Case Report

Percutaneous Tracheotomy in Emergency Situation Setting

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Abstract

While Percutaneous Tracheotomy (PT) has become a standard procedure to ensure airway patency in elective indications, it is not yet accepted as standard for the management of emergency airway situations, despite more and more reports highlighting its use in this setting. After comparing PT with other emergency airway access techniques, we report a new approach performed under general anesthesia for the management of patients with major airway obstruction leading to « no ventilation, no intubation » situations.

INTRODUCTION

In 2003, the American Society of Anesthesiology (ASA) defined a difficult airway as a situation in which facemask ventilation or tracheal intubation of the upper airway is not adequate or unsuccessful [1,2]. Many new airway devices have been created to manage these conditions safely. However, when both ventilation and intubation are impossible, invasive airway access has to be considered either by emergency tracheotomy or percutaneous airway access, including cricothyroidotomy and percutaneous tracheotomy (PT). Risk factors leading to a « no ventilation, no intubation » situation include difficult mask ventilation, difficult direct laryngoscopy and multiple attempts at tracheal intubation by an experienced anaesthesiologist [3,4]. Furthermore, diagnosed and undiagnosed obstructive disease of the upper airway frequently leads to this situation.

WHAT ARE THE INVASIVE AIRWAY ACCESS IN A “NO VENTILATION, NO INTUBATION” SITUATION?

Cricothyroidotomy

Cricothyroidotomy is a procedure frequently selected in the frame of emergency situations. Basically, cricothyroidotomy consists of percutaneous tracheal access through the cricothyroid membrane. The main advantage of this technique is related to the easy accessibility of the cricothyroid membrane. As it is located superficially to the skin in the middle part of the neck, minimal dissection is required and the procedure is fastly executed. Cricothyroidotomy can be performed by puncture with a narrow-bore cannula-over-needle (≤2mm in diameter), a wide-bore cannula-over-trocar (≥4mm in diameter) or a wire-guided (Seldinger) technique [5]. The cricothyroid membrane can also be approached surgically through a small incision.

The cricothyroidotomy procedure has been advocated as the emergency airway procedure of choice because it is faster and simpler than surgical tracheotomy and easier to learn by nonsurgical staff members and paramedics [5,6]. However, it was reported that emergency cricothyroidotomy and tracheotomy are equally effective with comparable complication rates, suggesting that both procedures can be performed safely with low overall morbidity [5].

Cricothyroidotomy with a narrow-bore cannula-over-needle allows jet ventilation, but appropriate output after each jet delivery is essential to avoid pneumothorax and hypercapnia. This output is compromised in some clinical situations, particularly when severely obstructing tumors are present [7]. Even with modern jet ventilation incorporating a cut off system and alarms in case of overpressure, ventilation remains challenging in patients with upper airway obstruction. Ventilation systems with larger diameters, whilst improving ventilation, carry a greater risk of posterior tracheal wall injuries due to the higher pressure required to insert such devices [8]. Furthermore, as the cricothyroid membrane is small, damage to the cricoid cartilage may occur inducing irreversible long term injuries of the upper trachea such as subglottic stenosis and voice disorders [9]. Laryngeal fracture and bleeding, secondary to the insertion of a small tube (6 mm in diameter), are also possible with a surgical approach. Moreover, because of the limited ventilation possibilities and potential complications, cricothyroidotomy should be considered a temporary procedure that often requires subsequent conversion to a conventional tracheotomy [5].

Cricothyroidotomy is generally performed in emergency situations, whereas PT is routinely used in selected indications.
The latter is therefore generally preferred by medical staff. Failure to identify the cricothyroid membrane occurs frequently and is the principal cause of failed cricothyroidotomy [10]. Different cricothyroidotomy techniques have been tested on human cadavers with the finding that anatomical-surgical techniques were associated with a higher success rate, a faster tracheal tube insertion time, and a lower complication rate than puncture techniques in inexperienced health care personnel, underscoring the impact of operator experience on the success of a specific technique [11].

