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Orbitocranial War Injuries: Report of 14 Cases

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Objective: In this study, we review the initial clinical and radiological management and early outcomes of 14 patients with orbitocranial war injuries treated at the University Hospital Split between 1991 and 1995. Methods: This investigation involves 14 patients (13 soldiers and 1 civilian) with orbitocranial war injuries. The mean patient age was 31 years (range, 23–54 years). The penetrating object was a metal shrapnel fragment in 8 patients and a bullet in 6 patients. The results of clinical and radiological management were retrospectively analyzed. Results: The mean time from the moment of wounding to hospital admission was 6 hours (range, 1–30 hours). The mean Glasgow Coma Scale score was 8 (range, 3–14). Craniotomy was the basic neurosurgical procedure, and three patients were treated with simple scalp wound debridement and closure. Osteoplastic operations of the orbital bones were performed in 13 patients. Enucleation/evisceration was performed in 6 patients (42.8%). At discharge, the mean Glasgow Outcome Scale score was 13, and 1 patient died in the hospital. Blindness (including amaurosis and anophthalmus) was present in nine eyes (8 patients), light-perception positivity and projection positivity were present in four eyes, and visual acuity was at 0.1 in 1 patient. Conclusion: An early multidisciplinary therapeutic approach and computed tomography as a diagnostic procedure are necessary for a good result in the treatment of orbitocranial war injuries.

Introduction

Orbitocranial war injuries are important in military surgery for clinical, humane, and scientific reasons. Although these injuries are an uncommon entity, they are often associated with vision- and life-threatening complications.

In contemporary conflicts, as a result of the use of high-velocity and different explosive munitions, which are forbidden by international conventions, an increase in this type of injury can be expected. Because of the severity of these injuries, the need for multidisciplinary diagnostic and therapeutic management is unavoidable.[1-6]

An accurate analysis of damage to the face, orbit, and brain can be obtained by computed tomography.[7] Coronal and axial thin slices provide definitive images of the bony structures involved and warrant optimal preoperative planning, which is stressed as a means of avoiding complications.[8,9]

In this study, we review the initial clinical and radiological management and outcomes of 14 patients with orbitocranial war injuries treated during the war in Croatia and Bosnia and Herzegovina from 1991 to 1995.

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Patients and Methods

During the war in southern Croatia and the war in Bosnia and Herzegovina (from August 1991 to December 1995), 14 patients were admitted because of orbitocranial war injuries to the University Hospital Split. They were mostly Croatian Army soldiers (N = 12), one member of the Army of Bosnia and Herzegovina, and one civilian. The mean patient age was 31 years (range, 23–54 years). However, only treatable individuals are included in this study.

On admission, a complete history was obtained from each patient. All patients were initially evaluated and treated in the emergency room by a multidisciplinary team of specialists.

The penetrating object was a metal shrapnel fragment in 8 patients and a bullet in 6 patients. The mean Glasgow Coma Scale (GCS) score for 13 patients was 8 (range, 3–14), and for one patient the GCS score was unknown because of sedation. The mean time from the moment of wounding to hospital admission for 13 patients was 6 hours (range, 1–30 hours). For one patient (operated on at the war hospital in Bosnia and Herzegovina), this time was 120 hours. Antibiotic (penicillin, gentamycin, metronidazole), antitetanus, antiedematous, and antiepileptic drugs were administered. After initial evaluation and stabilization, all patients underwent plain X-ray evaluation of the skull and orbit as well as computed tomography.

The basic neurosurgical procedure was craniotomy with limited debridement of the brain (maximally sparing of undamaged brain tissue) and extraction of accessible bone and metallic fragments. In 13 patients, the pericranium was used as a dural graft; lyodura was used in one patient. In all patients, the dural defect was closed to be watertight.

Postoperatively, patients with GCS scores < 7 were transferred to the intensive care unit for mechanical respiratory support. After being weaned from the respirator, the patients were transferred to the Department of Ophthalmology.

Microsurgical management (closing the wound and restoring the integrity of the eyeball) was done immediately. Extraction of foreign bodies was done only if they were in the anterior chamber or if they were protruding from the wound. Primary enucleation or evisceration was performed for the most severely traumatized eyes. Eyelids and surrounding wounds and defects were primarily reconstructed if possible.

Lesions associated with severe facial and facial bone damage were treated with the assistance of the maxillofacial surgeon. After completion of neurosurgical, ophthalmologic, and maxillofacial treatment, the patients continued their rehabilitation in special rehabilitation centers in Croatia. All result are summarized and presented in the tables and figures.

