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ORIGINAL ARTICLE

Tracheostomy: Open Surgical or Percutaneous? An Effort to Solve the Continued Dilemma

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Abstract Due to lack of globally standardized guidelines and clarity on indications, patient selection, intra-operative preparations, technique, complications, postoperative care and decannulation protocols, percutaneous tracheostomy (PT) has come in vogue as compared to standard open surgical tracheostomy (OST). PercuTwist and guide wire dilatational method (GWDF), techniques of PT, offer lesser operative time and ease of surgery being a bedside procedure. There seems to be paucity of Indian literature on rising trend of increasing indications, post-operative care, management of complications and outcomes of tracheostomy. And thus, there arises a felt need to envisage a study in tertiary care setup targeting these issues and to question the so far unchallenged acceptance of new techniques and technology. Our aim is to study the recent trend of indications, complications, and outcomes of both OST and PT in a cohort of Indian patients who underwent tracheostomy. 80 patients with mean age of 59.0 ± 15 years underwent tracheostomy (OST: 48 (60%), PT: 32 (40%), and among PT, PercuTwist: 16 (50%), GWDF: 16 (50%)) for various indications with objectives to compare operative time, complications and decannulation rates of tracheostomy surgery, within the follow up period of 3 months. Most common indication of elective tracheostomy was prolonged ventilation, and for emergency ones, upper airway obstruction. Mean operative time taken by all the three techniques was comparable, i.e., 16.3 v/s 15 v/s 15.3 min (Open v/s PT GWDF v/s PT PercuTwist). Most common intra-operative complication of OST was haemorrhage (16.3%) and that of PT was false passage (8.8%). Early post-operative complications were haemorrhage (OST: 3.75%, PT: 1.25%) and tube blockage and dislodgement (equal distribution among OST and PT). Late post-operative complications were stomal granulations in PT: 7.5%. Outcomes of tracheostomy were significantly better with OST (36 (45%)) than PT (14 (17.5%)). In PT group, PercuTwist fared better than GWDF in terms of lesser complications (PercuTwist: 10%, GWDF: 18.6%) and better decannulation rates (PercuTwist: 13.6%, GWDF: 3.75%). Most common indication for tracheostomy remains prolonged intubation; complication of OST is intra and early post-operative haemorrhage and that of PT being tube dislodgement and blockage. Outcomes in form of successful decannulation are with OST.

Keywords Emergency tracheostomy · Elective tracheostomy · Open surgical tracheostomy · Percutaneous tracheostomy · PercuTwist · Guide wire dilatational method · Decannulation

Introduction

Tracheostomy is one of the oldest surgical procedures but popularized in the early 1900s by Chevalier Jackson, as mentioned in literature [1]. Open surgical tracheostomy (OST) used to be standard modality of management for elective cases. Although not globally standardized, but few guidelines were available detailing indications, patient selection, per operative preparations, technique, complications, postoperative care and on decannulation. However,

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in the past 20 years, percutaneous tracheostomy (PT) like 'The Guide Wire Dilatational Forceps Method' (GWDF) and 'The PercuTwist Method' has become a popular choice. Advocates for percutaneous techniques cite various advantages like smaller skin incision, less tissue trauma and lower incidence of complications like wound infection and peristomal bleeding. Furthermore, the procedure can be performed at the bedside by health professionals other than Otorhinolaryngologist, reducing risks associated with transfer of patients on mechanical ventilation to operation theatre and releiving operating room resources including time and personnel.

The most common indications for tracheostomy still are prolonged endotracheal intubation, lower airway protection in the comatose patients, upper airway obstruction (UAO) and tracheobronchial toileting [2]. But, with rising rate of detection of Head and Neck Squamous Cell Carcinoma (HNSCC) in South East Asia Region (SEAR) countries, especially India, there is a surge in demand for elective tracheostomies. Due to this, percutaneous tracheostomy (PT) is coming in vogue being a bedside procedure and requiring much less surgical skills. But this procedure does require careful patient selection as there are various incidences experienced by authors as well as recorded in literature where emergency OST had to be performed as rescue procedure due to intraoperative complications of PT [3].

