ORIGINAL ARTICLE

Safety and Feasibility of Very Early Bronchoscopy-assisted Percutaneous Dilatational Tracheostomy in Anterior Cervical Spine Fixation Patients

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Abstract

Background: Anterior cervical spine fixation (ACSF) is a common mode of stabilization of cervical spine injuries. These patients usually need a prolonged mechanical ventilation, so an early tracheostomy is beneficial for them. However, it is often delayed due to the close proximity to the surgical site, due to the concerns of infection, and increased bleeding. Percutaneous dilatational tracheostomy (PDT) is also considered a relative contraindication due to the inability to achieve adequate neck extension.

Objectives: The objectives of our study are to assess the:

- Feasibility of performing a very early percutaneous dilatational tracheostomy in cervical spine injury patients, post-anterior cervical spine fixation.
- Safety in doing so with regard to surgical-site infection, early, and late complications.
- Benefits with regard to outcome measures like ventilator days and length of stay (LOS) in the intensive care unit (ICU) and hospital.

Materials and methods: We performed a retrospective review of all patients who underwent anterior cervical spine fixation and bedside percutaneous dilatational tracheostomy in our ICU from 1st January 2015 to 31st March 2021.

Results: Out of the 269 patients admitted to our ICU with cervical spine pathology, 84 were included in the study. About 40.4% patients had injury above C5 level (*n*-34) and 59.5% had below C5 level. About 86.9% patients had ASIA-A neurology. In our study, percutaneous tracheostomy was done at an average of 2.8 days from the cervical spine fixation. Average length of ventilator days post-tracheostomy was 8.32 days, ICU stay was 10.5 days, and hospital stay was 28.6 days. One patient developed anterior surgical-site infection.

Conclusion: We conclude from our study that a very early percutaneous dilatational tracheostomy can be done in post-anterior cervical spine fixation patients as early as within 3 days without significant complications.

Keywords: Cervical spine fixation, Complications, Feasibility, Percutaneous tracheostomy.

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Highlights

Our study has shown the feasibility of performing a very early percutaneous tracheostomy, as early as 3 days, in patients with anterior cervical spine fixation. Use of real-time bronchoscopy can circumvent the limitation of the inability to give neck extension. Surgical-site infection, which is the main concern, is very minimal. Ventilator days and intensive care stay can be significantly reduced.

Introduction

Traumatic cervical spine injuries often lead to diaphragmatic and respiratory muscle paralysis along with tetraplegia, especially with injuries above the level of C5. This, in turn, leads to impaired ability to clear secretions, inadequate pulmonary ventilation, and worsening pulmonary vital capacity.[1,2] Early stabilization in the form of anterior cervical spine fixation (ACSF) is the standard procedure in these cases, though a posterior and combined approach can be performed in select situations.[3] Early spinal stabilization reduces pulmonary complications and facilitates quicker mobilization.[4] Due to inadequate respiratory effort, prolonged mechanical ventilation and ICU stay is generally expected. Early tracheostomy in these patients would assist in improving patient comfort, reduce sedative requirements, as well as shorten the duration of weaning and ICU stay.[5,6] It also eases nursing care, facilitates tracheobronchial clearance, and allows speech and oral nutrition.

The commonest procedure done to stabilize the injured cervical spine is ACSF. This involves a surgical incision adjacent to the trachea. Proximity of the tracheostomy site to the surgical

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incision bears the risk of cross-contamination. Hence, while performing tracheostomy, an approach involving minimal incision without risk of communication to the ACSF incision is mandatory. Percutaneous dilatational tracheostomy (PDT) is an ideal option in such instances. Percutaneous dilatational tracheostomy possesses the advantage of limited tissue handling and dissection, which is preferred in patients with ACSF. However, due to limited neck extension possible in patients post-ACSF conventional PDT is considered a relative contraindication.

