

# **Ozone-oxygen therapy in maxillo-facial bone surgery.**

Malanchuk V.A., Kopchak A.V.

Department of Oral and Maxillo-Facial Surgery, National Medical University,  
Zoologichna 1, Kiev, Ukraine

## **Abstract**

The aim of the study was to estimate the clinical efficiency of the ozone-oxygen therapy in patients who underwent the maxillofacial bone reconstructive operations. For this purpose 75 patients with mandible(9) and maxillary deformations(12), jaw fractures(35), defects(3) and posttraumatical deformations(6) of facial bones were studied. Different types of osteotomy, with intraoral approach mainly, followed by distraction were performed. Ozone therapy, that included rinsing of oral cavity by ozonated water and intravenous injections of ozonated saline (200-400ml with ozone concentration 1-1,5 mg/l), was used in postoperative period. Immunological studies showed the immune system suppression preoperatively in all groups of patients, especially as to the T-system ( $p<0,01$ ) and local protective factors in saliva ( $p<0,05$ ) in compare to control group of healthy persons. Immunosuppression accompanied by activation of oral microflora increased the risk of complications development. After ozone application we observed the increase in immunological indexes as well as the improving of oral hygiene. The biochemical studies of the lipid peroxydation indicated the mild compensatory activation of antioxidant system. At the same time the level of peroxydation products in saliva and blood did not increase. That proves the absence of toxical effect of ozone in proposed concentrations. The acceleration of clinical signs dynamics was also observed. The received results show that ozone therapy enables to improve the postoperative period flow and to diminish the risk of complication development in facial bone surgery.

## **Introduction**

The last decades were marked by the development and wide clinical application of the new methods of bone reconstruction and plastic operations on maxillo-facial area. This trend includes the wide range of different surgical interventions for posttraumatic and postoperative deformities, bone grafting, ortognatic surgery, distractive osteogenesis. In present the numerous operations for eliminating of defect and deformities of different genesis, that were unyielded to correction in the past are performed by maxillo-facial surgeons in cooperation with specialists of closely-related surgical disciplines (5). Such operations on facial bones, as usual, are connected with considerable traumatization, and progressive hypoxia either local or general. The proximity to the infected oral cavity, nasopharings and paranasal sinuses, that are characterized by great bacterial contamination, as well as worsening of oral hygiene caused by the surgical intervention, create the suitable conditions for the penetrations of microorganisms into the operation area. The development of

infectious complications, delay or qualitative changes in consolidation process and necrotizing of bone and soft tissues in the operation area cause the unsatisfactory functional and esthetic results of treatment. In this connection the role of postoperative treatment aimed to create the optimal conditions for regeneration and to prevent the development of complications is very important (5).

We consider that the application of ozone therapy coupled with other pharmaceutical means could be expedient for optimization of postoperative period flow in patients who underwent the operations on facial bones.

The first reports on the ozone usage in medicine dated from the beginning of 20-th century when Wolf had successfully used ozone in treatment of suppurative wounds (10). In subsequent years the new investigations concerning the mechanisms of ozone's biological action were carried out. It made possible to spread the indications of the method on the diverse number of different diseases (2).

It was proved, that ozone had an influence on the oxygen metabolism, rheological properties of blood, antioxydative balance and immune system (1,6). Biological effects of ozone are determined by ozone-induced enzymes activation and expression of active biological substances - some interleukines in particular (2, 9). Ozone was successfully used in stomatology in the form of intraoral irrigations with ozonated water (7,4). The possibility of improving the oral hygiene and decrease in inflammation activity in oral mucous was proved (3). The last data also give an evidence of the positive influence of ozone therapy on the bone metabolism and the improvement of reparative processes in bones by ozone usage (8). Such are the main prerequisites for the use of ozone therapy in maxillo-facial surgery in cases of bone plastics and bone reconstructive operations.

The aim of the present study was to estimate the clinical efficacy of ozone therapy in complex treatment of patients, operated for facial-bone pathology.

