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Results of Ultrasound Examination in Patients With Fractures of the Alveolar Process of the Jaws

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Abstract: The article presents the results of ultrasound examination in patients with fractures of the alveolar process of the jaws using various immobilization methods. During the immobilization period, along with the main treatment, attention should be paid to implementing a set of measures that improve bone metabolism indicators in patients with fractures of the alveolar process of the jaws. The aim of the study is to assess the influence of various immobilization methods on the state of bone tissue of the alveolar process of the jaws (PAOJ) using ultrasound osteometry. Materials and methods: 65 patients with PAOJ were examined, divided into three groups according to the immobilization method: traditional smooth splints, splints with the use of additional agents (mouthwash and calcium-D3), as well as splints fixed with composite. Ultrasound examination was conducted in three stages: before immobilization, on the 14th day, and after removing the fixing structures. Results: It was established that the velocity of ultrasound waves increased after treatment in groups with alternative immobilization methods, indicating better density and reparative regeneration of bone tissue compared to the traditional method. Conclusion: Using gentle methods of immobilization allows for a reduction in inflammatory complications, preservation of periodontal health, and improvement of conditions for bone fragment consolidation during the treatment of PAOJ. Conclusion: Using gentle immobilization methods allows for a reduction in inflammatory complications, preservation of periodontal health, and improvement of bone fragment consolidation conditions during PAOJ treatment. It was established that the passage rate of ultrasound waves increased after treatment in groups with alternative immobilization methods, indicating better density and reparative regeneration of bone tissue compared to the traditional method. Conclusion. Using merciful methods of immobilization allows for a reduction in inflammatory complications, preservation of periodontal health, and improvement of bone fragment consolidation conditions during PAOJ.

Keywords: fractures of the alveolar process of the jaws, maxillofacial trauma, immobilization of the jaws, ultrasound osteometry.

Relevance. Currently, according to various authors, facial skeleton fractures account for 3.2%-5.8% of all injuries [5,6,8]. The majority of facial bone injuries are jaw fractures, with 77.0% to 90.0% of patients seeking treatment for these in specialized medical institutions [1,4,8,11,13]. Given the increasing incidence of maxillofacial trauma, the issue of providing comprehensive and specialized care for alveolar process fractures of the jaws remains relevant. Treatment for this category of patients is carried out using both conservative (orthopedic) and surgical methods; often, a combination of these two main types of specialized treatment is employed. Despite advancements in treatment methods for mandibular fractures, infectious and inflammatory complications frequently occur in the post-traumatic period. The development of these complications depends on several factors, including the presence of teeth with pathological processes in the periodontal tissues. Significant factors contributing to the development of complications include the state of the body's resistance, impaired blood circulation, and innervation in the fracture zone [1,3,9].

Currently, among the treatment methods for fractures of the jaw alveolar processes, the most widely used is the immobilization of fragments using smooth dental splints. When splints are applied, it becomes difficult to perform professional and individual oral hygiene. With prolonged immobilization, the hygienic condition of the oral cavity deteriorates. Dental plaque microorganisms are the direct

cause of inflammatory processes in the periodontium. Normally, resistance mechanisms counteract microorganisms, but as soon as they overcome this defense at any site, an infectious process develops with tissue damage. Prolonged presence of bronze-aluminum ligatures in the cervical region of the teeth also leads to the development of an inflammatory process in the periodontal tissues, resulting in periodontitis - to obtain one of the experimental models of periodontitis, a ligature is applied to the tooth's cervical area. In periodontal diseases, the application of dental splints leads to an exacerbation of periodontitis, which aggravates the course of the disease, and in some cases, it is impossible to apply splinting structures [2,4,6-10].

There is no data in the literature on the effect of dental splints on the condition of periodontal tissues in patients with alveolar process fractures. Many authors propose abandoning the use of dental splints in favor of alternative methods for immobilizing alveolar bone fragments [5,11-13]. However, these methods have not gained widespread use, and dental splints remain the primary method of fracture immobilization in alveolar process fractures, though their impact on periodontal tissues in patients has not been studied.

Research objective: To evaluate the impact of various immobilization methods on the bone tissue condition of the alveolar process of the jaws using ultrasound osteometry.

Materials and methods: The work is based on the experience of treating 65 patients with alveolar process fractures of the jaws. All patients with alveolar process fractures were divided into the following groups depending on the treatment method:

Group 1 - 20 patients were treated using smooth dental arch bars for immobilization; Group 2 - 22 patients were treated using smooth dental arch bars for immobilization with the application of "Medical Herbs" (Splat) mouthwash and CALCIY TRIACTIVE® D3; Group 3 - 23 patients were treated using dental splints fixed with composite filling materials for immobilization.

