Our Experience with Percutaneous Tracheostomy at A Tertiary Care Centre

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ABSTRACT

Introduction: Percutaneous tracheostomy (PCT) has become popular all over the world during the past two decades. Our aim was to record the learning curve, safety and complications of percutaneous tracheostomy, when introduced in a teaching hospital and also compare it with the conventional open procedure. We also analyzed the various parameters which can possibly influence the incidence of complications.

Material and Methods: 36 patients underwent tracheostomy; 12 in open tracheostomy group, 24 in the percutaneous tracheostomy group which further consisted of 12 patients each in Ciaglia and Griggs methods of tracheostomy.

Results: There were 17 (8 major and 9 minor) complications in the percutaneous tracheostomy group and one in the open tracheostomy group. In the percutaneous tracheostomy group, Ciaglia single staged dilatation technique was faster than the Griggs technique. In our study, complications were significantly related to neck girth but not to thyroid notch to suprasternal notch distance, age, sex, place of procedure and technique of procedure.

Conclusion: Percutaneous tracheostomy has a steep learning curve in a teaching institution. However, if continually performed, the percutaneous tracheostomy is a safe and rapid alternative to surgical tracheostomy.

Keywords: Percutaneous tracheostomy, open tracheostomy, neck parameters, complications

INTRODUCTION

Tracheostomy has become the most commonly performed procedure in critically ill patients requiring long term mechanical ventilation.[1,2] The standard operative tracheostomy technique presented by Jackson[3] though time tested, has its own disadvantages in ICU settings. More often than not, it requires shifting of critically ill patients to operation theatre and monitoring by an anaesthetist with related extra cost.

The modern era of percutaneous tracheostomy began in 1985, when Ciaglia introduced a percutaneous tracheostomy procedure that used an easy and straight forward Seldinger technique.[4] Percutaneous tracheostomy meets the demand of an alternative to surgical tracheostomy. Apart from ability to perform the procedure bedside in the hands of an experienced surgeon/ anaesthetist, percutaneous tracheostomy (PCT) is also fast and easy to perform. In many centers PCT is the procedure of choice in critically ill patients.[5] In this study the aim was to record the learning curve, safety and complications of percutaneous tracheostomy in a teaching hospital at tertiary care centre.

MATERIAL AND METHODS

This prospective study was conducted in Department of Otolaryngology and Head and Neck surgery, Kasturba Medical College Hospitals, Mangalore and Government Wenlock Hospital, Mangalore, Karnataka, over a period of 1.5 years between March 2010 and September 2012. Ethical committee clearance was taken from Manipal university ethical committee. Informed consent was taken from patient or 'next of kin.

The study group consisted of 36 patients (27 men and 9 women), selected by inclusion exclusion criteria and consisted of two groups; the percutaneous tracheostomy group and the open tracheostomy group. The percutaneous dilation tracheostomy group was further subdivided into two groups which had

1. Ciaglia single circumferential dilation.
2. Griggs forceps dilation.

There were 12 patients in each group. We included patients referred for tracheostomy from Intensive care unit (ICU) and patients in whom elective tracheostomy was done before major head and neck surgery. We excluded patients in airway emergencies with unprotected airway, patients who required positive end expiratory pressure greater than 20 cm of water, midline neck mass –thyroid, coagulopathy, very obese patients, short or bull neck, non-palpable cricoid cartilage, gross deviation of trachea, infection at or near site of tracheostomy, previous major neck surgery, previous radiation, unstable cervical spine, malignancy at the site of tracheostomy and in children.

All patients were placed on 100% oxygen and received intravenous sedatives and a short acting paralytic agent. All procedures were performed by faculty members of the department. The neck was extended using a roll under the shoulder and a small rubber head ring is placed under the patients head to stabilise it. The patient's neck was painted and draped in a usual sterile fashion. A subcutaneous injection of 2% lignocaine with 1:100,000 epinephrine was given before the skin incision. The thyroid cartilage was located between the forefinger and thumb and the anatomical landmarks were identified and marked. Possible site of insertion is marked between 1st and 2nd tracheal rings or 2nd and 3rd tracheal rings. Endotracheal tube is deflated, tracheal tube is positioned just below the level of vocal cords and the cuff is reinflated to re-establish the seal. The tube was held in position ensuring the