Though there are few studies extolling the virtue of early tracheostomy in cervical injury patients, hardly a few studies have advocated the use of PDT in such instances. Early PDT (within 5 days) in such patients can be a challenging procedure due to technical difficulties like restricted access to trachea and handling of inflamed hypermic tissue post surgery along with potential concern of increased risk of surgical-site infection (SSI).[7] Tracheostomy is thus often delayed, usually beyond 6 days, once soft-tissue inflammation resolves.[8]

We aim to assess the feasibility of performing a very early percutaneous dilatational tracheostomy in patients post-ACSF. We hypothesize that utilizing real-time assistance under fiber-optic videobronscope guidance, PDT can be performed circumventing the concern of neck extension. We also aim to assess the safety in doing such an intervention with regard to SSI, early and late complications, and also the benefits by analyzing the outcome measures.

Materials and Methods

This study was conducted at Ganga Hospital, Coimbatore, India, from 1st January 2015 to 31st March 2021, after the approval of the Institutional Review Board. Our institute is a trauma center with an affiliated rehabilitation facility. A retrospective review of prospectively collected data was performed. Patients underwent ACSF for a variety of reasons, including traumatic spinal cord injury (SCI) and degenerative disc diseases. All patients who underwent cervical spine fixation by anterior or combined anterior and posterior approach in whom bronchoscopy-guided percutaneous tracheostomy was performed were included in the study. Patients who were given a trial of extubation, whose records were incomplete, and who expired or were lost to follow-up 3 months postoperatively were excluded from the study. The timing of tracheostomy was determined by the multidisciplinary critical care team.

Technique of PDT

All patients underwent bedside fiber-optic video-bronchoscopy-assisted PDT in the ICU under aseptic conditions. The procedure was done under sedation and paralysis using fentanyl 2 µg/kg, propofol 1–2 mg/kg, and vecuronium 0.1 mg/kg. The technique proposed by Ciaglia et al. was used. The patient was positioned supine without hyperextension of the neck. All procedures were performed by the same team of maxillofacial surgeon and senior intensivist. During the procedure, the patient was monitored for vital parameters and adverse events. A record of the immediate complications, including major and minor bleeding, desaturation, bradycardia, tracheal cartilage fracture, posterior-wall injury, pneumothorax, surgical emphysema, or paratracheal placement was made. Duration of the procedure from needle insertion to tracheostomy tube insertion was also noted.

Outcome Measures

The data collected include patient demographics (age and sex), mode of injury, other associated injuries, level of cervical injury and ASIA classification, timing of tracheostomy, duration of mechanical ventilation, LOS in the ICU, and LOS in hospital. Early and late complications were recorded. Local and systemic complications were also recorded. Patients were followed up till the time of discharge or 90 days post-ACSF, whichever was later. Post-discharge follow-up was done at 4 weeks, 8 weeks, and 3 months in OPD clinics. The presence of superficial and deep SSI was determined by CDC criteria, and relevant CT scans and wound swabs were taken in suspected patients.

Results

During the study period, 269 patients were admitted to our ICU with cervical spine pathology (traumatic and nontraumatic). The total number of patients included in the study was 84 (Flowchart 1). Patients who expired during hospital stay, lost in

