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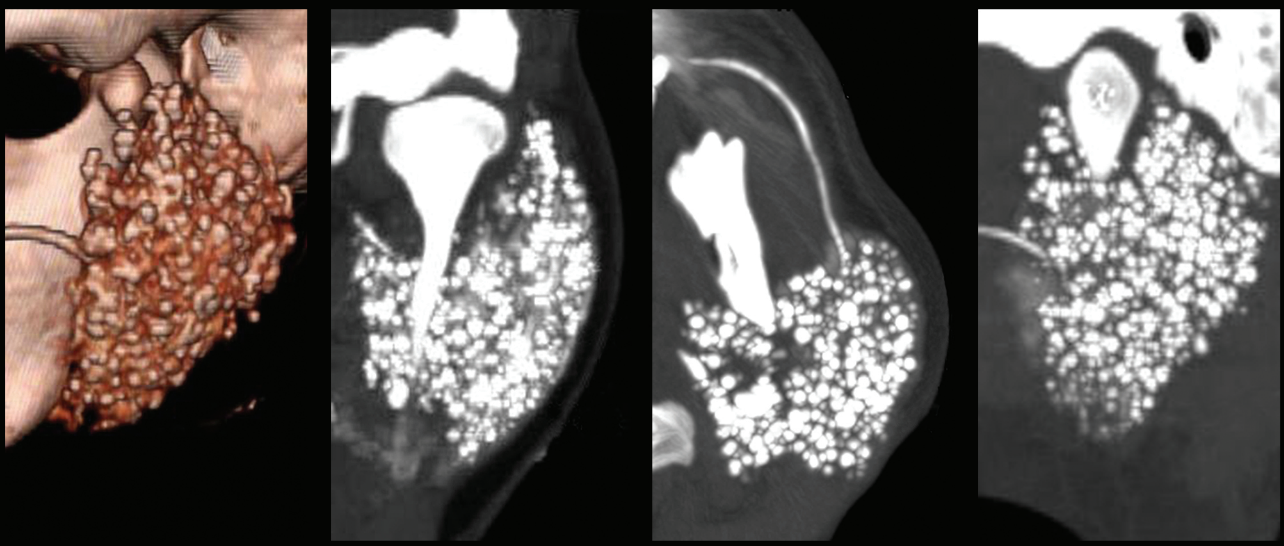

TMJ Trauma

TMJ´s Posterolateral Dislocation with Tympanic Plate Fracture. Case Report

Facial Nerve Trauma

Facial Nerve Neuropathy Caused by its Stretching

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Journal of Diagnostics & Treatment of Oral & Maxillofacial Pathology goals to publish the cutting-edge and peer-reviewed articles on work in oral and maxillofacial surgery and neighboring specialties. The journal includes the following topics: implants surgery, head and neck imaging, microvascular and reconstructive surgery, oral and maxillofacial pathology, head and neck surgery/oncology, TMJ lesions/disorders, head and neck trauma, plastic surgery, pharmacology/drugs.

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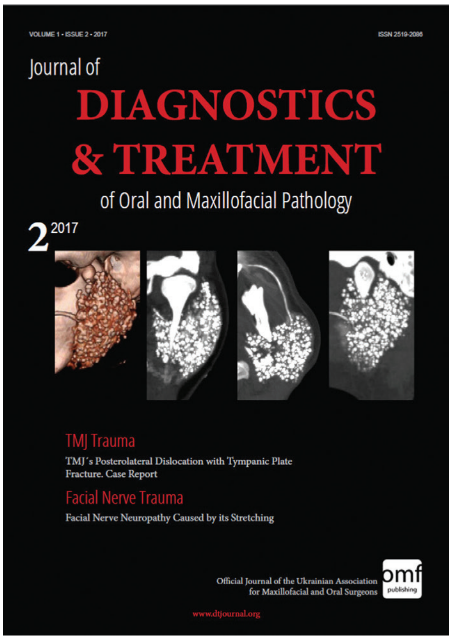

Cover images (Multidetector CT sialogram scans of the left parotid gland of 35-year-old female with Sjogren's syndrome) are courtesy of: Dr. Tetiana O. Shamova (Diagnostic Center "Asklepii", Kyiv, Ukraine), Dr. Ievgen I. Fesenko (Department of Oral & Maxillofacial Surgery, PHEE "Kyiv Medical University", Kyiv, Ukraine), Lesia Ie. Smirnova (Kyiv, Ukraine)

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Editorial

Swimming in the Oceans of Media Technologies

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ABOUT ARTICLE

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Dr. Rod Rodrich, an Editor-in-Chief of the *Plastic and Reconstructive Surgery* (USA) in the April Issue's Editorial [1] provides us with a great review of how the media influences the surgery specialties. It's the holy truth. People day by day become more interested in medical information technologies provided by social media such as Instagram, Facebook, Twitter, and Telegram. It has become normal for non-medics. Some people follow the plastic surgeon and watch how the liposuction is performed in OR. Others follow maxillofacial surgeon watching how the fibula free flap surgery is performed [Fig 1] with the help of precise 3D printing.

FIGURE 1. Instagram post of Dr. Todd Hanna (New York, USA) demonstrates the surgical plan of fibula free flap technique upon mandibular defects not only as educational case for less experienced colleagues but also informing future patients about surgical stages. It facilitates patients` understanding of the treatment and helps colleagues to get different experience.

The surgeons certainly are more interested in this digital movement than others.

It's a new way to find new patients, friends, colleagues, mentors and others. By sharing posts and movies, the surgeons reveal the secrets [Figs 2, 3] of the operating room, which other colleagues have not even seen.

We should meet the new challenges. We should use its advantages as well as we must become a "long term thinkers in a digital first environment" as Seave A. (2015) called Ron Mobed, CEO of Elsevier, in *Forbes* [2].

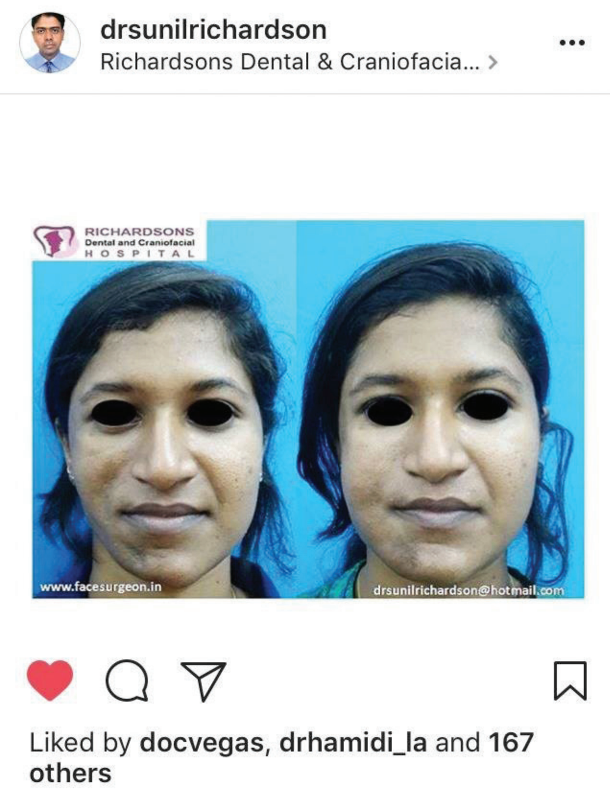

FIGURE 2. Instagram post of Dr. Sunil Richardson (Nagercoil, India) demonstrating the result of treatment of Parry-Romberg syndrome – hemifacial atrophy.

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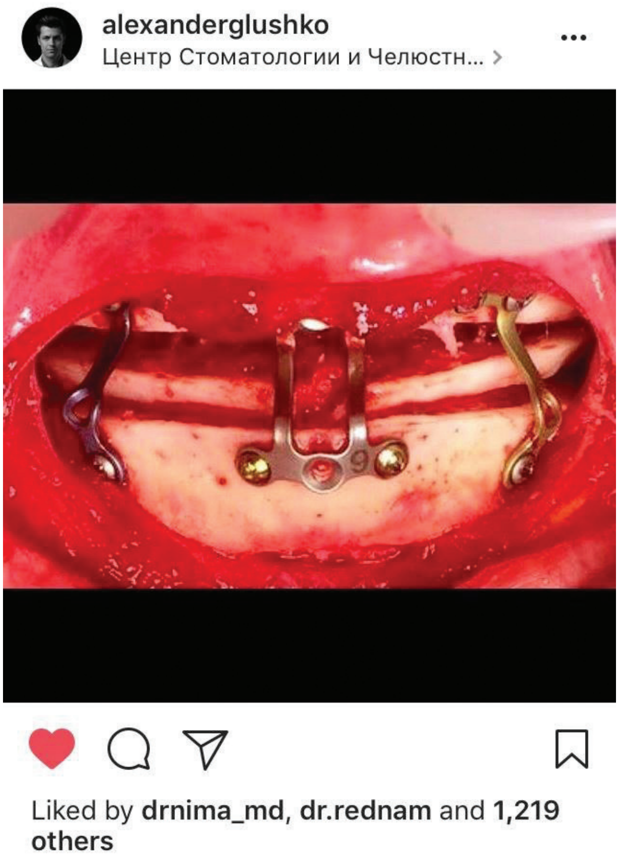

FIGURE 3. Instagram post of Alexander Glushko, PhD (Moscow, Russia): "This is how the stepped osteotomy of the chin looks. This technique allows to achieve more stable movement, a softer transition without sharp protrusions and it almost never requires additional bone plasty".

Dr. Rodrich made deep analysis of the whole spectrum of social media (Twitter, SnapChat, Facebook, LinkedIn, etc.). I would like to discuss Instagram with you. Please, do not judge too harshly, but yes, I created my Instagram page only in 2017. But in a short period of being an Instagram user I was impressed of its advantages and impact on maxillofacial surgery. I'm not advertising Instagram, but want to say how surgeons can benefit from it. E-mails are staying more and more boring and heavier compared to quick to post, quick to read, and quick to answer Instagram.

We all benefit from sharing our routine surgical procedures. Our patients benefit because they become more informed. Surgeons benefit because they become more experienced and can make medical connections with specialists with whom they only dreamed of becoming in touch. And what is most important is that the development of our specialty is dynamic.

When swimming in the oceans of media technologies we should be careful not to drown in not evidence-based medical science which result in unproved achievements for both our practice and patients.

For this purpose, the *Journal of Diagnostics and Treatment of Oral and Maxillofacial Pathology* is our safe boat which can bring us with peer-reviewed science to the coast we want to reach.

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Patient Consent

Written patient consent was obtained to publish the clinical Instagram photographs.

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TMJ´s Posterolateral Dislocation with Tympanic Plate Fracture – Case Report

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ABSTRACT

Temporomandibular joint (TMJ) dislocation is characterized by mandibular condyle dislocation out of articular cavity, fixated in an abnormal position in which self-reduction it is not possible. The TMJ traumatic dislocation occurs after medium and high intensity trauma directly on the joint or on symphyseal area and it is generally associated to fractures. This report documents a case of an unusual posterolateral dislocation of the left condyle with tympanic plate fracture, insignificant fracture of mandibular condyle, and discuss about the clinical symptoms, classification of dislocations, and treatment. A list of similar cases from the last 10 years is also showed.

Introduction

Temporomandibular joint (TMJ) dislocation is characterized by mandibular condyle dislocation out of the articular cavity, fixated in an abnormal position in which self-reduction is not possible. Commonly, the dislocation occurs in the anterior direction after wide open mouth movement associated with spasm of masticatory muscles [1].

The TMJ movements are guided by the masticatory muscles and limited by articular ligaments. The factors considered essential to such injury to occur are the size and direction of applied force, the position of the jaw (mouth in a wide-open position) and the anatomic features of the joint, such as ligament laxity. The TMJ traumatic dislocation occurs after medium and high intensity trauma directly on the joint or on symphyseal area. This kind of TMJ dislocation is in almost all cases associated to fractures and it is very uncommon a TMJ dislocation without condylar fracture [2]. The aim of this paper is to describe a case of posterolateral dislocation of the TMJ with tympanic plate fracture and a tiny medial condylar segment.

Case Report

A 27-year-old man was referred to the Oral and Maxillofacial Surgery (Restauração Hospital, Recife/Brazil) because he could not open his mouth and referred otalgia and hearing loos after a fall. Physical examination showed facial asymmetry and severe deviation of the mandibular midline to the left side (Fig 1A) associated with cross bite

FIGURE 1. Deviation of the mandibular midline (**A**). **(Fig 1 continued on the next page.)**

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FIGURE 1 (cont'd). Cross bite malocclusion (**B**).

malocclusion (Fig 1B). The patient was not able to do any mandibular movement. An external protuberance on the lateral of the left zygomatic arch was evident.

A computed tomography (CT) scans showed posterolateral dislocation of left TMJ with tympanic plate fracture in the ipsilateral side and a tiny bone medial spicule of the condyle (Figs 2, 3). No significant mandibular fractures were noted. The manual reduction would be attempted first under local anesthesia and sedation.

The treatment consisted in administration of midazolam orally, thirty minutes before the procedure, and anesthetic block of auriculotemporal nerve. The surgeon realized closed reduction with mandibular traction to the anterior and contralateral position. During the procedure, the patient was conscious and did not referred pain. After procedure bleeding from left ear was noted, but it was self-limiting (Fig 4).

The left condyle returned to its original position. The patient was oriented to limit the jaw movements and take liquid diet for seven days. Non-steroidal anti-inflammatory drugs were prescribed for four days. Because his otalgia and hearing loss, he was referred to an otorhinolaryngology service.

The postoperative course was uncomplicated and the patient was discharged with almost normal mandibular movement and 35 mm mouth opening seven days later. Facial contour and occlusion after reduction were

FIGURE 2. 3D-CT shows posterolateral dislocation of the left TMJ and cross bite malocclusion

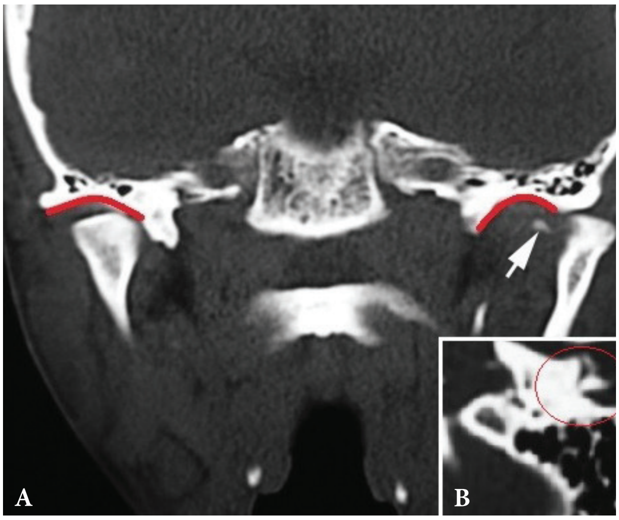

FIGURE 3. Coronal CT scan (**A**) shows posterolateral dislocation of the left TMJ with tympanic plate fracture in the ipsilateral side and a tiny medial bone spicule (*arrow*) of the condyle. Glenoid fossas are indicated by *red curves*. On the sagittal CT scan of the condyle (**B**) the red circle indicates the fracture of tympanic plate.

FIGURE 4. Bleeding from left ear (self-limiting)

satisfactory (Fig 5).

The follow-up was of two years; mandibular function was normal but hearing loss was still present.

Discussion

To review similar cases of unusual TMJ dislocations in the English literature a Pubmed search was conducted using the following search criteria: (Unusual or rare) and (dislocation or luxation) and (TMJ). Bu et al [3] reported their case and 17 additional cases until 2007. Prabhakar and Singla et al [4] reported their case, the 17 cases described by Bu et al [2] and one additional case until 2011. Three additional cases were identified until June 2017 by the authors of this paper [5, 6, 7]. Details of cases of the last ten year are descried in Table 1.

Allen and Young [8] purposed a classification for TMJ dislocations. They classified these dislocations in Type I (lateral subluxation) and Type II (complete dislocation). Satoh et al [9] (Table 2) purposed three subcategories for Type II dislocations: IIa, in which the condyle is not hooked above zygomatic arch; IIb, in which the condyle hooked above the zygomatic arch and IIc, in which condyle lodged inside zygomatic arch, which is fractured.

In this case, hearing loss and otalgia was referred for the patient. The CT scans showed a small fracture on the left tympanic plate. The pain was controlled by non-steroidal anti-inflammatory drugs after the procedure and he was immediately referred to an otorhinolaryngology service to investigate his hearing loss The signs of tympanic plate fracture are usually manifested early and includes: otorrhagia, otalgia, hearing loss and stenosis of the external auditory canal. Hearing deficits is due to rupture of the tympanic membrane, laceration of the auditory canal anterior wall, edema of the TMJ or disarticulation of the

FIGURE 5. Facial contour (**A**) and occlusion (**B**) after reduction were satisfactory.

auditory ossicles. When the acoustic nerve is damaged, permanent deafness may occur [10].

