Tracheostomy and tracheal intubation in military history

John B Booth FRCS MRaES

J R Soc Med 2000;93:380–383

UNITED SERVICES SECTION, 16 SEPTEMBER 1999

Tracheostomy is an ancient operation; tracheal intubation has a short history. This is an account of their development in military medicine, with a focus on British experience.

TRACHEOSTOMY

McClelland¹ divided the history of tracheostomy into five phases: first was the period of *legend*, 2000 BC–1546 AD; then the periods of *fear*, 1546–1833 (performed only by a brave few, often at the risk of their reputation), *drama*, 1833–1931 (generally performed only in emergency, on acutely obstructed patients), *enthusiasm*, 1932–1965 ('If you think tracheostomy...do it'), and finally *rationalization*, 1965 onwards (relative merits of intubation and tracheostomy debated).

In the period of legend, Homer referred to the operation of relieving choking persons by cutting open the trachea, and Alexander the Great (356–323 BC) is said to have punctured the trachea with the point of his sword when a soldier was choking from a bone in the throat². Asclepiades, from the 2nd century BC, is generally regarded as the first tracheostomist, but the few surviving fragments of his writings do not mention tracheostomy directly. The first definite evidence concerns Antonio Musa Brasavola³ who in 1546, with his own hands, opened the windpipe of a man on the point of death from angina and an abscess. In 1620 Habicot recorded four cases in his *Question Chirurgicale*⁴, the second of which was to remove blood clot from the larynx.

Although a well-established operation by 1825, tracheostomy was not often performed in battle. Cooper⁵, who saw service at the Battle of Waterloo, commented that 'quite horrendous injuries can be sustained in the mouth whether included in the upper or lower jaw, even widely flapping open the pharynx, without the necessity for tracheostomy'. MacLeod⁶, in *Notes on the Surgery of the War in the Crimea* (1854–1856), remarked on the high survival from such injuries in cases that reached the surgeons:

'The neck has been injured by gunshot, more or less severely, 128 times, and yet only 4 deaths have resulted from the wounds yet it must be true that a large number die on the field from these injuries. It would be useless, but sufficiently easy, to record cases, in which balls, and

Figure 1 Two double-cannula tracheostomy tubes with separate trochar. This set, made by Down Brothers, is from a set for fleet and staff surgeons in the Royal Navy. It belonged to an officer in the Indian Army Medical Service and was in issue between 1895 and 1900 [Photograph kindly supplied by Mr C Jefferiss]

even bayonets, have traversed the neck, and yet did not injure the great vessels; sometimes passing from side to side, sometimes from before backward, it would appear almost impossible the blood-vessels could have escaped the wounding agent, and yet no indication of any mischief followed.'

Fifty years later, Makins⁷ reported on two cases from the South African War in which tracheostomy was performed. In one the bullet had entered on the outer side of the right arm and exited 3 inches (7 cm) below the tip of the left mastoid process, through the sternomastoid. Subsequently there was free haemorrhage into the right posterior triangle, emphysema and dysphagia. The bullet had passed obliquely between the trachea and oesophagus wounding both tubes. The patient died an hour after the tracheostomy. In the second, the bullet entered at the centre of the margin of the left trapezius and exited at the mid-line of the neck over the trachea. There was increasing dyspnoea and emphysema began to develop. Tracheostomy was performed and the tube was removed after four days, whereupon the wound closed promptly and the patient, a surgeon, returned to his duties. Figure 1 shows the instruments that might have been used. Perhaps the best-known example of injury to the oropharynx is a 22-year-old soldier in the French Artillery injured at the siege of Antwerp in December 1832. A shell burst above the battery, a fragment struck the gunner and 'Nothing whatever remained of the lower jaws save the four

fractured double teeth, and injured fragment on the right side, and thus the tongue dropped down to the length of several inches, exposing the cavity of the throat, a horrible and ghastly sight'. Over time the wound partly healed despite earlier gangrene and he was fitted with a beautiful prosthesis, illustrated by Ballingall⁸ in three woodcuts. The patient became known as the 'Gunner with the Silver Mask'. The same author⁹, in *Outlines of Military Surgery*, noted that wounds of the larynx and trachea were not in the first instance peculiarly dangerous, though sometimes emphysema of the surrounding tissue would require the wound to be thrown open, to permit healing by granulation. He recorded instances where both the trachea and the oesophagus had been completely divided, the wound in each case becoming fistulous; the patient breathed through a silver tube which at mealtimes was withdrawn from the trachea to make room for introduction of an elastic gum tube into the oesophagus, for feeding.

