Grand Rounds

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A 24 year-old gentleman was transferred from an outside institution for evaluation of TASER dart in the right lower eyelid. The gentleman sustained multiple TASER wounds elsewhere on the body, but no other medical issues. The patient was not able to give any reliable history or subjective complaints due to severe psychosis.
NEXT STEP?
Diagnosis?

Ruptured Globe! Ruptured Globe! Ruptured Globe!
But.. A Simple Ruptured Globe?
The TASER

- Thomas A Swift’s Electric Rifle:
  - “A less lethal weapon” (1974)
  - Meant to immobilize violent and threatening individuals in law enforcement.
- Two harpoon-like barbed electrode darts with trailing conductive wires to a target 3–6 m away.
- Wires complete an electrical arc: short-duration (fraction of a millisecond) repetitive pulses (5–30 pulses per second), each of 50 000 V.
- 160 ft/sec, up to 35 ft
- Triggers skeletal muscle contraction and tetany
- 1.4% sustain significant injury (face, groin, neck)
TASER Injuries

• High-voltage, low current stimulation tetanizes skeletal muscle, while leaving smooth and cardiac muscle unaffected.
• Medical attention is usually sought for removal of lodged darts (9.5 mm long)
• Reported sequelae: contusions, abrasions, skin lacerations, mild rhabdomyolysis, testicular torsion and miscarriage.
55 year-old man with a Taser to the right lower lid
Vision: 6/18
Inferior SCH, microhyphema, vitreous hemorrhage
Tip of barb visible within the vitreous
Sclera sutured and cryopexy was applied
Vision improved post-operatively
CATASTROPHIC GLOBE DISRUPTION AS A RESULT OF A TASER INJURY

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was more cooperative and reported light perception vision in the affected eye. The wound remained watertight. B-scan showed a retinal detachment with possible lens material in the vitreous. Despite efforts to locate the patient, she was lost to follow-up after 1 week.
• 35 year-old man six days s/p blunt trauma from a Taser gun in the right eye, complains of decreased vision in both eyes since trauma.
• BCVA 20/50, 20/100
• Tapp: 48 OD

• Subconjunctival hemorrhage, PSC od, angle recession on gonio od, two clock-hours retinal dialysis od, ASC os
• Underwent pneumatic retinopexy and cryotherapy
• Lost to follow up before cataract surgery.
Diffuse retinal injury from a non-penetrating TASER dart

Case report

A 39-year-old man was brought to the emergency department after being subdued with a TASER gun by the police. The TASERing resulted in immediate loss of consciousness. Three TASER prongs were found on the patient's clothing, and a fourth was found firmly embedded medially in his right lower lid (Fig. 1). His visual acuity on presentation was 20/400 in the right eye and 20/20 in the left eye. Pupil reactions and confrontational visual fields were normal. Ocular motility was full, with mild pain on upgaze. The intraocular pressures were 20 and 14 mmHg in the right and left eyes, respectively. A TASER probe was embedded in the right lower eyelid with a corresponding laceration and surrounding ecchymosis. However, no electrical burn was observed on the eyelid skin. A small subconjunctival hemorrhage was noted nasally in the right eye. Corneas and lenses were clear, and irides intact. Anterior chambers were formed without inflammation. Dilated fundus examination of the right eye showed a string of retinal hemorrhages surrounding a large area of subretinal hemorrhage inferonasally, measuring approximately 3 disk-diameters in extent (Fig. 2). No retinal tear was identified. The vitreous was clear with no evidence of cells in the anterior vitreous. A CT scan of the orbits showed intact globes, and localized the prong in the right lower lid, extending into the anterior orbit, with the tip terminating in the right lacrimal fossa. There was no radiographic evidence of rectus muscle involvement (Figs. 3, 4).
Diffuse retinal injury from a non-penetrating TASER dart

