THE CHARACTERISTICS OF MANAGEMENT OF CONCOMITANT CRANIOFACIAL INJURY COMPLICATED BY CEREBROSPINAL FLUID RHINORRHEA

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The aim of the investigation was to reveal the characteristics of the management of penetrating craniofacial injury against the background of polytrauma, and develop the algorithm of preoperative examination and treatment of concomitant craniofacial trauma complicated by cerebrospinal fluid rhinorrhea based on the use of modern neuroimaging techniques.

Materials and Methods. 637 sufferers with major concomitant injuries underwent treatment in Nizhny Novgorod Regional Traumatology Centre from 2010 to 2012. 85 patients (13.34%) had concomitant cerebral and facial skeleton injuries, among them there were 62 (9.7%) cases with cerebrospinal fluid rhinorrhea revealed on admission. Mean age of those suffered from craniofacial injury was 31.2±13.9 years (min — 16; max — 88). The severity of injuries according to ISS (Injury Severity Score) was 35.15±17.40 scores (min — 9; max — 77).

Results. Concomitant injury of brain and bones of the facial skeleton in polytrauma was found in 13.3% of patients with polytrauma. 9.7% cases were found to have penetrating craniofacial injuries. Relying on the experience obtained, we suggested the algorithm of preoperative assessment and planning of surgical management of craniofacial injury complicated by cerebrospinal fluid rhinorrhea using modern neuroimaging techniques based on the assessment of a patient's condition. The use of the algorithm in everyday practice in patients with penetrating craniofacial injury and polytrauma enables to improve the diagnosis and objectify the time optimal for surgical management of cerebrospinal fluid rhinorrhea, reduce the lethality up to 8%, and the morbidity of pyoinflammatory complications — up to 4.8%.

Key words: craniofacial injury; cerebrospinal fluid rhinorrhea; polytrauma.

Various forms of craniofacial injury (CFI) rank one of the leading positions in the structure of neurotrauma reaching 10–34% [1, 2]. Today its forms are well characterized: cranioorbital injuries [1]; craniofacial injuries with optic nerve compression [2], CFI with penetrating injuries of paranasal sinuses [3]. Cerebrospinal rhinorrhea (CR) has been found to complicate an isolated CFI in 22.9% of cases. Basal liquorrhea with 14-day duration and more requires operative treatment, since pyoinflammatory complications in this case develop in more than 10% of injured [3].

However, there are still unstudied management problems of penetrating CFI against the background of multisegmented injuries of thoracic and/or abdominal organs, long bones, spine in severe "high-energy" polytrauma [4].

The views of researchers on time periods of CFI surgery in major polytrauma are contradictory [5–8].

Moreover, there has not yet been determined the position of modern techniques of neuroimaging and cerebral perfusion assessment in the existing algorithms of examination and preoperative preparation of patients with penetrating facial skeleton injuries and concomitant CR against the background of polytrauma [9, 10].

The aim of the investigation was to reveal the characteristics of the management of penetrating craniofacial injury against the background of polytrauma, and develop the algorithm of preoperative examination and treatment of concomitant craniofacial trauma complicated by cerebrospinal fluid rhinorrhea based on the use of modern neuroimaging techniques.

Materials and Methods. 637 sufferers with major concomitant injuries underwent treatment in Nizhny Novgorod Regional Traumatology Centre on the base of N.A. Semashko Regional Clinical Hospital (Nizhny Novgorod, Russia) from January, 2010 to December, 2012. Among them 85 patients (13.3%) had concomitant cerebral and facial skeleton injuries. CR was revealed on

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admission in 62 patients with CFI and polytrauma (9.7%). Mean age of those suffered from CFI complicated by CR was 31.2±14.3 years (min — 16; max — 88). There were 42 male and 20 female patients. The severity of injuries according to ISS (Injury Severity Score) was 41.1±16.0 scores (min — 12; max — 77). Awakening level according to Glasgow Coma Scale (GCS) on admission averaged 9.7±3.2 scores (min — 3; max — 14). All the admitted patients underwent computed tomography (CT) of the injured segments.

