

Percutaneous Tracheostomy – Long-Term Outlook, a Review

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Objective: To review the techniques and long term complications of the various techniques of percutaneous tracheostomy in the critically ill patient.

Data sources: A review of studies reported on the various percutaneous tracheostomy techniques.

Summary of review: A tracheostomy is frequently performed in the critically ill patient when prolonged mechanical ventilation, airway protection and pulmonary toilet are required. It is also facilitates weaning from mechanical ventilation, reduces laryngeal injury and improves patient comfort thus decreasing the need for sedation. The percutaneous dilatational technique can be easily and rapidly performed at the bedside. Short-term complication rates associated with percutaneous tracheostomies range between 7 - 22% and include bleeding, pneumothorax, subcutaneous emphysema, paratracheal insertion, posterior tracheal wall laceration, damage to or insertion through the endotracheal tube, hypoxia, hypotension and arrhythmias, cuff leak, endotracheal tube obstruction, loss of airway, premature extubation and wound infection. Peri-operative mortality ranges from 0.2 - 0.7%. The incidence of these complications often depends on the experience of the operator. Long-term complications and their incidence are not as well defined.

Conclusions: In the critically ill patient who requires a tracheostomy, the percutaneous tracheostomy has become the method of choice as it can be performed at the bedside, leaves a smaller scar after decannulation and may be associated with fewer complications compared with the standard surgical technique. (**Critical Care and Resuscitation 2004; 6: 280-284**)

Key words: Intensive care, tracheostomy, percutaneous, complications

Tracheostomy is frequently performed in intensive care unit (ICU) patient.¹ Indications include requirement for prolonged mechanical ventilation, airway protection, pulmonary toilet and for emergency airway management.¹⁻⁴ It is also useful to facilitate weaning from mechanical ventilation, reduce laryngeal injury from endotracheal tubes, improve patient comfort, decrease the need for sedation, improve oral hygiene and provide a secure airway for patient management outside the ICU.¹

Percutaneous tracheostomy was developed in the

1950's and 60's to minimise the complications from surgical tracheostomy and provide a cost effective bedside procedure in the ICU.⁵ Its use became more widespread after the introduction in 1985 by Ciaglia of a new method of percutaneous dilatational tracheostomy (Cook Critical Care, Bloomington, IN),^{2,6-8} where a Seldinger technique was used to pass serial dilators of increasing sizes over a guidewire positioned in the trachea. The Rapitrach® was developed in 1989 by Schachner,⁷ using a sharp bevel-tipped dilating forceps. However this technique was associated with a relatively

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high complication rate,^{3,8} and is currently not marketed. In 1990, Portex (Portex, Hythe, Kent, UK),^{7,9} introduced a percutaneous technique using modified Howard-Kelly forceps to dilate the trachea over a guidewire. In 1999, Ciaglia developed a single dilator technique, promoted as “the Blue Rhino” dilator (Cook, Bloomington, IN).¹⁰ This product has been emulated by the Portex company (Portex, Hythe, Kent, UK) as the UltraPerc®.

Percutaneous tracheostomy has the following advantages compared with surgical tracheostomy,¹¹⁻¹⁴ It is performed at the bedside, thus eliminating the need for patient transfer to the operating room, it reduces the need for specialist surgeons and anaesthetists, if performed by experienced intensive care staff, and is a relatively easy procedure to learn and perform.

Several studies have shown lower complication rates with percutaneous tracheostomy compared with surgical tracheostomy.^{4,11,12,14} Recent meta-analyses also show lower post-operative complication rates with percutaneous tracheostomy.¹⁴⁻¹⁶ Short-term complication rates associated with percutaneous tracheostomies range between 7 - 22%.^{1,17-22} These include bleeding (1 - 9%),^{1,5,18} pneumothorax and subcutaneous emphysema (1 - 4%),⁵ paratracheal insertion (1 - 7%),^{5,23} posterior tracheal wall laceration,²⁴ damage to or insertion through the endotracheal tube,^{25,26} hypoxia, hypotension and arrhythmias, cuff leak, endotracheal tube obstruction,^{1,27} loss of airway, premature extubation and wound infection (1 - 3%).¹⁹ Peri-operative mortality ranges from 0.2 - 0.7%.^{1,5,17,19,22}

