



## Technical note

## Endoscopic repair technique for traumatic penetrating injuries of the clivus

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## ABSTRACT

Unlike basilar skull fractures, penetrating traumatic injuries to the clivus are uncommon. We present two novel and interesting cases of traumatic crossbow arrow injury and penetrating screwdriver injury to the clivus. A review of the literature describing methods to repair these injuries was performed. A careful, systematic approach is required when working up and treating these injuries, as airway preservation is critical. An adaptation to the previously described “gasket-seal” method for skull base repair was utilized to repair the traumatic cerebrospinal fluid (CSF) fistulas. This repair technique is unique in that it is tailored to a much smaller defect than typical post-surgical defects. Two patients are presented, one with a post-traumatic CSF fistula after penetrating crossbow injury to the clivus and one with a penetrating screwdriver injury to the clivus. The patients were treated successfully with transnasal endoscopic repair with fascia lata graft and a nasoseptal flap, a novel adaptation to the previously described “gasket-seal” technique of skull base repair.

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## 1. Introduction

Penetrating injuries to the clivus represent a rare and unique medical emergency due to the nature of the objects used and the delicate anatomical regions affected with the possibility of devastating neurological sequelae. Cerebrospinal fluid (CSF) leakage at any location has the potential to lead to meningeal infection with subsequent morbidity and mortality. Fractures at the skull base are potentially devastating pathologies not only because of the vital structures which are in close proximity but also because there is a potential for tears in the dura mater and subsequent CSF leak [1]. By far, trauma is the most common cause of CSF rhinorrhea [2]. Here we present two cases of penetrating trauma to the clivus and subsequent management and reconstruction of the defects.

## 2. Case presentations

## 2.1. Patient 1

A 50-year-old man presented to the emergency center with a crossbow arrow impaled intraorally after an unsuccessful suicide

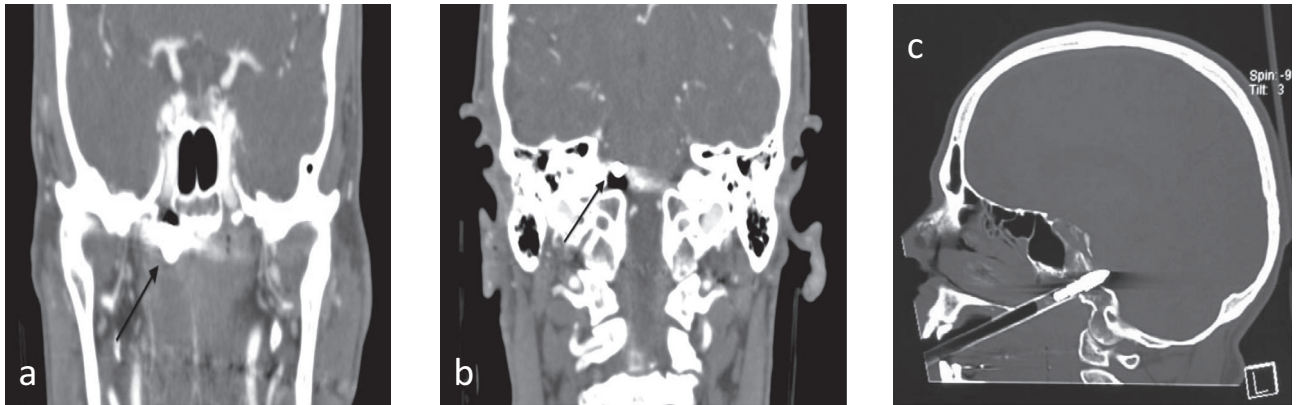
attempt. He was neurologically and hemodynamically stable but very agitated and combative.

Prior to removal of the arrow, the patient was taken for CT angiogram to evaluate for vascular injury. The arrow was found to have passed just inferomedial to the junction of the petrous and lacerum segment of the right internal carotid artery (Fig. 1a). As the arrow coursed posteriorly, it penetrated the right clivus and the tip of the arrow came to rest just to the right of the verte-brobasilar junction (Fig. 1b).

