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Brain injury due to air gun shot: report of three adult cases

Havalı silah yaralanmasına bağlı beyin hasarı: Üç erişkin olgu sunumu

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Air guns (AGs) are arms that use air or another compressed gas to propel a projectile. Generally, brain injury may occur in children due to their incomplete skull development; however, the less-resistant and thin region of the skull in adults may also be penetrated by an AG shot. In this paper, we present three adult cases treated in our clinic for brain injury caused by an AG. The first case had brain and skull damage related to the high pressure of the compressed gas, and the others additionally had foreign bodies in their brain. All of the patients were operated. Two were discharged without neurological deficit; the third case had a permanent slight hemiparesis. Average follow-up was 11 months and no abscess formation was observed in this period. AGs are known as low-velocity arms; however, they have the potential to cause brain injury, and brain penetration may occur especially in the relatively less resistant and thin sites of the skull such as the orbit and temporal and occipital bones. As cerebrospinal fluid leakage is one of the expected conditions, urgent surgery is usually required.

Key Words: Air gun; brain injury; surgery.

Havalı silahlar basınçlı hava veya diğer gazların kullanılarak hızla boşaltılması ile çalışır. Genellikle kafatası tamamıyla gelişmemiş çocuklarda beyin hasarı görülmekle birlikte erişkinlerde daha az dirençli ve ince bölgelerinden kafatasını delerek beyin hasarına yol açabilir. Bu yazıda, havalı silah yaralanması sonucu beyin hasarı olan ve tedavi edilen üç erişkin olgu sunuldu. İlk olguda yüksek basınçlı gazın etkisine bağlı kafatası ve beyin hasarı, diğer olgularda ek olarak yabancı cisme nedeniyle beyin hasarı saptandı. Tüm olgular ameliyat edildi, iki olgu nörolojik kaybı olmaksızın taburcu edildi, üçüncü olgu hafif hemiparezi ile taburcu edildi. Ortalama 11 aylık izlemde olgularda beyin apsesi gelişimi gözlenmedi. Havalı silahlar düşük hızlı silahlar olarak bilinirler, ancak beyin hasarına neden olabilirler, özellikle ince ve daha az dirençli bölgeler olan orbita, temporal ve oksipital kemikleri delerek beyin hasarına yol açabilirler. Beyin-omurilik sıvısı kaçağı genellikle beklenen bir durum olup acil cerrahi tedavi gereklidir.

Anahtar Sözcükler: Havalı silah; beyin hasarı; cerrahi.

Air guns (AGs) are arms that use air or another compressed gas to propel a projectile, such as a ball-bearing or pellet.[1] AG weapons have been used for over 400 years since their production in the middle of the 16th century.[2] The new models of AGs are more powerful and are capable of producing severe damage.[1,3] These can develop a muzzle velocity of 330 to 340 ft/sec, which exceeds the impact velocity of 150 to 170 ft/sec required to pierce the skin, and which approaches the additional 200 ft/sec required for bone penetration.[4] However, AGs can be modified to increase the damage caused by the pellet.[1,2]

The head, neck and eyes are the areas of the body most frequently injured by AG shots.[1,2,4,5] Much has been published on the effects of AG pellets penetrating sensitive organs, particularly the eyes, but fewer fatal cases have been reported.[6-8] The majority of fatal incidents reported have involved children and adults.[1,3,5] Pellets have entered through the eyes, temple or forehead, and then penetrated the brain.[1,3,4,6,7]

In this paper, we present three cases of AG injuries with brain damage and also briefly review the management and follow-up of this type of injury.

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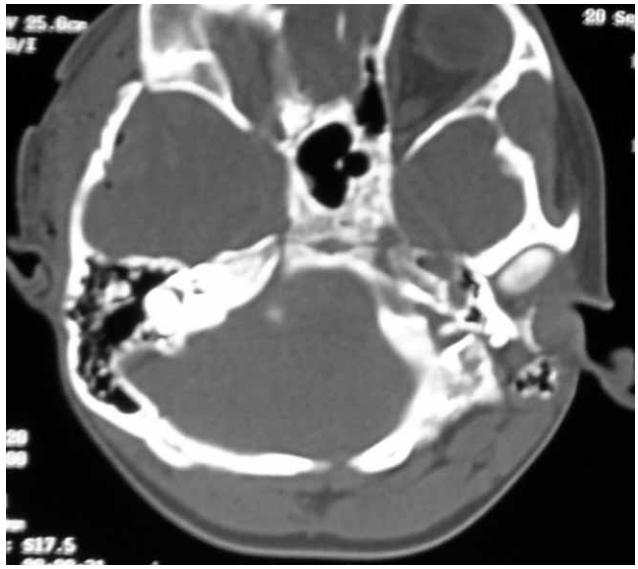