Nakashima et al [2] described a case of anterior TMJ dislocation overlooked for more than two decades where the patient referred aural symptoms. There is no study suggesting that anterior dislocation has relevance in aural symptoms. This can be justified by the stretching of the anterior malleolar ligament of the malleus but this hypothesis has not been proved.

The usual treatment for TMJ dislocation consists in manual reduction with controlled traction under local or general anesthesia, which depends on patient conditions [5]. Surgical techniques are needed when non-surgical methods have failed. Deng et al [11] suggests that endoscope-assisted reduction is a great treatment method for TMJ dislocation, mainly for long-standing condylar dislocation. They justify that endoscope-assisted reduction provides a good TMJ view with a small incision which minimizes the risk of surgical complications.

It is difficult to determine a specific treatment protocol for posterior dislocation into the external auditory canal because there are not many reports. Vasconcelos et al [5] reported a case of posterior dislocation where the manual reduction under local anesthesia failed, so the patient was treated by closed reduction under general anesthesia using percutaneous traction with a zygomatic hook placed in the mandibular notch.

The purpose of treatment consists: Repositioning the condyle in the glenoid fossa; observing the involvement of the tympanic plate or external ear canal; maintaining the patency of the external auditory canal and prevent TMJ ankylosis and infection [9]. In the present case, the reduction was performed under local anesthesia and sedation with satisfactory results.

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None.

TABLE 1. Details of Unusual Cases of TMJ Dislocations Identified by the Authors (Last 10 Years)

Author	Year of Publication	Type of Dislocation	Etiology/ Reduction Time (Days)	Treatment	Follow Up
Prabhakar and Singla	2011	Bilateral anterosuperior dislocation intact mandibular condyles in the temporal fossa	Fall/45 days	Manual reduction under general anesthesia failed. Open treatment was performed. Left side: Eminectomy and high condylar shave. Right side: Condylectomy with coronoidectomy	9 months: Maximal mouth opening of 33 mm with adequate mandibular function and occlusion
Vasconcelos, Rocha and Cypriano	2010	Posterior dislocation of an intact mandibular condyle	Trauma to the chin/same day of the accident	Manual reduction under general anesthesia, using percutaneous traction with a zygomatic hook placed in the mandibular notch	2 weeks: Limited mouth opening
Papadopoulos and Edwards	2010	Superolateral dislocation of an intact mandibular condyle	Motor vehicle accident/same day of the accident	Manual reduction under local anesthesia, parenteral sedation and general anesthesia were unsuccessful. Right coronoidectomy was performed and intermaxillary fixation for 2 weeks	6 weeks: Maximum incisal opening of 32 mm (physiotherapy was required due to limited opening weeks before)
Li et al.	2009	Superolateral dislocation of an intact mandibular condyle	Motorcycle accident/same day of the accident	Manual manipulation under general anesthesia with muscle relaxant	6 months: Mouth opening distance was maintained and there were no symptoms of disorders in both condyles
Bu et al.	2007	Superolateral dislocation of an intact mandibular condyle into the temporal fossa	Motorbike accident/ 5 days	Manual reduction under general anesthesia failed. Mouth-gags to make the patient's mouth as large as possible were used and the forceps mouth-gags were turned around in a clockwise direction. Intermaxillary fixation for 2 weeks was performed	2 months: Maximal mouth opening and free mandibular movement. 12 months: Free of symptoms

TABLE 2. Classification of TMJ Dislocations.

Classification	Clinical Features
Allen and Young (1969)	
Type I	Lateral subluxation
Type II	Complete dislocation
Satoh et al (1994) modification	
Type IIA	Condyle is not hooked above zygomatic arch
Type IIB	Condyle hooked above zygomatic arch

Conflict of Interests

The authors declare no conflict of interest.

Role of Author and Co-authors

Alípio Miguel da Rocha Neto (concept of the paper and writing).
João Luiz Gomes Carneiro Monteiro (material collection and writing).
Patrícia Mendonça Borba (material collection).
Auremir Rocha Melo (material collection).
Lívia Mirelle Barbosa (material collection).
Belmiro Cavalcante do Egito Vasconcelos (editing).

Ethical Approval

Approval was obtained from the Medical Ethics Committee of the University of Pernambuco.

Patient Consent

Written patient consent was obtained to publish the clinical photographs.

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Задньобоковий вивих скронево-нижньощелепного суглобу з переломом барабанної пластинки скроневої кістки. Клінічний випадок

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Вивихи СНЩС
Оталгія
Кровотеча з вуха

РЕЗЮМЕ

Для вивиху скронево-нижньощелепного суглобу (СНЩС) характерне зміщення суглобової голівки нижньої щелепи із суглобової ямки. При цьому голівка зафіксована в ненормальному положенні, при якому самостійне повернення в ямку неможливе. Посттравматична дислокація СНЩС відбувається після травми середньої та високої інтенсивності безпосередньо на ділянку суглобу або на ділянку симфізу нижньої щелепи, і це, як правило, в поєднанні з її переломами. У цій доповіді подано приклад незвичного задньобокового вивиху лівої суглобової голівки з переломом барабанної пластинки скроневої кістки і незначним переломом суглобової голівки нижньої щелепи. Проведено обговорення клінічні симптоми, класифікації вивихів та їх лікування. Також проведено аналіз подібних випадків за останні 10 років.

Заднебоковой вывих височно-нижнечелюстного сустава с переломом барабанной пластинки височной кости. Клинический случай

Алипио Мигель да Роча Нэто[1], Жоао Луиз Гомес Камеиро Монтеиро[2], Патриция Медонса Борба[3], Ауремир Роча Мэло[4], Ливия Мирель Барбоса[5], Бельмиро Кавальканте до Эгито Васконселос[6]

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РЕЗЮМЕ

Для вывиха височно-нижнечелюстного сустава (ВНЧС) характерно смещение суставной головки нижней челюсти из суставной ямки. При этом головка зафиксирована в ненормальном положении, при котором самостоятельное возвращение в ямку невозможно. Посттравматическая дислокация ВНЧС происходит после травмы средней и высокой интенсивности непосредственно на участок сустава или на участок симфиза нижней челюсти, и это, как правило, в сочетании с ее переломами. В этом докладе приведен пример необычного заднебоковом вывиха левой суставной головки с переломом барабанной пластинки височной кости и незначительным переломом суставной головки. Проведено обсуждение клинических симптомов, классификаций вывихов и их лечения. Также проанализированы подобные случаи за последние 10 лет.

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Surgical Note

Anterior Maxillary Distraction – a Boon to Treat Cleft Maxillary Hypoplasia

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ABSTRACT

We describe our experience of using anterior maxillary distraction for the correction of cleft related maxillary hypoplasia. Clear historical overview and meticulous description of the surgical technique are given. The technique is described step-by-step from the type of incision to the prosthetic rehabilitation. An advantage of anterior maxillary distraction over the other conventional techniques is reasoned. The paper is illustrated both the view of intra-oral tooth-borne screw appliance and four representative cases. This technique provides excellent well-predicted result and can be widely recommended in anterior maxillary distraction.

Introduction

Age-old techniques like Le Fort I osteotomy and Le Fort I distraction have been used for correction of cleft related maxillary hypoplasia [1]. In 2003, Dolanmaz first used the anterior segmental maxillary distraction technique [2]. Since then it has become a very useful technique for correction of cleft related maxillary hypoplasia. The greatest advantage of anterior maxillary distraction over the other aforementioned conventional techniques is that since only the anterior portion of the maxilla is being moved forward, there is no worsening effect on velopharyngeal closure [3, 4].

Surgical and Prosthetic Techniques

The appliance (Fig 1) can be placed intra-operatively as advocated by Gunaseelan or it can be placed prior to operation as practiced by the author. This prevents cement failure. The procedure takes place under general anesthesia with oral endotracheal intubation. A maxillary vestibular incision is made from first molar to another molar. The mucoperiosteum is reflected to expose the maxillary bone up to the infraorbital foramen. A buccal linear osteotomy cut is made on both sides at a similar level with a 701 bur under copious irrigation above the level of the root apices from the pyriform rim to the predetermined distraction site between the premolars and molars parallel to the occlusal plane. Lateral nasal osteotomes are used to cut the lateral nasal wall from the pyriform rim at the same level of the buccal cut on both sides. Care is taken to protect the nasal mucosa. The nasal septum is then transected at its base just beyond the distraction site using a guarded septal

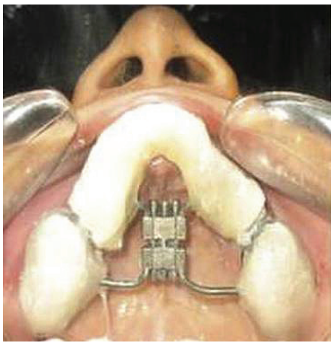

FIGURE 1. Intra-oral tooth-borne screw appliance.

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CASE 1. Result after anterior maxillary distraction. Photographs before (**A**) and after (**B**) treatment.

osteotome. Vertical interdental cuts are made between the second premolar and first molar through the buccal cortex using a bur. These are then deepened using spatula osteotomes. This is followed by palatal osteotomy using a curved osteotome with very gentle force because using tactile sensation for guidance. The palatal bone is not cut completely to avoid damage to the periosteum. Luxation on both sides is performed using gentle force to fracture the anterior maxilla. The completion of the osteotomy cut is confirmed by activation of the distractor screw intraoperatively and symmetrical movement on both sides was confirmed. Closure of the vestibular incision was then performed using a 3-0 Vicryl suture. Activation of the screw starts typically on the fifth postoperative day and at the rate of four turns twice a day. This advances the maxilla by 0.72 cm per day.

After completion of distraction, the maxilla is left for consolidation for 12-14 weeks. Thereafter the appliance is removed and prosthetic rehabilitation for the gap created is done by fixed partial denture (FPD)/dental implants

Conclusions

This technique improves dental arch crowding, advances the maxilla and improves the profile of the patient and is also better for the speech of the patient [5].

CASE 2. Patient showing good results after anterior maxillary distraction. Photographs before (**A**) and after (**B**) treatment.

CASE 3. Excellent improvement in facial profile. Clinical photographs before (**A**) and after (**B**) treatment.

CASE 4. Improvement in facial profile. Clinical photographs before (**A**) and after (**B**) treatment.

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Conflict of Interests

The authors declare no conflict of interest.

Role of Author and Co-authors

Sunil Richardson (concept of the paper and writing).
Dhivakar Selvaraj (material collection and writing).
Shreya Krishna (editing).

Ethical Approval

Approval was obtained from the Medical Ethics Committee of the Rajas Dental College and Hospital.

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Written patient consent was obtained to publish the clinical photographs.

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Хірургічний запис

Дистракція переднього сегменту верхньої щелепи – перевага в усуненні недорозвитку верхньої щелепи, спричиненого її розщілиною

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Остеотомія по Ле Фор I
Дистракція по Ле Фор I
Піднебінно-глоткове з'єднання
Гвитовий апарат з опорою на зуби
Частковий фіксований протез з опорою на імплантати

РЕЗЮМЕ

Ми описуємо наш досвід використання дистракцій переднього сегмента верхньої щелепи для корекції недорозвитку верхньої щелепи, спричиненим її розщілиною. Наведено чіткий історичний огляд і докладний опис хірургічної техніки. Методика описується покроково від типу розрізу до ортопедичної реабілітації. Обґрунтована перевага дистракції переднього сегмента верхньої щелепи порівняно з іншими класичними методами. Стаття проілюстрована гвинтовим апаратом з опорою на зуби, який використовується в цій методиці, так і на чотири клінічні випадки. Ця методика забезпечує відмінний, добре прогнозований результат і може бути широко рекомендована для дистракції переднього сегмента верхньої щелепи.

Хирургическая записка

Дистракция переднего сегмента верхней челюсти – преимущество в коррекции недоразвития верхней челюсти вызванного её расщелиной

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Дистракция по Ле Фор I
Небно-глоточное смыкание
Винтовый аппарат с опорой на зубы
Частичный фиксированный протез с опорой на имплантаты

РЕЗЮМЕ

Мы описываем наш опыт использования дистракций переднего сегмента верхней челюсти для коррекции недоразвития верхней челюсти, которое вызванное ее расщелиной. Приведен четкий исторический обзор и описание хирургической техники. Методика описывается пошагово от типа разреза к ортопедической реабилитации. Обосновано преимущество дистракции переднего сегмента верхней челюсти по сравнению с другими классическими методами. Статья проиллюстрирована как винтовым аппаратом с опорой на зубы, что используется в этой методике, так и на четырьмя клиническими случаями. Эта методика обеспечивает отличный, хорошо прогнозируемый результат и может быть широко рекомендована для дистракции переднего сегмента верхней челюсти.

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Facial Nerve Neuropathy Caused by its Stretching

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ABSTRACT

Purpose.
Study the dynamics of changes in electrophysiological parameters of the facial nerve in cases after operative interventions on the parotid and submandibular glands, as well as determine the possibility of using electrical stimulation of the nerve on the hardware-software complex "DIN-1" for the treatment of neuropathy caused by its stretching.
Patients and Methods.
31 patients were examined after surgery on the parotid and submandibular glands.
Results.
Based on the performed patient examinations after parotidectomy and extirpation of the submandibular glands, it was established that in the postoperative period they may have neuropathy of the facial nerve, the cause of which is the stretching of the nerve. Clinical improvement and elimination of symptoms were correlated with normalization of electrophysiological indices of the state of affected branches of the facial nerve.
Conclusions.
Due to the use of the hardware-software complex "DIN-1" for diagnosis and treatment of the facial nerve neuropathy caused by its stretching, we managed not only to identify and prove the existence of this disease, but also to shorten the terms of rehabilitation of patients 4 times.

Introduction

In recent years, according to our clinic, the number of patients with tumors and tumor-like formations of parotid salivary glands has increased [1-3]. The most common complication after performing such a complex surgical intervention as parotidectomy is paralysis of the facial nerve or its individual branches.

Often, tumors or tumor-like formations of the parotid gland are under the branches or trunk of the facial nerve. The branches of the facial nerve, being under the tumor, are already in the "stretched state". In order to separate the facial nerve or its branches from a tumor or tumor-like formation, it is necessary to "isolate" the branches of the nerve while slightly stretching them. In this way, we can remove the pathological focus with minimal trauma to the facial nerve (Fig 1). In the postoperative period, these patients develop neuropathy of the facial nerve or its branches.

The purpose of the study was to investigate the dynamics of changes in the electrophysiological indices of the "stretched" facial nerve in patients with tumors and tumor-like formations of the parotid glands and submandibular glands after surgical interventions and to determine the possibility of using electrical stimulation of the nerve at the hardware-software complex "DIN-1" in the rehabilitation period for treatment of neuropathy.

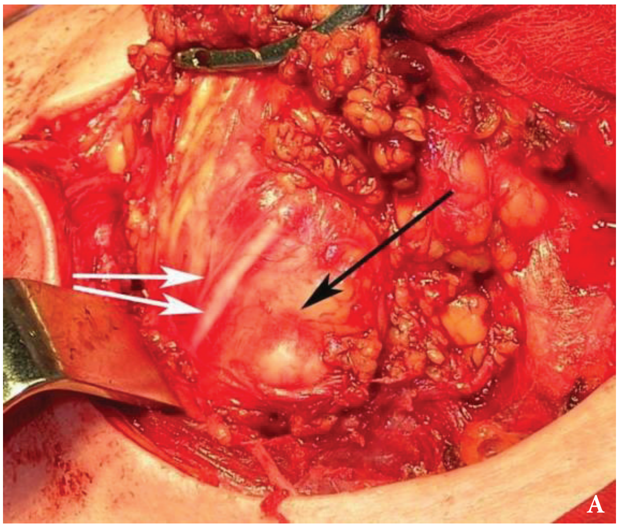

FIGURE 1. Intraoperative view (**A**) of the parotid gland tumor (*black arrow*) located under the branches of the facial nerve (*white arrows*) **(Fig 1 continued on the next page.)**

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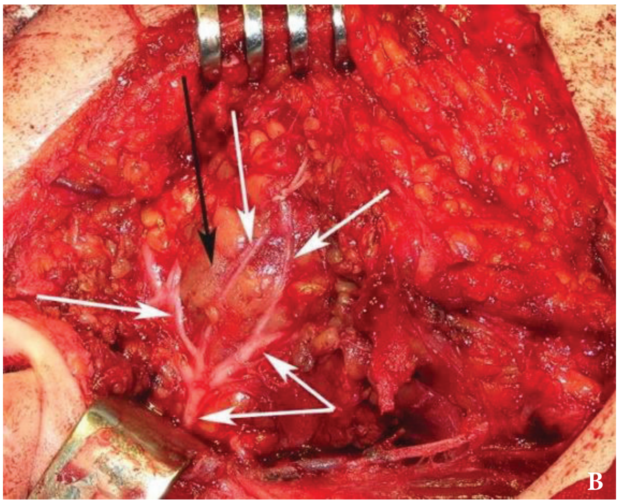

FIGURE 1 (cont'd). Intraoperative view (**B**) of the parotid gland tumor (*black arrow*) located under the branches of the facial nerve (*white arrows*).

