

## Equipment

# Vessel dilator cricothyrotomy for transtracheal jet ventilation

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*Needle cricothyrotomy is a safe, relatively easy procedure and has been described to enable pulmonary ventilation for patients in both elective and emergency situations. Conventional IV cannulae are short, thin-walled, and easily kinked and, therefore, do not provide a secure system to jet oxygen into the trachea. The vessel dilators of most 7-9 French introducer kits are firm, pliable, resist kinking, and can be passed easily into the tracheal lumen. We describe our experience with the use of vessel dilator cricothyrotomy to oxygenate and ventilate the lungs of patients in emergency and elective situations.*

Hypoxaemia resulting from failed intubation can be a significant cause of anaesthesia-related morbidity and mortality. Anatomical variations, upper airway pathology, laryngospasm and the presence of foreign bodies, blood or secretions, are common causes of intubation failures.<sup>1</sup> It is possible that many complications resulting from unsuccessful airway management could be avoided if an alternative method of patient oxygenation were immediately available.<sup>2</sup>

Needle cricothyrotomy has been described for application of local anaesthesia into the trachea for endoscopy<sup>3,4</sup> and for artificial ventilation and oxygenation both in elective<sup>5-8</sup> and emergency<sup>2,9-13</sup> clinical settings. Needle cricothyrotomy is easy to perform and safe because the

cricothyroid membrane is relatively avascular. Also, the complete ring of the cricoid cartilage provides rigid circumferential support maintaining the maximum tracheal diameter during percutaneous cannulation of the tracheal lumen.<sup>14</sup>

The IV cannulae of commonly used IV cannula-over-needle assemblies are thin-walled, easily compressed and prone to kinking. Often when they are used in needle cricothyrotomy for application of local anaesthetics into the trachea, the patient's cough flexes the catheter from a caudad to a cephalad direction. If a Sander's jetting device were then attached, the jet stream of oxygen would be away from instead of towards the alveoli, aggravating rather than correcting preexisting hypoxaemia.

The vessel dilator of a 9 Fr introducer kit (Burrton #P935AK) is pliable, firm and resists kinking. It is 16.5 cm long, has an 18 ga lumen and a Luer lock fitting. It is easily passed through the cricothyroid membrane and is suitable for transtracheal jet ventilation using the Carden intermittent jetting device (Aire-cuf® Carden intermittent jetting device, Bovina-70-57500), which is a modification of the original Sanders equipment.<sup>15</sup> We describe the technique and our experience.

### Techniques

The following equipment is prepared:

- 1 Vessel dilator from 9 Fr introducer kit
- 2 40 cm "J" wire, 0.035" diameter
- 3 18 ga 2½" teflon catheter-over-needle assembly
- 4 #11 scalpel blade
- 5 10 ml syringe half filled with 2 per cent lidocaine
- 6 3 ml syringe with 26 ga needle filled with 2 per cent lidocaine

After aseptic intracutaneous injection of local anaesthetic in an awake patient, the 18 ga IV catheter-over-needle assembly with the 10 ml syringe attached is directed through the cricothyroid membrane in the mid-sagittal plane aiming caudad about 45° to the skin (Figure 1). Easy aspiration of air bubbles confirms tracheal

### Key words

AIRWAY: cricothyrotomy, obstruction; EQUIPMENT: airway; VENTILATION: jet, transtracheal.

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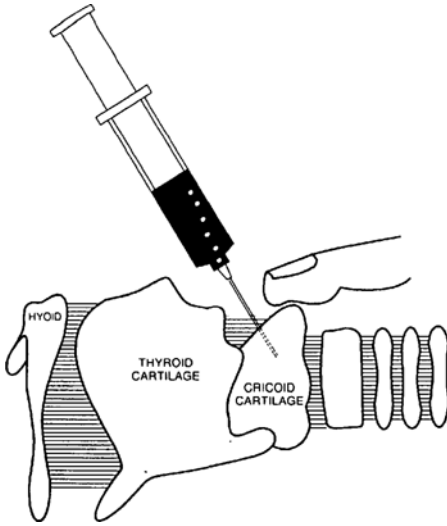


FIGURE 1 The correct intratracheal position of the 18 ga IV cannula is confirmed by repeated air aspiration. Finger placement on the cricoid cartilage confirms correct puncture site.

