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# THE STATE OF HEMODYNAMICS AND LEVEL OF REPAIR PROCESSES IN PATIENTS WITH LOWER JAW FRACTURES

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*Biomechanical investigations made it possible to determine the character and extent of functional deformations of a lower jaw in its different parts. Minimal deformations are observed in the region of the angle and alveolar part in the horizontal plane of the lower jaw. Deformations in the mentum part are not regular and depend on the kind of functional load.*

Among fractures of facial bones, injuries to the lower jaw are most frequent, ranging from 70 to 95% [1-3]. A tendency toward growth in this kind of traumatism is noted.

Refinement of the surgical treatment of lower jaw fractures remains an urgent problem since the number of inflammatory complications remains high and, according to the reports published in this country, come to 10 ± 37.2% [4-6].

The criteria for estimating the efficiency of surgical treatment of lower jaw fractures were clinical data, as well as the results of laboratory and functional methods of the examination of patients.

The purpose of the present work was to investigate and analyze, with the help of a PC, the clinical results of traditional methods of the osteosynthesis of the lower jaw (with a wire suture) and operation procedures developed by the present authors and justified biomechanically (osteosynthesis with a miniplate), as well as elucidation of the data needed to develop a mathematical model for predicting the outcome of a disease.

For determining the state of regional blood circulation in a lower jaw on its fracture, we employed the rheography technique based on the bipolar method [7]. As detecting and recording devices we used a PG1-02 rheograph and ELKAR-6 electrocardiograph. We recorded rheograms on both fractured and symmetric healthy sides. When the rheograms were processed, we took into account both qualitative, and quantitative characteristics [8]. We plotted the former by applying the analysis of the shape of the rheographic curve, its basic elements and features (apex shape, steepness of the ascending and descending parts, the presence and clearness of the dicrotic wave, its relationship with the rheogram apex, and the presence of additional waves on the descending part of the curve), whereas the latter were used for determining the rheographic index (RI), vascular tension index (VTI), peripheral resistance index (PRI), and elasticity index (EI) expressed in percents [9-11]. Rheograms of 25 practically healthy people aged from 20 to 37 were used for control. We made rheographic examination before operation and 1, 2, 3, and 4 weeks after osteosynthesis.

To reveal the specific features of the repair process in the dynamics on lower jaw fractures, we carried out ultrasonic osteometry for those patients who earlier were examined rheographically. For this purpose we used an EOM-01Ts echoosteometer. To obtain more effective information in the process of osteometry, we used the mode of "base increment". In all of the cases when the lower jaw was fractured in the regions of the body of the jaw and its angle, a transducing probe was located strictly in the region of the chin and a detecting probe distally from the fracture slit. The distance between the probes was standard and equal to 50 mm. In order to improve the conducting medium, the contact heads of the probes were smeared with Vaseline oil. The readings of the device were taken

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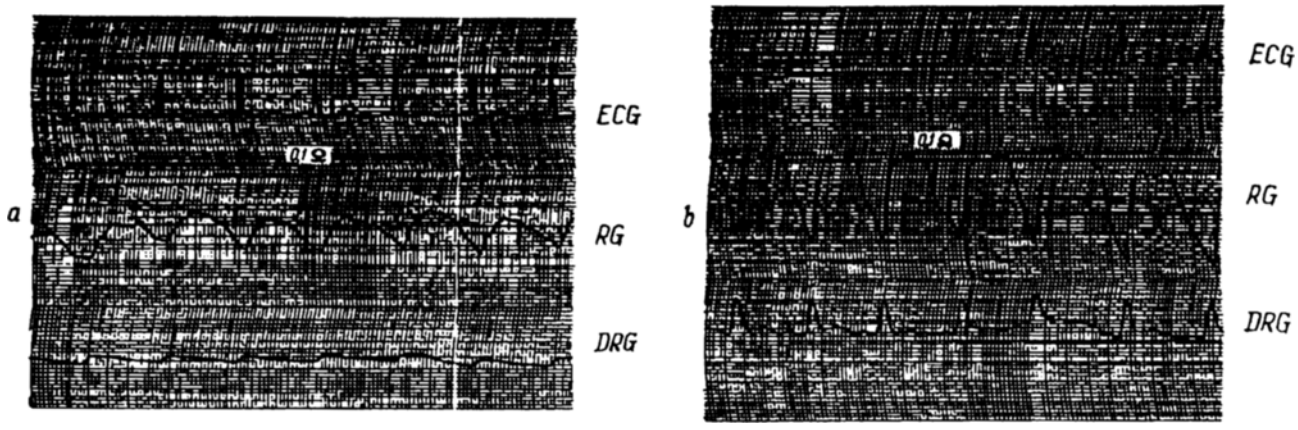


