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Factors Indicating on Differentiated Approach in Treatment of Severe Focal Brain Injures

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Abstract: Background: Modern methods of complex diagnostics in neurotraumatology, in particular computed tomography (CT) and magnetic resonance imaging (MRI), enable neurosurgeons to make a differentiated approach to choosing the right method for treating traumatic and other brain injuries. Objective: To elaborate criteria for differentiated treatment of severe focal traumatic brain injuries. Methods: Results of treatment in 126 patients with severe craniocerebral injury have been examined, 74 of them were undergone to surgical methods of treatment, and 52 patients were treated conservatively. To all patients computed tomography and magnetic resonance imaging procedures of the brain were done. The results of treatment were assessed using Glasgow Outcome Scale. Criteria for selection of patients were fact of severe isolated craniocerebral injury, depth and time of loss of consciousness, availability of CT and MRI of brain in dynamics, and operational findings. Results: It was determined a high degree of possibility of tomographic objectification and consecutive transformation of substrates of injured brain. It is noted, that the most frequent traumatization is observed for frontal (43.4%) and temporal (40.5%) brain lobes. Conclusions: Introduction of differentiated approach to using conservative and surgical methods of treatment for severe traumatic cerebral contusion and hematomas of brain, and preference of conservative treatment led to greater efficiency and adequacy of treatment of these patients.

Keywords: Severe Craniocerebral Injury, Cerebral Contusions, Differentiated Treatment

1. Introduction

In neurotraumatology, there is an era of imaging all substrates of skull and brain content, it replaced, dominated for decades, empirically intuitive approach in treatment of traumatic and other brain injuries [3, 4].

It is known that with diffusion or focal lesions of the brain, the coordinated work of the whole organism suffers. Possibilities of modern comprehensive diagnostics, particularly computed tomography (CT) and magnetic resonance imaging (MRI) provided evidence of available intracranial changes in various focal brain lesions, including in traumatic its injuries. Use of modem diagnostic techniques has completely changed information support of diagnostic and treatment process at various focal cerebral affections, including traumatic focal cerebral contusions [3, 4]. The most important thing is MRI, CT and PET allowed to change approaches and significantly improve the quality of surgical care for patients with severe focal lesions of the brain [11, 12].

2. Methods

We conducted a retrospective and comprehensive analysis of the case histories of 126 patients with severe craniocerebral injury with intracranial traumatic hematomas and foci of brain crush, who received treatment in Clinic of Neurosurgery of National Hospital of Ministry of Health Care of the Kyrgyz Republic from 2005 to 2011. The main part of patients came from the northern regions of Kyrgyzstan, southern regions are located in the remoteness from the capital of the country, the patients were admitted to hospital in the period from the end of 2004 to the beginning of 2011. All patients were undergone CT or MRI, in some cases - in dynamics. Leading signs of our patients for analysis of facts are state of consciousness, presence of traumatic intracranial hematomas and foci of brain crush, revealed by tomography in acute period of severe craniocerebral injury.

In the Kyrgyz Republic, all citizens have equal access to

health services, but there are privileged categories of citizens: children, disabled people and pensioners. The main sources of financing for the health care system of the Kyrgyz Republic are: public funds (budget and compulsory health insurance), private household expenses (mainly in the form of personal payments) and external funds from international development organizations. The results of treatment were assessed using Glasgow Outcome Scale: Criteria for selection of patients were fact of severe isolated craniocerebral injury, depth and time of loss of consciousness, availability of CT and MRI of brain in dynamics, and operational findings, which indicating that results of craniocerebral injury are intracranial traumatic hematomas, foci of brain crush. Table 1 shows possibilities of objectification of substrates of severe craniocerebral injury with CT and MRI [13, 14].

Due to these possibilities, neurosurgeon today has a clear idea about true changes of structures of injured brain in natural proportions in real time terms. Neurosurgeon can already see the real picture of suffering brain to decide, which method of treatment better to use. Whereas before the era of tomography, surgical treatment in focal brain injuries was performed only by indirect indicators, essentially blind, without imaging picture of its real sizes, features of its spreading and not knowing features of craniocerebral ratios. Each of points of Table № 1 has only practical importance, being base for all further statements in diagnostic, therapeutic and prognostic relations.

