Analysis of structure and treatment results of injured patients with electric trauma

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Summary
The structure and results of electric trauma treatment in 502 patients were studied by authors. The obtained data testify about efficacy of active surgical tactics in this group of patients.
Key words: electric trauma, X-ray densitometry, necrectomy, osteonecrectomy, decompressive necro- fasciotomy, amputation and exarticulation, autodermoplasty

INTRODUCTION

Electric current attacks the organism of injured person through 2 pathogenic mechanisms: 1. reflectory influence through nerve system leading to blood circulation and breath disorders; 2. direct impact of thermic, electrochemical and electrodynamical factors. The first factor determines severity of general reaction to the organism, particularly it is the main factor in fetal outcome due to heart fibrillation, respiratory center paralysis, shock and laryngospasm; the second factor determines the deepness of local tissue reaction. [1,6,3].

The severity of electric trauma depends on physical parameters of electric current, physiological condition of organism and environment peculiarities. Electric current with low voltage (120-220 V.) is more dangerous than high voltage current causes more frequent heart fibrillation incidence. High air humidity encourages arch contact generated in voltage more than 1000 V. The last type of injure must be classified as termic but not electrical burn [3,4].

In our days electrical burns do not exceed 2-3% but they cause invalidity and in some cases death. So due to its significance electrical burns it takes one of the first places [6,2]. The purpose of this work is analysis of structure and results of treatment of patient injured from electric trauma.

MATERIALS AND METHODS

502 patients with electric trauma were hospitalized during the period from 2001 to 2012. The number of such patients remains high by our surveillance data (fig. 1).

Average age of injured patients was 17,5 ±16,2 years (from 6 months to 80 years). Male 367 (73,1%), female 135 (26,9%). The most frequently (42,8%) patients were in a working age from 19 to 60 years.

The majority of injured patients 284 (56,6%) were children and teenagers, the half part of them were in age of 6 month to 18 years (fig.2).

Early diagnosis of burn depth, difficulties of definition optimal terms of necrectomy and rational methods of plastic restoration of thermic injured areas were persons with osteonecrosis of the scull. There were 32 (6,4%) such patients. To estimate the depth of lesion X-ray densitometry was applied. It let to assess the level of mineralization in injured bone after burn trauma and define the grade of bone tissue regeneration after bone milling in early terms after trauma (2-3 weeks).

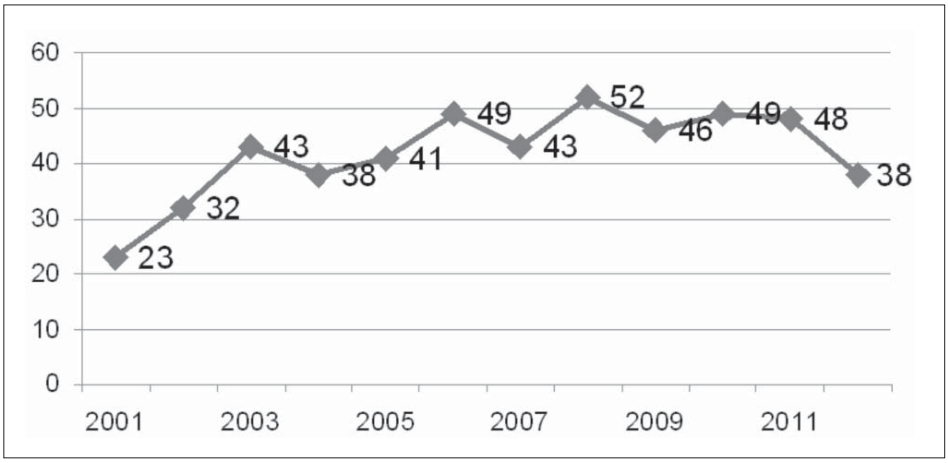


Fig. 1. The number of patients with electro thermal injury hospitalized to burns unit of RRCEM from 2001 to 2012

