Injury to the Temporal Lobe via Medial Transorbital Entry of a Toothbrush

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J Neurol Surg Rep 2013;74:23–28.

Abstract

Objectives Intracranial penetration by foreign bodies entering via the orbit represent an unusual form of traumatic brain injury. Nevertheless, much is at stake with high risk for cranial nerve and neurovascular injury. We present a case where the bristled end of a toothbrush entered the brain as a projectile via the superior orbital fissure and discuss considerations for surgical management.

Setting A 35-year-old woman suffered a periorbital injury after her husband threw an electric toothbrush at a wall and the head of the toothbrush became a missile that projected through her superior orbital fissure and into her right temporal lobe. She complained of headache and incomplete vision loss in the affected eye.

Intervention After obtaining a cerebrovascular angiogram, we proceeded with emergent orbital decompression and anterograde extraction of the foreign body via a modified frontotemporal orbitozygomatic approach with drilling of the skull base allowing for en bloc removal of the toothbrush.

Conclusions The patient recovered well with improvement in her vision and partial third and sixth nerve palsies. This report illustrates a unique mechanism of injury with a novel intracranial foreign body. We review the neurosurgeon's need for prompt management with an approach customized to the structure of the offending object, the damaged elements, and the surrounding cranial nerves and vascular anatomy.

Keywords
- foreign body
- penetrating
- superior orbital fissure
- superior orbital fissure syndrome
- toothbrush
- traumatic brain injury

Introduction

Intracranial foreign bodies via the transorbital route are rare.[1] Amongst cases of transorbital intracranial injury, projection of the foreign body through the superior orbital fissure occurs in an estimated 68% and damage typically occurs to the brainstem, cavernous sinus, or temporal lobe.[2] Introduction of a foreign body via the orbit can occur either via missile projection or via stab injury, and the trajectory into the brain may be related to the mechanism of injury.[2,3] Obtaining a thorough history and establishing a high level of suspicion for these types of injuries when periorbital trauma is found on physical exam is important, as in the case of missiles the patient may be unaware that a foreign body was retained[2,4] and stab injuries may be associated with psychiatric illness that may limit reliable history. [5–7]

Here we describe a unique foreign body within the brain: the bristled end of an electric toothbrush, which entered the parenchyma of a patient's right temporal lobe as a projectile through the medial orbit. The case is framed here in a description of the radiographic findings as a function of the mechanism of injury relative to similar cases, the surgical

received
December 14, 2012
accepted
January 3, 2013
published online
May 29, 2013

DOI http://dx.doi.org/10.1055/s-0033-1346976.
ISSN 2193-6358.

decision making involved in safe extraction of intracranial foreign bodies via modern modified skull base technique, and considerations for antibacterial prophylaxis.

Case Report

A 35-year-old woman employed as a dental hygienist was transferred from an outside facility to our level-one trauma center after presenting with a foreign body in her right orbit. She reported that while at home the prior evening, she was in the bathroom with her husband who became enraged when his electric toothbrush failed to work properly, and that he threw the device at a nearby wall. The toothbrush (Sonicare; Philips, Andover, Massachusetts, USA) reportedly shattered into numerous pieces upon impact with the wall and one of these flew directly into the patient's right medial orbit. She stated that in addition to pain, initially she had blurred but not absent vision in the right eye. At the time of presentation to our institution, her eye had swollen shut and she complained of constant, severe aching pain in her right eye and a bilateral headache that radiated to the back of her neck.

At the outside facility the patient was medicated for pain and given piperacillin/tazobactam (Zosyn, Pfizer, New York, New York, USA), and a computed tomography (CT) scan of the head and a CT angiogram (CTA) were obtained, as were basic serum laboratories. On examination at our institution the patient had stable vital signs; she had a Glasgow Coma Scale (GCS) of 15 and was in moderate distress. Her right eyelid was swollen shut, and there was no obvious external foreign object visible. There was a small curvilinear laceration just below her medial canthus, and her lacrimal punctum were intact. Her right pupil was 5 mm and fixed and visual acuity was 20/400. No abnormalities were noted with regard to the left eye. The anterior globe did not appear lacerated, and the anterior chamber was clear. On limited exam of extraocular muscle function, no gross abnormality was noted. No other abnormal physical exam findings were noted on presentation.