Fig. 1. Rheogram of the lower jaw on the side of fracture (a) and on the opposite side (b).

only upon stabilization of measurement. Examination of patients was made before operation and 1, 2, 3, and 4 weeks after surgical intervention.

As a result of rheographic examinations we established the character and specific features of the blood supply of the lower jaw in the zone of fracture, as well as in the symmetric parts on the healthy side. Qualitative estimation of rheograms showed that the changes in the shape of the rheographic curve were observed in all of the patients on the fractured side and in the majority of patients in the symmetric region. Moreover, the rheographic curve had a characteristic form: the tip of the curve was flattened, the dicrotic wave was smoothed out or often was altogether absent (Fig. 1a), and a venous wave appeared on the descending portion of the curve. The foregoing changes were always more pronounced on the sore side (Fig. 1b). In the postsurgery period we noted typical changes in the shape of the rheographic curve. After osteosynthesis with a miniplate (first group of patients) the indications that the configuration of the curve becomes normal on the fractured side were noted already starting from the second week. By the third-fourth week the rheographic curve was characterized by a sharp tip, well pronounced dicrotic wave, and by the absence of additional waves on its descending part. In all of the periods of observation, in the patients of the second group (osteosynthesis with wire suture) the qualitative characteristics of rheograms testified to a less dynamic normalization of blood circulation. As concerns the quantitative characteristics, the most considerable changes occurred with the value of RI on both the fractured and the healthy side. In the patients of the first group we noted a considerable increase in the intensity of blood flow starting from the second and by the fourth week.

In the patients of the second group the RI began to increase 2–3 weeks after operation. At a later time (3–4 weeks) the value of this index did not change. In the patients of both the first and second group the intensity of blood flow did not attain the level typical of the people of the control group.

In both groups at all times of observation the blood flow intensity on the healthy side of the lower jaw was higher than in the region of fracture. However, after a period of four weeks the asymmetry coefficient for the fractured and the healthy side was 0.87 in the first group of patients and 0.71 in the second, indicating a more dynamic normalization of the blood supply to the lower jaw in patients operated with the help of a miniplate.

As compared with the control group, the value of RI on the healthy side before operation was higher in both clinical groups. After the lapse of four weeks the values of RI in the first group almost equalled those of the control group (88.8%). In the second group of patients the RI value was equal to 0.05 Ω, i.e., was smaller by 30%.

Comparing the blood flow intensity indices in the patients of the first and second groups with fractures in the regions of the body and the angle of the jaw, we may note that the greatest differences are observed in the periods of 2–4 weeks after operation. After 2–4 weeks, the blood flow intensity in the patients of the first group turned out to be higher, with a statistically reliable difference being noted 3–4 weeks after operation.

On the symmetric healthy part of the jaw in patients with fractures in the region of the body and angle of the jaw we noted the dynamics of the change in the blood flow intensity generally similar to that on the fractured side. In the first and second groups on the fractured side we observed a smooth increase in the intensity of blood