In the First World War the proportion of missile injuries involving the head and neck, compared with the rest of the body, was very high—five times higher than in the Second World War. Yet the surgeons of the time were slow to recognize the benefits of tracheostomy in maxillofacial injuries, avoiding it whenever possible. Only in the Second World War did the value of the procedure become clear, not only for averting asphyxia and simplifying anaesthesia but also for protecting the airway after operation. Writing in 1943, R Scott Stevenson commented that penetrating wounds of the larynx, in contrast to blows, were particularly dangerous because of the risks of local oedema and of local infection with subsequent lung complications; in such cases tracheostomy would be necessary, with ligation of bleeding vessels and removal of any foreign bodies. The operation, he thought, should be done under local anaesthesia—without haste. When an emergency operation was required he recommended laryngotomy¹⁰.

By far the best account of nose and throat injuries, still, is that written by Grant and Whale¹¹ in 1915. American experience in the First World War is well described by Roberts¹².

INTUBATION

It was the Glasgow surgeon William Macewan who in 1880 recommended insertion of tracheal tubes by the mouth instead of tracheostomy or laryngotomy¹³. He had passed metal tubes in two conscious patients, removing them 35 and 36 hours later. The main advantage, in his view, was avoidance of anaesthesia and surgery in the very ill. Macewan eventually became a surgeon rear-admiral and a consultant to the Royal Navy, but his paper was ignored for the better part of forty years.

Figure 2 Operation to restore the buccal mucosa and cheek with a pair of tubed pedicles, Sidcup, 14 December 1918. The nasotracheal tube is seen coming from the right nostril and passing over the patient's forehead [Illustration kindly supplied by Dr Andrew Bamji and reproduced by permission of the Froggnal Centre, Queen Mary's Hospital, Sidcup, Kent]

In 1916, Major Harold Gillies (the 'father of plastic surgery'¹⁴) was at the Cambridge Military Hospital. There he had a visit from Colonel J F W Silk, who advised on the method of anaesthesia for facial or upper airway surgery: a number 10 rubber catheter should be passed down one nostril to the pharynx, and the anaesthetic agent (chloroform with oxygen) should be given with the patient sitting up; there was no need to intubate the trachea. At the Royal Society of Medicine a year later he emphasized that, even in patients requiring plastic surgery to the face, intratracheal anaesthesia was seldom necessary¹⁵. Tracheal intubation was little used in the UK at that time; the custom was to insert a Kuhn's tube and pack gauze around the pharynx (Kuhn's tube, developed in 1902, was made with a spiral of thin metal and, with its S-shaped cross-section, was virtually uncrushable). Writing in 1918 about anaesthesia in facial surgery, Lieutenant Rubens Wade referred to the use of a 'Kahn's tube' with the patient supine (almost certainly he meant Kuhn's)¹⁶. Soon afterwards Captain J C Clayton¹⁷, a colleague of his at Queen's Hospital (now Queen Mary's Hospital), Sidcup, stated that in more than six months' experience of facial and jaw injuries, requiring some 400 anaesthetics for minor preparatory operations and 100 for plastic surgery, he had used a single nasal tube that in his opinion made the extreme sitting-up position unnecessary (Figure 2). For cases where there was no likelihood of blood entering the mouth, Wade devised a modified airway tube incorporating an empty rifle cartridge (Figure 3).

In 1920 Wade wrote a chapter on anaesthesia for Gillies' *Plastic Surgery of the Face*¹⁸ in which he described introducing a catheter into the trachea with the aid of a Mosher's laryngeal speculum. However, intratracheal anaesthesia was effected by means of a laryngotomy or in

Figure 3 Hewitt's airway tube as modified by Phillips. This tube has a hole through each side of the metal portion. Note the hollow stopper, made to fit the mouth from an empty rifle cartridge case, designed by Clayton

rare instances a tracheostomy. Ether was the intratracheal agent of choice and was given under positive pressure. In this book Wade remarked that the rubber nasal tube described by his colleague Clayton was liable to kink at the level of the ala, but that this could be overcome by cutting the tube short at that point and inserting into it one end of a right-angled metal connection. For cases with extensive loss of the mandible and the fragments not controlled by splints (therefore no support to the base of the tongue) he recommended laryngotomy or tracheostomy as the simplest method to maintain a clear airway—but he himself had needed to do this only once.

