ORIGINAL ARTICLE

Comparison of clinical outcomes between anteroposterior and lateral penetrating craniocerebral gunshot wounds

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Objective: To investigate and compare, using a retrospective clinical study, the clinical outcomes of penetrating craniocerebral gunshot wounds (PCGW) with respect to the trajectory of penetration in the axial plane.

Methods: In total, 22 patients with PCGW caused by conflict, suicide attempt, or accidental firing were included in this study. They were divided into two groups: anteroposterior and lateral. All patients underwent surgical treatment following emergency intervention.

Results: Of the 22 patients, 16 had anteroposterior and 6 had lateral penetrating injury. Four patients with anteroposterior and five patients with lateral injury died despite surgical treatment. Mortality rate was 25% in the anteroposterior and 83% in the lateral injury group.

Conclusion: We found that lateral PCGW is the most devastating type of missile injury to the head.

Cranial gunshot wounds frequently produce devastating injuries to the central nervous system (CNS) structures.^{1–3} Such wounds are classified as tangential, perforating, and penetrating. Penetrating craniocerebral gunshot wounds (PCGW) are the most devastating type of missile injury to the head. This type of injury, especially if it crosses in the coronal and midline sagittal planes, is usually fatal.⁴

We present 22 cases of PCGW who were treated in our hospital. Depending on the intracranial course of the penetrating agent, we classified the injury types in the axial plane as anteroposterior or lateral. We present a comparison of the clinical outcomes of the two groups and review of the literature.

PATIENTS AND METHODS

In total, 22 patients with PCGW were treated between 1993 and 2003 at the Department of Neurosurgery, Maresal Cakmak Military Hospital. The patients were evaluated initially by paramedics at the point of injury and transferred to our hospital following administration of first aid.

After the initial neurological examination, the Glasgow Coma Scale (GCS) score of each patient was recorded. All patients underwent radiological examination with plain x ray and computerised tomography (CT) scans. The site of injury, wounding agent, and intracranial lesions were determined and recorded after the radiological evaluation. Infratentorial wounds were excluded from this study. The patients were divided into two groups according to the trajectory of the wounding agent in the cranium; if the agent crossed the brain from left to right or right to left, this injury was classified as lateral (fig 1A), and if the course of the agent was from the anterior part of brain to the posterior or vice versa, it was classified as anteroposterior (fig 1B). Supratentorial anteroposterior and lateral injuries were investigated separately.

All patients underwent surgical treatment including primary closure of the wounds, debridement of necrotic tissues, removal of fragments, and/or duraplasty. Postoperative complications were evaluated and managed in detail. Therapy with broad spectrum antibiotics was given to all patients for 3 days postoperatively. The number of deaths and their causes were recorded for each wound type, and the duration of stay in hospital was determined for each patient. A rehabilitation period was also planned for disabled patients.

RESULTS

In total, 22 consecutive patients with supratentorial PCGW underwent surgical management over a 10 year period. All the patients were male, mean age 22 years (range 20–30). Of the 22 patients, 15 (68%) were injured during conflict, 5 (23%) were suicide attempts and 2 (9%) were injured accidentally. A bullet was the wounding agent in 12 (55%) patients and shrapnel in 10 (45%).

Injury was anteroposterior in 16 patients (73%) and lateral in six (27%). The wounding agent was a bullet in eight of the (50%) of 16 patients with anteroposterior injury and shrapnel in the remaining eight patients. In the group with lateral injury, the wounding agent was a bullet in four cases (67%) and shrapnel in the other two.

Mean GCS score on admission was 9 (range 3–15). The GCS score for each group is shown in table 1. Of 16 patients with anteroposterior injury, 10 (63%) had a GCS score between 6 and 10, while four (67%) of the six patients with lateral injury had a GCS score <5.

All patients underwent surgery. Primary closure was performed in 7 (32%) patients, debridement of necrotic tissues and retained fragments in 15 (68%), and debridement in association with duraplasty in 6 (27%).

