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Original Article

The level of discomfort during the use of different circuits of the mechanical ventilator

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Abstract

Objectives: Endotracheal tube (ETT) intubation is a life-saving procedure in patients with respiratory failure. However, the presence of an ETT can cause significant discomfort. A tracheostomy tube is used to administer a mechanical ventilator, resulting in a more stable airway and fewer serious injuries. Noninvasive ventilators (NIPPVs) administer ventilation through masks and must be tightly fixed to the face. ETT, tracheostomy, and NIPPV are the most common methods of ventilator maintenance. However, these interventions often cause discomfort to patients. This study aimed to compare discomfort associated with ETT, tracheostomy, and NIPPV. **Materials and Methods:** Forty-nine conscious patients with postextubation NIPPV and eight conscious patients who underwent postextubation tracheotomy were evaluated for discomfort. A questionnaire survey on discomfort was performed before and after NIPPV or tracheostomy. These patients reported their level of discomfort on a visual analog scale. **Results:** The levels of sore throat, nasal pain, body pain, activity limitation, respiratory discomfort, oral discomfort, difficulty coughing sputum, worry about respiratory tube disconnection, back pain, anxiety, worry about long-term admission, sleep disturbance, and general discomfort during ETT intubation were higher than during tracheostomy or NIPPV (all $P < 0.05$). The mean level of discomfort was approximately 5–6 points (moderate) in patients with ETT and 2–3 points (mild) in patients with NIPPV or tracheostomy. **Conclusion:** The level of discomfort was higher in patients who underwent ETT intubation than in those who underwent NIPPV or tracheostomy. However, the level of discomfort was similar between the patients with NIPPV and those who underwent tracheostomy.

Keywords: *Endotracheal tube, Noninvasive positive pressure ventilator, Respiratory failure, Tracheostomy*

Introduction

Endotracheal tube (ETT) intubation is a life-saving procedure for patients with respiratory failure [1]. However, the presence of an ETT causes significant stress and discomfort. Clinical care for patients during ETT intubation often focuses on the ETT and ventilator tubing stability but does not focus on reducing the discomfort of ETT intubation [1]. These patients often require sedation or analgesia, allowing them to use a mechanical ventilator (MV). However, sedation and analgesia often lead to complications [1].

A tracheostomy tube is used to administer a positive pressure ventilator and to provide access by airway clearance [2]. The advantages of tracheostomy include a more stable airway and fewer serious injuries [2]. A tracheostomy is often performed in patients with long-term mechanical ventilation to decrease complications and morbidity [2].

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Non-invasive positive pressure ventilation (NIPPV) is used to administer positive pressure ventilation through a mask, without the need for ETT intubation or tracheostomy. NIPPV has been recommended for the treatment of respiratory failure from multiple etiologies such as chronic lung diseases, neuromuscular diseases, congestive heart failure, and other diseases with respiratory insufficiency. It has been proven to be more effective in preventing intubation than standard oxygen therapy [3]. NIPPV is commonly used in both acute and chronic respiratory failure, and is, therefore, increasingly used to treat respiratory

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failure in emergency rooms, intensive care units (ICUs), or special respiratory units [3].

Patients with respiratory failure occasionally require prolonged mechanical ventilation to maintain positive ventilation. ETT, tracheostomy, and NIPPV are the most common methods used to maintain a positive ventilator for these patients. However, these interventions often cause discomfort to patients. Therefore, it is important to assess the discomfort caused by these interventions. Although there have been some previous studies on the discomfort caused by ETT, tracheostomy, and NIPPV, to our knowledge, no study has compared the discomfort from these interventions in the same patients. Therefore, the purpose of this study was to compare discomfort from ETT, tracheostomy, and NIPPV in patients with respiratory failure.

Materials and methods

Study programs

All patients admitted to the respiratory care center (RCC) between January 2022 and December 2022 were evaluated for this analysis. The RCC was established as a policy for caring for patients with respiratory failure who were difficult to wean and required prolonged MV for more than 3 weeks but were hemodynamically stable. Patients were eligible for RCC if they met the following criteria: maintained MV for >3 weeks due to respiratory failure, hemodynamically stable, not infused with vasoactive drugs, and without unstable hepatic or renal failure. This study was conducted in accordance with the Declaration of Helsinki and was approved by the Research Ethics Committee of the institution, and informed consent was obtained from all participants. This study was approved by the Ethics Committee of Taipei Tzu Chi Hospital (12-X-014).

Variables recorded

The following variables were recorded for the study patients: demographics, underlying diseases, serum albumin, complete blood count, renal function (blood urea nitrogen and creatinine), liver function (alanine aminotransferase), and arterial blood gas data. Previous histories of pulmonary diseases, neurologic disease (neuromuscular disease, cerebrovascular accident, and intracranial hemorrhage), cardiac diseases, liver cirrhosis, and renal dysfunction were recorded.