Patients and Methods

Under our supervision, there were 31 patients aged 18 to 60 years who underwent operations on the parotid gland – parotidectomy and submandibular gland – extirpation of the gland. The operations were carried out for the removal of benign tumors and tumor-like formations of major salivary glands. In all these examined cases tumors or tumor-like formations were under the branches or trunk of the facial nerve. Therefore, when carrying out parotidectomies, we had not to break the integrity of the nerve, stretch its branches, separate and move them away from tumor formation. At the same time, the integrity of the nerve trunk was preserved and, in our opinion, the operations were performed with minimal trauma to the facial nerve. However, the next day after such operations, neuritis (neuropathy) of certain branches of the facial nerve was diagnosed; i.e. the patient had a paralysis of his facial muscles. In surgical interventions (removal of tumors) on the parotid glands, any branch (depending on the localization of the pathological focus) of the facial nerve was involved in the pathological process (stretching), and when removing the submandibular glands, only the marginal branch of this motor nerve was involved.

The depth of paralysis of facial muscles was determined according to the most accessible and universal, in our opinion, six-degree system (scale) according to House W.F., Brackmann D.E. (1985) [4]. Some authors (Kang TS, et al., 2002; Vrabec JT, et al., 2009) [5-7] proposed to make some changes into the House and Brackmann six-degree system. But initially a six-degree scale for the determination of facial paralysis by House-Brackmann (1985) is next:

Normal (1 degree) – the symmetry of the face corresponds to the morphophysiological features of the individual. There are no deviations in the functions of facial muscles during rest or arbitrary movements, pathological involuntary movements are excluded.

Slight paralysis (2 degree) – during rest symmetrical face. Arbitrary movements: the skin of the forehead is folded; Moderate effort when closing eyes; Asymmetry of the mouth during a conversation.

Moderate paralysis (3 degree) – during rest there is a slight asymmetry of the face. Arbitrary movements: forehead skin – moderate; Eyes completely close with difficulty; when the angle of the mouth moves, there is a slight weakness, movement is made with effort.

Moderately severe paralysis (4 degree) – during rest there is an asymmetry of the face, as well as reduced muscle tone. Arbitrary movements: the forehead's skin is motionless; Eyes cannot be completely closed; there is an asymmetry when moving corner of the mouth, the movement of the muscles is difficult.

Severe paralysis (5 degree) – during rest there is a considerable degree of asymmetry of the face. Arbitrary movements: the forehead's skin is motionless; Eyes do not close completely, when closed, the pupil rises; Mouth asymmetric, motionless.

Total paralysis (6 degree) – the patient's face is still, a masklike face (usually one half). Arbitrary movements of the skin of the forehead, mouth, eyes are absent.

To measure the static and dynamic electrophysiological parameters (conduction, resistance, tone) of soft tissue sites that are innervated by the facial nerve, 31 subjects were equipped with a hardware-software complex for diagnosis and treatment (with simultaneous electrical stimulation of the nerve) "DIN-1" [8, 9]. For the treatment of this neuropathy, we conducted two courses of electrostimulation of the nerve (one course of electrostimulation lasted for 7 days) with a break of also 7 days, i.e. rehabilitation treatment lasted 21-22 days.

The control of the electrophysiological parameters of the facial nerve (conduction, resistance and tone) was 32 subjects – practically healthy people of the same age, without concomitant diseases. The control group of the duration of the treatment of postoperative neuropathies was 36 patients after operations on the parotid and submandibular glands (if there was a stretching of the facial nerve during the operation). This control group in the postoperative period used traditional medicaments (Nucleo CMP forte (Grupo Ferrer Internacional, S.A., Spain) and Neurovitan (Hikma Pharmaceuticals PLC, Jordan)), i.e. rehabilitation treatment for these patients was carried out without the use of the hardware-software complex "DIN-1".

The obtained digital survey data was processed by a conventional variational-statistical method using a personal computer and statistical software package "SPSS 11.0 for Windows" and "Microsoft Excel 2000". Reliability of the survey results was assessed by Student criteria. Differences were considered significant at $P < 0.05$.

Results

A study of the depth of the paralysis of facial muscles with neuropathies caused by the stretching of the facial nerve (with electrical stimulation on the hardware-software complex "DIN-1") showed that the next day after the operation, the moderately severe paralysis (4 degree) was detected in 18 of 31 patients (in 58.0%), moderate paresis (3 degree) was observed in 10 subjects (32.3%), slight paralysis (2 degree) – in 3 patients (9.7%). On the 3rd day after parotidectomy: the moderately severe paralysis (4 degree) was detected in 18 of 31 patients (58.0%), moderate paralysis (3 degree) was observed in 10 subjects (32.3%), slight paralysis (2 degree) – 3 people (9.7%). On the 7th day after the operation: the average paralysis (4 degree) was detected in 15 of 31 patients (in 48.4%), moderate paresis (3 degree) was observed in 9 subjects (29.0%), minor paralysis (2 degree) – in 7 people (22.6%). On the 14th day after the surgical intervention: the moderately severe paralysis (4 degree) was detected in 3 of 31 patients (9.7%), moderate paralysis (3 degree) was observed in 13 subjects (41.9%), slight paralysis (2 degree) – in 15 people (48.4%). On the 21-22 day after parotidectomy: a slight paralysis (2 degree) was observed in 4 subjects (12.9%), and the norm (1 degree) was observed in 27 patients (87.1%).

A study of the depth of the paralysis of facial musculature with neuropathies caused by nerve stretching in 36 patients of the control group (without treatment with the hardware-software complex «DIN-1») showed that on the next day after the operation, the moderately severe paresis (4 degree) was detected in 22 of 36 patients (61.1%), moderate paralysis (3 degree) were observed in 10 subjects (27.8%), slight paralysis (2 degree) – in 4 patients (11.1%). On the 7th and 14th days after parotidectomy: the moderately severe paralysis (4 degree) was detected in 22 of 36 patients (61.1%), moderate paralysis (3 degree) was observed in 10 subjects (27.8%), slight paralysis (2 degree) – 4 people (11.1%). On the 21-22th day after the operation: the moderately severe paralysis (4 degree) was detected in 15 of 36 patients (41.7%), moderate paralysis (3 degree) was observed in 9 subjects (25.0%), slight paralysis (2 degree) – in 12 people (33.3%). One (1) month after the operation: middle paresis (4 degree) was detected in 6 of 36 patients (16.7%), moderate paralysis (3 degree) was observed in 18 subjects (50.0%), slight paralysis (2 degree) – in 12 people (33.3%). Three (3) months after the operation, a slight paralysis (2 degree) was observed in 5 subjects (13.9%), and a norm (1 degree) in 31 patients (86.1%).

On the next day after the surgery (Fig 2), the average arithmetic index of conduction of the marginal branch of the facial nerve was 31.5 ± 1.1 (at the norm of 97.4 ± 2.0 conventional units). This indicates a significant ($P < 0.001$) decrease of this indicator. On the 3rd day after parotidectomy, a significant decrease of this indicator continued to 40.4 ± 1.1 ($P < 0.001$). On the 7th day after the operation, the conductivity index of the marginal branch slightly increased and amounted to 45.8 ± 1.0 units, i.e. remained significantly lower ($P < 0.001$) compared to healthy people. On the 14th day of the treatment, the conductivity index of the marginal branch continued to increase and was 81.3 ± 1.4 units, but remained significantly lower ($P < 0.001$) compared to healthy people. At 21-22 days, the conductivity index of the peripheral branch of the facial nerve for these subjects was 93.8 ± 1.2 units and reliably ($P > 0.05$) did not differ from the group of healthy people (Fig 2).

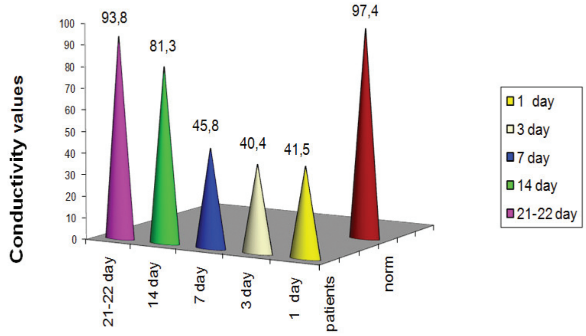

FIGURE 2. Conductivity values of the marginal branch of the facial nerve after parotidectomy in patients with nerve stretching in the dynamics of treatment.

On the next day after the parotidectomy was performed (Fig 3), the average arithmetic index of the resistance of the marginal branch of the facial nerve was 31.9 ± 10.8 units in 31 patients (at a norm of 11.3 ± 0.6 conventional units). This indicates a significant ($P < 0.001$) decrease in this indicator. On the third day after the operation, there was a slight increase in the resistance rate to minus 27.8 ± 10.1 units ($P < 0.001$). On the 7th day after the operative intervention, the resistance index of the marginal branch increased and amounted to minus 6.7 ± 2.6 units and still remained significantly lowered ($P < 0.001$) compared to the indices of resistance of healthy people. On the 14th day of treatment, the index of resistance of the marginal branch of the facial nerve continued to increase and was already 5.8 ± 0.5 units, but still remained significantly lower ($P < 0.01$) than healthy people (norm). On days 21-22 the resistance index of the marginal branch of the facial nerve was 10.2 ± 0.4 conventional units in these subjects and already reliably ($P > 0.05$) did not differ from the index of resistance of healthy people (Fig 3).

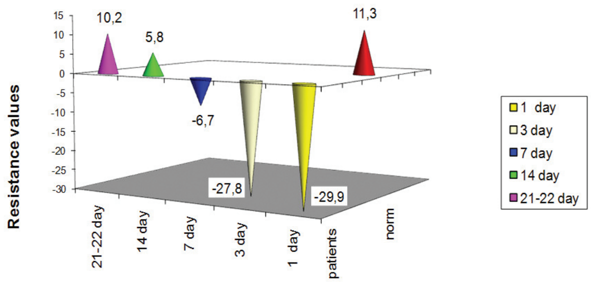

FIGURE 3. Values of resistance of the marginal branch of the facial nerve after parotidectomy in patients with nerve stretching in the dynamics of the treatment.

The next day after the operation (Fig 4), in 31 patients the arithmetic value of the tone of the marginal branch of the facial nerve was 2.72 ± 0.04 units (at the norm of 2.18 ± 0.01 units). This indicates a significant (P < 0.001) increase in the tone of the corresponding branch of the facial nerve. On the 3rd day after the operation, a decrease in the tone index was observed in comparison with the previous examination period to 2.52 ± 0.04 units (P < 0.001). On the 7th day after the operation, the index of the tone of the marginal branch was 2.36 ± 0.01 units and still remained significantly elevated (P < 0.001) compared to the index of the edge branch of the facial nerve of healthy people (norm). On the 14th day of the treatment, the index of the edge branch normalized and was 2.24 ± 0.01 units (P <0.001). On the 21-22th day the index of the tone of the marginal branch of the facial nerve in these subjects was 2.19 ± 0.02 units and already reliably (P > 0.05) did not differ from the index of the tone of the marginal branch of the facial nerve of healthy people (Fig 4).

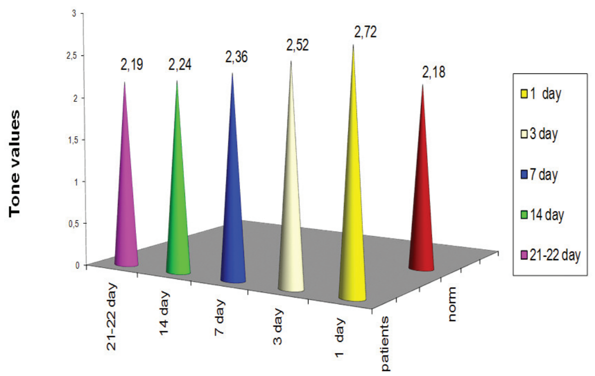

FIGURE 4. The indices of the tone of the marginal branch of the facial nerve after parotidectomy in patients with nerve stretching in the dynamics of the treatment.

The next day after the operation (Fig 5) in 31 subjects, the arithmetic value of the conductivity of the buccal branches of the facial nerve was 40.1 ± 1.1 units (at a rate of 96.5 ± 1.8 conventional units). This indicates a significant (P < 0.001) decrease of this indicator. On the 3rd day after parotidectomy, the value of this indicator was kept at a low level and it was equal to 42.1 ± 1.1 conventional units (P < 0.001). On the 7th day after the operation, the index of conductivity of the buccal branches remained practically at the same level and amounted to 47.7 ± 1.2 units, i.e. also remained significantly lower (P < 0.001) compared to healthy people. On the 14th day of the treatment, the index of conductivity of the buccal branches increased and was 76.7 ± 1.5 conventional units and still was significantly lower (P < 0.001) compared with healthy people. On the 21-22th day, the index of conductivity of the buccal branches of the facial nerve in the same subjects was 93.2 ± 1.1 units and already reliably (P > 0.05) did not differ from the group of healthy people (Fig 5).

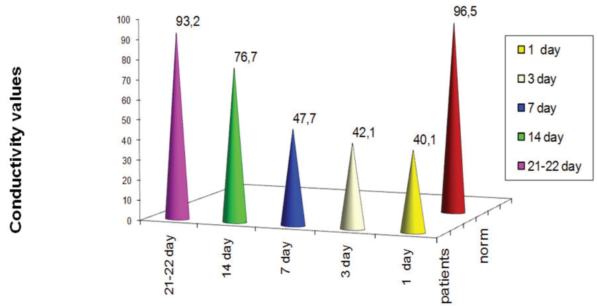

FIGURE 5. Conductivity values of the buccal branches of the facial nerve in patients with nerve stretching after parotidectomy in the dynamics of treatment.

The next day after the parotidectomy was performed (Fig 6), the average arithmetic index of resistance of the buccal branches of the facial nerve in 31 of the examined patient was minus 29.9 ± 10.7 units (At a norm of 11.2 ± 0.6 standard units). This indicates a significant (P < 0.001) decrease in this indicator. On the 3rd day after the operation, the resistance index was maintained at the same level - minus 29.9 ± 10.7 units (P < 0.001). On the 7th day after the operative intervention, the index of resistance of the buccal branches increased and amounted to minus 4.8 ± 1.8 units and still remained significantly lowered (P < 0.001) compared with the indices of resistance of healthy people. On the 14th day of the treatment, the index of resistance of the buccal branches continued to increase and was already 7.9 ± 0.4 units, but still remained significantly lower (P < 0.01) than of healthy people. On days 21-22, the index of resistance of the buccal branches of the facial nerve in the same subjects was 10.2 ± 0.4 conventional units and already reliably (P > 0.05) did not differ from the index of resistance of healthy people (Fig 6).

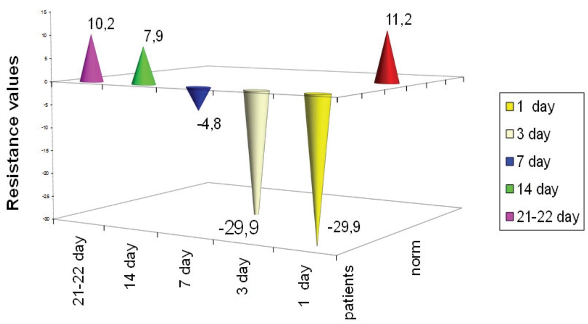

FIGURE 6. Indicators of resistance of the buccal branches of the facial nerve in patients with nerve stretching after parotidectomy in the dynamics of the treatment.

On the next day after the operation (Fig 7), the average arithmetic index of tone of the cheek branches of the facial nerve in 31 examined patients was 2.58 ± 0.04 units (at a norm of 2.19 ± 0.01 units). This indicates a significant (P

< 0.001) increase in the tone index of the buccal branches of the facial nerve. On the third day after the operation, a significant increase in the index of tone of the cheek branches was maintained – 2.41 ± 0.01 units (P < 0.001). On the 7th day after the operation, the index of the tone of the buccal branches was 2.36 ± 0.01 units and was significantly elevated (p<0.001) compared with the index of the tone of the buccal branches of the facial nerve of healthy people (control group). On the 14th day of the treatment, the index of the tone of the buccal branches remained elevated and was 2.29 ± 0.01 units (P < 0.01). On the 21-22th day the index of the tone of the buccal branches of the facial nerve in these subjects was 2.19 ± 0.02 units and reliably (P > 0.05) did not differ from the index of the tone of the buccal branches of the facial nerve of healthy people (Fig 7).

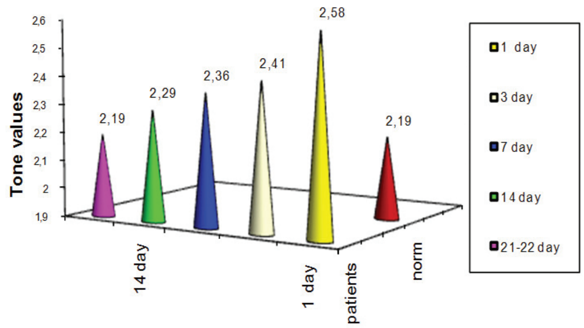

FIGURE 7. The parameters of the tone of the buccal branches of the facial nerve in patients with nerve stretching after parotidectomy in the dynamics of the treatment.

