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Article

Complicated mandible fracture treatment with xenogenic bone graft: A case report

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Abstract: The problem of filling the bone cavity remains relevant in maxillofacial and oral surgery. There is a large selection of osteotropic materials of various natures for filling of bone defects of different etiology. The aim of our research was to improve the result of surgical treatment in a patient with a complicated mandibular fracture with the use of collagenic xenograft during osteosynthesis. In this article, we introduce our experience in the treatment of a patient with a complicated mandibular angle fracture in a combination with the follicular cyst. The obligate steps of treatment included stabilization of the bony fragments, a decrease of risk in fracture line malposition along with titan mini- plates and shortening in the time of bone regeneration due to a filling of bone defect with the osteotropic material. This approach allowed us to reduce the rehabilitation period and further prosthetic treatment after 4-5 months without additional bone grafting manipulations. Though, the use of collagen osteotropic material, possessing osteoconductive properties, can improve the treatment of patients with mandibular fractures.

Keywords: follicular cyst, fracture, mandible, osteosynthesis, mini-plate, collagenic xenograft

1. Introduction

In clinical cases, when the teeth are removed from the fracture line, and the bony defect is not filled, the risk of developing purulent inflammatory diseases increases.

The bony tissue can regenerate and change its micro- and macrostructure. Due to the delicate balance between the formation and loss of bone tissue, changes occur in the form of static and dynamic stress applied to the bone; if the applied stress is greater than the normal physiological level, the equilibrium is deflected towards osteoclasis (this relationship is known as Wolf's law of restructuring of bone structure). Nature has envisioned different types of mechanisms for bone repair after fractures to cope with the different mechanical environments surrounding the fracture. It is known that incomplete fractures (cracks), which allow only micro-movement between fracture fragments, heal with a small number of calluses along the fracture line or without them (primary healing). Unlike incomplete fractures, complete fractures are unstable and therefore generate macro displacement and heal with a large callus protruding from the sides of the bone (secondary tension) [1].

L.N. Hench (2007) in his work identified 4 biomechanical stages of bone restoration after fractur e[2-4]:

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1st stage: At the site of the initial fracture, the bone does not function, it is characterized by low rigidity, like that of rubber

2nd stage: The bone is not functioning at the site of the original fracture, but there is hard tissue with great rigidity

3rd stage: The bone is partially non-functional at the site of the original fracture and partially - on the unaffected part of the bone, there is a hard tissue with high rigidity

4th stage: The site of failure does not correspond to the site of the original fracture. Failure occurs at high rigidity

These changes correspond to cellular changes, depending on time and on the type of extracellular matrix at the site of tissue repair. The strength of the healing fracture increases significantly when mineralization of the osteoid occurs, approximately 4-6 months after the onset of healing.

The choice of treatment helps to prevent possible displacement of the bone fragments, which can delay or interfere with the healing of the fracture line.

Grafts of different nature are widely used in traumatology, oncology, surgery, also in oral and maxillofacial surgery [5-6]. There are accurate requirements for graft properties as biological compatibility, absence of unpleasant reactions (allergy, reaction 'transplant against host'), availability and others [5].

The 'golden' standard for jaw reconstruction during bone plasty, guided bone regeneration, dental implantation is considered autograft because of a combination of bone conductive ('matrix' role) and inductive (direct osteogenesis stimulation) properties [7]. Also, rather often the xenogenic materials (collagen, hydroxyapatites, their combinations) are used but they have only bone conductive properties but in comparison with autogenous materials there is no need in new trauma creation which is obligate for harvesting [8,9].

Although, properties of pointed grafts almost are not studied for jaw fractures treatment. Also, more often in literature information about fractures of jaws as complications of harvesting can be founded [10].

The aim of our case repot was to improve the results of surgical treatment in a complicated mandibular fracture with the use of collagenic xenograft during osteosynthesis.

2. Materials and Methods

Patient, 39 y.o. female, (height = 178 cm, weight = 58 kg) was admitted to the Department of Maxillofacial Surgery of the Sechenov University with complaints of pain on the left side of the mandible, swelling of the left cheek, limited mouth opening and malocclusion.

Extraoral physical exam revealed altered facial configuration due to soft tissues edema at the left buccal, parotid, and submandibular regions. The skin color was physiological. Pain and fragments mobility at the left mandibular angle were noted during palpation. Regional lymph nodes were not enlarged. The mouth opening was less than 20 mm. There was no evidence of dysphagia. During intraoral checkup lacerations and swelling of the mucosa in the area of the left third lower molar was noted, the crown of the tooth was grossly decayed. Swallowing was free, painless. The occlusion was significantly altered due to fragments dislocation.