Focal brain damages are characterized by the fact that pathology acts within a certain area - the focus. The causes may be various pathological processes: neoplasms, vascular and infectious processes, as well as traumatic bruises with hemorrhages, which are mainly limited to a certain area of the brain. Scientists also identify multi-focal damages of brain which have more than one focal (damaged areas) [17].

Table 1. *An importance of CT and MRI for diagnostics of severe craniocerebral injury.*

№	Degree of manifestation	Indicators of CT and MRI
1	++	Vital objectification of brain injuries.
2	+++	Identification of additional substrates of brain injures (hematomas, skull fragments).
3	+++	Condition of cerebrospinal fluid space.
4	+++	Degree of brain's response to injury.
5	++	Imaging of brain vessels.
6	++	Identifying craniocerebral ratios (brain dislocation).
7	++	Study of consequential evolution

Note: + weak manifestation.
++ Moderate manifestation.
+++ High severity of sign.

Distribution of patients by age and gender was quite typical for craniocerebral injury, which corresponded to data of numerous references. It should be noted that in our study there were more young and middle-ages men. Men to women ratio was 3.5:1. It was determined a clear dominance of focal brain injuries by type of shock mechanism (68%) over anti-shock mechanism (32%). Fractures of bones of skull, both fornix and base, are noted in 74% of cases. Cerebrospinal fluid otorrhea and nasal liquorrhea were in 34% of cases.

Distribution of focal brain injuries by lobe localization is presented below (Table 2).

Table 2. *Percentage distribution of focal injuries by parts of brain.*

№	Parts of brain	Percentage ratio
1	Frontal region	43.4
2	Temporal region	40.5
3	Parietal region	12.8
4	Occipital region	41
5	Cerebellum	2.3

According to Table 2 it may be noted that the vast majority of injurers have damaged frontal and temporal brain lobes, which can be directly related to mechanism of injury. Also, anatomical features of location of these brain lobes contributed to frequent traumatization of these brain lobes by shock and anti-shock wave. Of 126 patients, operative therapy was made to 74 affected patients, conservative treatment was conducted to 52 patients.

3. Results

Analysis of results of operated and non-operated patients by severity of general condition and level of impairment of consciousness, assessed by Glasgow coma scale, numerical values of which are presented below (Table 3 and Table 4).

Table 3. *Distribution of patients by severity and nature of treatment.*

Condition of severity	Operative therapy	Conservative treatment	Total
Moderate	13 (17.6%)	26 (50%)	39
Severe	41 (55.4%)	17 (32.7%)	58
Extremely severe	20 (27.0%)	9 (17.3%)	29
Total	74 (100%)	52 (100%)	126

Table 4. *Distribution of patients according to state of consciousness (Glasgow Coma Scale) and nature of treatment.*

Glasgow Coma Scale/points	Operative therapy	Conservative treatment	Total
13-15	12 (16.2%)	24 (46.2%)	36
9-12	16 (21.6%)	12 (23.1%)	28
3-8	46 (62.2%)	16 (30.7%)	62
Total	74 (100%)	52 (100%)	126

Table 5. *CT-MRI dynamics of sanogenesis of foci of brain crushing.*

№	Stages of organization of traumatic substrate	Time after injury
1	Growing perifocal edema	2-5 days
2	Increasing crush foci	2-7 days
3	Regression of perifocal edema	10-15 days
4	Resorption of crushing focus	5-6 weeks
5	Expansion of ventricular system	4-5 weeks
6	Transition to atrophic process	2-3 months
7	Formation cystic process	3-4 months

Table 6. *CT-dynamics of intracranial hematomas.*

№	Dynamics of CT changes of hematomas	Time after injury
1	Hyperdense phase of hematomas	1.5-2 weeks
2	Transition from hyperdense to isodense phase	2-3 weeks (10-15 days)
3	Transition from isodense phase to hypodense phase	3 and more weeks
4	Hematoma resolution (not always)	2-3 months

In our opinion, the main clinical data for determining the type of treatment for local damages of brain (conservative, neurosurgical) are the Glasgow coma severity scale, CT, MRI data in brain studies to verify the nature, localization of damage and dislocation of the median structures of the brain. Faster regression of neurological symptoms was observed when a surgery was performed by high (7-14) Glasgow coma scale and smaller focal damages and dislocation of brain of less than 7-5 mm in the transverse plane and 3-5 mm in the axial plane [15. 8].

