BEDSIDE PERCUTANEOUS TRACHEOSTOMY: A RETROSPECTIVE COMPARISON OF GRIGGS' FORCEPS, PERCUTWIST, AND SINGLE DILATOR AS CIAGLIA DILATIONAL TRACHEOSTOMY

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ABSTRACT

Objective: *The aim of this study was to evaluate the three different techniques of percutaneous dilatation tracheostomy (PDT) with Griggs' forceps (Portex), PercuTwist (Rüsch) and Single Dilator as Ciaglia (Portex) with respect to their advantages (timing, intubation device) and the complications of tracheostomy in the intensive care unit (ICU).*

Material and Method: *We performed 197 procedures of Griggs, PercuTwist, and single dilator mode percutaneous tracheostomy under general anesthesia, using a disposable percutaneous tracheostomy kit, in our clinic in the period from 2001 to 2013. The study evaluated intubation times, intubation equipment used, procedure durations, and complications.*

Results: *No significant difference was determined in distribution in terms of the patients' mean age and gender, and intubation device ($p>0.05$). There was no statistically significant difference in complication rates, procedure durations, and intubation time for the three techniques ($p>0.05$).*

Conclusion: *Percutaneous dilation tracheostomy applied with any of the three techniques is shown to be equally effective and safe.*

Keywords: *Tracheostomy, tracheostomy methods, bedside percutaneous tracheostomy complications, Griggs' forceps, PercuTwist, single dilator as Ciaglia.* **Nobel Med 2019; 15(2): 57-62**

YATAKBAŞI PERKÜTAN TRAKEOSTOMİ; GRİGGS' FORCEPS, PERCUTWIST VE CIAGLIA DİLATASYONEL TRAKEOSTOMİ YÖNTEMLERİNİN RETROSPEKTİF KARŞILAŞTIRILMASI

ÖZET

Amaç: Yoğun bakım pratiğinde perkütan dilatasyon trakeostomi (PDT) sıklıkla uygulanmakta ve farklı yöntemler tercih edilebilmektedir. Bu çalışmanın amacı, PDT için uygulanan üç farklı yöntemi ((Griggs' forseps (Portex), PercuTwist (Rüsch) ve Ciaglia (Portex)), bu yöntemlerin avantajlarını ve komplikasyonlarını karşılaştırmaktır.

Materyal ve Metot: 2001-2013 yılları arasında kliniğimizde genel anestezi altında tek kullanımlık PDT kiti kullanılarak, Griggs, Percutwist ve Ciaglia yöntemi ile toplam 197 PDT operasyonu gerçekleştirildi. Çalışmada entübasyon süreleri, entübasyon gereçleri, işlem süresi ve komplikasyonlar retrospektif olarak değerlendirildi.

Bulgular: Yaş, cinsiyet ve kullanılan entübasyon gereçleri açısından her iki grup benzerdi (p>0,05). Komplikasyon oranları, işlem süresi ve hastaların entübe kalma süreleri karşılaştırıldığında, gruplar arasında anlamlı fark yoktu (p>0,05).

Sonuç: Perkütan dilatasyon trakeostomi uygulamasında her üç tekniğin de eşit derecede etkin ve güvenli olduğunu düşünmekteyiz.

Anahtar kelimeler: Bedside perkütan trakeostomi komplikasyonları, Griggs' forseps, PercuTwist, Ciaglia yöntemi, dilatasyonel trakeostomi. **Nobel Med 2019; 15(2): 57-62**

INTRODUCTION

Tracheostomy is preferred in intensive care units since it prevents upper respiratory tract injury due to lengthened translaryngeal intubation.[1,2]

Bedside percutaneous dilatation tracheostomy (PDT) procedure should be quick and easy to carry out, particularly for intensive care unit (ICU) patients. Being quick, the procedure ensures that the patient is able to tolerate stress in response to trauma of surgery. Additionally, the patient should be protected from the side effects of the anesthesia agents used.

PDT is chosen as it can be completed at the bed side and is reliable, preventing the risks that develop during application and transport to surgery.[3] As dissection is limited, there is less tissue injury, and fewer instances of hemorrhaging and wound infections are observed.[4,5] Moreover, PDT is safer and more cost effective than conventional tracheostomy.[6]

Major complications linked to PDT are generally related to coagulopathy and hemodynamic instability.[7] Therefore, procedure should be performed quickly with minimum trauma. With this aim in mind, different techniques may be chosen.