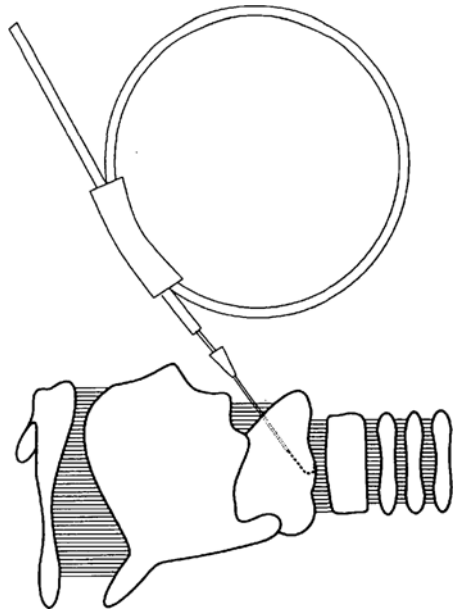


FIGURE 2 The "J" wire should easily pass into the tracheal lumen.

cannulation. The cannula is advanced off the needle into the trachea and the needle withdrawn. Reapplication of the syringe to the cannula, followed by repeated air aspiration confirms tracheal cannulation. Injection of 5 ml of lidocaine provides topical anaesthesia. Using sterile technique the "J" wire is passed through the IV cannula 8–10 cm into the trachea. The IV cannula is removed (Figure 2). The skin is incised at the puncture site with the scalpel blade and the vessel dilator passed over the "J" wire into the trachea for approximately 5–6 cm (Figure 3). The wire is removed and tracheal cannulation is confirmed by repeated free air aspiration. The vessel dilator is connected to the jetting device and a few brief jets delivered while observing chest expansion and checking for subcutaneous air. The vessel dilator is fixed to the patient's neck with 1/2" tape or silk suture. Intravenous anaesthetics, analgesics, and muscle relaxants are then administered as needed. Jet ventilation is maintained at 15–25 jets per minute, each of one-second duration.

**Results**

Pulmonary ventilation has been achieved in 8 patients using this technique for a variety of surgical procedures such as direct laryngoscopy, laser treatments to the larynx, tracheostomy and for difficult fibreoptic intuba-

tions. In all cases pulse oximetry and arterial blood gas analyses confirmed adequacy of ventilation and oxygenation. Endoscopic examination at the end of the surgical procedure in five patients revealed minor bleeding at the mucosal puncture site and erythema at the level of the jet. The procedures lasted from 30 to 98 minutes. Anaesthesia was maintained with thiopentone and sufentanil IV. Muscle relaxation was maintained with atracurium.

In patients with partially obstructed airways the cricothyrotomy-jet ventilation technique provides a means to provide prophylactic transtracheal oxygenation in adequately sedated patients before fibreoptic instrumentation and intubation.

**Discussion**

The vessel dilator cricothyrotomy-Carden jetting device technique is a simple, reliable approach to oxygenate and ventilate a patient electively or as an alternative to direct laryngoscopy and intubation in emergency situations. The jetting device can be permanently available beside the anaesthetic machine connected by a Y to the same oxygen source. In life-threatening emergencies, jet ventilation can be provided through the 18 ga IV cannula.<sup>2</sup> Once the

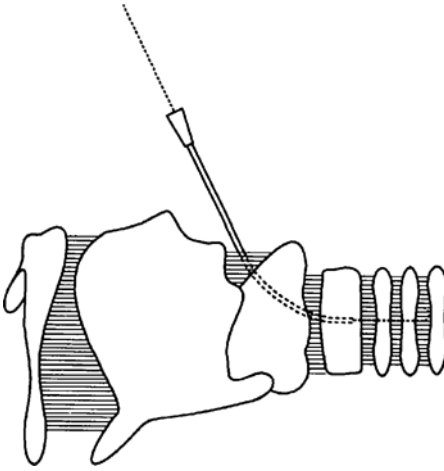


FIGURE 3 After a small skin incision is made, the vessel dilator can be advanced over the guide wire into the trachea.

patient is safely oxygenated, the more secure vessel dilator can be inserted.