Study program

Participants in this study were recruited from the RCC between January 2022 and December 2022. In total, there were 150 patients admitted to the RCC during this period. The inclusion criteria were patients with respiratory failure who had clear consciousness and were available for the questionnaire assessment. These conscious patients were initially intubated with an ETT, followed by tracheostomy or NIPPV. The exclusion criteria were patients' refusal, uncooperative patients, hemodynamic instability, and disturbed consciousness level. Figure 1 shows a flowchart of the case selection process. Of these patients admitted to the RCC, 109 were conscious and able to communicate with the medical staff. Eighty-seven cases were extubated after respiratory training. However, 49 patients experienced postextubation respiratory distress that required NIPPV. Oronasal masks were used in all patients using NIPPV. Twenty-two patients had ventilator dependence, and eight patients underwent tracheostomy.

The questionnaire was administered before and 3 days after tracheostomy. Administration of the questionnaire 3 days after was to exclude the influence of acute tracheostomy wound-related discomfort. For patients who underwent postextubation NIPPV, the questionnaire was administered before extubation and 3 days after NIPPV. As shown in Table 1, the questionnaire contained questions about sore throat, nasal pain, body pain, activity limitation, respiratory discomfort, oral discomfort, difficulty coughing sputum, respiratory tube disconnection, back pain, anxiety, worry about long-term admission, poor sleep, and general discomfort. The patients reported their level of discomfort on a nurse-asked Visual Analog Scale (VAS). A score of 0 indicates no discomfort, 1–4 indicates mild discomfort, 5–6 indicates moderate discomfort, and 7–10 indicates severe discomfort [4].

Statistical analysis

Continuous data are expressed as mean and standard deviation, while categorical data are expressed as frequencies and percentages. A paired *t*-test was used to analyze the discomfort between ETT and tracheostomy or between ETT and NIPPV. An unpaired *t*-test was used to analyze the difference in discomfort between tracheostomy and NIPPV. Chi-square tests were conducted to investigate the categorical outcomes. Statistical analyses were conducted using GraphPad Prism 9 (version 9.2.0; GraphPad Software, San Diego, CA, USA). $P < 0.05$ was considered statistically significant.

Table 1: Questionnaire of discomfort during intubation/ tracheostomy/noninvasive positive pressure ventilation

Q1.	Level of throat pain during ETT intubation/tracheostomy/NIPPV
Q2.	Level of nasal pain during ETT intubation, tracheostomy, and NIPPV
Q3.	Level of body pain during ETT intubation, tracheostomy, and NIPPV
Q4.	Level of discomfort when moving during ETT intubation, tracheostomy, or NIPPV
Q5	Level of respiratory discomfort during ETT intubation, tracheostomy, and NIPPV
Q6.	Level of oral pain during ETT intubation, tracheostomy, and NIPPV
Q7.	Level of discomfort in the inability to cough up sputum during ETT intubation/tracheostomy/NIPPV
Q8.	I worry about circuit or mask disconnection during ETT intubation, tracheostomy, or NIPPV
Q9.	Level of back pain during ETT intubation, tracheostomy, and NIPPV
Q10.	The level of anxiety during ETT intubation/tracheostomy/NIPPV
Q11.	I worry about prolonging my hospital stay during ETT intubation/ tracheostomy/NIPPV
Q12.	The level of sleep disturbance affected by ETT intubation, tracheostomy, and NIPPV
Q13.	Overall, the level of general discomfort during ETT intubation, tracheostomy, and NIPPV

NIPPV: Non-invasive positive pressure ventilation, ETT: Endotracheal tube

No any discomfort	Mild discomfort	Moderate discomfort	Severe discomfort	Extreme discomfort	Intolerable discomfort
0	1 2	3 4	5 6	7 8	9 10

