

The NOx-containing gas flows in the treatment of the ulceronecrotic defeats of feet in the patients with diabetes mellitus

Syndrome of diabetic foot (SDF) - one of the most common complications of diabetes mellitus, which is developed approximately in 15% of patients with this illness.

At present it is reliably known that under the conditions of prolonged hyperglycemia is developed the entire cascade of the metabolic disturbances, whose totality specifies the significant oppression of the production of the endogenous oxide of nitrogen. Scarcity endogenous NOx in the patients with diabetes mellitus causes the disorders of the neuroregulatory influence of somatical and autonomous nervous systems (diabetic neuropathy) and disturbance of microcirculatory functions. The totality of these factors contributes to the appearance of the ulcerous defects of feet, and the connection of second infection leads to the development of purulent complications and synchronization of process.

Studies on the study of the possibility of using the NOx-containing gas flows (NOx-CGF) for the local treatment of the ulceronecrotic defeats of feet in the patients with diabetes mellitus were carried out in the clinic of the endocrinology MMA of I. M. Sechenov (director – academician of RAMN, Prof. I. I. Dedov) together with the colleagues of scientific research center. NOx-CGF are used in 44 of patients with diabetes mellitus 1 (11 patients - 25%) and 2 (33 patients - 75%) types with various forms SDF, of them 25 men and 19 women at the age from 22 to 74 years (middle age - $55,6 \pm 4,4$ of years). In the investigated group of sick 39 patients (88,6%) had neuropathic form of SDF with the typical localization of ulcerous defects on the sole surface and in the distal divisions of the ungual phalanx of the I toe, in the region the projections of the head of the I mesopodial bone, on the sole surface of heel, in the interdigital spaces. Predominated the ulcerous defects of the I and II degree with a diameter of ulcers from 0,5 to 1,0 cm. At 4 patients (11%) there were deep (III degree) ulcers after the opening of phlegmons. The duration of existence of ulcerous defects in all patients - is more than two months in the absence of the effectiveness of the previous therapy.

Neuropathic ulcer of the typical localisation



Before healing

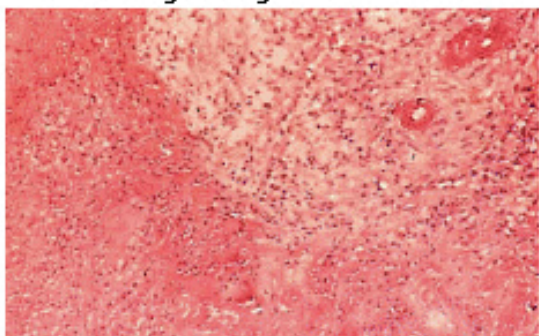


**After 8 days
(6 sessions of NOx Therapy)**

As the generator NOx-CGF is used the apparatus "PLASON". Daily the surface of ulcerous defect and the adjacent cloths blew out NOx-CGF with average exposure 90 it flogged, distance from the nozzle of manipulator to the surface of action - 1-2 cm. The course of treatment on the average composed 15 sessions. The local treatment of ulcerous defects compulsorily carried out against the background the normalizations of hyperglycemia, from the indications general antibiotic therapy was assigned by the preparations of wide spectrum, as far as possible they provided unloading the struck extremity.

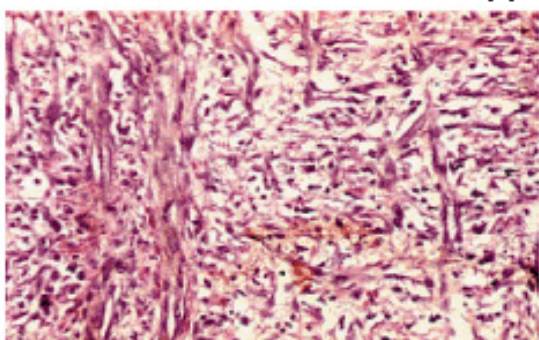
The results of a study were evaluated on the basis dynamic observation of the dimensions of ulcerous defect (every 5 days with the aid of the millimeter film of Opsite), was evaluated its degree according to Wagner, were considered the periods of the suppression of inflammatory reaction (hyperemia and edema of the surrounding cloths, painful syndrome), forming of granulating cloth and filling with it of ulcerous defect, appearance of boundary epithelization, complete healing of ulcer. For evaluating the flow of wound process were conducted the pathomorphological analyses of biopstat of the cloths of wound (prior to the beginning of treatment, also, through 7-14 sessions of NOx-therapy) and a cytological study of smear impressions from the ulcerous surface in the dynamics.

Biopstat of neuroischemic ulcer prior to the beginning of the treatment



The expressed necrotic changes in the cloths the predominance of inflammatory manifestations and significant microcirculatory disturbances. Staining with hematoxylin and eosin. Mag. x 150

Biopstat of neuroischemic ulcer after ten sessions of NOx-therapy



The activation of macrophage reaction, the proliferation of fibroblasts and an increase in the newly formed vessels with sharpening of the granulating cloth. Staining with hematoxylin and eosin. Mag. x 150

Already from the first sessions the decrease of inflammatory manifestations distinctly was noted, the expressed reduction in the intensity be ill, was activated the purification of the surface of ulcerous defect. The beginning of the forming of granulations on the average was fallen to the 4th day from the beginning of therapy. The boundary epithelization (expansion of epithelial rim from it was boundary wound on the average on 1-1,5 mm of every 3-4 days) noticeably was accelerated. The expressed positive dynamics was observed after 10 sessions in all patients: the sizes of ulcerous defects were reduced to 1/3 - 1/4 from the initial value. At 5 patients with the ulcers (with an initial diameter of 0,5-0,8 cm) small according to the size total epithelization began through 6-8 sessions of NOx-therapy. The reduction of the I phase of wound process on the average on 3-4 days was noted, The II phases - on 4-5 days. As a result the periods of stationary treatment and clinical recovery of patients noticeably were shortened. In the process of treating any side effects from the application of NO-CGF it was not observed.