The next day after the operation (Fig 8), the average arithmetic index of conductivity of the zygomatic branches of the facial nerve in 31 of the examined patient was 40.7 ± 1.1 standard units (with a norm of 97.6 ± 1.9 units). This indicates a significant (P < 0.001) decrease in this indicator. On the 3rd day after parotidectomy, the value of this indicator remained at the same level and it was equal to 41.7 ± 1.0 conventional units (P < 0.001). On the 7th day after the operation, the conductivity index of the zygomatic branches increased insignificantly and amounted to 44.6 ± 1.2 units, i.e. remained significantly lower (P < 0.001) compared to healthy people (control group). On the 14th day of the treatment, the index of conductivity of the zygomatic branches significantly increased in comparison with the previous examination period and was 76.2 ± 1.5 conventional units and still was significantly lower (P < 0.001) compared with healthy people. On days 21-22 the conductivity index of the zygomatic branches of the facial nerve in these subjects was 94.4 ± 1.3 units and already reliably (P > 0.05) did not differ from the group of healthy people (Fig 8).

The next day after the parotidectomy performed (Fig 9), the average arithmetic index of resistance of the zygomatic branches of the facial nerve in 31 patients

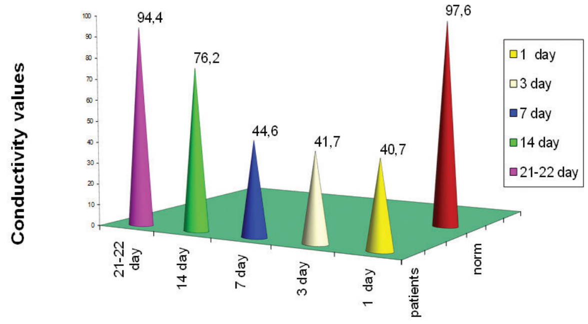

FIGURE 8. Conductivity indicators of the zygomatic branches of the facial nerve in patients with nerve stretching after parotidectomy in the dynamics of treatment.

surveyed was minus 29.7 ± 10.7 units (at the norm of 12.4 ± 0.6 standard units). This indicates a significant (P < 0.001) decrease in the resistance rate. On the 3rd day after the operation, the indices of the zygomatic branches of the facial nerve practically remained at the same level and amounted to minus 30.0 ± 10.8 units (P < 0.001). On the 7th day after the operation, the index of resistance of the zygomatic branch increased to minus 5.9 ± 2.3 units and remained reliably reduced (P < 0.001) compared with the indices of resistance of healthy people (control group). On the 14th day of treatment, the index of zygomatic branch resistance continued to increase and was 5.5 ± 0.5 units, but still remained significantly lower (P < 0.01) compared to healthy people. On 21-22 days after the operation, the resistance index of the buccal branches of the facial nerve in these subjects was 10.7 ± 0.4 conventional units and reliably (P > 0.05) did not differ from the index of resistance of healthy people (Fig 9).

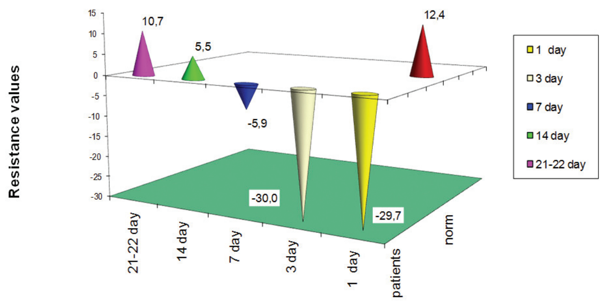

FIGURE 9. Indicators of the resistance of the zygomatic branches of the facial nerve in patients with nerve stretching after the performed parotidectomy in the dynamics of treatment.

The next day after the operation (Fig 10), the average arithmetic index of tone of the zygomatic branches of the facial nerve in 31 of the examined patient was 2.64 ± 0.01 units (at a rate of 2.19 ± 0.01 units), which indicated a significant (P < 0.001) increase in the tone of the zygomatic branches of the facial nerve. On the third day after the operation, the increase in the index of tone of the zygomatic branches was maintained - 2.41 ± 0.01 units ($P < 0.001$). On the 7th day after the operation, the index of tone of the zygomatic branches was 2.36 ± 0.01 units and remained significantly elevated ($P < 0.001$) compared with the index of the zygomatic branches of the facial nerve of healthy people. On the 14th day of treatment, the index of tone of the zygomatic branches remained elevated and was 2.29 ± 0.01 units ($P < 0.01$). On the 21-22th day the index of tone of the zygomatic branches of the facial nerve in these subjects was 2.19 ± 0.02 conventional units and reliably ($P > 0.05$) did not differ from the tone index of the zygomatic branches of the facial nerve of healthy people (Fig 10).

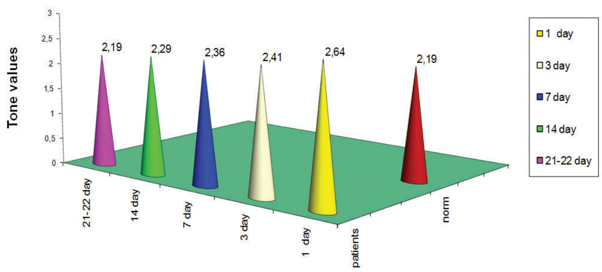

FIGURE 10. Values of the tone of the zygomatic branches of the facial nerve in patients with nerve stretching after parotidectomy in the dynamics of the treatment.

In cases after surgery on large salivary glands with stretching (during surgery) of the facial nerve, we found a regularity in the changes in the conductivity, resistance and tone of soft tissues innervated by this nerve in the postoperative period. The next day after the operative intervention, there was a significant decrease in the values of the conductivity and resistance of the nerve. These indicators reached their maximum deviations during the first 3 days after the operation. The parameters of the tone after the operation were increased, and reached their maximum values for the next day after the operation. With a favorable postoperative course (without the presence of hematomas in the area of postoperative wounds and extensive hemorrhages), changes in the conductivity, resistance and tone of the facial nerve in the direction of their normalization were observed on the 7-14th day after the operation. Positive changes in these indicators appeared 7-10 days earlier than the first clinical signs of neuropathy disappeared. Normalization of electrophysiological indices of soft tissues innervated by the facial nerve and complete disappearance of the clinical symptoms of the facial nerve neuropathy in patients treated with the hardware-software complex "DIN-1" occurred on the 21-22 day after the operation. If the postoperative period is unfavorable, i.e. in cases with hematomas and extensive hemorrhages in the area of the postoperative wound, the normalization of the previously mentioned parameters occurred slowly, approximately 7-10 days longer (the wound after these operations is always under the pressure gauze circular bandage that is retained without its replacement about 6-7 days, which makes it difficult to inspect the postoperative field).

Thus, the definition of static and dynamic electrophysiological parameters (conduction, resistance, tone) of soft tissue sites that are innervated by the facial nerve is a reliable prognostic test indicating a favorable or unfavorable course of the postoperative period in these cases and the effectiveness of the rehabilitative treatment of facial nerve neuropathies caused by stretching the nerve.

Based on the performed examinations of patients after surgical interventions (removal of tumors and tumor-like formations) on the parotid and submandibular glands, we found that in the postoperative period, the neuropathy of the facial nerve can occur, the cause of which is nerve stretching during an operative intervention. By measuring the static and dynamic electrophysiological parameters (conduction, resistance, tone) of soft tissue sites that are innervated by the facial nerve, we have proved the presence of postoperative neuropathy of the facial nerve caused by its stretching during parotidectomy. Neuropathy caused by stretching of the facial nerve, with a favorable course of the postoperative period and traditional medical treatment, is cured no earlier than 3 months after the operation.

The use of the hardware-software complex "DIN-1" for the diagnosis of this pathology and its treatment allows not only to reveal and prove the fact of the existence of the facial nerve neuropathy caused by its stretching during the operative intervention, but also to shorten the time for rehabilitation of such patients 4 times. Control of duration of treatment of neuropathies of the facial nerve was 36 patients operated on the parotid and submandibular glands with extension (during the operation) of the facial nerve without treatment with the hardware-software complex "DIN-1".

Conclusion

It was found out that in cases after surgical interventions on the parotid and submandibular glands, during which there is an extension of the branches of the facial nerve during the operation, the neuropathy of the nerve can be observed in the postoperative period [10-17]. The fact of the existence of the neuropathy of the facial nerve, caused by its stretching, is proved in patients after surgical interventions. Neuropathy caused by stretching during the operation of the facial nerve, with a favorable course of the postoperative period, with traditional treatment is cured no earlier than within 3 months after the surgery. Using the hardware-software complex "DIN-1" in the complex treatment of these patients allowed us to shorten the terms of their rehabilitation by 4 times.

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None.

Conflict of Interests

The authors declare no conflict of interest.

Role of Author and Co-authors

Oleksii O. Tymofieiev (concept of the paper and editing).
Anna I. Kryvosheieva (material collection and writing).
Beka Beridze (material collection).

Ethical Approval

Approval was obtained from the Medical Ethics Committee of the Shupyk National Medical Academy of Postgraduate Education, Kyiv, Ukraine.

Patient Consent

Not required.

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Нейропатії лицевого нерва, що викликані його розтяжінням

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Ключові слова:

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Параліч лицевого нерва
Невропатія лицевого нерва

РЕЗЮМЕ

Мета. Вивчити динаміку змін електрофізіологічних показників лицевого нерва у хворих після проведення оперативніх втручань на великих слинних залозах і визначити можливість застосування електростимуляції нерва на апаратурно-програмному комплексі «ДІН-1» для лікування нейропатії, викликаної його розтяжінням.

Методи. Проведено обстеження 31 хворого після оперативних втручань на великих слинних залозах.

Результати. На підставі проведених обстежень хворих після проведення оперативних втручань було встановлено, що в післяопераційному періоді може спостерігатися нейропатія лицевого нерва, причиною якої є не його травма, а розтяжіння даного нерва. Клінічне поліпшення і ліквідація симптоматики корелювали з нормалізацією електрофізіологічних показників стану уражених гілок лицевого нерва.

Висновки. За рахунок застосування апаратурно-програмного комплексу «ДІН-1» для діагностики та лікування нейропатії лицевого нерва, що викликана його розтяжінням, нам вдалося не тільки виявити і довести факт існування даного захворювання, але і скоротити терміни реабілітації хворих в 4 рази.

Нейропатии лицевого нерва вызванные его растяжением

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Ключевые слова:

Лицевой нерв
Электрофизиологические показатели
Растяжение нерва
Околоушная железа
Поднижнечелюстная железа
Большие слюнные железы.
Паралич лицевого нерва
Невропатия лицевого нерва

РЕЗЮМЕ

Цель. Изучить динамику изменений электрофизиологических показателей лицевого нерва у больных после проведения оперативных вмешательств на околоушной и поднижнечелюстной железах, а также определить возможность применения электростимуляции нерва на аппаратурно-программном комплексе «ДИН-1» для лечения нейропатии, вызванной его растяжением.

Методы. Проведено обследование 31 пациента после оперативных вмешательств на околоушной и поднижнечелюстной железах.

Результаты. На основании проведенных обследований больных после проведения паротидэктомий и экстирпаций поднижнечелюстных желез было установлено, что в послеоперационном периоде у них может наблюдаться нейропатия лицевого нерва, причиной которой является растяжение данного нерва. Клиническое улучшение и ликвидация симптоматики коррелировали с нормализацией электрофизиологических показателей состояния пораженных ветвей лицевого нерва.

Выводы. За счет применения аппаратурно-программного комплекса «ДИН-1» для диагностики и лечения нейропатии лицевого нерва, вызванной его растяжением, нам удалось не только выявить и доказать факт существования данного заболевания, но и сократить сроки реабилитации больных в 4 раза.

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The Efficiency of rhBMP-7 in Oral and Maxillofacial Bone Defects: A Systematic Review

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ABOUT ARTICLE

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ABSTRACT

Background.
Bone morphogenic protein-7 (BMP-7) is a molecule that has been clinically trialed and tested for use in regeneration of bone defects and its ability to induce bone formation by induction of gene expression [11]. Recombinant human BMP-7 (rhBMP-7) has surgical uses and is marketed under the brand name OP-1 (Olympus Biotech Corporation,). With the ever expanding discipline of oral surgery and the need for regenerative therapy for bone defects in the oral and maxillofacial region, this study was undertaken to compare the outcomes of different methods of use of BMP-7.
Methods.
The authors retrieved English publications on relevant studies from PubMed, ScienceDirect and Google Scholar from 2000 to 2016. In vitro and in vivo studies were included. The main outcomes were increased expression of osteogenic genes and radiographic bone fill.
Results.
In total, 676 human studies in the literature were identified but only four were ultimately feasible. The results showed a significant effect of rhBMP-7 both in-vitro and in-vivo. In all the studies used a systematic review was used to compare the outcomes of using rhBMP-7. The in vivo samples showed significant radiographic fill and efficient bone deposition [4]. In vitro studies showed increased expression of OCN and ALP biomarkers.
Conclusions.
rhBMP-7 is an effective tool that can be used to improve and speed up regenerative therapy of bone defects. However further human studies are needed to enhance and develop the use of this molecule in vitro.

Intoduction

Periodontal disease as well as bacterial bone infections can result in different types of defects in the alveolar and maxillofacial bone [1]. There are two types of periodontal bone defects infrabony defects and craters. Infrabony defects happen when bone resorption occurs unevenly in an oblique direction. In infrabony defects, the bone loss is generally restricted to one tooth [2]. Other bone defects are as a result of infection such as osteomyelitis and the presence or removal of cysts and tumors. The importance of repair and healing to prevent further bone loss or tooth loss is of great importance. Bone morphogenetic protein-7 (BMP-7) is a protein that stimulates and encourages growth of bone around many skeletal sites including the craniofacial bones [2]. It's expressed in the brain, kidneys and the bladder [3]. BMP-7 has been found to enhance growth around teeth, dental implants and the maxillary sinus floor [4]. Like other members of the bone morphogenetic protein family of proteins, it plays a key role in the transformation of mesenchymal cells into bone and cartilage. It has been demonstrated that BMP-7 treatment is sufficient to induce all of the genetic markers of osteoblast differentiation in many cell types [4]. RhBMP-7 is a protein molecule that has previously been used to repair osteogenic defects. This project will investigate publications that are analyzing the efficiency of rhBMP-7 on bony defects and their ability to cause bone regeneration. RhBMP-7 is a protein molecule that has previously been used to induce repair of osteogenic defects. This project will investigate publications that are dealing with efficiency of rhBMP-7 and analyzing the efficiency of rhBMP-7 on bone defects and their ability to induce bone regeneration in the oral and maxillofacial region.

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Review of the Literature

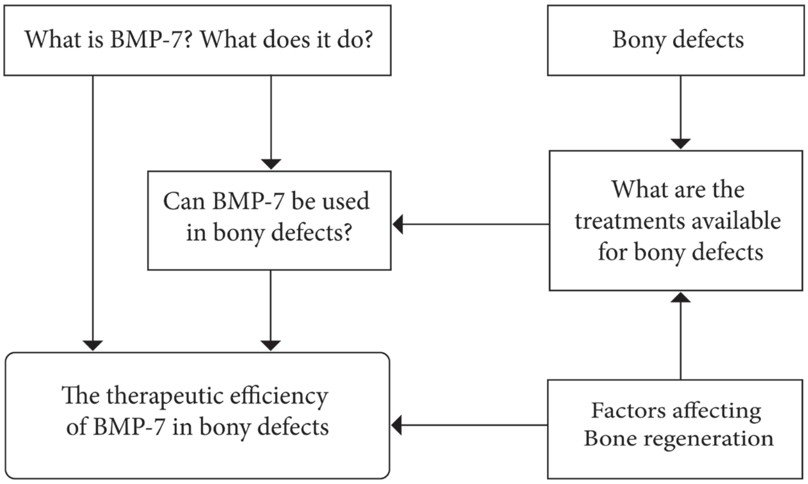

FIGURE 1. Theoretical framework

BMP-7 is a transforming growth factor that has the ability to regenerate bone at osteonomic defects and implants sites. The BMP-7 bone morphogenetic protein is also called the osteogenic protein-1 (OP-1). There have been few experiments done with BMP-7 as it is quite a recent development in comparison to other forms of gene therapy. Not only is BMP-7 therapeutic in bone defects (Fig 1) it is also being trialed for pulp mineralization. Other applications include renal therapy and as an anti-fibrotic therapy for diabetic nephropathy. Tissue engineering of alveolar bone surrounding implants involves targeted and sustained delivery of growth promoting molecules. They control the growth and formation of cartilage and bone during embryo development and after birth [5].