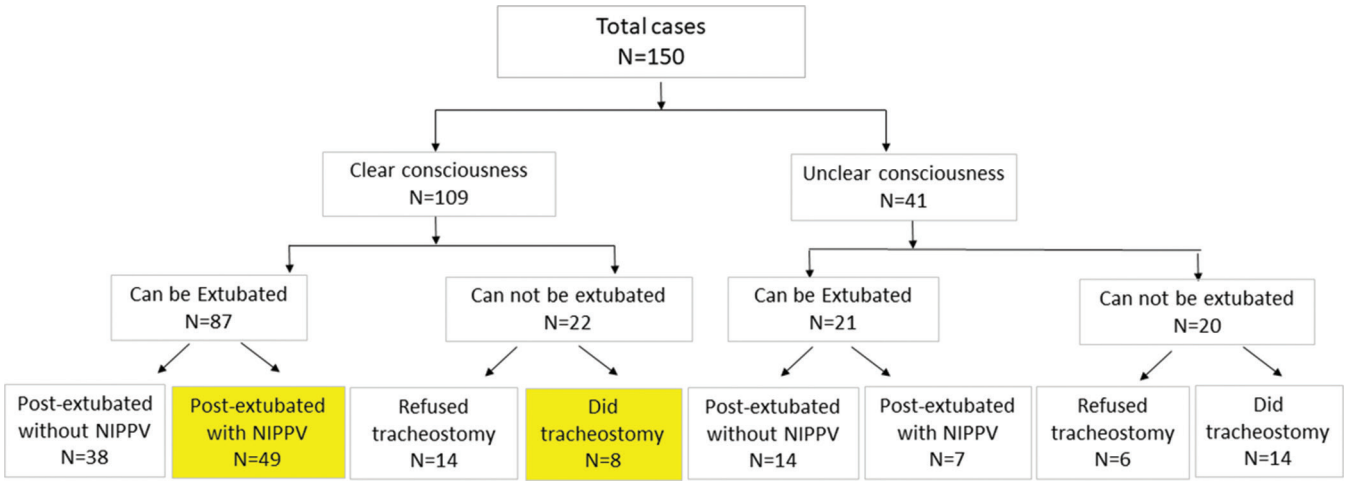

Figure 1: Flowchart of the case selection process. NIPPV: Non-invasive positive pressure ventilation

Results

In this study, 57 patients were included in the analysis, of whom 49 had NIPPV and 8 underwent tracheostomy. The baseline characteristics and underlying diseases are shown in Table 2. Their mean age was 71.4 ± 14.6 years. The study included 59.6% males and 40.4% females.

The discomfort experienced by patients undergoing ETT intubation and postextubation with NIPPV is shown in Figure 2. The level of throat pain (Q1) during ETT intubation (5.8 ± 1.9) was higher than that during NIPPV (2.1 ± 1.9, $P < 0.05$). The level of nasal pain (Q2) during ETT intubation (4.9 ± 2.0) was higher than that during NIPPV (2.5 ± 1.7, $P < 0.05$). The level of body pain (Q3) during ETT intubation (5.6 ± 2.4) was higher than that during NIPPV (2.2 ± 1.9, $P < 0.05$). The level of discomfort when moving (Q4) during ETT intubation (5.9 ± 2.1) was higher than that during NIPPV (2.2 ± 1.7, $P < 0.05$). The level of respiratory discomfort (Q5) during ETT intubation (5.7 ± 1.6) was higher than that during NIPPV (2.7 ± 1.7, $P < 0.05$). The level of oral pain (Q6) during ETT intubation (5.8 ± 1.8) was higher than that during NIPPV (2.2 ± 1.7, $P < 0.05$). The level of discomfort in not being able to cough up sputum (Q7) during ETT intubation (5.6 ± 1.8) was higher than that during NIPPV (2.4 ± 1.6, $P < 0.05$). The level of worry about circuit disconnection (Q8) during ETT intubation (5.4 ± 1.9) was higher than that during NIPPV (2.5 ± 1.6, $P < 0.05$). The level of back pain (Q9) during ETT intubation (5.8 ± 2.0) was higher than that during NIPPV (2.7 ± 1.9, $P < 0.05$). The level of anxiety (Q10) during ETT intubation (5.9 ± 1.9) was higher than that during NIPPV (2.5 ± 1.9, $P < 0.05$). The level of worry about prolonged hospital stay (Q11) during ETT intubation (6.0 ± 1.7) was higher than that during NIPPV (2.2 ± 1.8, $P < 0.05$). The level of sleep disturbance (Q12) during ETT intubation (6.0 ± 1.7) was higher than that during NIPPV (2.2 ± 1.8, $P < 0.05$). The level of general discomfort (Q13) during ETT intubation (6.4 ± 1.8) was higher than that during NIPPV (2.5 ± 1.9, $P < 0.05$).

The discomfort experienced by patients undergoing ETT intubation and tracheostomy is shown in Figure 3. The level of throat pain (Q1) during ETT intubation (6.6 ± 2.4) was higher than that after tracheostomy (2.6 ± 1.0, $P < 0.05$). The level of nasal pain (Q2) during ETT intubation (6.3 ± 2.7) was higher than that after tracheostomy (2.5 ± 1.1, $P < 0.05$). The level of body pain (Q3) during ETT intubation (6.0 ± 2.1) was higher than that after tracheostomy (2.4 ± 1.8, $P < 0.05$). The level of discomfort when moving (Q4) during ETT intubation (6.6 ± 1.9) was higher than that after tracheostomy (3.0 ± 1.4, $P < 0.05$). The level of respiratory discomfort (Q5) during ETT intubation (4.9 ± 3.1) was higher than that after tracheostomy (2.3 ± 1.3, $P < 0.05$). The level of oral pain (Q6) during ETT intubation (6.3 ± 2.0) was higher than that after tracheostomy (2.1 ± 1.9, $P < 0.05$). The level of discomfort in not being able to cough up sputum (Q7) during ETT intubation (5.6 ± 1.6) was higher than that after tracheostomy (2.9 ± 1.5, $P < 0.05$). The level of worry about circuit disconnection (Q8) during ETT intubation (5.0 ± 1.7) was higher than that after tracheostomy (2.3 ± 1.6, $P < 0.05$). The level of back pain (Q9) during ETT intubation (5.4 ± 1.5) was higher

