

## Laryngeal reconstruction following shrapnel injury in a British soldier: case report

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### Abstract

**Introduction:** Laryngeal injuries are uncommon but result in high mortality and morbidity rates when they do occur. We report a case of laryngeal fracture due to penetrating shrapnel injury, repaired with miniplates.

**Case report:** A 26-year-old soldier was involved in an explosion and sustained a shrapnel wound to his right neck. After immediate airway management at the field hospital he was transferred to the UK, where he underwent a neck exploration, laryngofissure and repair of the thyroid cartilage using miniplates. An endolaryngeal stent was placed, which was removed at a second operation seven days later. Post-operatively, the patient recovered well and his voice improved rapidly. Six months post-operatively, he returned to work.

**Discussion:** The cause and nature of laryngeal injury differs between wartime and peacetime. The methods of diagnosis and management strategies are reviewed. The early recognition of injury and protection of the airway are of paramount importance when dealing with laryngeal injury. Delayed laryngeal reconstruction using miniplates can give a good functional result.

**Key words:** Larynx; Neck Injuries; Reconstructive Surgical Procedures

### Introduction

Injuries to the upper aerodigestive tract are uncommon but have potentially fatal consequences.<sup>1</sup> During the war in Croatia (1990–1991), the incidence of neck injuries in patients presenting to one hospital was 2.5 per cent, and 37 per cent of these had associated head injuries. The majority of these injuries were inflicted by shrapnel.<sup>2</sup> A large, retrospective study carried out in 2005 found mortality rates for laryngotracheal trauma of 26.8 per cent, with blunt trauma resulting in a significantly higher mortality rate than penetrating injury.<sup>3</sup> Another study examined the difference between peacetime and wartime injuries; it showed that wartime injuries were more likely to be penetrating and associated with higher mortality than peacetime injuries. Furthermore, wartime laryngeal injuries were more likely to be found in conjunction with other injuries.<sup>4</sup>

The evolving nature of combat body armour has led to a decline in injuries to the trunk, but head and neck wounds are still common.<sup>5</sup> In the UK, serving military personnel are issued with the Osprey Improved Combat Body Armour, which includes removable neck and arm protectors. However, these are not always worn, as some soldiers feel they impair their mobility and ability to fire.

We present the case of a 26-year-old soldier who suffered a penetrating laryngeal injury and underwent delayed reconstruction, with a good functional result. Although not the first case of its kind, it highlights the different aspects of care these patients must receive in order to make a good recovery.

### Case report

A 26-year-old, previously fit and well Royal Marine was travelling in a vehicle that was hit by an explosive device whilst on duty in Afghanistan. He sustained a shrapnel injury to his right neck and was transferred to the nearest field hospital. He was stridulous on arrival. Endotracheal intubation was attempted but failed due to inability to visualise the larynx. An emergency cricothyroidotomy was performed. A piece of shrapnel was palpable in the right posterior triangle. The patient was taken straight to theatre where a neck exploration was carried out. There was no major vascular injury but there was obvious damage to the thyroid cartilage. A defect was seen in the right lateral wall of the pharynx, which was repaired in two layers. A tracheostomy was performed and the patient subsequently transferred to the UK for further management.

Nasendoscopic examination showed a swollen supraglottic region. Computed tomography (CT) scanning confirmed significant soft tissue swelling and disruption of the laryngeal cartilage with multiple small fragments (Figure 1). Gastrografin placed down the nasogastric tube showed a satisfactory position, with no leak from the pharyngeal repair.

Rigid laryngoscopy showed an oedematous supraglottis with no mucosal laryngeal features evident. Oesophagoscopy was normal, and a fine bore feeding tube was passed.

