Minimally invasive projectile retrieval: a case report

Residents gain skills to become master clinicians
As physician co-leaders of Palmetto Health’s neuroscience service, we share a vision to provide the most advanced neurology and neurological surgery treatments available to the residents of South Carolina. We are excited to share this edition of our neuroscience journal featuring articles about minimally invasive projectile retrieval and our residency program at Palmetto Health-USC Neurology.

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Meet our newest physicians

Catherine McClung Smith, MD
Pediatric Neurosurgeon
Palmetto Health-USC Neurosurgery

We're happy to welcome Dr. Catherine McClung Smith, who earned her medical degree from Morehouse School of Medicine in Atlanta and completed her residency in neurological surgery at Saint Louis University School of Graduate Medicine.

Dr. McClung Smith completed a fellowship in pediatric neurosurgery at Children’s Hospital of Colorado, Denver. Her specialty interests include the surgical treatment of epilepsy and functional disorders, traumatic brain injury, clinical outlines and guidelines.

David C. Strauss, MD
Neurosurgeon
Palmetto Health-USC Neurosurgery

We extend a warm welcome to Dr. David Strauss. Dr. Straus earned his medical degree from the University of Chicago Pritzker School of Medicine and completed a residency in neurological surgery at Rush University Medical Center in Chicago.

Dr. Straus completed an internship in general surgery and neurological surgery at Rush University Medical Center. He also completed a fellowship in skull-base surgery and cerebrovascular surgery at the University of Washington, Seattle.

Dr. Straus's research interests include valuating observational data in neurosurgery and patient-centered outcome measures for skull-base surgery. His specialty interests include neurosurgical oncology and skull-base neurosurgery.
Minimally invasive projectile retrieval—a case report

by Catherine McClung Smith, MD
We present the case of a 1-year-old male who presented to the neurosurgery service as a trauma major after he was shot in the head with a BB gun. The patient was awake, alert and neurologically intact on presentation.

The patient had a small left temporal entry wound and no exit. The projectiles were brought in by the patient’s parents for inspection and were found to be zinc plated steel (0.177 Caliber 4.5 mm) BBs. As the projectiles did not contain lead, the decision was made to leave the BB in situ. The projectile was low velocity and had passed through the patient’s hair to enter his cranial vault. Infectious Disease was consulted and the patient was started on Vancomycin for 24 hours followed by a short course of PO antibiotics.

The patient was monitored in the ICU overnight and a CT was performed the following morning that showed the projectile remained in the same location and no bleeding had occurred. The patient remained neurologically intact and normothermic during his hospital stay. As the patient lived near the hospital with his family, he was discharged to home after 24 hours of observation.

After close outpatient monitoring and a one-week clinic visit, the wound was found to have sealed nicely with no evidence of infection. At the time of the clinic visit, the patient’s parents expressed concern regarding leaving the BB in situ, as the child was very active and they had hopes of him playing sports. The fact that the BB was ferromagnetic (the BBs brought in by the parents had been tested) also prevented the patient from receiving an MRI in the future. The fact that the BB was also heavy and could migrate spontaneously remained a concern for both the parents and the surgeons involved in the care of the child.

Based on the parental concern, a follow-up with a stereotactic brain CT was performed. At that time, the patient’s parents requested removal of the BB. Due to the placement of the projectile, a long discussion was had as to the best removal method. Based on the placement, the surgeons had significant concerns that a traditional retrieval method – either open cortisectomy with removal of the foreign body or endoscopic retrieval – would be too dangerous as either might push the BB into the midbrain.

After a long discussion with the patient’s parents, the decision was made to proceed to surgery for projectile removal. Both the use of the endoscope or traditional cortisectomy remained possible. However, as the projectile was ferromagnetic, the decision was made to employ a high-powered magnetic source securely attached to a sterile stylet and passed through an endoscopic sheath. By using a high-powered magnet, the surgeons hoped to pull the projectile toward the surgical field and decrease the risk of pushing the projectile toward vital structures.

Prior to surgery, several spherical rare earth magnets were sterilized. The available surgical equipment for the OR at Palmetto Health Children’s Hospital was evaluated and a 19 French endoscopic introducer was selected for the surgery. The tip of the stylet was cut off and hollowed out and Dermabond was used to secure the sterile magnet in the hollow. Once the Dermabond had been allowed to cure, multiple tests...
were performed to ensure that the magnet would not move.