Various complications described during tracheostomy surgery are haemorrhage, false passage, hypotension, air embolism, apnoea, cardiac arrest and even damage to the thyroid and cricoid cartilages, recurrent laryngeal nerve injury, damage to posterior tracheal wall, and due to these complications, requirement of conversion of PT to OST. Postoperative Complications of tracheostomy, performed with either OST or PT, include haemorrhage, surgical emphysema, wound infection, tube displacement, tube blockage, pneumothorax, tracheal stenosis, tracheo-arterial fistula and tracheoesophageal fistula [2, 4].

There seems to be paucity of Indian literature on this recent trend of increasing indications, post-operative care, management of complications and outcomes of tracheostomy. And thus, there arises a felt need to envisage a study in tertiary care setup targeting these issues. This study aims to understand the recent trend of indications, preoperative and postoperative complications, their sequalae and outcomes of both OST and PT in a cohort of Indian patients (who underwent tracheostomy) in view of recently rising trend of elective tracheostomies and so far, unquestioned acceptance of new techniques and technology.

Materials and Methods

After taking approval from the Institutional Ethics Committee, we carried out an observational descriptive study in the Department of ENT of a tertiary care hospital at West Bengal over a period of 22 months from Jan 2017 and Oct 2018, where, 80 patients who underwent tracheostomy, due to various indications, were included and followed up for 3 months postoperatively. Patients younger than 12 years and those who were lost to follow up within next 3 months, due to untimely demise owing to their other comorbidities or due to other reasons were excluded.

Methodology

We conducted this study with objectives in mind to study and compare operative time, complications (during and after tracheostomy as well as during tracheostomy care, both inpatient and domestic) and outcome of tracheostomy surgery, in form of successful decannulation, in surgeries performed with open surgical and Percutaneous techniques, among 80 patients who were included in study as per the inclusion and exclusion criteria. 48 patients underwent OST and PT was performed in remaining 32. Among the patients who underwent PT, 16 underwent PT with Guide wire dilatational forceps method and 16 with PercuTwist method.

Patients were worked up with details of existing comorbidities and tracheostomies were done in the OT and ICU setup. Open surgical tracheostomy was done by the standard Chevalier Jackson method [5], guide wire dilatational method percutaneous tracheostomy was done using the Howard Kelly dilatational Forceps and PercuTwist method percutaneous tracheostomy was done by Rusch self-tapping single screw dilator. All PTs were done with flexible fibre optic bronchoscopic guidance, which was introduced over a catheter mount through the endotracheal tube down to subglottis to have a visual control over the surgery being performed. Mean tracheostomy time, i.e., time taken from skin incision to insertion of tracheostomy tube was calculated in each case. Careful observations of and intra-operative, early (within 48 h) and late (after 48 h) post-operative complications, including those which developed during in-patient and domestic tracheostomy care and, later on, during decannulation, were monitored and recorded in each case, during our follow up period of 3 months.

For statistical analysis, data was entered in Microsoft excel spreadsheet and then analysed by SPSS version 24.0 and Graph Pad Prism version 5. Z-test (Standard Normal Deviate) and Student's t test (unpaired) was used to test the

significant difference of proportions. P value ≤ 0.05 was considered as statistically significant.

Results

A total of 80 patients who were admitted in the wards and ICU, on long term ventilation requiring Tracheostomy were included in the study according to the inclusion and exclusion criteria as mentioned earlier. Various parameters during the tracheostomy as per objectives were noted in order to compare them.

Out of total 80 patients, 12 (15.0%) were females and 68 (85.0%), males. The mean age (mean ± S.D.) of patients was 59.0 ± 15 years with range 22–80 years and 49% of patients were in the age group of 45–65 years.

12 (15.0%) patients were suffering from Carcinoma larynx, 8 (10.0%) from Carcinoma Oral Cavity, 26 (32.5%) survived stroke, 26 (32.5%) patients had respiratory failure due to other co-morbidities and 18 (22.5%) were victims of road traffic accident with multiple injuries. 13 (16.3%) of these patients had to undergo tracheostomy for indication of airway protection, 23 (28.8%) for difficult airway and failed intubation, 37 (46.3%) patients for prolong intubation (suffering from co-morbidities other than stroke) and 7 (8.8%) patients for stridor during presentation (with underlying benign pathologies). GWDF type tracheostomy was performed on 16 (20.0%) patients, PercuTwist on 16 (20.0%) and OST on rest 48 (60.0%).

