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Treatment and Rehabilitation of Patients with Subtotal Mandible Defects.

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ABSTRACT

This paper presents the results of studies on the restoration of functional activity of the dento-facial system in patients with total and subtotal defects of the mandible by using different surgical methods of the mandible resection. We conducted operations using the technique developed by the authors in total 18 patients diagnosed with ameloblastoma (4 patients), well-differentiated adamantinoma (2 patients), fibrous dysplasia of the mandible (2 patients), and bisphosphonate osteonecrosis, complicated by pathological fracture of the mandible (10 patients). As part of the study, we have found that the developed intraoral access allows preserving the integrity of the neurovascular and muscular structures of the lower third of the face. The proposed surgical method allows starting rehabilitation earlier than the conventional percutaneous approaches do. We have found that using a developed intraoral approach for the removal of mandible tumors made possible to reduce the surgical trauma, to adapt bone, tendon and muscle, and neurovascular anatomical and topographical structures, and to improve the effectiveness of treatment of patients with subtotal defects of the mandible.

Keywords: resection, defect reconstruction, mandible, surgical approach, tumor, osteonecrosis

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INTRODUCTION

Resection of the mandibular fragments for cancer [1], after a course of chemotherapy, as well as on the background of progressive inflammation with chronic intoxication symptoms is characterized by functional and aesthetic disturbances in the maxillofacial area [2,3]. Currently, the mandible resection is performed through the widely used percutaneous surgical techniques with composite pedicle flaps applied for simultaneous elimination of the defect, and, in some cases, with reconstructive plates [4,5]. However, these methods in the postoperative period are characterized by aesthetic defects, and overpriced expenses on rehabilitation activities against low rehabilitation rates of the quality of patients' life [6,7].

The severity of functional disorders and the duration of the rehabilitation period in patients with jaw resection done by conventional methods depend in most cases on the amount of preserved anatomical structures of the mandible [8,9]. There are different points of view on the need to perform bone grafting and its terms [10,11]. Nevertheless, together with the formation of scar tissue in the projection of the removed mandibular bone fragment, there is the progressing local, neurological and rheological disorders characterized clinically by functional disorders or chewing muscles stricture, which in most cases is due to the extent of surgical trauma [12,13]. There is an obvious need to develop surgical techniques that promote preventing the rough scarring of perimaxillary tissues [14,15], and allow starting the rehabilitation activities, which help to improve the quality of patients' life, as early as possible; these factors have determined our research objective.

Objective of Research

To develop a new surgical approach for surgical interventions with optimization of functional muscle activity in the projection of subtotal defect of the mandible in order to reduce the rehabilitation period of patients.

MATERIALS AND RESEARCH METHODS

From 2010 to 2015, 18 patients have undergone surgery by the developed technique. The average age of the patients is 54 years old (18-76 years old), diagnosed with ameloblastoma (4 patients), well-differentiated adamantinoma (2 patients), fibrous dysplasia of the mandible (2 patients), and bisphosphonate osteonecrosis, complicated by pathological fracture of the mandible (10 patients). Preoperative investigation was carried out by using a computer multi spiral tomograph Toshiba Aquilion 64. After the initial computer processing of digital data the latter was converted for the creation of a virtual 3D reconstruction model. The contrast level was chosen individually in each case for bone structure visualization separately from soft tissues in creating a three-dimensional model. The obtained data was used for planning the course of the operation, which was carried out after the complete clinical and laboratory examination.

Course of the operation

A horizontal incision of mucosa was performed under endotracheal anesthesia, with nasal intubation and oropharynx tamponade, in the oral cavity over the vestibular surface up to periosteum 0.5 cm below the gingival margin, leaving three centimeters on each side from the affected mandibular bone area, and extending its 1.5-2 cm vertically downward. Further, the subperiosteal mobilization of a muco-periosteal flap was carried out with the release of peripheral branches extending from the mental foramen. The second horizontal incision was performed on the glossal side 0.5 centimeters below the gingival margin, and extended from the affected mandibular area per three centimeters towards a healthy area, followed by periosteal mobilization of a mucoperiosteal flap. Then, a vertical, full-thickness mandibular body cut was made in the frontal segment, medial to the mental foramen, with further moving of bone segment aside. In some cases, in order to preserve the peripheral innervation in the lateral fragment of the mandible, the cut of the outer cortical plate was made in the projection and throughout the mandibular vascular bundle, followed by its isolation and lateralization (Figure 1).

