



# DCMC Emergency Department Radiology Case of the Month

These cases have been removed of identifying information. These cases are intended for peer review and educational purposes only.

Welcome to the DCMC Emergency  
Department Radiology Case of the Month!

In conjunction with our Pediatric Radiology specialists from ARA, we hope you enjoy these monthly radiological highlights from the case files of the Emergency Department at DCMC. These cases are meant to highlight important chief complaints, cases, and radiology findings that we all encounter every day.

If you enjoy these reviews, we invite you to check out Pediatric Emergency Medicine Fellowship Radiology rounds, which are offered quarterly and are held with the outstanding support of the Pediatric Radiology specialists at Austin Radiologic Association.

If you have any questions or feedback regarding the Case of the Month, feel free to email Robert Vezzetti, MD at [rmvezzetti@ascension.org](mailto:rmvezzetti@ascension.org).

**This Month: Pediatric injury from gunfire, both intentional and accidental, is on the rise. Morbidity and mortality from these injuries is significant. This case highlights this, as well as the need to treat every firearm as if it is loaded and ready to fire.**



FELLOWSHIP - PEDIATRIC EMERGENCY MEDICINE

## PEM Fellowship Conference Schedule: July 2019

- 3rd - NO CONFERENCE. HAPPY FOURTH OF JULY!
- 8th - PEM Fellow Orientation
- 9th - PEM Fellow Orientation
- 10th - 9:00 EMTALA /Transfer Basics.....Dr Yee  
10:00 Local Transfer Process.....Dr Chu  
11:00 CHD Pre and Post Op.....Dr Ruttan
- 11th - Fellows Welcome Party
- 17th - 9:00 TBD  
10:00 BRUE.....Drs Costello/Vezzetti  
11:00 Mentorship.....Dr Allen  
12:00 ED Staff Meeting
- 23rd - Journal Club
- 24th - 9:00 M&M.....Drs Chu/Fuller  
10:00 Board Review: Pulmonary.....Dr Whitaker  
12:00 Research Meeting

Guest Pediatric Radiologist: Dr Eugene Tong, MD

Simulations are held at the Seton CEC.  
Lectures are held at DCMC Command Rooms 3&4.  
Locations and topics are subject to change.  
All are welcome!

When the initial battles in the Revolutionary War broke out in April 1775, few colonists desired complete independence from Great Britain, and those who did were considered radical.



Thomas Jefferson, John Adams, Roger Sherman, and Benjamin Franklin were tasked with writing the Declaration of Independence. Ultimately, Jefferson wrote most of it.

## Case History

The radio at the Charge Nurse's station in the ED alerts you that a child is coming by air transport for a gunshot wound. Apparently the child's father was showing him a gun when it discharged, striking the child in the head. EMS was called and the child was transported to an outside facility (several hours from Dell Children's, which is the nearest Level 1 Pediatric Trauma Center as well as the nearest Pediatric Trauma Center of any level). There he was reported to be alert and speaking, with an initial GCS of 15. During the course of his evaluation, he became somnolent (reported GCS of 7) and was intubated with Ativan and Rocuronium. Shortly after that, episodes of bradycardia were noted, the child was given 5 cc/kg of 3% Normal Saline, and a non-contrast enhanced CT scan of the head was obtained. The decision was then made (and probably made prior to that) to transport the child to DCMC. Prior to transport, he was given Ancef and is was placed on Vecuronium and Versed drips for transport.

On arrival, the child is sedated and paralyzed. He is intubated. His vitals look stable at this time: afebrile, HR of 110, BP of 90/60, RR 25, Sat of 100%. There is a small wound (appears to be the entry wound) to the midforehead without an apparent exit wound. He has no other signs of trauma and there are no other injuries.

You review the history with the child's uncle. He tells you the child's father (who is presently being interrogated by law enforcement) was showing his son a "high powered pellet handgun" when the gun went off at point blank range, striking the child in the forehead. He tells you EMS was immediately called.

