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Review Article

Emergency cricothyrotomy

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Abstract
The indications for the ruling for the Gulf Forces that emergency cricothyrotomy is to be performed where the airway is thought to be compromised are reviewed. The advantages of this procedure are outlined and some of the likely consequences regarding the incidence of complications and their management predicted.

Introduction

The British Forces assembled in the Middle East have been prepared from a medical point of view in training and support better than any force which has taken the field in the past. There is a high proportion of Medical Corps personnel, but in addition to this the training of paramedics has developed apace. Their guidance is concentrated in a series of standing operating procedures to ensure some uniformity of treatment plan for greater speed and efficiency, especially where documentation may be scanty. This philosophy differs in no way from that utilised by the many 'mass casualty plans' developed by civilian hospitals. With regard to airway management the plan is for emergency cricothyrotomy to be performed well forward prior to rearward evacuation: *Operation Granby: Standing Operating Procedures and Casualty Treatment Regimes For Burns. Paragraph 2: All patients thought to have sustained respiratory injury in association with burns should have an elective prophylactic cricothyrotomy carried out early to prevent fatal respiratory obstruction occurring during medevac to the burns unit.*

Background

Laryngologists have historically been unwilling to use the cricothyroid route due to the risk of cricoid stenosis. However much of their experience was with large bore tubes through an extensive incision (Matthews and Hopkinson, 1984). Cawthorne designed special instruments to avoid this but it was still standard practice to convert to a tracheostomy due to the high incidence of subglottic stenosis (Editorial, 1984)). This principle was derived from the experience of Chevalier Jackson (Jackson, 1921). It must be remembered that the complications seen were probably specific to that era in that his patients often had significant inflammatory and infectious laryngeal diseases such as diphtheria, tuberculosis, syphilis and Ludwig's angina. There were no antibiotics available, nor biocompatible tubing materials. Cricothyrotomy was brought back into popular use by cardiothoracic surgeons for prolonged ventilation following cardiothoracic surgery. Brantigan and Grow (1976) reported a series of 655 patients and showed that it was a safe, easy and satisfactory procedure. This had the effect of re-establishing the procedure, an example being that the policy of the Cardiothoracic Unit at Guy's Hospital was changed in 1977 so that any patient requiring prolonged ventilation had cricothyrotomy and not tracheostomy (Gleason *et al.*, 1984).

Advantages

Cricothyrotomy is especially suited for gaining control of the airway in cases of severe haemorrhage or emesis where visualised intubation is impossible. Other cases are when the teeth are clenched, failed intubation and when there is a possibility of cervical spine injury. In certain clinical situations in which oral or nasotracheal intubation is difficult or contraindicated, cricothyrotomy becomes the safest and quickest way to obtain an airway. It has been advocated by the American College of Surgeons as an appropriate alternative to endotracheal intubation for emergency acquisition of an airway (Collicott *et al.*, 1984). Cricothyrotomy is faster, simpler, less invasive and less likely to cause haemorrhage than tracheostomy and many consider that the high morbidity and mortality associated with emergency tracheotomy make it undesirable as a technique for gaining immediate airway control (Boyd and Conlan, 1979; Kastendieck, 1983). There is a considerable advantage in that it is easier to perform by unskilled personnel. Information

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concerning the use of cricothyrotomy in non-elective situations is poor, but a 1989 review of 33,500 flight records of an emergency medical service showed that 15% of the patients required preflight or inflight intubation (Miklus *et al.*, 1989).

Technique

The technique consists of identifying the cricothyroid membrane and incising it, enlarging the incision and placing a tube in the trachea. The cricothyroid membrane lying in the space between the thyroid and cricoid cartilages can be identified by palpating a notch, slight indentation or 'dip' in the skin inferior to the laryngeal prominence (Mace, 1988). It does not calcify with age and is immediately subcutaneous in location with no overlying large veins, muscles or fascial layers, allowing easy access. However the right and left cricothyroid arteries traverse the superior part and anastomose near the mid-line. A horizontal incision through the skin and the cricothyroid membrane is often advised (Iserson *et al.*, 1985). However, in an emergency, a vertical skin incision is preferred which can be easily extended (Mace, 1988). For incision into the cricothyroid membrane itself the instructions in the commercial kit (Minitrach, Portex UK Ltd) describe a vertical incision, as do some authorities, presumably to avoid laterally placed vessels (Matthews and Hopkinson, 1984). This not only jeopardises the cricoid cartilage but also the cricothyroid arteries previously mentioned, with a potential for serious haemorrhage (Terry and Cook, 1989).