The result of treatment is summarised in table 1. Nine (41%) patients died despite all treatment modalities, four (44%) of whom of had anteroposterior injury and five (56%) lateral. All of the patients with GCS score <5 on arrival in both groups died. In addition, one patient with anteroposterior injury and GCS score of 7, and one patient with lateral injury and GCS score of 6 died at the end of the first week post-surgery. Diffuse brain damage was the cause of death for seven (78%) of nine patients. The mortality rate was 25% among the patients with anteroposterior injury and 83% for those with lateral injury. Mean duration of stay in the hospital was 17 days (range 1–76 days); 23 days for the patients with anteroposterior injury and 7 days for those with lateral injury.

DISCUSSION

Of all types of missile wounds to the head, PCGW are the most likely to be fatal. Usually they are caused by high

Abbreviations: CNS, central nervous system; CT, computed tomography; GCS, Glasgow Coma Score; PCGW, penetrating craniocerebral gunshot wound

Figure 1 Axial CT scan of patients with penetrating gunshot wounds: (A) lateral, showing the bifrontal hemispheric injury with intracerebral and interhemispheric fissure haemorrhage and brain oedema; and (B) anteroposterior, showing the left frontoparietal injury with intracerebral haemorrhage, brain oedema, and midline shift.

velocity missiles or by handguns fired from a very close range, as in suicide attempts. In the military context, gunshot wounds to the head are characteristically high velocity insults, resulting in a penetrating wound. After the bullet penetrates the outer and inner tables of the skull, it crosses whole brain structures and a percussion wave is transmitted throughout the brain, causing widespread destruction of neuronal cell membranes.⁴ Varying degrees of cavitation in the brain occur along the bullet's path, usually several times larger than the diameter of the bullet.⁴⁻⁷ In our series, a bullet was the wounding agent in 50% of the patients with anteroposterior and 67% of the patients with lateral injury.

The operative approach was largely the same in both groups—that is, radical debridement. Treatment comprised of four stages; immediate saving of life, prevention of infection, preservation of the nervous tissue, and restoration of anatomical structures.⁸⁻¹⁰ Although there are several different techniques for the surgical management of such injuries, this approach became the de facto standard of treatment for PCGW in our institution.

Consensus is lacking on the prognostic values and limits of salvage of PCGW in the literature. Erdogan *et al* reported that the presence of diffuse brain damage, brain stem injury, CNS infection, or ventricular injury was associated with poor outcome.⁴ The level of consciousness is also a reliable indicator of severity of injury, correlating predictably with morbidity and mortality.^{11,12} The mortality rate increases when the GCS score is <4.⁴ In our series, the GCS score was <5 in the majority of patients with lateral injury, whereas it was 6–10 in most cases of anteroposterior injury. All the patients in both groups with GCS score <5 died, which showed that the trajectory of the wounding agent does not affect the prognosis independently of the GCS score on arrival. However, the patients with later injury usually had lower GCS scores at admission.

Ventricular injury is another poor prognostic factor among these patients. The ventricular system is one of the most vulnerable brain sites to damage caused during lateral

PCGW. The fragile structure of this system and close proximity to vital structures make it a vital site.^{4,13} It is difficult to cause a lateral injury without damaging the ventricular system, and therefore high mortality and morbidity rates are inevitable in patients with such injuries. In our series, five of the six patients with lateral injury had ventricular injury with different penetration sites.

The involvement of both cerebral hemispheres was another cause of the poor prognosis in the lateral injury group, whereas only one hemisphere was affected in the anteroposterior injury group, thus the mortality rate was lower. The protection of the other cerebral hemisphere contributed significantly to the prediction of the outcome in patients with anteroposterior injury. This group was also associated with longer hospital stay because of less brain damage compared with the lateral injury group, and required more rehabilitation period.

We observed bihemispheric damage in the patients' brains after lateral PCGW. This rapid destruction of both hemispheres may be relevant to the high mortality rate and shorter hospital stay.

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Table 1 Distribution of the patients according to GCS scores and type of injury, and results of treatment

Type of injury	GCS score on admission			Result of treatment		
	3–5	6–10	11–15	Death	Disabled	Well
Anteroposterior	3	10	3	4	6	6
Lateral	4	1	1	5	1	0

GCS, Glasgow Coma Scale.