Acta med. Croatica, 51 (1997) 233–237

Case Report

EARLY INTRACRANIAL INFECTIONS AFTER BRAIN MISSILE INJURIES — THE ROLE OF COMPUTER TOMOGRAPHY IN DIAGNOSIS AND TREATMENT

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During the war in Croatia, from August 1991 until December 1994, 138 soldiers were treated at the Split University Hospital for different brain injuries inflicted by missiles. Nine of these 138 patients developed intracranial infection. This retrospective study reports on the outcome of these 9 intracranial infections caused by penetrating missile head injuries. In case of clinically suspected infection, computerized tomography scan was obtained at two time points during the course of infection in the same patient. Scans were obtained with and without contrast media, 7 to 14 days after the injury and the 4 weeks later. The role of computerized tomography in the detection and follow–up of various intracranial infections and long–term consequences were evaluated.

Key words: computerized tomography, missile head injury

Received for publication July 6, 1996

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INTRODUCTION

Complications following penetrating missile injuries to the brain include contamination from the projectile,[1, 2] retained bone and missile fragments[2–5] and disruption of cerebrospinal fluid (CSF) circulation due to a breach in the ventricular system.[2, 3, 6] Computerized tomography (CT) examination improves the outcome in patients with penetrating missile injuries to the brain, as it is useful for the assessment of the type and extent of intracranial injury. CT can also predict the need of surgery to prevent intracranial infection. For example, in the detection of brain abscess, the sensitivity of CT was found to be over 92%.[7] We used CT for initial and follow–up diagnostic study, in combination with other diagnostic procedures with and without contrast media 7 to 14 days after injury, and then again 4 weeks later.

MATERIALS AND METHODS

During war in Croatia, from August 1991 till December 1994, 138 Croatian soldiers (mean age 25.3 years; range 21–35 years) were treated at the Department of Neurosurgery, Split University Hospital (the main hospital for Southern Croatia) for different brain injuries caused by projectiles. Immediately upon admission, appropriate chemotherapeutic measures were taken (e. g., antibiotics according to the war scheme, antitetanus prophylaxis, antitedematous therapy, etc.). After stabilization, CT brain scan was performed at the Department of Radiology (Somatom DRG, Siemens, Germany). On CT examination of the brain, we used bone and tissue windows, and in some cases image reconstruction was performed. Appropriate neurosurgical procedure (wound debridement across all layers and dural reconstruction) was then performed.

In nine patients with clinically suspected intracranial infections, CT scan was repeated several times with and without contrast media (7–14 days and 4 weeks later). The criteria of Baltas at al.[9] were used to make the diagnosis of intracranial infection. The clinical diagnostic procedure included lumbar puncture, and cytologic, biochemical and bacteriologic analysis of CSF, with antibiogram of isolated bacteria.[10]

Estimation of CSF concentration of antibiotics (MIC, MBC) was not performed. The patients were followed up for 6 months.

RESULTS

All patients were men aged 21 to 35 years. Three patients were injured by sniper bullet, and six by mine and mortar fragments. The entrance wound was in the occipital (N=2), parietal or frontal (N=6) and temporal (N=1) region. Seven patients were neurosurgically treated within 24–48 hours after the wounding (mean 32 hours). On admission, most patients had a Glasgow Coma Scale (GSC) Score of 5 or less (Table 1).

Infection of the central nervous system (CNS) occured after 8 to 63 days of hospitalization. An early infection was a poor prognostic sign when combined with other risk factors. The initial CT findings were: intracerebral hemorrhage, brain edema,

Table 1
Clinical data in nine patients with intracranial infection

Case	Age (yr)	GCS[1] on admission	GOS[2] in 6 months	Injury–infection interval (days)	Organisms cultured	CSF fistula
1	22	4	death	8	*Acinebacter* spp.	+
2	35	3	12	63	*Streptococcus viridans*	+
3	24	5	13	24	MRSA[3]	+
4	28	3	12	9	MRSA[3]	+
5	21	4	death	12	Unknown	+
6	24	4	15	15	*Proteus mirabilis*	–
7	29	4	death	14	MRSA 3 + *Acinobacter* spp. + *Ps. Aeruginosa* + *Proteus mirabilis*	+
8	27	7	12	15	SA[5] + *Enterobacter* spp. + *Ps. aeruginosa* + *Enterococcus*	+
9	23	3	death	9	MRSE[4] + *Ps. euruginosa* + *Klebsiella pneumoniae* + *Alcaligenes* spp.	+

