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Research article

Management of traumatic hyoid bone fractures: A case series

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ABSTRACT

Purpose: Hyoid bone fractures are uncommon, reported mainly in cases of hanging. There is a paucity of reports involving other mechanisms, and only a handful of case reports are available to guide the management of these fractures, especially within the emergency department setting. This study focused on identifying optimal initial airway management and subsequent treatment of patients with hyoid fractures.

Methods: Patients presenting to an adult major trauma referral centre between January 2007 and July 2014 with a diagnosis of hyoid bone fracture were identified. Patient records were reviewed retrospectively.

Results: Of the 19 patients identified, 16 cases were secondary to blunt force trauma. Motor vehicle crashes accounted for eight of the 19 cases. All patients with major trauma were intubated as part of their initial airway management, while 50% of the minor trauma patients were intubated. Only one patient underwent surgical repair of the hyoid bone. Most patients experienced excellent outcomes with no hyoid fracture-related complications.

Conclusion: Early intubation for suspected hyoid fractures is advised for those with a penetrating mechanism of injury, clinical features of airway compromise, and severe associated injuries. Conservative, nonsurgical management of hyoid fractures remains the mainstay of management. A minimum 24-hour period of observation for patients who are not managed with endotracheal intubation is advised.

Keywords: Hyoid, fracture, trauma, airway, management

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INTRODUCTION

The hyoid is a slender U-shaped bone that is suspended beneath the mandible at the level of the third cervical vertebra. Superiorly, it is attached to the styloid processes of the temporal bones by the stylohyoid ligaments. Inferiorly, the thyrohyoid membrane loosely connects the hyoid firmly to the thyroid cartilage. It is unique because of its isolation from the rest of the human skeleton, rendering it highly mobile. The hypoglossal nerve is situated just above the tip of the greater cornu of the hyoid bone.[1] The hyoid bone provides for the attachment of the suprahyoid and infrahyoid muscles. It participates in all the functional and nutritional activities of the orofacial complex including swallowing and phonation; it acts as a base for the tongue and plays a role in maintaining a patent airway.

Owing to the bone's protected position and mobility, it is rare for an isolated fracture of the hyoid to occur. When the neck is hyperextended however, it loses this anatomical protection and becomes vulnerable to fracture.[2] Due to their frequent association with injuries to the mandible, larynx, pharynx, and the cervical spine, fractures of the hyoid might not be recognized immediately.[3] This is mainly because hyoid fractures can be asymptomatic with a few reported cases of rapid cardiorespiratory compromise secondary to missed diagnosis.[4]

The prevalence of hyoid bone fracture is reported as being 0.002% of all fractures;[5] however, this statistic appears to be determined anecdotally from references as far back as 1949. An incidence as high as 1.15% has also been reported.[6] A systematic review of 46 cases from 36 articles published by Ramchand et al., in 2012 recommended conservative nonsurgical means as first-line treatment in the management of most hyoid fractures.[3] The authors recommended reevaluation if the patient's condition deteriorated or did not improve. Owing to their rarity, only a handful of case reports have been published in medical literature, with no clear consensus for their management. This case series sought to examine the incidence, initial management of hyoid fractures, and patient outcomes presenting to a single major trauma centre in Australia.

METHODS

The study was conducted at the Emergency & Trauma Centre, The Alfred Hospital, an adult major trauma centre in the state of Victoria, Australia. The state is serviced by one paediatric and two adult Major Trauma Service (MTS) centres catering to a population of approximately 5 million people. Major trauma triage guidelines direct approximately 85% of major trauma patients to a MTS centre for definitive treatment.[7] The Alfred Emergency & Trauma Centre receives in excess of 2000 trauma patients per year with over 1300 patients having an Injury Severity Score (ISS) of >15.