Percutaneous tracheostomy performed under bronchoscopic guidance may be associated with a reduced complication rate.^{20,24,28-30} However, continuous bronchoscopy may cause hypercarbia and increased airway pressures.^{23,31} Complication rates may also be affected by patient selection, technique, operator experience, correction of bleeding tendency prior to surgery and anatomical variations.^{32,33}

Different measurement techniques have been used to compare different tracheostomy techniques, making comparison's difficult (e.g. Anon *et al*,³² showed similar complication rates between the Ciaglia technique and the Portex technique, while, Van Heurn *et al*³³ and Nates *et al*,³⁴ showed a lower surgical complication rate and bleeding with the Ciaglia technique). Recent reports have shown promising results with the “Blue Rhino” dilator.^{10,35}

Several studies have attempted to describe the pathologic morphology of tracheas post percutaneous tracheostomy (Ciaglia technique) at autopsy.^{36,37} One pathological study in 42 tracheal specimens following percutaneous dilatational tracheostomy,³⁶ demonstrated that 25% of tracheostomies were misplaced. Furthermore, they describe a typical transverse anterior wall

rupture in 76% of patients, a third of which also demonstrated fracture of neighbouring tracheal rings. Cartilaginous defects were minor, explaining the relatively low incidence of tracheal stenosis. Long term complications of percutaneous tracheostomies include laryngotracheal stenosis, tracheomalacia, voice change, tracheo-oesophageal fistula, cosmetic problems such as scarring and skin tethering and even tracheal atresia.³⁷⁻⁴⁰

Studies evaluating the long term complications of percutaneous tracheostomies have been few, partly because of the relatively high mortality rate in ICU patients and the difficulty in establishing subjective and objective criteria to define significant complications.^{41,42} Most studies have also concentrated on the long-term complications of the Ciaglia percutaneous dilatational technique.^{17,40-48} Only three have evaluated the Portex technique.^{39,49,50}

An additional difficulty in performing long term follow-up studies is the preference for different techniques by different centres, making large scale, long term comparative studies harder to achieve. Direct causality of subjective or objective findings in patients who have survived critical illness is hard to determine. Prolonged translaryngeal intubation itself is associated with laryngeal stenosis and may be the cause of this finding at follow-up. Cuff pressure impacting on mucosal perfusion of the translaryngeal or tracheostomy tubes, which is not usually well documented, may also impact on the incidence of tracheal stenosis.^{1,40}

Tracheal stenosis is symptomatic when 75% or more of the tracheal diameter is reduced.⁴⁰ Objective findings of minimal or moderate stenosis may not be clinically significant. Some authors however have regarded a stenotic lesion of more than 10% of the tracheal lumen as significant.^{40,45-46} McFarlane *et al*,⁴⁴ reported four cases of laryngotracheal stenosis viewed on direct laryngoscopy 9 days to two months post tracheostomy. It was unclear whether these may have been caused by the previous endotracheal tube. Law *et al*,⁴¹ studied 41 patients with a median follow up time of 565 days. All patients were asymptomatic in terms of cough, pain or dyspnea, but seven (i.e. 17%) had noticed voice change. Twenty seven patients underwent spirometry and forty one underwent laryngotracheoscopy. Their results showed that only 4 patients had more than 10% stenosis, all of them asymptomatic. Walz *et al*,⁴⁷ followed up 106 patients who had undergone percutaneous tracheostomy using the Ciaglia technique. Two dimensional x-ray examination of the trachea was used to determine tracheal narrowing; 43% of the patients had more than 10% stenosis and only one patient, with more than 50% stenosis, was symptomatic.

