Initial Airway Management of Blunt Upper Airway Injuries: A Case Report and Literature Review

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Introduction

Upper airway injuries due to blunt injury are uncommon, but may be life threatening, with their potential for rapid deterioration. The method of initial airway control is controversial. A case report involving the pre-hospital airway management of a patient with a significant blunt laryngeal injury is presented, followed by a literature review of the initial airway management of patients with these injuries. A suggested management algorithm is presented.

Case Report

A 23 year old man had presented to a general practitioner's surgery at Jindabyne, close to the New South Wales ski fields. The patient had driven himself in a 30 minute journey, after being struck on his anterior neck by a snowboard. Shortly before this event he had consumed a meat pie and a soft drink. On presentation, he was mildly dyspnoeic when sitting and unable to lie flat, as this resulted in increased dyspnoea. He had a hoarse voice and was unable to swallow saliva, which he was spitting out and was moderately blood stained. Intravenous access was obtained, and oxygen administered via a face mask. Oxygen saturation was 100% with supplementary oxygen and haemodynamic parameters were within normal limits.

The author (duty consultant for Southcare, which provides a helicopter retrieval service to Southern NSW and the Australian Capital Territory) was contacted and a retrieval activated. Due to the distance involved, a response time of one hour was anticipated. The local medical officer (LMO) was requested to arrange for lateral cervical and chest X-rays to be performed. She was also given instructions on how to perform a surgical cricothyroidotomy should airway obstruction occur.

On arrival of the retrieval team the clinical picture was as previously described. A remarkably calm, but concerned, young man was leaning forward, spitting out blood stained saliva. He did not appear to be significantly dyspnoeic in this position, but became quite dyspnoeic on even assuming the upright position. His anterior neck was diffusely swollen and exquisitely tender. This prevented palpation of the laryngotracheal skeleton and detection of crepitus. There were no other apparent injuries. In particular, his cervical spine was non-tender. His cervical spine X-ray (Figure 1) showed air in the pre-tracheal tissues, but the laryngotracheal air

Figure 1. Lateral cervical X-ray showing air in pre-tracheal tissues.

column appeared to be intact. No abnormality of the cervical spine was revealed and the chest X-ray was unremarkable. It was apparent that this young man had sustained a significant injury to his upper airway, but the exact level of injury was unknown.

Treatment options (as they appeared to the author at the time) were:

1. Observation. Continue oxygen therapy and transfer back to Canberra, a journey of approximately one hour, allowing for transfer by ambulance from the surgery to the helicopter landing site. Whilst appealing in its simplicity, the potential for deterioration with worsening oedema and the limited space for airway manoeuvres in flight weighed against it.
2. Surgical Airway. The author had never performed a tracheostomy and his only cricothyroidotomy had been on an unfortunate sheep at an EMST course. Furthermore, the anatomical landmarks were difficult to palpate, due both to oedema and the tenderness present.
3. Oral endotracheal intubation under general anaesthesia. No facilities for inhalation induction were available, but the author performs endotracheal intubation every day of his working life!

It was decided to follow the third option. Assistance was provided by two Australian Capital Territory Ambulance Service paramedics. After the patient was pre-oxygenated for three minutes in the sitting position, thiopentone 450 mg and suxamethonium 100 mg were administered, and cricoid pressure applied as the patient lost consciousness and was positioned supine. At laryngoscopy the epiglottis was visible, but the laryngeal inlet was obscured by blood (from a pharyngeal laceration). A size 7.0 cuffed oral endotracheal tube (ETT) was inserted to a greater depth than usual (25 cm at lips). This ETT was smaller than usual, to allow for anticipated narrowing of his airway. Its position was confirmed by end-tidal carbon dioxide monitoring and auscultation. Anaesthesia was continued with a morphine-midazolam infusion and transport to The Canberra Hospital was uneventful.