The initial area of subretinal hemorrhage progressed into an exudative retinal detachment over the following 3 days. A Ganzfeld electroretinogram (UTAS-E 2000, LKC Technologies, Inc, Gaithersburg, MD), following the ISCEV standard for clinical electrophysiology [3], was performed on our patient at this time and showed a 63–70% decrease in a- and b-wave amplitudes for rods when compared to the fellow normal eye, but only a 10% reduction in cone amplitudes. Cone responses were also delayed by 1–2 ms (Fig. 5). Over the next 2 months, the retinal detachment gradually resolved, leaving a few residual intraretinal hemorrhages and some hyperpigmented scars. Visual acuity progressively improved over 2 months time to 20/25. No new complications developed over this period of time. Unfortunately, the patient was lost to follow-up, and we were unable to assess for late sequelae of the injury.
Review article: Emergency department implications of the TASER

Megan Robb, Benjamin Close, Jeremy Furyk and Peter Aitken
Emergency Department, The Townsville Hospital, Townsville, Queensland, Australia

Cardiovascular

Several studies have examined electrocardiogram (ECG) changes in healthy volunteers with TASER exposures. They found a significant increase in heart rate decrease in PR interval. One study conducted on pigs observed cardiac either directly through a thoracotomy or echocardiography, which demonstrated high rates of 200/min during use of TASER. Other variables might impact on the risk of inducing a ventricular arrhythmia after a TASER exposure, such as the presence of drugs and the barb distance. A study conducted on anaesthetized pigs found that ventricular tachycardia and VF could be induced, but only when adrenaline had been given first to simulate stress. A similar pig study found that cocaine reduced the VF threshold and hence increased the vulnerability to VF. The distance from the Taser barb to the heart has also been investigated in pigs, and the findings applied to human models. In theory, VF would be more likely when electrodes are closest to the heart and, for this reason, people with a low body mass index might be at higher risk.

Sudden death

There has also been concern about whether or not TASER is the cause of death of patients in some circumstances. Amnesty International (2006) has published an article that suggests that death can be attributed to the use of TASER in over 150 patients. However, many of the patients who have died as a result of exposure to the TASER had illicit drugs in their systems. Coronial reports into the cause of deaths in many of these patients did not attribute death directly to TASER, but associated it with the death. TASER International acknowledges that drug use increases the risk of death following TASER use.

Pregnancy

There is a theoretical risk of the TASER causing adverse effects to the foetus and there is one case report describing the miscarriage of an 8–10 week gestation pregnancy following TASER exposure. A barb lodged in the patients' abdomen above the uterus and the following day she experienced vaginal bleeding and subsequently miscarried 7 days later. The author suggests a link between the TASER and the miscarriage as the uterus and amniotic fluids act as excellent conductors of electrical current. Foetal death might have occurred as a result of a cardiac arrest or thermal injury to the placenta resulting in uteroplacental insufficiency. However, in this case a causal relationship was not able to be established.

Report, an intracranial penetration of a barb occurred in a 16-year-old boy. CT demonstrated possible dural perforation. He was neurologically intact. It was removed in the operating theatre. A recent case of pharyngeal perforation from a barb penetrating the neck has also been reported.

TASER International describes a case of a pneumothorax caused by a barb penetrating the left upper anterior chest of a slim-built man. In another case,
**Review article: Emergency department implications of the TASER**

Megan Robb, Benjamin Close, Jeremy Furyk and Peter Aitken
Emergency Department, The Townsville Hospital, Townsville, Queensland, Australia

**All patients exposed to TASER should have**

1. ABC – airway, breathing, circulation and vital signs
2. Secondary survey – look for other injuries
3. Treat injuries – lacerations, burns as per departmental guidelines
4. Remove barbs – unless risk that has penetrated body cavity, joint, eye, cranium
5. Assess tetanus status – ADT as required
6. Baseline investigations – consider BSL, ECG and venous blood gas as screening test

**High-risk groups**

- drug-or alcohol-intoxicated patients
- mental health patients
- patients with pre-existing cardiovascular disease, pacemaker or ICD’s
- multiple TASER exposures
- low BMI
- obstetric patients >24/40
- patients considered to have ‘excited delirium’

