A Simple and Effective Method for Bleeding Control During Percutaneous Dilatational Tracheostomies

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Research article

Keywords: percutaneous dilatation tracheotomy, intradermal injection, bleeding

Posted Date: December 31st, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-136108/v1>

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Abstract

Objectives: This study describes an intradermal injection technique for reducing bleeding during a percutaneous dilatation tracheotomy (PDT).

Methods: Fifty-two consecutively recruited patients who underwent PDTs were analysed in a prospective study that was conducted between May 2019 and January 2020. This is a prospective study and fifty-two patients who underwent PDT were recruited from May 2019 to January 2020. They were randomly divided into an observation group and a control group. The patients in the observation group accepted the execution of the intradermal injection technique during their local anaesthesia. A comparison was made between the two groups' intraoperative bleeding, postoperative bleeding, operation time and length of incision.

Results: A total of 52 patients were enrolled in this study, 33 males (63.5%) and 19 females. The mean age was 63.0 ± 9.9 years, with the patients' age ranging from 45 to 80 years. The mean BMI was 29.2 ± 5.1 kg/m². There was no significant difference in gender, age, BMI index and whether they had an endotracheal tube between the two groups ($P > 0.05$). The observation group's intraoperative bleeding was less than that of control group ($\chi^2 = 8.308$, $P = 0.009$). There was no significant difference in operation time between the two groups ($t = -0.904$, $P = 0.372$). There was no PDT-related death.

Conclusion: The intradermal injection technique can be used to effectively and safely reduce bleeding during PDTs. This technique provides a lower intraoperative bleeding grade without increased the procedure's duration.

Introduction

Percutaneous dilatation tracheotomy (PDT) has become a common technique for the ventilation of patients in intensive care unit (ICU), and the method used has been modified several times since it was first described by Ciaglia in 1985^[1-4]. These improvements have made the procedure safer and more convenient. However, bleeding is a frequent complication that has been reported by nearly all of the authors of various studies on PDT^[5-9]. Of all the complications of PDT that can cause death, bleeding accounts for 38.0% and 31.0% of this bleeding occurs during the PDT^[10]. Mild and moderate bleeding can be controlled by means of local compression and ligation, whereas severe or lethal bleeding mostly requires a surgical method for haemostasis. Up to now, few studies have focused on therapeutic strategies for bleeding during a procedure^[5, 6]. Despite preoperative ultrasonography of the neck and other medical diagnostic techniques being applied to provide visualisation of the large blood vessels^[11], it is difficult to predict which specific vessels will be injured. Compared to superficial vessels that contribute to bleeding during a PDT, previous studies have paid more attention to deep vessels^[12].

It is this study's view that the injury of superficial blood vessels at the beginning of the procedure leads to a blurred operative field, the operators experiencing emotional tension, prolonged operation time and

surgical failure, as well as having other potential complications.

Currently, no one research has specifically focused on the control of surgical incision bleeding in PDTs. The present study proposes a simple method that reduces bleeding at the commencement of a PDT.

This study was conducted in accordance with the Declaration of Helsinki and has been approved by the ethics committee of the First Affiliated Hospital of Hebei North University. All participants gave informed consent.

Methods

Patients and grouping method

This prospective study was carried out from May 2019 to January 2020, and 52 patients were recruited consecutively. They were randomly divided into an observation group (n = 26) and a control group (n = 26). The proposed intradermal injection technique was applied to the patients in the observation group.

The inclusion criteria were as follows: patients who required prolonged mechanical ventilation or endotracheal intubation and patients needing an emergent artificial airway establishment. The exclusive criteria included patients with abnormal anatomy of the anterior neck or trachea, patients younger than 18 years old, patients with an infection around the incision and patients who have coagulation abnormalities.

The following clinical data was recorded preoperatively: gender, age, body mass index (BMI) and whether they had an endotracheal tube (Table 1).