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head and neck are in midline and the airway is maintained. A horizontal incision of 1.5-2.0 cm was made at the chosen site. Blunt dissection was performed after this with artery forceps, keeping in midline to identify anatomical landmarks. The 14G needle and cannula with attached 10ml syringe filled with normal saline is inserted in the midline in a caudal direction to avoid likelihood of guide wire being passed into pharynx. Correct placement of the needle was confirmed by aspiration of air into the syringe. In the subsequent steps, a guidewire, cutaneous dilator tracheal dilator and tracheostomy tube was passed using Seldinger technique. In Griggs method, Griggs dilating forceps was used to dilate the trachea, whereas in Ciaglia method, single curved dilator was used to finally dilate the trachea. The tracheostomy tube was finally guided over the guide wire into the trachea.

Open tracheostomy was performed using standard surgical procedure in operation theatre. Intravenous sedation, paralysis and management of endotracheal tube were performed by anesthetist. Patients positioning and infiltration was done in a fashion similar to PCT. A 4 cm incision was given two fingers above suprasternal notch, midline raphe of strap muscles was divided and the thyroid isthmus was retracted upwards. The trachea was identified, and a horizontal incision was made in interspace between the first, second or third tracheal rings. Under direct visualization the endotracheal tube was withdrawn and tracheostomy tube was placed.

Before the procedure the patient characteristics like indication for tracheostomy, days of intubation, and bleeding parameters of the patient were noted. With the neck extended, the girth of the neck at the level of incision site and distance between thyroid notch to suprasternal notch were noted. Details of procedure like time taken for procedure and complications of procedure were noted. Bleeding during tracheostomy was graded as minimal, moderate and severe.[6] In minimal, there is no bleeding, or bleeding stops by itself on pressure. Moderate bleeding calls for special wound dressing and/or drug. Severe bleeding requires surgical intervention. Hypoxia was defined as an oxygen saturation of less than 90%.[7] The difficulty of procedure was graded using the classification of Fovea and Quintel[6]; no difficulties, some difficulty encountered, and procedure abandoned.

STATISTICAL ANALYSIS

We used the convenience sampling method and data was

Characteristics	Percutaneous tracheostomy		Surgical	
	Ciaglia	Griggs	Combined	
Number of patients	12 (%)	12 (%)	24 (%)	12 (%)
Age				
<50yrs	5 (41.6%)	8 (66.6%)	13 (54.1%)	1 (8.3%)
50-70yrs	5 (41.6%)	1 (8.3%)	6 (25%)	9 (75%)
>70 yrs	2 (16.6%)	3 (25%)	5 (20.8%)	2 (16.6%)
Sex				
Male	9 (75%)	9 (75%)	18 (75%)	9 (75%)
Female	3 (25%)	3 (25%)	6 (25%)	3 (25%)
Days of intubation				
0-5 days	3 (25%)	2 (16.6%)	4 (16.6%)	2 (16.6%)
6-10 days	5 (41.6%)	5 (41.6%)	10 (41.6%)	3 (25%)
11-15days	2 (16.6%)	3 (25%)	5 (20.8%)	0 (0%)
>15 days	2 (16.6%)	2 (16.6%)	4 (16.6%)	0 (0%)
Haemoglobin level				
Normal	11 (91.6%)	9 (75%)	20 (83.3%)	11 (91.6%)
Anaemia	1 (8.3%)	3 (25%)	4 (16.6%)	1 (8.3%)
Platelets				
<50 lakhs	0 (0%)	0 (0%)	0 (0%)	0 (0%)
50-75 lakhs	0 (0%)	0 (0%)	0 (0%)	0 (0%)
>75 lakhs	12 (100%)	12 (100%)	24 (100%)	12 (100%)
PT				
<17	8 (66%)	8 (66%)	16 (66.6%)	11 (91.6%)
>17	4 (33%)	4 (33%)	8 (33.3%)	1 (8.3%)
INR				
>1.5	0 (0%)	0 (0%)	0 (0%)	0 (0%)
<1.5	12 (100%)	12 (100%)	24 (100%)	12 (100%)
GCS				
0-5	3 (25%)	2 (16.6%)	5 (20.8%)	3 (25%)
6-10	8 (66.6%)	10 (83.33%)	18 (75%)	3 (25%)
11-15	0 (0%)	0 (0%)	0 (0%)	6 (50%)
Time taken				
0-10 min	2 (16.6%)	4 (33.3%)	6 (25%)	0 (0%)
11-20 min	8 (66.6%)	4 (33.3%)	12 (75%)	8 (66.6%)
>20 min	2 (16.6%)	4 (33.3%)	6 (25%)	4 (33.3%)