Examination of patients with jaw alveolar process fractures and the control group was conducted 3 times during the course of treatment: before immobilization (upon admission to the department), on the 14th day of immobilization, and on the day of removal of immobilizing structures.

To determine the degree of reparative regeneration and perform a comparative assessment of different methods of alveolar process fragment immobilization, ultrasound osteometry was utilized. Ultrasound osteometry was employed to evaluate the functional state (density) of the jawbone in the fracture zone. Diagnostic examinations were conducted at various intervals after immobilization (upon removal of the structures and one month after treatment), which allowed for assessing the quality of reparative osteogenesis under different immobilization methods.

In our research, we used an ultrasound method for measuring the bone tissue density of the alveolar process, which involved measuring the speed and time of ultrasound impulses passing through all soft tissues, bone tissue, and again soft tissues, with their thickness not exceeding 1 cm. An important aspect of using ultrasound osteometry is strict adherence to the static distance between the ultrasound Doppler heads, as it plays a crucial role in obtaining data on the volume of the measured bone tissue of the alveolar process.

Due to the fact that ultrasound does not propagate in air, a special gel was applied to the ultrasound Doppler sensors, which were then pressed tightly against the examined areas of facial skin above the alveolar process. To obtain statistically reliable research results, measurements were taken multiple times, usually thrice, and the obtained data were averaged. Since the measuring device is connected to a personal computer, the measurement data and their results are automatically stored on the computer's hard drive using software. The data obtained during the study were compared with the speed and time indicators of ultrasound passage in the mandibular bone, which normally ranges from 3,000 to 3,500 m/sec. Ultrasound osteometry was performed when applying and removing immobilizing structures (after 3 weeks).

Research results.

Studies of ultrasound conductivity in the mandibular bone tissue of patients with mandibular alveolar process fractures were conducted by measuring the speed and time of ultrasound wave propagation. This allowed for a quantitative assessment of the degree of consolidation of the mandibular alveolar process fragments (Petrenko V.A., Burdin V.V., 2006).

The initial purpose of our research was to study the dynamics of changes in the ultrasound wave propagation time during the period of fragment immobilization in the treatment of mandibular alveolar process fractures in patients using various methods of immobilization for mandibular alveolar process fragments.

Ultrasound osteometry in the treatment of PAOCH in patients was performed at a frequency of 120±36 kHz. The ultrasound wave transmitting diagnostic head was positioned on the distal side relative to the PAOCH fragment, while the receiving head was placed on the proximal side. The distance between the diagnostic sensors was strictly fixed at 94 mm.

Studies were conducted in all groups of patients with PAOCH. Measurements were taken before immobilization and after removal of the immobilizing structure, typically 21 days after immobilization.

When comparing the relative mineral density of bone tissue in patients with different immobilization methods, statistically significant differences were revealed in measurements in the PAOCH region.

Table 1General average ultrasound osteometry indicators in patients with PAOCH using various immobilization methods (n=65)

Groups	Total average ultrasound osteometry indicators (mm/sec.)	
	Before immobilization	After immobilization
Group 1	2267.2	2591.5
Group 2	2253.1	2604.7
Group 3	2313.5	2631.6

It was established that the speed and time of ultrasound wave propagation before immobilization in all groups of examined patients averaged 27.7±0.5 m/sec. ($p<0.05$). After removal of the fixation device, the ultrasound travel time on the affected side, which was immobilized using the traditional method (Group 1), was longer than in the other groups. In the remaining groups, it was shorter, indicating denser bone tissue in the fracture zone in these patients.

Thus, the higher the density of the medium, the faster ultrasound travels through it, and conversely, the looser the medium, the slower sound passes. Therefore, it can be concluded that using immobilization methods that help preserve the anatomical and functional integrity of periodontal complex tissues reduces the risk of inflammatory processes, thereby improving blood biochemical parameters, particularly the state of bone metabolism, which in turn affects the quality and speed of fragment consolidation in the treatment of maxillary alveolar process fractures.

Conclusion. The conducted study confirmed that the choice of immobilization method significantly affects bone density and reparative processes in the fracture zone of the maxillary alveolar process. The use of dental splints with additional oral care products, as well as composite materials for fixation, provides more favorable conditions for healing due to better preservation of periodontal tissues and a reduction in the risk of inflammatory complications. Thus, abandoning traditional ligature fixation in favor of alternative methods can increase the effectiveness of treating patients with maxillary alveolar process fractures and improve long-term treatment outcomes.

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