Results

Among the 176 patients with craniocerebral missile injuries initially treated at the University Hospital Split, 14 (8%) had

TABLE I

CLINICAL AND RADIOLOGICAL DATA OF THE PATIENTS WITH ORBITOCRANIAL WAR TRAUMA

Patient	Age (years)	Injury	Time (hours)	Brain Exposed	Retained Metal	Retained Bone	Glasgow Coma Scale Score	Surgical Procedure	Infection	GCO Score	Follow-Up (days)
1	54/C	S	26	−	+	+	12	Craniotomy	−	14	18
2	23/CA	S	2	−	+	+	9	Craniotomy	−	15	23
3	31/CA	S	3	+	+	+	11	Craniotomy	−	15	19
4	26/CA	B	2	+	−	+	7	Craniotomy	+	14	61
5	39/BHA	S	4	−	+	+	7	Simple wound closure	−	13	28
6	45/CA	B	4	+	−	+	14	Craniotomy	−	14	36
7	27/CA	B	120	+	−	+	3	Simple wound closure[a]	+	Death	7
8	30/CA	S	2	−	+	+	7	Simple wound closure	−	12	31
9	26/CA	S	1	−	+	+	8	Craniotomy	+	12	45
10	24/CA	B	1	−	−	+	7	Craniotomy	−	13	46
11	23/CA	S	2	−	+	+	8	Craniotomy	+	14	31
12	28/CA	B	2	+	−	+	5	Craniotomy[b]	+	12	57
13	31/CA	S	1	−	+	+	10	Craniotomy[b]	+	14	34
14	33/CA	B	30	+	−	+	Unknown (sedation)	Craniotomy[b]	+	12	51

Abbreviations: C, civilian; CA, Croatian Army soldier; BHA, Bosnia and Herzegovina Army soldier; S, shrapnel; B, bullet; GCO, Glasgow Outcome Scale; +, yes; −, no.

[a] Operated on in a war hospital.

[b] Reintervention.

orbitocranial wounds (Table I). Typical radiological findings (skull radiographs and computed tomographic scans of the head and orbit) are shown in Figures 1 to 4. The ophthalmologic findings, surgical procedures, and early ophthalmologic outcomes are presented in Table II.

Discussion

A progressive increase in the incidence of war eye injuries has been noted during the last 100 years, primarily because of the great strength of modern explosive weapons, the fragmentation of new projectiles, and, during the war in Croatia, the use of devices forbidden by international conventions (multiple mine pellets).[10]

High-velocity projectiles and the large mass of foreign bodies increase the probability of penetrating orbitocranial injuries. There are two distinct mechanisms of tissue rupture: (a) crushing by the bullet during its passage through the tissue, and (b) a few milliseconds later, stretching of the surrounding tissue by temporary cavitation. Small high-velocity fragments transfer a huge amount of energy soon after entering the body, readily causing laceration.[11] High-velocity fragments also cause secondary damage as a result of fragmentation of the bone, which is shattered by the missile on impact. These secondary "missiles" can cause more damage than the bullet itself.

Currently, one of the best diagnostic modalities for orbitocranial imaging is computed tomography. Computed tomography provide excellent soft-tissue detail within the orbit, and it is especially helpful in the imaging of the bones of the orbit and the detection and localization of foreign bodies.[12] Our results are in agreement with this statement (Fig. 1-4). The coronal images provide an excellent view of the orbital floor, roof, and cribriform plate and enhance detection and assessment of the nature of the intracranial penetration of the penetrating material.

Fig. 1. Skull X-ray film shows the wound entrance in the medial part of the right orbital roof.

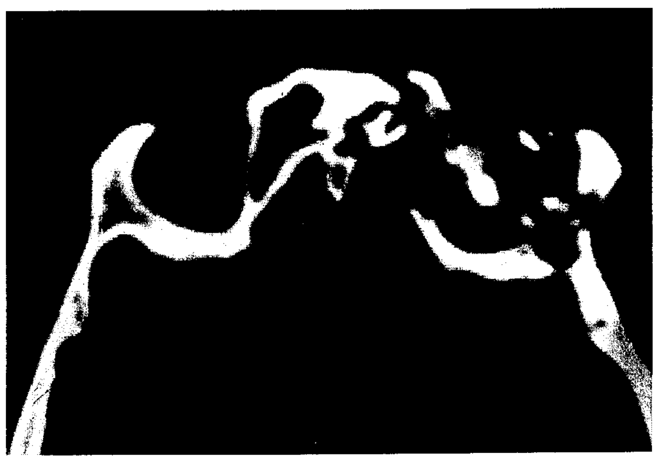

Fig. 2. Computed tomographic bone window image demonstrates a multifragmental lateral orbital wall fracture, a medial orbital wall fracture, and an entrance wound in the orbital roof. The right eyeball is destroyed.

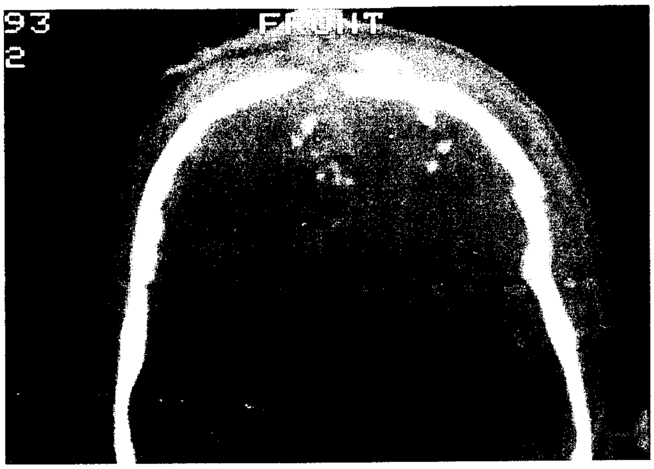

Fig. 3. Computed tomographic scan of the brain (the bone window) shows the exit wound in the medial part of the frontal bone. Numerous bone fragments are visible in the brain.

