

Aspects of application of plasma streams in treatment of the explosive wounds of finiteness

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Supported on the material, based on experience of 97 wounded with explosive extremities' wounds treatment, the authors recommend new methods of treatment based on application of plasma streams. More favorable current of the postoperative period, reduction of a degree of expressiveness inflammatory and septic complications and their frequencies more than on 20% prove the advantages of the given methods. The received results allow using plasma streams at surgical processing explosive wounds of extremities at all stages of rendering of the surgical help. The simplicity, reliability and significant reduction of time when processing by explosive wounds are an important particularity of the methods.

Key words: plasma streams, explosive wounds of extremities.

Introduction. The big practical importance in modern field surgery and medicine of accidents is represented by treatment of wounds of finitenesses. According to the literature of last decades in the general structure of fighting damages the quantity of wounded men in finiteness reached 55 - 70 %, and in the number of wars and regional military conflicts 75 - 80 % [2, 4, 7, 9, 13].

Among all kinds of fighting damages of finitenesses explosive wounds, which, in aggregate with fragmental wounds, reach 80 - 85 %, prevail. They are distinguished by their weight and are the typical sample of a polytrauma of wartime. These wounds differ special complexity and extensiveness of destructions of tissue structures, multiple fractures of bones, ruptures and bruises of soft tissues, separations of segments of finitenesses. Surgical processing of a modern explosive trauma is extremely complicated because of difficult configurations wounded channels and distension of the damaged tissue. All this defines high death rate and invalidization, special complexity and duration of a treatment [1, 3, 8, 11, 14].

As a result the search and working out of new medical technologies and possibilities of medical influence proceeds. Recently especially the plasma surgery, as one of priority directions of technical development of surgery starts to get great value. Plasma streams find application in field surgery and medicine of accidents at fire and explosive wounds of soft tissues, internals of an abdominal cavity, lungs, other internals and systems. Thus a problem of the prevention of development of complications is possible only at elimination of local damages of finitenesses by removal of the destroyed tissues in the course of primary surgical processing, a careful hemostasis, sterilization and wound hermetic sealing. The more spacious the destructions of tissues and heavier the

damaged bones, the more indications to early rendering of the surgical help which should be regarded as the urgent surgical help under vital indications [5, 6, 10, 12].

The purpose and research problems.

The Purpose of the given research was a determination of the possibility of the improvement result at treatment wounded with explosive defeats of the limbs when using plasma radiations. According to this purpose there were set next tasks:

1. To get the comparative estimation of the results of the clinical use-thread plasma streams under explosive wounds of finiteness's efficiency.

2. To establish the indications for plasma application at surgical processing of a wound, to define the optimum methods of their application and volume of operative interventions.

Material and methods. Since 1989 the use of plasma streams at treatment of the finitenesses wounded and amazed with explosive wounds was conducted by us. The help was rendered in the range of the early and urgent surgical help. Totally the 97 such victims were passed the treatment, among them the basic group was arranged from 50 victims whose complex treatment was spent with application of plasma streams. The control group was arranged from the rest 47 wounded men whose treatment was conducted similarly, but without plasma application. The signs of development of purulent-septic complications were observed 36 % of wounded men by the moment of the treatment's beginning and 7 % - developments anaerobic infections.

Operative intervention to all the victims was carried out, as a rule, at the day of the wounded man's receipt, and consisted in surgical processing of a wound. Choice operation at contact explosive wounds with a separation of a segment of finiteness was primary amputation. At insignificant damages of feet it was possible to be limited to primary surgical processing of a wound with a section both by cutting out impractical tissues and fasciotomy. At through wounds of finitenesses operation in volume primary, or secondary surgical processing was made from the party both entrance, and the day off of apertures of the wounded channel. At a difficult configuration of the wounded channel the additional cut for access to its central part where the volume of maximum damages was required.

Surgical processing of wounds started after proof stabilization of the wounded man's condition. The technique of plasma's application in a mode «coagulation» and «a plasma irradiation» was following: in parallel edge of the wounded surfaces imposed a damp sterile gauze napkin for the prevention of thermal defeat of edges of a wound high-temperature the returnable turbulent streams reflected from the wounded surface, gas embolism and for time decrease in intensity of a bleeding from a wound wall.