[1]GCS = Glasgow Coma Scale Score
[2]GOS = Glasgow Outcome Scale
[3]MRSA = methicillin resistent *Staphylococcus aureus*
[4]MRSE = methicillin resistent *Staphylococcus epidemidis*
[5]SA = *Staphylococcus aureus*

Table 2
Initial CT findings in nine patients with intracranial infection on admission

Case	Intracerebral hemorrhage	Edema	Bone fragments	Shell fragments	Pneumocephalus
1	+	+	+	–	–
2	–	+	–	–	+
3	+	+	+	+	–
4	+*	+	+	+	–
5	+	–	+	–	–
6	+	+	–	–	+
7	+**	–	+	–	+
8	+	+	+	–	–
9	+	–	+	–	+

* intraventricular hemorrhage
** subarachnoidal hemorrhage

bone and metal fragments, and pneumocephalus (Table 2). Other findings included hemorrhage into the ventricular system (case No. 4) and subarachnoidal hemorrhage (case No. 7). In our group of patients, the initial clinical manifestations of CNS infection included fever, altered consciousness and in some cases, coma. CT findings of these nine patients are presented in Table 3 (characteristic images are presented in Figures 1–3). Eight of these nine patients had meningitis with cerebritis, and one had abscess. In one patient, (case No. 2) the infection occurred on day 63 after the injury.

Retained bone and foreign metal bodies, as well as CSF fistula, had an important role in the development of CNS infection (Tables 1 and 2). Retained bone fragments were detected in seven and metal fragments in two patients. Eight of these nine patients had CFS fistula. In six patients, CSF fistulas were found at the entrance wound. Nasal CSF rhinorrhea, and otoliquorrhea were observed in one

Table 3

CT follow–up studies in nine patients with intracranial infection

	Days between initial CT and follow up CT with CT findings			
Case	7–14	15–30	31–45	45
1	Cerebritis, meningitis			
2				Subdural empyema with ventriculitis
3		Absces		
4	Cerebritis, meningitis			
5	Cerebritis, meningitis			
6		Cerebritis, meningitis		
7		Cerebritis, meningitis		
8		Cerebritis, meningitis		
9	Cerebritis, meningitis			

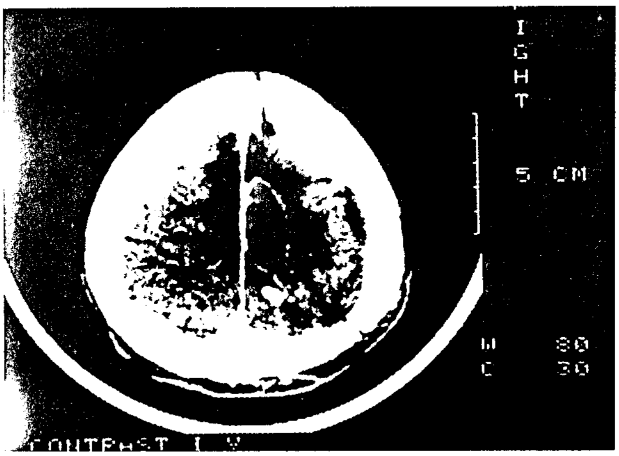

Fig. 1. *Postcontrast CT scan revealed a large ring–extending abscess to the high convexity right frontoparietal area. A foreign body (bone fragment is also seen (Case 3).*

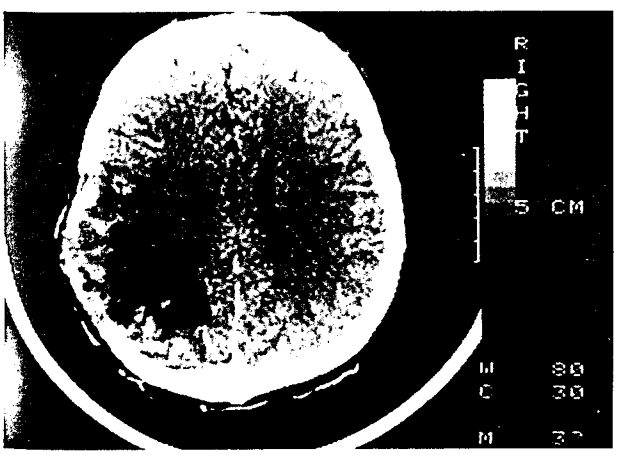

Fig. 2. *Contrast–enhanced CT scan shows a large, irregular, extending area of hypodensity. A small foreign body is seen. Cerebritis (Case 8).*