Table-1: Patient Characteristics

Tracheostomy indication	Ciaglia	Griggs	Combined	Open
Prolonged intubation	5 (41.6%)	7 (58.33%)	12 (50%)	2 (16.6%)
Airway protection	5 (41.6%)	2 (16.6%)	7 (29.1%)	4 (33%)
Airway Obstruction	0 (0%)	0 (0%)	0 (0%)	4 (33%)
Pulmonary toilet	2 (16.6%)	3 (25%)	5 (20.8%)	2 (16.6%)

Table-2: Indications for Tracheostomy:

Difficulty	No difficulty	Some Difficulty	Abandoned
Griggs (n=12)	9	1	2
Ciaglia (n=12)	8	3	1

Table-3: Difficulty Between Ciaglia And Griggs Methods:

collected using a semi structured proforma. Various parameters were assessed between open and percutaneous tracheostomy as well as the two groups of percutaneous tracheostomy. Analysis was carried out using SPSS version 17.0 using student t test and $p<0.05$ was considered as significant.

RESULTS

Our study was a prospective study on percutaneous tracheostomy and surgical tracheostomy done either in bedside ICU settings or in operation theatre. 36 patients were included in our study. There were 24 patients in the percutaneous tracheostomy group which was further divided into Ciaglia and Griggs group and 12 patients in the surgical tracheostomy group. Patient characteristics are shown in Table-1.

The most common age group was 61-70 years, youngest patient being 22 years and the oldest being 82 years. Out of the 36 patients there were 9 females and 27 males in our study. The indication for percutaneous tracheostomy in our study was mainly prolonged intubation in ICU patients ranging from 1 day to 21 days (Table-2).

Time taken was measured from the time of skin incision to successful placement of tracheostomy tube. Mean time taken in percutaneous tracheostomy was 14 minutes which was less than open tracheostomy (16.33 minutes), which is statistically insignificant. In the percutaneous tracheostomy group, Ciaglia single staged dilatation technique was faster than Griggs forceps dilatation, though the results were insignificant.

In our study, correlation between difficulty encountered in open and percutaneous tracheostomy was found to be insignificant. Two cases of Griggs method and one case of Ciaglia method were abandoned (Table-3).

Intra-procedural and post-procedural complications were analyzed. There were 17 complications in the percutaneous tracheostomy group and one in open tracheostomy group during the procedure and within a period of 2 weeks after the procedure. The results were not statistically significant (Table-4). We have found no significant difference in complications between Griggs and Ciaglia set used.

In our study we have found highly significant correlation between neck girth and complications. Also correlations between complications and thyroid notch –suprasternal notch distance were found to be insignificant (Table-5 and 6).

Out of the 24 percutaneous tracheostomies, 13 were done in ICU settings and 11 were done in OT settings. All the open tracheostomies were done in OT settings. We have found no significant correlation between complications, when procedures were done in ICU and OT. Moreover complications were not significantly related to age, sex, and place of procedure and technique of procedure (Table-4).

DISCUSSION

Advances in the ability to sustain critically ill patients have increased the need for tracheostomy in ICU patients. Open tracheostomy is time proven from the times of Chevalier Jackson.[3] But it has its own limitations, as it requires shifting of patients to Operation Theatre which may be unsafe for heavily compromised ICU patients. There is also an increased demand on operation theatre time, which is expensive and often in short supply. This has created an interest for less invasive, bed side, safe, rapid, cost effective and simple procedures.[9]

Ciaglia introduced a percutaneous tracheostomy procedure that used easy and straight forward Seldinger technique with progressive dilatation.[4] The potential advantages of this procedure, includes its technical ease, smaller incision and limited soft tissue dissection with fewer wound complications.[10] These advantages including a shorter procedure time and ability to perform the technique as a bed side ICU procedure has resulted in its wide acceptance as an alternative to surgical tracheostomy.

During the past two decades, the numbers of percutaneous tracheostomies has increased considerably with development of other techniques like Griggs forceps technique.[12] The feature of this tracheostomy is the use of a pair of modified Howard -Kelly forceps for blunt dilatation of the pretracheal and intercartilagenous tissue after insertion of the guidewire into the trachea.