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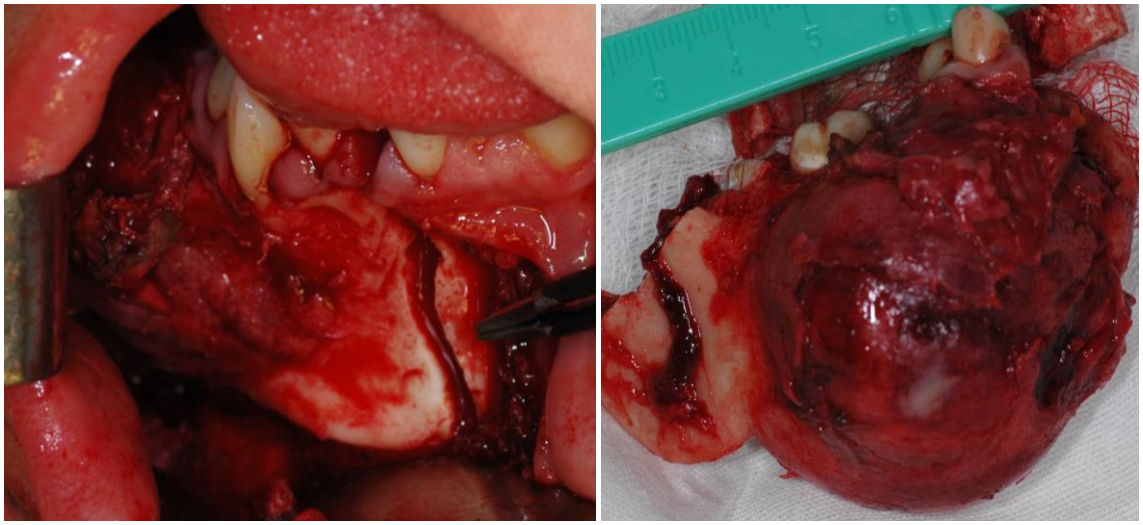

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Figure 1: a) Intraoral surgical approach, a vertical cut of the mandibular body performed medial to the mental foramen b) A removed tumor with a fragment of the mandible

Resection of the affected bone tissues was conducted within the boundaries of healthy tissue, and resection of the affected perimaxillary soft tissues was carried out with microscopic techniques. The preserved bone fragments were arranged in close anatomical position and fixed with Kirschner wires, reconstructive plates, and bone autoplastic grafts. Operating wound was closed in two to three layers; in cases of inflammatory signs, a tube, perforated drainage was retracted to the skin through the submental triangle. The surgical treatment completed with fixation of the preserved fragments with the use of intermaxillary rubber traction by means of titanium microscrews installed in the oral vestibule.

RESULTS

Retrospective analysis of the results of surgical treatment through a conventional percutaneous approach for total or subtotal resection of the mandible showed high efficiency (Figure 2). However, long-term results and the quality of life of patients were accompanied by negative reactions of both patients and their relatives.

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Figure 2: Patient P. diagnosis: Primary cancer of the mandible. a) total resection of the mandible through percutaneous approach, b) 3D reconstruction (state after resection, in 8 years)

It was found that in this study group only 1.8% of patients underwent complete radiographic and radiological examination in terms of preoperative preparation. According to data from outpatient medical records of regular medical check-ups, no follow-up studies were carried out in the postoperative period in patients of this group. The results of a retrospective analysis showed very poor aesthetic characteristics with obvious scar changes having preserved near the perimaxillary soft tissues, and lacking any functional activity. Most patients had significant weight loss not related to the cancer progression, but caused by a total resection of the mandible and by a pronounced stricture of chewing muscles, with the dislocation of scar tissues, and resulted in functional disorders of the gastrointestinal tract and the respiratory system (Figure 3).