It has been some time since the initial injury at CT scans. You obtain a CXR (will help with ET tube confirmation of location) and a non-contrast enhanced CT scan.

### Modified Glasgow Coma Scale for Infants and Children

	Child	Infant	Score
Eye opening	Spontaneous	Spontaneous	4
	To speech	To speech	3
	To pain only	To pain only	2
	No response	No response	1
Best verbal response	Oriented, appropriate	Coos and babbles	5
	Confused	Irritable cries	4
	Inappropriate words	Cries to pain	3
	Incomprehensible sounds	Moans to pain	2
	No response	No response	1
Best motor response*	Obeys commands	Moves spontaneously and purposefully	6
	Localizes painful stimulus	Withdraws to touch	5
	Withdraws in response to pain	Withdraws to response in pain	4
	Flexion in response to pain	Abnormal flexion posture to pain	3
	Extension in response to pain	Abnormal extension posture to pain	2
	No response	No response	1

\*If patient is intubated, unconscious, or preverbal, the most important part of this scale is motor response. Motor response should be carefully evaluated.

### Pediatric Glasgow Coma Scale

The pediatric GCS score is a very important part in the evaluation of any child with any head trauma. The score is useful to assess the clinical status of the child and detect the potential for intracranial injury, although this is debated.

The adult version of the GCS was created in 1974 by Graham Teasdale and Bryan Jennett, with the pediatric version making its debut about 10 years after the adult version.

Intubated patients cannot have their verbal and eye responses tested, so they get a score of 1, modified as 1T. There is some controversy regarding the score, as inter-rated reliability has been reported as poor in some studies. Note that there are two Pediatric Scales - verbal and nonverbal.



The Statue of Liberty is not located in New York! It is really located in Jersey City, New Jersey.



Harvard was the first university in the United States and was founded in 1636. The school is named for John Harvard.

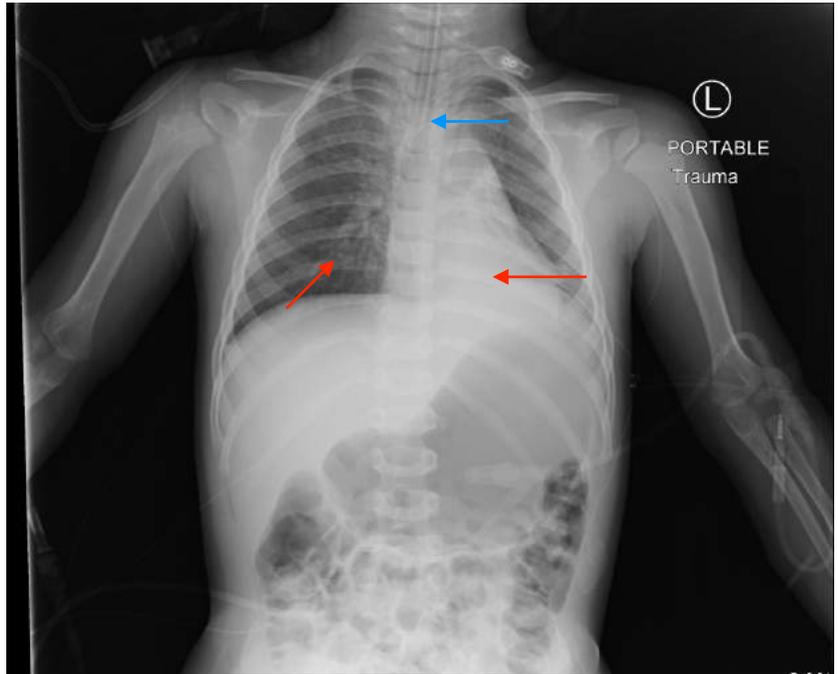


The Liberty Bell was last rung on George Washington's birthday in 1846. It cracked a few hours later. If you closely examine the bell, the word "Pennsylvania" is misspelled (missing an "n"). It was built for \$250.00 and first rung on July 4, 1776 during the first public reading of the Declaration of Independence.