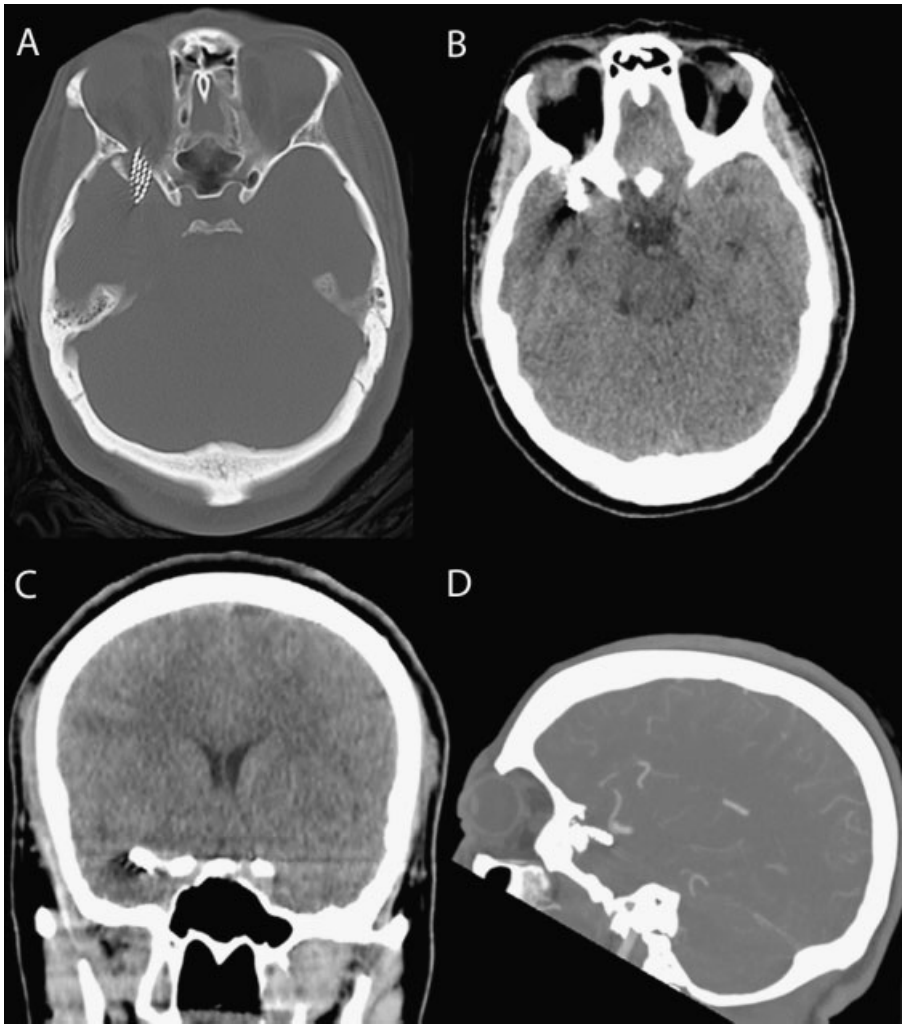

Fig. 1 Preoperative computed tomography (CT) and computed tomography angiography (CTA) with toothbrush violating the right middle fossa. (A) Axial CT with fracture through the right sphenoid bone with toothbrush bristles visible. (B) Axial CT with head of toothbrush visible in anterior temporal lobe. No associated hemorrhage seen. (C) Coronal view demonstrating tip of toothbrush near the anterior clinoid process. (D) Lateral CTA showing proximity of foreign body to right middle cerebral artery (MCA) bifurcation.

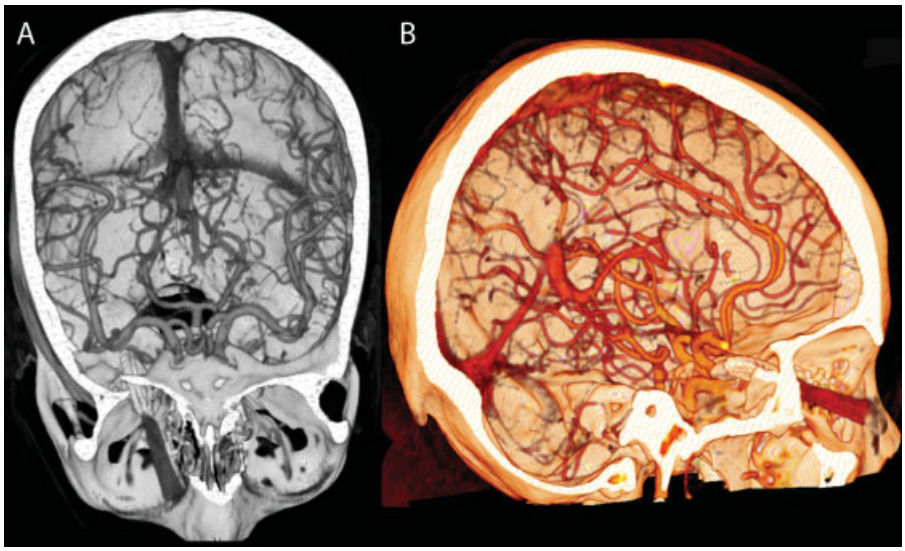

Fig. 2 Three-dimensional computed tomography angiography reconstruction cutaway views. (A) Foreign body trajectory through superior orbital fissure. Nearby middle cerebral artery (MCA) bifurcation is intact. (B) Lateral view. Toothbrush head displacing sphenoid fragment laterally.