The patient was admitted to the Intensive Care Unit, where ventilation via the ETT and sedation continued. CT scan demonstrated a comminuted fracture of the cricoid cartilage and an undisplaced fracture of the thyroid cartilage. Surgical repair was performed on the next day. After induction of anaesthesia and formation of a tracheostomy, laryngoscopy and bronchoscopy revealed gross supralaryngeal and laryngeal oedema. One fragment of the cricoid cartilage was found to be displaced posteriorly, and there was a defect in the cricothyroid membrane (repaired with a tissue graft). The cricoid cartilage fractures were reduced and repaired with 4/0 Prolene sutures.

The patient's postoperative course was uneventful. His tracheostomy was decannulated on day 7. He was discharged on day 10 and, against medical advice, he returned to snowboarding within 3 weeks. Eleven months after the injury, he underwent laryngoscopy and bronchoscopy, which showed a polyp on the right vocal cord, which was removed. The rest of his laryngo-tracheal-bronchial tree appeared normal. One month after this he was reviewed by the ENT surgeon, and noted to have a "soft voice" but was otherwise well. He was then lost to follow up, failing to attend further appointments. However, he telephoned the surgeon's rooms some three years following the accident complaining that his voice was not normal. An appointment for review was made, but he failed to attend.

Literature Review

Upper airway injuries are relatively rare, mainly because the larynx and trachea are protected by their position relative to the bony protection of the mandible, sternum and cervical spine. Estimates of incidence vary widely, from 1:137,000 inpatient admissions[1] to 1:125 trauma admissions.[2] An unknown percentage of patients die before reaching medical attention. Estimates of pre-hospital mortality vary between 15%[3] and 81%.[4] This last figure includes patients with intrathoracic airway injuries.

Most reports and reviews are from the USA and report both penetrating and blunt trauma. Most deal with only small numbers of patients — the two largest series from single institutions present 120 patients over a 23 year interval,[5] and 46 patients over 5 years.[6] One analysis attempted to overcome the paucity of numbers by retrospectively examining an inpatient database of some 54 million patients (spread across 11 states of the USA) for patients admitted with blunt laryngeal trauma.[1]

Mechanism

Mechanisms of blunt upper airway injury include:

1. Unrestrained occupants of motor vehicles. Sudden deceleration of the vehicle causes the occupants to be thrown forward, usually with the head and neck extended, exposing the throat. Contact often occurs with the dashboard or steering wheel (or airbag in one report).[7]
2. Pedestrians versus motor vehicles.
3. Motorcyclists — especially "clothesline" type injuries.
4. Direct trauma resulting from interpersonal violence.
5. Attempted suicide by hanging.

While most of these modes of injury involve considerable force, O'Keefe cautions that even apparently trivial trauma may result in a life-threatening injury.[8] Perhaps as a consequence of the modes of injury, there is a preponderance of males, 77% in one series[1] and 86% in another.[6] The average age of patients was 37 and 33 respectively in these two series.

Location of Injury

Gussack has reported that 50% of injuries involve the cricoid cartilage and crico-thyroid membrane, with the remainder evenly distributed between injuries to the thyroid cartilage and thyrohyoid membrane, and the cervical trachea.[9, 10]

Complete laryngo-tracheal separation has been reported to occur in as many as 63% of patients with blunt airway injuries.[11] Injuries at the level of the cricoid cartilage are most likely to be associated with laryngo-tracheal separation.[11, 12] The larynx is connected to the trachea by the cricotracheal ligament, a thin elastic membrane, which is a relatively weak point.

When blunt injury causes laryngotracheal separation, the airway is often held in close approximation by peritracheal connective tissue and the soft tissues of the neck and mediastinum. This situation often allows the airway to remain patent in the short term provided that spontaneous negative pressure ventilation is maintained.

Diagnosis

While the presence of a penetrating airway injury is usually obvious, a high index of

suspicion is often required to diagnose patients with blunt airway trauma. Diagnosis is often more difficult as upper airway trauma is commonly associated with other injuries, especially closed head injuries, facial fractures, cervical spine injuries, injuries to the neck vessels and chest trauma. If the patient is intubated for other reasons, the diagnosis of airway injury may be missed. Cozzi reports the diagnosis of fractured thyroid and cricoid cartilages with airway compromise only being made after a second failed extubation in a patient with a closed head injury resulting from a motor vehicle accident.[13] The history of the injury may provide valuable information to the likely presence of an upper airway injury.