Patients with a coded ICD-10 diagnosis of hyoid fractures that presented between January 2007 and July 2014 were identified (hyoid bone S12.8). Among these patients, cases with computerised tomography (CT) confirmation ($n = 18$) or an operation report ($n = 1$) documenting direct visualisation of the hyoid fracture were included in this study. An explicit chart review of the medical records of these patients was conducted to extract the presentation and management of the hyoid fractures.

Data collected included age; sex; the mechanism of injury; ISS; initial Glasgow Coma Score (GCS) as recorded by the attending paramedics; mode of management of the airway; timing and place of intubation if performed; any documentation of 'difficult' intubation; subsequent management of the airway; associated injuries; hospital length of stay (LOS); discharge destination from hospital; and mortality. Major trauma was defined by an ISS of >15.

RESULTS

There were 29,976 trauma presentations to The Alfred E&TC over the study period. Of these, 19 cases of traumatic hyoid bone fracture were identified, giving an incidence of 0.063% (95% CI: 0.033%–0.093%). One patient was female, the remainder were males. The ages ranged from 21 to 87 years (median = 46 years). There were 13 patients defined as major trauma. Tables 1A and 1B outline the characteristics and subsequent management of these patients. Tables 2A and 2B outline the characteristics and management of patients with minor trauma ($n = 6$).

A history of direct trauma to the hyoid region was documented in all 19 cases, with 84% ($n = 16$) of the fractures caused by blunt injury. Vehicular incidents comprised almost half of the cases (47%, $n = 9$) and 56% of blunt injury cases – four cases involved cars, four involved motorbikes, and one incident occurred whilst the patient was riding a bicycle. Among other blunt injury mechanisms, two occurred at the workplace – Patient 2 suffered a crush injury to the head and neck secondary to

Table 1A. Patient characteristics – major trauma.

Patient no.	Age (years)	Sex	Mechanism of injury	Initial GCS	Injury Severity Score	Associated injuries
1	56	M	CC	10	75	A, C, P, S
2	70	M	Crush injury	3	29	F, H
3	26	M	Self-harm – laceration	13	26	Ly, N
4	31	M	Fall >20 m	3	66	F, H, L
5	40	F	CC	3	41	A, F, H, S
6	50	M	Self-harm – laceration	15	43	B, N
7	30	M	MBC	14	29	F, S, L
8	40	M	CC	3	41	C, F, H, L, P
9	77	M	Self-harm – laceration	14	18	Ly, N
10	65	M	Self-harm – strangulation	3	22	C, L, P
11	46	M	Assault with a hammer	13	29	F, H, Ly
12	34	M	MBC	10	57	C, F, H, S
13	43	M	CC	13	57	C, F, H, S, L, Ly

M: male; F: female; CC: car crash; MBC: motorbike crash; GCS: Glasgow Coma Score.
Associated injuries: A = intra-abdominal; B = burns; C = chest; F = facial; H = head; L = long bone; Ly = laryngotracheal; N = other neck structures; P = pelvis; S = spinal.

entrapment in machinery equipment, while Patient 4 fell from a crane at a 25-metre height. One patient (Patient 19) fell from standing height but sustained impact to his neck upon contact with a table. A further two blunt injury cases were secondary to alleged assault (Patient 14 was punched, while Patient 11 was hit with a hammer). Two patients presented post-hanging from attempted self-harm. All three cases of penetrating-injury-related hyoid fractures were caused by self-inflicted lacerations.

No patients had isolated hyoid fractures. The most commonly associated injuries in all patients were facial bone fractures, which were present in 10 (53%) cases. Seven patients sustained concomitant laryngotracheal injuries. Further associated injuries included intracranial ($n = 7$), spinal ($n = 7$), chest ($n = 6$), long bone ($n = 5$), pelvic ($n = 3$), neck ($n = 4$), and intra-abdominal ($n = 2$) injuries and burns ($n = 1$).