Preoperative Imaging

A CTA and a thin-cut CT scan of the head were obtained prior to surgery for surgical planning and neuronavigational purposes (►**Fig. 1A–D**). A foreign body with visible bristles consistent with the head of the toothbrush was visualized entering medially to the globe, traveling through the superior orbital fissure (SOF), and breaking through the greater sphenoid wing into the middle fossa with a laterally displaced fragment and ending in the anterior temporal lobe (►**Fig. 2A, B**). The extraocular muscles appeared unaffected. The optic canal was intact; however, the shaft of the toothbrush head did appear to touch the optic nerve. No significant hemorrhage was seen.

Management

After neurosurgery service evaluation, ophthalmology was consulted and the decision was made to perform urgent surgical extraction of the foreign body. The patient was consented for a modified frontotemporal orbitozygomatic craniotomy with extraction of the intraorbital and intracranial portions of the toothbrush. In the operating room a curvilinear incision was made behind the hairline from the root of the zygoma curving gently toward the contralateral mid-pupillary line. A two-piece supraorbital modification of the orbitozygomatic approach was performed as described previously[8] by drilling three bur holes—one at the McCarty keyhole, one in the inferior squamous bone, and one in the posterior frontal calvarium. These were connected with a foot-plate drill to create a pterional craniotomy, and the drill was also used to extend the craniotomy anteriorly to the edge of the orbital bar. A reciprocating saw was used to score a sagittal cut through the orbital rim lateral to the supraorbital foramen and then a coronal cut medial to lateral along the anterior skull base toward the superior orbital fissure, as well as a lateral cut just lateral to the frontozygomatic suture down to the superior orbital fissure. Osteotomes were used to complete the release and removal of the orbital hemibar. The sphenoid wing was drilled down and the lateral orbital wall was partially taken down to the superior orbital fissure to further decompress the orbit (►**Fig. 3B**). The temporal lobe could then be elevated, and the skull base followed toward the superior orbital fissure until the bristles of the toothbrush head could be located (►**Fig. 3A**). The sphenoid was then drilled laterally to the trajectory of the foreign body until there was sufficient space to mobilize the toothbrush (►**Fig. 3C**). When the head of the toothbrush was freed and mobile it was pulled posteriorly while simultaneously maintaining pressure on the toothbrush shaft to keep it pressed down against the skull base to help prevent additional friction on the optic nerve (►**Fig. 3D**, **3E**). A small dural rent was found and sealed. Ophthalmology measured the intraocular pressure immediately before (19 mm Hg) and after surgical treatment (8 mm Hg).

Postoperatively, the patient's course was uneventful. Her vision remained 20/400 throughout her 3-day hospitalization, and limited lateral rectus function was noted. Her pupil remained nonreactive and enlarged. Our infectious disease team was consulted for recommendations for antibiotic coverage for intraparenchymal oral flora. Clindamycin and ciprofloxacin were recommended prophylactically for a 7-day course. She was also evaluated by our social work service and was deemed safe to return home with her husband. She was discharged on antibiotics, prophylactic antiepileptics, and a steroid taper.

Follow-Up

Two weeks postictus, the patient noted improving pain and improving vision (20/50). Since the event she had quit her job as a dental hygienist.

Discussion

The neurosurgical literature contains an abundance of reports of foreign bodies that have entered the cranial vault via the SOF. Penetrating traumatic injury of the brain