Mean operative time (Mean ± S.D.) of patients was 16.3 ± 3.7 min with range of 12 - 25 min and the median was 15 min. Mean operative time taken by all the three techniques was comparable, i.e., 16.3 v/s 15 v/s 15.3 min (Open v/s PT GWDF v/s PT PercuTwist).

The intraoperative complications noted were false passage of tracheostomy tube and intraoperative haemorrhage. A total of 60 (76.3%) patients did not suffer from any intraoperative complications. Both techniques combined, we saw 7 (8.8%) patients suffering from false passage and 13 (16.3%) patients having intraoperative haemorrhage. Comparison of OST and PT witnessed Z-Score as 7.6 and overall results, were statistically significant and largely in favour of OST (in terms of no complications and false passage) with P value < 0.05 (Student's unpaired t test). Detailed comparison has been tabulated in Table 1.

Post-operatively, all patients were kept under care of Intensive/Critical Care Unit of our tertiary care centre. Early post-operative complications (within 48 h of surgery) we witnessed were early post-operative haemorrhage, surgical emphysema, tracheostomy tube dislodgment and blockage; and all of these were successfully tackled by ENT and Anaesthesiology team of this hospital. Overall, 4 (5.0%) patients had early post-operative haemorrhage, 4 (5.0%) patients developed surgical emphysema, 4 (5.0%) patients had their tracheostomy tube blocked and 4 (5.0%) patients had them dislodged. 64 (80.0%) patients did not suffer any early postoperative complications. On comparison of OST and PT techniques, the Z-Score came out to be 9.6 and results were overall statistically significant with P value < 0.05 (Student's unpaired t test), in terms of surgical emphysema, total and no complications. Detailed comparison between OST and PT is here as per Table 2.

Among late post-operative complications (after 48 h), which our patients had to suffer, both during inpatient as well as domestic tracheostomy care, we witnessed development of stomal granulations in 8 (10.0%) patients. One (1.35%) patient of Carcinoma oral cavity, who was tracheostomised using OST method and was discharged from hospital 45 days postoperatively, with hope of decent level of domestic tracheostomy care, developed stomal myiasis due to presumed neglect. 67 (83.75%) of our patients suffered no complications. Comparing OST and PT, the results were statically significant with P value < 0.05 and in favour of OST (Student's unpaired t test). Details are as per Table 3.

Finally, when we looked at the crux of the issue, the outcomes of tracheostomy, a significant number of fortunate patients, 50 (62.5%), could achieve successful decannulation. Among the rest 30 (37.5%), decannulation trial failed in 21 (26.25%) patients as they became dependant on tracheostomy, and in 9 (11.25%) patients, we could not initiate decannulation trial due to continuation of their late postoperative complications. On comparison of tracheostomies done with OST and PT, results were significant with P value < 0.05 in favour of OST (Student's unpaired t test). Detailed comparison is as per Table 4.

Subgroup Analysis

Among the 32 (40%) subjects who underwent tracheostomy via PT technique, we performed a subgroup analysis with same study objectives, i.e., to study operative time, intra-operative, early and late postoperative complications, as well as outcomes of tracheostomy, in terms of successful decannulation, between subjects who underwent PT tracheostomy with PercuTwist method (16 patients ∼ 20%) versus GWDF method (16 patients ∼ 20%). Results were in favour of PercuTwist method of percutaneous tracheostomy, in terms of lesser surgical complications as well as better outcomes with statistically significant P value < 0.05 (Student's unpaired t test). Comparative details are as per Table 5.