A low horizontal stab of the membrane would avoid this risk. Either a tracheotomy tube or a standard endotracheal tube can be used in cricothyrotomy. Proper tube size is important in assuring successful cannulation without excessive trauma. Since the average size of the cricothyroid membrane in the adult is about 22 to 30 mm wide and 9 to 10 mm high the tube ideally should have an outer diameter no greater than 8.5 mm. In general the tube is 1 mm smaller than that which would be used for orotracheal intubation (Iserson *et al.*, 1985). The technique recommended is blunt and requires some guesswork to insert the cannula, leading some authorities to suggest that the tissues should be dissected onto the cricothyroid membrane and the cannula inserted under direct vision (Ryan, 1990). However, this is not appropriate for the emergency cricothyrotomy in the field. Another approach has been to suggest that the safety of the procedure would be enhanced if a Seldinger technique was used for insertion (Corke and Cranswick, 1988). Use of a guarded needle to puncture the cricothyroid membrane and dilators passed over a guide wire to make a channel would reduce the chance of damage to blood vessels and incorrect placement. British practice is to insert a cuffed tube of 6mm internal diameter. The cuff is deflated but is available should assisted ventilation be required.

Drawbacks

A number of complications can occur with cricothyrotomy. Their reported frequency varies from 6 to 39 per cent, depending on whether the procedure was performed electively or as an emergency (McGill *et al*, 1982). In a series of 15 cases performed for removal of post-operative secretions one patient had bleeding, which was controlled by external pressure for 15 minutes, and one developed subcutaneous and mediastinal emphysema related to violent coughing (Pederson *et al.*, 1988). Misplacement into the mediastinum in mistake for the trachea has been reported (Tran and Hedley, 1987), as has intraoesophageal placement (Claffrey and Phelan, 1989). At the time of insertion there is always some venous bleeding, but this resolves with pressure (Ryan, 1990). However severe bleeding, as already indicated, may occur (Terry and Cook, 1989). A 40 per cent complication rate for elective cricothyrotomy (38 cases over 3 years) was reduced in the following four years to 23 per cent (39 cases). The technique used was essentially the same except that only vertical skin incisions and a smaller tube (5 mm internal, 8.5 mm outer diameter) were used. The frequency of incorrect site of tube placement and haemorrhage showed no improvement (Erlandson *et al.*, 1989). It seems that incorrect tube placement, which accounts for a large proportion of complications, is most likely to be operator dependent (Miklus *et al.*, 1989). One can only guess at the complication rate 'in the field' but the Army Medical Services have elected for a tube of 4mm internal diameter (Quicktrach®, VBM Medical) and conversion to a 6mm when the patient has settled. In one study of the airway management of 176 consecutive traumatized patients aeromedically transported from the scene of injury, airway control was attempted in 70 (39.5 per cent) and successful in 67 (95.7 per cent). Of these, an astonishing 62 out of 65 were by successful blind nasotracheal intubation (95.1 per cent). In 59 cases this was by an emergency doctor and three by a paramedic. Cricothyrotomy was performed in the field only on two patients, each with a contraindication to blind nasotracheal intubation. The complication rates were for the blind nasal intubations three out of 65 (4.6 per cent). One of the two patients having cricothyrotomy developed subglottic stenosis (50 per cent) (O'Brien *et al.*, 1988).

Long-term Complications

The resurgence of cricothyrotomy initiated by the cardiothoracic series was condemned by leading laryngologists. Carden (1981) suggested that in Brantigan and Grow's series of cardiothoracic patients the long-term complication of subglottic stenosis might have been masked by an exercise intolerance secondary to cardiovascular disease. That this is a real risk in patients with an uncompromised cardiovascular system, was emphasised in a German study (Balogh *et al.*, 1987). It was thus advocated by many that cricothyrotomy should be used only in emergencies, as subglottic stenosis is serious, difficult to treat and often irreversible. This problem also occurs in tracheostomy (Andrews and Pearson, 1971), where lesions occur mainly at two places, the stoma and the site of the balloon cuff (Grillo, 1989). This has not been completely alleviated by the introduction of low pressure and high compliance cuffs (Grillo *et al.*, 1971). It has also been shown that as early as 48 hours after intubation, endotracheal tubes may cause a variety of abnormalities such as glottic oedema, vocal cord granulation and erosion over the arytenoids (Lindholm,

1970). It is not just pressure which is the problem, other aetiological factors include hypotension during mechanical ventilation, tracheal infection and the irritative quality of tubing material (Andrews and Pearson, 1971). The pathological process involved in causing stenosis seems to be reparative fibrosis following injury caused by intubation. Another factor may be delayed healing of the subglottic mucosa possibly exacerbated by full thickness cricoid cartilage necrosis (Quiney and Gould, 1985). It has also been found that there is a high incidence of voice change following cricothyrotomy (Gleason *et al.*, 1984). This is usually associated with laryngeal fracture resulting from placement of a tracheostomy tube that is too large for the size of the cricothyroid membrane (McGill *et al.*, 1982). Dysphonia can also be caused by injury to the vocal cords and this region should be avoided by *never* directing the blade superiorly.

Conclusion

It is a well known fact that war tends to force the pace of any development. Currently the question of whether to intubate via the nasal or oral route or perform cricothyrotomy or tracheostomy has been taken locally. The numbers have been small and the results of various studies contradictory or at best confusing. The recommendation that cricothyrotomy be the standard procedure in wartime has put it on a firmer footing. If not used in this conflict, then it will still have the authority of this decision as a precedent for any further situation where mass casualties are foreseen. This has serious implications for the training of paramedical personnel, the instructions given to receiving hospitals and for the laryngologists who will be called upon to sort out any complications which may ensue.

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