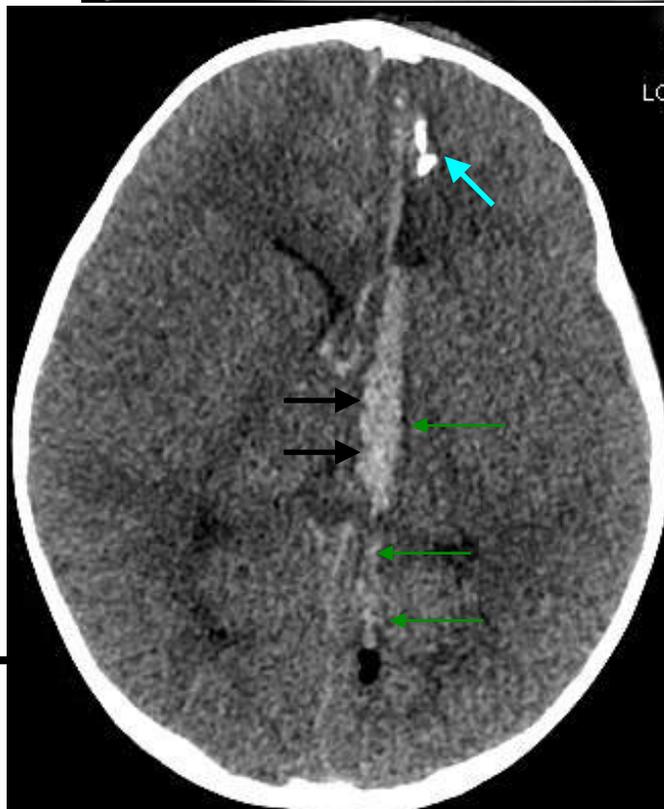
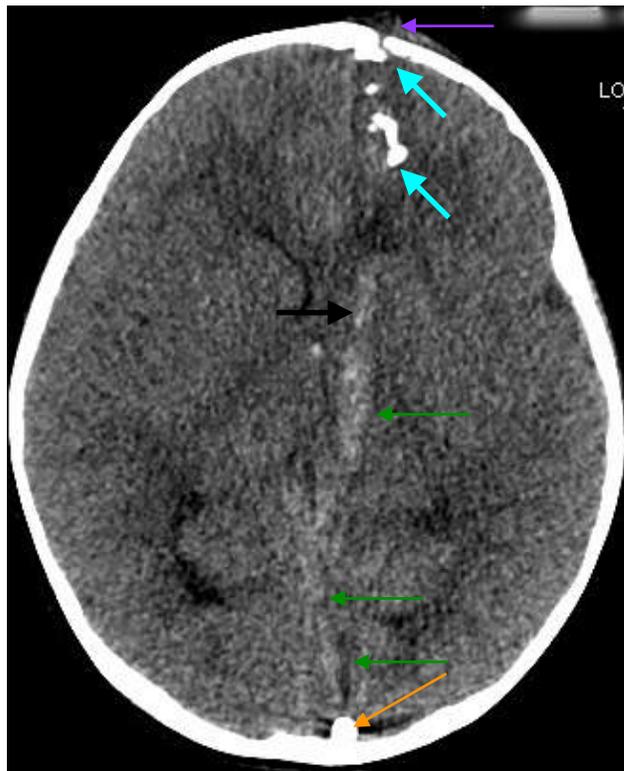
Pediatric gunshot injuries are not as common in the adult population, but they are increasing, and are the third leading cause of pediatric deaths. Nearly 1300 children die and 5700 are treated for gunshot wounds every year.