The orthopantomogram showed a fracture line in the area of tooth 3.8 and oval-shaped area of radiolucency with teeth 3.7 and 3.8 roots involvement (Fig. 1).

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Figure 1. Orthopantomogram before surgery

After primary checkup and radiological evaluation an intermaxillary fixation was performed, the bite was stabilized in a physiological occlusion with arch bars and rubber elastics.

The patient was examined in a standard pre-surgical volume: laboratory (blood and urine tests) and instrumental (EKG, chest x-ray) studies.

Multi-spiral computed tomography of the lower jaw determined an oval-shapes bony lesion with dimensions of 20x16x16 mm at the level of teeth 3.7 and 3.8 roots. The bone was swollen at the level of 3.6-3.8 teeth, a periosteal reaction was noted, the contours of the jaw were enlarged, the cortical plates were thinned. A pathological fracture of the lower jaw with fragment displacement occurred, the fracture line passed through 3.7 and 3.8 teeth sockets (Fig. 2).

Figure 2. Patient's CBCT at admission

Under general anesthesia (nasotracheal intubation) the patient underwent teeth 3.6, 3.7, 3.8 extraction, cystectomy and osteosynthesis. The angular fracture of the lower jaw was reduced and stabilized with two 6-hole titanium bone mini-plates and 10 mm length mini-screws. The bony defect was filling with xenograft "Collost". The external approach was chosen due to the violation of the integrity of the mucosa in the area of the fracture line for a long time, the need to remove the cyst, reposition the fragments of the lower jaw and fix them

The patient was treated with the "Collost" osteotropic material (xenogenic collagen osteotropic material of I type with 3D structure obtained from the skin of cattle ("BIOPHARMHOLDING", Moscow, Russia). We used this material in 2 forms: 2 balls (diameter 8 mm each) and membrane (sizes: 30x20x3 mm). According to manufacture company instruction the material has sterilized with all necessary methods for biological materials and, also, with γ-radiation being in flacon. Before implantation to the wound the material was placed in sterile saline of temperature 25 Celsius for 15 minutes; the average volume increased in 20% for balls and membranes from firsts.

Operation technique.

Stage 1. The teeth 3.6, 3.7 and 3.8 were removed (Fig. 3a).

A bony cyst 20x15 mm size was determined. A cystectomy was performed and with the removal of small bony fragments d=3x5 mm. (Fig. 3b).

Stage 2. After preliminary marking, an incision was made in the submandibular region on the left, departing from the edge of the lower jaw by 2.0 cm, up to 2.5 cm long. The skin, subcutaneous fatty tissue is dissected in layers, m. platysma, the own fascia of the neck. The body and the angle of the lower jaw on the left were skeletonized; a planar finely comminuted oblique fracture with a displacement of a smaller fragment upward and inward with a defect in the external cortical plate was found (Fig. 3c).

The fracture was reduced, bony fragments were stabilized in a correct position with two titanium 6 -hole bone mini-plates and 10 mm titanium mini-screws (Fig. 3d).

The wound was washed with antiseptic solutions, layer-by-layer sutured with interrupted sutures with Vicril 3.0 threads. Intradermal suture was applied Prolene 5.0. A plastic catheter was placed at the fracture line (Fig. 3e).

Stage 3. The intraoral operative wound was irrigated with antiseptic solutions. The bone cavity was filled with collagen osteotropic material in a shape of balls and threads. The graft was covered with a resorbable membrane (Fig. 3f).The wound was sutured with Prolene 4.0 interrupted sutures (Fig. 3g).

Hemostasis was performed during the surgery. The cyst walls were sent for histological analysis.

Figure 3. a) Teeth 3.6, 3.7, 3.8;b) Founded bone cavity and fracture line; c) fracture line visualization; d)osteosynthesis; e) sutured skin after the intervention; f) the membrane covers the graft and bony defect; g) imposed interrupted sutures in the area of the postoperative wound

3. Results

The postoperative period was uneventful. A course of antibacterial, anti-inflammatory, analgesic therapy was carried out. Daily checkups were performed with intraoral antiseptic solution irrigations. s with, bringing the antibiotic " Lincomycin " to the fracture line through a catheter (Russia, Moscow LLC "Production of medicines") 2 times a day, 900 mg.