Flowchart 1: Patient selection

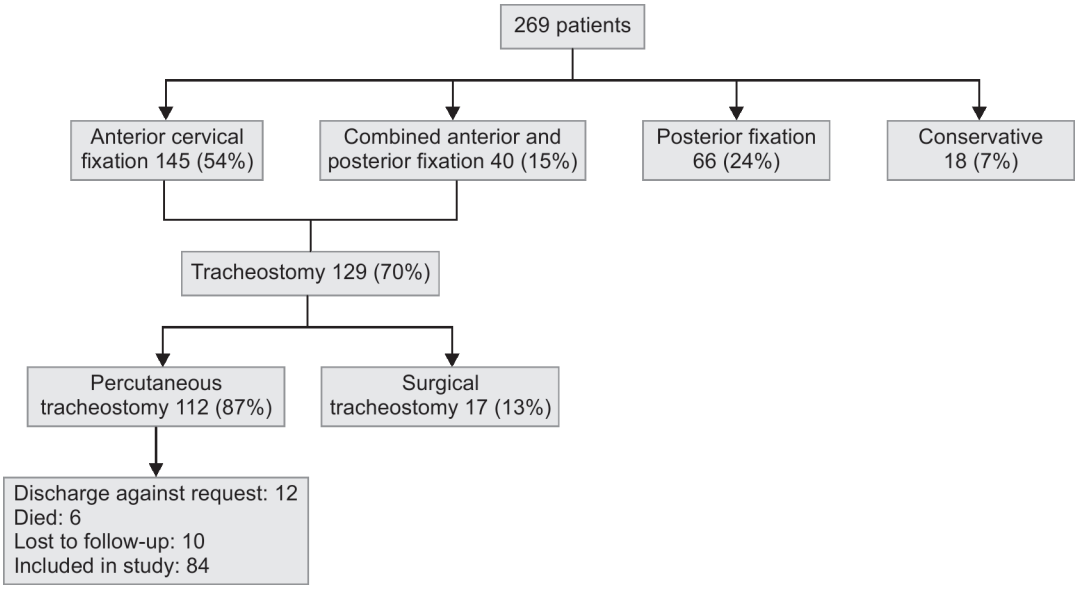

Table 1: Level of spinal cord injury

C2–C3	1 (1.1)
C3–C4	8 (9.5)
C4–C5	25 (29.7)
C5–C6	34 (40.4)
C6–C7	16 (19.0)

Values are presented as number of cases (percentage)

Table 2: Patient demographics

Age (range) (years)	(15–77), 41.24
Male (%)	95.23%
Mode of injury	
RTA	46.4%
Fall	48.8%
Others	4.76%
Level of injury	
Above C5	40.48%
Below C5	59.52%
Associated injuries	
Head	14.28%
Chest	2.38%
Others	16.66%
None	66.66%
Type of fixation	
Anterior	85.71%
Anterior plus posterior	14.28%
ASIA classification	
A	86.9%
B	10.7%
C	2.38%

follow-up, and who got discharged against medical advice were excluded from the study.

Of these patients, 95.2% (*n*-80) were male and 4.7% (*n*-4) female. Their ages ranged from 15 to 77 years, and the mean age was 41.2 years. The common modes of injuries were road traffic accidents (46.4%) and fall from height (48.8%). The other etiologies included fall of heavy object and nontraumatic mechanism (4.76%). The levels of SCI are mentioned in Table 1. About 40.48% had injury above C5 (*n*-34) and 59.52% had below C5 (*n*-50).

Those who suffered SCI were grouped according to the severity of the underlying neurologic injuries based on the ASIA classification system as follows: ASIA A (86.9%), B (10.7%), and C (2.38%). Patient demographics are mentioned in Table 2.

Percutaneous tracheostomy was done at an average of 2.8 days from the cervical spine fixation, ranging from 0 to 9 days. The distribution of tracheostomy days post-ACSF is demonstrated in Figure 1.

Average length of ventilator days post-tracheostomy was 8.32 days (ranging from 1 to 24 days). The LOS in the ICU varied from 3 to 26 days, with an average of 10.5 days. Total hospital stay duration varied from 10 to 90 days, with an average of 28.6 days.

At discharge, only 15 (17.85%) patients were decannulated. The rest of them were sent with a tracheostomy tube or fenestrated tube (Table 3).

The average timing for tracheostomy was 8.70 minutes. Hyperemia with increased bleeding was observed in four patients, which was managed with local pressure or ligating the vessel. Bradycardia requiring the use of atropine was seen in seven

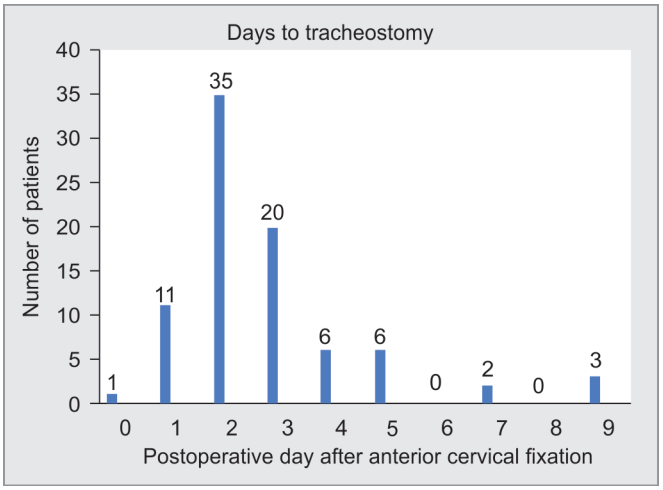

Fig. 1: Distribution of the number of patients for each postoperative day, tracheostomy was performed after ACSF