Signs and symptoms may be divided into major and minor. Major signs and symptoms are suggestive of significant airway injury.[2,14,15,16] These major diagnostic criteria are:

1. Subcutaneous emphysema (which may develop some time after the initial injury);
2. Dyspnoea;
3. Stridor; and
4. Inability to tolerate the supine position.

Fuhrman[2] emphasizes that patients unable to tolerate the supine position should be suspected to have sustained a cricotracheal separation, and should undergo immediate tracheostomy to secure their airway. Patients with these injuries are not static. Edwards[17] reported three patients who had initially stable airways, but who sustained respiratory arrests while being evaluated.

Minor diagnostic criteria include local swelling and tenderness, hoarseness of voice, dysphagia and haemoptysis.

Relevant investigations include:

1. Lateral cervical spine X-rays, which may reveal subcutaneous emphysema and the presence of cervical spine injuries.
2. Chest X-ray, which may reveal pneumothorax related to upper airway injury, and the presence of associated injuries.
3. Laryngoscopy, which may be direct or indirect. Indirect laryngoscopy may be challenging due to poor patient compliance and difficult visualisation. Direct flexible nasolaryngoscopy usually has better patient compliance, and allows assessment of vocal cord movement, patency of the airway above the trachea and integrity of the laryngeal mucosa. However, false negatives have been reported[18] and caution in the use of topical local anaesthetic has been advised, because of the risk of aspiration.[2,15]
4. CT of the larynx is the imaging mode of choice. This assesses the integrity of the laryngeal skeleton.[2,5] However, false negatives can occur, especially when the larynx and trachea are already splinted by a tracheal tube.[6,13]

Classification of Severity of Injury

Schaefer's classification is most commonly used:[5]

1. Minor endolaryngeal haematomas or lacerations, without detectable laryngeal fractures.
2. Laryngeal oedema or haematoma, or minor mucosal disruption without exposed cartilage.
3. Massive oedema, large mucosal lacerations, exposed cartilage, displaced fractures, and vocal cord immobility.
4. As per group 3, but with comminuted or unstable fractures.

Initial Airway Management

The mode of initial airway management is controversial, and in the author's opinion, needs to be tailored to fit each individual case. Schaeffer's classification may assist in planning treatment, but is of little value to the clinician faced with a patient with a suspected airway injury prior to investigation.

Treatment options include:

a. Observation, which Schaeffer recommends for patients in Group 1, for a minimum of 24 hours.[5]
b. Surgical tracheostomy under local anaesthesia (LA). This is recommended as the airway management of choice by the majority of authors, for all patients save those with mild injuries in Schaeffer's Group 1.[2, 5, 6, 11, 16, 17, 19, 20, 21, 22] However, the use of surgical tracheostomy under LA may be restricted by several factors, including the requirement for surgical expertise, a need for patient co-operation (may be limited by patient age, hypoxia or confusion due to other causes), difficult anatomical landmarks due to oedema or haematoma, and a need for urgency in securing the airway. Furthermore, should the injury be at the distal tracheal or bronchial level, then a tracheostomy will be of no benefit.
c. Oral endotracheal intubation under general anaesthesia (GA). This is recommended as the technique of first choice by some authors.[9, 10, 12, 14] It is likely to be the fastest and least invasive mode of securing the airway. Even patients with complete laryngotracheal separation have been reported to be successfully intubated orally.[23] However, cricoid pressure[6] and positive pressure ventilation[6, 15] are both contraindicated, as they may cause further airway disruption.