### **Materials and methods**

75 patients who underwent the bone plastic and bone reconstructive operations on facial bones during the period of 1996 - 2000 years were put under the observation. Among them 9 were operated for mandible micro and macrogenia, in 12 patients the high osteotomies for maxillary malformations after uranostaphyloplasties were performed followed by antetransposition or distraction. In 5 patients the distractive osteogenesis was used for elimination of posttraumatic defects of the mandible. 6 patients were operated for the posttraumatic deformities of the mandible and zygomatico-orbital complex. 35 patients were treated for mandible fractures.

In all patients the local ozone therapy was used in the form of oral rinsing and irrigation with ozonated distillate water with (ozone concentration of 0,1 - 0,3 mg/l). If the significant dysfunction of immune system or the accompanied pathology was found in patients as well as if the operation was highly traumatic, the intravenous infusions of ozonated saline twice a week

were indicated, starting from the 3-d day after operation. In early postoperative period the intravenous ozone therapy was not use taking into consideration the thrombolytic effect of the low ozone concentrations. During each procedure of intravenous ozone therapy 400 ml of ozonated saline (ozone concentration was 1-1,5 mg/l) was infused. In cases when the marked postoperative oedema and in wide soft tissues exfoliation during the operation from 1 to 3 procedures of subcutaneous ozone-oxygen injections with ozone concentration of 3 mg/l were indicated.

On the 1-st day after hospitalization all patients were examined according to the standard protocol including anamnesis, clinical estimation of general and local status, radiological and laboratory investigations. The oral hygiene was evaluated using the Silness-Loe index, the intensity of gingival and periodontal inflammation - using PMA index. The dynamic of pain syndrome and postoperative oedema was studied during the whole period of treatment.

The complex study of immune and antioxidant system was carried out in all patients preoperatively. The estimation of immune indexes included, the definition of absolute and relative number of T and B cells, regulatory subpopulations of T-lymphocytes, serum immunoglobulins concentrations and circulate immune complexes level. The longitudinal study of immune system with an aim to find out the ozone's effect on the immune homeostasis was performed only in patients with the mandible fractures, that formed comparatively uniform and numerous group. The results obtained in this group were compared of 36 patients with mandible fractures treated according to standard protocol, without ozone therapy application. The asset of local immune status was performed, on the bases of immunoglobulins level definition in terms of 1, 3, 5, 7 days after operation. For the analysis the samples of non-stimulated oral liquid were taken an hour after the first meal, with a preliminary hygienic rinsing of oral cavity with distill water. In 1-st and 7-th day terms the content of malon dialdehyd (MDA), that is the final product of lipid peroxidation, and general antioxidant activity (AOA) in blood and saliva of the patients were defined. Control group consisted of 35 healthy volunteers. The differences between groups were estimated statistically using Student's T - criterion.

## Results

Immunological study showed the dysfunction of immune homeostasis of different degree, noted in all patients. They were as a rule connected with the cell immunity disturbances. Their degree depended on general health of the patient, the main disease type, the number of primary operations and the immune correction in preoperative period.

In patients with mandible fractures the dynamics of immunological indexes reflected the posttraumatic immune depression, and was similar in the majority of patients. In those who did not received ozone therapy the decrease in T-cells number and depression of T-helpers in early terms after trauma (up to 7-th day) was noted. The dysfunction of humoral immunity were matched to a small degree. The significant increase in circulating immune complexes was noted in blood plasma of the patients (Tab. I).

In all patients the significant changes of the local immune resistance were observed. From the 1-st day after operation the significant depression of SIgA level was noted. This index grew progressively worse and reached its minimum to the 3-d day, in later terms it increased but even at 7-th day term it was significantly lower than in control group (Tab. II). The serum IgA and IgG levels in saliva were significantly higher than in control group (IgG in saliva of healthy volunteers was defined in track concentrations). Serum IgM was not revealed in any observation of control group, and in the majority of patient post operatively. Therefore it was not taken in to account in further analysis.