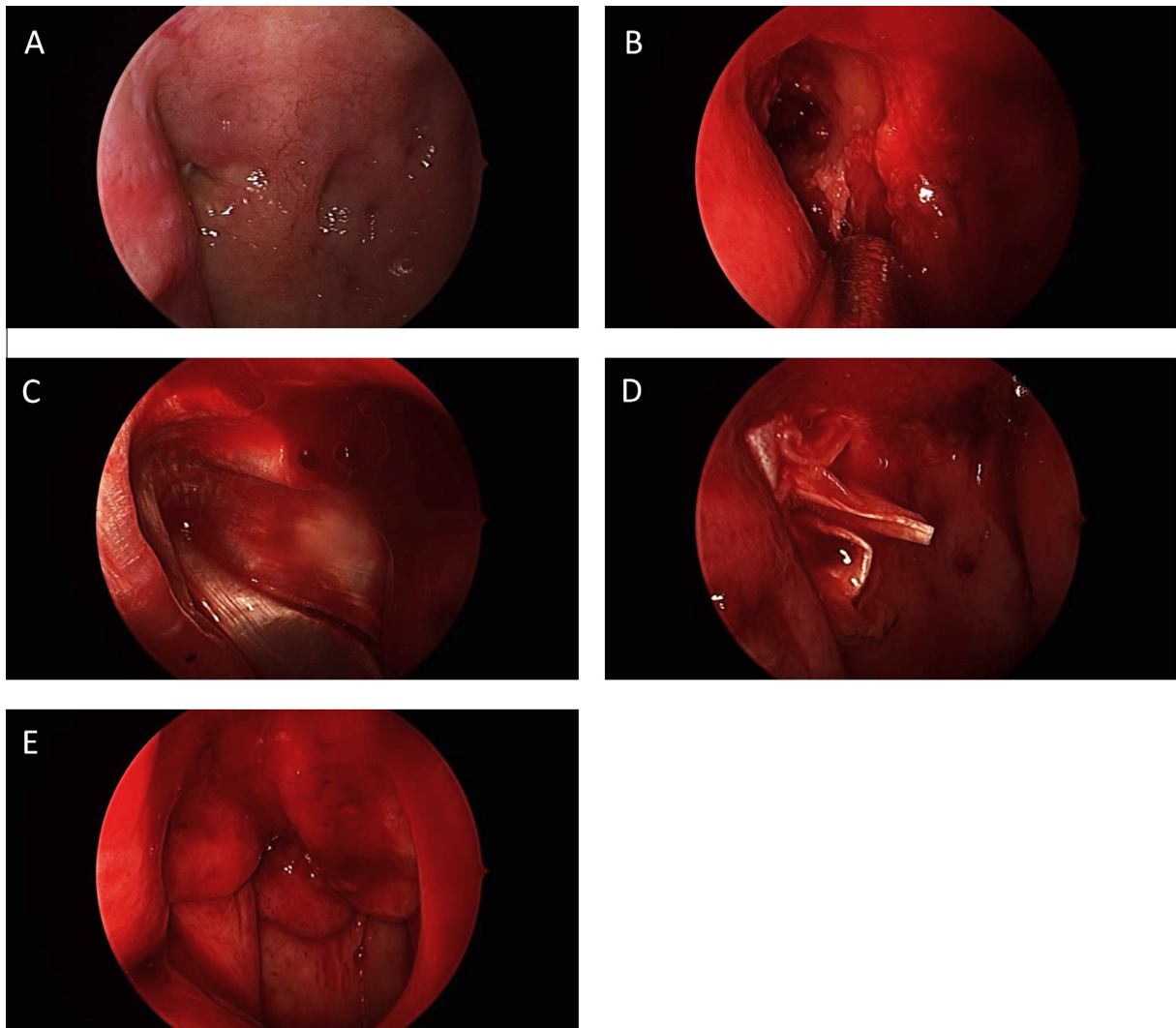
After determining that no significant vascular injury had occurred, the patient was transported to the operating room. As the arrow was protruding several inches from the mouth (Fig. 1c), there were several logistical concerns to address regarding safe removal while protecting the airway. A multidisciplinary effort to protect the airway involved anesthesiology, neurosurgery, and otolaryngology. It was not possible to introduce an endotracheal or nasotracheal tube without first removing the arrow. Likewise, there was no way to use bag-valve-mask ventilation should the patient's respiratory drive diminish with administration of intravenous sedation. Preparation for an emergency tracheotomy was necessary in the event the airway was compromised at any point during the removal of the arrow. While there was no major vascular injury present, there was still concern about bleeding obstructing the upper airway after the arrow was removed. With these precautions in mind, the arrow was removed with the aid of intravenous sedation. An endotracheal tube was then placed and the

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**Fig. 1.** Coronal CT angiogram shows the hyperdense arrow and air present along the track, located just inferomedial to the junction of the petrous and lacerum segments of the internal carotid artery (a). Coronal CT angiogram showing the arrow with adjacent intracranial air. The tip of the arrow seen here is just lateral to the vertebrobasilar junction (b). Sagittal CT scan showing the trajectory of the arrow with the tip piercing the clivus and entering the intracranial cavity. Of note, the arrow protrudes to a significant degree from the patient's mouth (not fully visualized on this image) (c).



**Fig. 2.** Mucosa overlying the clivus with defect arising from prior crossbow arrow (a) is seen. Mucosal defect is more easily appreciated after debridement of surrounding mucosa (b). Harvested fascia lata graft was cut to an appropriate size to ensure coverage of the defect (c). A ball of Surgicel (Ethicon for Johnson & Johnson Medical, Piscataway, NJ, USA) was placed centrally within the fascia lata and pressed firmly into the defect. Redundant fascia lata is seen protruding from the previous skull base defect to ensure a watertight seal (d). A harvested pedicled nasoseptal flap is laid over the now secured fascia lata graft (e) and held in place with fibrin glue and nasal packing.

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