- If the patient is not high risk and baseline investigation normal then can be discharged.
- If the patient has an abnormal ECG (arrhythmia) or chest pain, admit as per hospital protocols.
- If patient has an ICD or pacemaker – Normal ECG – Pacemaker check
  – Abnormal ECG – admit cardiology
- If patient >24/40 pregnant – refer to Obstetrics for CTG monitoring.
- If patient has a barb embedded in eye – refer ophthalmology.
- If suspicion barb has penetrated body cavity (cranium, peritoneum, joint), manage or refer as per usual practice.
- If suspicion barb has penetrated chest, ensure that patient has chest x-ray and pneumothorax excluded.
- If initial baseline investigations normal – treat coexisting conditions as per local protocols (i.e. drug intoxication, psychiatric condition, traumatic injuries)
Figure 1  The classification and regression tree (CART) model for open globe injuries: visual survival (LP or better) vs no vision (NP or enucleation).
Ocular Trauma Score

<table>
<thead>
<tr>
<th>Initial Visual Factor</th>
<th>Raw Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Initial visual acuity category</td>
<td></td>
</tr>
<tr>
<td>No light perception = 60</td>
<td></td>
</tr>
<tr>
<td>Light perception to HM = 70</td>
<td></td>
</tr>
<tr>
<td>1/200 to 19/200 = 80</td>
<td></td>
</tr>
<tr>
<td>20/200 to 20/50 = 90</td>
<td></td>
</tr>
<tr>
<td>≥ 20/40 = 100</td>
<td></td>
</tr>
<tr>
<td>B. Globe rupture</td>
<td>-23</td>
</tr>
<tr>
<td>C. Endophthalmitis</td>
<td>-17</td>
</tr>
<tr>
<td>D. Perforating injury</td>
<td>-14</td>
</tr>
<tr>
<td>E. Retinal detachment</td>
<td>-11</td>
</tr>
<tr>
<td>F. Afferent pupillary defect</td>
<td>-10</td>
</tr>
</tbody>
</table>

Raw score sum = sum of raw points
HM = hand motion vision

Source: Comp Ophthalmol Update © 2007 Comprehensive Ophthalmology Update, LLC
### Table 2: Correlation between patient characteristics and visual outcome

<table>
<thead>
<tr>
<th></th>
<th>Vision survival (n=77)</th>
<th>No vision (n=23)</th>
<th>Odds ratio</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>58 (75.3%)</td>
<td>16 (69.6%)</td>
<td>1.34</td>
<td>0.5953</td>
</tr>
<tr>
<td>Female</td>
<td>19 (24.7%)</td>
<td>7 (30.4%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–16</td>
<td>21 (27.3%)</td>
<td>3 (13.0%)</td>
<td>0.5692</td>
<td></td>
</tr>
<tr>
<td>17–39</td>
<td>26 (33.8%)</td>
<td>9 (39.1%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40–59</td>
<td>20 (26.0%)</td>
<td>7 (30.4%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥60</td>
<td>10 (13.0%)</td>
<td>4 (17.4%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cause of injury</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assault</td>
<td>11 (14.3%)</td>
<td>8 (34.8%)</td>
<td>3.2</td>
<td>0.037</td>
</tr>
<tr>
<td>Accident</td>
<td>66 (85.7%)</td>
<td>15 (65.2%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Initial VA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPL</td>
<td>1 (1.3%)</td>
<td>14 (60.9%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 3: The classification and regression tree (CART) analysis predictions compared with the actual visual outcomes

<table>
<thead>
<tr>
<th>Actual outcome</th>
<th>Visual survival</th>
<th>No vision</th>
</tr>
</thead>
<tbody>
<tr>
<td>CART predicts visual survival (LP or better)</td>
<td>72</td>
<td>6</td>
</tr>
<tr>
<td>CART predicts no vision (NPL/enucleation)</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>Minimal to severe visual loss</td>
<td>48</td>
<td>8</td>
</tr>
<tr>
<td>Profound visual loss</td>
<td>8</td>
<td>36</td>
</tr>
<tr>
<td>CART predicts minimal to severe visual loss (6/6–3/60)</td>
<td>8</td>
<td>36</td>
</tr>
<tr>
<td>CART predicts profound visual loss (worse than 3/60)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 4: The ocular trauma score (OTS) predictions compared with the actual visual outcomes