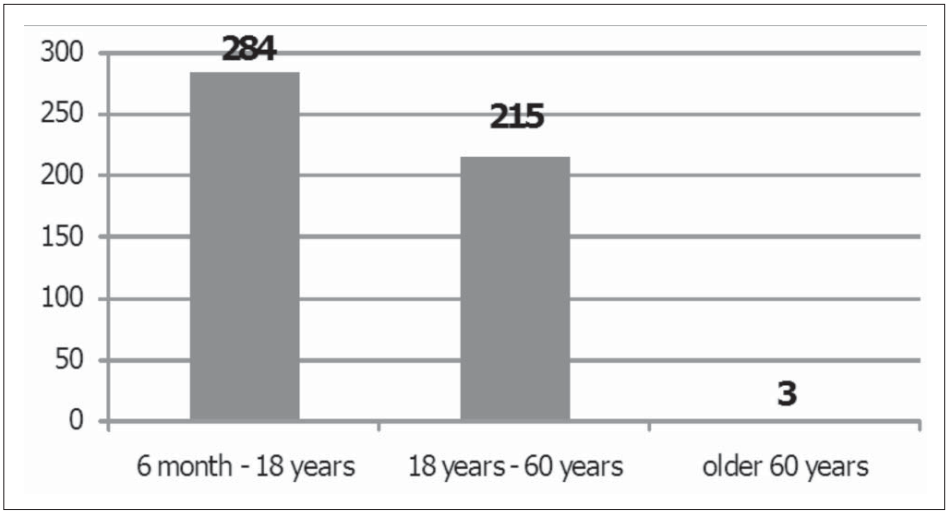


Fig. 2. Allocation of patients with electric trauma by age, %

RESULTS AND DISCUSSION

Electrothermic lesions were characterized with restricted area of burn. Only in 48 (9,6%) patients of this group total area of thermic injure exceeded 10% of body square, in 194 (38,6%) patients "current signs" had less 1% of body square, 126 (25,1%) patients had 1-3% of body square, 134 (26,7%) - 3-10% of body square (fig.3).

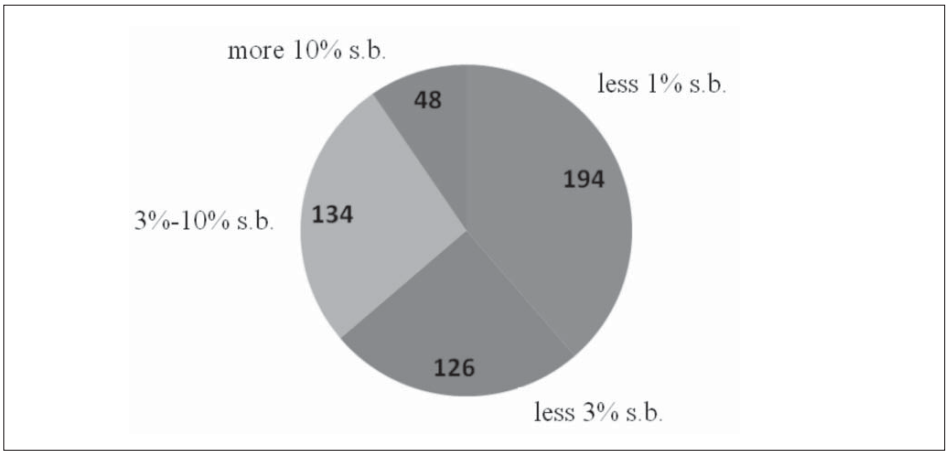
Totally operated 129 (25,7%) patients with deep and spread burns where we tried to keep active surgical tactics (Tab.1). In early terms after trauma necrectomy was performed in 116 (89,9%) patients, in 58 (44,9%) operated patients necrectomy was added with osteonecrectomy of fornix of scull bone, in 35 (27,1%) patients – with fasciotomy in first 6 – 12 hours after admittance to our center. In 5 patients after surgical treatment of burn wounds such temporary wound covers as "xenokoja" and "Foliderm" were applied. We had to perform amputation and exarticulation of extremities in 40 (31,1%) patients, in 4 (3,1%) patients interventions were done due to combined affection: 1 – laparotomy with hepatorrhaphy, 3 – initial surgical d-bridement of wound including bleeding vessel ligation in 1 case.

In all 129 patients after forming granulation tissue autodermoplasty was performed, in 1 patient this operation was completed with alloplasty, in 1 patient plasty by Borhin- Convers was done, in 1 patient stem by Filatov was created.

One of the most complicated type of electrothermal lesions is osteonecrosis of skull bone fornix. It was observed in 32 (6,4%) patients. In order to itemize the area for osteonecrectomy we performed roentgen - densitometry in several sites of burn wound and also in healthy bone structures of skull. Indexes of density are given in table 2.

