HEMATOMAS ASSOCIATED WITH PENETRATING WOUNDS OF THE BRAIN

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Penetrating wounds of the brain may be considered usefully in three general groups: (1) the gutter type of wound in which depressed bone fragments have lacerated the dura and been driven into the substance of the brain, but no foreign body is present; (2) penetrating wounds in which a metallic foreign body (bullet or high-explosive shell fragment) is retained in the brain; and (3) through-and-through wounds in which a missile has passed completely through a portion of the intracranial chamber. Certain observations have been made in the primary operative management of the latter two types of injury which appear to be of sufficient interest to report at this time. These observations are based on the combined experience of the authors in various forward medical installations (Field and Evacuation Hospitals) in the European Theater of Operations between June, 1944 and March 1945. During this period, 305 penetrating wounds of the brain have been operated upon.*

INTRACRANIAL HEMATOMAS DISTANT TO THE WOUND OF ENTRANCE ASSOCIATED WITH RETAINED FOREIGN BODIES IN THE BRAIN

Neurosurgeons are in general agreement that metallic foreign bodies in the brain should be removed at the time of primary debridement if readily accessible. However, if their removal necessitates an approach through uninjured cerebral tissue, it is felt that the risks of increasing the neurological deficit and of opening new avenues for possible infection from contaminated wounds outweigh the benefits to be gained and such foreign bodies are left in place. The policy has been, then, to remove them subsequently through a clean operative approach only when they are large, very near the surface, or productive of neurological symptoms or signs. But as far as primary operative management is concerned, it must always be remembered, and is strongly emphasized again here, that the pathology created by a missile passing through the brain is much more important than the disposition of the missile itself.

It was not until relatively late in the campaign, November, 1944, that the significance was appreciated of intracranial hemorrhage on the side opposite from the wound of entrance in cases of retained foreign bodies. Since that time, 11 patients have been operated upon who have had sizable

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* This series does not include simple compound depressed skull fractures but only those with laceration of the dura and actual brain damage.
hematomas located either in the opposite subdural space or in the substance of the brain in or adjacent to the tract made by a metallic foreign body at a site distant to the point of penetration. In retrospect we feel sure that similar lesions were overlooked in earlier cases.

If a foreign body, particularly a small one, is visualized on x-ray examination close to the cortex of the side opposite that of entrance, there is no way of knowing whether its location marks the end of the tract through the brain or whether it reached the meninges or skull and bounced back into the brain without fracturing the bone. If such a missile did reach the surface, the possibility of its tearing cortical vessels and causing hemorrhage into the subdural or subarachnoid spaces or into the substance of the brain itself is not unlikely. In fact, hematoma in all three locations may be present simultaneously since these spaces may be connected at the instant of trauma. Also, it seems probable that cortical vessels, or more likely some of the vessels leading from the cortex to the dura in the region of the dural sinuses, may be ruptured without the foreign body ever actually reaching the surface, as large subdural hematomas have been encountered where it was impossible to find any evidence of a missile tract reaching the surface (Cases 1 and 2).

When there is intracranial hemorrhage at a point distant to the wound of entrance, this blood does not escape and a space-occupying hematoma is formed. As a result, the decompression automatically obtained in the greater percentage of penetrating brain wounds is not present and the pathological physiology assumes the character of that seen in closed head injuries, where in addition to actual cerebral damage at the moment of trauma, subsequent injury due to cerebral compression may be a more important factor.

In the absence of direct injury to vital centers of the brain stem, it is apt to be this cerebral compression from intracranial hemorrhage that is the lethal factor in penetrating wounds of the brain. If intracranial hemorrhage is massive and diffuse throughout the brain, or if it fills the ventricular system with clots, the result may be fatal before the patient reaches the hospital. If such a patient does reach the hospital, surgical procedures so far have proved of little avail. However, if the hemorrhage is limited to the extradural or subdural spaces or to any one area of the cerebrum so that a localized subcortical hematoma, even though large and even though extending into one of the lateral ventricles, is formed, then surgical evacuation is often possible and an early attack may be life-saving.

It has become our policy, therefore, when a foreign body has crossed the midline and lies within 2–3 cm. of the cortex of the opposite side by x-ray, to place a burr hole on this side as nearly as possible over the location of the missile. This is done whether or not a fracture on this side is visualized by x-ray. If no extradural bleeding is encountered, an opening is made in the dura. If no subdural hematoma is present and the cortex appears entirely normal, nothing more may be done. However, if the cortex is soft-