Facial bone fractures were also most common among the minor trauma patients. Additionally, two of the six minor trauma patients had associated minor cervical spine fractures – Patient 16 suffered a C7 transverse process fracture, while Patient 17 sustained a C5 spinous process fracture.

There were 16 cases that were intubated as part of the initial airway management using the rapid sequence induction (RSI) technique. Of these, nine were carried out by paramedics, with only one case documented as 'difficult' (Patient 1). Of those intubated in the emergency department (ED; $n = 6$), two were documented as 'difficult' (Patients 9 and 19). Patient 11 was taken to theatre for extensive facial trauma and intracranial injury, and underwent standard direct laryngoscopic intubation by an anaesthetist.

All major trauma cases were intubated, five of which had an initial GCS of 3. One patient (No. 6) was intubated at the scene specifically for the management of obvious tracheal injury, while the remaining were intubated for the management of associated injuries. When considering the four isolated neck injuries (Patients 3, 9, 14, and 18), three were intubated.

Of the six minor trauma cases, three were intubated, including one en route to hospital. The rationale for intubation in Patient 15 was signs of obvious airway compromise (including hoarse voice and stridor), while Patient 16 was intubated for agitation and combativeness. Patient 19 was intubated for stridor and neck swelling. Subsequent tracheostomy was performed in six of the 16 patients for management of multiple complex injuries requiring prolonged ventilation, while the rest were managed with endotracheal tube (ETT).

The hyoid fractures in all minor trauma cases were managed conservatively. Only one patient with major trauma underwent surgical repair of the hyoid fracture (Patient 9). Patient 9 was also the only patient whose hyoid fracture was confirmed on direct visualisation. Interestingly, he did not undergo subsequent CT scanning. The primary indication for surgery in this patient was exploration of associated penetrating deep neck lacerations. This patient was documented to have a difficult intubation with two failed attempts in field. Postoperatively, he was managed with an ETT.

The most common site of hyoid fracture was the limb of the greater horn ($n = 11$), with 95% being unilateral. Only Patient 14 was found to have a fracture of the body of the hyoid, while Patient 18

Table 1B. Patient management – major trauma.

Patient no.	Intubation	Time of intubation	Documented "difficult" intubation	Subsequent airway management	Hyoid fracture details	Conservative management of hyoid fracture	LOS (days)	Discharge outcome	ENT follow-up
1	Y	Scene	Y	Trache	R; junction; undisp	Y	39	Rehab	N
2	Y	Scene	N	Trache	L; junction; undisp	Y	126	Rehab	N
3	Y	ED	N	Trache	R; junction; undisp; medial angulation	Y	6	Rehab	Y
4	Y	Scene	N	ETT	L; GH; superiorly displaced; medial angulation	Y	46	Rehab	N
5	Y	Scene	N	ETT	R; GH; lateral angulation	Y	30	Rehab	N
6	Y	Scene	N	Trache	R; GH; undisp	Y	140	Rehab	N
7	Y	ED	N	ETT	L; junction; displaced; medial angulation	Y	23	Rehab	N
8	Y	Scene	N	Trache	R; junction; lateral angulation	Y	8	Deceased	N/A
9	Y	ED	Y	ETT	L; GH inferiorly displaced	N	14	Rehab	Y
10	Y	Scene	N	ETT	R; distal GH; undisp	Y	1	Deceased	N/A
11	Y	OT	N	Trache	L; junction; undisp; lateral angulation	Y	16	Home	Y
12	Y	ED	N	ETT	L; distal GH; displaced	Y	19	Rehab	N
13	Y	Scene	N	ETT	R; GH; undisp	Y	16	Rehab	N

Y/N: Yes/No; ED: emergency department; OT: operation theatre; Trache: tracheostomy; ETT: endotracheal tube.
Hyoid fracture details: R = right; L = left; junction = junction of the body and greater horn of the hyoid; GH = limb of the greater horn of the hyoid; undisp = undisplaced.
LOS: hospital length of stay; Rehab: rehabilitation institution; ENT: ear, nose, and throat surgery.

