

# An Intracerebral Penetration of Air Shotgun Pellet in Toddler: A Case without Neurological Sequelae

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## Abstract

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**BACKGROUND:** A non-powder firearm including air shotgun remains a significant source of injury to children. It causes severe damage and can involve the brain, eyes, heart, abdomen, and other body parts.

**CASE REPORT:** A toddler boy was accidentally shot by an air shotgun at the forehead, and there was no sign of neurological deficit, both before and after surgical removal of the pellet. Herein, we report a case of air shotgun pellet which penetrated a toddler's head from the forehead, all the way up to the occiput. Removal of the pellet was successfully performed without eliciting any neurological sequelae.

**CONCLUSION:** Air shotgun pellet may potentially cause severe injury to the central nervous system when the head is affected, which can be safely prevented by a prompt but deliberate surgical removal. The study would also like to emphasise the importance of education to reduce gunshot incidence in the pediatric population.

## Introduction

Firearms, according to its energy source, can be classified into traditional and non-powder firearms. Traditional firearms generate energy by burning gunpowder to propel a projectile, while non-powder firearms derive its power from compressed air or carbon dioxide. Non-powder firearms such as pellet gun, air rifles, ball-bearing guns, paintball guns, are significant sources of injury and death among children and adolescents. The injury can involve the brain, eyes, head, neck, chest, abdomen, and extremities [1] [2]. Non-powder firearms have a velocity ranging from 80 to 300m/s and can cause injury up to 20-60 feet away. Pellets have several designs such as wad cutter, round nose, sharp-pointed, and hollow point [2].

The head, neck, and eyes are the most frequent area injured by air shotgun. Pellets may enter the skull through eyes, as well as the temporal and

occipital bone because they are relatively thin and less resistant compared to other head regions. Air shotgun pellet injury to the head may be either penetrating in which pellet enter the skull but does not exist, or perforating through the skull in which there are inlet and outlet wound injury. The penetrating injury is usually due to a pellet shot with high velocity from a modified air shotgun, fired from a very close distance [3].

Non-powder firearms are dangerous as it can inflict severe injuries and even death to children [1] [2] [4] [5]. Non-powder firearms are widely available in toy stores, department stores, and online stores with the premise that non-powder firearms are considered toys which are relatively safe for children to play with [4]. In contrast, the injury caused by shooting another person or himself can be serious and fatal. It usually occurs by accident, typically boys being the usual victim, potentially due to a lack of adult supervision [5].

In the United States, approximately 3.2 million

non-powder guns are sold each year, and not all areas have the law to regulate the purchase [1] [4]. Non-powder firearms typically have a velocity of 150-1,200 feet per second, compared with 0.22-caliber handguns which generate the velocity of 800 feet per second. Non-powder firearms have the power to penetrate human skin and bone. The risk of death increases if the speed is more than 350 feet per second [1].

We reported a toddler with penetrating air shotgun pellet from the forehead to the occipital bone without outlet wound injury. The case is considered unique and because the patient had a normal neurological function and recovered without any significant complication.

A 2-year-old male toddler with fully conscious, came to the emergency room with his parent after his forehead was wounded by an air shotgun. He vomited twice, had no history of decrease of consciousness, seizure, headache, and extremity weakness. The accident occurred after he and his grandfather were playing with air shotgun and did not know that there was pellet in that air shotgun. The grandfather fired at patient's forehead from a distance less than one meter. Upon admission, his vital signs were stable with blood pressure 100/60 mmHg, pulse rate of 110 beats per minute, respiratory rate 20 breathes per minute, and axillary temperature of 36.7°C. There was an open wound on his left forehead, 5mm in diameter. All other physical examinations were within normal range. The neurological investigation revealed that the patient was fully conscious with Glasgow Coma Scale of E4V5M6, his pupils were round, isochoric, 3mm in diameter, excellent muscle strength on all four extremities, with an absence of meningeal signs or pathological reflex. The skull radiograph found thick round shape material on the right occipital region.