The corner of an inclination of a plasma stream in relation with a plane wounded made surfaces 30 - 45 degrees. Forward and circular movements lengthways of the wounded surfaces, on distance 5 - 15 mm, the processing wounded surfaces were conducted. After a section of soft tissues and removal free separated and necrotic detritus of a wounded surface processed a plasma stream under which influence the remained impractical fabrics and exudation instantly evaporated, there was a coagulation and a hemostasis on an influence course, the pellicle was formed coagulated.

Plasma streams were used and at the further bandagings for removal of impractical tissues, for hemostasis and sterilisation of wounded surfaces.

Following operating modes were used:

«coagulation» - for stopping the diffusive bleedings from a file of the damaged muscles and a full hemostasis from vessels in the sizes to 1,5 - 2 mm in diameter;

«a plasma irradiation» - for bactericidal processing of wounded channel ozone and ultra-violet software components;

«destruction» - for removal necrosis tissue.

In a mode of «destruction » the temperature of a plasma stream was 6000⁰ C - 13000⁰ C, length of a plasma stream 10 - 17 mm, diameter - from 1 to 1,5 mm. In a mode «coagulation» the temperature of a plasma stream was 2500⁰C - 4000⁰C, length of a plasma stream 8 - 14 mm, diameter - from 1,5 to 2 mm. Vessels more than 2 mm in diameter were necessarily in addition stitched. In a mode of «a plasma irradiation» the temperature was 40⁰C - 60⁰C, at the expense of distance increase between a plasma torch and a wounded surface to 2 - 5 sm.

The peculiarity of the method of plasma application in skilled group was consisted in the following:

The skin section was made by a steel scalpel through a wound, and at perforating wounds - from entrance and target apertures. Hypodermic fatty tissue was dissected by plasma in a mode of «section» during 1,5 - 2,5 minutes, and thus the effect of a definitive hemostasis from dissected tissues was reached.

The wide section aponeurosis, with additional cross-sections in the field of wound corners was conducted. During this moment plasma was applied with the bactericidal purpose in a mode of «a plasma irradiation» on a course of muscular tissues during 1,5 - 2 minutes.

A level-by-level section impractical muscle with the necrotic tissue was conducted in all cases. All revealed alien bodies, bone fragments etc. left. Separate remained necrotic tissue evaporated in a mode of «destruction». The definitive hemostasis was provided in a mode of «coagulation» during 2 - 3 minutes.

Fragments of the damaged bone were not processed, except for the sharp ends, capable to cause secondary injury of tissues . With the haemostatic and bactericidal purpose of edge bone fragments were processed by plasma in a mode of «coagulation» during 2 - 3 minutes. The rare stitches were put in to muscles. Plasma was used at this stage in a mode of «a plasma irradiation» purpose, during 2 - 3 minutes.

Results and discussion. When applying «a plasma irradiation» with the drying and bactericidal the treatment's complex by streams of plasma, wounded men were marked by the following features of a current wound processes. In the first two days after surgical processing the majority of patients was marked by subjective improvement of health state, reduction of pain intensity in the field of a postoperative wound because of anaesthetizing action of plasma on an operational wound's surface.

During three - five days the condition of victims of the basic group the tendency to temperature normalization improved progressively, defined - average indexes 37,9⁰ ± 1,1⁰ C (in control group 38,3⁰ ± 1,1⁰), authentically decreased indicators of leukocytosis in peripheral blood to 9,9 ± 1,2 * 10⁹/l (in control group 10,7 ± 1,3 * 10⁹/l), leukocytes an index of an intoxication (LII) to 2,9 ± 0,5 (in control group 3,4 ± 0,4).

On the fifth - the seventh days after operation the condition of 65 % of patients from the basic group was estimated as rather satisfactory (in control group - 40 %), LII progressively decreased to level 2,4 ± 0,4 (in control group to 2,7 ± 0,2), indicators

leukocytes - $8,9 \pm 1,4 * 10^9/l$ (in control group $9,7 \pm 1,3 * 10^9/l$) improved. Edges of wounds kept moderate puffiness, on a bottom and walls granulations started to appear. The average level microbes infection wounds in the basic group during this period was much less, than in control group, thus in 15 % of cases absence of microorganisms' growth was marked. Indicators of a body temperature of wounded men from the first group within these days were within $37,6^0 \pm 0,3^0$ C, in control group - $37,9^0 \pm 0,4^0$ C.