4. Discussion

As noted in Tables 3 and 4, by comparison of operated and non-operated persons by severity and state of consciousness, it is found a significant difference between these indexes and results of treatment. For example, if it was more severe injury of large areas of brain (confirmed by CT and MRI), the Glasgow Coma Scale may indicate a more favorable outcome indexes. The Table 5 presents CT-MRI dynamics of sanogenesis of foci of brain crushing.

It should be noted that this transformation of foci of brain injuries is not fixed for each patient within specified time. Depending on age of patient, degree of compensation, brain dislocation and other factors, these changes of injured areas of brain may vary on a large scale, both in time and size. But it may be said with certainty that these morphological transformations of crushed areas of brain occur with a certain sequence. Apparently, such sequential pattern is typical to many living organs and tissues, as a protective mechanism for self-organization and self-regulation of brain tissue [5, 6].

Long-term observations of intracranial hematomas allowed to note that hematomas eventually undergo sequential changes, which are clearly seen in computed tomographic studies [12, 15].

As it is indicated in Table 6 intracranial hematomas, regardless of causes of its formation, undergo consequential phase transformation, knowledge of which has practical importance in diagnosis and solving a question on surgery. If tomography will be done during isodense phase, hematoma may not be determined. It may be diagnosed only by indirect signs - by shift of midline of brain or by deformation of ventricular system.

In addition, depending from phase of condition of hematoma, various types of craniotomy and methods of removal of hematoma may be done. For example, if surgical therapy for removal of hematoma in hyperdense or isodense phase is required, we have to make this osteoplastic or resectional craniotomy with mandatory use of general anesthesia with incubation. This is considered as a relatively heavy, traumatic surgery intervention. If surgical therapy will be done in hypodense phase, then hematoma may be removed by a method without craniotomy only by imposition of a single burr hole and without use of intubation anesthesia with puncture of hematoma. Therefore, in recent years, we have tried where possible (if patient's condition allows) to operate intracranial hematomas specifically on hypodense phase (sub-acute or chronic stage), using low invasive and minimally invasive surgical methods that are economical in every respect. Surgical treatment of patients with large focal lesions with a progressive or fulminant course should be conducted before decompensation develops [18].

Based on long-term observations, we have developed preliminary criteria for differentiated treatment of severe focal injuries of brain substance, where indications for surgical and conservative treatment are clearly specified.

4.1. Indications for Surgery Intervention

1. Persistent stay of patient in phase of rough decompensation.

2. State of consciousness is sopor or coma (by Glasgow Coma Scale <10).
3. Significant clinical signs of brain dislocation.
4. Volume of crushing focus on CT and MRI are more than 50 cm^3 in frontal lobe and more than 35 cm^3 in case of temporal localization.
5. Presence of intracerebral hematoma with diameter greater than 4 cm.
6. Brain midline shift is more than 5 mm or gross deformity, covering cisterns (lateral and axial dislocation of brain).

4.2. Indications for Conservative Treatment

1. Staying patient in subcompensation phase or moderate clinical decompensation.
2. State of consciousness is spoor or obtundation (by Glasgow Coma Scale greater than 10).
3. Absence of evident clinical signs of dislocation of brain stem.
4. Volume of crushing focus or hematoma is less than 45 cm^3 for frontal, less than 30 cm^3 for temporal lobe.
5. Absence lateral (displacement up to 5 mm) and axial dislocation of brain.
6. Even presence of intracranial hematoma with diameter less than 4 cm.

Analysis of outcomes (within 1.5 months of observations) of treatment of patients with severe focal injuries of substance of brain showed a significant difference in effectiveness of treatment depending on its type. According to Table 7 it appears that outcomes in using conservative treatment were significantly better than in surgical therapy.

