WARTIME CRANIOBASAL INJURIES IN SOUTHERN CROATIA

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SUMMARY — During the war in Croatia (1991-1995), 26 patients with craniobasal (facio-orbital) injuries were treated in southern Croatia. Numerous complications that accompany these lesions give them specific neurological importance. Patient records were retrospectively analyzed in order to assess outcome in this group of patients. Cerebrospinal fluid fistula was observed in one third of the patients. Cerebrospinal fluid fistulae based infection occurred in over 50% of cases. Endocranially located retained foreign bodies were seen in 10 patients. A higher rate of reoperation (mostly for cerebrospinal fluid fistula) was recorded in this group of patients as compared with other sites of head injuries. Favourable outcome was recorded in 18 and unfavorable outcome in 8 patients, whereas 3 patients died. This survey of patient records showed it to be of utmost importance to follow the well defined neurological policy according to which the primary wound repair (especially of the temporal bone dura mater) should be a definitive one. Cerebrospinal fluid fistulae, retained foreign bodies, low Glasgow Coma Scale on admission, and reoperation exert an unfavorable effect on patient outcome.

Key words: Brain injuries — epidemiology; Craniobasal trauma — complications; War; Wounds, penetrating — complications; Croatia

Introduction

Craniocebral injury, either primary or secondary, is often fatal. These injuries account for 10%-15% of all war injuries and are the most common cause of death at the battlefield. Head injuries in war are in their appearance massive, and often very destructive for all neurocranial layers, involving a broad population. According to the angle of impact upon cranial structures they can be of penetrating, perforating, and tangential type. A special group of open war injuries to the head are those called craniobasal injuries (facio-orbito-craniobasal injuries). In this type of injuries, the projectile intruding the skull or leaving it after causing the lesion traverses parasinus cavities and/or eyehole, providing a broad communication between the contaminated outer world and the sterile endocranial content. Even when direct brain lesions caused by the projectile intracraniocerebral pro-gression are excluded, the complications such as cerebrospinal fluid fistula (CSFF) and ascending meningitis that accompany craniobasal lesions make them highly significant. Although known as a phenomenon since ancient times, post-traumatic CSFF was first described in 1770 by Bidloo. W. Dandy accomplished the first neurosurgical CSFF repair of a frontobasal injury using a fascia lata graft and muscle. Attention should be paid to the so-called discontinuous fracture where the fracture of the calvaria at the site of projectile entry is not connected with the one at the skull base.

In the series presented by Campbell and Kuhlenbeck, the incidence of these lesions exceeded 35%. After resuscitation measures, all patients underwent neurologic and radiologic diagnostic workup.

Computed tomography (CT) coronal and axial thin slices performed through eye bones and neurocranium, also using ‘bony’ window, enabled optimal selection of neurosurgical strategy, including head and neck surgeons and ophthalmologist consultation. The neurosurgical treatment consisted of large craniotomy, gentle but thorough debridement, removal of all reachable indwelling foreign bodies, watertight dural closure using a graft, and skin closure without tension. Simple wound closure was performed in those patients show-
and penicillin crystal (600 MIU/d), gentamicin (3x80 mg/d) and metronidazole (3x500 mg/d) were routinely administra-
ted to all patients. All patients received sodium phenobar-
bital (2x100 mg) for prevention of seizures.

Patients and Methods

From August 1991 till October 1995, a total of 176 pa-
tients with craniocerebral injuries sustained in war were
reated at Department of Neurosurgery, Split University
Hospital1. There were 26 (14.8%) patients with cranio-
bral war injury (Table 1).

There were 24 men and two women, mean age 30 years.
In the great majority of patients, the time elapsed from
wound infliction (transport time) to hospital admission was
less than 48 hours, and in only two patients more than 48
hours. The wounding agents were shell fragments in two
thirds and bullets in one third of patients. The initial neu-
rologic status (GCS score3) was unfavorable (<7) in 14 and
favorable (>7) in 11 patients. One patient was sedated and
under the influence of a relaxant. There were different di-
nect effects of the projectile intrusion into the endocranium
(CT and skull x-rays): 5 aerocoa, 12 intracerebral hemato-
mas (ICH), 1 epidural hematoma, 1 intraventricular hem-
orrhage, and 1 encephalohcice into the sphenoid sinus. In all
patients a comminuted fracture of the skull base was present.

More than a half of patients were treated through large
craniotomy and one third by simple wound closure, whereas
three patients were operated on elsewhere.

On outcome assessment, the Glasgow Outcome Scale
(GOS)4 was intentionally modified to enable easier evalu-
ation. Death, vegetative state, and severe disability were

![Fig. 1. Discontinuous fracture (according to Johnsson and Dutt, 1947).](image1)

![Fig. 2. Numerous superficially and subcranially located shell frag-
ments.](image2)

![Fig. 3. Frontobasal multi-fragmented fracture involving orbital hole.](image3)
Table 1. Cranial base injuries in major armed conflicts:

<table>
<thead>
<tr>
<th>Armed conflict/Appeared</th>
<th>% of cranial base injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>World War II (1939-1945), HW Cushing</td>
<td>3.0</td>
</tr>
<tr>
<td>Korean war (1950-1953), AM Mieczkowsky</td>
<td>3.9</td>
</tr>
<tr>
<td>Vietnam war (1965-1973), Hammer/Ross</td>
<td>1.5</td>
</tr>
<tr>
<td>Israel war (1982-1985), B Bredvold</td>
<td>13.2</td>
</tr>
<tr>
<td>Croatia war (1991-1995), M Tudor</td>
<td>14.8</td>
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classified as unfavorable outcome, whereas favorable outcome included moderate disability and good recovery.