   Gussack[9, 10] concludes that oral intubation can be successfully performed provided that it is done under direct vision only, performed by an experienced practitioner, and with a smaller tube than normal. However, the practitioner must be prepared to move rapidly to tracheostomy if intubation proves difficult. He reserves tracheostomy for patients with obvious severe airway disruption from blunt injury, those with penetrating injuries opening into the inferior larynx or trachea and for failed intubation. Other authors caution that oral intubation may result in inability to pass the tube due to the formation of a false passage or completion of cricotracheal separation.[2, 5, 6, 11, 16, 19] The mode of induction (intravenous versus inhalation) is discussed in few of the papers under review. Inhalation induction theoretically may be superior, due to maintenance of spontaneous ventilation and avoidance of positive pressure ventilation.[6, 15] However, this must be balanced against the risks of a full stomach, or the presence of an uncooperative patient.
d. Rigid bronchoscopy under GA is recommended by some authors as the best technique of securing the airway, while simultaneously diagnosing the severity and level of injury. Theoretically, an inhalation induction may be preferred, for the same reasons (and with the same risks) as above. It has been particularly recommended for distal tracheal and bronchial injuries,[24] and for airway injuries in the paediatric population.[15, 20] However, a degree of skill and practice, possessed by few practitioners other than ENT or thoracic surgeons, is required for its use. Furthermore, should the cervical spine be unstable, its use is contraindicated.
e. Awake fibreoptic intubation is also recommended by some authors.[6, 7, 25, 26, 27] For distal tracheal or bronchial injuries it may well be a method of choice for securing the airway.[20] However, there is a recent case report of three cases of laryngeal trauma induced in elective intubations in patients with non-traumatised airways,[28]

and it is likely that traumatised larynxes are more at risk. While the passage of the fibreoptic bronchoscope should be non-traumatic, the act of "railroading" the ETT over it may well aggravate any injury, and has been reported to cause completion of laryngotracheal separation.[11, 22]

f. Awake nasal intubation is contraindicated as attempts to pass an ETT blindly can cause further injury. Attempted blind nasal intubation has been reported to result in completion of laryngotracheal separation.[6]
g. Awake oral intubation under direct vision is theoretically possible, but coughing or gagging could cause disruption of an otherwise patent airway. This is not mentioned as a technique in any of the papers under review.
h. Surgical or needle cricothyroidotomy is not recommended, as the cricoid is often the level of the injury, which may well be aggravated.[20]
i. Percutaneous tracheostomy is also not recommended, as it may result in aggravating the injury.[6, 22]

DISCUSSION

Laryngotracheal injuries resulting from blunt trauma are fortunately rare, but may have dire consequences. A high index of suspicion is required to make the diagnosis, as they are often associated with other, more obvious injuries such as closed head injuries, cervical spine injuries, facial trauma, and chest trauma. Conversely, life threatening injuries may be associated with an apparently trivial injury.

There is controversy regarding the best method of securing the damaged airway. The majority of authors concur that tracheostomy under local anaesthetic is the "gold standard" and the safest option. However, where personnel are lacking surgical expertise, where there is urgency to secure an airway, or where patient co-operation is lacking, oral intubation under GA is a reasonable option. If personnel skilled in the use of a rigid bronchoscope are available, then this is a reasonable option (again under GA) to both diagnose the lesion and secure the airway, provided the cervical spine is stable.

If oral intubation under GA is chosen, there are theoretical grounds to favour inhalational induction and preservation of spontaneous ventilation. However, the presence of a full stomach, an uncooperative patient, or coughing or gagging may favour intravenous induction, with the proviso that cricoid pressure and positive pressure ventilation should be avoided when possible.

In the case presented, the author was limited by a lack of surgical skill to perform a tracheostomy under LA. In retrospect, the application of cricoid pressure had the potential to aggravate the injury. The choice of ETT size was appropriate. A size 7.0 cuffed ETT is smaller than would normally be chosen for an adult male, but is still of a sufficient size to permit adequate ventilation and suction. Possibly an even smaller ETT would have sufficed. A 6.0 ETT was available should the 7.0 have been difficult to insert. The ETT was placed to a greater depth than usual so that the tip was hopefully beyond the level of injury, but remained above the carina. In the "out-of-hospital" setting there was no option to check the position with a flexible bronchoscope. It should be noted that the author's "fall-back" technique should oral intubation have proven impossible, cricothyroidotomy, may well have resulted in completion of crico-tracheal separation in this case.

A suggested protocol for management of patients with these injuries is given below (Figure 2).