The neck was explored. The left thyroid cartilage was more or less intact, but multiple displaced fragments of the right thyroid cartilage were found (Figure 2a). There was complete disruption of the anterior commissure and

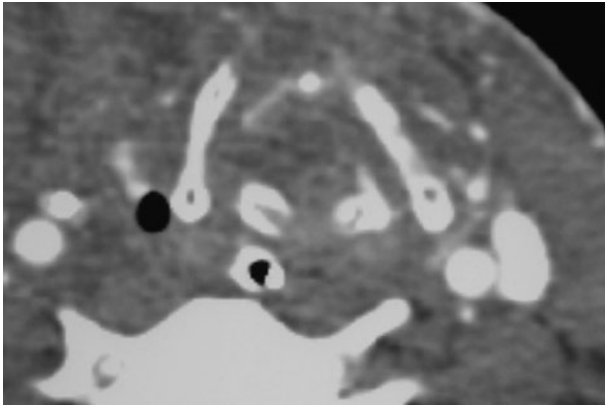


FIG. 1

Axial computed tomography scan of the neck, demonstrating laryngeal injury.

no identifiable mucosal structures on the right side of the endolarynx. A laryngofissure was carried out. The fragments were repaired with two miniplates (Figure 2b). The left true vocal fold was sutured to the perichondrium of the left thyroid cartilage. A laryngeal stent was inserted and secured with a non-absorbable stitch. The strap muscles were sutured over the remaining defect to provide a seal.

Post-operative feeding was via the nasogastric tube, and intravenous antibiotics were administered for seven days. The endolaryngeal stent was removed on the seventh day. At this stage, nasendoscopy showed the left vocal fold to be mobile with no evidence of aspiration or pooling of saliva. Over the next few days, an oral diet was introduced. The patient was decannulated on the 10th post-operative day without complication. His nasogastric tube was removed and his diet was increased steadily. He was able to tolerate a normal diet on discharge. Post-operative radiographs showed the position of the two plates (Figures 3a and 3b) to be satisfactory.

The miniplates were removed after three months. The patient underwent extensive post-operative speech and language therapy and made excellent progress. He was given Stemple vocal function exercises which required twice daily practice for a period of three months. Following this, his maximum phonation increased from 7.8 to 19.8 seconds in a variety of pitches. He could maintain a level of 60 dB easily, but his voice quality decreased when forcibly using his voice. Follow-up nasendoscopic examination showed good abduction and closure of the vocal folds.

### Discussion

Our patient's clinical course highlights several important aspects of the management of laryngotracheal injuries. It should be noted that the treatment of penetrating injuries may be more urgent than the treatment of blunt injuries. Also, the facilities available at a field hospital will differ from those at a trauma centre; therefore, surgical management may be altered to suit the circumstances.

Schaefer classified laryngeal injuries into four grades,<sup>6</sup> to which Fuhrman *et al.* added a fifth and also suggested what the management of each grade should involve (Table I).<sup>7</sup> The injury described here met the criteria for grade four.