Bone morphogenetic proteins form a unique group of proteins within the transforming growth factor superfamily of genes and have a vital role in the regulation in the bone induction and maintenance [3]. Alveolar bone supports the tooth and implant structure, i.e. the jaw bones. This alveolar bone can be destroyed when teeth are lost due to trauma or disease. Therefore it is important that after tooth loss this bone regenerates and repairs itself. Currently there are treatments which are used to heal this alveolar bone. Periodontitis is an infectious inflammatory disease that results in attachment loss and alveolar bone loss. Periodontal tissue repair or regeneration involves production of new cementum, periodontal ligament, and alveolar bone. Several studies have been undertaken to investigate the best way to reproduce and mimic periodontal tissues [6]. Bone formation and regeneration is the most important aspect of successful periodontal therapy. The activity of bone morphogenetic proteins was first discovered in the 1960's, but the proteins responsible for bone induction were unknown until the 1980's. Because of their osteoinductive ability, bone morphogenetic proteins have gained a lot of interest as treatment options and adjuncts for periodontal defects [6].

BMP 7 has been proposed as a therapy for bone regeneration and Pulp mineralization in root part of pulp. General uses of bmp-7 also include kidney therapy. BMP-7 is expressed in brain kidneys and bladder. The protein encoded by this gene is a member of the TGF-β superfamily. Like other members of the bone morphogenetic protein family of proteins, it plays a key role in the transformation of mesenchymal cells into bone and cartilage. It is inhibited by noggin and a similar protein, chordin, which are expressed in the Spemann-Mangold Organizer. BMP-7 may be involved in bone homeostasis. It is expressed in the brain, kidneys and bladder [3].

BMPs play a role in the differentiation, proliferation, growth inhibition, and arrest of maturation of a wide variety of cells, depending on the cellular microenvironment and the interactions with other regulatory factors [1, 7]. When BMPs bind to their cell surface receptors on mesenchymal cell, a BMP signaling cascade is activated. This results in the expression of genes that lead to the synthesis of macromolecules involved in cartilage and bone formation, and the mesenchymal cell becomes either a chondrocyte or an osteoblast. Implantation of this protein component of bone matrix resulted in a complex series of cellular events, including mesenchymal cell infiltration, cartilage formation, vascularization, bone formation, and ultimately remodeling of the new bone tissue along with population by hematopoietic bone marrow elements [8]. In addition to differentiation of cells into the chondrocyte lineage, BMPs have been shown to directly differentiate into cells of the osteoblast phenotype.

BMP7 induces the phosphorylation of SMAD1 and SMAD5, which in turn induce transcription of numerous osteogenic genes [6]. It has been demonstrated that BMP-7 treatment is sufficient to induce all of the genetic markers of osteoblast differentiation in many cell types [3].

Bone morphogenetic proteins (BMPs) form a family of growth factors originally isolated from extracellular bone matrix that are capable of inducing bone formation in unusual places. The expression, tissue localization, and function of BMP-7 (OP-1) during tooth development were studied in rodents. Patterns of BMP-7 gene expression and peptide distribution indicated that BMP-7 was present in dental epithelium during the dental lamina, bud, and cap stages [9].

Continuity defects of the mandible frequently result from tumor removal or significant trauma, and reconstruction of these defects can be difficult. For defects with extensive hard and soft tissue loss, microvascular free tissue transfer often provides an excellent reconstructive option. However, significant site morbidity as well as non ideal bone stock for dental implant rehabilitation may occur [10].

The development of bone morphogenic proteins (BMPs) has offered an alternative to traditional bone grafting, which has been the gold standard for oral and maxillofacial reconstruction [11]. Clinical application of BMPs has evolved to include defects of the facial skeleton including those involving the mandible and maxilla [12]. There have been many reports of the use of BMPs regarding orthopedic as well as alveolar augmentation. There have been few studies addressing the use of BMP in reconstructing critical-size defects of the mandible.

Alloplastic materials have been used alone and in conjunction with osteoprogenitor cells, as well as with BMPs to facilitate bone regeneration [13]. BMPs can be used to drive in vitro, in vivo, and ex vivo differentiation of adult-derived osteoprogenitor cells into bone-forming osteoblasts [14]. While BMPs hold great promise for craniofacial reconstruction, significant concern has been generated over the safety of the current available forms of rhBMP-7 due to reports of clinically operative site edema in applications of craniomaxillofacial and spinal sites [15]. The effects of direct application of exogenous BMPs to bone defects may also prove to be too unpredictable for clinical use. Some studies have shown that the application of rhBMP to the repair of the human spinal column is associated with resorption of vertebral bodies in certain cases [16]. Therefore future treatments involving the implantation of osteoblastic cells differentiated ex vivo from mesenchymal stem cells by exposure to BMPs may prove to be the safest and most efficacious mode of therapy [17]. Periodontal regeneration depends on four ideas. The signalling, cells, blood supply and scaffold need to target the tissue defect. Each of these elements plays an important role in the healing process. Cells provide the apparatus for new tissue growth and differentiation. Growth factors and proteins regulate the cellular activity causing stimulation of cells to differentiate and produce matrix toward the developing tissue. New vascular tissues provide the nutritional base for tissue growth and homeostasis. Scaffolds guide and create a template structure three-dimensionally to make possible the above processes critical for tissue regeneration. A major complication and limiting factor in the achievement of periodontal regeneration is the presence of microbial pathogens that reside on tooth surfaces as plaque-associated biofilms [18]. Thus infection control is a key to periodontal therapy success.

The biological principle of using cell-occlusive barriers was described by Melcher on the repair potential of periodontal tissues [19]. It was found that guided tissue regeneration (GTR) could be motivated by removal of the epithelial and gingival connective tissue from periodontal defects. Providing space to maximize PDL cells, cementoblasts, and osteoblasts to migrate selectively, proliferate and differentiate within the periodontal defects help in promoting the reconstruction of the supporting tissue and attachment [20].

Cellulose membranes were the first biomaterial applied as surgical barriers for periodontal GTR, followed by expanded polytetrafluoroethylene (ePTFE) and a variety of absorbable polymers [21]. Currently used materials include polylactic acid, polyglycolic acid, polyglactin, and both soluble and non-soluble collagen barriers [22]. The use of non-absorbable barriers requires a second surgical procedure for barrier removal, usualy performed after 4–12 weeks following surgery. Absorbable barriers made from synthetic polymers are biocompatible, and biodegradable through physicochemical hydrolysis. Collagen barriers, made of type I collagen from bovine or porcine tissues, are degraded through enzymatic processes that may take from 6–8 weeks to as long as 4–8 months. In comparison with non-absorbable barriers, the absorbable types display the advantage of easy adaptation to the defect area without need for barrier removal [23].

Scaffolds and implant materials have also been used for periodontal therapy and bone regeneration in bony defects. In order to improve the efficiency absorption of bioactive molecules into scaffolding materials may aid long term growth factor release. This can be done before or after fabrication of the scaffold [24]. Bioactive molecules integrated directly into a bioresorbable scaffold are released by a diffusion-controlled mechanism that is regulated by the pore sizes such that different pore sizes affect the tortuosity of the scaffold and in so doing control the release of protein [25]. The rate of growth factor release depends on the type and rate of degradation of the delivery device, and the rate of growth factor diffusion through pores of the scaffolds. This approach works efficiently as cell invasion into the scaffolds regulates the release of BMPs to heal craniofacial defects. Development of suitable controlled-release of the bioactive molecules devices and/or alternative mode of delivery is needed.

Several bioactive molecules have demonstrated strong effects in promoting periodontal wound repair in preclinical and clinical studies. These bioactive molecules include PDGF [26], IGF-I, basic fibroblast growth factor (FGF-2) [27, 28] TGF-1 BMP-2 -4 -7 and -12), and enamel matrix derivative (EMD) that have shown positive results in stimulating periodontal regeneration. In addition, PDGF, BMP-2, and BMP-7 have been shown to promote peri-implant bone regeneration [29].

Material and Methods

Sampling method for this research involved articles published from 2000 to 2016. Search engines included Google Scholar and PubMed, ScienceDirect were used to search for the related articles using key words: BMP-7, bony defects, rhBMP-7, recombinant gene therapy OP-1. 30 articles based on their titles and abstracts, were used for background information (Fig 2).

Inclusion criteria:

1. Studies that included patients with a history of treatment BMP-7 or OP-1.
2. Including patients from pediatrics to elderly of both sexes.
3. Patients who undergone surgical and non-surgical treatments for osteonecrosis of the jaw.
4. Dental journals only.
5. In vitro studies.
6. In vivo studies.

Exclusion criteria:

1. Animal studies and basic science.
2. Articles published before yr 2000.

Materials were collected from Pubmed Cochrane collection and Science Direct.

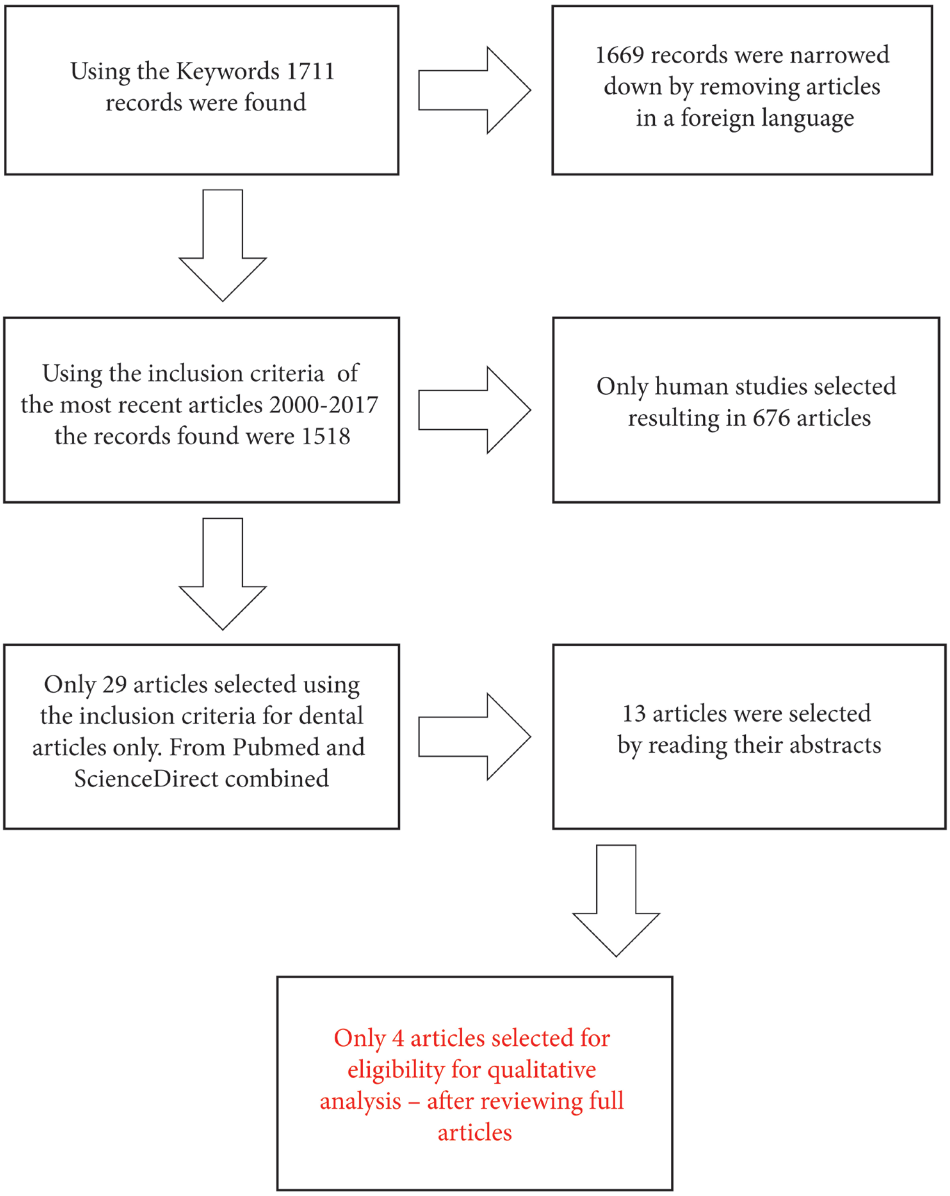

FIGURE 2. Flowchart showing how articles were selected using the inclusion and exclusion criteria

Results

TABLE 1. Results – Articles Included in the Study and Relevance

#	Authors	Year	Title	Journal Full Name	Abstract	Type of Study
1	Van den Bergh JP, Ten Bruggenkate CM, Groeneveld HH, Burger EH, Tuinzing DB.	2000	Recombinant human bone morphogenic protein-7 in maxillary sinus floor elevation surgery in 3 patients compared to autogenous bone grafts. A clinical pilot study.	Journal of Clinical Periodontology	Three patients with autologous sinus grafts were compared with three patients who had sinus lifts with rhBMP-7. 6 months later they were compared for resultant bone growth. 1 patient treated with rhBMP-7 showed vascularized, quality bone	In vivo
2	Clokie CM, Sándor GK	2008	Reconstruction of 10 major mandibular defects using bioimplants	Journal of the Canadian Dental Association	Ten patients with major mandibular defects due to ameloblastoma or osteomyelitis were included in this study. The resection defects were reconstructed and held by plates in the correct position. They were filled with bioimplant containing (BMP-7). After 1 year functional and aesthetic reconstruction was completed	In vivo
3	Zhi L, Chen C, Pang X et al.	2011	Synergistic effect of recombinant human bone morphogenic protein-7 and osteogenic differentiation medium on human bone-marrow-derived mesenchymal stem cells in vitro.	International Orthopaedics	The effect of rhBMP-7 with or without osteogenic differentiation medium (ODM) on hBMSCs in vitro. The control test was done with rhBMP-7 and ODM alone with hBMSCs. The ALP, OCN, OP and mRNA was examined. Upregulated expression of these, indicated a synergistic effect.	In vivo
4	Qin W, Zhu H, Chen L, Yang X, Huang Q, Lin Z.	2014	Dental pulp cells that express adeno-associated virus serotype 2-mediated BMP-7 gene enhanced odontoblastic differentiation.	Dental Materials Journal	AAV2 mediated BMP-7 (AAV2 BMP-7) was trialed to induce odontoblastic differentiation of human dental pulp cells (DPSs). An increase in ALP activity and mineralized nodules showed promoted odontoblastic differentiation.	In vivo

Table showing the articles chosen in order of dates published and the relevant information, the authors name and type of study

The study done by Clokie et al. (2008) showed the most successful results (Table 1) and the research carried out by Van den Bergh et al. (2000) showed similar success despite some limitations during their study. The studies carried out by Lianteng Zhi et al. and Wei Qin et al. (2011) also showed success in rhBMP-7 in vitro studies. The results found from the four research papers indicate a standardized use of BMP-7 molecules. Although delivery was different, all experiments used the BMP-7 molecules for the effect of bone regeneration. Some researchers used the BMP-7 along with osteogenic differential medium Lianteng Zhi et al. [30]. Whereas other research used BMP-7 infected adeno-associated virus serotype 2 Wei Qin et al. [31]. Some research was found on BMP-7 delivery within implant scaffolds too which are discussed below [32]. Osteogenesis is an orchestrated process with engagement of committed mesenchymal stem cells, osteoprogenitors, osteoblasts and osteoclasts and is characterised by sequential expression of a cascade of relevant genes. The level of alkaline phosphatase (ALP) has been recognised as a functional biomarker of osteoblast differentiation [27] and calcium deposition in the extracellular matrix as an indicator of subsequent endochondral bone formation [30].

The research done by Lianteng Zhi et al. investigated the effect of recombinant human bone morphogenetic protein-7 (rhBMP-7) with or without osteogenic differentiation medium (ODM) on osteogenic differentiation of primary human bone marrow-derived mesenchymal stem cells (hBMSCs) in vitro. The osteoinductive ingredients in ODM include β-glycerophosphate (5 mM), L-ascorbic acid (50 mg/l) and dexamethasone (10 nM) [30].

The authors say within the first few days the cells exposed to the BMP-7 with ODM showed morphological changes. Lianteng Zhi et al. showed that the minimal dose for inducing in vitro osteoblastic differentiation of hBMSCs was 0.1 μg/ml rhBMP-7. They also observed that rhBMP-7 did not cause calcium deposition in vitro culture of primary hBMSCs within the first 17 days, except for a moderate increase in calcium content in the ODM group with 1.0 μg/ml rhBMP-7. However, calcium deposit was significantly present with rhBMP-7 at concentrations of 0.1 and 1.0 μg/ml after 35 days of osteogenic differentiation in the presence of ODM (Fig 3). This period of time for calcium deposition corresponds well with the clinical timing of bone healing in humans. The experiment they did showed that alkaline phosphatase activity and calcium deposits in hBMSC culture were notably increased at different concentrations. The calcium content in hBMSC culture was 30% higher in the 1.0 μg/ml rhBMP-7 group than that in the 0.1 μg/ml rhBMP-7 group demonstrating a dose-dependent osteoblastic differentiation by rhBMP-7 ODM (Fig 3). However, the research mentioned the same

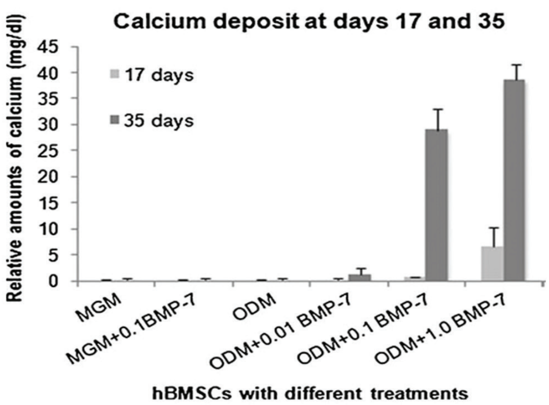

FIGURE 3. Results from the study by Zhi L et al [30]. The effect of rhBMP-7 on hBMSCs with and without ODM. Graph showing the amount of calcium deposited in the 6 different study groups.

dose of rhBMP-7 without ODM induced a lower level of ALP and calcium deposits. The same results were said to have been seen when the OD medium was used on its own. Lianteng Zhi et al. discuss that the result indicated a combined effect of rhBMP-7 and ODM on osteogenic differentiation. The authors used quantitative real-time reverse-transcriptase polymerase chain reaction (RT-PCR) analysis and they say this showed up-regulated Osteopontin and Osteocalcin mRNA levels, which confirms the synergistic effect of rhBMP-7 and ODM. The study showed that rhBMP-7 with ODM had a combined synergistic effect on up-regulation of osteogenic genes as well as osteogenic differentiation of primary hBMSCs in vitro. In the presence of ODM, the researchers found that the lowest concentration of rhBMP-7 needed to induce significant osteogenic differentiation of hBMSCs was 0.1 μg/ml [30].