In 7 - 10 days the condition of the majority of wounded men from the basic group (to 85 %) was estimated as rather satisfactory, there was a further decrease in indicators LII (on the average to $2,1 \pm 0,3$) and leukocytosis ($7,4 \pm 0,2 * 10^9/l$). Also decreased seepage of fabrics, edges of wounds were condensed, development signs of epithelium from edges of wounds were visually defined. Fluctuations of temperature within these days were marked in borders $37,2^0 \pm 0,2^0$ C. In control groups during this period rather satisfactory condition was marked at 60 % of wounded men, indicators LII were within $2,4 \pm 0,2$. The quantity of leukocytes in blood was marked at level $8,4 \pm 0,3 * 10^9/l$.

By the end of the second week in the basic group against a satisfactory general condition at more than at 90 % of wounded men, the noted painful reaction in wounds, and the body temperature was marked within norm. Indicators of peripheral blood and LII in these terms were normalized more than at 80 % of wounded men. At bacteriological contamination research microbe's infection was much less, than in control group. During this period at 75 % of patients were removed stitches from the taking in wounds, healing of wounds of soft tissues they had occurred without complications. In the control group the normal indicators of peripheral blood and LII were marked only at 65 % of wounded men.

Conclusions. We establish, that the use of plasma radiation allows to carry out qualitative preventive maintenance of a surgical infection, strongly pressurize the wound surface, to conduct the reliable and definitive hemostasis from vessels up to 1,5 - 2 mm in diameter that has especially value at explosive wounds. In the surgery field at the primary and secondary surgical processing plasma application is shown at all stages of medical aid rendering, especially at stages of early rendering and urgent surgical help. Processing of wounded surfaces is recommended at all stages in modes of «destruction», «coagulation» and «a plasma irradiation», except for plasma processing of large blood vessels (more than 2 mm).

The analysis of the received data testifies that the use of plasma in the course of treatment of explosive finitenesses wounds was promoted the improvement of results of wounded men treatment and has favorably affected to the treatment outcomes. Application of plasma's streams at the given kinds of wounds allows the solving the following problems effectively:

- 1) More favorable current of the postoperative period, reduction of degree of expressiveness of postoperative pains and earlier restoration of function of finitenesses;
- 2) Reduction of terms of wounded men' treatment on the average on 15 - 25 % and reduction of frequency and degree of pyoinflammatory's expressiveness and septic complications more than on 20 %.
- 3) The preventive maintenance of a surgical infection of bullet wounds and decrease in quantity of purulent complications on 30 - 35 %;
- 4) A reliable and definitive hemostasis on a course of operative intervention from vessels to 1,5 - 2 mm in diameter;

5) Reduction of operative interventions time at gunshot wounds of finitenesses on the average on 20 % and increase in throughput of surgical stages.

The simplicity, reliability and considerable reduction of explosive wounds processing time allow to recommend the application of the given method in the surgery field when, in the deadlines, dictated by military conditions, it is necessary to render the surgical help as much as possible to a greater number of wounded men and victims. Plasma application is shown at all stages of the medical aid rendering at wounds of finitenesses, especially at stages of early rendering and urgent surgical help.

**პლაზმის სხივების გამოყენება ნაღმის აფეთქებით
გამოწვეული კიდურების ჭრილობების დროს
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რეზიუმე:

ნაღმის აფეთქებით გამოწვეული კიდურების დაზიანების დროს მოწოდებულია პლაზმის სხივების გამოყენებაზე დაფუძნებული თერაპიის მეთოდი...ამგვარი მკურნალობის უპირატესობას ადასტურებს ჩირქოვან-ანთებითი და სექტიკური გართულებების სიხშირის 20%-ზე მეტად შემცირება და ოპერაციის შემდგომი პერიოდის მიმდინარეობის გაუმჯობესება. მნიშვნელოვან თავისებურებად უნდა ჩაითვალოს აგრეთვე ამ მეთოდის სიმარტივე, საიმედოობა და ჭრილობის ქირურგიული დამუშავების დროის შემცირება. ეს კვლევა იძლევა საშუალებას პლაზმის სხივები გამოყენებულ იქნას კიდურების ნაღმის აფეთქებით დაზიანების დროს მკურნალობის ყველა ეტაპზე.

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