Norwood *et al*,⁴² interviewed 100 patients following bronchoscopy-guided percutaneous dilatational tracheo-

stomy (Ciaglia technique) with a median follow up of 26 months. Forty eight patients underwent tracheal CT scan evaluation and 38 underwent fiberoptic laryngotracheoscopy. Twenty seven per cent complained of subjective voice change and 2% had persistent hoarseness. Ten per cent reported persistent respiratory problems. Tracheal stenosis, defined as more than 10% stenosis on CT scan evaluation was found in 31% of patients. Three of the fifteen patients (i.e. 20%) with tracheal stenosis were symptomatic. Fiberoptic evaluation showed vocal cord abnormalities in 11% of the patients and severe tracheomalacia in one patient (i.e. 2.6%). The authors conclude that there is a quantifiable risk of long term complications such as tracheal stenosis, although most patients with these findings are asymptomatic.

Van Heurn *et al*,⁴⁶ investigated 54 patients following percutaneous tracheostomy with the Ciaglia technique, using tomography of the trachea. They found that 26% of the patients developed tracheal stenosis of more than 10%. None of these patients complained of dyspnea. The only factor associated with an increased risk of tracheal stenosis, on univariate analysis, was the experience of the operating surgeon. They conclude that the incidence of tracheal stenosis with percutaneous tracheostomy is lower than standard surgical tracheostomy, and that an experienced operator may further reduce the incidence.

The Portex kit has previously been studied by Leonard *et al*,³⁹ who examined 49 patients surviving at least six months following percutaneous tracheostomy. Fourteen patients (i.e. 36%) had significant subjective complaints regarding voice change, cough and dyspnoea. All patients, except one, had a good or satisfactory scar and none had evidence of tracheal stenosis on spirometry or tracheoscopy. One patient was known to have subglottic stenosis on previous examination. The authors concluded that the Portex technique is comparable to other existing techniques and that it is unclear whether subjective or objective findings can be attributed to the tracheostomy itself, previous laryngeal intubation or other pre-existing problems.

Another group who studied the Portex technique,⁴⁹ evaluated twenty five patients using a questionnaire and spiral CT of the trachea using sagittal and coronal reconstructions. Forty four per cent of patients reported a change in voice and no patient had disfiguring scars. On CT scanning, 32% of patients had obvious tracheal dilatations, the clinical significance of which was unclear.

Tracheal stenosis is mostly defined as more than 10% reduction in diameter,^{41,45,47} but the clinical significance of this level of obstruction is unclear. Further studies of possible tracheal stenosis following tracheostomy, using techniques other than spirometry,

will be of great interest. Although tracheal stenosis appears to be reasonably common depending on the technique of percutaneous tracheostomy and the method of follow-up detection, it does not appear to have great clinical significance.

We recently studied the long-term complications in patients undergoing percutaneous tracheostomy using the Portex technique (Portex, Hythe, Kent, UK).⁵⁰ Compared with the Ciaglia technique there have been fewer reports on long term follow up of the Portex technique. We showed that 38% of patients complain of some degree of voice change and 31% complain of shortness of breath, more than half of which have heart or lung disease to explain this. Most patients have a minimally visible scar. Spirometry showed an abnormal inspiratory obstructive pattern in 19.5% of patients, most of which were symptomatic for voice change and cough. Most patients with tracheal stenosis on spirometry (i.e. 62.5%) had undergone re-intubation for failed extubation in the ICU prior to tracheostomy insertion. This may suggest that this subgroup of patients is at risk of developing longer term complications.

Conclusion

In summary, the current literature shows good overall results and an acceptable long-term complication rate following percutaneous tracheostomy. Our own study using the Portex technique has findings in keeping with the current literature.⁵⁰ Other factors unrelated to the tracheostomy procedure itself may well contribute to the incidence of tracheal stenosis in these patients. Comparative studies examining either percutaneous versus surgical tracheostomy, different techniques of percutaneous tracheostomy or percutaneous tracheostomy versus prolonged endotracheal intubation are difficult to evaluate because of, varying patient populations, varying techniques of tracheostomy as well as follow-up tools (e.g. CT versus endoscopy), variable timing of the tracheostomy, and background "noise" in the form of the general conduct of the ICU and how patients are managed (e.g. the level of sedation and the amount of patient movement tolerated may impact on the incidence of tracheal stenosis regardless of the airway device used).

Despite these difficulties, we feel that it is the responsibility of intensivists to thoroughly evaluate all new techniques introduced into the ICU.

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