In 1919, Silk¹⁹ described a nasal airway consisting of an ordinary straight rubber drainage tube of firm texture, 6–7 inches long. A bevel enabled the tube to open up a passage past any slight obstruction and a second hole afforded additional security. The newly cut edges could be smoothed off with a file or sandpaper. After insertion a safety pin was passed through one wall of the tube to prevent it slipping backwards further into the airway.

Stanley Rowbotham qualified in 1915 and soon afterwards became regimental medical officer to the 4th Hussars. In 1919 he was posted to the Queen's Hospital, Sidcup, and by then the wide-bore pharyngeal airway described by Silk had been introduced as a return airway, allowing the ether-laden expired gases to be directed away from the surgeon and the pharynx to be packed. In a 1920 paper Rowbotham recorded how, after a chance blind intubation with the wired catheter, he had given thought to the curve necessary for a successful attempt; efforts were made to judge the curve on the catheter required to direct

its end towards the mid-joint of the thyroid cartilage²⁰. A further modification of the insufflation technique was the introduction of a second tube into the trachea, alongside the insufflating tube, to give free and reliable breathing or to-and-fro respiration via a large-bore tube. Rowbotham found that this method of tracheal catheterization was very uncertain, the correct curve for each case being difficult to estimate. The laryngoscope used by Rowbotham at this stage was of the Hill's pattern, with illumination either from an attached distal lamp or by a pencil light pushed down by the side of the laryngoscope.

Having served in the First World War as a captain in the RAMC, Ivan Magill was posted to the Barnet War Hospital (now Barnet General Hospital), where he gave occasional anaesthetics, before moving to Sidcup^{21,22}. Magill fashioned his own tracheal tubes from wide-bore rubber tubing initially bought from a shop in Tottenham Court Road. He cut the end of the tube obliquely and sterilized and lubricated it. The tube was passed along the floor of the nose, close to the septum, and at the point where the respiratory sounds were loudest it was pushed on through the glottis during inspiration. If this failed, it was rotated to one side to bring it into the desired position. It was this blind nasal intubation technique for which he became famous²³. When asked what position the head should be in and with how much cervical extension Magill replied, 'as if sniffing the morning air' or 'the position of drinking a pint of beer' (Figure 4).

Magill's tubes did have the disadvantage of perishing, especially when harshly treated. Sykes recalled that, while a prisoner-of-war in the Second World War, he was obliged

Figure 4 Ivan Magill inserting a nasotracheal tube. He is listening over the end to confirm correct placement of the tip in the trachea

to return to Kuhn's tube because 'it had one great and solid advantage over modern methods; it did not depend on dry batteries, which all disappear under the counter in wartime'. His laryngoscope was useless because of lack of batteries and his Magill's tubes had become unsafe to use—but Kuhn's tube was 'absolutely indestructible'²⁴.

In 1940, Sydney Leader, a dental surgeon, set up a company from his flat in Great Portland Street, London, calling it Portland Plastics; later it became Portex. In 1943 Leader visited Major H L Thornton, an RAMC anaesthetist at Basingstoke Hospital, which then had a plastic and maxillofacial surgical unit. In Thornton's judgment, Leader's vinyl acrylic resin tube was in every way as satisfactory as Magill's rubber endotracheal tube, and in some respects better²⁵. The new material withstood repeated boiling without deterioration and was unaffected by oily lubricants, by the anaesthetic agents then in use and by most strong antiseptics. An additional advantage was that the curve could be modified at will and there was less of a tendency to kink. A very smooth finish to the surface was also possible²⁶.

CONCLUSION

The 'period of rationalization' is not yet over: debate continues on the relative merits of tracheostomy and intubation in military injuries. The Ministry of Defence's most recent *Field Surgery Pocket Book* (1981)²⁷ emphasizes that tracheostomy is better done early, and possibly unnecessarily, than too late. In extreme emergencies laryngotomy is favoured (now often called cricothyroidotomy), and prepacked kits for this procedure are commercially available.

In the Falklands War, the number of injured soldiers requiring tracheostomy was negligible. In the Gulf War, preparations were made for cricothyroidotomy in case of inhalation injuries, but it was never needed.