A cytological study of exudate from the ulcerous surface showed that after only several sessions of NOx-therapy is reduced the microbial seeding, the phagocytosis of bacteria and detrite is strengthened, the content of macrophages with the decrease of the percentage of the dystrophically changed neutrophils increases. The number of fibroblasts increased through 7-14 sessions. The histological study of biopstat in these periods testified about significant reduction in the signs of microcirculatory disturbances, necrotic and inflammatory manifestations, macrophage reaction was strengthened, then - proliferation of fibroblasts and neo-vascularization, increase in the granulating cloth, boundary epithelization and cicatrization of defect.

Subsequently these studies were continued in the department of the faculty surgery of the 2nd therapeutic department MMA of I. M. Sechenov on the base City Hospital №61. It should be noted that into the departments of purulent surgery they will hospitalize patients with the heaviest forms of SDF: by deep and extensive trophic ulcers with the predominance of necrotic component, the extended purulent inflammation with the involvement of tendons and bones (osteomyelitis), the acrogangrenous defeats of finger and etc. The like gravity of local process is define by exampled from one side by undercompensation for hyperglycemia, with another - by the deep defeats of main arteries (atherosclerosis) and veins (varicose disease), that cause significant trophic disturbances.

In this investigation the NOx-containing gas flows are used for the treatment of 41 patients with different pyonecrotic complications of SDF.

Forms of the defeat of lower extremities in patients with SDF

	Trophic ulcers		Pyoinflammatory processes		Moist gangrene of the finger		Moist gangrene of the foot	
	Abs.	%%	Abs.	%%	Abs.	%%	Abs.	%%
Man	10	83	8	67	3	43	4	60
Women	10	83	8	67	3	43	4	40
Summary	12	29,3%	12	29,3%	7	17,1%	10	24,3%

Duration of pathologic local process from the beginning of development to the entering into the clinic - from several days with the pyoinflammatory pathology and the necrotic changes to 1 months with the ulcerous defeat.

The procedure of local treatment was determined by the nature of the existing defeats:

- with the presence of the ulcerous defects, not complicated by the extended purulent inflammation, their surface finished NO-CGF in the regime of NOx-therapy with the subsequent use of biological bandages with respect to the stage of wound process;
- in patients with the pyoinflammatory defeats was produced the opening of ulcer and flows with the subsequent working NOx-CGF by the application of dressings;
- in patients with the necrotic defeats, by which it was required only necrectomy, NOx-CGF used after its fulfillment as in the cases enumerated above;
- if the patient had himself indications for the radical surgical treatment, NOx-CGF used both for the preoperation preparation and in the postoperative period for the stimulation of the healing of wounds.

The deep ulcer of sole after hiding of phlegmon and flow into the region of medial malleolus



Before NOx-therapy



After 2 week treatment (10 sessions of NOx/therapy)



After 1 and a half month treatment (2 courses of NOx/therapy with 10 session)

The procedure of NOx-therapy is analogous described above, difference consisted only in the duration of course (on the average of 20 sessions). In connection with the expressed gravity of local process and its depth in a number of cases were carried out repeated courses on 10-15 sessions with the interruptions during 7-10 days.

The use of an NOx-therapy with the ulcerous and pyoinflammatory forms of SDF led to the fact that perifocal inflammation and edema of cloths around the ulcerous defect already after the first sessions noticeably decrease. Especially clearly this was expressed in the group of patients with the pyoinflammatory complications of diabetic foot. With the ulceronecrotic defeats approximately to 7 days from the beginning of treatment they observed the purification of ulcerous surface from the pyonecrotic impositions and the decrease of purulent discharge. To 14 days from the beginning of treatment in 50% of patients the surface of ulcer was carried out by bright granulations and was noted the expressed boundary epithelization. To the completion of the course of treatment - to 18- 21 days in 67% of patients is noted the total epithelization of ulcerous defects, in rest - decrease of sizes of ulcer to 75-80% of the initial level.

With the necrotic defeats of finger and soft tissues of foot in 9 cases of 17 (52,9%) the nature of defeat and gravity of the state of patients made it necessary to resort to the amputation of lower extremity at the level of thigh. In 23,5% of patients against the background for the therapy by the nitrogen oxide it was possible to limit only to amputation of finger or to carry out "economical" the amputation of feet with the subsequent satisfactory healing of postoperative wound.

Distribution of patients with the necrotic defeats by the volume of operational interference

	Distal amputation of the foot	Amputation finger	Amputation of the thigh
Amputation of the thigh	1	2	6
Women	-	1	3

In 23% more of patients with pyonecrotic defeats complex therapy made it possible to reach the stabilization of process without operational interference.

Thus, taking into account the key role of the scarcity of the nitrogen oxide in the disturbances of nervous and vascular trophicity, and also indirected by this the oppression of cellular proliferation, the distortion of morphogenesis and the torpid flow of reparative regeneration, that determine the development of the syndrome of diabetic foot, the method of exogenous NOx-therapy with the use of an apparatus "PLASON" is pathogenetically substantiated. The made observations make it possible to optimistically estimate its clinical significance.

**The extensive pyo-necrotic ulcer of the foot
(Neuroischemic form of SDF)**



Before the treatment

**After 4 and half months
of conservative treatment
(3 courses of NOx-therapy
with 12 sessions)**