The patient’s head was placed in pins and registered in the Stealth Station. A trajectory was picked based upon the original trajectory of the projectile. A small flap was made in case a craniotomy would be needed, and the original entry site was increased in size with an M8 drill bit to allow passage of the introducer. Several small bone fragments were removed from the parenchyma after increasing the size of the dural opening. Both the modified and an unmodified 19 French introducer were Suretracked to the Stealth Station. The unmodified introducer was passed to just above depth and the stylet was removed. The modified stylet was then passed through the introducer to depth and several attempts were made at projectile retrieval.

When the projectile was not initially retrieved and minor trajectory adjustments failed to produce the projectile, fluoroscopy was brought into the room to confirm that the BB had not migrated. With the help of fluoroscopic guidance the projectile retrieval was seen in real time. The projectile was shown to be attached to the magnet and several images were obtained as it was pulled free from the parenchyma.

Postoperatively, the patient woke and continued to do well. He remained neurologically intact and at his cognitive baseline. Postoperative imaging was significant for a small track where the introducer was passed and negative for hematoma.

Discussion
There is a paucity of data in the literature on the management of non-powder pediatric projectiles and most of the literature is in the form of case reports[1-3]. While some data is available for the use of antibiotics in penetrating injuries, the vast majority of these injuries are bullet wounds at the time of active combat[4]. The argument could be made that the battlefield is significantly less clean than a BB gun projectile; however, battlefield projectiles are expected to be higher velocity with a greater ability to sterilize and cauterize the wound. Battlefield projectiles still become infected due to the material they pass through and carry with them[4]. The same was expected of the projectile in the case of our patient, hence the antibiotics.

Likewise, while there is literature available on the migration of both bullet and bullet fragments after penetrating head injury[5-10], the authors are not aware of literature on migration of projectiles in a pediatric population. Based on the available literature regarding migration of bullets and bullet fragments, the argument could be made that the projectile should have been retrieved at the time of injury. The authors initially held off as the patient was neurologically intact and the projectile was in such a location as to make retrieval more risky than leaving the projectile in situ.
Similarly, due to the location of the projectile and lack of literature on projectile extraction or projectile migration, the argument could have been made to leave well enough alone. The patient's parents, however, felt that their son was an active child and the idea of leaving a foreign body in place that could migrate spontaneously or at the time of a head impact was very disconcerting. His parents also wanted the patient to have the opportunity to be an active and normal child. The possibility that an impact could result in migration of the BB was an area of concern to both parents and surgeons. In addition, removing the ferromagnetic projectile would allow the patient to receive medical care in the form of MRIs if needed in the future.

Examples of foreign body extraction exist in the literature; although, most cases involve more superficially located material or material removed at the time of surgery for evacuation of either a hematoma or abscess[1, 4]. In one case study, the endoscope was used to retrieve a projectile from the caudate nucleus of a 4-year-old after the child was involved in an injury similar to our patient's[2]. Unfortunately, in the case of our patient, while the endoscope could be used to visualize the projectile, removal of the projectile would be very difficult due to its location adjacent to both the brainstem and deep cerebral veins. Graspers would run the risk of damaging adjacent structures and a basket would need to be pushed past the projectile in order to retrieve it.

Ultimately, the choice of retrieval method proved to be poetic in the case of our patient. A spherical rare earth magnet was utilized as the retrieval method for the projectile. The same patient had been hospitalized at a much younger age after he had consumed several similar magnets. At that time the magnets had to be removed operatively and he lost several inches of his intestines.
The difficulty the authors had in the magnetic BB retrieval is likely secondary to scar tissue formation after the initial injury. The lack of evidence-based guidance resulted in a delay of several weeks. In the future, if a magnetic retrieval is indicated, the authors recommend that the retrieval be done within the first few days of injury. In addition, as there is currently not an endoscopic magnet, the retrieval device will need to be assembled at the time of surgery for each case.

**In Conclusion**

Cases such as this one need to be evaluated on a case-by-case basis. There is very little research on intracranial projectiles in a pediatric population outside of case reports. The amount of data is not likely to change in the near future as pediatric intracranial foreign bodies are rare. Wartime injuries do occur in pediatric populations; however, the collection of data at the time of active combat remains difficult at best. We encourage any neurosurgeon or other health care professional who has the opportunity to care for a patient such as ours to publish the treatment and outcome. Any additional data would be beneficial to the medical community to guide evidence-based medicine in the care of these complicated patients.

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Palmetto Health’s “4-BRAIN” phone line for neurosurgical transfers—Because seconds matter.

Providers now can call 844-64-BRAIN to transfer urgent and emergent neurosurgical and neurological patients easily and efficiently.