Table 7. *Outcomes of treatment of severe focal brain injuries (Glasgow Outcome Scale).*

Glasgow Outcome Scale	Operated	Not operated
Good recovery	21 (28.4%)	29 (55.8%)
Moderate disability	23 (31.1%)	15 (28.9%)
Rough disability	16 (21.6%)	5 (9.6%)
Vegetative state	3 (4.0%)	1 (1.9%)
Death	11 (14.9%)	2 (3.8%)

Thus, by comparing results of affected during surgical intervention and conservative management with using methods of intensive care, we found significant possibilities and effectiveness of conservative intervention in severe focal injuries of substance of brain with crushing and intracranial hematomas. Although they are always tempting for surgical intervention - in this case, there is usually dangerous and already not required traumatic substrate and which, of course, justifies surgical manipulation. However, surgical intervention sometimes does not eliminate inevitable disabling morphological effects, especially in case, where surgical intervention was performed in functionally important regions of the brain [4, 9, 10].

However, active surgical intervention often involves additional traumatization of brain, especially in case of complete resection of crushing foci. Proposed postulate - "removing focus of brain contusion within normal tissues" is wrong statement regarding brain injuries today. We think that mechanistic transferring principles of operation of pathological processes (inflammation, tumor or other) to neurotraumatology and neurosurgery is not justified [1, 2, 5].

All the more, according to literature of recent years and results of our own observations, it was found that, in traumatic focal contusion and hemorrhagic strokes, phenomena of apoptosis in brain cells are developed with formation of zones of penumbra. With adequate medical influence on these processes it can be prevent development of programmed death (apoptosis) of neurons and tissue processes in *trifocal* zones and partly in zone of contused brain cells may be recovered [7, 8].

As a result of improving tactics of treatment of severe focal brain contusion and intracranial hematomas, with their sizes not more than 35-40 mm, as well as with positive clinical and neurological dynamics, surgical intervention is not justified. We have experience of intensive drug treatment with systematic observation of patients for weeks and months. We have a number of successful cases of outcome of trauma without surgical therapy with almost complete resolution of not only small, but also medium-sized (45 mm in diameter) intracranial hematomas (Figure 1), confirmed by tomography and full resolution of their neurological disorders.

In our opinion, in certain cases, conservative treatment better promotes development of sanogenic mechanisms and compensatory abilities of injured brain, than surgical therapy. This is supported by data of neuroimaging studies in dynamics (Table 7).

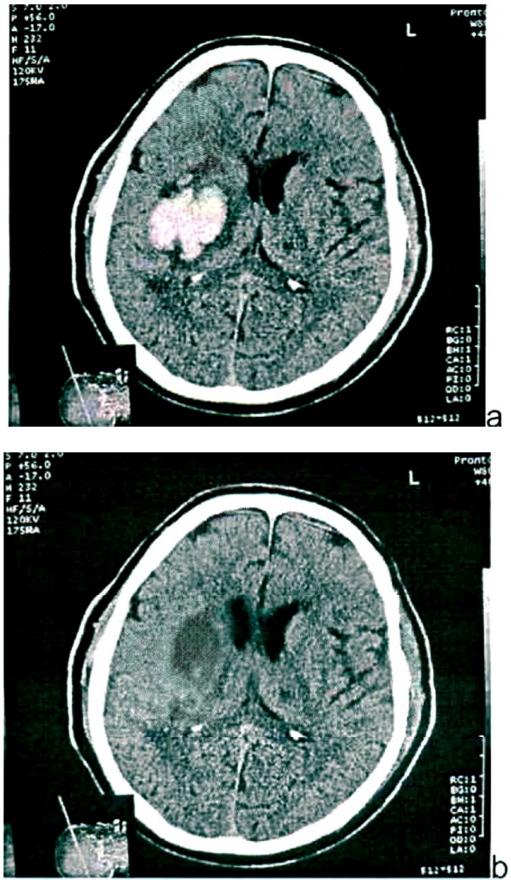

Figure 1. *CT of brain with focal injury after trauma (a) and after 21 days of treatment (b). Pictures with higher resolution (and the clearer ones)*

5. Conclusions

Thus, results of our observations justify an advisability of expanding indications for conservative management of patients with severe focal injuries of substance of brain, even in presence of intracranial hematomas, with size of no more than 45-50 cm, do not cause dislocation of brain stem midline structures.

Only by using CT and MRI, we may in vivo and clearly judge the combination of different components of brain injuries, presence, location and extent of contusion, hematomas and many other intracranial changes. Nature of these changes with taking into account dynamics of clinic in the future has an impact of choice of method of treatment and, finally, outcome of traumatic process.

Conflict of Interest

There are no conflicts of interest.

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