CT was performed on 64-section tomographic scanner Toshiba Aquilion TSX-101A (Toshiba Medical systems, Europe B.V., Netherlands) in accordance with standard programs, and if necessary – according to protocols of Brain Perfusion and CTA (computed tomography angiography). Statistical analysis was carried out using parameter estimation methods. The data were processed using Statistica 10.0 program (StatSoft Inc., 2011). All patients received treatment according to ATLS protocol (Advanced Trauma Life Support) including correction of respiratory disturbance, the maintenance of adequate arterial pressure and cerebral perfusion pressure, water-electrolytic balance, analgesia and antibacterial treatment.

Results and Discussion. The injuries in the studied patients with CFI complicated by CR were caused by: traffic accidents — 57 cases (91.9%), industrial accidents — 2 cases (3.2%), fall from height — 3 cases (4.8%). Tables 1–3 show the traumatism characteristics, the patients' distribution over CFI types, the severity of concomitant injuries according to ISS and outcomes.

59 of 62 patients (95.2%) were admitted in the state of shock with injuries estimated over 20 scores according to ISS that made it possible to perform emergency lifesaving procedures only.

Table 1

Traumatism characteristics in patients with craniofacial injury complicated by cerebrospinal fluid rhinorrhea

Injuries (n=62)	Number of injuries	
	Absolute number	%
Cervical spine cord injury	24	38.7
Pulmonary contusion	50	80.6
Abdominal injuries	18	29.0
Limb fracture	45	72.6
CFI:		
Mild brain contusion	13	20.9
Moderate brain contusion	12	19.3
Severe brain contusion	37	59.7

Table 2

Severity structure of concomitant injuries in accordance to ISS

ISS, scores	Number of patients (n=62)	
	Absolute number	%
Under 20	3	4.8
20–40	28	45.1
40–70	26	41.9
Over 70	5	8

Table 3

Distribution of outcomes according to Glasgow Outcome Scale

Outcomes	Number of patients (n=62)	
	Absolute number	%
Death	5	8
Autonomic status	4	6.4
Severe disability	7	11.3
Moderate disability	20	32.3
Recovery	26	41.9

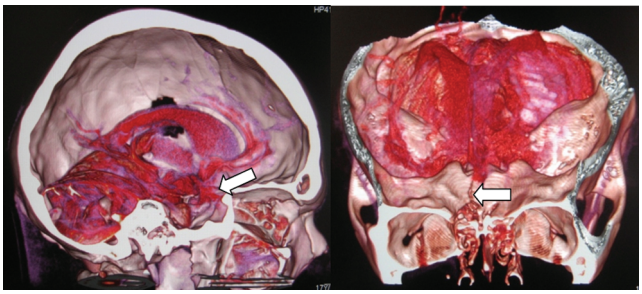

Fig. 1. 3D-reconstruction CTC. An arrow shows cerebrospinal-fluid fistula localization

2 patients with CFI and CR were urgently operated on for intracranial hematomas. During urgent medical intervention both patients underwent the revision of the anterior cranial fossa base and the repair of cerebrospinal-fluid fistulas using an expanded frontotemporal approach. Both patients had good treatment results with liquorrhea stopping within the first postoperative days. Thus, cerebrospinal-fluid fistulas were urgently repaired in 3.2% of sufferers.

During anti-shock measures conservative treatment of liquorrhea was performed: 13 patients underwent ventricular drainage, 35 patients — lumbar spinal fluid drainage in case there were no cerebral dislocation signs. 9 patients were too severely injured to undergo spinal fluid drainage, and they had to receive conservative treatment including diuretics, antibiotics, etc.

As a result, against the background of conservative treatment, CR was arrested in 31 patients, which amounted 50% of the total number of patients with penetrating CFI.

If CR signs persisted for more than 10 days, it gave occasion to perform a thorough cerebral CT including: CT-cisternography (CTC), CT perfusion (CTP), CT-angiography (CTA). CTC enabled to image not only single fistulas (Fig. 1), but also multiple fistulas — by contrast collected in paranasal sinuses (Fig. 2).