'T-dagger' is a new percutaneous tracheostomy kit[12] introduced in India. The shaft of the T-dagger is smoothly curved at an angle of about 30 degree, with an elliptical cross section and accommodating number of oval holes. A 'J' tipped guidewire catheter is passed through a tunnel of the shaft and guide catheter to facilitate the formation of the stoma over it.

Rapitrac paercutaneous tracheostomy technique allows the insertion of a full size 7.0 (ID) or 7.5 (ID) cuffed tracheostomy tube into the trachea.[13] A specially designed percutaneous tracheostomy tool with inbuilt dilator is used to dilate the trachea. The tracheostomy tube is then inserted between the jaws of the dilator with a slight twisting movement.

Studies have compared the complications of the percutaneous technique with the open technique. The complications of the percutaneous technique have been classified into early[9] which include intra-procedural and those which occur within two weeks of the procedure. The late complications occur after 2 weeks of the procedure. Intra procedural complications are paratracheal insertions, loss of airway for more than 20 seconds, accidental decannulations, haemorrhage of more than 250 ml and pneumothorax.[7] Few studies also reported cardiac dysarrythmias.[15]

Complications	Percutaneous (n=24)	Tracheostomy	Combined	Surgical
	Ciaglia(n=12)	Griggs(n=12)	(n=24)	(n=12)
Major				
Paratracheal insertion	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Converted	1 (8.3%)	2 (16.6%)	3 (12.5%)	0 (0%)
Difficulty	3 (25%)	1 (8.3%)	4 (16.6%)	0 (0%)
Loss of airway	0 (0%)	1 (8.3%)	1 (4.2%)	0 (0%)
Minor				
Transient hypoxia	2 (16.6%)	4 (33.3%)	6 (25%)	0 (0%)
Subcutaneous emphysema	1 (8.3%)	1 (8.3%)	2 (8.3%)	1 (8.3%)
Bleeding moderate	0 (0%)	1 (8.3%)	1 (4.2%)	0 (0%)

Table-4: Intra Procedural and Post Procedural Complications of Percutaneous and Surgical Tracheostomy Group:

Type of Tracheostomy	Complication	Mean Neck Girth(cms)	Std deviation	P value
Percutaneous				0.006
Nil	18	38.39	2.452	
Hypoxia	4	33.63	4.151	
Both	2	41.25	1.768	
Surgical				.124
Nil	11	38.35	4.020	
Emphysema	1	45.40		
P=0.006 highly significant				

Table-5: Comparison of Complications Vs Neck Girth in Open and Percutaneous Tracheostomy Group:

Type	Number	Mean(TN-SN) cms	Standard deviation	P value
Percutaneous				
Complications	6	7.800	1.4142	.568
Open				
Complications	1	9.000	1.4275	.835
Not significant				

Table-6: Comparison of Thyroid Notch –Suprasternal Notch (TN-SN) Distance Vs Complications in Open and Percutaneous Tracheostomy Group:

In our study we had 8 major and 9 minor complications in the percutaneous group. In the major complications we had 4 significant difficulties, 3 conversions, and 1 loss of airway in this group. In the patient in whom we had a loss of airway, patient suffered a cardiac arrest. Prompt resuscitation rescued the patient. Paratracheal insertion is one of the major complications in a difficult percutaneous tracheostomy. Paratracheal insertion is because of slippage of metal dilators off the calcified trachea or usage of soft guidewires which leads to kinking and development of false passages. Major haemorrhage of more than 250 ml can be seen in 0-4% of percutaneous tracheostomies as compared to surgical tracheostomies (0-3%).[15] We had one moderate haemorrhage in our series(8.3%). Other than injuries to major vessels, the percutaneous tracheostomy actually has a tamponading effect on small vessels and can also be used advantageously in coagulopathies.[15] Pneumothorax which occurs in 0-3% of cases as compared to 0.5-4% of surgical tracheostomies is due to neck extension and damage to cervical pleura. Cardiac dysrythmias may be because of hypoxia, hypotension or unrelated causes as these tracheostomies are done in very sick patients.[15] Accidental decannulation has been reported in 4% of percutaneous tracheostomies.[9] This complication is less common when compared to surgical tracheostomies because of lesser tissue dissection in PCTs. However if accidental decannulation does happen there may be difficulty in recannulation even at 7-16 days after tracheostomy due to the small size of the wound.[16]

Inability to complete the procedure (1%) may occur at a significantly higher rate than surgical tracheostomy. Failures can be because of learning curve or dilator slippage over the calcified cartilages. Immediate conversion to ST is necessary in these cases. In our study one case in Griggs group in whom we lost the airway procedure was converted to surgical tracheostomy. Another case in the Griggs group had a vasovagal attack during the dilatation and stoma formation. This patient also had to be converted into bedside surgical tracheostomy. One case in Ciaglia group has to be converted because of the inability to successfully dilate the trachea with Ciaglia dilator.