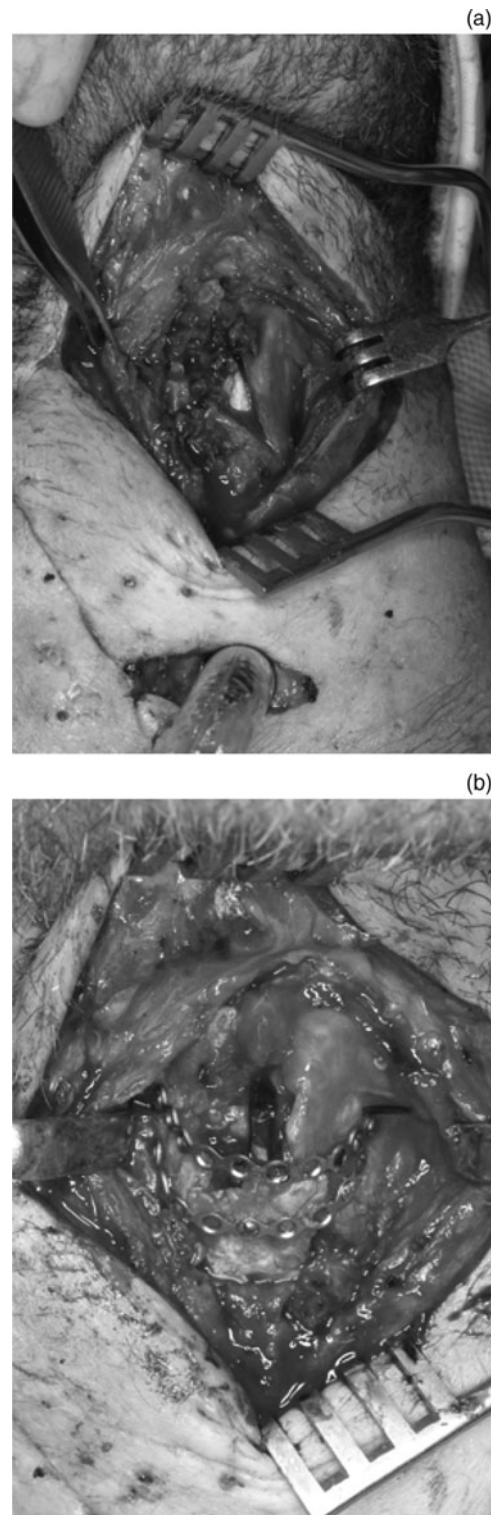


FIG. 2

Intra-operative photographs demonstrating (a) the laryngeal injury and (b) miniplate fixation.

After an initial failed intubation, our patient received a cricothyroidotomy. Cricothyroidotomy is a safe, rapid technique of obtaining an airway in such circumstances.<sup>8</sup> Although a tracheostomy was performed at the time of initial surgery, it has been shown that, in patients with minor laryngotracheal injuries, a tracheostomy can be safely withheld.<sup>9</sup> In our case, diagnosis was made

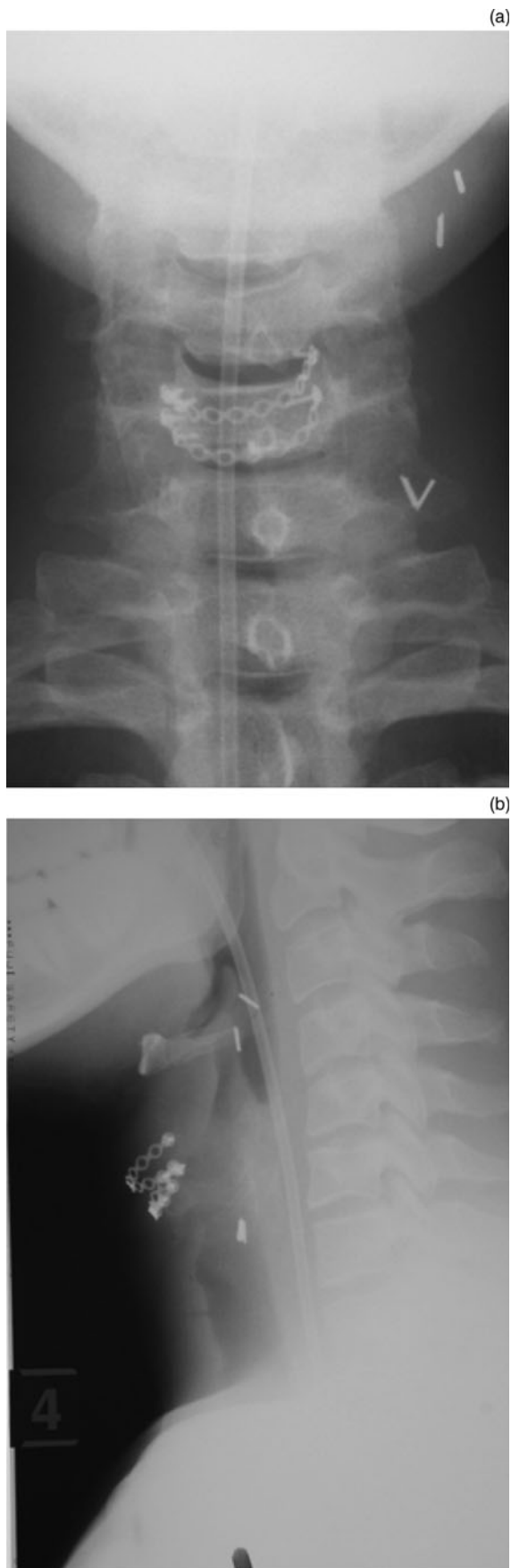


FIG. 3

Post-operative (a) antero-posterior and (b) lateral radiographs, demonstrating good position of miniplates.