Vessel dilator cricothyrotomy-Carden jetting device is suitable for laser surgery because it provides the surgeon with an unobstructed view of the surgical field. The vessel dilator must be protected with pettipads and compressed air rather than oxygen should be employed to prevent laser-induced fires.<sup>16</sup>

We have used this technique in patients with subglottic stenosis for whom the surgeons planned tracheostomy and Montgomery stent placement. The passage of the "J" wire assured accurate placement of the vessel dilator in the lumen of the stenosed trachea. Ventilation was maintained with the vessel dilator cricothyrotomy-jetting device technique throughout the tracheostomy and during the difficult procedure of placing the Montgomery tube. The small calibre of the vessel dilator in no way interfered with the surgical procedure. When the Montgomery tube was positioned in the trachea the vessel dilator was withdrawn, reinserted through the T limb and directed down the trachea; then, manual jet ventilation was resumed. This provided a simpler means of pulmonary ventilation with a Montgomery tube than previously described.<sup>17</sup>

The complications of the cricothyrotomy-manual jet ventilation procedure include air embolism and surgical emphysema<sup>7</sup> resulting from faulty vessel dilator placement. Puncture of the oesophagus can occur during needle

cricothyrotomy. Careful aspiration of free air should confirm correct intratracheal placement of the cannula.

Barotrauma is always a potential risk.<sup>18</sup> Spoerel<sup>7</sup> has shown intraluminal pressures may reach 40 cm H<sub>2</sub>O when jet ventilation is used with 50 lb·in<sup>-2</sup> through a 16 ga catheter. Inspection of chest movements, reduction in line pressures with the reducing valve, limiting inspiration to one second or less and allowing adequate time for expiration will decrease risks of pneumothorax. In cases of total airway obstruction, inspiratory time must be reduced to less than one second until an expiration route is established through the vocal cords or an additional cricothyrotomy. Usually, however, total airway obstruction exists only during inspiration, not during expiration.<sup>2</sup>

Occasionally the cannula will be positioned so that the jet stream of oxygen is directed against the posterior wall of the trachea or Montgomery tube. In such situations, the chest will not expand with each jet. This limits oxygen delivery and air entrainment resulting in inadequate ventilation and CO<sub>2</sub> elimination. Advancement of the dilator 2–3 cm usually resolves the problem.

Several authors have described variations of cricothyrotomy for oxygen insufflation using a variety of catheters and devices.<sup>10,18–22</sup> Most IV cannulae are too thin-walled and prone to kink or flex rendering jetting ineffective. The vessel dilator is firm yet pliable and can be bent into suitable position without kinking. Placement with the "J" wire guide prevents submucosal tunnelling.

The vessel dilator cricothyrotomy-manual jet ventilation technique is easy to teach. The equipment is simple and could be permanently stationed at every anaesthetic machine and emergency cart. Familiarity with the technique and immediate availability of the apparatus could be life-saving.

In summary, we have described a simple modification of cricothyrotomy-Sanders jet ventilation using a vessel dilator from the 9 Fr introducer kits. The procedure has many applications in both elective and emergency situations. We believe that the Sanders jet ventilation device should be standard equipment in the operating room and anaesthesia emergency kits.

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## Résumé

*La cricothyrotomie à l'aiguille est une technique sûre et relativement facile mais les cathéters IV souvent utilisés ont une paroi mince qui peut s'affaisser, empêchant l'utilisation d'un système à injection d'oxygène. Les dilateurs vasculaires des ensembles d'introducteur 7-9 French sont souples mais résistants et on peut les glisser facilement dans la trachée. Nous les avons utilisés pour l'oxygénation et la ventilation pulmonaire de nombreux patients, y compris en situations d'urgence.*