In the postoperative period the protocol of antibiotic therapy included: cefotaxime 1,0 g x 2 times per a day intramuscularly, antihistamine (suprastin (Egis, Budapest, Hungary)1 tablet 1 time per a day), daily dressings, 0,05% water chlorhexidine rinses 3 times per a day. All treatment was performed for 7 days.

In early postoperative period a control panoramic view was made. The bony cavity after teeth extraction and cystectomy was visualized, titanium plates and screws in a right position. As well as bony fragments were in a correct position (Fig. 4).

Figure 4.Patient orthopantomogram 1 day after surgery

The results of intraoperative histological examination are as follows: follicular cyst remains.

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After 7 years the bone reparation process has finished. Furthermore, the patient had dental implants placement. Loss of dental implants is not related to a fracture that occurred more than 7 years ago. Due to improper loading on the installed orthopedic structures, bone resorption occurred (fig.5).

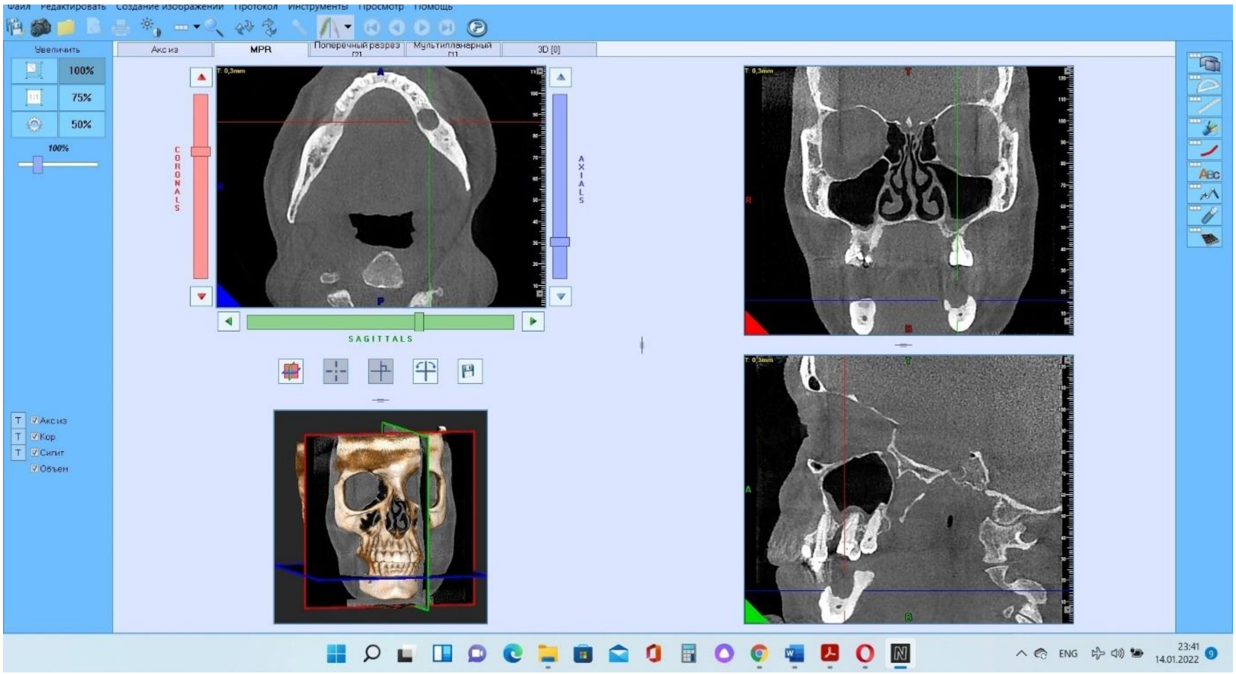

Figure 5. CT-scan after dental implant loss before bone plasty after 7 years surgery

After the removal of the dental implants that have undergone peri-implantitis, repeated CBCT examinations and repeated prosthetics will be performed, considering the mechanical load and the peculiarities of the bite.