during surgery, given the urgent need to operate. However, in situations in which investigation is possible (for example, in a case of blunt trauma with little respiratory distress), CT has been shown to be more sensitive than flexible laryngoscopy for identifying laryngeal injury (100 vs 75 per cent).<sup>10</sup> In addition, three-dimensional CT scanning is more specific than two-dimensional scanning.<sup>11</sup>

The best method of diagnosing and managing laryngeal injuries has been debated for many years. With regards to the choice and timing of surgery, Stassen *et al.*, in a retrospective study, found that the most frequent operative intervention for both blunt and penetrating injury was a primary airway repair within eight hours of the original injury.<sup>12</sup> Danic *et al.* suggested that acute laryngeal trauma should undergo definitive repair as the primary treatment within 24 hours.<sup>13</sup> As his injury occurred in Afghanistan, our patient fell outside this window for the timing of his primary repair. He was, however, assessed by a head and neck surgeon on day two. Surgery was intentionally delayed to allow the oedema to settle, resulting in an increased blood supply to the area and less chance of wound breakdown.<sup>14</sup>

- **Laryngeal injuries require prompt assessment of the airway, with stabilisation as required**
- **Surgical reconstruction can be delayed to allow stabilisation of the patient and transfer to an appropriate hospital**
- **Appropriate surgery and full use of the multidisciplinary team will lead to the best functional result for the patient**

The choice of repair in our case was miniplate fixation. A cadaveric study has demonstrated that the miniplate provided a stronger repair than wire-tube batton fixation, which in turn provided more strength than wire fixation alone.<sup>15</sup> The miniplate was used to distract the fragments and subsequently to maintain their position. The cervical fascia can also be used for immediate reconstruction of the larynx, with good resulting phonation.<sup>16</sup> Our patient's decannulation on the 10th day post-repair fits within the average range of 7 to 60 days post-repair.<sup>17</sup>

The need for multidisciplinary care is important during rehabilitation of these patients. Regular speech and language therapy, together with dietician input, will enable the patient to develop as much phonatory and swallowing ability as possible, while ensuring they do not become malnourished.<sup>18,19</sup> In such cases of military injuries, the Royal Marines Trauma Risk Management team work to ensure patients' psychological care, to help prevent post-traumatic stress disorder.<sup>20</sup>

The good functional outcome in our patient was almost certainly the result of his high level of fitness prior to his injury, coupled with his high degree of motivation. The speech and language therapy exercises he was given demanded regular practice and a significant level of commitment. He showed extraordinary compliance with his speech therapy regime and made extremely rapid progress through the levels of phonating exercises.

### Conclusion

Although laryngotracheal injuries are potentially fatal, the best chance of recovery is through appropriate management of the airway as a first line measure. The need for and timing of surgical reconstruction is best determined

TABLE I  
CLASSIFICATION AND MANAGEMENT OF LARYNGEAL INJURIES<sup>6,7</sup>

Grade	Laryngeal findings	Airway	Management
1	No fractures Minor lacerations Minimal oedema	Minimal airway symptoms	Observation Supportive medical care
2	Undisplaced fractures Mucosal damage without cartilage exposure	Mild airway compromise	Tracheostomy Microlaryngoscopy Bronchoscopy Oesophagoscopy
3	Displaced fractures Vocal fold immobility	Significant airway compromise	Tracheostomy Microlaryngoscopy Bronchoscopy Oesophagoscopy Open laryngeal exploration
4	Multiple fractures with instability	Significant airway compromise	Tracheostomy Microlaryngoscopy Bronchoscopy Oesophagoscopy Open laryngeal exploration
5	Laryngotracheal separation	Catastrophic airway obstruction	Tracheostomy Microlaryngoscopy Bronchoscopy Oesophagoscopy Open laryngeal exploration

by an experienced head and neck surgeon where time permits. Surgery itself may be delayed in certain cases without adverse effect.