Table 2A. Patient characteristics – minor trauma.

Patient no.	Age (years)	Sex	Mechanism of injury	Initial GCS	Injury Severity Score	Associated injuries
14	59	M	Assault – fist	15	11	Larynx fracture
15	47	M	MBC	15	14	Orbital fracture, larynx fracture
16	21	M	MBC	14	6	C6/C7 TP fracture
17	57	M	Bicycle crash	14	14	LeForte III, C5 SP fracture
18	31	M	Self-harm – strangulation	15	14	Soft tissue neck injury
19	87	M	Fall	15	11	Rib fracture

M: male; F: female; MBC: motorbike crash; GCS: Glasgow Coma Score; C5/6/7: corresponding C spine; TP: transverse process; SP: spinous process.

sustained bilateral greater horn fractures after attempted self-harm by strangulation. The degree of fracture displacement and angulation varied greatly, even when considering the mechanisms of injury.

Of the six patients with minor trauma, two (Patients 14 and 15) were treated with adjunctive steroids (dexamethasone) for airway oedema. In both cases, the rationale for steroid treatment was the finding of stridor and hoarseness of voice. Patient 14 presented to the ED with hoarseness of voice and odynophagia and was discharged within 24 hours after steroid therapy. Interestingly, Patient 15 was initially noted to have dysphonia but no swallowing or airway difficulty. However, he underwent an emergency intubation en route to hospital for rapidly developing stridor. He received steroid therapy and was subsequently extubated within 48 hours. Patient 16 who was intubated in the ED for agitation, was diagnosed with the hyoid fracture incidentally on CT scanning. He was extubated within 24 hours. Patient 17 had a prolonged hospital stay for the management of associated injuries. Patient 18 was discharged after four days, mainly managed in hospital for deterioration in mental health. Patient 19 was extubated after three days with no hyoid fracture-related complications. He subsequently died due to multiple underlying comorbidities including end-stage cardiac failure and chronic pleural effusions.

There were two further deaths at hospital discharge (secondary to multiple injuries), one within 24 hours of hospital admission. Among the 13 major trauma patients, 10 were discharged to a rehabilitation facility, with one patient being discharged home directly. Hospital LOS varied between 1 to 140 days. With the exception of Patient 19, all patients with minor trauma were discharged home, with two patients discharged within 48 hours.

Outpatient Ear, Nose, and Throat (ENT) unit follow-up was arranged for five of the 16 surviving cases (31%). All five cases (Patients 3, 9, 11, 14, and 15) sustained associated laryngeal fractures and had documented voice changes at the time of discharge. The rationale for the follow-up of these patients was to assess for residual dysphonia. Initial follow-up times varied between 4–6 weeks post-discharge. Interestingly, Patients 11, 14, and 15 had residual hoarseness of voice on follow-up. Only Patient 13, with undisplaced laryngeal and hyoid fractures, was not followed up. He did not have documented dysphonia. No patients, regardless of follow-up, underwent subsequent imaging to assess hyoid fracture healing.

DISCUSSION

To date, this is the largest reported single-centre case series on hyoid fractures among adult patients. Incidence of the injury appears low, consistent with previous literature. Cases with concomitant severe injuries were managed by securing the airway, but those with isolated neck or minor associated injuries were successfully managed by observation. The presence of a hyoid fracture did not appear to add to the degree of difficulty of orotracheal intubation. Surgical repair of the hyoid bone was rarely performed.

Historically, the diagnosis of a hyoid fracture was taken as evidence of strangulation or hanging. During postmortem examination, hyoid fractures were found to be present in an estimated 21% of deaths due to constriction of the neck.[8] In recent times, presentations of hyoid fractures have been noted increasingly in association with motor vehicle crashes (MVC). Kaufman et al.,[4] provided a schematic representation of the mechanism of hyoid fracture in MVCs, with Ramchand et al.,[3] also

Table 2B. Patient management – minor trauma.