Table I

The immune indexes of the patients with mandible fractures.  
(M $\pm$ m)

Index	Patients, treated with the use of ozone		Patients, treated according to the standard protocol		Control group
	1 day after hospitalization	7 day after hospitalization	1 day after hospitalization	7 day after hospitalization	
leucocytes	6,84 $\pm$ 0,3	5,06 $\pm$ 0,2	7,25 $\pm$ 0,25	5,1 $\pm$ 0,2	5,64 $\pm$ 0,28
limfocytes %	25 $\pm$ 1	28,6 $\pm$ 0,9	25,8 $\pm$ 1,3	35 $\pm$ 0,55	37,11 $\pm$ 1,2
limfocytes	1,67 $\pm$ 0,05	1,39 $\pm$ 0,06	1,57 $\pm$ 0,02	1,8 $\pm$ 0,1	1,95 $\pm$ 0,09
T-cells, %	32,6 $\pm$ 1,1	34,6 $\pm$ 1,5	33,7 $\pm$ 0,5	40 $\pm$ 1	41,18 $\pm$ 1,2
T-cells, mcl	0,55 $\pm$ 0,03	0,46 $\pm$ 0,1	0,58 $\pm$ 0,02	0,8 $\pm$ 0,05	0,58 $\pm$ 0,04
T-helpers, %	19,1 $\pm$ 0,96	23,4 $\pm$ 1,2	22 $\pm$ 1,2	26 $\pm$ 0,9	16,76 $\pm$ 0,6
T-helpers, mcl	0,3 $\pm$ 0,02	0,31 $\pm$ 0,01	0,37 $\pm$ 0,05	0,5 $\pm$ 0,04	0,33 $\pm$ 0,02
T-supressors, %	13,4 $\pm$ 0,73	11,18 $\pm$ 0,42	14,3 $\pm$ 0,5	13,1 $\pm$ 0,3	12,51 $\pm$ 0,6
T-sup., mcl	0,22 $\pm$ 0,02	0,15 $\pm$ 0,005	0,24 $\pm$ 0,02	0,2 $\pm$ 0,08	0,24 $\pm$ 0,01
Th/Ts	1,68 $\pm$ 0,11	2,13 $\pm$ 0,06	1,68 $\pm$ 0,08	2,06 $\pm$ 0,7	1,34 $\pm$ 0,67
B-cells, %	18,66 $\pm$ 0,26	18,09 $\pm$ 0,49	18,2 $\pm$ 0,2	19,5 $\pm$ 0,2	17,54 $\pm$ 0,5
B-cells, mcl	0,31 $\pm$ 0,09	0,26 $\pm$ 0,08	0,34 $\pm$ 0,1	0,39 $\pm$ 0,13	0,3 $\pm$ 0,01
CIC, kD	0,64 $\pm$ 0,03	0,67 $\pm$ 0,05	0,58 $\pm$ 0,3	0,3 $\pm$ 0,01	0,44 $\pm$ 0,03
IgG, g/l	10,38 $\pm$ 0,56	12,39 $\pm$ 0,51	10 $\pm$ 0,1	13,6 $\pm$ 0,3	11,99 $\pm$ 0,4
IgA, g/l	1,59 $\pm$ 0,1	1,5 $\pm$ 0,05	1,57 $\pm$ 0,04	1,65 $\pm$ 0,03	1,96 $\pm$ 0,07
IgM, g/l	1,3 $\pm$ 0,1	1,13 $\pm$ 0,05	1,39 $\pm$ 0,1	1,1 $\pm$ 0,05	0,9 $\pm$ 0,05

The estimation of the oral hygiene, gingival and periodontal state showed the significant worsening of hygiene indexes (the mean value of Loe-Silness index was 1,76 $\pm$ 0,19). On this background the hyperemia and oedema of gingival papilla and margin was observed - the PMA value was 38,2 $\pm$ 1,2, that conform to mild gingivitis.