Table 1 Intra-operative complications in all cases who underwent tracheostomy

Ser no	Intraoperative complications	Open surgical tracheostomy (OST)	Percutaneous tracheostomy (PT)	*P* value*
1	False passage	2	5	< 0.05
2	Haemorrhage	10	3	> 0.05
	Total	12	8	> 0.05
	No complications	36	24	< 0.05

*Student's unpaired t test

Table 2 Early post-operative complications

Ser no	Early post-operative complications	Open surgical tracheostomy (OST)	Percutaneous tracheostomy (PT)	*P* value*
1	Surgical emphysema	0	4	< 0.05
2	Haemorrhage	3	1	> 0.05
3	Tracheostomy tube blockage	2	2	> 0.05
4	Tracheostomy tube dislodgement	2	2	> 0.05
	Total	7	9	< 0.05
	No complications	41	23	< 0.05

*Student's unpaired t test

Table 3 Late post-operative complications

Ser no	Late post-operative complications	Open surgical tracheostomy (OST)	Percutaneous tracheostomy (PT)	*P* value*
1	Stomal granulations	2	6	< 0.05
2	Stomal myiasis	1	0	> 0.05
	Total	7	6	< 0.05
	No complications	41	26	< 0.05

*Student's unpaired t test

Table 4 Outcomes of tracheostomy

Ser no	Tracheostomy outcomes	Open surgical tracheostomy (OST)	Percutaneous tracheostomy (PT)	*P* value*
1	Decannulation failure	9	12	< 0.05
2	Decannulation trial could not be initiated	3	6	
3	Total	12	18	< 0.05
	Decannulation success	36	14	< 0.05

*Student's unpaired t test

Discussion

Standard tracheostomy using an open surgical approach, usually performed by ENT surgeons has been contested by Anaesthesiologists with the percutaneous tracheostomy technique for many decades. Percutaneous techniques have been advocated and are emerging as a common method of securing definitive airways in patients on mechanical ventilation, with advantages including smaller skin incision, less tissue trauma, and lower incidence of wound infection and peristomal bleeding but also with more intra-operative complications, notably, false passage [3]. However open surgical tracheostomy is still preferred in midline neck masses, coagulation abnormality (better haemostasis control), patients requiring high level of respiratory support ($FiO2 > 70\%$ and $PEEP > 10$), cases of cervical spine injuries (lack of provision of neck extension during surgery), obesity ($BMI > 30\ kg/m^2$, due to very short neck and surgical landmarks) and paediatric patients [6]. Multiple metanalyses, review of literatures and independent studies have compared the open surgical and percutaneous tracheotomy techniques; however, there is still no consensus at this time, or guidelines, for suggestion of the optimal approach in terms of minimizing intra and post-operative tracheostomy complications and for overall betterment of our clientele [4, 7].

Emergency tracheostomies were done in fair numbers in past on patients suffering from head and neck malignancies and presenting with stridor. With rising awareness and better diagnostic modalities, this trend is slowly shifting towards purposeful elective tracheostomies in such cases. Similar trend was seen in our study where 20 (25%) of our subjects were suffering from HNSCC and only 7 out of these underwent emergency tracheostomy.

Most common indication for tracheostomy in our study was prolonged intubation (46.3%), followed by failed intubations in cases of difficult airway (28.8%). Prolonged intubation (> 7 days) remains most common indication of elective tracheostomy as per existing literature and clinical consensus guidelines [8, 9]. Among the cases of HNSCC, most common malignancy leading to upper airway obstruction (UAO), landing up with stridor and requiring emergency tracheostomy was Carcinoma Larynx. This

Table 5 Subgroup analysis of complications and outcomes of tracheostomy among patients who underwent percutaneous tracheostomy with PercuTwist method versus GWDF method

Ser no	Complications of percutaneous tracheostomy	PercuTwist method	GWDF method	*P* value*
1	*Intra-operative complications*			
1a	False passage	2	3	< 0.05
1b	Haemorrhage	1	2	< 0.05
	Total	3	5	< 0.05
	No complications	9	7	< 0.05
2	*Early post-operative complications*			
2a	Surgical emphysema	0	1	< 0.05
2b	Haemorrhage	1	1	> 0.05
2c	Tracheostomy tube blockage	1	2	< 0.05
2d	Tracheostomy tube dislodgement	1	2	< 0.05
	Total	3	6	< 0.05
	No complications	13	10	< 0.05
3	*Late post-operative complications*			
3a	Stomal granulations	2	4	< 0.05
3b	Stomal myiasis	0	0	> 0.05
	Total	2	4	< 0.05
	No complications	14	12	< 0.05
4	*Outcomes of tracheostomy*			
4a	Decannulation failure	4	8	< 0.05
4b	Decannulation could not be initiated due to late post-operative complications	1	5	< 0.05
	Total	5	13	< 0.05
	Decannulation success	11	3	< 0.05

*Student's unpaired t test

finding is similar to various studies, and, in fact, is quite common presentation in glottic carcinomas [2].