Results of performed roentgen-densitometry investigations showed that in necrosis zone bone mineralization was absent, there we saw transformation into fibrose, cartilaginouse and bone tissue. Degree of bone tissue regeneration was also estimated after its stimulation with bone milling. In the zone of osteonecrosis the bone density was lower than standart (0,61 ± 0,04 conventional units) in 3 times (0,22 ± 0,03 conventional units). At the same time in the site where bone milling was performed these indexes were 0,43 ± 0,04 conventional units, i.e.

Fig. 3. Allocation of patients by area of electro thermic burn



Tab. 1. Types of surgical interventions in patients with electrical burns (n-109)

Initial interventions	abc, (%)
Necrectomy	116 (89,9)
Osteonecrectomy	58 (44,9)
Decompressive necro- fasciotomy	35 (27,1)
Xenoplasty	3 (3,2)
Covering with "Foliderm"	2 (1,5)
Amputation and exarticulation	40 (31,1)
Laparotomy	1 (0,7)
Initial surgical d-bridement of wound	3 (3,2)
Secondary interventions	**abc, (%)**
Autodermoplasty	129 (100,0)
Alloplasty	1 (0,7)
Plasty by Blokhin - Convers	1 (0,7)
Creating of stem by Filatov	1 (0,7)

Tab. 2. Roentgendebsitometrical indexes of skull bone density (conventional units)

Standart	Osteonecrosis site	Bone milling site
0,61 ± 0,04	0,22 ± 0,03	0,43 ± 0,04

they were higher than in osteonecrosis. This testified about regeneration process after drilling perforative apertures.

Bared necrotizing bone without periosteum is a bad basis for dermal transplants, so stimulation of granulation tissue creation above bone tissue is necessary. It is tradition to perform milling apertures with diameter 1,5 cm. in equal distance from each other to the bared bone in 2-3 steps. The depth of milling apertures depends on the spreadness of osteonecrosis. They are performed while capillary bleeding appears. Traditional approach to this category of injured patients requires surgical interventions to the bone surface to be done in 1 month after trauma in several steps. Then we had to wait natural spontaneous rejection of metaphysial osteonecrotic tissues and subsequent covering these sites with granulation tissue. In this tactics of surgical treatment the process of wound purification lasted several months.

We applied active surgical tactics which was the early radical osteonecrectomy depending on roentgen-densitometry results. Data of intervention area and depth of osteonecrectomy are given in table 3.

During operation thermic damage of external bone lamina was detected in 25 (78,1%) patients, total damage of bone lamina was revealed in 7 (21,9%) patients. No necrosis extension to the brain and its meninges were observed. In 23 patients (71,9%) limited (less then 1/3 of skull fornix square) lesion area of injured bone tissue occurred. That let us perform radical single-stage osteonecrectomy. In 6 (18,5%) patients area of osteonecrosis was estimated as extended occupying more then 1/3 of skull fornix square. Two- and more-stage operation was executed them. Only in 3 patients (9,4%) the area of lesion was insignificant.

In postoperative period none of patients with osteonecrosis of skull fornix had intracranial complications, perhaps, the reason is early operative intervention. We purpose that optimal term for osteonecrectomy on skull fornix is 2-3 weeks after thermic trauma. By that time demarcation line between 2 injured tissues becomes more distinct and no suppurative complication has time to develop.

To accelerated wound purification after osteonecrectomy we applied some technical tricks in management of these patients. If the wound area was less then 1/3 of skull fornix square we performed early single-stage osteonecrectomy of all surface of injured zone. Apertures were milled closer in the distance 0,5 - 1,0 cm from each other. In patients with vast osteonecrosis (more then 1/3 of skull fornix square) apertures milled to the difference depth of bone tissue in 2 steps. Bottom of milled apertures got to spongy substance of bone tissue when we had only lesion of external lamina. No further action endeavored. In case of total bone necrosis it was milled to pachymeninx.