Patient no.	Intubation	Time of intubation	Documented "difficult" intubation	Subsequent airway management	Hyoid fracture details	Adjunct steroids	LOS (days)	Discharge outcome	ENT follow-up
14	N	N/A	N/A	N/A	R; body; undisp	Y	1	Home	Y
15	Y	En route	N	ETT	L; GH; displaced & medial angulation	Y	6	Home	Y
16	Y	ED	N	ETT	L; GH; medial displacement; angulation	N	2	Home	N
17	N	N/A	N/A	N/A	L; distal GH; undisp	N	8	Home	N
18	N	N/A	N/A	N/A	L & R; GH undisp; L: medial angulation; R: lateral angulation	N	4	Home	N
19	Y	ED	Y	ETT	L; GH; displaced	N	22	Deceased	N

Y/N: Yes/No; ED: emergency department; en route: during transport from site to hospital; N/A: not applicable; ETT: endotracheal tube.
Hyoid fracture details: R = right; L = left; junction = junction of the body and greater horn of the hyoid; GH = limb of the greater horn of the hyoid; undisp = undisplaced.
Class: Weintraub classification.
LOS: hospital length of stay; Rehab: rehabilitation institution.

Table 3. Schaefer–Fuhrman classification of laryngeal injury.[11–13]

Group 1	Minor endolaryngeal hematomas or lacerations No detectable fracture No airway compromise
Group 2	Oedema, hematoma, and minor mucosal disruption without exposed cartilage Non-displaced fracture Varying degree of airway compromise
Group 3	Massive oedema, large mucosal lacerations, and exposed cartilage Displaced fracture(s) Vocal cord immobility
Group 4	Same as group 3 but more severe with: Severe mucosal disruption Disruption of the anterior larynx Unstable fractures Two or more fracture lines

postulating that MVCs expose the hyperextended neck area to blunt force trauma. Several case reports have highlighted the incidence of hyoid fracture after direct trauma, such as helmet injury.[9,10]

Our study confirmed that blunt injury from MVC was the most common mechanism for hyoid fracture in our population. As in previous studies, the overwhelming majority of the cases were in males.

Upon presentation to the ED, there should be a high index of suspicion for airway injury if trauma has been sustained to the lower facial structures or neck. Blunt neck trauma should raise the suspicion of laryngotracheal injury. This is best categorized by the Schaefer–Fuhrman classification (Table 3)[11–13] for blunt neck trauma. While the Schaefer–Fuhrman classification combines clinical, endoscopic, and radiological findings, it may serve as a guide to the urgency and anticipated degree of difficulty in securing the airway. Predisposing mechanisms involving direct trauma to the neck should also raise the suspicion of a hyoid bone fracture. Diagnosis may be made more difficult by the presence of closed head injuries, facial fractures, cervical spine injuries, and injuries to the large vessels and chest.

Early intubation of patients with suspected hyoid fractures, especially in patients with associated severe injuries, is prudent and practiced in the majority of cases. Advanced airway techniques, such as awake fiberoptic intubation or nasoendoscopy, to assist with airway visualisation may be ideal. However, they are not suited for the field, nor in a patient who may be uncooperative or intoxicated. Securing the airway does not appear to be made difficult in isolated hyoid fractures, with prehospital and ED personnel successfully intubating the majority of these patients on the first attempt. Newer intubation techniques involving video laryngoscopes may increase visualisation while still allowing rapid intubation and portability, and thus, can be useful tools in securing the airway. Evidence of lacerations to the pharynx, oedema, haematoma, and fragments of hyoid bone perforating pharyngeal mucosa may be noted in up to 30% of intubations via laryngoscopy.[4]

Once the airway is secured, it appears that a hyoid fracture in itself without airway oedema is benign and not attributed as a direct causative factor towards mortality. From their observations of isolated hyoid fractures, Szeremeta and Morovati[14] and Kaufman et al.,[4] recommend that the patient be observed for at least 48–72 hours for airway obstruction as a late complication. Soft tissue swelling and compressive forces from haematoma formation can cause rapid hypoxia and cardiovascular demise, as was experienced by one patient in this report (Patient 15).