Table 2: Characteristics and diseases of patients

Demographic characteristics	mean ± SD or *n* (%)	Laboratory characteristics	mean ± SD
Age (years)	71.4±14.6	WBC (cells/mm^3)	7524.0±2676.1
Gender,		Hb (g/dL)	10.2±1.5
Male (*n*, %)	34 (59.6%)	BUN (mg/dL)	33.1±25.0
Female (*n*, %)	23 (40.4%)	Cr (mg/dL)	1.4±1.4
Pneumonia	46 (80.7%)	Na (mEq/L)	136.8±15.4
COPD,	23 (40.4%)	K (mEq/L)	4.0±0.6
Neurologic diseases	17 (29.8%)	Albumin (g/dL)	3.2±0.4
Coronary arterial diseases	12 (21.1%)	ALT (U/L)	32.7±33.2
Congestive heart failure	6 (10.5%)	PH	7.43±0.04
Liver cirrhosis	3 (5.3%)	PaO_2 (mmHg)	94.6±32.2
Renal insufficiency	11 (19.3%)	$PaCO_2$ (mmHg)	42.0±7.3
		HCO_3^- (mEq/L)	27.3±4.1

SD: Standard deviation, ALT: Alanine aminotransferase, BUN: Blood urea nitrogen, COPD: Chronic obstructive pulmonary disease, Cr: Creatinine, Hb: Hemoglobin, pH: Acid-base, PaO_2: Partial pressure of oxygen in arterial blood, $PaCO_2$: Partial pressure of carbon dioxide in arterial blood, HCO_3^-: Bicarbonate, WBC: White blood cell

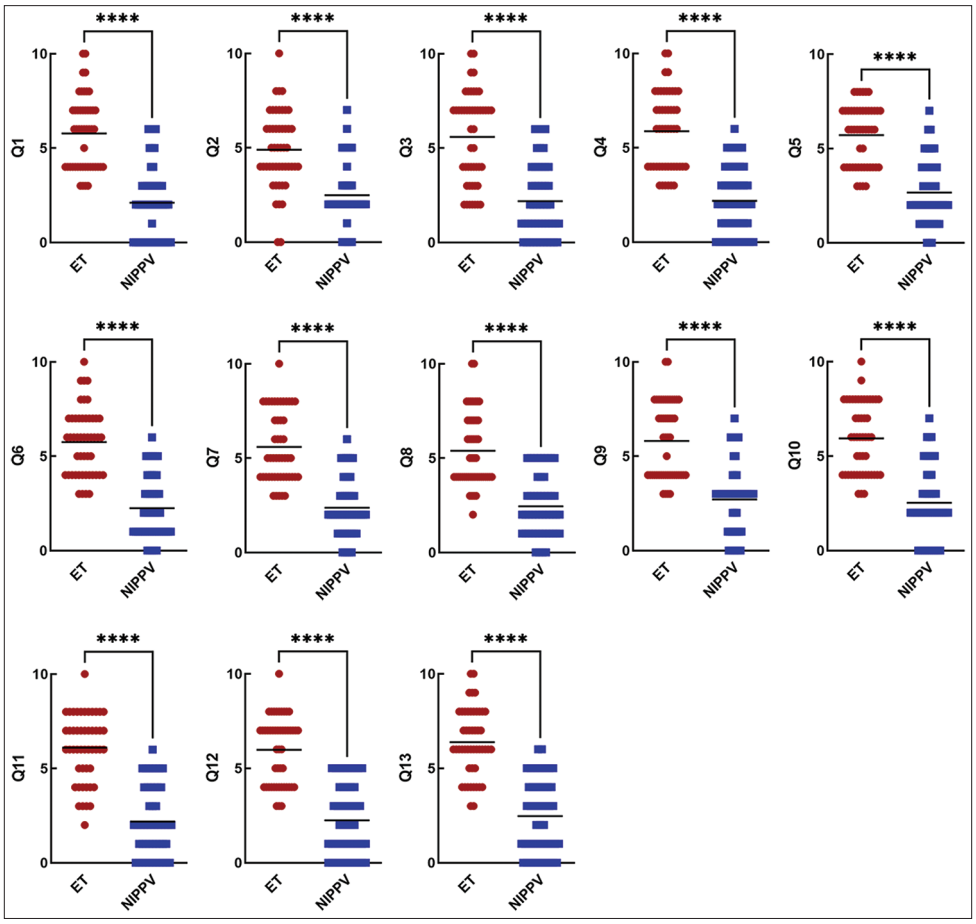

Figure 2: Level of discomfort between endotracheal tube and noninvasive positive pressure ventilator. ET: Endotracheal tube, NIPPV: non-invasive positive pressure ventilation, ****P<0.001

than that after tracheostomy (3.1 ± 1.6, P < 0.05). The level of anxiety (Q10) during ETT intubation (6.4 ± 1.8) was higher than that after tracheostomy (3.0 ± 1.7; P < 0.05). The level of worry about prolonged hospital stay (Q11) during ETT intubation (6.3 ± 1.5) was higher than that after tracheostomy (4.0 ± 2.1, P < 0.05). The level of poor sleep (Q12) during ETT intubation (6.0 ± 2.4) was higher than that after tracheostomy (2.6 ± 1.3, P < 0.05). The level of general discomfort (Q13) during ETT intubation (5.9 ± 1.9) was higher than that after tracheostomy (3.5 ± 1.5, P < 0.05).