Table 3: Airway at discharge

Tracheostomy tube	21 (25%)
Fenestrated tube	48 (57.1%)
Decannulated	15 (17.8%)

Values presented as number (percentage)

Table 4: Complications

Bleeding (not amounting to transfusion)	4 (0.04%)
Bradycardia	7 (0.08%)
Desaturation	8 (0.09%)
Surgical-site infection	1 (0.01%)

Values presented as numbers (percentage)

patients. Desaturation during the procedure (SpO_2 less than 85%) was observed in eight patients, and the lowest recorded saturation was 74%. It was treated with positive-pressure ventilation, and no patient had any cardiac compromise (Table 4).

One patient developed superficial SSI at anterior site and two developed SSI at the site of posterior fixation. Wound swab culture for the anterior was negative, and the patient was treated with empirical antibiotics. In all these cases, tracheostomy was done within 4 days of spine fixation. None of the patients developed deep SSI.

No patient had accidental decannulation while performing the PDT. None of the procedures had to be aborted because of any unforeseen events or complications. No patient had any cardiopulmonary complications during the procedure or any life-threatening complications from the PDT.

Discussion

Patients who sustain cervical spine injuries are expected to have prolonged mechanical ventilation due to poor respiratory effort from diaphragmatic and chest wall paralysis, inability to clear tracheobronchial secretions,resulting in atelectasis and subsequent infection. Approximately 20% of patients with cervical spinal cord injuries will require tracheostomy.[9] The timing of tracheostomy in such patients is not specifically defined. One of

Table 5: Review of literature of tracheostomy in anterior cervical spine fixation

References	*Year*	*No. of patient*	*Type of tracheostomy*	*Mean timing of tracheostomy post-ACSF (days)*	*Mean ICU LOS (days)*	*Mean hospital LOS (days)*
Chen et al.	2018	98	PDT-78.6% OPEN-18.4%	6.8	20	31
Kaczmarek et al.	2016	51	PDT-all	6		110
Dusterwald et al.	2015	72	PDT-17 OPEN-52			
Binder et al.	2015	38	OPEN-All	15	39.3	48.78
Babu et al.	2012	20	PDT-4 OPEN-16	6.9		39
Romero-Ganuza et al.	2011	28	PDT-All	8.3	33.83	
Berney et al.	2008	71	PDT-3 OPEN-68	4		
O'Keeffe et al.	2004	17	PDT-12 OPEN-5	8.8		
Our study	2021	84	PDT-All	2.8	10.5	28.6

the issues delaying tracheostomy has been the anterior surgical approach to stabilize the spine. Open tracheostomy in such cases may communicate, causing contamination of the surgical site and hence get delayed to obviate such risks. This delay necessitates prolonged airway support and ventilation in some patients. Performing an early tracheostomy in these patients is beneficial with regards to fewer days of sedation, reduced duration of mechanical ventilation, and reduced ICU and hospital LOS, thereby reducing cost of treatment.[1,10–12] However, performing tracheostomy in a patient who recently has undergone anterior cervical spine fixation is difficult. Concerns are regarding the feasibility of the procedure due to close proximity to the surgical site, inability to extend the neck for access, the timing of procedure, and complications associated with it especially surgical site infection, wound dehiscence, bleeding, granuloma, etc.

There is significant variation in the definition of an "early" tracheostomy. In a systematic review of 12 RCTS, a wide range of 2–10 days has been used as the "early" cutoff and 6–28 days as the late cutoff.[13]

Chen et al., in their retrospective analysis of 98 patients, categorized those who underwent tracheostomy within 4 days of ACSF as the early group. In total, 39 patients underwent early tracheostomy with an average of 2.4 days, and the rest in the late group underwent PDT with an average of 9.7 days.[14] In the study by Kaczmarek et al., early was defined as PDT performed within 30 days.[10] Tracheostomy was done at a mean time of 6 days post-ACSF (all underwent PDT).[10] The study by Dusterwald et al. showed a bimodal distribution in the timing of tracheostomy with the first peak on the day of surgery owing to the practical advantage of performing both the surgeries together and the second peak about a week later. About 72% were open tracheostomy.[15] Most of the studies in the literature showed an average delay of 3.8–15 days post-ACSF.[3,4,8,16,17]