The role of steroids in the management of airway oedema secondary to hyoid fractures has not been well studied, although their theoretical benefit overshadows the minimal risk of adverse side effects, justifying their use. Two patients in this case series were managed with dexamethasone – one intubated and one without intubation.

Conservative treatment, rather than surgical repair, remains the mainstay of hyoid fracture management. Surgical repair is reserved for patients with associated laryngopharyngeal lacerations and bony fragments, diagnosed either on direct laryngoscopy or through CT imaging. This study found a 5.2% rate of surgical management. Comparatively, Ramchand et al.,[3] reported that 10.9% of cases underwent surgical repair of hyoid fractures. In light of these findings, the authors have proposed a flowchart for the management of hyoid fractures (Figure 1).

Dalati et al.,[6] report that prognosis for hyoid bone fractures is excellent, even in cases of nonunion. Osseous healing in any fracture typically takes 6 weeks. Symptom resolution for hyoid fractures has been reported between 2–8 weeks.[2,10] Thus, surgical repair is recommended only for compound hyoid

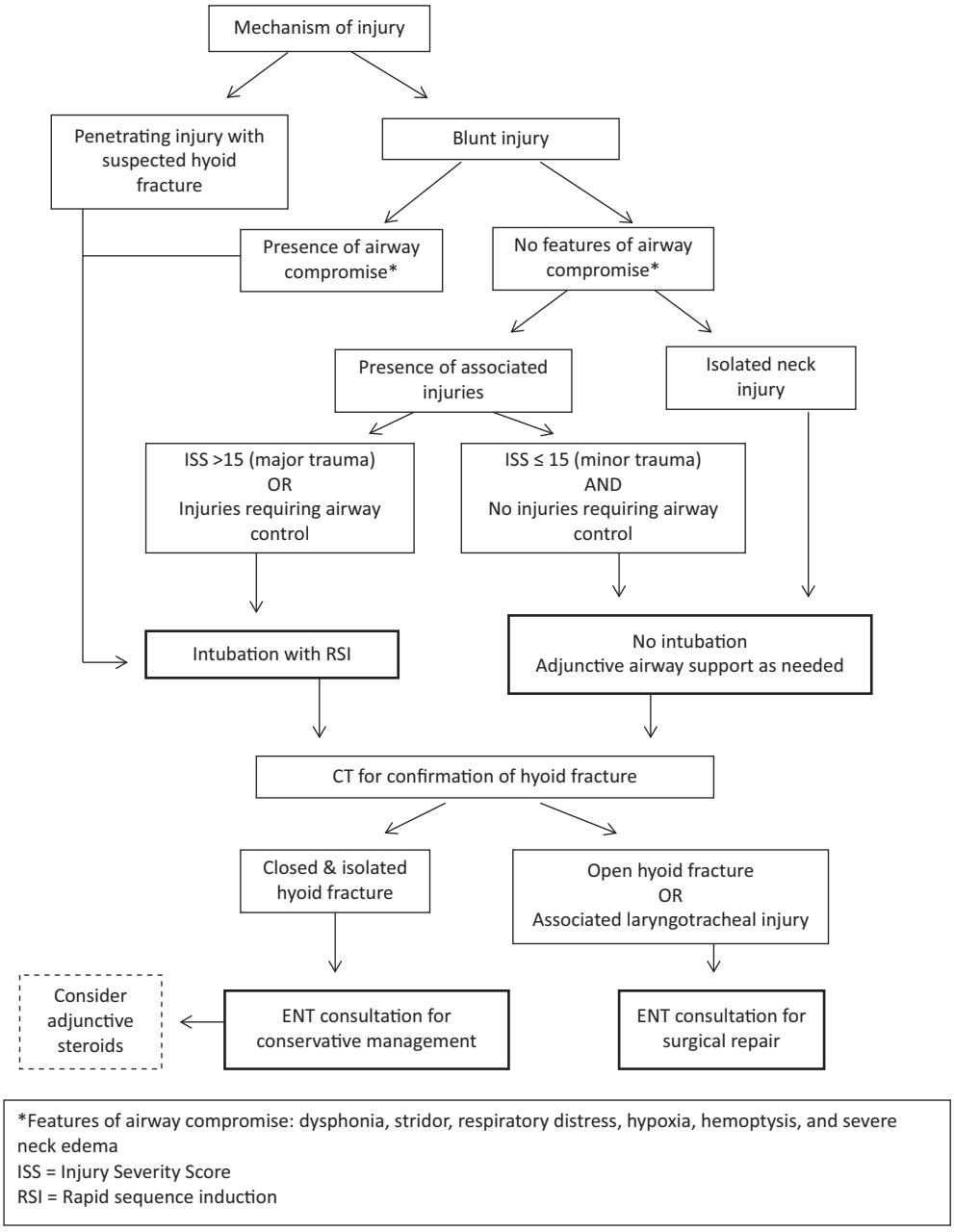

Figure 1. Initial management of traumatic hyoid bone fractures.

fractures and those associated with laryngopharyngeal lacerations.[13] It appears that for these same reasons, subsequent imaging to assess hyoid fracture healing is unnecessary.