One comprehensive study looked at these injuries in Houston, from 2001 to 2016, in patients 2.5 months to 15 years of age. In this study, the most commonly injured anatomic locations include the head, face, and neck/spine. The majority of patients were male. 38% of the injuries were caused by handguns, 25% by BB guns, and 12% by shotguns. Disturbingly, intentional versus accidental injuries were 54.5% and 48.9% respectively in this study. Of the intentional injuries, about 5% were suicide attempts. The majority of the injuries occurred in a family residence and an adult was supervising the victim in 26% of cases. 10% of cases resulted in criminal charges being filed. A Los Angeles study found of 304 injured, 206 had sufficient evidence to determine intent and of these, 10% were considered unintentional. The majority of unintentional injuries were in younger children, were caused by a forearm in the home, and more likely to involve friends/family. Intentional injuries accounted for all deaths in the study.

This is the child's chest xray. It is a one view study, not the usually-obtained two view study. In trauma cases, a one view chest radiograph is sufficient to detect clinically significant pneumothoraces, hemothoraces, rib fractures, and ET tube location (of course to verify location, visual inspection, clinical exam, and vital signs are also used). In this study, the ET tube is in good position (blue arrow); there is bilateral perihilar and retrocardiac opacities (red arrow). In a trauma setting, this may be due to atelectasis, pulmonary contusion, or aspiration.



The child's selected CT images are seen here. There is an anteroposteriorly/parasagittal oriented left frontal entry gunshot wound (purple arrow) with an associated tract of hemorrhage and shear injury (green arrow). The projectile, appearing to be a spherical bullet approximately 6 mm in diameter, along with fragmentation, is seen as well (orange arrow). A small calvarial fracture can be seen (aqua arrow). There is intraventricular hemorrhage (black arrow) but no mass effect is present. Is further imaging indicated? Does the child need an MRI?



### Imaging Penetrating Head Injuries

CT is the imaging modality of choice in patients with penetrating head injuries from both low and high velocity mechanisms. This modality allows assessment of the skull (allowing for determination of entry and exit wounds), location of any retained foreign bodies, the detection of hematomas and hemorrhage, and the direction the projectile has taken. Of course, the damage a projectile does is dependent on the size/shape of the object and the distance fired. The main factor in predicting damage is the amount of kinetic energy produced, which is proportional to the mass and velocity of the projectile. High velocity injuries produce cavitory shockwaves as they traverse tissue, causing more damage.

