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Glass Fragment Injury to the Craniocervical Junction with Interatlantooccipital Penetration to the Subarachnoid Space: Not-To-Be-Missed Important Aspects of Craniocervical Trauma Even in the Middle of the COVID-19 Pandemic: Case Report and Review of Literature

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Key words
- Craniocervical junction
- Craniocervical traumatic injury
- Emergency medicine
- Glass fragment
- Interatlantooccipital penetration
- Nonmissile penetrating injury
- Spinal immobilization

Abbreviations and Acronyms
CNS: Central nervous system
CT: Computed tomography
MO: Medulla oblongata
MR: Magnetic resonance

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Supplementary digital content available online.

Citation: World Neurosurg. (2020) 141:402-405.
https://doi.org/10.1016/j.wneu.2020.06.065
Journal homepage: www.journals.elsevier.com/world-neurosurgery

Available online: www.sciencedirect.com

BACKGROUND: **Nonmissile penetrating injuries to the craniocervical junction caused by a glass fragment are rare, and a standard management strategy has not been established.**

CASE DESCRIPTION: **A 75-year-old Japanese man was brought into our emergency department after receiving a left retroauricular stab wound by broken glass fragments. After spinal immobilization, a computed tomography (CT) scan revealed glass fragments penetrating at the right craniocervical junction to the interatlantooccipital subarachnoid space. CT angiography showed that both vertebral arteries were not injured. Magnetic resonance imaging demonstrated that the glass fragments did not penetrate the cervical cord or medulla oblongata. These glass fragments were removed via a midline incision from the external occipital protuberance to the C7 and with laminectomy without suboccipital craniectomy. Five of the glass fragments were found and removed in total. The dural defect was patched with a free fascia autograft. His postoperative course was uneventful. Postoperative CT angiography showed that both vertebral arteries were intact and the glass fragments had been removed completely.**

CONCLUSIONS: **CT graphical diagnosis is useful for the management of penetrating craniocervical junction trauma, and it should be considered in the evaluation of patients who have suffered craniocervical penetrating injury even in the absence of major wounds or bleeding. Spinal immobilization of patients with craniocervical penetrating injuries is crucial to avoid not only secondary neurologic damage but also secondary critical vascular damage. Incomplete or inadequate assessment of craniocervical stab wounds results in unexpected hazards that are preventable.**

INTRODUCTION

Nonmissile penetrating injuries to the craniocervical junction caused by a glass fragment are rare, and a standard management strategy has not been established. The only warning sign may be an insignificant wound in the suboccipital or retromastoid region. It is important for the emergency physician to be reminded that what appears to be a superficial laceration can sometimes be more serious.[1] Usually these injuries produce obvious neurologic deficits, but occasionally patients present with minor oozing of blood, cerebrospinal fluid leak, or related symptoms. We present a rare case of glass fragment injury to the craniocervical junction with interatlantooccipital penetration to the subarachnoid space and a review of literature. This case report emphasizes the importance of imaging evaluation in the penetrating injuries to the craniocervical junction, as well as spinal immobilization at the initial assessment.

CASE PRESENTATION

A 75-year-old Japanese man was brought into our emergency department after receiving a left retroauricular stab wound by a broken glass fragment. He plunged headfirst into a glass window in his home due to inebriation. His wife found him lying on the floor with a small glass fragment stabbing into the right retroauricular craniocervical junction. She removed the visible glass fragment carefully and called an ambulance immediately. On arrival, the patient remained in a state of inebriation. Only oozing blood from under the hair was found. A small wound was found in the left retroauricular craniocervical junction after the hair was shaved around the wound (Figure 1A). Despite the small entry of glass penetration, emergency trauma work-up was performed under spinal immobilization. A computed tomographic (CT) scan revealed glass fragments penetrating at the right craniocervical junction to the interatlantooccipital subarachnoid space (see Figure 1B). CT angiography showed that both vertebral arteries were not injured (see