Fig. 3. *Gross dilatation of the left and moderate dilatation of the right ventricle with almost incomplete loss of brain tissue in temporoparietal region. Subdural abscess in the region of retained bone fragment.*

patient each. The causative agents were gram negative (N=2), gram positive (N=3), mixed (N=3) an unknown (N=1).

All patients received combined therapy and were hospitalized for 32–99 days. During the follow–up (up to 6 months), four patients died (from infection, pulmonary embolism, cardiopulmonary failure and hydrocephalus — family refused treatment).

DISCUSSION

Computed tomography is the method of choice for evaluation of patients with penetrating head injuries, particularly in the emergent or acute setting[11, 12] and it eliminates the need of X–ray of the skull.[13] Although CT is not as sensitive as magnetic resonance imaging (MRI) for early detection of cerebritis, for example, CT was preferred due to MRI unavailability. Furthermore, contrast–enhanced CT has been found to be more sensitive than non–contrast MRI for the detection of meningitis.[14] Our initial CT findings are similar to those published in a report on craniocerebral injuries in Croatian soldiers (see Table 2).[15]

In our series, nine out of 138 men developed CNS infection following penetrating intracranial injury. Previous reports have shown that the main risk factors for the development of CNS infection following penetrating injuries include CSF fistulas and retained foreign bodies,[1, 5, 7, 9] although the issue is still controversial.[16, 17]

The percentage of infections in patients who developed CSF fistula after craniocerebral injuries ranges from 36% to 49.5%[1, 5] and reaches 84.6% in patients with combined fistula and retained foreign bodies.[5] Our results are in accordance with previously published reports.[18]

Some authors suggest not to remove retained bone fragments if the patient has no other major risk factors, such as wound dehiscence or CSF leakage.[19] It is important to emphasize that all patients with CNS infection and retained foreign bodies had at least two other risk factors such as GCS of 5 or less, extensive brain injuries, CSF fistula, frontobasal trauma, inadequate wound debridement and delayed transport to the hospital.

In previous studies on missile head wounds, the GCS score appeared to be related to the prognosis: a GCS score of 5 or less in one report was associated with a favorable outcome in 35% of cases, compared to a GCS score of 13–15 which was associated with a favorable outcome in 94% of cases.[20] Five out of nine of our patients had good outcome.

CSF fistulas increase the chance of infection drastically. Reports from Iran–Iraq and Vietman war showed that the chance of infection was increased 20 times in patients with CSF fistulas.[8, 19] In eight out of nine of our patients, a CSF fistula at the entrance wound with either rhinorrhea or otoliquorrhea were present.

Computed tomography allows early diagnosis of the type of infection, better follow–up of medicamentous or neurosurgical treatment, and evaluation of residual lesions.

R E F E R E N C E S

1. Aarabi B. Comparative study of bacteriological contamination between primary and secondary exploration of missile head wounds. J Neurosurg 1987; 20: 610–6.

2. Carey ME, Young HF, Mathis JL. A bacteriological study of craniocerebral missile wounds from Vietnam. J Neurosurg 1971; 34: 145–54.

3. Carey ME, Young HF, Rish BL, Mathis JL. Follow up study of 103 American soldiers who sustained a brain wound in Vietnam. J Neurosurg 1974; 41: 542–9.

4. Haagan HE. Early complications following penetrating wounds of the brain. J Neurosurg 1971; 34: 132–41.

5. Taha JM, Haddad FS, Brown JA. Intracranial infections after missile injuries to the brain: report of 30 cases from Lebanese conflict. J Neurosurg 1991; 29: 864–8.