The discomfort experienced by patients undergoing NIPPV and tracheostomy is shown in Figure 4. The level of throat pain (Q1) during NIPPV (2.1 ± 1.9) was similar to that during tracheostomy (2.6 ± 1.0, P > 0.05). The level of nasal pain (Q2) during NIPPV (2.5 ± 1.7) was similar to that during tracheostomy (2.5 ± 1.1, P > 0.05). The level of body pain (Q3) during NIPPV (2.2 ± 1.9) was similar to that during tracheostomy (2.4 ± 1.8, P > 0.05). The level of discomfort when moving (Q4) during NIPPV (2.2 ± 1.7) was similar to that during tracheostomy (3.0 ± 1.4, P > 0.05). The level of respiratory discomfort (Q5) during NIPPV (2.7 ± 1.7) was similar to that during tracheostomy (2.3 ± 1.3, P > 0.05). The level of oral pain (Q6) during NIPPV (2.2 ± 1.7) was similar to that during tracheostomy (2.1 ± 1.9; P > 0.05). The level of discomfort in not being able to cough up sputum (Q7) during NIPPV (2.4 ± 1.6) was similar to that during tracheostomy (2.9 ± 1.5, P > 0.05). The level of worry about circuit or mask disconnection (Q8) during NIPPV (2.5 ± 1.6) was similar to that during tracheostomy (2.3 ± 1.6, P > 0.05). The level of back pain (Q9) during NIPPV (2.7 ± 1.9) was similar to that during tracheostomy (3.1 ± 1.6, P > 0.05). The level of anxiety (Q10) during NIPPV (2.7 ± 1.9) was similar to that during tracheostomy (3.0 ± 1.7, P > 0.05). The level of worry about prolonged hospital stay (Q11) during NIPPV (2.5 ± 1.9) was less than that during tracheostomy (4.0 ± 2.1, P < 0.05). The level of sleep disturbance (Q12) during NIPPV (2.2 ± 1.8) was similar to that during tracheostomy (2.6 ± 1.3, P < 0.05). The level of general discomfort (Q13) during NIPPV (2.5 ± 1.9) was similar to that during tracheostomy (3.5 ± 1.5, P < 0.05). The minimal clinically important difference (MCID) for a 10-point VAS is 1.4 [5]. Among the various discomforts, only the disparity in the level of concern regarding prolonged hospital stay is significant enough to meet the MCID.

Table 3 presents the outcomes related to complications, hospital length of stay, and successful weaning, comparing patients who underwent tracheostomy with those receiving NIPPV. There was no significant difference in the incidence