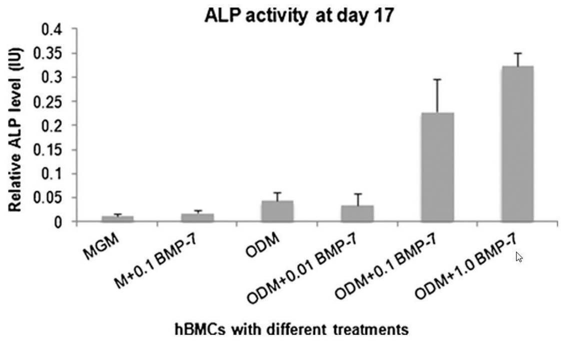

FIGURE 4. The ALP Activity in study groups [30] at day 17. Graph showing the ALP activity in the various different groups.

The study done by Wei Qin et al. investigated the potential of adeno-associated virus serotype 2 (AAV2) mediated BMP-7 (AAV2-BMP-7) to induce odontoblastic differentiation of human dental pulp cells (DPCs) in vitro. The authors used AAV2 to deliver BMP-7 and the biologic effects of the protein on dental pulp cells were tested by observing the activity of alkaline phosphatase, the expression of dentin sialophosphoprotein (DSPP) and osteocalcin (OCN). The proliferative ability of the cells was also analysed. Alkalinephosphatase was used as a marker as there was a higher level of ALP in differentiating odontoblastic cells when compared with undifferentiated mesenchymal cells [31]. To determine the function of BMP-7 on odontoblastic differentiation, the authors used ALP enzymatic assays to test ALP activity. ALP in the cells that were infected with AAV2-EGFP were said to have increased slightly with time. In contrast, the activity of ALP was significantly higher in AAV2-BMP-7-infected dental pulp cells. Wei Qin et al. found that after 14 days the formation of mineralized nodules showed an increased mineralization in dental pulp cells. These results suggested that BMP-7 promoted odontoblastic differentiation and mineralization in the dental pulp cells in vitro (Fig 5).

To assess if AAV2-BMP-7 could encourage odontoblastic differentiation, the expression levels of dentinsialophosphoprotein (DSPP) and Osteocalcin mRNA the authors used real-time PCR. They stated in their results that mRNA levels of DSPP and OCN in the AAV2-BMP-7 group were 7.03 times and 3.12 times higher than that in the control group at 7 days, respectively. Although the DSPP and OCN mRNA showed a decrease in expression with time, Wei Qin et al. say expression levels were higher than that of the control group. Together, the significantly increased levels of ALP activity and DSPP

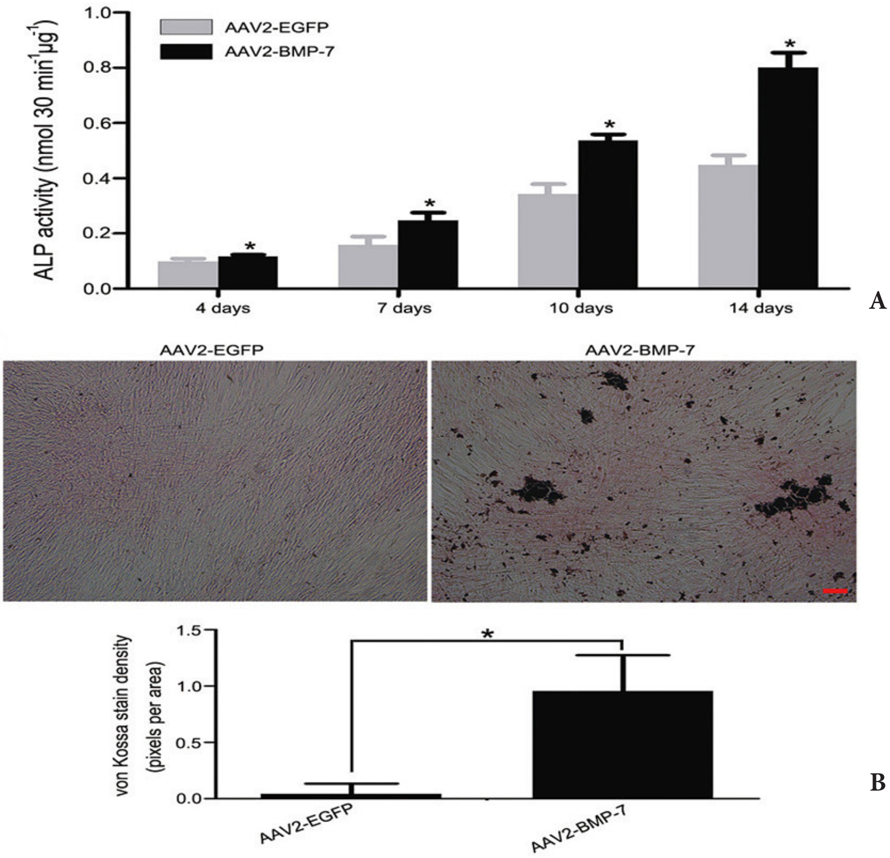

FIGURE 5. Results from the study by Wei Qin et al. [31]. (**A**) Graph showing ALP activity in the different study groups and control group. (**B**) ALP staining in the AAV2-EGFP control group and the AAV2-BMP-7 group.

and OCN mRNA in the AAV2- BMP-7 the authors say that BMP-7 promoted the differentiation of DPCs to odontoblast-like cells in vitro [31] (Fig 5).

The study done by J.P.A van den Bergh studied the bone formation by BMP-7 molecules with a collagen carrier. The BMP-7 molecules were implanted in the maxillary sinus of 3 patients. The research used three other patients with simple sinus floor elevation using autogenous bone grafts. The authors followed the patients for six months after the implants were placed. The researchers found the first patient who had a BMP-7 graft placed, had well integrated and vascularized bone tissue which they confirmed by using the histological examination. In the second female patient with BMP-7 graft there was said to be no bone formation observed. A cyst-like granular tissue mass was found was removed. The authors say the third patient who was also female and who received bilateral sinus grafts, slight bone formation was seen however it showed flexible tissue thus an implant placement was postponed. In all 3 patients with the autogenous grafted sinuses a bone appearance similar to normal maxillary bone was clinically seen and tested histologically. Dental implants could be placed six months after sinus floor elevation surgery. Van den Bergh et al. found that the BMP-7 molecule has the potential for initiating bone formation in the human maxillary sinus within 6 months after a sinus floor elevation operation [3].

Cameron M.L. Clokie et al. used ten patients, with ameloblastoma and osteomyelitis in the body or ramus of the mandible, as a sample. They used 4 males and 6 females. Their ages ranged from 18 to 73 years of age with a mean age of 43.1 years. They manually created a bioimplant, by mixing the BMP-7 with demineralized bone matrix, then molded it into the shape of the mandible using reverse phase medium and implanted into the bony defect. They covered and fixed the bioimplant in the defect then followed up the patients for a minimum of 9 months. Cameron et al talk about the clinical and radiographic evidence of restoration of mandibular continuity with no complications.

The authors say of the 10 patients, 4 had dental implants placed in their reconstructed mandibles. In one case, the implants were placed 8 years following the reconstructive surgery. An important point mentioned in the results of this research was that, in all 10 patients, bone formation was consistently first sensed on clinical examination during manual manipulation of the reconstructed segment. Radiographic evidence of bone formation was not fully evident until 1 year after the reconstructive procedure. However, at 1 year following reconstruction, the researchers found it difficult to differentiate between

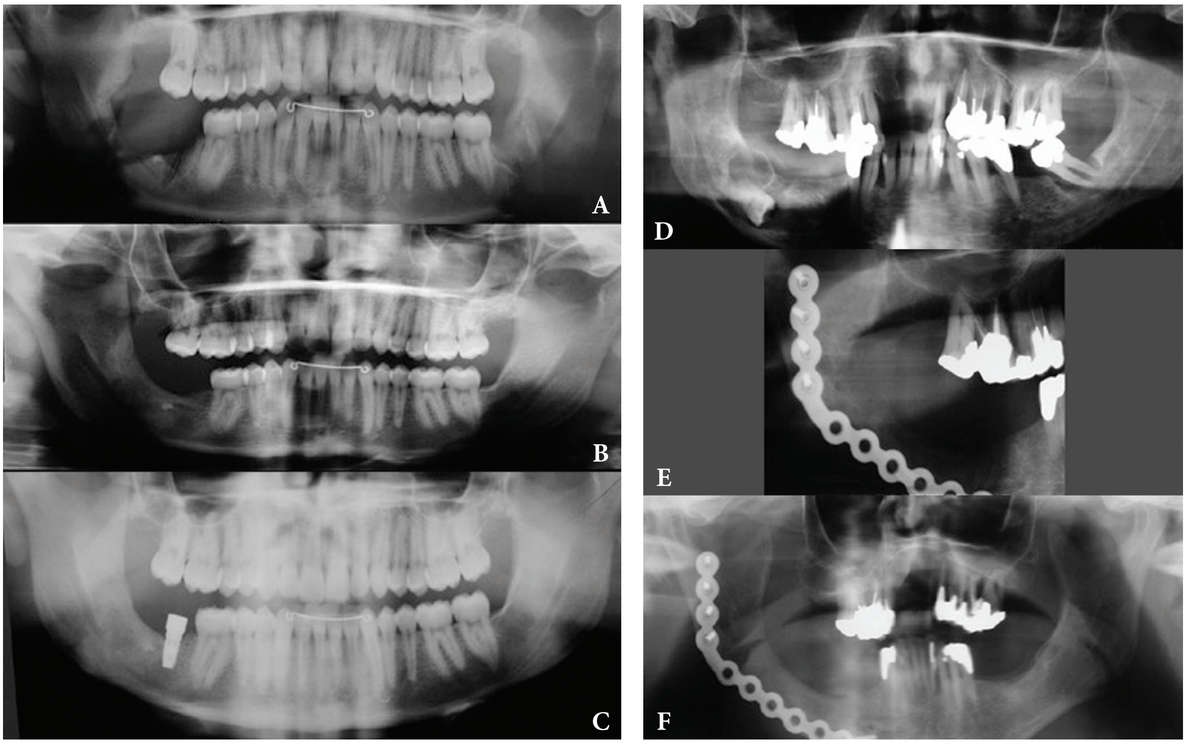

FIGURE 6. Radiographic images of patient in pre and post-implant treatment from the study by Clokie at al [32]. (**A**) radiograph of a 19-year-old boy post resectional surgery prior to implant placement. (**B**) 1 year after bioimplant with BMP-7 is placed. (**C**) 9 months post implant placement in 19 year old. (**D**) 62-year-old man pre-treatment (**E**) post treatment 6 months after bioimplant is placed. (**F**) 1 year post bioimplant placement bone formation.

bone that was formed from the BMP bio-implant and native pre-existing bone [32] see Figure 6.

Discussion

RhBMP-7 was used in different modalities in the four studies to test for the efficiency of rhBMP-7 in bone defects thus although difficult to compare the results from each study on a standardized scale it is easy to see the success in rhBMP-7 therapy studied by each author.

The study by Lianteng Zhi et al. ALP activity in hBMSC culture was significantly increased at 0.1 µg/ml rhBMP-7 and was further enhanced at the concentration of 1.0 µg/ml in the presence of ODM. Their results showed that that there is a minimal dose threshold of BMP-7 required for inducing osteogenic differentiation of hBMSCs in vitro. Lianteng Zhi et al showed that the minimal dose for inducing in vitro osteoblastic differentiation of hBMSCs was higher than 0.1 µg/ml rhBMP-7 under synergistic effect of ODM. Although ODM without rhBMP-7 increased ALP activity above the baseline level, the ODM with 0.1 µg/ml rhBMP-7 induced a five-fold higher ALP level comparatively. There was also a significant difference of rhBMP-7-induced ALP levels between 0.01 µg/ml and 0.1 µg/ml rhBMP-7 concentrations in the presence of ODM. The authors observed that rhBMP-7 did not promote calcium deposit in vitro culture of primary hBMSCs at an earlystage. The scientists strongly believe that not just rhBMP-7 is responsible for the increases osteogenic activity but dexamethasone is also another factor that may interplay with rhBMP-7 to create the synergistic effect of ODM and rhBMP-7 observed in this study [32]. The objectives of this study to test the osteogenicity of rhBMP-7 has been proven by this author.

There have been several studies to test the effect of dexamethasone on BMP activity and using this data the authors state that not only was the BMP-7 successful with the ODM but the synergic effect could be attributable to the dexamethasone within the ODM however further studies are required [28]. When compared to the research done by Wei Qin et al. in which dental pulp cells that were infected with AAV2-BMP-7 showed notably increased ALP activity and formed mineralized nodules. AAV2-BMP-7 also increased the expression of mineralization-related genes, which included DSPP and OCN. There was no considerable difference between the proliferative ability of AAV2-BMP-7 and the control group showing the virus was not cytotoxic. Compared to the rhBMP-7 used as a bone graft implant the results from this study showed less rhBMP-7 promoted the odontoblastic differentiation in the dental pulp cells than in the implanted grafts [28]. However the results having shown the expression of mineralization related genes indicate the therapeutic potential of AAV2-BMP-7 in dental tissue regeneration [30]. The later stage of odontogenic differentiation observed by Hakki et al. tells us that the rhBMP-7 stimulates ALP and biomineralization in a dose dependant manner to initiate differentiation of human periodontal ligament stem cells [33].

From the study by Cameron M.L Clockie et al it is seen that there was successful reconstruction of large mandibular defects. The author also found that there was sufficient restoration of mandibular height and width, which is very important and vital for functional prosthetic rehabilitation. Proper reconstruction also ensured that appropriate facial form was recreated. The authors stated that, patient morbidity and overall cost to the health care system, including length of hospital stay, were significantly reduced using this technique [27].

The synthetic bone used for these patients overcomes the problems associated with autogenous bone grafting as well as the limitations of finding donor sites. The BMP-7 bio-implants showed the ability to copy the healing of natural bone and resorb and be replaced by autologous bone. Successful reconstruction of 10 major mandibular defects was achieved. Both functional and esthetic results were comparable if not better than those achieved with autogenous bone grafting [32].

In comparison the studies by Clokie et al. show a significant result with the BMP-7 molecules in defect sites. The study by Wei Qin et al. showed a promising use of BMP-7 in dental pulp cells causing osteogenic proliferation indicating the need for further studies so that it can be used in other oral and maxillofacial applications. Lianteng Zhi et al. shows a synergistic effect of the BMP-7 molecule associated with dexamethazone or ODM.

The most promising results faired from Clokie et al. study as it was done in vitro in large bone defects where implants were efficiently placed it would seem their research showed greatest success when compared with invitro studies. The studies done by Wei Qin et al. and Lianteng Zhi et al. are comparable as although different markers were used, rhBMP-7 was said to have contributed to 3 fold increase in OCN expression and a 30% increase in calcium deposits in each study respectively [30, 32]. The second objective of this study was to test the ability of rhBMP-7 to regenerate bone in the oral and maxillofacial region. The bone deposit seen in the radiographs in Figure 6 show just this.

Van den Burgh et al. studied the biopsies of the first and third patients that were grafted with BMP and stated that sufficient bone formation was possible with the implantation of rhOP-1 in the human maxillary sinus, with a collagen delivery device, within a 6 months period. In addition, the bone volume percentage, osteoid surface percentage, and the presence of osteoblast in the area all demonstrate the fact that rhBMP-7 has got the ability to engage enough mesenchymal cells in the human maxillary sinus which leads to enough bone formation for the placement of dental implants. A similar result was seen in the study carried out by Clokie et al. Van den Burgh et al. discovered the first male patient case the bone tissue that was found was all lamellar bone. In the other 2 cases both of which were females, case 2 showed no bone formation whatsoever but there was a postoperative swelling on the patient's face 6 days post sinus grafting with the rhBMP-7. Case 3 of their study, on the other hand displayed a change with most of the immature bone present being lamellar while the rest portrayed a more woven appearance of bone. This was accompanied by a facial swelling 6 days after sinus grafting with rhBMP-7. Whether or not the detected swelling was caused by an unwanted tissue reaction to the rhBMP-7 or its carrier, and whether it has had a negative effect on the induction of bone, needs to be studied more in depth. According to the results found from this study, a more in depth analysis is required regarding the rhBMP-7. However results after 6 months are comparable to the study done by Clokie et al. only slightly differing in technique with the latter study having used a bioimplant and van den Burgh using an autologous graft. All the studies found suggest the success of rhBMP-7 in bone defect sites [3, 32].