In 1 week granulation tissue sprawled from milled apertures and gradually covered all bone. Non rejected by that time bone intersections, zones of totally injured bone structures between milling apertures and zones of totally injured bone structures were mechanically removed without any technical difficulties and significant bleeding. So accelerated preparation of wound surface for plastic defect covering was reached. Covering of defects formed after craniotomy and osteonecrectomy was performed with free autodermoplasty. Suggested method of early osteonecrectomy with application of roentgen densitometry investigations for estimation of temp of regeneration processes in osteonecrosis of skull bone fornix let us minimize terms of treatment in average for 1 – 1,5 months.

We would like to present clinical case demonstrating our approaches in management of patients with osteonecrosis of skull fornix bone.

Patient A. aged 9.5 years (case history ą 39082/1804) was hospitalized to our clinic 5.05.2003 with complaints to burn wounds of face, scalp, body, both of upper extremities, general weakness, pain in the area of wound.

Case history: 12 days before admittance he got burn due to high voltage electrical current. He was hospitalized to the reanimation department of 2nd Tashkent State medical Institute clinic where antishock therapy was applied. Taking into account the 4th grade burns of both upper extremities 25.05.2003 exarticulation of right humeral articulation and amputation at the level of upper third of left forearm were performed. Then this patient was transferred to our clinic.

General condition of child was poor. The patient was in conscious, skin and visible mucous membrane had light-rose color. Temperature was 36.9°C. Breathing was clear through nose. Breathing frequency – 20 in a minute.

Tab. 3. Allocation of patients with osteonecrosis of skull bone fornix depending on the depth, area of lesion and clinical picture

Character of electrothermic lesion of skull bone fornix	Number of patients	
	abs.	%
Depth of burn		
Damage of external bone lanima	25	78,1
Total damage of bone lamina	6	20,7
Area of lesion		
Insignificant (10-30 cm^2)	3	9,4
Limited (1/3 of skull fornix)	23	71,9
Extended (more than 1/3 of skull fornix)	6	18,5

Vesicular respiration was heard in lung auscultation. Heart sounds were muffled. Pulse rate was 110 in a minute, rhythmic, with satisfactory filling and tension. Blood pressure – 110/60 mm. Hg. Abdomen in palpation was soft, painless and movable in breathing act. Liver and the spleen were not enlarged.

On the face, scalp, front surface of neck there were burn wounds with undefined shape. Wounded surface located on the face and scalp was covered with solid necrotic black scab. On the parietal area there was 3 x 4 cm. bared bone with osteonecrosis signs. Sensitivity was absent. Soft tissues around this zone was edematous

Fig. 4. Patient A. The view of burn surface on the skull fornix (16th days after trauma)

Fig. 5. Patient A. Milling of apertures in 3 weeks

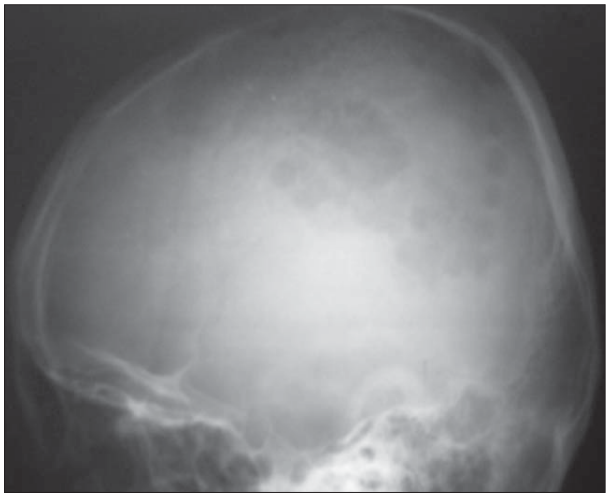


Fig. 6. Patient A. X-ray film, side projection, in 3 weeks after trauma – zone of skull bone destruction