Table 1
The base baseline demographic characteristics of the two groups.

	observation group (n = 26)	control group (n = 26)	χ^2/t	P value
Gender (male/female)	16/10	17/9	0.083	0.773
age(years)	61.1 ± 9.3	64.9 ± 10.3	-1.405	0.166
BMI (kg/m ²)	30.3 ± 5.3	28.2 ± 4.7	1.496	0.141
endotracheal tube (yes/no)	21/5	20/6	0.115	0.734

Preparation and study design

All of the operations were performed under a local anaesthetic (Lidocaine, Shang Dong Qi Lu Medicine Corporation. China. 5 ml: 100 mg. 1-4.5 mg/kg, and the patients were given an individual analgesic

(Fentanyl Citrate, Sinopharm Group Industrial Co., Ltd. Langfang Branch. 2 ml: 0.1 mg. 0.002–0.004 mg/kg) and sedated (Midazolam, Jiangsu Enhua Pharmaceutical Co., Ltd. 2 ml: 2 mg. 0.05–0.075 mg/kg) in accordance with the Individual condition of patients. The operation was performed by a senior neurosurgeon who is experienced in performing PDTs, having done more than 500 PDTs. The patients' vital signs, such as arterial oxygen saturation, blood pressure and cardiac rhythm, were monitored continuously throughout the procedure. The intraoperative bleeding, operation time, length of incision and postoperative bleeding were recorded. The degree of bleeding is defined as follows: grade I, which is when there is no obvious bleeding and no additional treatment is needed, grade II, which means that the bleeding can be stopped by means of local compression and ligation, or grade III, which is when exploratory surgery is necessary to stop the bleeding. For this study, the postoperative stage is defined as within 72 hours after the operation. Each patient's dressing was changed every eight hours postoperatively, and at the same time, the state of the incision was examined meticulously. The state of the incision is defined as: type I, the incision is clean and there are no abnormal changes in skin appearance type II, any one of these complications are present: skin necrosis, secretion, swelling, or infection.

Intradermal injection technique

In the process of local anesthesia a skin protuberance was made by intradermal injecting for the patients in the observation group. (Fig. 1); then, a transverse incision was made through the protuberance. In this way, a bloodless operative field was provided.

Surgical method

The patients were placed in the supine position. The same PDT Kit (Portex Ltd, Hythe, Kent, UK) was used for the two groups. After sterilisation and local anaesthesia, a transverse incision about 1.2 to 1.5 cm in length was made between the second to fourth tracheal cartilage rings. The endotracheal tube was withdrawn to a proper position where it would not affect the trachea puncture. Evaluating the distance between the anterior of the tube and the vocal cord is difficult without the help of an endoscope. If the body surface anatomical landmarks of the anterior neck are not clear, the incision should be at least one finger width above the suprasternal fossa. After the skin cutting, the superficial subcutaneous tissue was separated simply and slightly. Then, gradually, the trachea puncture, guide wire insertion, dilatation of the trachea stoma and tracheal cannula insertion were done.

Statistical analysis

All of the data was analysed via SPSS software version 19.0 (IBM, Chicago, IL, USA). The quantitative variables are expressed as mean $\pm$ standard error, and the comparison of means was tested by means of a student's t-test. The categorical variables are described as percentages, and Chi-squared tests were performed to compare the percentages. $P < 0.05$ was considered statistically significant.

Results

Fifty-two patients were enrolled in the study, of which 26 were in the observation group and 26 were in the control group. Of these, 33 were male (63.5%) and 19 were female. The mean age was 63.0 ± 9.9 years, with the patients' ages ranging from 45 to 80 years. Forty-one of the patients (78.8%) had an endotracheal tube and 11 did not have an endotracheal tube. The mean BMI was 29.2 ± 5.1 kg/m².

The demographic characteristics of the two groups is presented in Table 1. There was no significant difference in gender, age, BMI index and whether they had an endotracheal tube between the two groups ($P > 0.05$). The observation group's operation time was shorter than that of the control group (2.86 ± 0.71 min versus 3.14 ± 1.40 min), but there was no significant difference ($t = -0.904$, $P = 0.372$).

