure, it took around 30 min. However, after a few consecutive attempts, the time for the operation decreased significantly to 4-6 min. At times, it took only 2.5 min for very simple cases. The learning curve was easy to overcome for surgeons [Figure 2].

The procedure is not intended to replace any mature procedures, such as COST or percutaneous tracheostomy. The FOST, however, can be an alternative choice when surgeons prefer a faster method and do not want to carry out tracheostomy with blind dissection or dilatation.

The limitation of the study is that the number of patients operated with the proposed procedure was small and its feasibility and efficacy should be evaluated in the future.

Conclusion

The FOST may be a plausible alternative procedure for surgeons who want to perform a faster tracheostomy but still need delicate dissection to avoid any uncertainty.

Conflict of interest statement

The authors have no conflicts of interest to declare.

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