Ciaglia *et al.* developed a tracheostomy method using a percutaneous multiple dilatational technique.[8] Using this method, dilatation of different widths is achieved using staged dilators.

The single-step dilatation method, called Blue Rhino, was developed to reduce the complications like posterior wall injury, hemorrhage, and hypoxia, which can occur during multiple dilations with the Ciaglia method. It was developed as a flexible, cone-shaped dilatator with the aim of shortening the duration of tracheostomy. This method allows dilatation in a single step using a guidewire and directional catheter.[9]

The rotational dilatation technique called PercuTwist uses a single screw-shaped dilatator with controlled rotation clockwise around a guidewire to separate the pretracheal tissues. During screwing, the vertical traction caused by the screw may prevent injury to the posterior wall of the trachea. After the widest portion of the dilatator enters the trachea, the dilatator is rotated in the opposite direction to remove it, and the tracheostomy cannula is inserted along a guidewire.

The Griggs technique uses a reusable set of special forceps.[10] The tip of the forceps has a channel that the guidewire can pass through. The guidewire is passed through the hole at the tip of the forceps. In one or two stages, the subdermal tissue and trachea are opened and dilated using the forceps. When the stoma is large enough for the cannula, it is inserted in the trachea and fixed.

The aim of this study was to evaluate the three different PDT techniques - Griggs' forceps (Portex), PercuTwist (Rüsch) and Single Dilator Ciaglia (Portex) - in regard to their advantages (timing, intubation device) and complications of tracheostomy in an Intensive Care Unit (ICU).

MATERIAL AND METHOD

We retrospectively investigated 197 cases of percutaneous tracheostomy performed under general anesthesia, using a disposable Percutaneous Tracheostomy Kit with the Griggs, PercuTwist or Blue Rhino methods, in the Anesthesiology and Reanimation Clinic between the years 2001 to 2013 after receiving ethics committee permission.

Patients with hemostasis disorder (activated partial thromboplastin time and prothrombin time more than 1.5 times the control values, platelet count is lower than 50,000 /mm^3), previous neck surgery or local infections, those with short necks, large thyroid tissue, and morbidly obese patients were not suitable percutaneous tracheostomy.

Enteral feeding of patients ceased six hours before the procedure. All patients were monitored with electrocardiography, pulse oxymetry and invasive/non-invasive arterial blood pressure monitoring. Under general anesthesia, pressure- or volume-controlled ventilation was applied to the patients who were placed flat in the supine position, and support was placed under the shoulders to ensure head extension. The procedure was performed by a specialist and a resident doctor with at least three-year experience under sterile conditions. Immediately before the procedure, endotracheal tube cuff was deflated, it was moved to a point just below the vocal cords, and was re-inflated. No change was made to the patients with laryngeal mask airway (LMA) until the cannula was inserted.

In our application the tracheal cartilage was palpated at the 1-2 or 2-3 interval, and local infiltration with 2-3 ml of local anesthetic containing 20 mg/ml lidocaine HCl and 0.0125 mg/ml epinephrine HCl was injected. One of the percutaneous dilatation techniques was used to complete the tracheostomy procedure. The tracheostomy tube cuff was inflated, tracheal aspiration completed, and after ventilation sounds were heard bilaterally to confirm the position of the tracheotomy tube, the patient was attached to a mechanical ventilator. A sterile sponge was placed around the tracheostomy tube and the neck tie was fixed. All patients had lung graphs taken after the procedure for control purposes.

Complications (major bleeding, minor bleeding, desaturation, right bronchial intubation, tracheoesophageal fistula, minor esophageal injury, reverse surgical procedure, tracheal stenosis) were recorded. After the procedure, minor bleeding was assessed as bleeding that did not stop with the sponges around the stoma and/or blood appearing during aspiration from the tracheostomy tube. Major bleeding was defined as bleeding that continued for more than 24 hours from the stoma and/or within the trachea during aspiration in spite of pressurized compress. Additionally, the time to complete the procedure (duration from needle entry to insertion of the tracheostomy cannula) and mechanical ventilation durations were also recorded.

All PDT procedures were performed at the bedside by two doctors.