The Kucuk-Mallig χ² test, Mann-Whitney U test, Fisher exact test and χ² distribution test were used on statistical analysis.

Results

Three deaths were recorded in the group of patients with cranial base injuries. The mortality rate slightly exceeded total mortality rate (10.23%, N=176). All patients with lethal outcome had unfavorable GOS (<7 points) on admission. These patients died 3-4 days from the wounding, i.e. from primary neurosurgical management, so death was caused by the primary, irreversible, extensive cerebral lesion rather than by the complications commonly observed in this anatomic region.

Early complications developed in one third of patients: CSF in seven (Fig. 4) and infection (meningoencephalitis) in five patients (including four of the five patients with CSF). Bacteriologic analysis of CSF from the infected patients showed an equal distribution of gram-positive and gram-negative infectious agents, with a predominance of *Staphylococcus aureus* and *Escherichia* sp. It should be noted that the initial infection with gram-positive bacteria was later substituted by gram-negative bacteria. All patients initially received the same antibiotic prophylaxis, which was subsequently specifically changed according to the antibiotic sensitivity test. Two patients developed early seizures.

On postoperative control CT scans, 12 patients were free from retained foreign bodies endocranially, whereas in ten patients foreign bodies had not been (or could not be) properly removed. Only two infections were recorded in the group of patients free from retained foreign bodies on control CT; whereas in ten patients with the evidence of retained foreign bodies there were 4 cases of meningoencephalitis, 3 cases of CSF and one patient with early seizures.

The size of the projectile endocranial trajectory had no statistical significance on the outcome, as favorable outcome was recorded in seven of nine patients with the bullet trajectory through both cerebral hemispheres. Only two of seven patients with two or more cerebral lobes involved had unfavorable outcome.

The transport time had no effect on the incidence of infectious complications because all patients were admitted to the hospital and underwent neurosurgical management within the time period shorter than the critical 48 hours.

In the group of patients operated on by large craniotomy there was only one reoperation, whereas in the group with the simple wound closure and/or operation there were three reoperations. All patients reoperated on (n=4) had a CSF (with or without infection).

According to the simplified GOS, there were eight (30%) patients with unfavorable outcome and 18 (70%) patients with favorable outcome.

Discussion

Mortality rate in recent large armed conflicts is still high (10%) despite advances in neurosurgical techniques, well organized health service, and properly trained personnel. In the group of patients with cranial base lesions it is slightly higher (11.5%) because of the specific anatomic region (border between the neurocranium and viscerocranium) and common use of high velocity missiles. In the management of cranioencephal-wat injuries, the primary neurosurgical goal is to reduce intracranial pressure (decompressive craniet-

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![Fig. 4. Relationship between cerebrospinal fluid fistula (CSFF) and wound site.](image-url)
my, evacuation of all spaceoccupying endocranial hematomas, to provide optimal perfusion of the brain tissue, to remove all reachable foreign endocranial materials (especially bone fragments), to perform thorough debridement, to close dura mater in a watertight fashion, and to ensure that skin incision has no tension on cranial defects. The same holds for cranial defects and torn basal dura mater. The defects should be repaired optimally in order to prevent CSF effusion through the skin at the wounding site or CSF rhinorrhea or CSF otorrhea (discontinuous fracture). The incidence of CSFF in the war was as high as 18%, and in our patients (N=176) it was 12%. In this special group of patients cranial defects (injuries) is in 27%. CSF effusion provides a basis for different infectious complications, their incidence being as high as 50%. In the presence of CSFF, the rate of infection is 15-fold that of aseptic wounds.

In wartime, it may often be difficult to perform a distinguished radiologic workup (e.g., CT cisternography with coronal slices) and to locate the site of cranial base defects or to define the site of dura perforation, although generally, the defects are commonly larger than those from peacetime accidents. In cases with very extensive wounds (defects) it may occasionally be difficult to act according to the aforementioned principles of management for these lesions. Without a multispecialty approach (that may even include a plastic surgeon) by a neurosurgeon, an ophthalmologist, and a head and neck surgeon, it is not easy to close the defects in these rare cases. The reoperation rate is higher than for war wounds located elsewhere (cranial vault). It is well known that reoperations contribute significantly to poorer outcomes.

In our series, the reason for reintervention was CSF effusion and/or infection in the majority of cases. Therefore, therapeutic goal is that the primary wound repair (especially of the cranially torn dura mater) be a definitive one, followed by aggressive intensive therapy and early rehabilitation. The type of projectile, the type of war wound, the transport time, the size of the projectile endocranial trajectory, and the patient’s age and sex had no significant impact on the outcome, whereas primary brain lesion (initial GCS), CSF retained endocranial foreign bodies, infections and reoperations had a major impact on the outcome.

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Sažetak

RATNE KRANIOBAZALNE OZLJEDE U JUŽNOJ HRVATSKOJ

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Ključne riječi: Ozljede glave – epidemiologija; Kraniobazalna trauma – komplikacije; Rat, Rane, penetrirajuće – komplikacije; Hrvatska