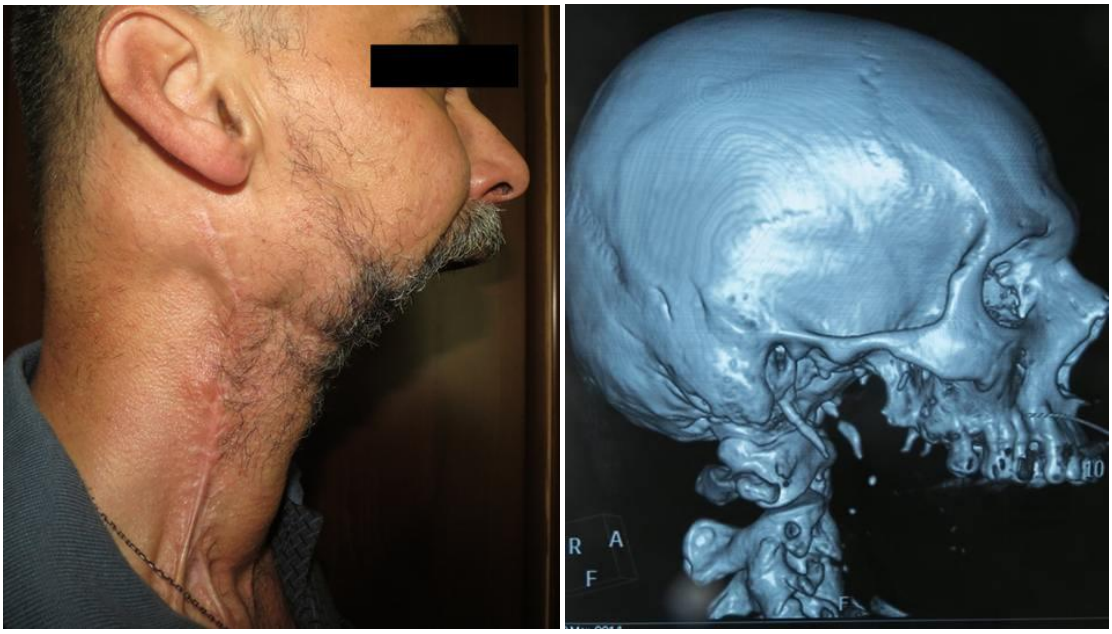

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Figure 3: Patient P. diagnosis: Primary cancer of the mandible. a) Total resection of the mandible through percutaneous approach, lateral projection b) 3D reconstruction (state after resection, in 8 years), dislocation of perimaxillary scar tissues

This group of patients in most cases have had their meals through a nasogastric tubes, and other devices. Two patients have been fed through a gastrostomy tube for 8 and 5 years, respectively. The data obtained in the retrospective group was comprehensively analyzed, with taking into account the clinical and laboratory characteristics of long-term results of surgical treatment, indicators of the quality of life of patients, and the results served as the basis for defining the objectives of the study and the direction of clinical work.

At the planning stage of surgical treatment, the volume of the excisable mandibular tissues was determined according to multislice spiral computed tomography. Using this method of study provides a sufficient amount of information needed to forecast and correct the intraoperative problems. Moreover, the X-ray radiological method allows substantiating both a set of preventive measures aimed at the prevention of complications developing in the postoperative period and the starting dates of the rehabilitation activities.

