Retained intracranial metallic foreign bodies

Report of two cases

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The authors discuss two examples of extensive migration of retained metallic foreign bodies. The potential for further neurological injury from migration, formation of neurotoxic breakdown products, and the danger of infection are factors to be assessed when considering the removal of retained intracranial metallic foreign bodies.

KEY WORDS  •  gunshot wounds  •  intracranial foreign bodies  •  brain abscess

Deep infection is recognized as a major complication of retained intracranial foreign bodies that follow gunshot wounds of the head. However, it is widely thought that retained metallic fragments have less potential for infection than retained bone fragments and other debris. Because of the potential for infection, Cushing emphasized the need to remove indriven bone fragments and other foreign bodies as long as their removal could be accomplished without any increase in damage. We are reporting two cases that illustrate infrequently experienced sequelae of retained intracranial metallic foreign bodies (MFB) which may influence the vigor with which the surgeon pursues retained fragments.

Case Reports

Case 1

A 13-year-old boy was admitted on August 9, 1972, following a .38 caliber gunshot wound of the left parietooccipital area. Initially the right pupil was 4 mm and fixed, and the left pupil 2 mm and reactive. Oculocephalic reflex was present on the left side only; there was right-sided decerebrate posturing with occasional flexion movements in the left arm. Skull x-ray films revealed an intact .38 caliber bullet in the region of the interpeduncular cistern (Fig. 1 upper left).

First Operation. The patient underwent debridement of the wound and a left temporal craniectomy with removal of necrotic portions of the left temporal lobe. The missile could be palpated within the interpeduncular cistern but could not be removed. Postoperatively there was decerebrate posturing bilaterally, otherwise no change in his neurological status. He was nursed in the supine position. On the first postoperative day there was abduction of the left eye on passive rotation of the head as well as the onset of hyperthermia and diabetes insipidus. Skull
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Case 1.

Upper Left: A .38 caliber bullet is shown in the region of the interpeduncular cistern shortly after admission.

Upper Right: After 6 days the bullet is seen to have migrated a distance of 7 cm into the posterior fossa.

Lower Left: A summary of serial skull x-rays showing the movement of the bullet. The patient was nursed supine.

x-ray films taken on the third postoperative day revealed that the bullet had migrated 3.5 cm caudally through the tentorial hiatus into the posterior fossa. On the sixth postoperative day both pupils were slightly reactive and both eyes abducted only to passive head movement; bilateral decerebrate posturing continued. The craniotomy flap was tense. A ventriculogram revealed slightly enlarged lateral ventricles with no shift of midline structures. The bullet had migrated an additional 4.0 cm caudally (Fig. 1 upper right). Closed ventricular drainage was begun.

Second Operation. A posterior fossa craniectomy was performed on the eighth postoperative day, the vermis incised and the bullet removed from the region of the anterior medullary velum. There was no improvement and he died on the 16th hospital day.

Postmortem Examination. Examination of the brain revealed a missile tract entering the left posterior parietal area and exiting through the medial portion of the left temporal lobe. The bullet then migrated from the interpeduncular cistern along the mesencephalon, through the superior cerebellar peduncle, coming to rest in the roof of the fourth ventricle (Fig. 1 lower left).

Comment

The weight of the retained MFB combined with the patient's supine position favored passage of the bullet from the subarachnoid space through the pia into the brachium conjunctivum. No example of intraaxial migration of a MFB from an extraaxial position was found in a review of the literature. The onset of the hypothalamic disturbances may have been related to the start of this migration. Additionally the loss of adduction of the left eye to passive head movement, with retained pupillary responses may have resulted from passage of the MFB in the vicinity of the median longitudinal fasciculus.
Case 2

An 18-year-old woman was brought to the hospital on January 19, 1974, after sustaining a .45 caliber bullet wound of the right occipital region. She was alert but disoriented; there was bilateral amaurosis with reactive pupils. Skull x-ray films revealed an entry wound in the right paramedian occipital area and a large copper-jacketed MFB deeply situated in the left hemisphere (Fig. 2 upper left). The wound was debrided but medially placed bone fragments involving the superior sagittal sinus were left undisturbed and the MFB was not removed. The patient was nursed supine. On the third day she could see light, and identify colors and faces. Skull x-ray films showed a 4.0 cm posterior migration of the MFB, its trajectory remained in the left hemisphere (Fig. 2 upper right). During the second hospital week her vision returned except for a persisting bilateral inferior altitudinal field defect, and she started to walk. Serial x-ray films revealed sequential posterior and caudal migration of the fragment in the left occipital (Fig. 2 lower left).

Operation. On the 32nd hospital day she underwent bilateral occipital craniotomy with removal of additional bone fragments as well as the MFB. Cerebral tissue adjacent to the copper-clad bullet was stained green. Several large bone fragments were left between the leaves of the falx and in the superior sagittal sinus.

Comment

This large, copper-clad bullet entered the right occipital lobe and crossed through the falx to enter the left hemisphere. Supine bed rest and subsequent walking favored first posterior, then caudal migration of the fragment through previously unpenetrated white matter. Oxidation of the copper sheath resulted in staining of the surrounding tissue.
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Discussion

Along with the danger of infection, one must weigh other potential hazards of retained MFB when considering their removal. Retained MFB may result in ventricular obstruction and hydrocephalus, further neurological injury resulting from migration and the formation of toxic breakdown products, and distant hematoma formation.\(^7\) Retained MFB may have less potential for infection than other debris since the fragment is sterilized when fired and MFB usually track deeper, dissociating themselves from other indriven contaminating material.\(^3,5\) However, in Maltby's\(^5\) series of 94 cases with retained fragments, there were 12 infections associated with MFB alone. The infectious potential of retained MFB following civilian gunshot wounds may be less than in military wounds — there is less tissue injury resulting from lower muzzle velocities in civilian weapons.\(^8\)

The migration of intracranial metallic fragments has been recognized since the First World War.\(^4,11\) Large, migrating fragments have the potential to extend neurological injury during convalescence and potential intracranial migration should be anticipated. Such migration may in fact be capitalized upon by suitable positioning of the head: deep lying MFB's may be allowed to settle through relatively silent areas of brain to more readily accessible regions. Markham and co-workers were able to lodge a .22 caliber bullet, which had been free in the ventricular system, into the white matter about the posterior horn, using 5 to 6 G of force generated by a centrifuge.\(^3\)

A final hazard of retained MFB illustrated by the second case is the formation of toxic breakdown products. Sherman\(^9\) has described the removal of brass shrapnel from the brainstem of a patient 10 days after injury. At operation the shrapnel was associated with a cyst stained green with cuprous chloride. Subsequent work by Fischer, \(et \ al.\),\(^2\) revealed intracerebral copper wire to be poorly tolerated in cats with the development of a severe toxic reaction and necrosis of brain tissues. Sights and Bye\(^10\) implanted lead and copper-plated lead shotgun pellets into cat brain. Lead produced a minimal tissue reaction whereas copper-plated lead pellets caused a severe inflammatory reaction with necrosis and sterile abscess formation.\(^10\) Owing to the intense scarring which is produced, copper-clad foreign bodies should be removed whenever possible.

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