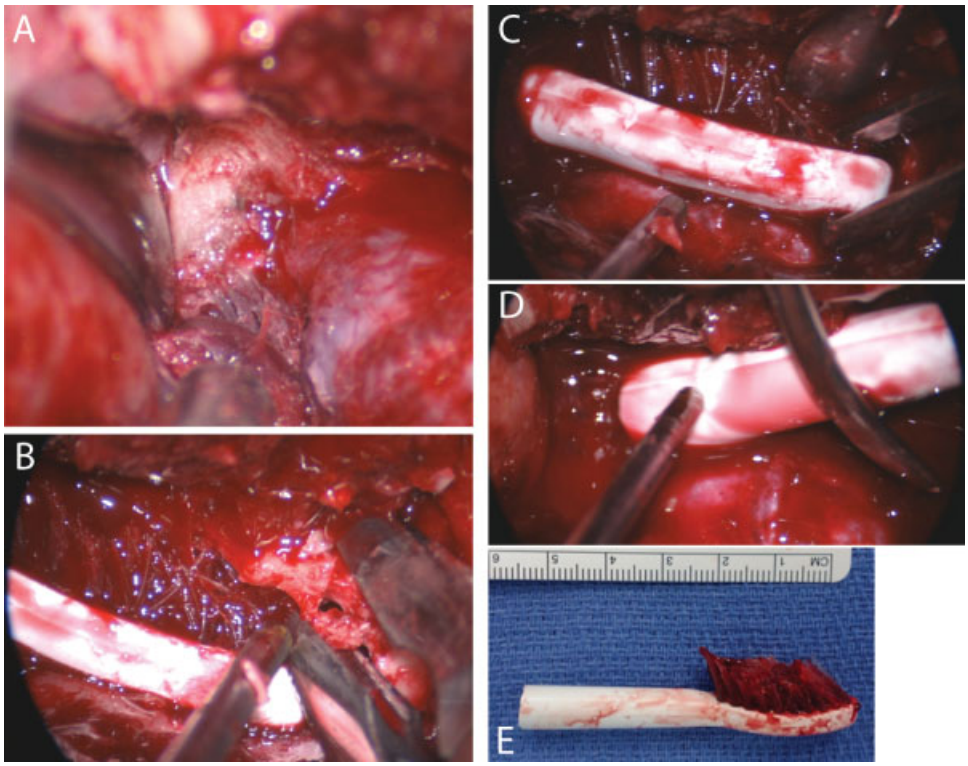

Fig. 3 Removal of toothbrush from temporal lobe. (A) Bristles visible (bottom) with partial drilling of sphenoid wing. (B) Removal of additional sphenoid bone. (C) Head of brush exposed and free. (D) Distal end of toothbrush fragment exiting middle fossa (note downward pressure being placed to keep it against the skull base and preventing further damage to optic nerve). (E) Removed toothbrush fragment.

via the skull is relatively uncommon, representing 0.4% of traumatic head injuries,[9] and though the transorbital route certainly represents only a small fraction of these injuries, descriptions of foreign bodies entering the brain via the SOF are especially interesting as it is second in size only to the foramen magnum as a route to the brain that can be traversed without bony fracture. Protection of the brain within a strong bony enclosure is an extremely conserved feature of vertebrate evolution; therefore, brain injuries that bypass this guard highlight a chilling vulnerability to relatively low force mechanisms. This report adds not only another novel man-made object to the list of those that have entered living human brain, but also draws attention to a unique trajectory and mechanism of insertion as well as approaches to surgical management and considerations for prevention of infection.

Reports of toothbrush injury upon the brain are rare. Excluding reports of nonpenetrating toothbrush-induced seizures,[10,11] there is only one report of a toothbrush handle entering the brain.[12] In that case the handle end entered the SOF and terminated in the medial middle fossa; the bristled end of the brush, however, remained well outside of the orbit. Although there has been a prior report of the bristled end of a toothbrush entering the medial orbit,[13] the brush in that case avoided the SOF and ended up extracranially in the ethmoid sinuses. Most reports of intracranial foreign bodies that enter through the SOF describe objects that approximate a wedge or stylus shape, allowing them to dissect through tissue planes, slide against the orbital walls, and pass through the slitlike SOF. Examples of these types of foreign bodies include pens and pencils,[4,5,12,14] chopsticks,[15,16] paintbrush handles,[17] and knives.[18,19] The blunt, widened end of a toothbrush makes for an atypical missile head and warrants special consideration for removal. Many reports of intracranial foreign bodies entering via the orbit describe a cautious orbital removal, pulling the object out of the brain via the orbit after appropriate imaging has been obtained. Other cases are managed via extensive surgical approaches,[18] but even in many of these cases the goal is protection of critical anatomy and reduction of bony obstacles prior to withdrawal of the object via the orbit and repair of dural defects after removal. Descriptions of anterograde removal of transorbital intracranial foreign bodies are scarce.[3,20] Although the head to shaft ratio of the foreign body described here is considerably less than that of a hunting arrow, the anterograde technique of removing the intracranial foreign body along its trajectory of entry as described by O'Neill et al[20] was felt to have the lowest risk of additional injury to brain parenchyma, neurovasculature, and the optic nerve in this case, given the enlarged leading end of the toothbrush. The patient's presentation was consistent with a traumatic SOF syndrome (Rochon-Duvigneaud syndrome), prompting urgent decompression of the SOF by removal of the foreign body.[21] The orbitofrontal modification of the frontotemporal orbitozygomatic approach used in this case allowed for decompression of the orbit and an improved trajectory, and also allowed the brain

to sag away from the temporal skull base, thus minimizing the need for brain retraction while drilling the skull base.