Late complications are related to cosmesis, wound infection and tracheal stenosis. Wound infection is related to tissue dissection. Avoidance of broad dissection and tissue disruption results in lesser chance of development of this complication when compared to ST.[15]

Early studies have revealed significantly more early major complications of PCT as compared to surgical tracheostomy.[17] Later studies[9,18] have revealed that early minor complications such as minor haemorrhage, subcutaneous emphysema are more common in percutaneous group as compared to surgical tracheostomy. Our study also showed more early minor complications in the PCT group as compared to open, though there was no significance. Late complications like wound infection, cosmesis and tracheooesophageal fistula are less

in PCT group (8%) when compared to ST group (13%).[11] When complication rates are compared as a whole (major and minor),there is no difference in intraprocedural complications between the two groups.

Many variables have to be taken into account when complications are compared between percutaneous tracheostomy and surgical tracheostomy. One of them is the place of tracheostomy. All our surgical tracheostomies were done in the Operating room. About half of our PCT's were done bedside. Comparison of complications between tracheostomies done in the ICU or otherwise did not show any difference. Studies[16] have shown that even though the overall complication rate for peri-operative complications were less in bedside tracheostomies than operation room tracheostomies (5% vs. 20%), no significant difference was found in complication rates of percutaneous tracheostomies and surgical tracheostomies done bedside. However there was an increased incidence of postoperative complications in the percutaneous tracheostomy group done bedside when compared to surgical tracheostomy group in this study.[16]

The other variable is type of percutaneous tracheostomy, some techniques of tracheostomy have a higher rate of complications than some others. Cooks Kit (multiple dilator technique) has a lower complication[15] than Rapitrach system. The Rapitrach set of schaffner et al[13] and the guidewire dilator forceps of the Griggs have poor performance record. The insertion of a sharp instrument into the trachea and blind dilatation is not safe surgical technique and may not be reproducible at a successful rate.[15] To date the Ciaglia technique with its avoidance of sharp tracheal instrumentation and gradual dilatation till placement of tracheostomy tube has been considered safer when compared to the other methods. Our small series of patients did not show any significant difference in complication rates between Ciaglia and Griggs methods of tracheostomy.

In our study the surgeons (otolaryngology consultants) of our teaching hospitals were using the percutaneous technique of tracheostomy for the first time in our institute. We had 17 perioperative complications in 24 patients, this would represent the learning curve of PCT in our department. The difference in complications of PCT reported by different groups[16,18,19] have incited researches to look for the learning curve for this procedure. In a study by Douglas D. Massick,[16] the complication incidence for first 100 PCT procedures were analyzed, it was found that out of the 63 perioperative complications, the first 20 had 34 complications. In this cohort there was an increased incidence of post operative complications (major haemorrhage, tube dislodgement and death), though the value did not reach statistical significance. Late complications like tracheal stenosis was higher in the first 50 patients when compared to the next 50.Another significant finding of the study was that suboptimal cervical anatomy contributed to complications independent of operator experience. Our study which includes our institutional experience by different surgeons also demonstrated this steep learning curve.

We had certain limitations to our study. In assessment of learning curve, we could not assess a single surgeon's learning curve since there were multiple surgeons involved. Moreover, the small number of patients decreased the power of our study. Randomization was not done between two study groups. Patients with unfavourable neck anatomy tended to go into the surgical tracheostomy group indicating selector bias. Moreover, we could not study the late complications in our study.

CONCLUSION

In conclusion percutaneous tracheostomy has a steep learning curve in a teaching institution. Our short study of 24 cases has brought out the peri-operative and post-operative complications associated with percutaneous tracheostomy. As it is a partially blind procedure even under bronchoscopic guidance, suboptimal cervical anatomy is a high risk for complications. We conclude that early experience of this procedure should be in operating theatre.

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