Combined application of air- plasma flows and nitrogen oxide in the treatment of the gunshot wound

Clinical observations are based on the treatment of 834 injured, who entered military hospitals VVS and NCMD MO RF from different stages of the medical evacuation within the period of 1999-2001 yr. with the bullet and mine-explosive injuries of different localization.

Combined application of air- plasma flows (APF) and nitrogen oxide in the treatment of the gunshot wounds

Anatomical region of the injury	Number of injured		Group of the injured			
	abs.	%	APF + NO		NO	
			abs.	%	abs.	%
Head	34	4,1	-	-	34	4,1
Breast, the body	98	11,8	69	8,3	29	3,5
Upper extremities	158	18,9	108	12,9	50	6,0
Lower extremities	544	65,2	368	43,9	176	21,3
ALTOGETHER	834	100	545	65,1	289	34,9

There were isolated 2 clinical groups of injured, in treatment of which was used the apparatus "PLASON": The I group composed of 545 injured with the gunshot wounds of soft tissues and the osteomuscular wounds of different localization. Repeated surgical treatment of bullet wounds was conducted in the first twenty-four hours from the moment of arrival, including the revision of wound, to necrectomy, opening and the drainage of purulent flows and haematomas. In the final stage was carried out the working APF in the regime of the sparing coagulation with the required determination of the level of microbial seeding and sowing of microflora. After the fulfillment of the plastic stage of wound they processed by the nitrogen oxide in the therapeutic regime of the work of apparatus "PLASON" (5-7 sec. to 1 cm^2 of area) paravulnerable, through the vent lines or over the surface of transplant. The rapid calming of inflammatory phenomena in all cases was noted, decrease be ill in the wound, the primary healing of wounds and the adherence of skin transplants, which required on the average of 5-6 sessions.

THE II group composed of 289 injured with the extensive or plural injuries of soft tissues, requiring closing second seams or autoplasty. To all injured was carried out repeated simultaneous radical surgical treatment with carving of nonviable cloths and hyper-granulations. Wounds processed with APF in the regime of coagulation before the appearance of a coagulation film ("partial drying" of wound). It was noted, that after 2-3 workings the bacterial seeding of wounds considerably decreased, and the phase of dehydration set in earlier, which made it possible to reduce the periods of the healing of bullet wound, carrying out the stage of plastic closing within the earlier periods. Usually to 2-3 days after repeated plasma surgical treatment of bullet break and obtaining of the level of the bacterial seeding lower than critical - 10^{4-5} CFU/1g of cloth - was carried out closing wound by the application of the primary- deferred or early second seam. In the case of the presence of large wound surfaces and impossibility of closing the wound by seams was carried out one of the forms of dermautoplasty of wound defect to 3-5 days. The subsequent workings NO – CGF paravulnerable, on the vent lines or over the surface of transplant made it possible in 98% of cases to reach the healing of wounds according to the type of primary and in 100% of cases to avoid the rejection of transplants.

The damages of extremities occupied key place - 84,1%.

Structure of injured with the damages of the extremities

Nosologic group	Abs.	%
Mine-explosive injuries. Plural fragmentation injuries of soft tissues with the bullet breaks of upper and lower extremities.	247	35,2
Bullet breaks of the upper extremities	84	12,0
Bullet breaks of lower extremities.	106	15,1
Injuries of soft tissues of the upper extremities	61	8,7
Injuries of soft tissues of lower extremities.	59	8,4
Mine-explosive, bullet, open damages to brush.	145	20,6
In all.	702	100

With the treatment of the mine-explosive and bullet wounds of extremities with the massive pollution was used the combined procedure of action APF and nitrogen oxide. The daily application of an apparatus “PLASON” was combined with the local action of fermentation preparations (trypsin, chemotrypsin, “Iruksol”), and also with the massive antibacterial therapy. The phenomena of perifocal inflammation were descended through 5-6 sessions, swelling disappeared, changed the nature of exudate (instead of the purulent - serous), microbial seeding was reduced. The primarily deferred seams were superimposed on 3-5, early second - to 6-7 days, transferring the open bullet fracture of long tubular bones into that closed and creating thus conditions for the consolidation of break according to the type “of that closed”. Wounds healed to live according to the type of primary tension within the periods of the healing of clean wounds in 96% of cases. The complications in the form of partial festering observed in 4% of cases; however, they did not require repeated surgical treatment. The appearances of osteomyelitis was not noted.

Under the conditions for plural fragmentation injuries with the defect of soft tissues in connection with the scarcity of its own plastic material, the complexity of the cultivation of skin rags with the application of expanders in the reparative- regenerative phase was used the biostimulation action of apparatus “PLASON” - NOx- therapy. The treatment of wounds combined with the application of “Kuriozin”, the ointments of “Levomecoli”, “Aktovegin”, by the immunomodulation therapy. The accelerated epithelization was achieved predominantly due to the stimulation of an increase in the boundary epithelium.

Data of the clinical application of plasma flows and nitrogen oxide in the treatment of bullet wounds and their infectious complications make it possible to effectively solve the following problems of military field surgery:

*- to finally and reliably carry out hemostasis and to hermetically seal the wound surfaces of the bullet wounds of different localization with the diameter of the damaged vessels to 1,5 mm;
*- due to the rapidity of hemostasis to reduce the time of surgical treatments of bullet wounds, especially with the presence of large muscular massif and purulent complications;
*- to sharply reduce a quantity of purulent complications due to the sterilizing properties of plasma flow, and with their presence or appearance - to rapidly liquidate them;
*- within the early periods to shut bullet wound, superimposing the primary- deferred seams on 1,5±0,5 days after surgical treatment, early second seams to 4,5±0,5 days and to transfer purulent wound into the clean, and the infected bullet break - into the closed clean;
*- favorably to affect the reparative processes, the periods of the healing of wounds and possibility of conducting the early rehabilitation of injured;
*- this method of therapeutic action is accessible for its rapid mastering and application under the military field and extreme conditions.

The carried out estimation of military-economic effectiveness from the introduction of apparatus “PLASON” in the stages of the medical evacuation made it possible to make the following conclusions:

*- the flows of air plasma have the greatest effectiveness in conducting of hemostasis of bullet wound in the comparison with other methods;
*- the expenditures of supplies for conducting of surgical treatments of bullet wounds and fulfilling the reconstructive- reducing operations can be reduced to 20%;
*- is possible the decrease of the periods of the treatment of bullet wounds and their purulent-infectious complications into 1,6±0,2 times, and, therefore, also an increase in the capacity of the surgical subdivisions of the stages of the medical evacuation;
*- the application of air plasma flows and NO in the treatment of the bullet wounds of soft tissues, bullet breaks, injuries after mine-explosive damages and their purulent-infectious complications can be begun from the stage of rendering to the qualified surgical aid;
*- method is accessible for the military field surgeons and does not require prolonged special preparation.

Thus, the developed in the military field surgery new method, based on the combined action of air plasma and exogenous nitrogen oxide, is the highly effective and acceptable method of surgical treatment of wounds in the stages of the qualified and specialized surgical aid, and its application makes it possible to considerably improve the results of treating the bullet wounds of soft tissues, mine-explosive injuries and wounds with the purulent-infectious complications. This method is promising trend under the military field and extreme conditions, and also under the peacetime conditions.

(CFU- the colony-forming units)