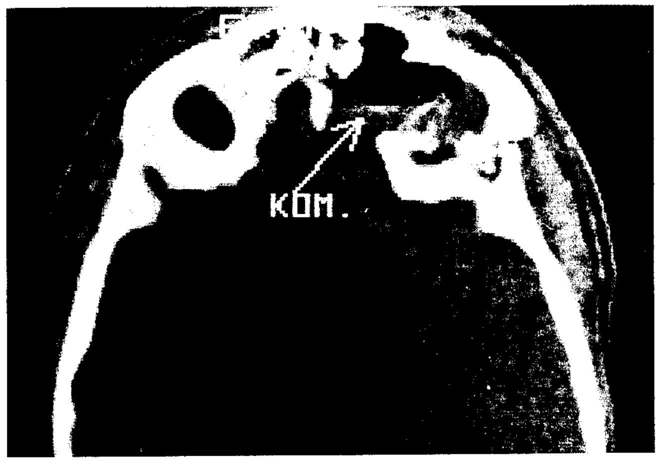

Fig. 4. This computed tomographic scan shows the findings of the same patient (from Fig. 3) 21 days later. There is an encephalocele in the right orbit as a complication.

A penetrating orbitocranial trauma is a potentially life-threatening injury. A 12% mortality was found among 42 patients with orbitocranial wounds treated during World War II.[13] This type of injury (both in war and civilian practice) is rare. In a large series of 351 missile head injuries in the Vietnam War, orbital penetration was noted in only 0.6% of cases.[14] The high percentage of orbitocranial wounds in our study (8%) can be explained as a reflection of the rocky terrain of the battlefield, the high prevalence of sniper fire, and the use of explosive devices forbidden by international conventions. Croatian army soldiers who sustained orbitocranial wounds were injured in the inferior aspect of the skull, with missiles or fragments penetrating through the orbit, below the area of helmet protection. That fact supports previously published data on the effectiveness of the helmets and the high degree of troop discipline in combat.[15]

Although the wounds were severe, only one injured soldier died (Table I, patient 7, primarily operated on in a war hospital). In some patients, a few days after the initial treatment, complications such as leaking of cerebrospinal fluid, cerebral abscess, meningitis, or epilepsy appeared. We did not find a difference in the type or number of complications regardless of the type of transplant used for dural closure. In the cases of postoperative leakage of cerebrospinal fluid (Table I, patients 12–14), we immediately reoperated, and defects of dura mater and frontobasal and fronto-orbital defects were closed with "sandwich" additions.

Early ophthalmologic outcome was relatively good (Table II). The most common outcome of perforating injuries is vision impairment and a number of subsequent complications. It is currently believed that the success of surgical treatment should be evaluated on the basis of the resulting vision and the absence of complications, and not based on the number of enucleated eyes.

TABLE II

OPHTHALMOLOGIC FINDINGS AND EARLY OUTCOME IN 14 PATIENTS WITH PENETRATING ORBITOCRANIAL WAR TRAUMA

		Surgical Procedure			
Patient	Type of Injury[a]	Closing the Wound	Enucleation/Evisceration	Osteoplastic Operation of the Orbital Bones	Outcome
1	Left perforating	+	–	+	Amaurosis
2	Right perforating	+	+	+	Amaurosis
3	Left perforating	+	+	+	Amaurosis
4	Right blast efect	+	–	+	Amaurosis
5	Left perforating	+	+	+	Amaurosis
6	Right blast efect	+	–	+	Visual acuity, 0.1
7	Left blast efect	+	–	–	Death
8	Left blast efect	+	–	+	L+ P+[b]
9	Right and left perforating	+	–	+	Amaurosis (right), L+ P+ (left)
10	Right perforating	+	–	+	Amaurosis
11	Left blast efect	+	–	+	L+ P+
12	Right blast efect	+	+	+	Anophthalmus
13	Right blast efect	+	+	+	Anophthalmus
14	Right blast efect	+	–	+	L+ P+

+, yes; –, no.

[a] In all cases, the penetrating object was a metal fragment ($N = 8$) or a bullet ($N = 6$).

[b] L+ P+, light-perception positivity, projection positivity.

Although there was a relatively large number of enucleations in our study (6 of 14, 42.8%) because of the severity of the injuries, it is almost impossible to compare our results with results obtained from previous wars.[16-18] However, a certain number of severely injured eyes can be expected to require subsequent enucleation because of painful atrophy or phthisic blind eye.

As a result of the early management of wounds with antibiotics, our patients experienced few infections. The favorable results obtained in this study, however, in terms of survival, neurological and ophthalmologic outcome, and absence of serious complications, provide insight into the specific problems in combat casualty care that may arise in the future.

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