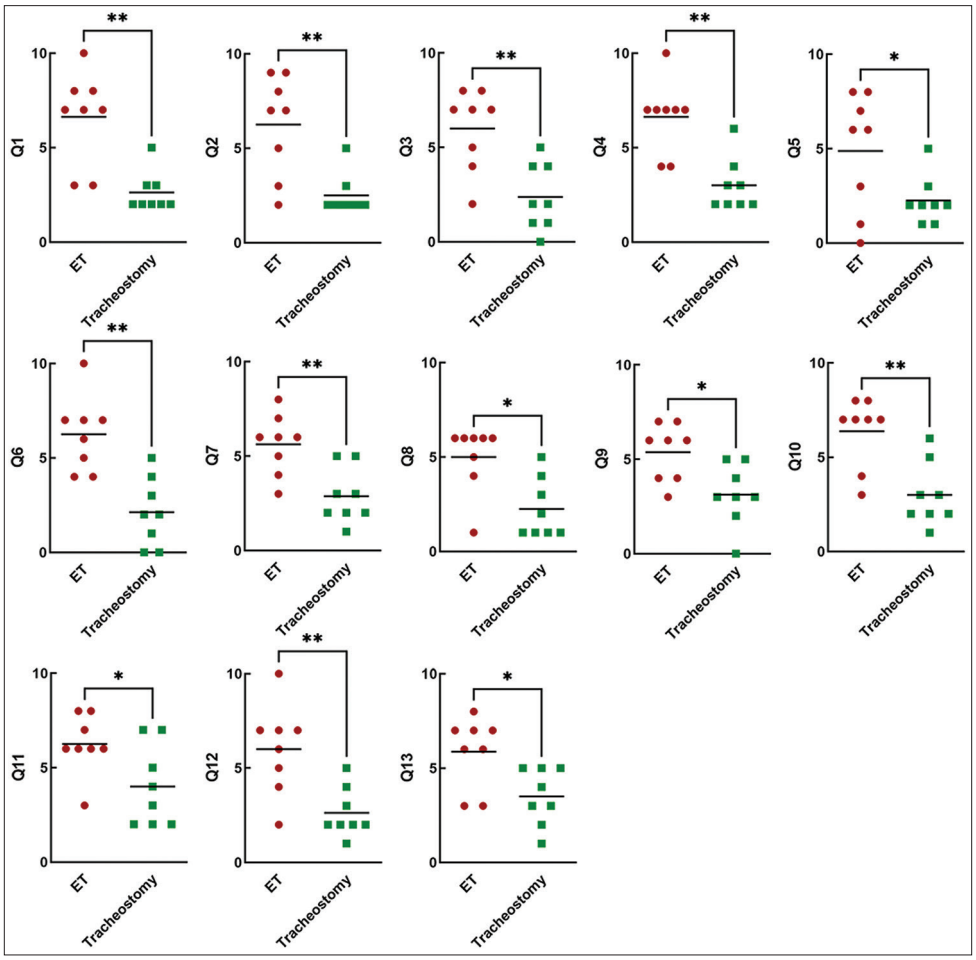

Figure 3: Level of discomfort between endotracheal tube and tracheostomy. ET: Endotracheal tube, *P<0.05, **P<0.01

of pneumonia between the two groups, with rates of 10.2% in the NIPPV group and 12.5% in the tracheostomy group (P = 0.846). The occurrence of bleeding was higher in the tracheostomy group (12.5%) compared to the NIPPV group (0%) (P = 0.013). There was no statistically significant difference in the rates of successful weaning from the ventilator or overall survival between the two groups (both P > 0.05). The duration of ventilator support was significantly shorter in the NIPPV group (43.8 ± 13.9 days) compared to the tracheostomy group (57.5 ± 17.6 days) (P = 0.016). The hospital length of stay did not differ significantly between the groups (P = 0.557).

Discussion

In this study, we determined the level of discomfort during ETT intubation, NIPPV, or tracheostomy. We found that the levels of throat pain, nasal pain, body pain, discomfort when moving, respiratory discomfort, oral pain, discomfort in not being able to cough up sputum, worry about circuit or mask disconnection, back pain, anxiety, worry about prolonged hospital stay, sleep disturbance, and general discomfort were significantly higher during ETT intubation than those during NIPPV or tracheostomy. The levels of these discomforts were similar between NIPPV and tracheostomy, except that the concern about prolonged hospital stay was less during NIPPV than during tracheostomy. This study provides data on the quality of life under different circuits in patients with respiratory failure. These results are important for the clinical care of these patients.

Although ETT intubation is often a life-saving procedure, the presence of an ETT is a significant source of stress that leads to considerable discomfort in patients [1]. Physiologically, ETT has been shown to produce stress stimuli, accompanied by increased catecholamine, tachycardia, and hypertension [1]. Sore throat is the most common ETT-related discomfort, occurring in 20%–74% of cases [6-8]. Despite advancements in the care of patients with ETT, sore throat remains a concern following ETT intubation [8]. The trachea is highly innervated, expresses nociceptors, and is, therefore, prone to pain after ETT intubation [6]. ETT placement also results in mechanical tissue injury and induces an influx of neutrophils that are more prone to sensing pain [6]. Besides, an ETT in the throat leads to a feeling of choking, stress, and inability to breathe or communicate [7]. Other common ETT-related discomforts were also noted. Chest discomfort was described in 27% of the patients [1]. Cough can be evoked by ETT stimuli. For ETT stability, these patients are almost restricted with limited head, neck, and body movement. Other common ETT-related symptoms include dyspnea, generalized discomfort, and