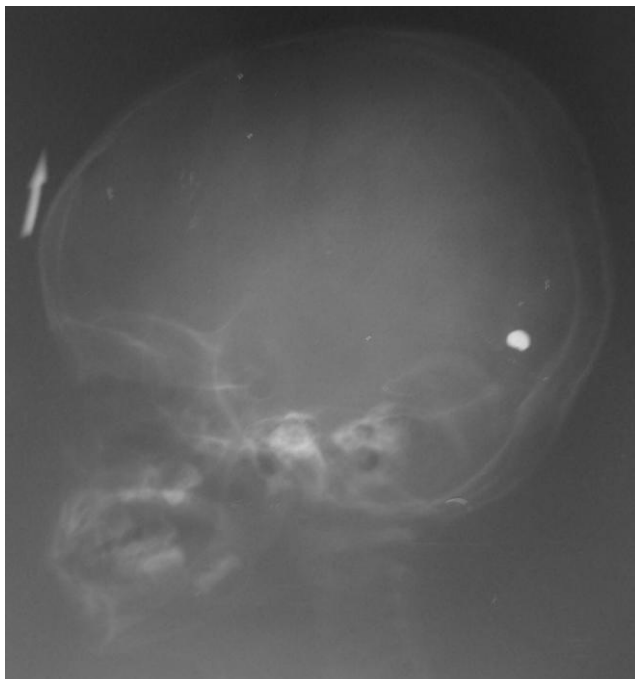


Figure 1: Skull radiograph lateral view; marker (arrow) and the pellet (opaque round shape material)

We predicted that the pellet only lodged in one side of the brain hemisphere and attached to the occipital bone. The head CT scan revealed a foreign object with metal density in the right occipital region which enter from the left frontal area, accompanied with an intracerebral hematoma from the frontal to the occipital areas, by the foreign body pathway. Besides, pneumocephalus was found around the foreign object, as well as intraventricular haemorrhage, brain swelling, and left frontal bone fracture. We then performed a three-dimensional reconstruction of the skull, which revealed an entry wound of 6mm in diameter without any other apparent fractures and pellet nested in internal tubule of the right occipital bone.

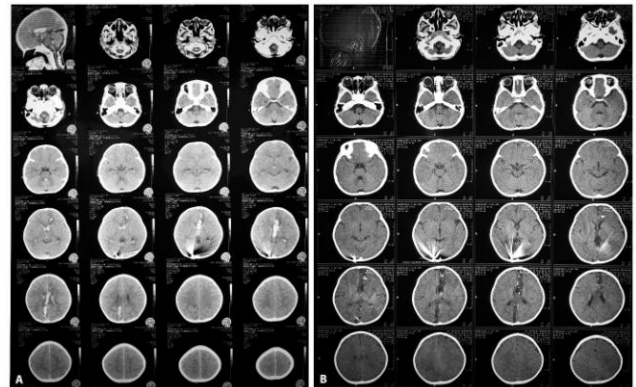


Figure 2: Head computed tomography for the first time came to the emergency room (A) and at the next two weeks after the incident (B)

After two weeks of closed monitoring, the patient was stable, fully conscious with no apparent neurological deficit or signs of infection. We run a head computed tomography, which showed a foreign body in the right occipital region with neither intracerebral hematoma nor intraventricular haemorrhage but presented with few fragments along its pathway.



Figure 3: The C-arm to detect the position of the pellet (A) and draw site marking on the right occipital region (B)

We then performed a surgical procedure to remove the corresponding foreign body guided by mobile C-arm. The patient was in a prone position with head down. We used C-arm to detect pellet

position and draw site marking for incision. We did a single borehole in the middle of the marked zone and evaluated the corresponding area using C-arm, by which we discovered the position of the pellet was right below that hole. We later removed the pellet and its fragments with subsequent C-arm imaging to confirm that there was no remaining unextracted shrapnel. The pellet was 6mm in diameter, with round shape.



Figure 4: The pellet

The patient was stable after surgery. The wound was fully healed, and there was no sign of neurological sequelae or symptoms of cerebral infection. He was discharged 7 days after the surgery. To date, he was completely functional and independent for doing daily activities adjusted for his age.