Fig. 1. Fragmented fracture with contusion is shown on the squamous part of the right temporal bone in CT scan.

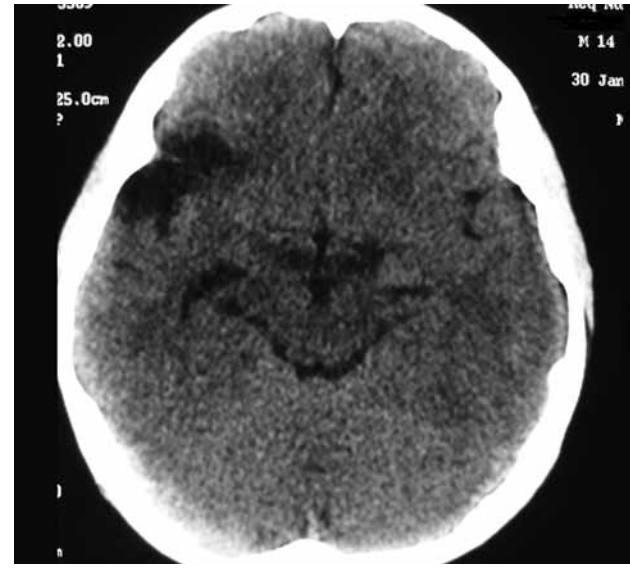

Fig. 2. Repeat CT scans revealed an encephalomalacic area on the right temporal lobe.

CASE REPORTS

Case 1- A 15-year-old male was admitted because of a close range AG shot to his right temporal region. His Glasgow Coma Score (GCS) was 12 and there was no lateralization sign. There was a skin defect of about 3 x 4 cm and depressed bone beneath it; however, there was no powder burn or imprint on the skin. Computerized tomography (CT) scans showed a fragmented fracture with contusion in the same area (Fig. 1). After craniectomy, excision of bone fragments and damaged brain tissue and a duraplasty with fascia lata graft were performed. Anti-edema, anti-epileptics and prophylactic antibiotics were administered for 10 days. After 10 months, there were no neurological sequelae and no abnormality in CT scans except for an encephalomalacic area on his right temporal lobe (Fig. 2).

Case 2- A 40-year-old male was admitted following a suicide attempt with an AG. He had no focal neurological deficit. A metallic screw was seen in the deep parietooccipital region on the left side (Fig. 3) and his right parietal bone was fractured, with a hemorrhage in the screw trajectory in CT scans (Fig. 4). The patient was operated only for duraplasty, so no attempt was made to remove the screw. Anti-edema, anti-epileptics and combined antibiotics were prescribed postoperatively. At four weeks, no abscess in the vicinity of the screw was seen, so combined antibiotic therapy was stopped. Follow-up CT scans did not demonstrate any abscess formation or displacement of the screw (Fig. 5).

Case 3- A 16-year-old male was brought to emergency service after an AG shot to the temporal region. His GCS was 13 and he had quadriparesis. CT scans