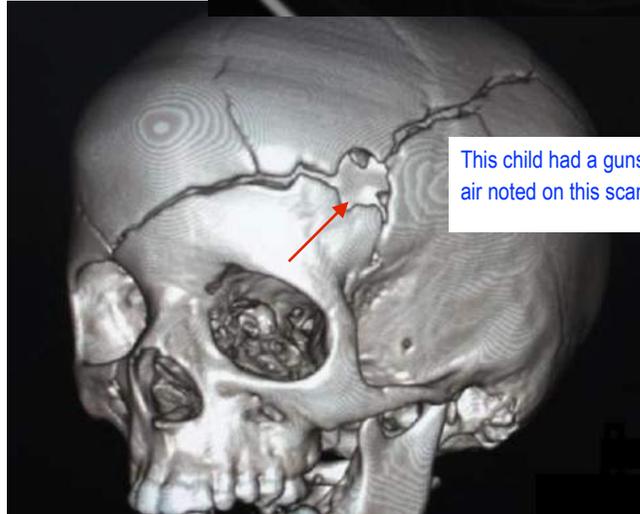
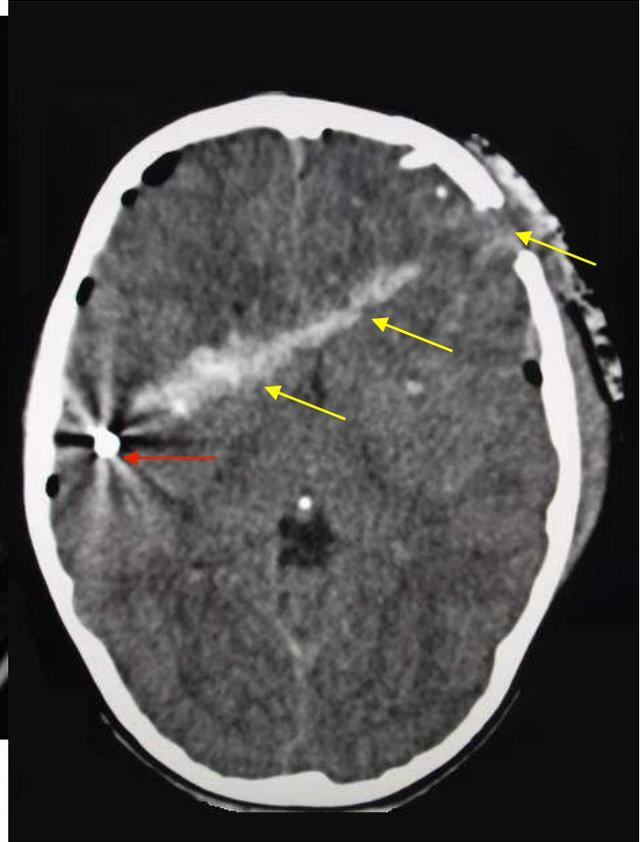
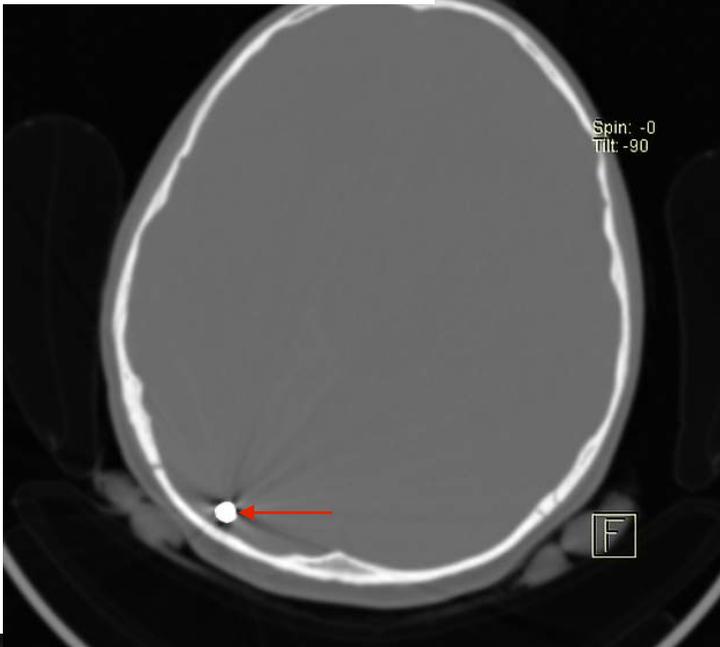
Philadelphia was the original capital of the US.

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The Smithsonian Air and Space Museum is the most-visited museum in the US (9 million visitors a year) and only second to the Louvre in worldwide attendance.

These images show two victims of gunshot injuries. The images at the bottom are of a 15 year old who sustained a high velocity wound during a hunting accident; the projectile is present and there is hemorrhage as well as a fracture at the entry wound. The images immediately below are an 8 year old who was injured while playing with her parent's pistol. In both cases, these victims were not alone and were with adults.

This child has sustained a gunshot wound; note the entrance wound with skull fracture, the path of hemorrhage, and the retained bullet.



This child had a gunshot wound that entered at the right orbit; there is free air noted on this scan. The 3D recon view is seen on the left.