None of the patients experienced grade III bleeding; thus, only the grade I and grade II bleeding of the two groups was compared. The observation group's intraoperative bleeding was less than that of the control group ($\chi^2 = 8.308$, $P = 0.009$). Two patients in the observation group needed compression to control mild bleeding. In the control group, one patient needed ligation and 10 patients needed compression to stop the bleeding.

Although there was no significant difference between the two groups' postoperative bleeding ($\chi^2 = 1.209$, $P = 0.465$), the observation group's grade II postoperative bleeding rate is lower than that of the control group (11.5% versus 23.1%). Three patients in the observation group needed compression to stop the bleeding. In the control group, five patients required compression and one patient required ligation.

There was no significant difference between the two groups' incision state ($\chi^2 = 0.354$, $P = 0.552$) (Table 2).

Table 2
PDT results of the two groups.

	observation group(n = 26)	control group(n = 26)	χ^2/t	Pvalue
operation time(min)	2.86 ± 0.71	3.14 ± 1.40	-0.901	0.372
length of incision(cm)	1.28 ± 0.11	1.29 ± 0.10	-0.265	0.792
intraoperative bleeding (grade I/grade II)	24/2	15/11	8.308	0.009
postoperative bleeding (grade I/grade II)	23/3	20/6	1.209	0.465
Incision state Type I/ Type II	25/1	24/2	0.354	0.552

No other early complications, such as subcutaneous emphysema, pneumothorax, tracheal rupture or hypoxia, were found in this trial. There was no PDT-related death.

Discussion

Bleeding is inevitable in almost all surgical procedures, and PDT is no exception. However, there is hardly any available literature concerning the treatment of bleeding during PDTs^[5, 6, 8, 13, 14]. In addition, the bleeding described in the available literature generally refers to severe or fatal bleeding, which has to be treated separately, most of the corresponding arteries originate from the external carotid artery and the subclavian artery^[12]. Incision of the skin, puncture of the trachea and dilatation of the stoma are considered to have a direct relationship with bleeding during a PDT^[15]. The vessels that surround or supply the thyroid are responsible for deep or invisible bleeding^[5, 9, 13]. Superficial bleeding is mostly ascribed to the anterior jugular vein and the small branches of the external carotid artery and the subclavian artery^[12].

Despite the fact that superficial and subcutaneous tissue bleeding is not a life-threatening situation, it can cause poor visual conditions, nervousness and misjudgement of anatomical structure, prolong the duration of an operation. affect the following steps (steps of PDT after shin incision)^[16] and even lead to a catastrophic event. Therefore, superficial bleeding should be considered.

An intradermal injection has been used as an efficient and safe technique for haemostasis in breast surgery^[17]. The hydro-dissect effect between the epidermis and the dermis is the main mechanism of haemostasis.

Currently, this is the first study on the application of an intradermal injection for a PDT. Based on the data provided by the present study, it is concluded that implementing an intradermal injection for a PDT is an effective, safe and simple method.

In this study, the execution of the intradermal injection technique made skin cutting a bloodless procedure and provided a clear initial surgical field. In addition, intraoperative bleeding was effectively reduced. None of the patients suffered vascular injury during the intradermal injection. Only two patients in the observation group experienced type II bleeding compared to 11 in the control group ($P < 0.01$). With regard to postoperative bleeding, there was no significant difference between the two groups ($P = 0.465$); however, the observation group's grade II postoperative bleeding rate was 11.5%, and the control group's grade II postoperative bleeding rate was 23.1%. The reason for postoperative bleeding is unknown. The initial bloodless surgical field may facilitate accurate trachea puncture, guide wire insertion, dilatation of the trachea stoma and tracheal cannula insertion, which contribute to a lower postoperative bleeding rate.

The mean operation time of the observation group was 2.86 ± 0.71 min, and there was no significant difference between the two groups' mean operation times ($P = 0.372$). Despite an extra step being added to the observation group's procedure, the operation time did not increase and it did not increase any more than in other studies^[2, 15, 18].