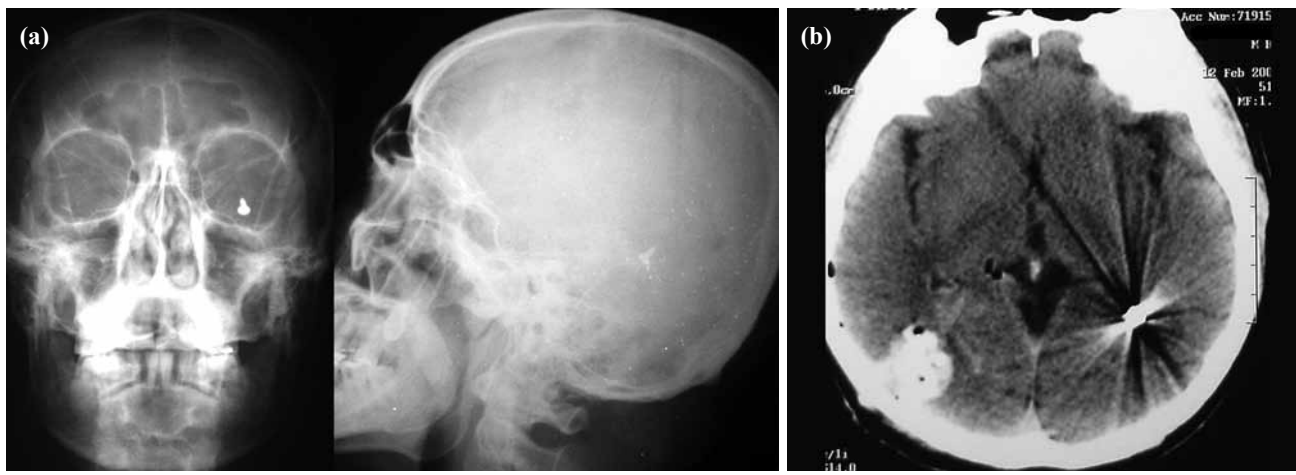

Fig. 3. **(a)** X-ray shows metallic screw in the left deep parietal region. **(b)** CT scan shows metallic body and intracerebral hemorrhage along its trajectory.

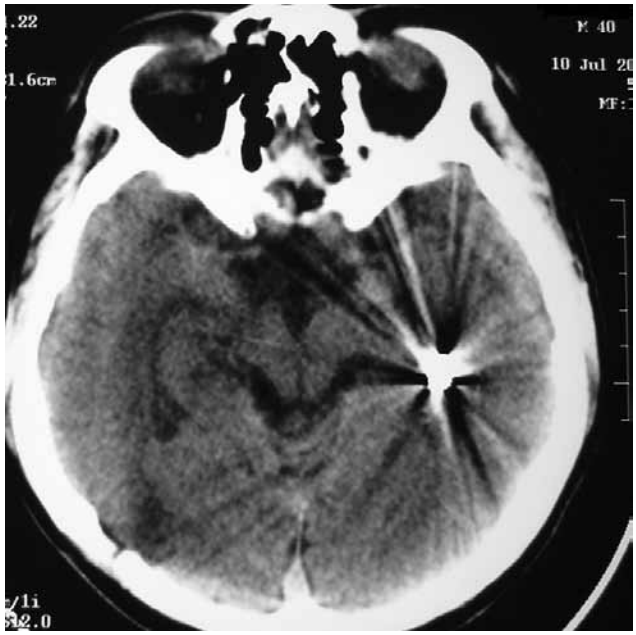

Fig. 4. CT scan at five months demonstrates encephalomalacic area and metallic screw.

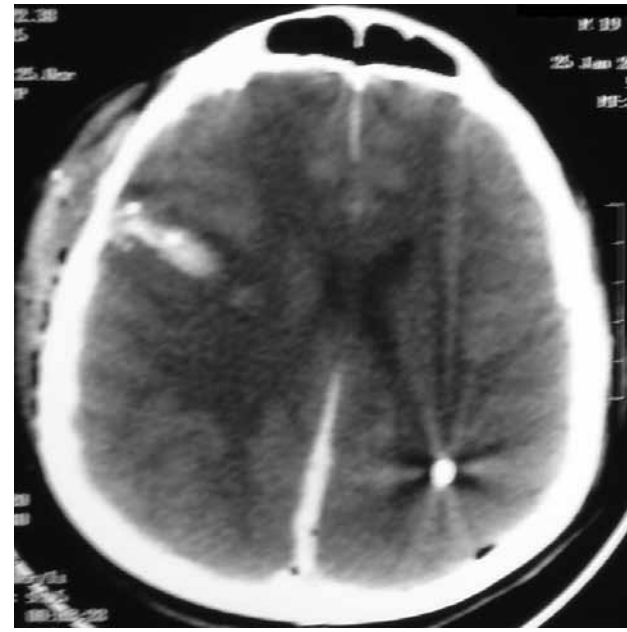

Fig. 5. CT scan showing an intracerebral hemorrhage under the fracture and the metallic body.

showed an intracerebral hemorrhage beneath the fracture, which was in a state of disarray (Fig. 5). We removed the subdural and intracerebral hemorrhage completely and performed duraplasty with fascia lata graft. As in the previous case, the metallic fragment was left in the left parietal region. Postoperatively, he received a two-week intravenous combined antibiotic treatment. His CT scans after six months confirmed that there were no abscesses (Fig. 6).