Cerebral CTP was performed after CTC to estimate cerebral perfusion. If there were found the zones of abnormal perfusion, CTP was followed by CTA of cerebral vessels. The zones of ischemic lesion in patients with polytrauma were estimated as the failure of cerebral blood flow autoregulation, and we considered it to be a relative contradiction to surgical repair.

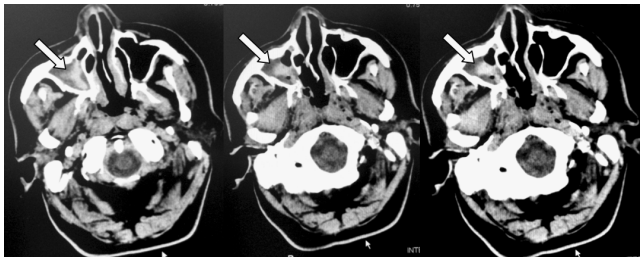

Fig. 2. A series of axial tomograms of Patient D. after intrathecal nonionic iodine-containing contrast injection shows contrast accumulation in the right maxillary sinus (arrows)

Table 4

Severity structure of concomitant injuries in accordance with ISS in a group of operated patients with cerebrospinal rhinorrhea

ISS, scores	Number of patients (n=29)	
	Absolute number	%
Under 20	0	0
20–40	10	34.5
40–70	16	55.1
Over 70	3	10.3

Table 5

Cerebrospinal-fluid fistula localization in a group of operated patients with cerebrospinal rhinorrhea

Fistula localization	Number of patients (n=29)	
	Absolute number	%
Ethmoid bones	9	31
Sieve plate	8	27.6
Multiple sources	12	41.4

If there were revealed the areas of reduced perfusion below the ischemic threshold against the background of cerebral angiospasm, we performed hyperdynamic infusion therapy (the so-called triple-H therapy) [11] and infusion of Ca^{2+} antagonists. Surgical management was delayed of 3–4 days. As a rule, this time was enough to stabilize a patient's condition and no thorough CT reinvestigation required. However, if disorder of consciousness persisted, surgical repair was withheld.

Meningitis developed in 3 nonoperated patients (4.8%). All these patients were comatose since admission, and had severe cranial and cerebral injuries preventing from any reparative operations and spinal fluid drainage.

In total, in 29 patients CR turned out to be resistant to conservative treatment and persisted for more than 10 days requiring surgical correction. In these patients moderate brain contusion was revealed in 5 cases (17.2%), severe brain contusion — in 24 cases (82.8%). Concomitant injuries were the following: cervical spine cord injuries — 12 (41.4%), pulmonary contusion — 26 (89.7%), abdominal injuries — 12 (41.4%), limb fractures — 21 (72.4%).

Surgical management was aimed at cerebrospinal-fluid fistula repair and one-stage osteosynthesis of facial and cerebral cranium.

On average the operations were performed on 18±7 day (min — 10; max — 34). Tables 4–5 show the characteristic of these group patients in the severity of concomitant injuries and cerebrospinal-fluid fistula localization.

A comparative analysis of the groups of operated and nonoperated patients showed that they statistically significantly ($p<0.05$) differed in the severity of injuries according to ISS, as well as in the frequency of abdominal injuries.