The ozone therapy use contributed to the normalization of cell immunity in patients with non-complicated postoperative flow of mandible fractures (Tab. I). In the majority of patient, the

content of circulate immune complexes decreased, furthermore the significant decrease of this index could be obtained even in local ozone use only.

The improvement of the local immune indexes was observed. It manifested in increase of SIgA level and normalization of serum immunoglobulins levels in saliva (Tab. II). The increase in local immune reactivity promoted the improvement of oral hygiene indexes (the mean value of Loe-Silness index was  $1,02 \pm 0,07$ ) and depression of marginal periodontal and gingival inflammation (PMA value was  $27,1 \pm 1,4$ ). The more rapid disappearing of postoperative oedema (mean level  $2,2 \pm 0,1$  days) and decrease in pain syndrome, noted by the patients from the first procedures, were typical in ozone therapy use. We have not observe any suppurative infection in the group, where ozone was applied. The biochemical data revealed the mild decrease in MDA content (to  $8,2 \pm 1,2$ ) and at the same time - significant increase of AOA in saliva and blood of those patients who underwent the intravenous ozone therapy.

Table II

The levels of immunoglobulins in saliva  
( $\bar{I} \pm m$ ).

Index	Patients, treated with the use of ozone			Patients, treated according to the standard protocol			Control group		
	SIgA	IgA	IgG	SIgA	IgA	IgG	SIgA	IgA	IgG
1 day	$70 \pm 2,7$	$0,41 \pm 0,02$	$3,2 \pm 0,06$	$69 \pm 5,7$	$0,4 \pm 0,01$	$3,3 \pm 0,1$	$100 \pm 1$	$0,2 \pm 0,02$	—
3 day	$74 \pm 2,4$	$0,26 \pm 0,01$	—	$47 \pm 2,4$	$0,36 \pm 0,02$	$2,4 \pm 0,3$			
5 day	$77 \pm 2,09$	$0,19 \pm 0,003$	—	$58 \pm 3,5$	$0,34 \pm 0,02$	—			
7 day	$89 \pm 3,2$	$0,24 \pm 0,01$	—	$75 \pm 2,5$	$0,36 \pm 0,01$	—			

### Discussion

The results of present study give an evidence of successful usage of ozone therapy in postoperative rehabilitation of the patient who underwent the surgical interventions on the facial bones. The background for the ozone positive action is the modulative effect upon the immunity and antioxidant system. It was noted that the most prominent effect of ozone is provided as to the cell immunity and local protective mechanisms. The normalization of the local immune indexes could be obtained by the local ozone use only, even in low concentration. At the same time in patient with the severe maxillo-facial pathology the immunological disorders are more profound, and characterized by the significant misbalance of different immunity links. That makes the combination of local and intravenous ozone therapy quite preferable. In some cases we consider even the additive pharmaceutical immune correction quite expedient.

It was stated, that ozone application in low concentration does not cause the increase in lipid peroxydation products, and on the contrary causes the decrease of high MDA levels in blood and saliva owing to the compensatory activation of the AOA. It proves that ozone therapy has no toxic effect in proposed concentrations.

The positive ozone's action on metabolic and immune processes promotes the optimization of clinical signs. Ozone, in particular, decreases oedema, pain syndrome, improves the oral hygiene.

As mentioned before, allows to recommend the insertion of ozone therapy in complex treatment of patients, who underwent the bone plastics and bone reconstructive operations on facial skeleton.

### **Conclusions**

1. In early postoperative period in patients, who underwent the bone plastics and bone reconstructive operations on maxillo-facial area the depression of immune protective factors and activation of lipid peroxydation either in oral cavity or in the whole organism develops.
2. The insertion of ozone therapy in complex treatment of this category of patients allows to normalize the immune indexes and to activate the AOS.
3. The use of ozone therapy allows to improve the dynamics of clinical signs and to prevent the development of complications.

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