Fig. 6. CT scan of the third case shows metallic screw and encephalomalacic area.

DISCUSSION

Air guns are generally known to be of low velocity; however, the latest models with the increased velocity of the pellet are capable of causing a larger amount of tissue damage. In addition, the damaging effect of AGs can be increased with user modifications. Therefore, some authors remark that there is no sharp cut-off point between high and low velocity guns.[1,2] Some authors have reported permanent sequelae and fatalities following AG injuries related to cerebral damage.[2-5] More articles have been published related to firearm gunshot wounds to the head than of AGs.[9,10] We believe that AG injuries are probably more frequent, but they are regularly recorded as firearm injuries.

The head is the most commonly penetrated part of the body, and the orbit is the most common part of the skull resulting in cerebral injury.[1,2,4,5,7,8] Non-fatal injuries following AG pellet penetration include significant brain damage causing permanent impairment and those involving the eyes may result in blindness.[6,8] Furthermore, possible points of entry for pellets are the thin bones of the skull, especially the temporal and the occipital squamae.[2,3,5] Since a child's skull development is not yet complete, children are the most frequent victims of AG injuries and fatalities involving the brain, and boys predominate in all reported fatal and non-fatal cases.[1,3,4,11] Although the adult skull is more protected against the penetration of AG pellets, the possibility of penetration and damage to the brain has been increased with adjacent shots and modified AGs.[1,2,12] Especially in suicide attempts, shooting in the temple region may result in death.[5,13]

Fatalities are closely related to the damaged part of the brain and the level of the damage.[1,2,5,8,9] It has been reported that the pellet injury may affect both hemispheres in some cases, like in our second and third cases, and/or the neurological examination may be normal, as in our second case.[5] Nevertheless, some authors have reported cases with mortal or significant sequelae such as brain stem injury, arteriovenous fistula and hemiplegia.[2-5] Bratton et al.[6] reported that 101 American children suffered from AG injury, 11 (11%) of whom sustained cranial injuries, and three (3%) of those with intracerebral injuries died. Some authors advocate debridement of the damaged tissue and wound, and the removal of bone fragments with early surgery.[3-5] We also agree that early surgery on the damaged tissue should be performed since patients with penetration injury generally have cerebrospinal fluid (CSF) leakage, and duraplasty must be performed in these cases.

Likewise, authors have claimed that the foreign body or pellet should be removed if they are readily accessible. Miner[4] suggested that the foreign body may be left if it is inaccessible. In this situation, we also do not recommend the removal of an intracerebral foreign body or pellet. Because a bullet has a high temperature and velocity due to the powder shot, a usual shotgun wound is less prone to bacterial contamination. Nevertheless, retention of the AG pellet or foreign body may be associated with long-term problems, such as intracerebral abscess.[2,4,5] Shaw and Galbraith[11] reported the fatal case of cerebral abscess that developed around a pellet and resulted in death 19 months later. However, use of new-generation combined antibiotics can prevent this complication. Recent publications have not reported abscesses or similar infection patterns. Consequently, we administered combined antibiotics in these cases for two weeks and repeated the CT scans to confirm that no abscesses had developed.

In conclusion, AG injuries to the head may be fatal due to brain injury following penetration of relatively thin areas of the skull since there is a potential for damage to the cerebrum, cerebral vessels or brain stem. Therefore, it is essential that all purchases of AGs be recorded and controlled. We recommend that the cases suffering from AG injury be managed in accordance with the protocol for gunshot wounds. Furthermore, if a foreign body is left in the wounded region, these patients should be treated with combined antibiotics to prevent intracerebral abscess or other types of infection. Early surgery should be applied in the case of CSF leakage or intracerebral hemorrhage.

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