Studies have shown that one of the challenges faced by emergency room providers and referring physicians is fast and efficient access to neurological and neurosurgical physicians in tertiary medical centers. Palmetto Health’s 4-BRAIN line allows emergency room providers and referring physicians to speak directly with a neurosurgeon or neurologist without going through an operator or long waits on the phone. Neurological problems that the 4-BRAIN line may be used for include intracerebral hemorrhages, subarachnoid hemorrhage, aneurysms, vascular malformations and brain tumors. The 4-BRAIN line is answered 24 hours a day, seven days a week.

Call 844-64-BRAIN (27246) for emergent neurosurgical transfers.
Tremendous technological advances combined with revolutionary treatment advances make this an exciting time to become a neurologist. Exciting new insights into the mechanisms and pathophysiology of neurological disease have led to more effective interventions in more neurological disorders than ever before. Yet, this is only the beginning as we explore how we think or accomplish complex activities, like playing the violin, among other things. The nervous system remains a mysterious and magical box that is waiting to be opened.

Neurological disorders carry a very significant morbidity and mortality burden. A shortage of practicing neurologists in South Carolina significantly adds to it. The high incidence of stroke and vascular disease is well described. Analysis of data reveals that trainees in residency programs tend to stay in the area where they train. The foremost goal of the Palmetto Health-USC Neurology Residency is to train physicians to become the very best clinicians who will serve the people of South Carolina for years to come, applying the same compassionate patient-centered care.
Mentoring by faculty throughout the years of training ensures that the neurology residents gain the skills required to become master clinicians and critical thinkers. Our residents also participate in quality improvement projects, clinical trials and population-based research projects to improve patient care and the overall health of the community. Our faculty members are actively engaged in clinical management of patients, teaching medical students and residents, clinical research, and serve as role models for residents and students alike. They work as part of a clinical team to foster systems-based care.

A multidisciplinary approach to the core competencies of patient care, medical knowledge, practice-based learning and improvement, interpersonal skills and communication, professionalism, and systems-based practice is emphasized. Residents in our program also have the opportunity to work at the first Stroke Center in the Midlands, a multidisciplinary program at Palmetto Health Richland that provides life-saving care using state-of-the-art technology and the latest advancements in stroke diagnosis and treatment.

We fully expect that a majority of our trainees will undertake further fellowship training in the subspecialties of neurology.

The aim of the first year of neurology training involves a comprehensive clinical experience in the areas of internal medicine, subspecialties of internal medicine, family medicine and emergency medicine. A first exposure to neurology also will occur. First-year residents provide medical care for patients within the confines of the team, but will gain skills and develop confidence in independent decision making related to medical issues (under supervision of senior residents and supervisory faculty).

In their second year, trainees are provided comprehensive clinical experience in adult neurology for both outpatient and inpatient diagnosis and management. This training will consist of 13 blocks of clinical rotations in adult neurology at Palmetto Health Richland, Neurology Outpatient Specialty Clinic at USC School of Medicine and the Dorn VA Medical Center. These rotations contain both adult inpatient and an integrated outpatient exposure.

Third-year residents have an exceptional opportunity to increase their depth of understanding of the field of neurology, psychiatry and pediatric diagnosis and management to lay the foundation for their future development. The clinical experience during this year is spent at Palmetto Health Richland, Palmetto Health Baptist, Palmetto Health Children’s Hospital, Neurology Outpatient Specialty Clinic at USC School of Medicine and the Dorn VA Medical Center. All the while, residents will experience increasing levels of responsibility for patient care and teaching as they attain supervisory roles for the trainees at earlier levels of training.

In the fourth year, residents develop an extensive knowledge base in neurology and the neurosciences that are both broad and deep. They will have developed competence at using the medical literature to guide patient care decisions (evidence-based medicine). The resident will demonstrate competence in all facets of the care provided to neurology patients and will demonstrate that they are prepared for practice after graduation. Fourth-year residents also assume an ascending level of responsibility for teaching. The remainder of the fourth year allows extensive elective options for mentoring, protected time for formulating a career path, intensive literature study, and a clinical or basic neuroscience research project.

One of the most important features of our neurology residency is the camaraderie of our residents and faculty. They learn together, play together and engage in lively interactions in conferences and in the clinic. We have a tremendously diverse patient population comprising the entire spectrum of neurological disorders. The rotations at the Dorn VA Medical Center also provide an opportunity for our residents to interact with a different and unique subset of the population.

We have a diverse group of residents with different interests, goals, talents, races, genders and cultural backgrounds. This adds to the depth of the program and each resident contributes in his or her own unique way.
Contact us for more information or to refer a patient

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