TASER dart causes penetrating intracranial injury

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SUMMARY

Although conducted electrical weapons (CEWs) such as the Thomas A. Swift's Electric Rifle (TASER) provide a less lethal means for subduing persons than firearms or stun guns, they have the potential to cause adverse injury. This report discusses the intracranial penetration of a TASER dart.

We present a case of a woman in her early 40s who was subdued by New South Wales Police with a TASER. The dart impacted her skull resulting in a tonic-clonic seizure. Examination and imaging in the emergency department revealed intracranial penetration to a depth of 4 mm. An emergency craniotomy was performed. She had no neurological deficits and subsequently discharged herself from the hospital.

This case demonstrates that penetrating head injury causing brain injury with subsequent seizures is possible with TASER use, contrary to common belief. While they are not intended to penetrate the skull, traumatic brain injury requiring neurosurgical intervention should be considered if CEWs such as TASER are pointed at the human head, especially at shorter ranges. This report demonstrates that utmost caution should be ensured with their use. We outline the weapon's mechanism, review the literature and discuss the physical properties of the collision in order to investigate the likelihood of intracranial injury.

BACKGROUND

Since their introduction in 1974, conducted electrical weapons (CEWs) have been increasingly used by law enforcement as a means of subduing hostile or uncontrollable persons. The most popular CEW in use worldwide is the TASER (Thomas A. Swift's Electric Rifle, TASER International, Scottsdale, Arizona), and their X26 models were in use by New South Wales (NSW) Police Force during this case.[1] By delivering an electrical shock via two fired electrodes, CEWs effectively immobilise targets temporarily. Although CEWs were designed to circumvent the lethality of traditional firearms or stun guns, the velocity, shape and electrical activity of the projectiles pose a risk of significant injury, especially when used at close range. There are a small number of case report descriptions of penetrating head injury. Here, we present a similar case in NSW, Australia, where a TASER dart impacting the patient's head resulted in intracranial penetration.

CASE PRESENTATION

A woman in her early 40s was brought into the emergency department under the police section for agitated behaviour in the community. She had a background of polysubstance abuse and drug-induced psychosis, but it is unclear whether she was intoxicated at the time of arrest. Her medical history is significant for anxiety, paranoid schizophrenia and polysubstance abuse. Her regular medications on admission included olanzapine (peroral daily) and aripiprazole (peroral daily and as a monthly depot dose).

During the altercation, she was immobilised with a TASER. An electrical shock was delivered, and she was observed to immediately suffer a generalised tonic-clonic seizure lasting approximately 15 s, with a 2-min post-ictal phase. En route to the hospital, she was sedated with droperidol as she was agitated and combative. She was started on 500 mg of levetiracetam two times per day and suffered no more seizures during her admission.

INVESTIGATIONS

In the emergency department, formal history and examination were initially limited due to her altered mental state. She was reassessed when complaining of pain in the back of the head. Physical examination revealed a metal dart impacted in her right scalp in the occipital region, with no active external bleeding.

Her Glasgow Coma Scale score was 14 (E4V4M6). Central and peripheral nervous system examination revealed no focal neurological deficit. CT of the head showed the metallic dart tip traversing 4 mm intracranially (figures 1 and 2).

TREATMENT

She underwent an emergent craniotomy for the removal of the foreign body (figure 3). Intraoperatively, laceration of the dura and parenchymal penetration of the dart tip were noted, but there was no active intracranial haemorrhage.

OUTCOME AND FOLLOW-UP

The patient recovered from surgery without neurological deficit and received intravenous antibiotics. She self-discharged prior to consolidation of an antibiotic plan. At 2-month follow-up, she was neurologically intact, and her wound had healed without evidence of infection. She had discontinued antiepileptic drugs and did not report seizure activity post-discharge. She continued to use recreational drugs and has had multiple subsequent admissions for overdose since her TASER injury.

DISCUSSION

This case demonstrates that a TASER dart aimed at a person's head is capable of penetrating intracranially. Here, we review the literature and discuss the mechanics of the weapon and its capabilities of causing a penetrating brain injury.