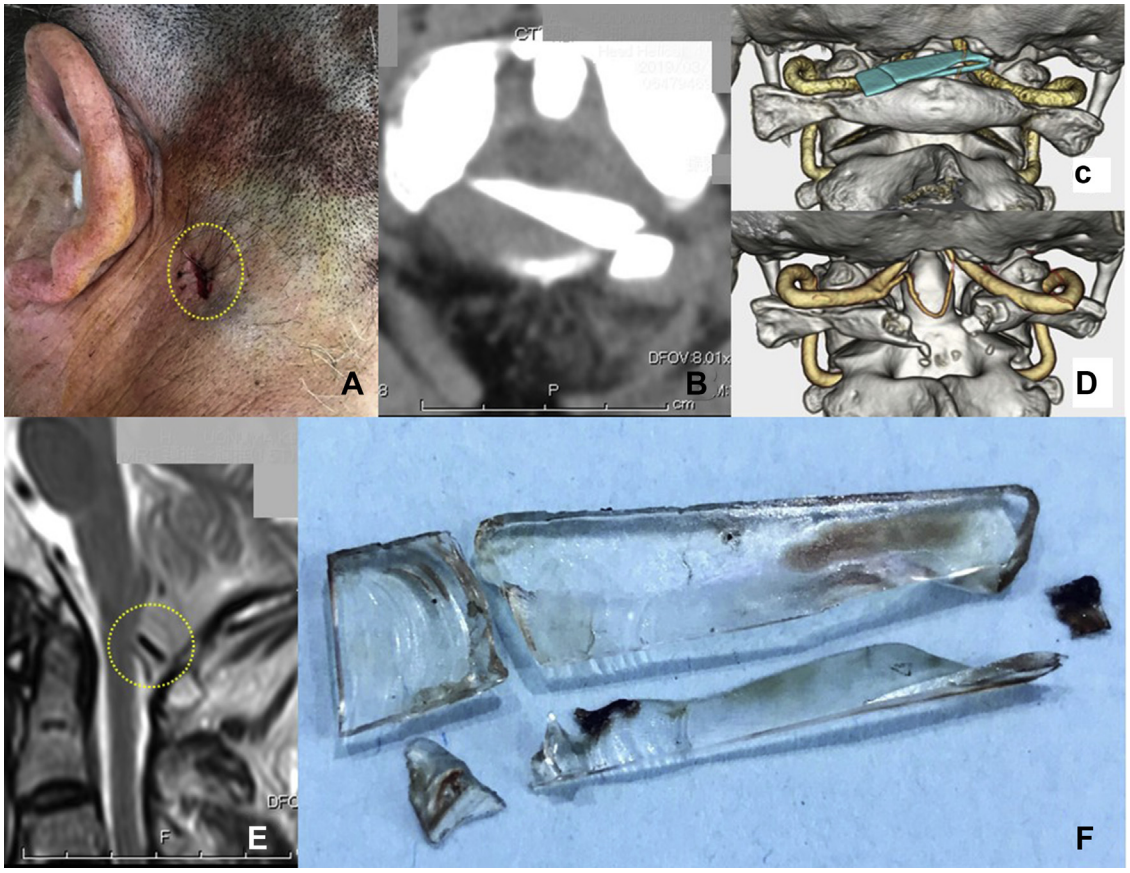

Figure 1. A small wound is found in the left retroauricular craniocervical junction after the hair was shaved around the wound (**A**). An axial computed tomography (CT) image showed a glass fragment running to the interatlantooccipital subarachnoid space from the left rear and an adjacent glass fragment (**B**). A 3-dimension CT angiography showed glass fragments running through the interatlantooccipital space close to the vertebral arteries from the left rear (**C**). Through a midline incision from the external occipital protuberance to the C7 and with C1 laminectomy without suboccipital craniectomy, they were removed (**D**). Preoperative magnetic resonance imaging demonstrated that the glass fragment and the upper cervical cord were contiguous (**E**). Five removed glass fragments (**F**) look like what the CT reconstruction image demonstrated preoperatively (**C**).

Figure 1C and D). Magnetic resonance (MR) imaging demonstrated that the glass fragments did not penetrate the cervical cord or medulla oblongata (MO) (see Figure 1E). By limiting the patient's neck movement, we prevented these glass fragments from injuring the vertebral arteries, cervical cord, or MO until surgical removal of the glass fragments was accomplished. These glass fragments were removed via a midline incision from the external occipital protuberance to the C7 and with C1 laminectomy without suboccipital craniectomy. Five of the glass fragments were found and removed in total (see Figure 1F). The dural defect was patched with a free fascia autograft. Postoperative CT angiography showed that both vertebral arteries and the MO were intact, as well as complete removal of the glass fragments (see Figure 1D). His postoperative course was uneventful, and he left the hospital without sequelae. Follow-up MR imaging showed his intact MO and cervical cord (Figure 2). As depicted in postoperative CT angiography (see Figure 1D), no traumatic pseudoaneurysm was detected by follow-up MR angiography. The patient was independent in his daily life without sequelae 4 months post operation.