Weintraub[15] proposed a classification system upon posthumous examination of hyoid fractures secondary to hanging and strangulation (Table 4). The authors noted that while this classification is relevant in retrospectively identifying the mechanism of injury, it is not inclusive of all hyoid fractures. In particular, the classification system is based on the direction of angulation of the fracture fragment (regardless of site). This system was not useful for Patients 1, 2, 6, 13, and 14, whose fracture fragments had no angulation. Moreover, this classification system had no bearing on the initial or subsequent management of the hyoid fractures. A CT image of Patient 16 (corresponding to Weintraub A type fracture) is presented in Figure 2, while that of Patient 11 (corresponding to Weintraub B type fracture) is presented in Figure 3.

This study was unable to comment on the common presenting symptoms and signs of hyoid fractures, given that a significant number of patients were unconscious at the scene. Even amongst

Table 4. Weintraub classification of hyoid bone fractures.[15]

A	Inward compression fracture • Result of manual strangulation • Greater horns compressed toward each other • Fractured fragment angulated or displaced medially
B	Anteroposterior compression fracture • Result of hanging or force in the anteroposterior direction • Greater horns diverge from each other • Fractured fragment angulated or displaced laterally • In cases of bilateral greater horn fractures, at least one fragment displaced laterally
C	Avulsion fracture • Result of muscular overuse; not seen with direct injury to the hyoid