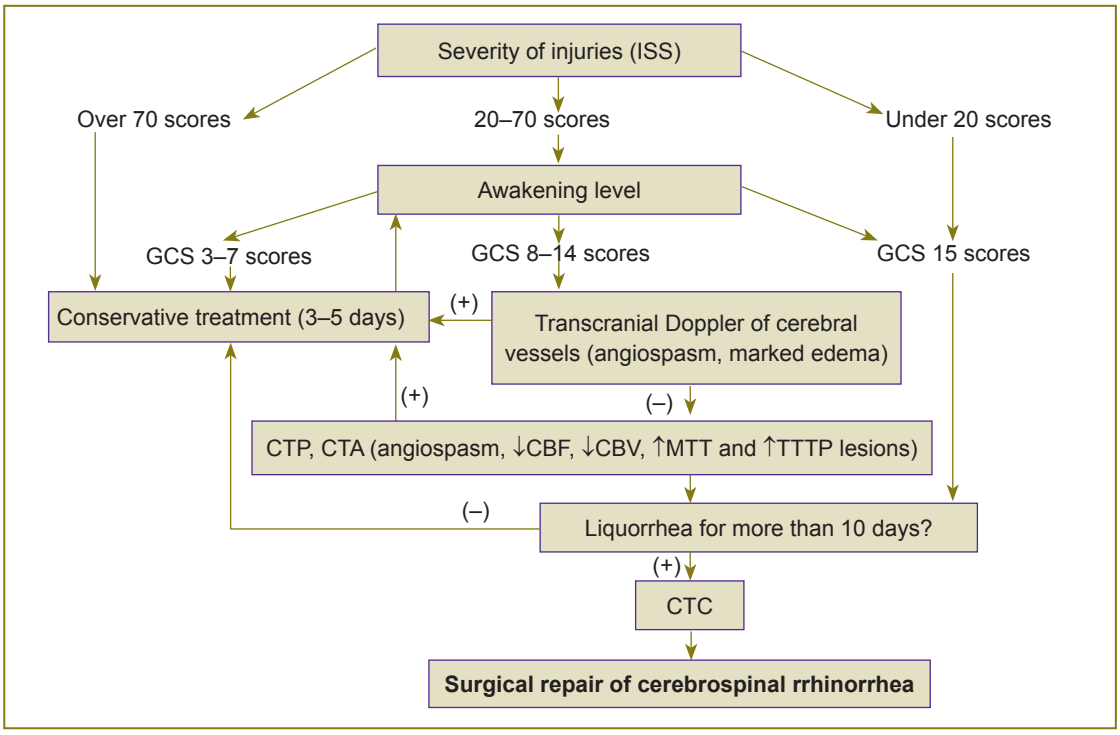

Fig. 3. Examination and treatment algorithm of patients with craniofacial injury and cerebrospinal rrhinorrhea

Operative therapy was predominantly performed by a multidisciplinary team including a neurosurgeon, a maxillofacial surgeon, and if necessary — an ophthalmologist and ENT specialist.

In 10 cases we used a bifrontal approach, in 11 — a unilateral subfrontal approach. For 8 patients we chose a unilateral supraorbital approach with eyebrow skin incision.

After the structures of anterior cranial fossa were revised and cerebrospinal-fluid fistula revealed, we performed a combined repair of the fistula: intradural suturing of dural defect followed by TachoComb plate application. Extradural repair was performed using a fat graft taken from the anterior abdominal wall or the anterior femoral surface, which was put on a bone defect (n=22). A musculo-aponeurotic pedicle graft was placed above a fat graft.

As the result of this surgical technique application 29 patients were recorded to have CR termination. Operated patients had no pyoinflammatory complications developed.

Based on the known algorithms of rhinorrhea detection and location of cerebrospinal-fluid fistulas [1], and taking into account our own experience, we developed an action sequence enabling to work out the management technique of CR patients relying on the severity of extracranial injuries and cerebral traumas, as well as cerebral blood flow state, both at cerebral macrocirculation level, and microvasculature level (Fig. 3). For this purpose we used modern facilities to estimate these parameters using contrast techniques: CTP and CTA.

The suggested scheme enables to use an active surgical management of patients with polytrauma and CR improving treatment results of such patients: it reduces mortality and frequency of intracranial inflammatory complications.

As any algorithm, the scheme is not exhaustive. The prospects of further improvements in imaging and invasion reduction are related to the introduction of MRT-estimation of cerebrospinal fluid flows (CISS and PC-MRI), as well as flat panel CT and mobile radiological devices such as Ceretom/Bodytom.

Conclusion. Simultaneous injury of brain and facial bones in polytrauma has been found to be revealed in 13.3% of sufferers with polytrauma. Penetrating craniofacial injuries occur in 9.7% of cases. The developed algorithm of examination and planning of surgical management of craniofacial injury complicated by cerebrospinal fluid rhinorrhea using modern neuroimaging techniques in patients with penetrating craniofacial injury and polytrauma in everyday practice enables to improve the diagnosis and objectivize the time optimal for liquorrhea nasalis surgical management, reduce the mortality up to 8%, and the frequency of pyoinflammatory complications in cerebrospinal fluid rhinorrhea — up to 4.8%.

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