In this study, the state of all of the patient's postoperative skin incisions was changed. The difference in the proportion of patients presenting with skin necrosis, secretion, swelling and infection between the two

groups was insignificant ($P > 0.05$). Bennett et al. report that there has only been one case of skin necrosis due to an intradermal injection in 20 years^[17], and this result is consistent with this study's findings.

Previous studies note that obesity makes it difficult to distinguish anterior cervical anatomy, which may lead to bleeding in PDT, however we have not affected by obese patients in this study^[19]. In this study, there was no significant difference between the two groups' BMI index ($P > 0.05$). The mean BMI was $29.2 \pm 5.1 \text{ kg/m}^2$, with it ranging from 20 kg/m^2 to 42 kg/m^2 , and 10 patients had a $\text{BMI} \geq 35 \text{ kg/m}^2$; however, these cases did not interfere with this study. For obese patients, in addition to the intradermal injection technique, the surgeon's experience was also responsible for decreased bleeding during their PDT^[20, 21].

The withdrawal of the endotracheal tube is a crucial step in the process. There were 41 patients (78.8%) who had an endotracheal tube. In this study, without the assistance of an endoscope, the endotracheal tubes were withdrawn until the trachea puncture resistance disappeared. Then, a traverse incision was made rapidly and precisely. Otherwise, the skin protuberance would have disappeared due to the prolonged duration.

This technique is not perfect; it can't provide a completely bloodless operative field for every patient. In this study, two patients in the observation group experienced small subcutaneous vein injuries and mild bleeding was visible in the process of skin cutting. However, this did not affect the following steps of PDT after shin incision.

Combining the intradermal injection technique with other modifications will greatly reduce a PDT's complications.

Limitations

This study was only a single-centre trial, and the procedure was only conducted by one surgeon. In addition, the sample size was limited and is too small to allow definitive conclusions to be drawn, but it is believed that the present study makes a useful contribution. A study with a large sample size that covers multiple centres should be undertaken in the future. Furthermore, the follow-up period was short and later complications were not considered in this study.

Conclusion

In conclusion, the intradermal injection technique can effectively reduce skin bleeding during PDTs. It can provide a bloodless operative field in the initial stages and facilitate the following steps of PDT after shin incision. It makes PDTs a safer procedure. Moreover, this process does not increase operation time.

Declarations

Ethics approval and consent to participate:

This study was conducted in accordance with the Declaration of Helsinki and approved by the ethics committee of The First Affiliated Hospital of Hebei North University.

Consent to publication:

All authors final approval of the version to be published.

Competing interests:

All of the authors had no any personal, financial, commercial, or academic conflicts of interest separately.

Availability of data and materials:

The datasets used or analyzed during the current study are available from the corresponding author on reasonable request.

Funding

This study was supported by the Research Fund for Hebei Province technology innovation guidance plan project (Science and technology Winter Olympics special project). No. 19977797D.

Authors Contribution

Conception and design of the research: Du XY. Acquisition of data: Du XY, Zhai XD. Analysis and interpretation of the data: Liu Z. Statistical analysis: Teng JL, Liu CY. Obtaining financing: None. Writing of the manuscript: Du XY, Teng JL. Critical revision of the manuscript for intellectual content : Du XY, Liu CY, Liu Z.

Acknowledgements

None.

References

- [1] Ciaglia P, Firsching R, Syniec C. Elective percutaneous dilatational tracheostomy. A new simple bedside procedure; preliminary report. Chest. 1985. 87(6): 715.
- [2] Şahiner İT, Şahiner Y. Bedside Percutaneous Dilatational Tracheostomy by Griggs Technique: A Single-Center Experience. Med Sci Monit. 2017. 23: 4684-4688.
- [3] Vargas M, Sutherasan Y, Antonelli M, Brunetti I, Corcione A, Laffey JG, Putensen C, Servillo G, Pelosi P. Tracheostomy procedures in the intensive care unit: an international survey. Crit Care. 2015. 19: 291.