The majority of reported transcranial foreign bodies that traverse the SOF are introduced in a stabbing fashion, presumably at relatively low velocities. Missile-type entry is less common and is believed to be more likely to involve bony fracture rather than simply following the course of the orbital walls into the SOF at the orbital apex.[2,3] In this case the lightweight toothbrush head became a projectile missile after it detached from the heavy battery base unit upon impact with a wall. The resultant injury with a trajectory through the SOF but with fracture of the medial sphenoid wing was fittingly somewhere in between a low-velocity stab wound where the bony anatomy guides the entire trajectory and a maximal velocity missile injury where the foreign body shows little respect for the bony structures. The trajectory in this case notably fits the zone-entry model outlined by Turbin et al[2] in which an entry point in the medial inferior aspect of the lower eyelid (Zone 3c) predicts temporal lobe injury and sphenoid wing injury. This case also serves as testimony to the potentially minimized physical exam findings with transorbital intracranial injuries. If the shaft of the foreign body remains visibly protruding from the orbit, it is likely to garner quite a lot of attention regardless of the true extent of intracranial injury. However, as numerous authors have pointed out in similar cases, if the entire object lies behind the plane of the face, the initial physical presentation can mute what may end up being a very drastic intracranial injury. This is perhaps best illustrated in a case where the diagnosis of a transorbital intracranial pen was overlooked until autopsy.[5]

Any foreign body entering the brain parenchyma under unsterile conditions raises a significant concern for cerebritis, meningitis, or abscess formation even after rapid complete extraction of the offending object. In their review of transorbital penetrating injuries, Schreckinger et al[4] recommended initiation of broad-spectrum antibiotics with good central nervous system (CNS) availability early on, but admittedly there are no data-supported guidelines for postoperative microbe control. In a 1977 review of 42 cases of retained transorbital intracranial wooden bodies, nearly half of the patients developed intracranial abscess.[22] Another pre-CT era study described 13 infections in a review of 44 patients (30%) with transorbital intracranial injury.[1] Importantly however, in 16 of the patients in that group (36%) diagnosis was delayed for more than 24 hours (most more than 1 week). In the modern neurosurgical era, gross total removal should be possible early on in the vast majority of cases and the risk of serious infection considerably lower. Even in an era of frequent neuroimaging, it should be noted that a high index of suspicion may be necessary for rapid diagnosis of retained foreign bodies in cases of periorbital trauma. In Turbin et al's more recent 2006 review,[2] 4 of 21 cases (19%) of occult (delayed diagnosis) transorbital intracranial foreign bodies were described as complicated by abscess or meningitis, whereas 1 of 16 cases (6%) of nonoccult injury was described as complicated by abscess. In the case described here, the toothbrush bristles exposed to the oral flora of another individual were introduced into the orbit and brain parenchyma of our patient. Used toothbrush bristles are known to harbor an extensive variety of aerobic and anaerobic pathogens originating from cutaneous and oral flora.[23,24] Therefore, despite the lack of evidence supporting postsurgical prophylaxis, at the recommendation of our infectious disease service broad prophylactic coverage with clindamycin and ciprofloxacin for 1 week was considered appropriate.

Conclusion

We present a unique case of transorbital traumatic brain injury from a bristled toothbrush head projectile. Surgical management of transorbital intracranial injury should take into account intraocular pressure, the presence of an orbital apex syndrome or superior orbital fissure syndrome, the potential for additional damage to neurologic or vascular anatomy, and the potential need for bony decompression and dural repair. Modern skull base approaches that permit simultaneous orbital decompression with optimal brain exposure and operative trajectories may be well suited to penetrating orbital injuries. Attention to the shape of the foreign body and surrounding neurovascular structures should guide whether an anterograde or retrograde (back out through the orbit) removal is indicated. Although wooden objects have a reputation as potent fomites, bristled oral-care objects should also be regarded as high risk for infection if they violate natural defensive barriers. A multidisciplinary approach to transorbital intracranial injuries is recommended with ophthalmology, neurosurgery, infectious disease, and potentially facial plastics services involved early on in management. Given the high incidence of either psychological disease and or violence associated with these types of injuries in the literature, psychiatric or social work consults should be strongly considered as well.

Acknowledgments

We have no funding sources to disclose.

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