Open-wound treatment for gunshot to the brain

Case report

Peijn van den Munckhof, M.D., Ph.D.,1 Vincent G. Geukers, M.D.,2 Fonnet E. Bleeker, M.D., Ph.D.,1 Celia E. Allison, M.D.,3 and W. Peter Vandertop, M.D., Ph.D.1

1Neurosurgical Center Amsterdam; 2Department of Pediatric Intensive Care of the Emma Children’s Hospital; and 3Department of Anesthesiology, Academic Medical Center, Amsterdam, The Netherlands

The authors report a case of a gunshot wound to the brain in a 2.5-year-old girl. To treat the uncontrollably elevated intracranial pressure, the patient underwent bilateral decompressive craniectomy and experimental open-wound treatment. She recovered to a good functional level. (http://thejns.org/doi/abs/10.3171/2012.3.PEDS1225)

Key words • gunshot wound • brain • open-wound treatment • decompressive craniectomy • outcome • trauma

Gunshot wounds to the brain are associated with high rates of mortality and morbidity.7 In children, poor results on initial neurological examination, a bihemispheric bullet path, and uncontrollably elevated ICP all correlate with a ≥ 80% mortality rate.3 When children with a poor initial GCS score survive, few are able to function independently.1,2 However, aggressive ICP control in a small series of pediatric GSW victims with such unfavorable prognostic features has been reported to improve survival and functional recovery.4 In the present case, we report on a child with a GSW to the brain who underwent bilateral DC and experimental open-wound treatment, and who recovered to a good functional level.

Case Report

History and Examination. This 2.5-year-old girl sustained a GSW to the head inflicted by her father, who subsequently committed suicide. Several hours later, the comatose girl was brought to our hospital. The GCS score at presentation was 5, and her pupils were normal sized and reactive to light. Brain CT scans showed a bihemispheric bullet path with right frontal entry and left frontoparietal exit wounds, subarachnoid hemorrhage and edema surrounding the bullet path, and extensive skull fractures (Fig. 1). Primary closure of the entry and exit wounds was performed, and an ICP monitor was implanted into the right frontal brain parenchyma. To prevent bullet injury–related infection, the patient was treated with amoxicillin and clavulanic acid (400 mg, 4 times per day). She was subsequently admitted to the pediatric ICU. The initial ICP was 4 mm Hg but rose to > 30 mm Hg within 12 hours, despite optimal sedation and muscle relaxation, induction of mild hypothermia, normocapnic mechanical ventilation, and the use of intravenous hypertonic saline. Repeat brain CT scans showed increased diffuse swelling, especially in the left hemisphere, but no resectable mass lesions or hydrocephalus (Fig. 1B and D).

Operations. To lower the ICP in our patient, we performed a DC on the left side. The ICP normalized following opening of the dura mater, which was subsequently left open. Skin closure or even approximation of wound edges, however, was not possible without ICP rising to > 25 mm Hg. To create more space for the swollen brain, a concomitant DC and dural opening were performed on the right side, but approximation of left-sided wound edges still caused pathologically elevated ICP. As an experimental, last-resort measure, we then applied skin augmentation on the left side by using a 10 × 20–cm Gore-Tex implant (Fig. 2). The cortex was covered with absorbable hemostatic cellulose (Surgicel). To prevent CSF leakage, an externalized wound drain was placed in between the

Abbreviations used in this paper: DC = decompressive craniectomy; GCS = Glasgow Coma Scale; GSW = gunshot wound; ICP = intracranial pressure.
Open-wound treatment for gunshot to the brain

Gore-Tex implant and the Surgicel-covered cortex. During Days 2–7, the ICP remained < 10 mm Hg while sedation was continued. On Day 7, the patient underwent a repeat operation. Skin closure was still not possible, but a smaller Gore-Tex implant was applied. Within 12 hours, however, the ICP rose to > 25 mm Hg. The patient underwent another operation, in which a larger Gore-Tex implant was reapplied. Her ICP then remained normal. Starting from Day 12, she was weaned off sedation and gradually regained consciousness.

Postoperative Course. One month after the GSW, skin closure on the left side could be performed without raising the ICP. The Gore-Tex implant was not adherent to the Surgicel-covered cortex, and the wound edges were revitalized by scraping off the dried superficial layer with a curved periosteal elevator. The bone flaps on the right and left sides were replaced 2 and 4 months after the GSW, respectively, and the patient then underwent rehabilitation therapy. One year after the GSW, she lives in good health with her mother. Follow-up neurological examination demonstrated mild right-sided paresis, clumsiness, and impaired fine motor skills of the right hand. Neuropsychological testing showed a Wechsler Preschool and Primary Scale of Intelligence IQ of 91, and a Reynell Developmental Language Scale score of 102, which are both average scores for a 3-year-old child.

Discussion

To our knowledge, this is the first reported case of open-wound treatment for uncontrollably elevated ICP following a GSW to the brain. The functional outcome of the child proved to be good despite indicators of poor prognosis such as an admission GCS score < 8 and a bihemispheric bullet path.

There are few published series of aggressive ICP control in pediatric GSW victims with unfavorable prognostic features. In 1989, Sarnaik et al. reported on 5 such children with admission GCS scores of 5–7. Elevated ICP was treated with hyperventilation, mannitol, pentobarbital, and surgery. Surgical management consisted of wound debridement with removal of accessible skin, bone, and bullet fragments; elevation of depressed skull fractures; ventriculostomy; evacuation of necrotic brain tissue and hematoma; and DC. Four of the 5 children survived, although mild-to-moderate cognitive dysfunction was noted in all of them. In 2003, Coughlan et al. reported less favorable outcomes in 7 pediatric GSW victims with admission GCS scores of 4–7, who were treated with craniotomy or DC. Three children died within 72 hours, 3 were left severely disabled, and 1 was left with a minor disability.

The current case of open-wound treatment confirms that a satisfactory outcome is possible when pediatric GSW victims with unfavorable prognostic features are treated aggressively. Of course, we cannot exclude the possibility that the same outcome would have been obtained with a less aggressive treatment approach, such as mannitol and pentobarbital only, or the use of ventriculostomy. However, the case presented here shows that open-wound treatment performed using skin augmentation might be considered as a viable treatment option in cases of uncontrollably elevated ICP despite DC.
Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: van den Munckhof, Vandertop. Acquisition of data: van den Munckhof, Geukers, Bleeker, Allison. Analysis and interpretation of data: van den Munckhof, Geukers, Vandertop. Drafting the article: van den Munckhof. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: van den Munckhof.

References

6. Wechsler D: [Wechsler Preschool and Primary Scale of Intelligence, (WPPSI–III), ed 3.] Amsterdam: Pearson Assessment and Information, 2005 (Dutch)