In our study, mean operative time of OST was slightly higher than both techniques of PT, however, the results were comparable and statistically not significant. These results matches with a randomized controlled trial with 1 year of follow up period, where it was found that mean operative time of OST was 22 min and that of PT was 17 min [10]. However, mean operative time depends on the case as well as on surgeon's expertise.

In a landmark meta-analysis, studying literature published over 36 years, done way back in 1996, it was deduced that open surgical tracheostomy lead of more post-operative complications and percutaneous tracheostomy is associated with higher level of intra-operative complications and thus, greater mortality rates [4]. This study compared OST (21 studies, 3512 patients) and PT (27 studies, 1817 patients) and demonstrated that intra-operative complications, notably among else, false passage of tube, were more frequent with percutaneous tracheostomy, which is comparable with our study. Among other intra-operative complication, haemorrhage, which this meta-analysis deduced as more frequent with PT (being a blind procedure then), was not witnessed in our study. This can be explained by stricter patient selection and endoscopic/ultrasound guided PT technique developed over decades, by our Anaesthesiologist colleagues.

Comparing two PT techniques, the PercuTwist and Guide-wire dilatational forceps methods, mean operative time taken was comparable with statistically insignificant results. Mixed opinions, on this issue, were found on literature search. PercuTwist PT was found to take slightly more time than GWDF PT, in a few studies, including a randomised controlled trial [11–13]. On analysis of complications, PercuTwist PT was found to result in lesser intra, early and late complications, as well as gave better outcomes in terms of successful decannulation, as our subgroup analysis suggested. Again, the opinions have found out to be divided with studies supporting PercuTwist [12] and few, in favour of GWDF [13]. It is reiterated, again, that operative time and procedural complications are completely dependent upon patient selection, surgical expertise and intuitional presence.

In this study, spanning over 22 months, we saw 50 (62.5%) being decannulated, similar to, or even better than results achieved and published by tertiary care centres worldwide dealing with tracheostomised patients with a dedicated team [14, 15]. OST technique was seen with

better tracheostomy outcomes, in form of decannulation rates, results, which are well supported by various studies as per a meta-analysis [16]. Reasons being, as proven by these studies, are establishment of well-defined insertion tract, ability to design a Bjork flap, facilitating early and effective tracheostomy tube changes, which further prevents tube blockage and ability to insert a double lumen tracheostomy tube leading to better nursing care [16].

Conclusions

Debate continues over most common and recent changes in indications for tracheostomy, various techniques and its' relatively common complications. With results of our study and review of existing literature, we can conclude that:

1. Most common indications for elective tracheostomy are prolonged endotracheal intubation due to need for continuation of mechanical ventilation, and for emergency tracheostomies, upper airway obstruction (UAO) secondary to glottic malignancies.
2. Open surgical tracheostomy takes longer time and the Otorhinolaryngologist must be vary about intra-operative hemorrhage. However, this technique does result in lesser amount of early and late post-operative complications.
3. Percutaneous tracheostomy, essentially being an intuitive procedure, regardless of technique and despite of endoscopic or ultrasonographic guidance, results in more incidences of false passage intra-operatively. The Anesthesiologist/Intensivist must look out for surgical emphysema, post-operative hemorrhage, tube blockage (due to mucous plug or blood clot) and tube dislodgement within 48 h of tracheostomy, and stomal granulation after that.
4. Conflicting conclusions have been derived for PercuTwist method of PT being associated with lesser incidences of intra, early and late post-operative complications, although it does take slightly longer time. But it has been felt that diligent patient selection and operator's expertise are vital to limit operative time and complications.
5. Outcomes of tracheostomy, in terms of decannulation rates, has been found to be better with traditional open surgical method as it facilitates early and easy tube changes and better tracheostomy care.

Limitations

This study lacks strength in terms of being a observational descriptive study, smaller sample size and unequivocal distribution of subjects among two groups.

Compliance with Ethical Standards

Conflict of interest All authors declare that they have no conflict of interests.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Written informed consent was obtained from all individual participants included in the study.

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