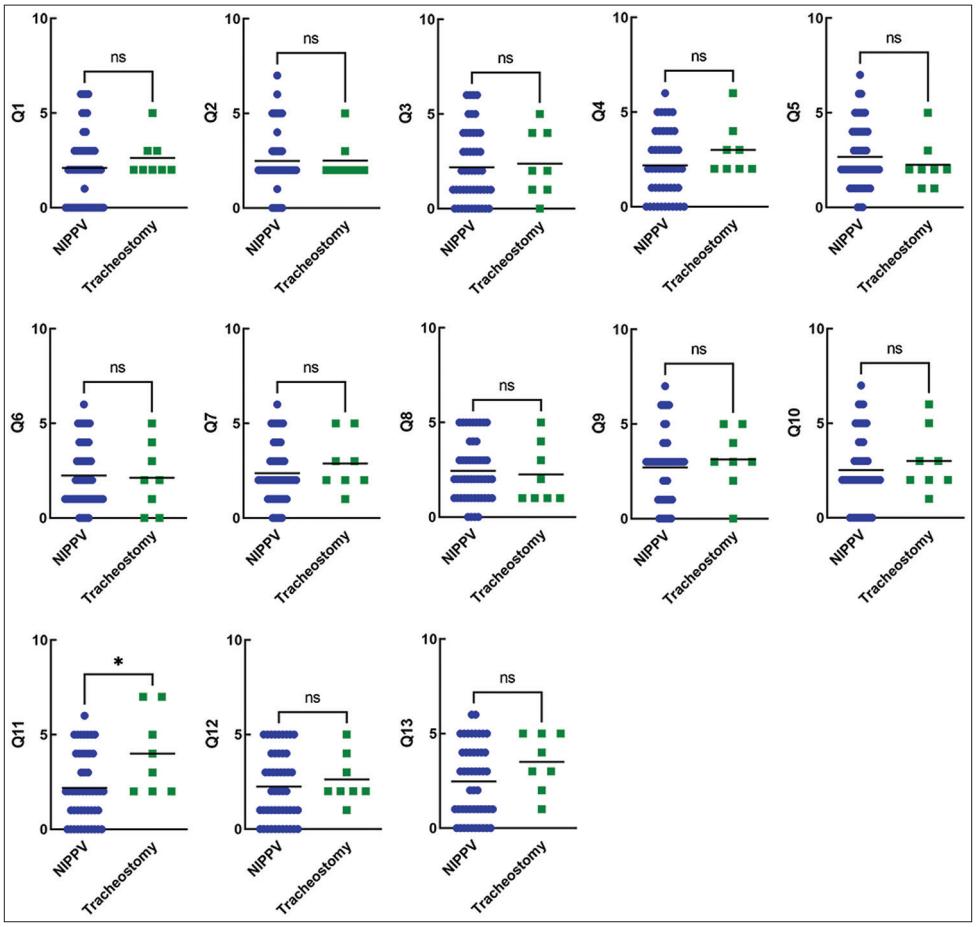

Figure 4: Level of discomfort between noninvasive positive pressure ventilator and tracheostomy. NIPPV: Non-invasive positive pressure ventilation, NS: Not significant, *P<0.05

Table 3: Outcomes of complications, hospital length of stay, successful weaning

	NIPPV	Tracheostomy	*P*
Pneumonia, *n* (%)	5/49 (10.2)	1/8 (12.5)	0.846
Bleeding, *n* (%)	0/49 (0)	0/8 (12.5)	0.013*
Successful weaning from ventilator, *n* (%)	28/49 (57.1)	4/8 (50)	0.708
Over survival, *n* (%)	45/49 (91.8)	8/8 (100)	1.000
Total ventilation day (days)	43.8±13.9	57.5±17.6	0.016*
Hospital length of stay (days)	61.9±23.6	67.0±13.4	0.557

*P<0.05. NIPPV: Noninvasive positive pressure ventilation

inability to communicate [9]. In addition, psychological status and anxiety levels may contribute to discomfort perception in these patients [8]. ETT discomfort has been shown to be associated with self-extubation, and sedation and restraints are often used for these patients. However, self-extubation and increased sedation can result in complications [1].

The use of tracheostomy in long-term care is increasing, and tracheostomy may decrease complications and reduce morbidity in patients who require MV. The advantages of tracheostomy include a more stable airway, fewer serious injuries, improved breathing, reduced need for sedation, elimination of the need for facial equipment, and an improved quality of life [2]. In our study, the discomfort experienced by patients with tracheostomy was significantly lower than that experienced by patients undergoing ETT intubation. However, some tracheostomy-related discomforts have been reported, including tracheal pain and irritation [2]. Previously, tracheostomy has been reported to have a profound negative impact on quality of life [10]. Gul and Karadag investigated the quality of life using the Short Form 36 in tracheostomized patients and found that tracheostomy had a negative influence on communication, body image, and mental well-being [10]. Hashmi *et al*. also found that mental and physical health scores were lower for those living with tracheostomy [11]. Gilony *et al*. investigated well-being in 24 individuals with tracheostomy and showed neck disfigurement, altered communication, and negative body image with a significant reduction in life satisfaction among patients [12]. These studies appear to show a negative impact of tracheostomies on patients. However, these studies compared patients with and without tracheostomies. In our study, tracheostomy was less uncomfortable than ETT intubation for patients requiring a circuit for MV.

NIPPV is increasingly being used in both acute and chronic respiratory failure to prevent ETT intubation [3]. Respiratory distress after extubation is a common event, and mortality rates of about 30%–40% are associated with reintubation [13]. NIPPV has been established as a useful and safe method to improve ventilation and has been suggested as a treatment

for respiratory distress [3]. NIPPV has many advantages in the management of respiratory failure, such as reducing the need for invasive ventilation, hospital stay, and mortality and morbidity [3]. For most cases, discomfort is tolerated [3].

Although NIPPV is being increasingly used owing to these advantages, it still has some problems. To avoid air leakage, the NIPPV mask must be tightly fixed to the face. Therefore, the most common complication is mask-related discomfort, such as nasal and oropharyngeal discomfort, pressure sores on facial skin, ear pain, ocular irritation, and claustrophobia [3]. Excessive air swallowing is also a common complication, with approximately half of the patients complaining of excessive air swallowing and gastric distention [3]. Therefore, careful assessment of the discomfort of patients using NIPPV is important. In our study, the level of discomfort was similar between NIPPV and tracheostomy, with both causing less discomfort than ETT intubation.

Sleep quality is impaired in critically ill patients. It has been found that environmental, physiological, and psychological factors contribute to sleep disturbances in patients with respiratory failure. MV use also causes sleep disturbance. Sleep disturbances may be a risk factor for delirium, which is a risk factor for postintensive care syndrome [14]. One previous study showed that patients treated with NIPPV had a reduction in deep sleep, more shallow sleep, and more fragmented sleep [14]. However, patients with ETT intubation experienced more sleep disturbance than those with tracheostomy or NIPPV in our study. Patients with ETT usually require analgesia or sedation, whereas those with NIPPV or tracheostomy usually do not require analgesia and sedation.

