Case Report

Use of high flow oxygen (HFO) for difficult airway management in Jael syndrome: a case report

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Abstract: Jael Syndrome is defined as an intentional craniofacial stab injury. There are few cases in the medical literature describing such facial impalements with the presence of the instrument in the face. Such cases present a complex challenge, involving many specialities, and in particular requires cautious considerations in the immediate preoperative management and intubation of such patients. The use of High Flow Oxygen (HFO) has an increasingly popular role in anaesthetic and intensive care practices, with numerous studies supporting its efficacy in preoxygenation and increasing the safe apnoea time prior to intubation. We report the case of a 20 years old man who presented with facial impalement with a kitchen knife following an altercation. Imaging confirmed that the knife passed through the nasopharynx and was embedded in his right occipital condyle. He was transferred to theatre, where prior to the removal of the implement and haemostasis control, he was preoxygenated using (HFO) and his airway secured with video laryngoscopy. Post operatively, he was kept sedated and ventilation in the Intensive Care Unit (ICU) prior to being successfully extubated and transferred to the ward. He was subsequently discharged form hospital with only mild sensory loss secondary to the injury. This case highlights the technical difficulties associated with the preoxygenation and intubation in patients presenting with facial impalement, and in particular use of HFO in providing for an extended safe apnoea time prior to securing a difficult airway in the context of maxillofacial trauma.

Keywords: Case report; oxygen; maxillofacial injuries; rapid sequence induction and intubation

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Introduction

Jael syndrome is named for a woman from the Bible. According to the verse, Jael killed Sisera, Commander of the Canaanite army, by driving a tent peg using a hammer into his temple (1).

There are only a few cases in the medical literature describing face impalement with the presence of the instrument in the face. Jael syndrome was first reported by Jefferson in 1968 when reporting the case of a 16 years old impaled with a tent peg (2), and was later defined by Harris *et al.*, in 1988, as an intentional craniofacial stab injury (3).

Jael syndrome is a rare occurrence. Very few trauma centres would have adequate experience in the management of such injuries. The management is multidisciplinary involving pre-hospital health care professionals, maxillofacial surgeons, radiologists, anaesthetists, intensive care physicians and, in some instances, neurosurgeons.

The management of these cases can be particularly challenging as the patients are often anxious, under the influence of alcohol or illicit drugs. Depending on the extent and depth of penetration, the instrument may be either removed under local anaesthesia or general anaesthesia (4,5). In deep penetrating injuries necessitating a general anaesthetic, one of the most challenging aspects is safe airway management (6-8).

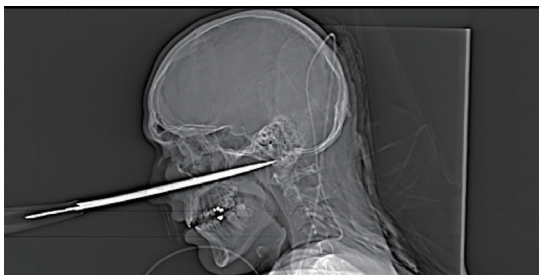

Figure 1 CT recon scan of patient.

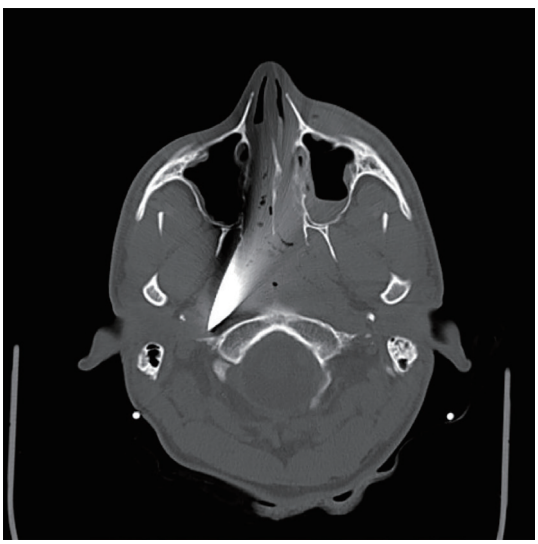

Figure 2 CT scan showing the tip of the blade lying medially to the right internal carotid sheath having entered from below the left orbital floor and transversed the nasopharynx.