During surgical intervention carried out by the proposed method, we found a new opportunity to gently peel the muscle fibers with their subsequent anatomically sound adaptation. This available opportunity allowed restoring in the postoperative period as accurately as possible not only their topography, but also the functionality of the entire maxillofacial system, thereby significantly reducing the terms of the rehabilitation period, and optimizing them to the maximum. In addition, the said approach allows preserving the integrity of the inferior alveolar neurovascular bundle, minimizing surgical trauma of both vessels and nerves, which also helps reduce the recovery period of motor and sensory innervation and the local blood supply, which is confirmed by histological studies. Postoperatively, after 2-3 months, there was an active opposed growth of chondroid and immature bone tissues observed in the areas of the resected bone with the preserved periosteum.

The histological features identified in the projection of the preserved tendon-muscle and periosteal structures represent favorable conditions for successful reparative regeneration in case of using bone autoplastic grafts. Based on the clinical and experimental results, we can recommend the earliest possible start of applying the functional load when using intraoral method of obtaining subtotal mandibular defects.

The effectiveness of the proposed surgical approach in the reconstruction of mandibular defects has been confirmed by clinical tests.

Example of a case report

Patient E. 44 years old, admitted to the department of maxillofacial surgery of Stavropol Regional Clinical Hospital, city of Stavropol, on 09.25.2013, medical history No. 1477/4.

Diagnosis

Fibrous dysplasia of the mandible with the affected (lysis) body, branches, and the condylar and coronoid process right.

Preoperative X-ray radiological investigation was carried out by using a computer multi spiral tomograph Toshiba Aquilion 64. Processed digital data was used for creating a virtual 3D reconstruction of the facial bones (Figure 4).

The obtained data were used for planning the course of operation, the preparation for which was conducted with clinical and laboratory investigations in accordance with the standard of surgical care.

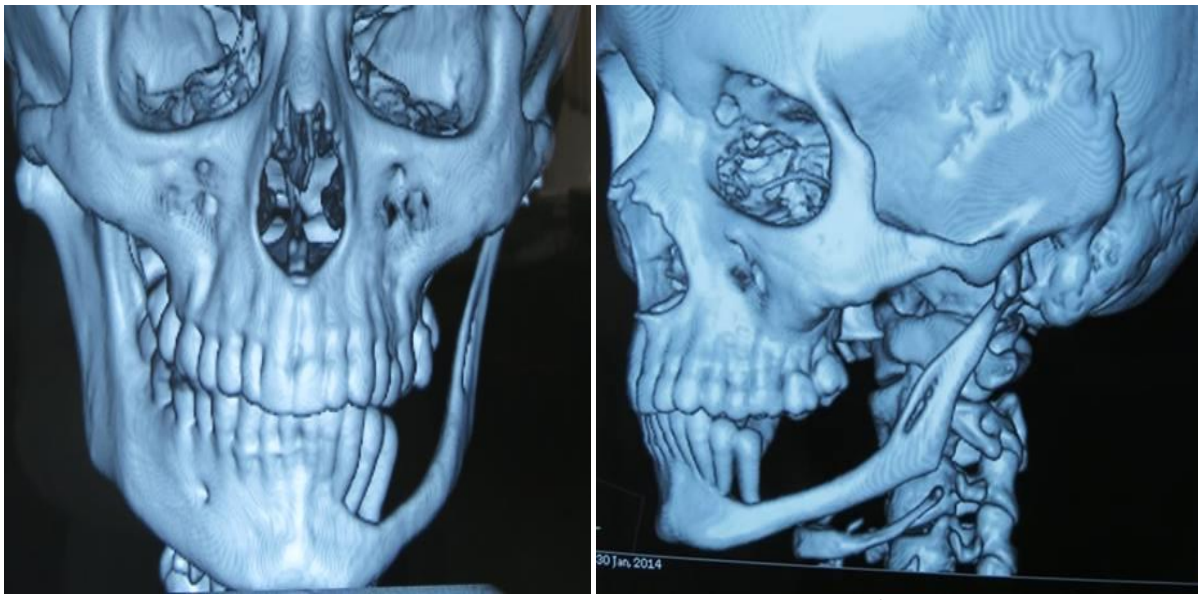

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Figure 4: a) 3D reconstruction of patient E., anterior projection b) Lateral projection