Statistical analyses were completed with NCSS (Number Cruncher Statistical System) 2007 & PASS (Power Analysis and Sample Size) 2008 statistical software (NCSS LLC, Kaysville, Utah, USA). When assessing the study data, in addition to descriptive statistical methods (mean, standard deviation, median, frequency and ratio). Kolmogorov-Smirnov normality test was performed on all data. Comparison of data with normal distribution were completed using the one-way ANOVA test, while comparison of data with non-normal distribution were completed using the Kruskal Wallis test. Pearson chi-square test and the Fisher-Freeman-Halton tests were utilized for comparison of qualitative data. The study had 95% confidence interval with a significance of $p<0.05$.

RESULTS

The age of the 197 cases included in the study varied from 16 to 92 years, with mean age identified as 58.08±18.92 years. The study included 91 female (46.2%) and 106 (53.8%) male cases (Table 1). Griggs forceps was applied to 131 patients, PercuTwist to 29 and Blue Rhino (dilator Ciaglia) to 37 patients.

No significant difference was determined in their distribution in terms of their mean age and gender ($p>0.05$) (Table 1).

The duration for which the patients were kept under mechanical ventilation was determined as 12.27, 12.03 and 12.65 days in the Griggs forceps, PercuTwist and single dilatator Ciaglia groups respectively, with no significant difference found ($p>0.05$) (Table 2).

The tracheostomy procedure was completed successfully using endotracheal tube and LMA, with no problems reported linked to these devices. There was no statistically significant differences between the endotracheal tube and LMA rates in the groups ($p>0.05$) (Table 3).

Table 1. Demographical data

	Griggs Forceps (n=131)	PercuTwist (n=29)	Single Dilator as Ciaglia (n=37)	*p*
Age mean±SD	58.51±18.41	57.62±20.02	57.51±19.60	0.958
Sex n (%)				
Female	62 (47.3)	12 (41.4)	17 (45.9)	0.868
Male	69 (52.7)	17 (58.6)	20 (54.1)	

Oneway ANOVA test, Pearson Chi Square test, **SD:** standart deviation, ***p:*** two-tailed significance

Table 2. The duration of the procedure and intubation time of the three techniques

	Griggs Forceps (n=131)	PercuTwist (n=29)	Single Dilator as Ciaglia (n=37)	*p*
Intubation time (day)	12.27±6.85	12.03±6.41	12.65±8.08	0.998
Tracheostomy time (min)	6.21±6.86	6.33±7.59	4.54±1.42	0.604

Kruskall Wallis test, ***p:*** two-tailed significance

Table 3. Intubation device

Intubation device n(%)	Griggs Forceps (n=131)	PercuTwist (n=29)	Single Dilator as Ciaglia (n=37)	*p*
Endotracheal tube	81 (61.8)	19 (65.5)	22 (59.5)	0.883
Laryngeal mask airway	50 (38.2)	10 (34.5)	15 (40.5)	

Pearson Chi Square test, ***p:*** two-tailed significance

Though minor bleeding was observed in 19 patients in the forceps group, three patients in the PercuTwist group and six patients in the Blue Rhino group, the difference between them was not significant (Table 4).

One patient had major bleeding, one patient had desaturation, one patient had right bronchial intubation, one patient had tracheoesophageal fistula, one patient had minor esophageal injury, one patient had reverse surgical procedure and two patients had tracheal stenosis identified, and all these complications were in the Grigg's Forceps group. There was no statistically significant difference in the complication rates between the groups (Table 4).

The tracheostomy procedure durations were determined as 6.21, 6.33 and 4.54 minutes for the Griggs forceps, PercuTwist and single dilatator Ciaglia groups respectively, and the difference between them was not significant (Table 2).

DISCUSSION

The efficacy of different techniques has been compared in many studies. Bleeding in the tracheostomy region may block the respiratory tract and cause complications like laryngospasm, bronchospasm, and aspiration; and affect respiratory and circulation receptors. Side effects like bleeding can be avoided by choosing the technique with minimum surgical trauma.[11]

In a review investigating the reliability of PDT methods, Sanabria *et al.* assessed 14 randomized controlled studies.[12] Stating that there was no difference between multiple dilations, forceps dilation, single-step dilation, translaryngeal, and other PDT methods in terms of major bleeding, they noted that the bleeding was less with single-step dilatation (Blue Rhino), and that this method was easier to apply.