The use of HFO in anaesthesia is a relatively recent development. Here, we discuss a case describing the first documented use of high flow oxygen in pre-oxygenating and the intubation of a patient with Jael Syndrome. We present the following article in accordance with the CARE reporting checklist (available at http://dx.doi.org/10.21037/jeccm-20-47).

Case presentation

A 20 years old male walked into the emergency department after being stabbed with a large kitchen knife in his left maxilla with the knife blade still *in situ*. He was a smoker and recreational consumer of alcohol, however he had no other past medical history nor was on any long term medications.

On arrival he was fully conscious, haemodynamically stable with no apparent airway compromise.

He underwent a CT head scan which showed that 12.5 cm of the knife was buried transfacially, penetrating through the left maxilla below the infraorbital margin and orbital floor (*Figure 1*). It traversed the left lateral nasal wall and nasal septum, crossing the contralateral nasopharynx and was embedded into the right occipital condyle at the base of skull. The point of the knife lay medial to the carotid sheath which contains the internal carotid artery, internal jugular vein and cranial nerves IX-XII (*Figure 2*). He did not reveal any "hard signs" that are described for immediate transfer to the operating room. He had a secondary survey completed and cross matched 4 units.

He was then transferred to the operating room to remove the knife and arrest any bleeding. At induction, preoperative antibiotics and tranexamic acid were administered intravenously.

With such a large foreign body protruding from his maxilla, it seemed to be difficult to pre-oxygenate or to bag-mask-valve ventilate the patient with a tight fitting mask. Our proposed plans for intubation were awake fibre-optic intubation, awake tracheostomy or RSI using video laryngoscopy and pre-oxygenation of with HFO administered via a Hudson mask. The blockage of the nostrils with blood and the blade precluded the use of nasal cannula.

He was pre-oxygenated for five minutes using HFO through a Hudson mask at a flow rate of 60 L/min (*Figure 3*). Following pre-oxygenation, the patient underwent rapid sequence induction using Fentanyl 100 mcg/Propofol 200 Mg /Rocuronium 90 mg Sugummadex and a Laryngeal Mask Airway were available to be used in case of failed intubation. HFO delivery was maintained throughout induction until satisfactory intubation conditions were achieved.

He was intubated using a glidescope whilst maintaining manual in-line stabilisation of his cervical spine. Due to the presence of the protruding knife, the intubation was technically difficult and was successful after the third attempt using the glidescope. Total apnoea time was three minutes. Throughout the period of apnoea his oxygen saturations remained at 99%. After intubation the first end tidal carbon dioxide concentration obtained was 5.4 kPa. No immediate adverse effects were observed.

He then underwent the surgical removal of the blade. The blade length was measured to be 20 cm with 12.5 cm impaling the patient's faces. Haemorrhage was controlled by local measures and the nasopharynx was initially packed with anterior and posterior RapidRhino® packs. They

Figure 3 Preoxygenation using high flow oxygen with a Hudson mask.

were replaced using two 18Fr Foley urinary catheters both inflated to 30ml, to tamponade the tissues on the lateral and posterior aspect of the nasopharynx. An anterior RapidRhino® was packed in the left nostril. Packing was kept *in situ* for 48 hours. At the time of the surgery, measurements of the knife of the length and penetration were recorded as part of the detailed medicolegal report. The offending article was placed into a sealed forensics bag for further forensic analysis. The following day the patient underwent a CT angiogram which showed a small air bubble in the right carotid space at the site of the tip of the removed blade, with no active extravasation nor signs of pseudoaneurysms. It was noted that there was a haematoma in the left cheek region and a left maxillary haemosinus. In addition, the CT showed mildly displaced fractures in the anterior and medial walls of the left maxillary sinus.

He was sedated and ventilated in the intensive care unit for a total of 33 hours. Subsequently he was extubated and later transferred to the ward for further management.

He was discharged from hospital 2 days later, and subsequently reviewed in maxillofacial outpatient clinic. He was assessed for cranial nerve deficit and only exhibited anaesthesia on the left infraorbital nerve distribution, and reported a feeling of occasional loss of balance but no vertigo. This had resolved on third follow-up appointment one month post discharge. He had suffered no adverse effects secondary to treatment.

A timeline of his care is summarised in *Table 1*. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institution and national research committees, and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient for publication of this Case report and any accompanying images.