**Tracheotomy**

Surgical tracheotomy has the advantage of providing a definitive and stable airway and is still considered to be the golden standard. This technique is, however, time consuming and relies on the surgical expertise of the medical staff. In a large retrospective study of 1175 tracheotomy procedures, the overall complication rate was 14.1% (intraoperative, early and late complication rates of 1.4%, 5.6% and 7.1% respectively) [12]. Of note, a retrospective study recently reported that surgical tracheotomy performed by residents in training supervised by experienced surgeons was not associated to increased complications [13]. Because the complication rate is reported to be two to five times higher in an emergency than in an elective situation, surgical tracheotomy is, therefore, not considered as the best option for rapid airway control. This is controversial. Studies analyzing the outcomes of emergency surgical airway procedures report comparable complication rates with surgical tracheotomy and cricothyroidotomy, suggesting that both procedures are effective and can be performed safely [5]. It should however be emphasized that, without knowledge of the exact surgical procedure and sufficient practice with tracheotomy, surgical tracheotomy is not an option [6]. The role of emergency PT is not currently well established. During the last decades, PT has become a procedure largely used in elective situations and is an acknowledged attractive alternative to a surgical approach, being significantly faster and more cost-effective [14,15]. The list of contraindications for PT has shrunk progressively over the last few years as users have gained more experience and adjuncts, such as bronchoscopy and ultrasound imaging, have increased the safety of the procedure. The use of PT has been reported in clinical conditions initially described as relative contraindications - obese patients, patients with injuries to the head and neck area and in emergency airway situations [16,17]. The most used PT technique described in the emergency setting was the Griggs wire-guided forceps method. A laboratory comparison of the Cigalia wire-guided dilators method versus the Griggs wire-guided forceps method showed benefits in terms of time of placement in favor of the Griggs technique: mean 217 seconds versus 89 seconds, respectively. In a prospective trial including 53 patients randomized to undergo the more recent Cigalia single dilator technique (so-called Cigalia Blue Rhino) or the Griggs technique, the investigators were not able to show any differences between both techniques regarding surgical duration or procedural complications [18].

Accordingly, the Griggs technique should be a technique of choice when PT is to be performed as an emergency procedure [19]. Furthermore, in a meta-analysis, Powell et al described a 1.2% perioperative complication rate and a 2.0% postoperative complication rate for the Griggs method which is lower than the complication rate induced by other PT techniques (7.6% - 22.9% and 5% - 6.5% respectively) [20].

The largest retrospective study on the use of PT in emergency conditions involved 18 patients. Indications for emergency PT included respiratory failure associated with anaphylaxis, supraglottic edema, cardiac arrest, and blood or edema blocking the airway preventing intubation. Among the 18 patients, nine had body mass indexes ranging from 30 kg/m² to 112 kg/m². The authors described successful placement of PT in all patients. No complications were documented after the procedure. Of interest, two patients had previously undergone cricothyroidotomy which did not function adequately [21].

The second largest retrospective study of emergency PT using a modified Griggs technique involved 10 patients with cervical spine fractures, maxillofacial trauma, head and neck burns and inhalation injuries [22]. The mean time from skin incision to intubation was 5.5 minutes including the oxygen insufflations period. There was no failure, no procedural related complications, and no conversion to an open technique. Long term follow-up did not reveal any other complications. Smaller reports showed similarly encouraging results with the Griggs technique in different clinical situations including upper airway obstruction due to hematoma [23], angioedema [24], cardiogenic shock [25], altered neck anatomy due to severe burn [26] and cancer of the upper airway [27]. The technique is described as safe and feasible and, in experienced hands, emergency PT is faster than open tracheotomy [28]. Given that the Griggs method of emergency PT is safe and rapid, some centers have implemented it as the procedure of choice for emergency airway access [29].

**Percutaneous Tracheotomy to ensure airway patency of patients with an expected "no ventilation, no intubation" situation**

Recently, we reported a modified PT technique used in a series of 13 patients with major upper airway obstruction [30].

Briefly, we combined the Griggs dilatation technique with the insertion, inside the trachea, of a narrow-bore cannula over-needle (Ravussin catheter, VBM Medizintechnik GmbH, Germany), designed to be inserted through the cricothyroid membrane. The Ravussin catheter was placed under local anesthesia just below the cricoid cartilage through the first ring of the trachea and its correct placement was confirmed by the presence of air bubbles (by aspirating into a syringe filled with water), and capnograph CO2 readings taken directly out of the catheter (Figure 1). PT was then performed under general anesthesia by introducing the guide wire through the Ravussin cannula. After removing the Ravussin cannula, the classical Griggs dilatation technique was performed in less than 1 minute. This technique is particularly useful in patients with major airway obstruction secondary to advanced head and neck tumors leading to a predictable “no ventilation and no intubation” status.
CONCLUSION

Cricothyroidotomy is a procedure classically used in emergency situations. However, because this procedure is potentially associated with long term complications, it requires often conversion to a formal tracheotomy during a second step. Surgical tracheotomy is a safe and effective way to securing the airway even in an emergent setting, but it is more time consuming and requires knowledge of the exact surgical procedure involved and sufficient practice and experience. Typically, PT is used in selected indications and is the procedure generally preferred by the medical staff who feels more comfortable with it. Although not traditionally used in emergency situations, emergency PT using the Griggs technique is feasible and safe. In experienced hands, PT can be performed as rapidly as cricothyroidotomy and has the major advantage of providing a definitive approach to the airway. Besides, it may be even easier and faster than open surgical tracheotomy. PT can be performed as rapidly as cricothyroidotomy and has the major advantage of providing a definitive approach to the airway. There are several factors that influence the choice of technique to manage the emergency airway including anatomical, user experience and available devices. All techniques should be first performed and practiced in non-emergency settings so that medical teams can learn to rapidly and successfully manage emergency airway conditions.

REFERENCES


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