### Predicting Outcomes in Cranial Gunshots

Pediatric studies are lacking, but the Memphis study identified Bilateral fixed pupils, Deep nuclear injury, transventricular trajectory, bihemispheric injury, injury to more than 3 lobes, systolic blood pressure <100 mm Hg, anemia, a GCS <5, and a base deficit < -5 mEq/L as predictors of mortality. The authors of this study applied the St Louis Scale for Pediatric Gunshot Wounds to the Head criteria and reached a conclusion that this criteria had a positive predictive value of predicting death of 78%. These findings were replicated in another study.

In 1870, July 4th became an official holiday. In 1941, it became a paid Federal holiday.

Yankee Doodle was originally a song meant to mock the unorganized colonists.



John Hancock is said to have written his signature larger than everyone else's so "fat old King could read it without his spectacles".



Three presidents have died on July 4th: John Adams, Thomas Jefferson, and James Monroe.

## High Powered Air Guns

These weapons may sound innocent ("air gun") but they are available in 0.22 caliber and can shoot their projectiles at over 1440 feet per second (fps). This is enough to break the sound barrier. They also can look very much like assault rifles and other, more powerful, handguns.



## Hypertonic Saline: Why It Is Used and How It Works:

Hyponatremia is not uncommon in head injured patients, which is one benefit of hypertonic saline therapy. However, this treatment is first line for osmotherapy. Hypertonic saline draws fluid from the interstitial space, improves cranial compliance, and decreases intracranial pressure (by counteracting the brain accumulation of extracellular osmolytes which occurs with blood-brain barrier dysfunction). Multiple studies suggest that hypertonic saline is superior to Mannitol for treating increased intracranial pressure. Initially a bolus of 5 cc/kg is used and there are studies that have looked at continuous infusion for patients with refractory intracranial hypertension.

Roquilly A, Mahe PJ, Latte DD, et al. Continuous controlled-infusion of hypertonic saline in traumatic brain-injured patients: a 9 year study. *Crit Care*. 2011. 15(5): R260.

## Case Resolution:

Pediatric Neurosurgery was consulted and examined the child in the trauma bay. He was taken to the operating room and had an intracranial pressure monitor placed. He was placed on q1 hour neurologic checks in the PICU and had a repeat CT scan, which showed no progression of his hemorrhage. Pediatric Infectious Disease was consulted for antibiotic recommendations. About one week later, the projectile was removed. He was extubated shortly after this procedure and Pediatric Rehabilitation was consulted. They recommended an appropriate rehabilitation regimen. A few days after the bullet was removed, the child underwent an MRI, which showed post operative changes but was otherwise unremarkable (see above for a selected image). He was discharged from DCMC about one month after his initial injury. He currently is continuing physical rehabilitation and should see Neuropsychology prior to starting kindergarten. He is not on anti-epileptic medications as he has not had seizures and is otherwise doing well.

## Teaching Points

1. Pediatric firearm injuries are not common, but are increasing in incidence. Safe gun storage and handling are important
2. In intubated patients, LOOK and LISTEN! A chest xray is helpful but does not replace a good physical exam to confirm tube placement.
3. The Glasgow Coma Scale is an extremely useful tool in pediatric trauma! It is an excellent summation of a child's clinical status. Remember there are two scales: one for verbal children and one for nonverbal children, so be sure to use the appropriate scale.
4. Pediatric forearm injuries are increasingly common. Studies from large metropolitan areas find intentional injury more common than accidental.
5. Penetrating trauma to the head requires careful and rapid treatment. Intubation should be considered in any patient whose GCS is less than 8 or in a patient who has deteriorating mental status.
6. Hypertonic saline (5 cc/kg of 3%) is used to buffer the effects of increasing ICP in head trauma patients. Consider its use in any patient with deteriorating mental status in the context of head trauma (blunt or penetrating).
7. Noncontrast head CT is the initial imaging modality of choice for head trauma patients. While CT is quick and widely available, transfer of a critically ill pediatric patient should not be delayed in order to obtain this (or any other) study.

## References

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