- [4] Wagner A, Wienhausen-Wilke V, Sondern K, Angelkort B. Dilatation Tracheotomy After Ciglia—its Use in an Internal-Medicine Intensive Care Unit. *Dtsch Med Wochenschr.* 2000. 125(6): 142-146.
- [5] Kaye C, MacLeod I, Dhillon M. Bleeding during percutaneous dilatational tracheostomy-What to do while waiting for the surgeon. *J Intensive Care Soc.* 2018. 19(1): 64-68.
- [6] Pilarczyk K, Haake N, Dudasova M, Huschens B, Wendt D, Demircioglu E, Jakob H, Dusse F. Risk factors for bleeding complications after percutaneous dilatational tracheostomy: a ten-year institutional analysis. *Anaesth Intensive Care.* 2016. 44(2): 227-36.
- [7] Klemm E, Nowak AK. Tracheotomy-Related Deaths. *Dtsch Arztebl Int.* 2017. 114(16): 273-279.
- [8] Hulde N, Koppen M, Gratzke M, Kisch-Wedel H, Brenner P, Hüge V. Hemorrhage of the innominate artery during percutaneous dilatation tracheotomy. *Anaesthesist.* 2018. 67(6): 448–451.
- [9] Grant CA, Dempsey G, Harrison J, Jones T. Tracheo-innominate artery fistula after percutaneous tracheostomy: three case reports and a clinical review. *Br J Anaesth.* 2006. 96(1): 127.
- [10] Simon M, Metschke M, Braune SA, Püschel K, Kluge S. Death after percutaneous dilatational tracheostomy: a systematic review and analysis of risk factors. *Crit Care.* 2013. 17(5): R258.
- [11] Fudickar A, Hörle K, Wiltfang J, Bein B. The effect of the WHO Surgical Safety Checklist on complication rate and communication. *Dtsch Arztebl Int.* 2012. 109(42): 695.
- [12] Wassmer S, Jalali A. Human anatomy. *Acad Med.* 2013. 88(6): 743.
- [13] Muhammad JK, Major E, Wood A, Patton DW. Percutaneous dilatational tracheostomy: haemorrhagic complications and the vascular anatomy of the anterior neck. A review based on 497 cases. *Int J Oral Maxillofac Surg.* 2000. 29(3): 217.
- [14] Simon M, Metschke M, Braune SA, Püschel K, Kluge S. Death after percutaneous dilatational tracheostomy: a systematic review and analysis of risk factors. *Critical care (London, England).* 2013. 17(5): R258.
- [15] Karimpour HA, Vafaii K, Chalechale M, Mohammadi S, Kaviannezhad R. Percutaneous Dilatational Tracheostomy via Griggs Technique. *Arch Iran Med.* 2017. 20(1): 49-54.
- [16] Espinoza A, Rosseland LA, Hovdenes J, Stubhaug A. Paratracheal placement of orotracheal tube: a complication when aborting percutaneous tracheotomy. *Acta Anaesthesiol Scand.* 2011. 55(7): 897.
- [17] Bennett KG, Gilman RH. Intradermal Infiltration of Local Anesthetic-Rapid and Bloodless Deepithelialization of the Breast Pedicle. *Plast Reconstr Surg Glob Open.* 2017. 5(2): e1225.
- [18] Liao LF, Myers JG. Percutaneous Dilatational Tracheostomy. *Atlas Oral Maxillofac Surg Clin North Am.* 2015. 23(2): 125.

[19] Rudas M. The role of ultrasound in percutaneous dilatational tracheostomy. *Australas J Ultrasound Med*. 2012. 15(4): 143.

[20] Song JQ, Xuan LZ, Wu W, Zhu DM, Zheng YJ. Comparison of Percutaneous Dilatational Tracheostomy Guided by Ultrasound and Bronchoscopy in Critically Ill Obese Patients. *J Ultrasound Med*. 2018. 37(5): 1061.

[21] Bhatti N, Mirski M, Tatlipinar A, Koch WM, Goldenberg D. Reduction of complication rate in percutaneous dilation tracheostomies. *Laryngoscope*. 2007. 117(1): 172–175.

Figures

Figure 1

In the process of local anesthesia a skin protuberance was made by intradermal injecting for the patients in the observation group. (Figure 1)