DISCUSSION

This report demonstrates the first precisely described successful treatment of penetrating glass injury to the craniocervical subarachnoid space. Appropriate evaluations and accurate diagnosis are crucial for the management of penetrating craniocervical junction trauma. Practicable diagnostic imaging should be considered in the evaluation of patients who have suffered craniocervical penetrating injury even in the absence of major wounds or bleeding. Incomplete or inadequate assessment of craniocervical stab wounds result in unexpected hazards that are preventable.

Penetrating injuries of the neck and face as a result of projectile (gun) and nonprojectile (knives and other sharp implements, such as screwdrivers or glass) mechanisms represent a significant source

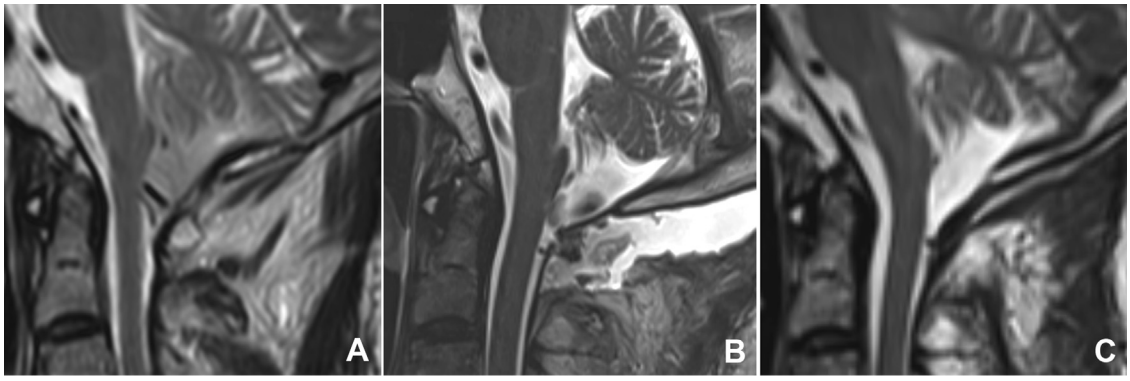

Figure 2. Follow-up magnetic resonance images show the intact medulla oblongata and upper cervical cord. (**A**) Preoperative sagittal T2-weighted image. (**B**) Postoperative sagittal T2-weighted image 12 days after operation. (**C**) Follow-up sagittal T2-weighted image 4 months after operation. Note that the preoperative sagittal T2-weighted image (**A**) shows traumatic subarachnoid hemorrhage as a signal intensity change of the subarachnoid space near the glass fragment.

of acute admission of civilians to accident and emergency departments and trauma units in the United Kingdom.[2,3]

Penetrating intracranial injuries are common in the deployed military medical environment.[4] The experience of civilian neurosurgeons with penetrating central nervous system (CNS) trauma varies depending on the location.[5] CNS blast injuries have been encountered frequently by military surgeons in Iraq and Afghanistan and are increasingly encountered by civilian neurosurgeons because of terrorist bombings in urban environments.[5] Civilian neurosurgeons on call for trauma should be prepared to manage penetrating CNS trauma.[5]

Nonmissile penetrating injuries to the craniocervical junction caused by a glass fragment are rare, and a standard management strategy has not been established. Although several reports of metal stab wounds at the craniocervical junction are available, a nonmissile penetrating craniocervical injury to the subarachnoid space by a glass fragment is extremely rare. This case demonstrates the first precisely described successful treatment of penetrating glass injury into the craniocervical subarachnoid space.