6. Hammon WM. Retained intracranial bone fragments: analysis of 42 patients. J Neurosurg 1971; 34: 142–4.

7. Meirowsky AM, Caveness WF, Dillon JD et al. Cerebrospinal fluid fistulas complicating missile wounds of the brain. J Neurosurg 1981; 54: 44–8.

8. Young WY, Zhao CS. Review of 140 patients with brain abscess. Surg Neurol 1993; 39: 290–6.

9. Baltas I, Tsoulfa S, Sakellariou P, Vogas V, Fylaktakis M, Kondodimou A. Posttraumatic meningitis: bacteriology, hydrocephalus and outcome. Neurosurgery 1994; 35: 422–6.

10. Bauer AW, Kirby MM, Sherris JC, Turck M. Antibiotic susceptibility testing by standard single disc method. Am J Clin Pathol 1973, 45: 493–6.

11. Ward JD, Chisholm AH, Prince VT, Gilman CB, Hawkins AM. Penetrating head injury. Crit Care Nurs Q 1994; 17: 79–89.

12. Chaudri KA, Choudhury, AR, Al–Moutaery KR, Cybulski GR. Penetrating craniocerebral shrapnel injuries during operation "Desert Storm": early results of a conservative surgical treatment. Acta Neurochir Wien 1994, 125: 120–3.

13. Rosenwasser R, Andrews DW, Jimenez DF. Penetrating craniocerebral trauma. Surg Clin North Am 1991; 71: 305–17.

14. Sze G. Infection and inflammation. In: Stark DD, Bradley WG, eds. Magnetic Resonance Imaging. St. Louis: Mosby Year Book, 1992; 670–99.

15. Besenski N, Jadro–Santel D, Jelavic–Koic F et al. CT analysis at missile head injury. Neuroradiology 1995; 37: 207–11.

16. Levi L, Borovich B, Guilburd JN et al. Wartime neurosurgical experience in Lebanon, 1982–1985 I. penetrating craniocerebral injuries. Isr J Med Sci 1990; 26: 548–54.

17. Brandvold B, Levi L, Feinsod M, George ED. Penetrating craniocerebral injuries in the Israel involvement in the Lebanese conflict 1982–85. Analysis of a less aggressive surgical approach. J Neurosurg 1990; 72: 15–21.

18. Rish B, Cavaness W, Dillon J, Kistler P, Weiss G. Analysis of brain abscesses after penetrating craniocerebral injuries in Vietnam. J Neurosurg 1981; 9: 535–41.

19. Aarabi B. Causes of infection in penetrating head wounds in the Iran–Iraq War. Neurosurgery 1990; 25: 923–6.

20. Aarabi B. Surgical outcome in 435 patients who sustained missile head wounds during the Iran–Iraq War. Neurosurgery 1990; 27: 692–5.

S. Janković, N. Bradarić, Ž. Bušić, Ž. Dujić, Š. Anđelinović, D. Primorac. Early Intracranial Infections after Brain Missile Injuries — The Role of Computer Tomography in Diagnosis and Treatment. Acta med. Croat. Vol. 51 (1997) No. 4–5, pp 233–237

S A Ž E T A K

RANE INTRAKRANIJSKE INFEKCIJE NAKON OZLJEDE MOZGA PROJEKTILIMA — ULOGA KOMPJUTORIZIRANE TOMOGRAFIJE U DIJAGNOSTICI I LIJEČENJU

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Tijekom Domovinskog rata u Hrvatskoj, od kolovoza 1991. do prosinca 1994. godine u Kliničkoj bolnici Split liječeno je 138 vojnika zbog različitih ozljeda mozga uzrokovanih projektilima. Devet od 138 pacijenata razvilo je intrakranijsku infekciju. U ovom retrospektivnom proučavanju prikazano je praćenje devet intrakranijskih infekcija uzrokovanih penetrirajućim ozljedama glave. U slučaju klinički suspektne infekcije, kompjutorizirana tomografija učinjena je svakom pacijentu najmanje dva puta, nativnom tehnikom snimanja uz primjenu kontrastnog sredstva, 7 do 14 dana nakon ozljede i 4 tjedna kasnije. Naglašeno je značenje kompjutorizirane tomografije u otkrivanju i praćenju različitih intrakranijskih infekcija i kasnih komplikacija.