Conclusion

Of all the research [33-38] that was included in this study and the papers we found that the BMP-7 molecule showed significance in bone development and differentiation.

The objectives of this study was to test the reliability and efficiency of rhBMP-7 in treating bone defects which was scientifically tested and brings us to the conclusion that it can be used effectively to treat bone defects. The study by Clokie et al. allows us to draw the conclusion that rhBMP-7 can be used effectively for bone loss treatments and in bone defects caused by disease such as osteomyelitis. We can also say that rhBMP-7 improves efficacy in the treatment of bony defects by reducing the hospital time as well the use of bioimplants also helps to reduce morbidity of autologous graft donor sites.

Previous studies on animals have also shown success rates in the use of rhBMP-7 in bone defect sites [28].

Over all despite the difference in methodology of each study reviewed in this research project we can conclude that rhBMP-7 is an efficient molecule for the therapy of bone defects, However further human studies are required to reinforce the use of rhBMP-7 in humans as results found in vitro studies are often not replicated when used in vivo.

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Conflict of Interests

The authors declare that they have no conflict of interest.

Role of Author and Co-authors

Nur Hatab (concept of the paper and editing).
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Not required.

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Ефективність рлКМБ-7 при оральних і щелепно-лицевих кісткових дефектах: загальний огляд

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Рекомбінантний людський кістковий морфогенний білок-7 (рлКМБ-7)
Рекомбінантна терапія
Остеогенний білок-1 (ОБ-1)
Направлена тканина регенерація (НТР)

РЕЗЮМЕ

Мета. Кістковий морфогенетичний білок-7 (КМБ-7) – це молекула, яка була клінічно випробувана та випробувана для використання при регенерації кісткових дефектів та її здатності індукувати утворення кісток завдяки індукції експресії генів [11]. Рекомбінантний людський КМБ-7 (рлКМБ-7) застосовується в хіургії і продається під маркою остеогенний білок (ОБ-1) (Олімпус Біотек Корпорейшин). При постійному розвитку спеціальності та необхідністю регенеративної терапії при дефектах кісток в оральній та щелепно-лицевій хірургії, це дослідження було проведено для порівняння результатів різних методів застосування КМБ-7.

Методи. Автори отримали англійські публікації про відповідні дослідження з PubMed, ScienceDirect та Google Scholar з 2000 по 2016 рр. Дослідження in vitro та in vivo були включені. Основними результатами було посилення експресії остеогенних генів та заповнення кісток на рентгенограмах.

Результати. Загалом в літературі було виявлено 676 досліджень, але в кінцевому підсумку було обрано лише чотири дослідження для аналізу. Результати показали суттєвий ефект рлКМБ-7 як in vitro, так і in-vivo. У всіх досліджених, проведених систематичним оглядом, було використано порівняння результатів використання рлКМБ-7. Зразки in vivo демонстрували значне радіографічне наповнення та ефективне осадження кісток [4]. Дослідження in vitro свідчать про посилення експресії біомаркерів OCN та ALP.

Висновки. РлКМБ-7 є ефективним інструментом, який може бути використаний для покращення та прискорення регенеративної терапії кісткових дефектів. Проте подальші дослідження людини необхідні для посилення та розвитку використання цієї молекули in vitro.

Эффективность рчКМБ-7 при оральных и челюстно-лицевых костных дефектах: общий обзор

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Остеогенная белок-1 (ОБ-1)
Направлена тканевая регенерация (НТР)

РЕЗЮМЕ

Цель. Костный морфогенетический белок-7 (КМБ-7) – это молекула, которая была клинически испытана и проверена для использования при регенерации костных дефектов и его способности индуцировать образование костей благодаря индукции экспрессии генов [11]. Рекомбинантный человеческий КМБ-7 (рчКМБ-7) применяется в хиургии и продается под маркой остеогенная белок (ОБ-1) (Олимпус Биотек Корпорейшин). При постоянном развитии специальности и необходимостью регенеративной терапии при дефектах костей в оральной и челюстно-лицевой хирургии, это исследование было проведено для сравнения результатов различных методов применения КМБ-7.

Методы. Авторы получили английские публикации о соответствующих исследованиях с PubMed, ScienceDirect и Google Scholar с 2000 по 2016 Исследования in vitro и in vivo были включены. Основными результатами было усиление экспрессии остеогенных генов и заполнения костей на рентгенограммах.

Результаты. Всего в литературе было обнаружено 676 исследований, но в конечном итоге был избран лишь четыре исследования для анализа. Результаты показали существенный эффект рчКМБ-7 как in vitro, так и in-vivo. Во всех исследованиях, проведенных систематическим обзором, было использовано сравнение результатов использования рчКМБ-7. Образцы in vivo демонстрировали значительное радиографическое наполнения и эффективное осаждение костей [4]. Исследования in vitro свидетельствуют об усилении экспрессии биомаркеров OCN и ALP.

Выводы. РчКМБ-7 является эффективным инструментом, который может быть использован для улучшения и ускорения регенеративной терапии костных дефектов. Однако дальнейшие исследования человека необходимы для усиления и развития использования этой молекулы in vitro.

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Modern Diagnostic Methods Used in Surgical Treatment of Peripheral Neuralgia

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ABOUT ARTICLE

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ABSTRACT

Purpose.
To determining the possibility of using stereolithography in the diagnosis of lesions of peripheral nerves in conditions of ossificated bone canals of the maxillary bone.
Material and Methods.
We examined 31 patients with secondary neurogenic lesions of trigeminal nerve using stereolithography.
Results.
Diagnostic capabilities of color stereolithography for diseases of the second branch of the trigeminal nerve were studied.
Conclusions.
High efficiency of stereolithography is proved. The method is recommended for use in medical practice.

Introduction

In modern medical practice, one of the main methods of diagnosis, of course, after a clinical examination of the patient, is radiography. The difficulties that arise when decoding it are related not only to the lack of a volumetric picture of the pathological process, which was localized both in the bone and in surrounding tissues, but also with an insufficient "visibility" of the bone canal in which the maxillary branch of the trigeminal nerve passes. When the bone canals narrow, there is no radiologic imaging of the pathological focus. Many pathological processes located inside the canals (ossification) are not available for diagnosis and examination using the radiography method. In the early 70-ies of the last century, as a result of scientific and technological progress, computer tomography was introduced into practice. This was a major achievement of modern medicine and, first of all, radiology. Computer tomography is a fundamentally new, noninvasive diagnostic method that allows one to visualize the relationship of individual organs and tissues in the norm and under different pathological conditions, based on the use of the principle of mathematical modeling of an X-ray image, followed by computer-aided construction of images of horizontal "slices" of the body on the display screen.

Computer tomography has taken a firm place in the diagnosis of diseases of the maxillofacial region. However, the unreal sizes of the prototype and certain difficulties in specifying the detailed location of the pathological focus, as well as revealing its relationship with other anatomical structures, creates many inaccuracies in diagnosis and difficulties in planning and during some surgical interventions on peripheral nerve trunks.

In recent years, a new modern technology for creating prototypes of the human skeleton appeared based on data obtained during medical scanning (CT, MRI). There are several types of this technology. One of the most famous among them is stereolithography. The basis of this method is the principle of layer-by-layer construction of the three-dimensional structure of the object and the creation of a model that corresponds exactly to the dimensions and shapes of parts of the human body (skull, upper jaw, lower jaw, etc.). In the literature, we did not find information on the possibilities of using stereolithography for lesions of the peripheral branches of the trigeminal nerve located in the bone canals of the maxillofacial skeleton.

The aim of the study was to determine the possibilities of using stereolithography in the diagnosis of peripheral nerve lesions [1-13] in conditions of ossificated bone canals of the maxillary bone.

Material and Methods

We examined 31 patients with diseases of the second branch

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(neuralgia, neuralgia-neuritis) of the trigeminal nerve with the method of stereolithography. All examinees necessarily had a general clinical examination, which included x-ray of the jaws in different projections, computed tomography, stereolithography. Stereolithographic models were produced by combining in a single technological chain of computer diagnostics the automated design of a virtual model and laser stereolithography. Stereolithographic models of the jaws were produced in the Technical Department of Belgium by a stereolithographic machine "SLA" from photopolymerized translucent composite materials with successive curing of individual thin layers joined together in a single unit. When the peripheral branches of the trigeminal nerve were stained in a different color, a color stereolithographic model of the maxillary bone was obtained. The data obtained during the diagnosis by conventional and color stereolithography was compared with the results, which were revealed during radiography, computer tomography and those acquired after the operation.

Results and Analysis

In the practice of maxillofacial surgeons and otorhinolaryngologists one of the main diagnostic methods, of course, after a clinical examination of the patient, is radiography. The difficulties that arise when deciphering it are related not only to the lack of a three-dimensional picture of the pathological process, which was localized both in the bone and in surrounding tissues, but also with insufficient "visibility" of some bone orifices and canals in which the maxillary branch of the trigeminal nerve passes. When the bone channels narrow, there is no radiologic imaging of the pathological focus. Many pathological processes located inside the canals (ossification) are not available for diagnosis and examination using the radiography method. In the early 70-ies of the last century, because of scientific and technological progress, computer tomography was introduced into practice. This was a major achievement of modern medicine and, first of all, radiology. Computer tomography is a fundamentally new, noninvasive diagnostic method that allows one to visualize the relationship of individual organs and tissues in the norm and under different pathological conditions, based on the use of the principle of mathematical modeling of an X-ray image, followed by computer-aided construction of images of horizontal "slices" of the body on the display screen. Computer tomography has taken a solid place in the diagnosis of diseases of the middle zone of the face. However, the unreal sizes of the prototype and certain difficulties in specifying the detailed location of the pathological focus, as well as revealing its relationship with other anatomical structures, creates many inaccuracies in diagnosis and difficulties in planning and during some surgical interventions on peripheral nerve trunks.

In recent years, a new modern technology for creating prototypes of the human skeleton appeared based on data obtained during medical scanning (CT, MRI). There are several types of this technology. One of the most famous among them is stereolithography. The basis of this method is the principle of layer-by-layer construction of the three-dimensional structure of the object and the creation of a model that corresponds exactly to the dimensions and shapes of parts of the human body (skull, upper jaw, lower jaw, etc.). In the literature, we did not find information on the possibilities of using stereolithography for lesions of the peripheral branches of the trigeminal nerve located in the bony canals of the maxillofacial skeleton. Stereolithographic models were produced by combining in a single technological chain of computer diagnostics the automated design of a virtual model and laser stereolithography. Stereolithographic models of the jaws were produced in the Technical Department of Belgium by a stereolithographic machine "SLA" from photopolymerized translucent composite materials with successive curing of individual thin layers joined together in a single unit. When the peripheral branches of the trigeminal nerve were stained in a different color, a color stereolithographic model of the maxillary bone was obtained. The data obtained during the diagnosis by conventional and color stereolithography was compared with the results, which were revealed during radiography, computed tomography and those acquired after the operation.

On the orthopantomogram, as well as the x-ray patterns of the maxillary bones, we did not succeed in detecting the foci of narrowing of the bone orifices and canals (sections of ossification) in the examined cases (Fig 1).

When carrying out a computer tomography of the facial bones (Fig 2), we also could not detect pathological foci (areas of narrowing of the bone apertures or canals) in the bones of the maxillofacial skeleton. When carrying out the usual stereolithographic models of the maxillary bones, the exit points of the peripheral branches of

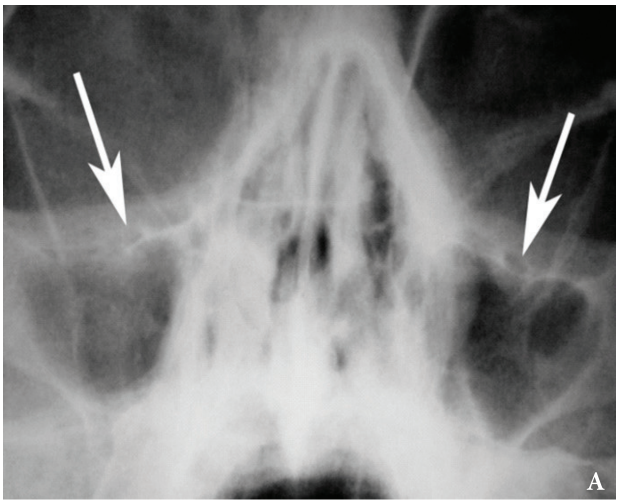

FIGURE 1. Radiograph of facial bones in a semi-axial projection (**A**). The *arrows* indicates the areas where the outlets of the infraorbital branches of the trigeminal nerve are located (**A**). **(Fig 1 continued on the next page.)**

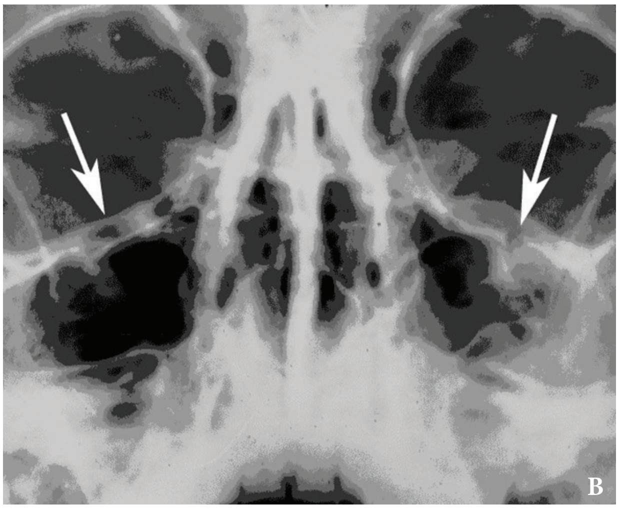

FIGURE 1 (cont'd). Radiograph of facial bones in a semi-axial projection (**B**). The *arrows* indicates the areas where the outlets of the infraorbital branches of the trigeminal nerve are located (**B**).

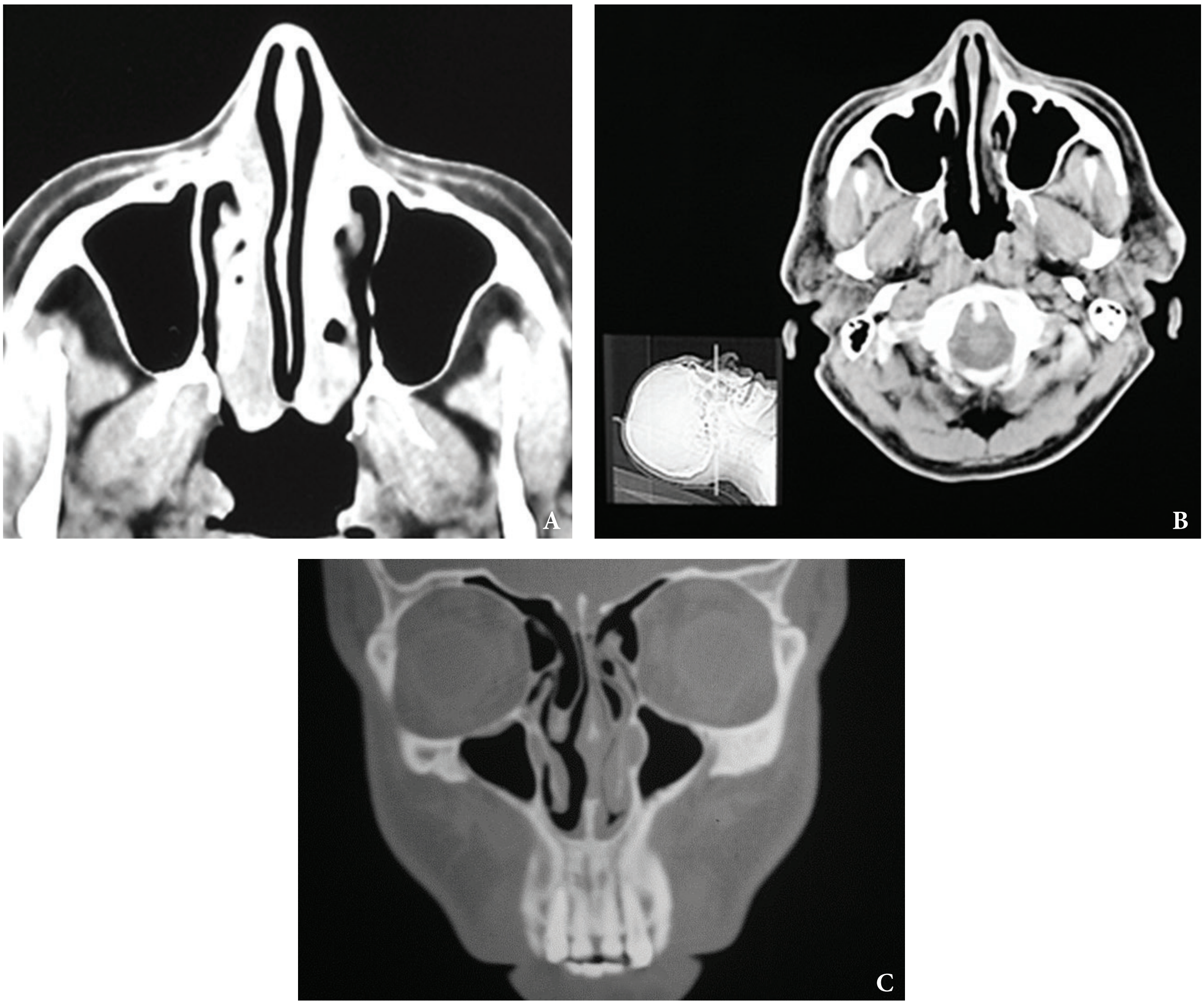

FIGURE 2. Computer tomography of facial bones in different projections. Sections are made at different levels (**A**, **B**, **C**).