In our study, tracheostomy was done at an average delay of 2.8 days ranging from 0 to 9 days. All 84 patients included in the study underwent percutaneous tracheostomy under bronchoscopic guidance. All procedures were performed bedside in the ICU. The neck was kept in neutral position without any extension. Tracheal deviation was observed in majority of the patients, however, the presence of real-time guidance with bronchoscope eased the procedure. Majority of the patients in our study underwent PDT at days 2 and 3 post-ACSF, showing the early feasibility of this procedure, despite the close proximity to surgical site and presence of tissue edema. Percutaneous dilatational tracheostomy helps in placing the entry incision away from the ACSF site and also minimal tissue dissection, thus minimizing communication and contamination of the surgical area.

The advantage of performing an early tracheostomy was assessed by the LOS in the ICU and hospital. Patients included in our study were discharged from the ICU on an average of 10.5 days, which was less compared with other studies in the literature (Table 5).

Tracheostomy is an invasive procedure with immediate risks like bleeding, both major and minor, hypoxia, tracheal cartilage fracture, surgical emphysema, posterior tracheal wall injury, paratracheal placement, pneumothorax, etc.[7,18] There is lack of long-term follow-up studies showing the incidence of these complications.[18,19] Romero-Ganuza et al. in their study on complications of tracheostomy post-ACSF observed 10.7% of patients having complications including minor bleeding, stoma cellulitis, but no SSI.[16] The authors have noticed perioperative complications like stomal cellulitis, minor bleeding, tracheoesophageal fistula, mediastinal abscess, and late tracheal stenosis.[1] Complications were higher in the delayed tracheostomy group.[1] Tracheal stenosis was also high in late group.

In our study, 4 patients had bleeding more than 30 ml. Bradycardia requiring the use of atropine was seen in 7 patients. Desaturation during the procedure (SpO_2 less than 85%) was observed in 8 patients, and the lowest-recorded saturation was 74%.

Another major concern of performing a tracheostomy in post-ACDF patient is the risk of SSI. The infection rate of anterior spinal surgery is reported to be less than 1% compared to 0–18% for posterior approach.[20] Blam et al. reported 14% incidence of wound infection with posterior stabilization,[21] while Berney et al. reported a 40% likelihood of developing SSI in the posterior site.[4] Surgical site infection in post-tracheostomy patients also showed a similar pattern in literature. Chen et al. had 5/98 cases of SSI in their late-tracheostomy group, four of which involved the PCF. Kaczmarek et al. had 2/51 patients developing SSI at the posterior site, but none of the anterior site.

Majority of the SSIs in tracheostomized patients are reported in open technique.[10] Complications unrelated to surgical site were also noted more with open tracheostomy than percutaneous.[15,22] Berney et al. also had a similar finding. One SSI could be definitely linked to the tracheostoma by identifying the same bacteria from both the sites.[4] Binder et al. had 2/38 patients who developed anterior cervical site infection that were treated with antibiotics. Open tracheostomy was performed in them.

We also had 2 patients developing infection at the posterior site and 1 at the anterior site in comparison with the literature.

About 87% of patients admitted to our ICU post-ACSF underwent PDT. It is a better choice than open tracheostomy with the benefits of limited dissection with less tissue damage, reduced wound infection, decreased risk of bleeding, and reduced time and cost.[23]

About 82.14% of patients in our study were discharged on either tracheostomy or fenestrated tube.

This study adds to the evidence of the safety and benefits of a very early tracheostomy in post-ACSF patients.

Limitations

Our study is still limited by the sample size and retrospective design. It is a single-center study without a comparator group. So, it is inadequately powered to assess the risk of infection. This review includes patients with and without spinal cord injuries, which may be a confounder.

Conclusion

We conclude that percutaneous tracheostomy as early as within 3 days can be performed in patients post-ACSF without significant immediate or late risks including SSI.

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