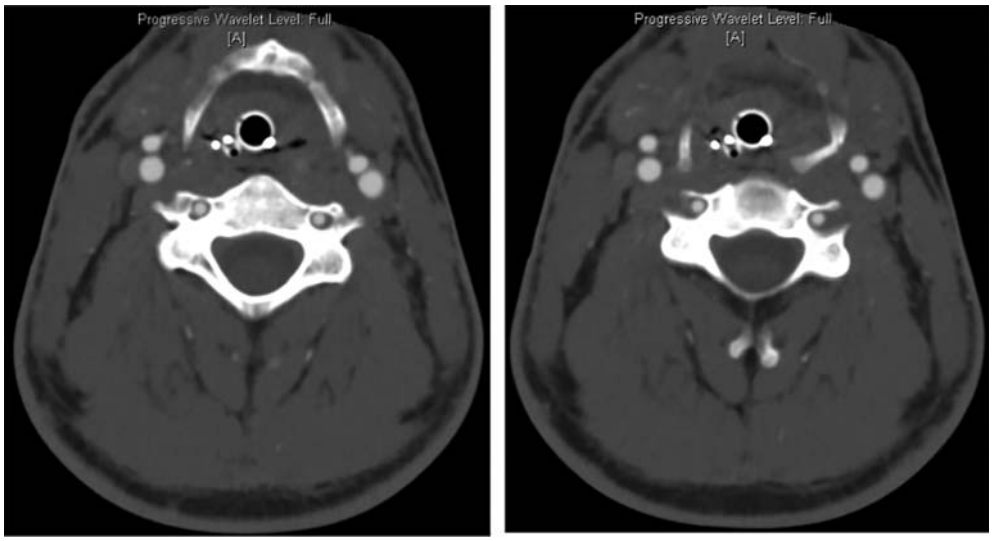

Figure 2A & 2B. Axial CT neck slices of Patient 16. Fracture of the left greater horn of hyoid with medial angulation of distal fragment (Weintraub classification A – Inward compression fracture).

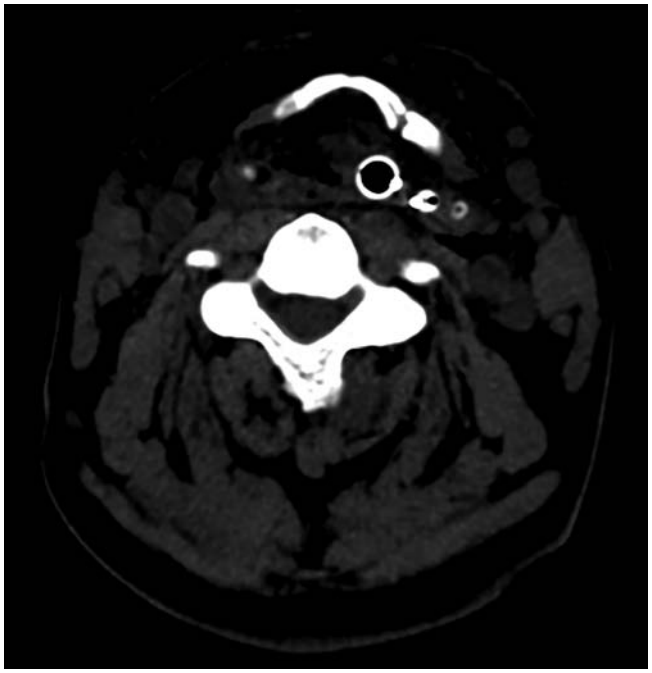

Figure 3. Axial CT neck slice of Patient 11. Fracture at the junction of the left hyoid body and greater horn with lateral angulation (Weintraub classification B – Anteroposterior compression fracture).

those who were conscious, patients' presenting symptoms were poorly documented, probably owing to the concomitant severe injuries at presentation. This report was further limited in identifying patients who were discharged with a recorded diagnosis. As hyoid fractures may be asymptomatic, a possibility of missed diagnosis exists and may have underestimated the true incidence of this condition. Early airway management and use of steroids continue to be recommended based on trauma resuscitation guidelines, rather than prospective comparative trials. Such trials are extremely unlikely due to the low incidence of this injury.

CONCLUSION

Hyoid fractures are uncommon, but should be sought for after history or examination findings of anterior neck trauma. Early intubation is practiced in the majority of cases and steroids are used sporadically to manage the resulting oedema. It is recommended that patients managed without intubation be observed for a minimum of 24 hours. Most patients did not undergo surgical repair of the hyoid bone, nor subsequent imaging to assess fracture healing. Outcomes appear to be determined by associated injuries rather than injury to the hyoid bone.

COMPLIANCE WITH ETHICAL REQUIREMENTS

This study was approved by The Alfred Research and Ethics Committee.

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