Course of the operation

A horizontal incision was performed under endotracheal anesthesia, through intraoral approach, from the 32nd tooth along the transitory fold, and extended to the upper edge of the pterygomaxillary fold left. A dissection was made in the mucosa, submucosa, and periosteum; the vestibular surface of the affected mandibular area was skeletonized. Further, the subperiosteal mobilization of a muco-periosteal flap was carried out with the release of peripheral branches extending from the mental foramen (Figure 5-a). Then, a vertical mandibular body cut was made in the frontal segment, medial to the mental foramen, with further rotation of a distal bone segment. In order to preserve the peripheral innervation in the lateral fragment of the mandible, the cut of the outer cortical plate was made in the projection and throughout the mandibular

vascular bundle, followed by its isolation and lateralization (Figure 5-b). Resection of the affected bone tissue was conducted within the boundaries of healthy tissue, and resection of the affected perimaxillary soft tissues was carried out with microscopic techniques. Then, a reconstructive plate was arranged in the anatomically close position and fixed with titanium screws to the preserved bone fragment (Figure 6-b).

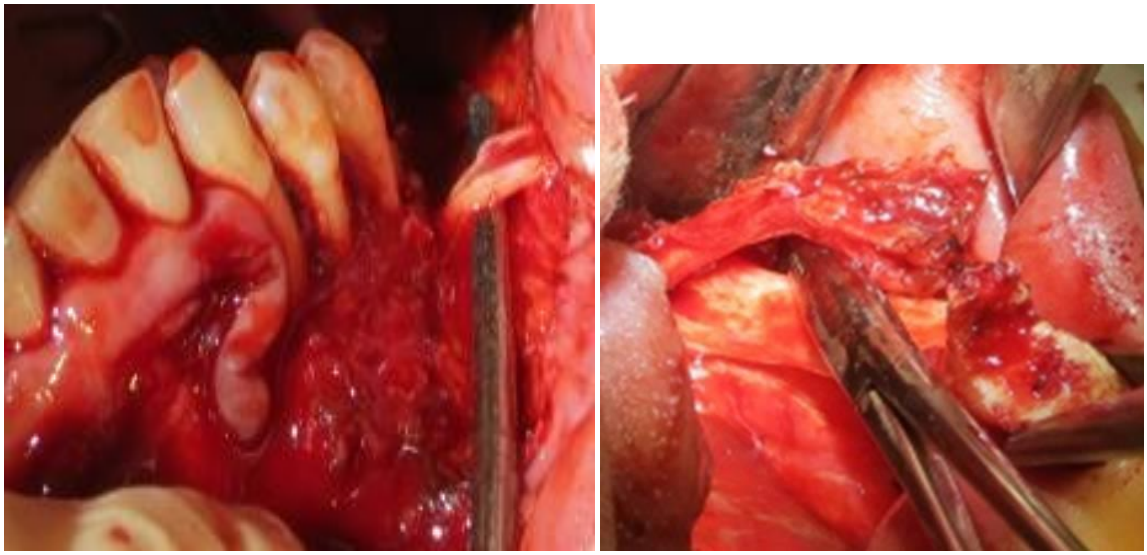

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Figure 5: a) Horizontal and vertical incision in the oral vestibule with the released peripheral branches of the neurovascular bundle; b) Extraction of the mandible with neurovascular bundle lateralization

Operating wound was closed in two to three layers, with a tube, perforated drainage retracted to the skin through the submental triangle. The surgical treatment completed with fixation of the preserved fragments with the use of intermaxillary rubber traction by means of titanium microscrews installed in the oral vestibule (Figure 6-a).