4. Discussion

According to the literature and our own experience, mandibular fractures are the most commone fractures of the facial bones. Patients with a fractured mandible present significant biting, chewing, and speaking function disorders [11]. The treatment of mandibular angle fractures represents a challenge due to their higher rate of complications, and there is currently no agreement as to the optimal treatment [12]. The experience of many studies shows that patients with mandibular fractures demand an individual approach in the choice of the treatment method, because there may be in a combination with bony lesions of different nature, odontogenic infection, fractures in different areas of the mandible or facile skeleton, etc. [5-10, 13]. In all these cases, a collagen osteotropic material was used to fill the bony defect. Even though the authors do not indicate the timing of full bone tissue regeneration so we can assume preliminary conclusions about the positive effect of the osteotropic material in this study on the timing of full bone regeneration.

Currently the mechanisms of bony regeneration are well studied but there are several factors that affect or delay the bony healing process; some are inherent to the patient, others to the fracture itself, and others to the medical management of the patient. The size

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of the gap or bony defect is an important factor for the use of bone grafts considering endochondral ossification [14, 15].

Despite the high efficiency of modern methods of treatment, the bone tissue can be restored in full volume not in all cases. For example, harvesting bone grafts from the anterior iliac crest for intraoral augmentation is a safe procedure for both young and elderly patients. Although there is some postoperative morbidity, such as gait disturbances, hypesthesia, scar formation, or delayed wound healing at the donor site, the incidence of these minor complications is low, and they are mostly of short duration. Major complications, such as fractures or incision hernias, are very rare. However, the volume of the bone graft was associated with a longer stay in hospital, which should be considered in the planning of iliac crest bone graft procedures [16]. That is why xenogenic materials are used to accelerate the reparative processes [17]. The basics of stimulation of regeneration are laid in induction, conduction, and regeneration due to the introduction of osteoprogenic cellular elements (stimulation by substitution). Every potency can be used to stimulate reparative osteogenesis both independently and in combination [18].

Guided bone regeneration is the common way of treatment for bony defects of the jaws. Principles are based in a combination of bone graft material and a barrier membrane, which covers and stabilize the augmented zone. The results of H. Staedt et al. study showed, that higher levels of enzyme activity indicate a more intense bone remodeling. Furthermore, guided bone regeneration with bone substitute particles and collagen membrane show a desirable, significantly earlier bone remodeling activity when compared regeneration procedures with bone substitute particles only. The membrane potentially acts like a bioactive compartment rather than just a passive barrier [19]. David S. Musson et al. concluded, that bovine bone particulates offer a purely osteoconductive material, with no anabolic advantage. However, abundant growth factors clearly can produce an anabolic bone effect. In this regard, development of a new materials could provide a clear benefit for surgeons faced with large bony defects, which left by themselves fail to heal and reduce the integrity of the surrounding bone [20].

In our study, a patient with a fracture of the mandible within the dentition was under observation for 8 years. The mandibular bone defect was filled with a xenogenic bone material. The results of our study indicate a decrease in the timing of osteoreparative processes and rehabilitation when using collagen osteotropic material in a combination with collagen membrane. With the use of osteotropic collagen material during the treatment of a patient with this clinical case, the period of healing and regeneration of bone tissue decreased from 6 to 5 months. No inflammatory processes were observed during treatment.

However, in clinical practice, avoidance by a dental surgeon or maxillofacial surgeon of filling the sockets of extracted teeth with osteotropic materials, especially when the fracture line passes through the dentition, can lead to the development of an empty socket syndrome, infectious and inflammatory complications, including posttraumatic osteomyelitis of the lower jaw. In addition, according to our data, the use of an osteotropic material is also possible in cases of combined pathology of the lower jaw, when, because of surgical intervention, a rather large bone defect is formed, which requires filling, as in the case of our clinical example.

The use of an osteotropic material with osteoconductive properties can improve the treatment outcome in patients with mandibular fractures within the dentition. This is due to both the stabilization of the fracture line, a decrease in the likelihood of displacement of fragments along with fixation with devices, and a reduction in the time of bone tissue regeneration, which reduces the rehabilitation period and allows further orthopedic treatment of patients in 4-5 months without additional bone grafting operations. The acceleration of the bone reparative process allowed the patient to place dental implants in the area of the missing teeth after 8 years.

5. Conclusions

Osteotropic materials are a good option for jawbone reconstruction and can reduce the healing time in the area of the fracture line. Even in complicated mandibular fractures in a combination with a jaw cyst of various etiologies, osteotropic collagen material provide favorable conditions for bone regeneration after simultaneous cystectomy and osteosynthesis due to osteoconductive properties. Such approach allows to have a predictable fracture healing and dental implant placement in the future. However, further prospective clinical trials should be performed in order to determine the optimal treatment algorithms.

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