#### References

- Thevasagayam MS, Pracy P. Laryngeal trauma: a systematic approach to management. *Trauma* 2005;**7**:87–94
- Danic D, Prgomet D, Milicic D, Leovic D, Puntaric D. War injuries to the head and neck. *Mil Med* 1998;**163**:117–19
- Bhojani RA, Rosenbaum DH, Dikmen E, Paul M, Atkins BZ, Zonies D *et al.* Contemporary assessment of laryngotracheal trauma. *J Thorac Cardiovasc Surg* 2005;**130**:426–32
- Danic D, Prgomet D, Sekelj A, Jakovina K, Danic A. External laryngotracheal trauma. *Eur Arch Otorhinolaryngol* 2006;**263**:228–32
- Rustemeyer J, Kranz V, Bremerich A. Injuries in combat from 1982–2005 with particular reference to those to the head and neck: a review. *Br J Oral Maxillofac Surg* 2007;**45**:556–60
- Schaefer SD. Primary management of laryngeal trauma. *Ann Otol Rhinol Laryngol* 1982;**91**:399–402
- Fuhrman GM, Stieg FH 3rd, Buerk CA. Blunt laryngeal trauma: classification and management protocol. *J Trauma* 1990;**30**:87–92
- Salvino CK, Dries D, Gamelli R, Murphy-Macabobby M, Marshall W. Emergency cricothyroidotomy in trauma victims. *J Trauma* 1993;**34**:503–5
- Grewal H, Rao PM, Mukerji S, Ivatury RR. Management of penetrating laryngotracheal injuries. *Head Neck* 1995;**17**:494–502
- Francis S, Gaspard DJ, Rogers N, Stain SC. Diagnosis and management of laryngotracheal trauma. *J Natl Med Assoc* 2002;**94**:21–4
- Meglin AJ, Biedlingmaier JF, Mirvis SE. Three-dimensional computerized tomography in the evaluation of laryngeal injury. *Laryngoscope* 1991;**101**:202–7
- Stassen NA, Hoth JJ, Scott MJ, Day CS, Lukan JK, Rodriguez JL, Richardson RD. Laryngotracheal injuries: does injury mechanism matter? *Am Surg* 2004;**70**:522–5
- Danic D, Milicic D, Prgomet D, Leovic D. Acute laryngeal trauma: a comparison between peace time and war injuries. *J Laryngol Otol* 1996;**110**:435–9
- Jonsson K, Jensen JA, Goodson WH 3rd, Scheusenstuhl H, West J, Hopf HW *et al.* Tissue oxygenation, anemia, and perfusion in relation to wound healing in surgical patients. *Ann Surg* 1991;**214**:605–13
- Lykins CL, Pinczower EF. The comparative strength of laryngeal fracture fixation. *Am J Otolaryngol* 1998;**19**:158–62
- Danic D, Milicic D, Prgomet D, Leovic D. Laryngeal war injuries. *Acta Med Croatica* 1995;**49**:33–7
- Gussack GS, Jurkovich GJ, Luteran A. Laryngotracheal trauma: a protocol approach to a rare injury. *Laryngoscope* 1986;**96**:660–5
- Brunicardi F, Andersoen D, Bullen T, Dunn D, Hunter J, Pollock R. *Schwartz's Principles of Surgery*. United States: McGraw-Hill Medical, 2005:235–240
- Freeman M, Fauzus M. *Voice Disorders and Their Management*. London: Whurr, 2000:69–88, 319–39
- Jones N, Roberts P, Greenberg N. Peer-group risk assessment: a post-traumatic management strategy for hierarchical organizations. *Occup Med (Lond)* 2003;**53**:469–75

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