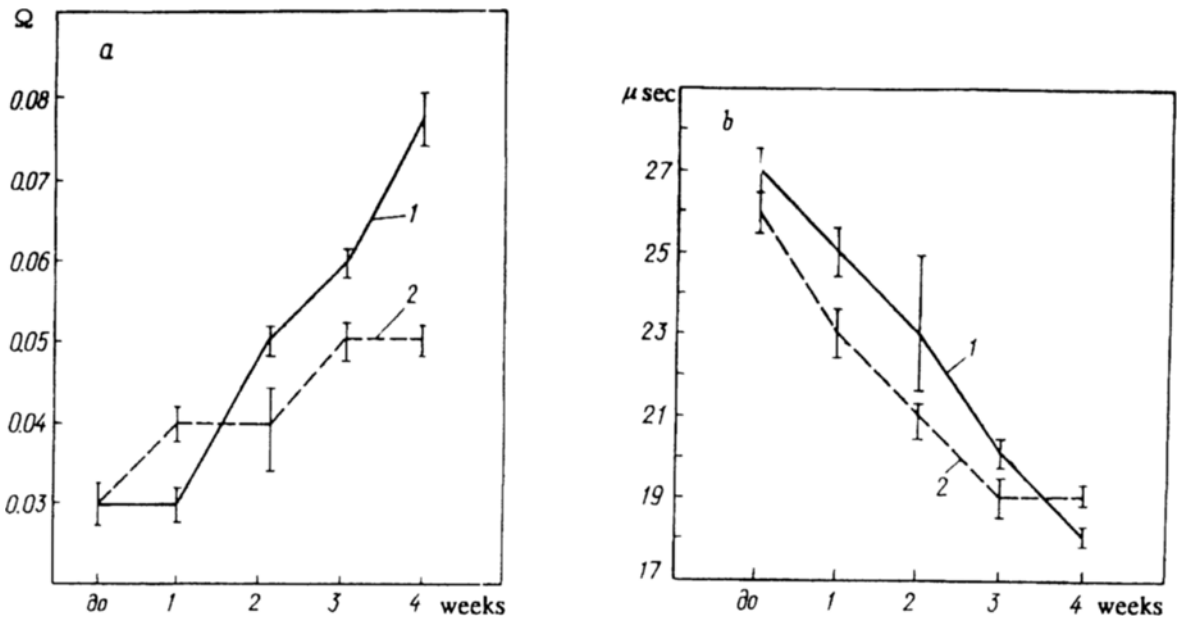


Fig. 2. The values of RI (a) and the time of ultrasound passage (b) on fractures of the lower jaw in the region of the angle (1, first group; 2, second group).

flow from the first to the fourth week. At the same time, on the healthy side we noted a decrease in the RI value by the third week in the first group and by the second week in the second group of the patients. This regularity can be attributed to neuroreflectory changes in the vascular bed of the lower jaw in response to the trauma and repair processes during the treatment of the fracture. For a more accurate and detailed analysis of the changes occurring in the regional blood flow on fracture of the lower jaw, we examined two groups of patients with identical fractures at the level of the wisdom tooth. The RI values in the first group of patients (osteosynthesis with a miniplate) increased intensively starting from the first week after operation and reached maximum values by the fourth week. In the second group of patients (osteosynthesis with a wire suture) we noted a less pronounced increase in RI. The increase in the intensity of blood flow was observed immediately by the end of the first week after operation and from the second to the third week. In the period from the third to the fourth week no increase in RI was observed. A week after operation the RI values were higher in the patients of the second group than of the first ($P < 0.01$). At a later time (2–4 weeks) the intensity of blood flow in the patients of the first group was statistically higher than in the second group (Fig. 2a).

Comparing mean characteristics of the rate of increment in the RI value we may note that in the patients of the first group this index increased by 0.0122 Ω (24.8%) for the whole period of observation, while in the patients of the second group the rate of increment was equal to 0.005 Ω or 1.1% indicating a faster improvement in the regional blood circulation in the patients of the first group.

In addition to the intensity of blood supply to the lower jaw, we analyzed the functional state of regional vessels, i.e., the values of the vascular tension index (VTI) on the fractured side and on the healthy symmetric part of the jaw. In the patients of the first group the VTI value on the sore side in all of the periods of observation was higher than in the control group. The greatest differences were noted before operation ($P < 0.001$). Four weeks after osteosynthesis, the VTI was almost normalized. Nearly the same dynamics of VTI was noted in the second group of patients, though the value of this index turned out to be somewhat higher (by 1.0%). The peripheral resistance index (PRI), which also shows the state of the tension of regional vessels, was higher in the first and second groups of patients before operation than in the control group ($P < 0.001$ and $P < 0.01$). In the postoperative period, the PRI gradually decreased and by the fourth week it approached the control values equal to 72.7% ± 3.4% in the first group and to 76.0% ± 1.8% in the second. This means that by the fourth week the tension of vessels is normalized.