Ventilators are used to rescue patients with respiratory failure. In addition to saving lives, it is also important to care for the patient's discomfort. A previous study showed that 88% of the patients reported at least one moderate-to-extreme ETT-related discomfort [9]. Physicians often focus their attention on elements crucial for the survival of ventilators. We suggest that psychosocial aspects, such as symptoms or quality of life, are also important. In the current study, the mean discomfort level in patients with ETT was approximately 5–6 points, indicating a moderate level of discomfort. In patients who underwent tracheostomy or NIPPV, the mean discomfort level for these symptoms was 2–3 points, indicating mild discomfort. In patients who cannot be extubated from the ETT, tracheostomy should be performed as soon as possible to reduce ETT-related discomfort and complications. For patients who meet the extubation criteria, the ETT should be removed as soon as possible. NIPPV can be used if respiratory distress develops following extubation.

The duration of ventilator use was shorter in patients receiving NIPPV compared to those undergoing tracheostomy. NIPPV has been recommended as part of the ventilator weaning process [15]. In this study, patients of the NIPPV group underwent respiratory training to fulfill extubation criteria and opted for NIPPV due to respiratory distress following extubation. After the temporary use of NIPPV, a substantial number of patients achieved successful weaning from ventilator support. For patients with respiratory failure unable to be weaned from ventilator, early tracheostomy is generally recommended [16]. However, in this study, patients delayed the procedure due to family reluctance to tracheostomy. They only consented to tracheostomy after encountering challenges in respiratory training. After tracheostomy, these patients subsequently underwent respiratory training. As a result, the tracheostomy group exhibited a longer duration of ventilator support. Bleeding is a common early complication of tracheostomy, with an incidence of approximately 5.7% [17]. Among our eight patients, only one experienced mild bleeding after tracheostomy. Since the primary objective of this study was to assess the discomfort level of patients rather than these clinical outcomes, there may be bias in comparing these outcomes due to the different clinical contexts of NIPPV and tracheostomy. Further, well-designed studies focusing on these clinical outcomes are needed.

Our study findings indicate that patients undergoing tracheostomy or NIPPV experienced significantly less discomfort compared to those with ETT interventions. However, it is crucial to note that even in these groups, patients still reported various forms of discomfort. Addressing these discomforts is crucial to tailor interventions to alleviate patient distress and promote their overall well-being. Pharmacological interventions, including the use of nonsteroidal anti-inflammatory drugs or acetaminophen to alleviate pain, sedative agents to alleviate anxiety, and mucolytic agents to facilitate easier coughing, can be employed to address specific symptoms and enhance overall patient comfort [18-20]. Nonpharmacological approaches, such as physical therapy, relaxation techniques, and breathing exercises, contribute to the overall relief of discomfort [21,22]. Careful patient positioning during interventions can minimize physical strain [23,24]. Psychological support services address anxiety, promoting improved well-being [25]. Thus, it is important to develop tailored care plans collaboratively, applying a targeted approach to alleviate patients' discomfort.

Limitations of the study

The current study has several limitations. One limitation of our study is its specific focus on a specific patient population admitted to the RCC with stable but subacute respiratory failure. We chose this patient population because they were relatively stable, experiencing fewer disease-or treatment-related discomforts, allowing for a more accurate assessment of the discomfort caused by the airway interventions. The conclusions drawn from our study may not be fully applicable to patients in critical or acute conditions within ICU settings. Future research specifically conducted in ICU environments is essential for a comprehensive understanding of discomfort levels in patients with acute respiratory failure. Another limitation is the sample size, specifically in the context of tracheostomy interventions. The inclusion of a smaller number of cases resulted from instances where patients and their families declined to do tracheostomy. This aspect is a potential source of bias in our investigation and may influence the comparative analysis among interventions. Despite these constraints, we still provide valuable insights within the scope of the available data. The third limitation lies in its focus on short-term discomfort levels. However, this study lacks an exploration of the long-term implications and overall impact on the quality of life for patients. This

limitation underscores the necessity for further research designed to investigate the long-term outcomes for patients who undergo these interventions.

Conclusions

In this study, we determined the level of discomfort during ETT intubation, NIPPV, and tracheostomy. We found that the level of throat pain, nasal pain, body pain, discomfort when moving, respiratory discomfort, oral pain, discomfort in not being able to cough up sputum, worry about circuit or mask disconnection, back pain, anxiety, worry about prolonged hospital stay, sleep disturbance, and general discomfort were significantly higher during ETT than during NIPPV or tracheostomy. The level of discomfort was similar between NIPPV and tracheostomy, except that the worry about prolonged hospital stay was less during NIPPV than during tracheostomy. These studies provide data on the quality of life of patients with respiratory failure under different circuits, which is very important for the clinical care of these patients.

Data availability statement

All relevant data are within the article.

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Conflicts of interest

There are no conflicts of interest.

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