Five case reports of penetrating glass injury of the spine are available.[6-10] Penetrating injuries of the spinal cord are relatively infrequent compared with blunt trauma. They mostly occur due to missile injuries, rarely due to glass or wood fragments.[11-13] Intradural foreign bodies due to these injuries are extremely rare. Common foreign bodies are from missile-penetrating bullets or metallic fragments and are rarely from rock and earth pieces resulting from mining injuries.[14] Chowdhury et al[15] reported 17 cases of nonmissile penetrating injury to the head and concluded that their cases can be managed with good results with proper (clinical and radiologic) evaluation and simple neurosurgical techniques. Weapons and other foreign objects causing injury included a teta (a pointed metal weapon with a wooden handle and a barb near the tip, used for hunting and fishing) in 4 cases, a dao (a sharp metal cutting instrument with a wooden handle used for cutting vegetables, fish, meat, bamboo, wood, etc.) in 3 cases, a bamboo stick in 3 cases, a metal rod in 2 cases, a knife in 2 cases, a sharp stone in 1 case, a metal steam chamber cover in 1 case, and a long peg in 1 case.[15]

The radiologic evaluation of penetrating neck and face injuries can be daunting given the emergency circumstances requiring imaging; in addition, given that this particular anatomic area of the body combines vascular, gastrointestinal, respiratory, endocrine, lymphatic, skeletal, and nervous systems, imaging of penetrating neck injuries can be challenging.

Dual-energy CT is less vulnerable to artefacts and provides images with a higher signal-to-noise ratio, thereby improving diagnostic performance.[16] It uses 2 different energy settings simultaneously, high (140 kVp) and low (80 kVp) with rapid alternation between the 2, which allows for the differentiation of materials based on their attenuation characteristics. There are times when MR imaging is essential for primary injury identification (e.g., the detection of wooden or nonmetallic foreign bodies, for which CT is far less sensitive). This can be better achieved using gadolinium-enhanced MR imaging, which can include a T2-weighted gradient-recalled echo sequence.[17,18] Temple et al[19] tabulated the main modalities used in imaging for penetrating brain injury including the clinical indications and contraindications for each modality.

From our experience with the present case, preoperative precise anatomic evaluation of the location of foreign bodies and their relative positions with peripheral neurovascular structures can lead to a favorable outcome. Prevention of a secondary disaster or further disasters is key for successful removal of foreign bodies in nonmissile penetrating injuries.

In unconscious trauma patients, airway maintenance with concurrent cervical spine protection is a priority.[20,21] To avoid the risk of secondary neurologic damage to patients with spinal injuries,[22,23] normative teaching systems, such as Prehospital Trauma Life Support (PHTLS) and Advanced Trauma Life Support, place great emphasis on the spinal immobilization of patients in the supine position, even for unconscious trauma patients.[24,25]

CT graphical diagnosis is useful for the management of penetrating craniocervical junction trauma, and it should be considered in the evaluation of patients

who have suffered craniocervical penetrating injury even in the absence of major wounds or bleeding. Incomplete or inadequate assessment of craniocervical stab wounds results in unexpected hazards that are preventable. Before image diagnosis, the spinal immobilization of patients with craniocervical penetrating injuries is crucial to avoid not only secondary neurologic damage but also secondary critical vascular damage.

A meticulous examination of the scalp and thorough neurologic and radiological assessment are required to evaluate the extent of the damage.[26] Careful preoperative planning with appropriate imaging and multidisciplinary consultation resulted in an optimized plan of treatment that minimized potential iatrogenic/secondary injuries. These are not-to-be-missed important aspects of craniocervical trauma even in the middle of the COVID-19 (coronavirus disease 2019) pandemic.

CONCLUSION

CT graphical diagnosis is useful for the management of penetrating craniocervical junction trauma and should be considered in the evaluation of patients who have suffered craniocervical penetrating injury even in the absence of major wounds or bleeding. Spinal immobilization of patients with craniocervical penetrating injuries is crucial to avoid not only secondary neurologic damage but also secondary critical vascular damage. Early multidisciplinary involvement and appropriate sequence of intervention leads to uneventful surgeries and a benign postoperative course.

ACKNOWLEDGEMENT

We are grateful to the Departments of Emergency Medicine and Orthopedics, Uonuma Kikan Hospital, for their continuous support.

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Conflict of interest statement: The authors declare that the article content was composed in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Received 31 May 2020; accepted 7 June 2020

Citation: World Neurosurg. (2020) 141:402-405.
https://doi.org/10.1016/j.wneu.2020.06.065

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1878-8750/$ - see front matter