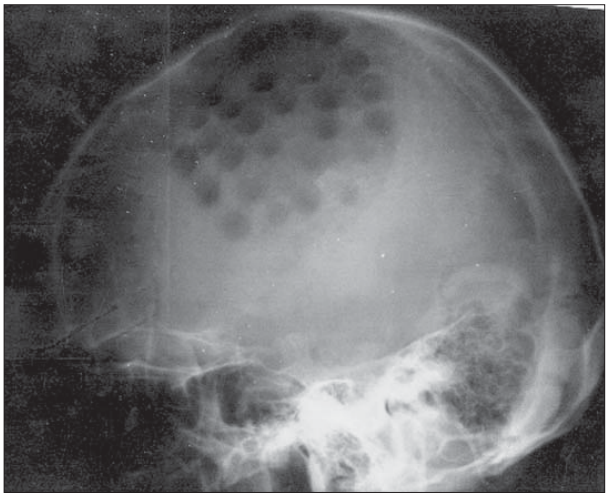


Fig. 7. X-ray film of skull after milling of multiple apertures

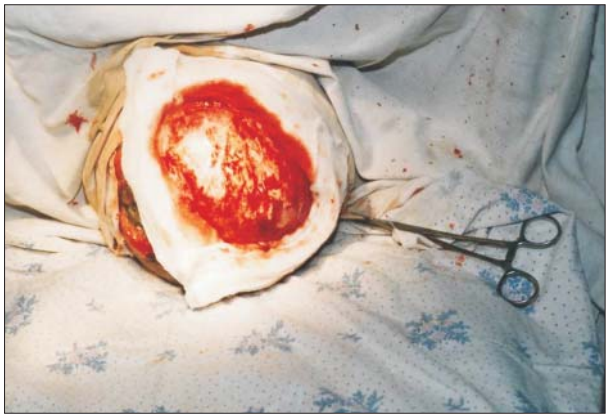


Fig. 8. Patient A. Covering of wound surface with granulation tissue

Fig. 9. Patient A. The view after autodermoplasty

and hyperemic. Postoperative stumps of both extremities were covered with granulations. Contact bleeding occurred.

Laboratory analysis: hemoglobin – 100 g/l, erythrocytes – 3.4 x 10^6, leukocytes – 9,2 x10^9, lymphocytes – 28%, erythrocyte sedimentation rate – 16 mm/h, general protein—56,8 g/l.

Patient was hospitalized to the reanimation department where he got complex treatment. On x-ray films of skull there were zones of destruction of forehead and parietal bones. Roentgen-densitometry showed decreasing of bone structure density. 21st and 29th of may 2003 craniotomy with milling of multiple apertures in frontal and parietal bones was performed (fig.4-6).

In postoperative period peripheral sections of wound surface were covered with granulation tissue. But in central sections total bone osteonecrosis was revealed (fig.7).

Roentgen-densitometry investigation showed absence of bone mineralization with decreasing of its density, that's why resection craniotomy of right parietal bone was performed. Then wound surface was covered with granulation tissue (fig.8).

14.06.2003 autodermoplasty with rifted autotransplant was executed. Engraftment was 100% (fig.9).

After performed complex treatment patient's condition considerably improved, clinical and laboratory indexes normalized. 25.06.2003 (51st day) patient in satisfactory state was discharged for ambulatory observation.

CONCLUSIONS

1. Electrothermic trauma which number of victims increases from year to year is often accompanied with deep lesion of soft tissues and bone structures.
2. Early operative intervention in osteonecrosis of skull fornix bones improves surgical treatment results and minimizes term of staying in hospital.
3. Method of roentgen-densitometry lets objectively estimate regeneration grade after active surgical treatment of osteonecrosis of skull fornix bones.

References/Piśmiennictwo:

1. *Alekseev A., Malutina Yu., Turnikov Yu. Active surgical treatment of deep burns in aged and senile patients // Annals of surgery.-2002.- p. 58-62.*
2. *Bakkali H., Ababou K., Bellamari H., Ennouhi A., Nassim sabah T., Achbouk A., Moussaoui A., Fouadi F.Z., Siah S., Ihrai H. La prise en charge des brulures electriques: a propos ge 30 cas //Ann. Burns Fire Dis. - 2009. - Vol.22. q1. - P. 33-36.*
3. *Buja Z, Arifi H, Hoxha E. Electrical burn injuries. An eight – year review //Ann. Burns Fire Dis. - 2010. - Vol.23, q1. - P. 4-7.*
4. *Fistal E., Lishenko E. Local tissue applied plasty of cover defects of skull fornix with bared bones // Trauma. – 2001. – v. 2. - p. 179-184.*
5. *Paramonov B., Porembskiy Ya., Yablonskiy V. Burns: Guidance. - SPb, 2000. - p. 64-65.*
6. *Zinatulin R., Funufin S., Treatment tactics of skull fornix bone in thermic burns//Collected scientific works of the 1st congress of combustiologists of Russia. M., 2005. - p. 164-165.*