There are different studies showing the Blue Rhino method is more reliable and associated with fewer complications.[13] An observational study investigating 70 patients with Blue Rhino observed mild complications (difficult tracheostomy cannula insertion in 10 patients, slight bleeding in seven patients, partial atelectasis in three patients, cuff leak in two patients, surgical tracheostomy in one patient) in 23 patients, while two patients experienced severe complications (desaturation in one patients, severe bleeding in one patient).[14]

In randomized studies by Kumar *et al.* comparing the Griggs and Blue Rhino methods, no difference was found between the two methods in terms of major complications, procedure duration, desaturation incidence, hypercapnia, and increase in peak pressure.[15]

A single-center prospective study including 572 patients assessing the Blue Rhino method reported 0.5% failure rate, 3% early period complications, and 0.7% late period complications.[16]

In a study by Karvandian *et al.* they stated the Griggs forceps dilatation method was quicker and the skin incision was smaller, but there were fewer complications like major bleeding and cardiac arrhythmia observed with the Blue Rhino single-step dilatation method.[17] The same study stated that the single-step dilatation method may be more reliable for use by inexperienced clinicians.

Table 4. Complication rates

COMPLICATION	Griggs Forceps (n=131)	PercuTwist (n=29)	Single Dilator as Ciaglia (n=37)	*p*
	n (%)	n (%)	n (%)	
Major bleeding	1 (0.8)	0 (0.0)	0 (0.0)	1.000
Minor bleeding	19 (14.5)	3 (10.3)	6 (16.2)	0.830
Desaturation	1 (0.8)	0 (0.0)	0 (0.0)	1.000
Right bronchial intubation	1 (0.8)	0 (0.0)	0 (0.0)	1.000
Tracheoesophagial fistula	1 (0.8)	0 (0.0)	0 (0.0)	1.000
Minor esophagial injury	1 (0.8)	0 (0.0)	0 (0.0)	1.000
Reverse surgical procedure	1 (0.8)	0 (0.0)	0 (0.0)	1.000
Tracheal Stenosis	2 (1.5)	0 (0.0)	0 (0.0)	1.000
Total number of complications	27 (20.6)	3 (10,3)	6 (16,2)	0,46

Fisher-Freeman Halton test, Pearson Chi Square test, ***p:*** two-tailed significance

When the PercuTwist and Griggs methods were compared, there was no difference in the complication rates. When the procedure durations are compared, the PercuTwist technique took an average of 5 min (2-25 min), while the Griggs method took 3 min (1-17 min). Despite having a longer duration, the PercuTwist technique was found to be reliable.[18]

In our study the tracheostomy procedure durations for the Griggs forceps, PercuTwist and single dilatator Ciaglia groups were determined as 6.21, 6.33 and 4.54 minutes, with no significant difference between the groups ($p>0.05$) (Table2).

A study by Anon *et al.* comparing the Ciaglia and Griggs techniques found that of 38 patients who underwent the Griggs technique, tracheal tear, wrong passage, and emphysema were each experienced by a single patient while three patients had bleeding.[19]

Birbicer *et al.*[20] studied the PercuTwist technique in 80 patients and found that only two (2.5%) developed minimal bleeding.

In our study, even though there was minor bleeding in 19 patients in the forceps group, in three patients in the PercuTwist group, and in six patients in the Blue Rhino group, there was no statistically significant difference between the groups ($p>0.05$) (Table 4).

In a study assessing the early complications linked to Griggs percutaneous tracheotomy, Pietkiewicz *et al.* observed the following complications in the peroperative period, hemorrhage in seven patients (4.6%), difficult procedure in three (1.9%), and cardiac arrest in one patient (0.65%).[21] In the early postoperative period, complications were observed in a total of 15 patients (9.7%); 10 patients had hemorrhage within 24 postoperatively hours (6.5%), three patients had infection (1.9%), and one patient had subcutaneous edema (0.65%).

Disayabutr *et al.* found the perioperative complication rate was 11%, reporting 5.5% desaturation, 3.3% moderate bleeding, 1.1% excessive bleeding and 1.1% mistaken extubation.[22]

In our study, one patient had major bleeding, one patient had desaturation, one patient had right bronchial intubation, one patient had tracheoesophageal fistula, one patient had minor esophageal injury, one patient had reverse surgical procedure, and two patients had tracheal stenosis. All of these complications were observed in the Griggs forceps group. There was no statistically significant difference between the groups in terms of complication rates ($p>0.05$) (Table 4). We link the reason for the higher rate of complications observed in the Griggs forceps group to the higher number of cases included in the study.

CONCLUSION

We conclude that all three techniques are equally effective in the application of percutaneous tracheostomy.

*The authors declare that there are no conflicts of interest.

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