The value of the elasticity index (EI) of vessels in the postoperative period turned out to be decreased in both groups of patients on the fractured side compared to the healthy one. In the postoperative period we noted a statistically reliable decrease in EI in all of the periods of observation that approached the values of the control group.

In order to determine the intensity of osteal repair processes in fractures of the lower jaw, we applied ultrasonic osteometry. We found that in the case of unilateral fractures of the lower jaw in the region of its body the time of ultrasound passage through it before operation substantially differed from the passage in the symmetric part on the healthy side.

A week after osteosynthesis the time of the ultrasonic wave passage decreased compared to the period before operation. Its greater decrease was noted in the first group of patients. There is a statistically appreciable difference in this index between the first and the second group. In the period of 3–4 weeks of observation, the time for passage of ultrasound was smaller in the first group than in the second ($P < 0.05$). On the healthy side of the jaw this index did not undergo any substantial changes in the postoperative period.

Analysis of the dynamics of changes in the time of the ultrasound passage in patients of the first group showed that the mean index of the rate of decrease in the time of 4 weeks was 2.2 $\mu$sec (9.6%). This differs from the data of the second group for which the index was equal to 1.8 $\mu$sec (8.3%). These differences indicate that the process of osteoreparation in patients of the first group proceeds more intensely than in the second.

Analysis of the osteometric data on fractures of the jaw in the region of its angle (Fig. 2b) showed that a week after operation there was a difference between the patients of the first and second groups because the values in the first group turned out to be higher than in the second ($P < 0.05$). This tendency persisted 2–3 weeks after operation; however, the difference was not reliable. Four weeks after operation the time of ultrasound passage in patients of the first group curtailed compared to the second group ($P < 0.001$). This means that the osteorepair process is faster in patients that were operated on with the aid of a miniplate compared to those with an osteosuture.

In the case of bilateral fractures of the lower jaw in the regions of the angles, in patients of the first and second groups we noted a reduction in the time of the ultrasound passage through the operated part and on the opposite fractured side without or with an insignificant displacement of chips. In a week the time of the ultrasound passage decreased sharply in the both groups. In patients of the first group in two weeks after operation it was 19 $\pm$ 0.3 $\mu$sec and persisted to 4 weeks. In patients of the second group the dynamics of the decrease in the time of ultrasound passage diffed from that in the first group: it differed by 2–4 weeks. In the symmetric portions in patients of the first and second groups no difference in this index in later periods (3–4 weeks) was noted.

In the case of bilateral fractures in the region of the body of the lower jaw in the time of observation of 1–3 weeks the time of ultrasound passage in patients of the first group was statistically smaller than in the second. In 4 weeks we noted the lowest values of this index in both groups (the differences were statistically reliable).

Thus, on the basis of the results of the functional methods of examination we established the specific features in the supply of blood in the lower jaw in the fractured region and on the healthy part in the first four weeks of observation. We defected differences in the recovery of blood flow in patients who underwent operation with the use of a miniplate applied to the bone and of an osteosuture. A more dynamic picture of the normalization of the blood flow intensity in the first group was observed from the second to the fourth week. At a later period (4 weeks) the values of RI in this group were the closest to the norm. In the second group of patients the recovery of the blood circulation was slower; only in the groups of patients with fractures of the lower jaw in the region of the angle was the RI higher a week after operation compared to the first group. In our opinion, the only reason for such a difference in blood supply in the patients of two clinical groups could be the recovery of the function (starting from the second week) after osteosynthesis by miniplates.

On the basis of ultrasonic osteometry, which made it possible to estimate the rate of repair processes in a bone, we found that the time of ultrasound passage in patients of the first group is reduced faster than in partients of the second group. The most substantial differences were noted in the periods of the first and fourth week after surgical intervention. In our opinion, the differences in the first week are due to a more accurate and close contact of bone fragments after osteosynthesis by miniplates and in the fourth week to an earlier recovery of the function. The obtained quantitative characteristics of the rheography (RI, VTI, PRI, EI) together with the data of osteometry

may underly the development of a mathematical model for predicting the outcomes of treatment and possible complications, as well as their prophylaxis and treatment.

## NOTATION

RI, rheographic index, Ω; VTI, vascular tension index, %; PRI, peripheral resistance index, %; EI, elasticity index, %.

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