<table>
<thead>
<tr>
<th>Actual outcome</th>
<th>Visual survival</th>
<th>No vision</th>
</tr>
</thead>
<tbody>
<tr>
<td>OTS predicts visual survival (LP or better)</td>
<td>75</td>
<td>0</td>
</tr>
<tr>
<td>OTS predicts no vision (NPL/enucleation)</td>
<td>2</td>
<td>23</td>
</tr>
<tr>
<td>Minimal to severe visual loss</td>
<td>50</td>
<td>0</td>
</tr>
<tr>
<td>Profound visual loss</td>
<td>5</td>
<td>45</td>
</tr>
<tr>
<td>OTS predicts minimal to severe visual loss (6/6–3/60)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OTS predicts profound visual loss (worse than 3/60)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Lid laceration**

<table>
<thead>
<tr>
<th></th>
<th>Visual survival</th>
<th>No vision</th>
<th>Odds ratio</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>11 (14.3%)</td>
<td>13 (56.5%)</td>
<td>7.8</td>
<td>0.0001</td>
</tr>
<tr>
<td>No</td>
<td>66 (85.7%)</td>
<td>10 (43.5%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Management of Open Globe Injury

**Clinical Features**
- Obvious corneal or scleral laceration
- Ocular volume loss
- Uveal prolapse
- Peaked/Eccentric Pupil
- 360’ bullous SCH (Posterior)
- Intraocular or protruding foreign body

**Diagnostic Eval**
- CT scan
- Surrounding facial/bodily injury

**Treatment**
- Assess for life-threatening injury
- Eye Shield
- Analgesics, antiemetics as needed
- IV antibiotics (Vancomycin, Ceftazidime)
- Elevate HOB
- Plan for operative repair
- NPO
- Anesthesia: avoid ketamine, succinylcholine
The surgeon should never enucleate an eye primarily unless restoration of the globe is impossible. No light perception (NLP) vision should not be used as an early enucleation criterion, because several reports of patients with initial NLP indicate that they later recovered some level of vision.26 Methodical repair can reconstruct many eyes that initially appear unsalvageable.

Fig. 13-14. When, owing to missing tissue, a scleral wound cannot be sealed, a patch graft can be fashioned from banked sclera, fascia lata, preserved pericardium, or scleral buckle material, and used to oversew the wound. By using interrupted horizontal mattress sutures through the graft and globe, the wound is compressed and a watertight seal can be obtained. Drawing prepared for this textbook by Gary Wind, MD, Uniformed Services University of the Health Sciences, Bethesda, Md.
Back to our patient...
Operative Findings

- Under general anesthesia, the orbit was inspected thoroughly.
- The metallic foreign body was found to have penetrated the globe medially.
- Using gentle traction, the foreign body was removed. Caught with the barb of the dart was retina and uveal tissue.
- Primary enucleation was performed once repair was not deemed possible.
- The patient was transferred to a psychiatric facility elsewhere for long-term care.
This was an excellent case that combined medical and surgical ophthalmological diagnosis and management, as well as general medical and mental issues. I learned the value of teamwork between ophthalmology, emergency medicine, psychiatry, and anesthesiology. The patient was unable to facilitate his own care, so the decisions to make were difficult but necessary. The patient received the best care we could offer, and the team was satisfied with the result.
Core Competencies

**Patient Care** - Took care to provide patient care that was compassionate and appropriate, and effective

**Medical Knowledge** - Recognized the signs and symptoms of ocular trauma, evaluated for associated defects and medical issues, and treated patients using standardized and a well-thought out plan of care.

**Practice-based Learning and Improvement** - demonstrate the ability to investigate and evaluate the care of our patients, including improving our methods of management of TASER eye injuries and ocular trauma with regard to literature.

**Interpersonal and Communication Skills** - demonstrate interpersonal and communication skills with a difficult and problematic patient that will result in the effective exchange of information

**Professionalism** - demonstrate a commitment to carry out professional responsibilities and an adherence to ethical principles despite many obstacles

**Systems-based Practice** - demonstrate the ability to call effectively on other resources, such as primary care and ancillary staff in the system to provide optimal health care.
Thank You

- Dr. Shinder
- Dr. Shrier
- Psychiatry
- Anesthesia
- Bellevue medical and ophtho teams
- Our Patient