Discussion

HFNO/HFO is a relatively novel technique for oxygen therapy providing more beneficial results compared to conventional oxygen therapy devices. The system is composed of an oxygen/air blender connected via an active heated humidifier to a nasal cannula, through a single-limb heated inspiratory circuit. It delivers a fraction of inspired oxygen (F_iO_2) from 21% to 100%, with a flow rate up to 60 L/min (9).

Although the mechanism of action of HFO is not fully understood it maintains oxygenation by providing high flows of gas. The high flow also creates positive airway pressure correlating with the flow rate (10-13). This high airway pressure improves oxygenation throughout the respiratory cycle, an effect than can be compared to the application of PEEP. It also acts to produce a reduction of dead space ventilation by the washout of the nasopharyngeal dead space volume (14,15). Due to the humidification and warming of the delivered oxygen, HFO is well tolerated and leads to improved mucociliary function and secretion clearance compared to conventional oxygen therapy devices (16,17).

The use of HFO has extended beyond its original scope in neonatal and paediatric patients to encompass both ITU and theatre settings. Evidence has shown it to be safe in the delivery of pre-oxygenation prior to RSI (18,19). Patel *et al.* were able to show that its use can increase the safe apnoea time in patients with a predicted difficult airway, proposing that it reduces the chance of desaturation by apnoeic oxygenation with gaseous exchange via dead space flushing (20). Its use in this case of maxillofacial trauma allowed for the adequate preoxygenation and apnoeic oxygenation and therefore a prolonged intubation window in what would otherwise be technically difficult circumstances.

Table 1 Timeline of care

Date	Time	Patient event
12/04/2019	2234 hrs	Patient presented to Emergency Department following stabbing with large knife protruding from left maxilla
12/04/2019	2303 hrs	Initial diagnostic CT scan shows knife penetrating left maxilla, extending 12.5 cm traversing across the nasal septum and contralateral nasopharynx, and embedded in the right occipital condyle
12/04/2019	2350 hrs	Admission to operating theatre
13/04/2019	0002 hrs	Preoxygenation with HFO
13/04/2019	0010 hrs	Induction of anaesthesia and intubation after 3rd pass using glidescope. Oxygen saturations maintained at 99% throughout period of apnoea
13/04/2019	0013 hrs	First ETCO2 recording of 5.4
13/04/2019	0025 hrs	Operation start time-knife removed, haemorrhage control achieved with packing nasopharynx with anterior and posterior RapidRhino® packs and then bilateral Foley catheters.
13/04/2019	0133 hrs	Discharge from operating theatre
13/04/2019	0134 hrs	Admitted to ITU, remained intubated and ventilated
13/04/2019	1202 hrs	Follow up CT Angiogram shows small air bubble at right carotid space, anteromedial to right internal carotid artery, but no active extravasation or signs of pseudo-aneurysms; mildly displaced fractures of left maxillary sinus anterior and medial walls noted
14/04/2019	1108 hrs	Extubation on ITU
14/04/2020	1444 hrs	Discharge from ITU
16/04/2020		Discharge from hospital after maxillofacial review
17/04/2020		First review in maxillofacial outpatients, reports numbness over left upper anterior teeth
02/05/2019		Second review in maxillofacial outpatients, reports occasional sensation of loss of balance with no vertigo symptoms; formal examination normal
30/05/2020		Third review and discharge from maxillofacial outpatients, balance issues resolved, ongoing sensory issues in left infra-orbital nerve distribution

Whilst the use of HFO has been shown to be efficacious in RSI and induction of anaesthesia, there are limitations in its use, particularly in the trauma patient. The nature of the injuries in our case necessitated the delivery of oxygen via a specialised mask, as the more commonly used nasal route was compromised. The use of HFO is also contraindicated in cases where the patient is suspected to have suffered from a base of skull fracture or open communication to the intracranial space. Likewise, consideration needs to be given to the presence of epithelial/mucosal injuries of the airway and presence of pneumothoraces.

Conclusions

The use of high flow oxygen should be considered as part of the management plan in providing pre-oxygenation and increased safe apnoea time in patients with penetrating maxillofacial injuries requiring intubation.

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Footnote

Reporting Checklist: The authors have completed the CARE reporting checklist. Available at http://dx.doi.org/10.21037/jeccm-20-47

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/jeccm-20-47). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are

appropriately investigated and resolved. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient for publication of this Case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

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