Acknowledgments I thank the colleagues who have kindly answered my questions or provided me with additional information—Mr John Ballantyne, Air Commodore Colin Maclaren, Air Vice-Marshal Manus Moran and Surgeon Vice-Admiral Sir James Watt—and Dr Ghislaine Lawrence, senior curator, Clinical Medicine, Collections Division, Science Museum. I have received particular help from Captain Peter Starling (ret'd), curator, Army Medical Services Museum, Alan Humphreys, librarian, Thackray Medical Museum, Dr Andrew Bamji, honorary consultant archivist, Froggatt Centre for Medical Studies, Queen Mary's Hospital, Sidcup and Mr Chris Jefferiss, consultant orthopaedic surgeon, Exeter. I would also like to acknowledge the help given by several anaesthetists—Dr

David Wilkinson, Dr Edith Gilchrist, Dr R S Atkinson, Dr Aileen Adams and Dr Geoffrey Rushman.

REFERENCES

- McClelland RMA. Tracheostomy: its management and alternatives. *Proc R Soc Med* 1972;**65**:401–4
- Gordon BL. *The Romance of Medicine*. Philadelphia: F A Davis, 1945:461
- Brasavola A M. *Hippocratis & Galeni Commentaria & Annotationes*, 1546
- Habicot N. *Question Chirurgicale*, 1620
- Cooper S. *First Lines of the Practice of Surgery*, Vol. 1: *Wounds of the Throat and Neck*. Edinburgh: Longman, Hurst, Rees, Orme & Brian, 1899:528–37, 540–54
- MacLeod GHB. *Notes on the Surgery of the War in the Crimea*. London: John Churchill, 1862:202–3
- Makins GH. *Surgical Experiences in South Africa 1899–1900*, 2nd edn. London: Hodder & Stoughton, 1913:318–19
- Ballingall G. Cases and communications illustrative of subjects in military and naval surgery. *Edin Med Surg J* 1842;**57**:116–21
- Ballingall G. *Outlines of Military Surgery*, 2nd edn. Edinburgh: Adam & Charles Black, 1832:279–82
- Stevenson RS. *The Ear, Nose and Throat in the Services*. London: Oxford University Press, 71–5
- Maitland AW, Grant J Dundas, Whale HL, West CE. *Injuries of the Eyes, Nose, Throat and Ears*. London: Hodder & Stoughton, 1915:96–115
- Roberts JB. *War Surgery of the Face*. London: John Bale & Danielsson, 1991:84–5, 157–61, 257–60
- Macewan W. Clinical observations on the introduction of tracheal tubes by the mouth instead of performing tracheostomy or laryngotomy. *BMJ*, 1880;**ii**:122–4, 163–5
- Magill I. Anaesthesia. In: Gillies H, Millard DR, eds. *The Principles and Art of Plastic Surgery*. London: Butterworth, 1957
- Silk JFW. Anaesthetics in home military hospitals. *Lancet*, 1917;**ii**:716
- Wade R. Methods of general anesthesia in facial surgery. *Lancet*, 1918;**i**:794–5
- Clayton JC. Ether anaesthesia for face and jaw surgery. *Lancet* 1918;**ii**:454
- Wade R. Remarks on anaesthesia. In: Gillies HD, ed. *Plastic Surgery of the Face*. London: Hodder & Stoughton, 1920:223–8
- Silk JFW. Anaesthetics: a nasal air-way. *Lancet* 1919;**i**:1030
- Rowbotham S. Intratracheal anaesthesia by the nasal route for operations on the mouth and lips. *BMJ* 1920;**ii**:590–1
- Pallister WK. Sir Ivan Whiteside Magill (1888–1986) and tracheal intubation. *R Soc Med Int Congr Symp Ser* 1989;(134):605–9
- Lee KG. The life and work of Sir Ivan Whiteside Magill, KCVO. *R Soc Med Int Congr Symp Ser* 1989;(134):601–4
- Rowbotham ES, Magill I. Anaesthetics in the plastic surgery of the face and jaws. *Proc R Soc Med* 1921;**14**:17–27
- Sykes WS. In: *Essays on the First Hundred Years of Anaesthesia*. Edinburgh: Livingstone, 1961:95–111
- Thornton HL. Vinyl-Portex tubing. *BMJ* 1944;**ii**:14
- Gordon RA, Ainslie EH. Experience with vinyl-plastic endotracheal tubes. *Anaesthesiology* 1945;**6**:359–61
- Kirby NG, Blackburn G. In: *Field Surgery Pocket Book*. London: HMSO, 1981