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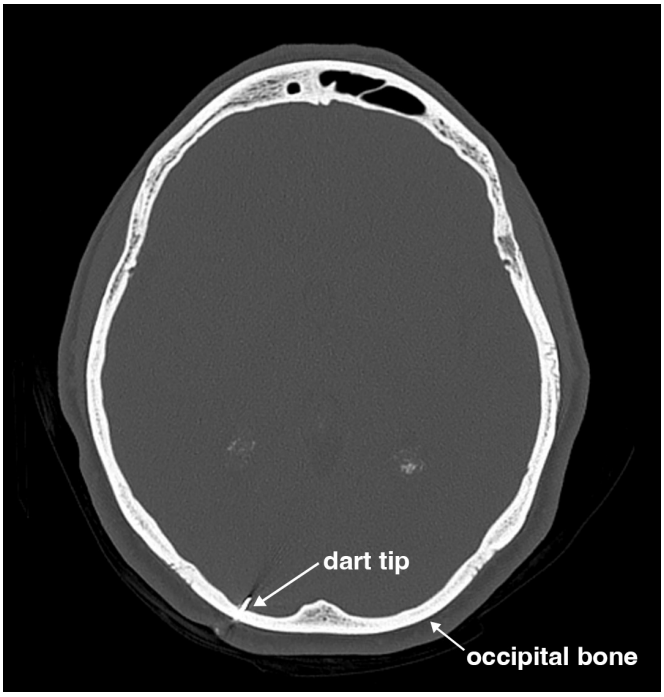

Figure 1 CT without contrast (axial view) demonstrating a metallic barbed tip penetrating intracranially in the right occipital region.

The electrodes fired from a TASER X26 take the form of two barbed darts that are propelled by compressed gas cartridges and embed themselves in the target's skin while remaining connected to the handheld unit by thin copper wires. The attachment of both darts to the body completes an electrical circuit, whereupon multiple high-voltage, low-current pulses specifically designed to overpower and tetanise voluntary skeletal muscle are delivered. The myocardium, theoretically, is spared in this process.[2] CEWs have reduced all-cause mortality by two-thirds, with a reported major complication rate of around 0.25%.[3 4] Injuries to specific organs have nevertheless been reported, such as ocular trauma,[5] testicular laceration[6] and intracranial injury. The mechanism of intracranial injury is typically blunt-force trauma secondary to falling,[7] but in rare cases it is due to direct penetration by the dart.

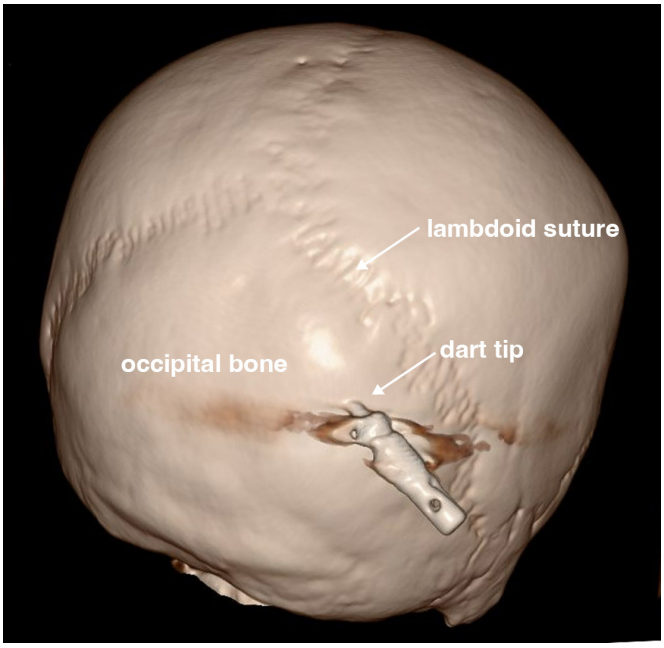

Figure 2 Three-dimensional CT scan reconstruction of the posterior cranium demonstrating the extracranial portion of the dart and point of entry.