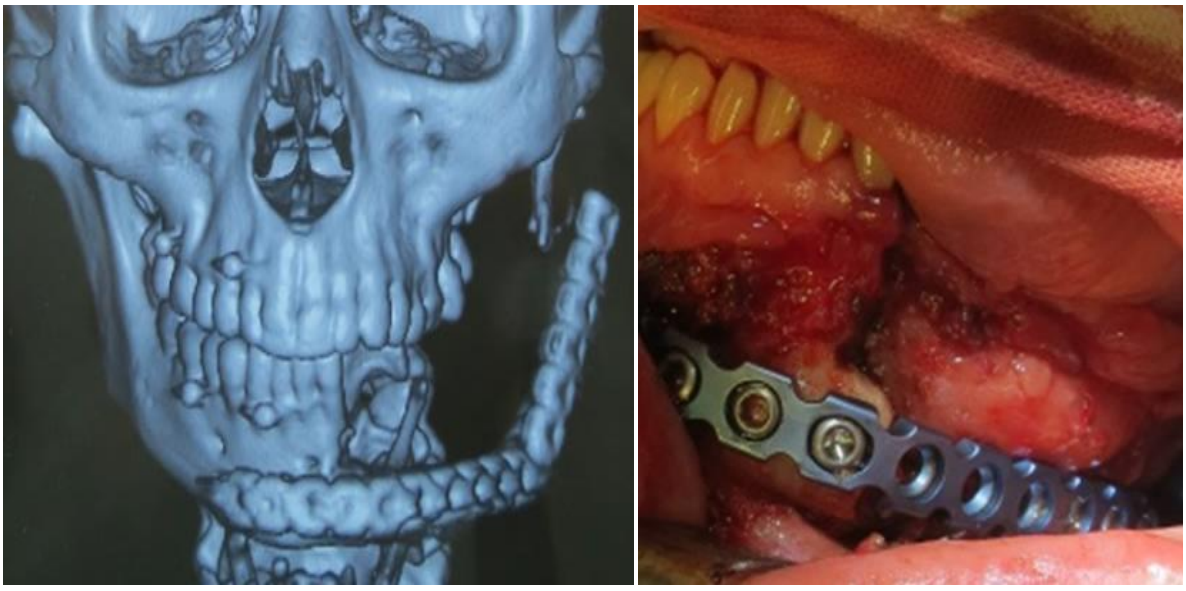

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Figure 6: a) MSCT 3D reconstruction of patient E., 2nd postoperative day. Microscrews were installed in the projection of 13-14, 16-17, 43-44, and 46-47 root ends; b) Installation and fixation of a titanium plate in the projection of the removed mandibular fragment through intraoral approach.

During the operation, the mobilized muscles such as a geniohyoid muscle, the anterior belly of the digastric muscle, a medial wing muscle, a lateral wing muscle, and a masticatory muscle from the surface of

the removed mandibular fragment were taken for ligature and fixed in the projection of the mental symphysis, and further over the entire surface of the implant in their sites of physiological attachment.

Drug-corrected postoperative period without inflammatory complications. The mandibular configuration has been restored; adequate bite status; stabilization of basic mandibular functional movements in 2 months.

The period of long-term follow-ups is over 2 years. Data of functional and clinical examination has significantly confirmed an increase in muscle mass, the presence of a functional tone and the interaction of synergistic and antagonistic muscles attached to the surface of the titanium implant in 96.2% of cases.

SUMMARY

The results of the study have shown that the surgical treatment of patients with subtotal defects of the mandible by the proposed technique ensures body-conserving tactics of gentle muscle fiber peeling with subsequent anatomically sound adaptation. This defect allowed restoring in the postoperative period as accurately as possible not only the topography of the resectable fragment, but also the functionality of the entire maxillofacial system, thereby significantly reducing the terms of the rehabilitation period. The developed surgical approach allows preserving the integrity of the inferior alveolar neurovascular bundle, minimizing surgical trauma of both vessels and nerves, which also helps reduce the recovery period of motor and sensory innervation and the local blood supply.

CONCLUSION

Thus, using a developed intraoral approach for the removal of mandible tumors made possible to reduce the surgical trauma, to adapt in optimal way bone, tendon and muscle, and neurovascular structures, and to improve the effectiveness of treatment and reduce the rehabilitation period of patients with subtotal defects of the mandible.

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