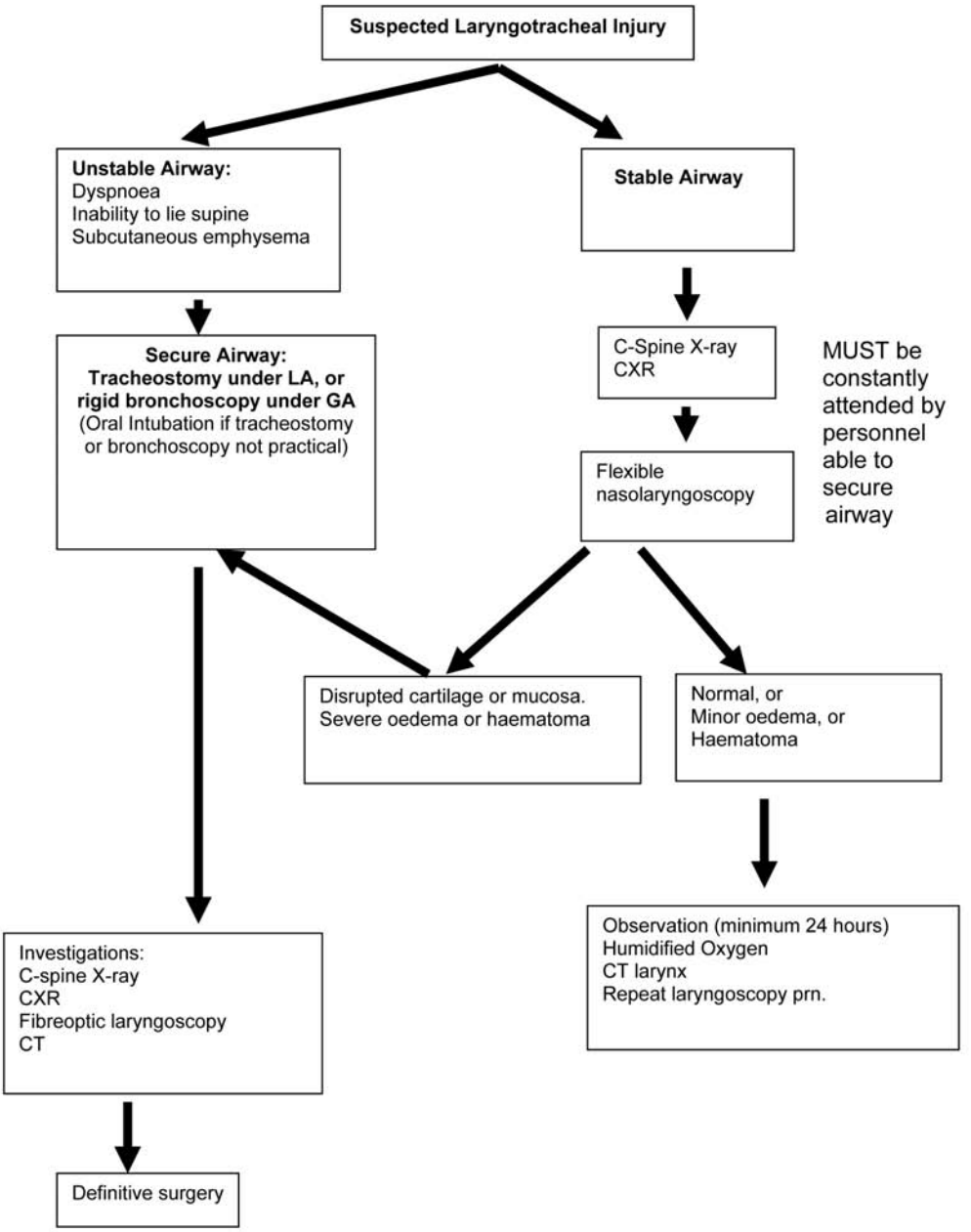

Figure 2. Suggested protocol for initial airway management and investigation of patients with suspected laryngotracheal injuries. (Adapted from Waldron RJ, Young RJ).[22]

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