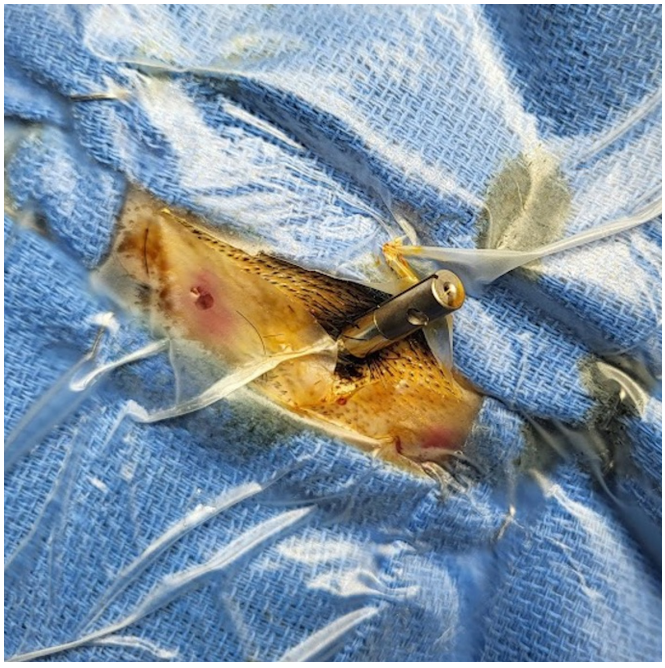

Figure 3 Appearance of the embedded dart intraoperatively, prior to craniectomy.

Six cases have been reported of varying depths of intracranial injury and clinical severity. Intradural injury, such as in our case, was confirmed in four previous cases, where neurosurgical intervention was required for the removal of the dart.[8–11] In the remaining two cases, there was incomplete penetration of the skull, with no perforation of the inner cortex of the skull.[12 13] No significant haemorrhage or parenchymal damage was found in any of these cases, and the patients had no focal neurological deficit postoperatively. In two cases, the patients were reported to experience non-specific mood symptoms, irritability, difficulty concentrating and headaches for some months after the incident.[9 13] Immediate loss of consciousness post-impact was reported in all cases except one. In this case, despite the intradural course of the dart, the patient went home after the injury and presented to the nearest hospital a few hours later complaining of a headache.[9] Electrical shock post-impact was delivered in three cases including ours.[8 13] As for the others, the shock was either not reported or only one electrode impacted the target. Seizure activity was reported in only one other case, in which the dart did not travel intracranially but embedded within the skull.[13] Our case is the first reported with intradural injury and an electric shock causing a seizure.

These cases demonstrate that targeting the head with a TASER can result in intracranial penetration. To determine its safety, we examine whether a TASER dart is consistently capable of penetrating the human skull. To do this, the kinematic properties of the dart need to be compared with the structural properties of the human skull. The important factors are the distance from which the dart is fired, the region of the skull that is impacted and the angle of incidence of the dart. Bollinger *et al* examined the piercing potential of X26 cartridges by experimental ballistic

analysis with a human skull simulacrum made from a hollow polyurethane sphere coated with silicone. They analysed the TASER X26 loaded with the XP 7.6 and XP 10.6 darts (denoting range in metres) at various distances, impacting spheres 5 mm or 7 mm in thickness (representing the range observed within the human skull). All darts were found to have intracranial injury potential in their experiment, with depth of penetration increasing with decreasing range. Notably, the XP 7.6 probe (in use by the NSW Police) penetrated the 5 mm and 7 mm skulls at 0.5 m, 1 m and 2 m, but only the 5 mm skull at a range of 4 m.[14] In our case, the dart penetrated 4 mm through the occipital bone, which is represented by the thicker 7 mm skull in this experiment. The results suggest that it would have only been possible at a range of less than 4 m.

According to a recent study, the threshold energy for a skull fracture to occur in low-velocity projectile impacts is 865 mJ.[15] A ballistic analysis completed for the UK government found that X26 probe weighs 2.8 g, possessing a kinetic energy of approximately 1.0 J at 3 m range and 0.7 J at 4.6 m.[16] This suggests that the cranial penetration is possible within this range, which is consistent with the experimental findings above.

These data imply that the projectiles fired by the TASER X26 models in use by the NSW Police possess the force necessary to penetrate the cranium not only at close range but also in the recommended operating range (2–4.5 m). Moreover, the addition of high-voltage electrical charge in these projectiles can precipitate seizure activity. Although full neurological recovery was demonstrated in all discussed cases, the requirement for neurosurgical intervention in most of these patients is a significant adverse consequence of TASER use. Law enforcement and security personnel need to be aware of this potential outcome.

Learning points

- If the head is hit by the darts of the TASER X26 model, they are capable of intracranial penetration, even within the recommended operating range.
- Intracranial penetration of a TASER dart can result in injury to the brain parenchyma, which may have secondary adverse effects such as seizure activity.
- Despite the extent of injury and the need for surgery, the outcome was significantly more favourable in comparison to firearm injuries.

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Case reports provide a valuable learning resource for the scientific community and can indicate areas of interest for future research. They should not be used in isolation to guide treatment choices or public health policy.

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