## Discussion

According to O'Neill et al., the majority of pediatric injury involved children between 12 and 17 years old (58.6%). Based on that data, 17 of 29 patients (56.8%) had a serious injury, 9 patients (31%) required surgery, 6 patients (20.7%) had significant morbidity, and 2 patients (6.9%) was death. The injuries were common to intracranial, eye, head, and neck (65.6%). Unfortunately, 2 of 3 patients who had intracranial injury was dead [1].

Similarly, Veenstra et al also found that eye was the most commonly affected area due to non-powder firearm (63%), followed by head (12%), neck (10%), abdomen (5%), lower extremity (5%), upper extremity (3%), and chest (2%) [2].

A cohort study from 2009 to 2014 discovered that there were 43 cases of pediatric injury caused by non-powder firearms, among which 84% was male with median age of 11 years old. The most common mechanism of injury was unintentional 84%. The other was assault 12%, suicide 2%, and unknown 2%. This study showed median injury severity score of non-powder firearms was 10, of which 14% was requiring surgery [4].

A similar 10-year period cohort study from 2003 to 2013 also found that 57 children had a non-powder gun injury (pellet, ball-bearing, or paintball gun). There was 77% ball-bearing gun injuries, 23%

pellet gun injuries, and 3% paintball gun injuries. The mean age was 11 years old; with 23% injury involved children age 10-13 years old and 19% of age between 14-17 years old. Boys were injured more often than girls (i.e., 84%). The non-powder gun injury was caused by accident (68%) and violence (32%) [2].

The most frequent entry sites for intracranial projection were thin bones like orbital, temporal, and occipital bones. Intracranial pellet projection was found in temporal (44.6%), parietal (23.2%), occipital (10.7%), frontal (7.1%), and the rest were multiple sites. The most common intracranial haemorrhage was intracerebral hematoma 51.7% [3].

Based on Zidan et al., study, the mortality of intracranially-lodged air gun pellet among adults and children was 10.3%. The morbidity comprises superficial wound infection, cerebrospinal fluid leakage, meningitis, brain abscess, hemiparesis, seizure, and dysphasia [3]. The primary factor necessitating immediate surgery was fear of intracranial abscess, of which commonly occurred. Multiple factors are leading to intracranial infection such as skull base fracture, cerebrospinal fluid leakage, extensive brain damage, delayed operation, and retained intracranial foreign body [3].

Even with appropriate sterilisation procedure and administration of antibiotics, brain infection may be rendered ineluctable. For instance, Zidan et al. used the prophylactic antibiotic with 3rd generation cephalosporin and metronidazole, yet there was still 5.1% of subjects developed brain abscess. Other preventive measures should also be advocated. For instance, the use of seizure prophylaxis. In that study, only 5% developed seizure after given antiepileptic drug, which one patient had retained pellet intracranial and the other not [3].

According to the Center for Disease Control and Prevention, factors affecting health are socioeconomic, laws and regulations, protective interventions, clinical interventions, and education [4]. Our case was an unintentional injury to air shotgun which can be prevented if the family members were well-educated and not assumed air gun as a toy for children. Fortunately, the injury was not fatal, and the patient did not get a neurological deficiency. It is thus critical to educate people who possess non-powder firearms on its safety, and proper education about using non-powder firearms is essential to reduce preventable injury in children.

Further continuous observation is needed as any sequelae may be developed in the future. No one can ensure this patient will always sequelae free. According to the pellet location and the wound tract, the left frontal and right occipital region were involved, the patient can develop any cognitive and visual impairment. The psychological aspect also important, like this 2 years old boy underwent such serious head surgery. The most common psychological impacts for children who had undergone surgery and anaesthesia

before 4 years of age are low listening comprehension and performance IQ [6]. So, language abilities and cognition are needed to be evaluated in the next following years.

Intuitively speaking, such prevention would require integrated cooperation between government, health personnel, and other significant stakeholders, such as child protection and social services. A tighter and strict law should be imposed for regulation of non-powder firearms. Hard punishment should also be applied to those who inadvertently harm others using this type of gun. The mass media may also be useful to educate people and raise awareness of air shotgun and its potential injuries.

### Conflict of Interest Disclosure

The authors declare no conflict of interest or any financial support. We had consent letter to the patient's family to publish this case.

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