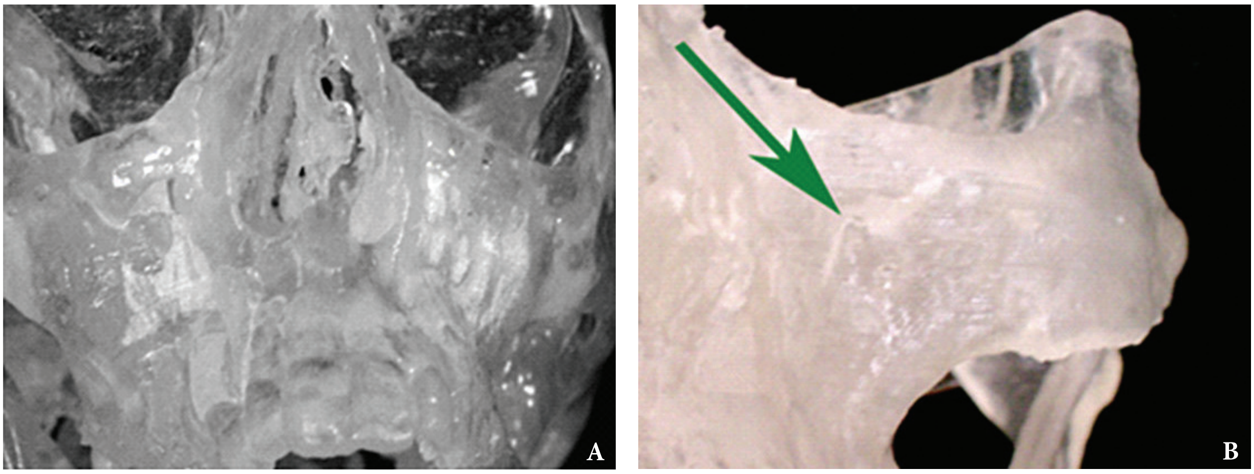

FIGURE 3. Stereolithographic model of the upper jaw of the patient with a narrowing of the infraorbital aperture (**A**, **B**). The projection of the infraorbital foramen is indicated by an arrow (**B**).

nerves from the infraorbital foramen "merged" into one color and were not visualized either at the point of nerve exit from the bone nor at the place of its passage in the corresponding canal (Fig 3).

In the making of colored stereolithographic models of the facial bones, the second branch of the trigeminal nerve was colored in a different color (dark red) to visualize the peripheral branches in the bone (Fig 4).

In the place of the exit of the maxillary nerve from the infraorbital foramen it is defined as a colored rounded portion with a diameter of 2 to 3 mm (in norm), (Fig 4).

The narrowing of the bone orifices less than the minimum size indicated by us coincided with the clinical manifestation of neurogenic lesion of the peripheral branch on the diseased side (Fig 4B). If along the course of the corresponding nerve in the bone canal, its colored contours (orientations) are "lost", then this indicated ossification, which was observed in a certain area of the given bone canal and always coincided with the pathological focus detected during the operative treatment - decortication of the corresponding part of the canal. Based on our survey we can state that color stereolithography makes it possible to obtain the real size of the pathological focus (ossification) in the bone canal, and also to determine its exact location (bone or canal). This circumstance gave us the opportunity to carefully study the localization and evaluate the complexity of the planned surgical intervention, as well as assess the options for approaching the location of the pathological focus.

Thus, with neurogenic diseases of the maxillofacial region due to narrowing of the bone canals through which the second branch of the trigeminal nerve passes, stereolithography made it possible to reveal the exact location of this narrowing along the bone tunnel and plan

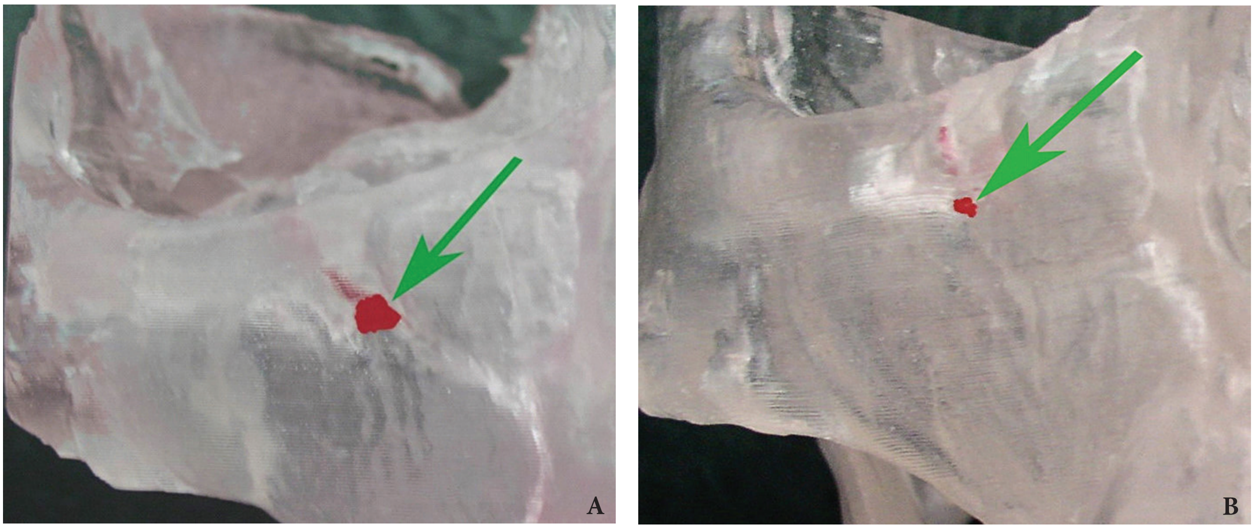

FIGURE 4. Stereolithography model of the maxillary bone in color. The location of the infraorbital nerve is colored dark red. The form of the infraorbital foramen (indicated by the arrow) is normal (**A**) and when it is narrowed (**B**).

in advance access to this portion of the jaw, and therefore carefully select the technique of conducting surgical intervention with minimal traumatic damage to the jaw bones.

Neuralgia of the trigeminal nerve is divided into two of their forms: central (lesion of the gasserian ganglion) and peripheral (lesion of the peripheral branches of the trigeminal nerve) [14-22]. You cannot mix neuralgia of central and peripheral genesis into one disease, because each of these forms has its own peculiarities of the clinical course, which requires different methods of their treatment.

Peripheral neuralgia arises as a result of the impact of the pathological process on various parts of the peripheral part of the trigeminal nerve.

To the etiological factors that may cause neuralgia of the trigeminal nerve of peripheral genesis may be included ossification of the infraorbital aperture (through it comes the infraorbital nerve).

Surgical methods for the treatment of peripheral neuralgia of the trigeminal nerve are reduced to conducting a neurotomy – dissection of the nerve and neurectomy – excision of the nerve region, nerve exeresis – removal of the nerve by twisting it out.

To date, there are many different methods of neurectomy of the second and third branches of the trigeminal nerve. The most promising methods for treating peripheral forms of neuralgia of the trigeminal nerve are decompression operations, i.e. with the release of peripheral nerve branches from the bone canals.

Decortication of the infraorbital or mandibular canal with resection of the neurovascular bundle is widely used in our clinic (Department of Maxillofacial Surgery of the Shupyk National Medical Academy of Postgraduate Education). A positive effect was observed in almost 90% of cases.

Electrophysiological methods that allow determining the presence or absence of irreversible changes in the peripheral branches of the trigeminal nerve. From special methods of examination, we performed a measurement of the electrophysiological parameters (conductivity, tone, resistance) of the trigeminal nerve at the points of its exit (the study was performed on the hardware-software complex "DIN-1"). With these electrophysiological studies of the branches of the trigeminal nerve (with neuralgia), we were able to prove that in more than 80% of cases its function remained, despite its violations, which were expressed in varying degrees.

Operations are usually performed under local anesthesia (local anesthetic solution Artikain-ZT) at the round foramen and infiltration of surrounding soft tissues (with premedication or with neuroleptanalgesia) or under general anesthesia. This provides painless intervention, calm behavior of patients during the operation and in the next few hours after it. In cases with severe psycho-emotional lability, we usually use narcosis

The question of the size and degree of disturbances in the sensitivity of the face after surgery is of interest. It, basically, corresponds to a zone of an innervation of a corresponding branch of a trigeminal nerve. Most of all, pain sensitivity is disturbed. Tactile and temperature sensitivity changes to a lesser extent, so damage to the denervated area by hot food, sharp objects takes place. However, over time, there is a tendency to narrow the zone and the degree of violation of all types of sensitivity. Complete restoration of sensitivity does not occur even a few years after the operation.

Along with the marked disorders of sensitivity, patients (in the first weeks or months after the operation) feel a tingling sensation, "creeping crawling", a feeling of tension in the denervated area. Patients prefer to eat with healthy side while eating. Any features in the process of using removable dentures, which will be made for the patients in the future, do not arise. The speech functionality does not suffer.

The disturbance of the sensitivity of the facial skin, although unpleasant to the patient, but in comparison with the neuralgic pains that preceded the operation, is incomparably less painful. They can get relatively used to it.

The next day after the operation, patients were assessed the electrophysiological parameters of the third branch of the trigeminal nerve with the help of the hardware-software complex "DIN-1". Depending on the received indices and complaints of patients, a course of rehabilitation treatment was appointed to optimize the postoperative course.

Patients were prescribed a course of treatment of electrostimulation in the area of the infraorbital opening, taking into account the data that we obtained in the diagnosis at the given point the day after the operation. Thus, we improve the trophic of the second branch of the trigeminal nerve in the postoperative period. The course of rehabilitation treatment using the hardware-software complex "DIN-1" consisted of 5 electrical stimulations. The course of electrostimulation was carried out daily or every other day. All patients for antiseptic treatment of the oral cavity, in the postoperative period, used the drug "Givalex" for the prevention of inflammatory phenomena.

After completion of the ongoing treatment of patients, i.e. at the time of their discharge from the hospital, we noted a complete recovery of all types of sensitivity in the innervation zone of the nerve. Neuralgic pain of the trigeminal nerve in the operated cases were not revealed.

Conclusions

Color stereolithography is the most modern method of examining a patient, which allows obtaining a three-dimensional model of bones of the facial skeleton. This method makes it possible to present a three-dimensional picture and to detect the exact location of the pathological focus (ossification), determine its real size, choose the method and place for operation (bone or a certain part of the length of the bone canal) of decorticating the maxillary canal. Color stereolithography is a method of diagnostics that allows the surgeon to think and work out the technique of the planned operation, to reduce the risk of occurrence of unforeseen situations during complex operations, which reduces the incidence of postoperative complications.

Stereolithography can be used in the diagnosis of ossification of the bone canals of the jaw bones, i.e. in places where the second peripheral branch of the trigeminal nerve passes. It is recommended for wide application in practical medicine.

Funding

None.

Ethical Approval

Approval was obtained from the Medical Ethics Committee of the Shupyk National Medical Academy of Postgraduate Education, Kyiv, Ukraine.

Patient Consent

Not required.

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Сучасні методи діагностики, що використовуються у хірургічному лікуванні периферичних невралгій

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ПРО СТАТТЮ

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Прийнятий: 04 червня 2017 року
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Ключові слова:

Трійчастий нерв
Вторинні неврогенні ураження
Стереолітографія

РЕЗЮМЕ

Мета. Визначити можливості використання стереолітографії у діагностиці уражень периферичних нервів при осифікації кісткових каналів верхньощелепної кістки.

Пацієнти та методи. Нами проведено обстеження 31 хворого з вторинними нейрогенними ураженнями другої гілки трійчастого нерва за допомогою метода стереолітографії.

Результати. Вивчені діагностичні можливості кольорової стерео літографії при захворюваннях II гілки трійчастого нерва.

Висновки. Доказана висока ефективність стереолітографії. Метод рекомендован для використання у медичній практиці.

Современные методы диагностики применяемые в хирургическом лечении периферических невралгий

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О СТАТЬЕ

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Система тройничного нерва
Вторичные неврогенные поражения
Стереолитография.

РЕЗЮМЕ

Цель. Определить возможности использования стереолитографии в диагностике поражений периферических нервов при оссификации костных каналов верхнечелюстной кости.

Пациенти и методы. Нами проведено обследование 31 больного с вторичными неврогенными поражениями второй ветви тройничного нерва с помощью метода стереолитографии.

Результаты. Изучены диагностические возможности цветной стереолитографии при заболеваниях II ветви тройничного нерва.

Выводы. Доказана высокая эффективность стереолитографии. Метод рекомендован для использования в медицинской практике.

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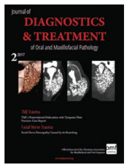

Radiological Note

Temporomandibular Joint of the Healthy Persons Upon Magnetic Resonance Imaging

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ABOUT ARTICLE

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Bilaminar zone of the TMJ

ABSTRACT

Purpose.
To present the anatomy of the temporomandibular joint of healthy people based on the results of the magnetic resonance imaging.
Patients and methods.
31 patients without the pathology of the temporomandibular joint were examined.
Results.
Based on the results of magnetic resonance imaging in patients without the pathology of temporomandibular joint anatomy of the temporomandibular complex was presented. Two methods of temporomandibular joint examination were compared: CT and MRI. Indications and contraindications (absolute and relative) for MRI were presented.
Conclusions.
Using the magnetic resonance imaging makes it possible to effectively diagnose degenerative, inflammatory and neoplastic diseases of joints and surrounding soft tissues as it was proved by the performed examination of the temporomandibular joint of healthy people.

Currently, one of the most common pathologies in the maxillofacial area are diseases of temporomandibular joints (TMJ). The pathology of the TMJ, among the diseases of the dento-jaw system, takes the third place after caries and periodontal disease (Sysoljatin P., Il'in A, Dergilev A., 2001; Pisarevsky Y., et al., 2003; Tymofieiev O.O., 2007, 2010, 2012; Ivasenko P. et al., 2009, et al.) [1-10]. Difficulties in revealing structural disorders in diseases of the TMJ are due to the anatomical features of these joints (Ryabokon E., 2004, 2006) [11, 12]. The TMJ is divided by an articular disc, fixed intraarticular ligaments, into two floors (cavities). The posterior intraarticular ligaments, together with the vessels and nerves between them, and the connective tissue form the bilaminar zone. The bilamar zone of the TMJ is located behind the articular disc. Two ligaments connect the disc to the temporal bone and to the condyle of the lower jaw. They are separated by the venous plexus (Zenker's cushion pad). The upper ligament, attached to the posterior margin of the fossa, is made of an elastic fibrous tissue, whereas the lower ligament, made of inelastic fibrous tissue, is attached to the posterior surface of the condylar process of the lower jaw. The inner surface of the TMJ cavities in the anterior part of the bilaminar zone is covered by endothelial cells, which form the synovial lining with the production of synovial fluid.

Among this pathology, the following diseases are common: dysfunction of the TMJ, arthritis and arthrosis. At the same time, we often have to meet with ankylosis, subluxations and neoplasms.

If a patient needs to be examined for a TMJ trauma or a fractured condylar process of the jaw is suspected, the best way to diagnose is computed tomography (CT). Computed tomography clearly visualizes the compact substance of bones and cavities filled with liquid (blood). To obtain images by a computer tomograph, X-rays are used. A computer tomograph is a special X-ray machine that rotates around the subject's body and takes pictures at different angles. CT is used to diagnose bone pathology, post-traumatic injury (violation of bone integrity), and also clearly visualize hemorrhages.

Magnetic resonance imaging (MRI) is a modern, universal, non-invasive and safe method for examining a patient, which is based on the magnetic properties of human tissues and allows diagnosing various joint diseases. To obtain an image when performing magnetic

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resonance imaging, X-ray radiation is not used, since the subject is placed in a strong magnetic field and this leads to the fact that all the hydrogen atoms in the patient's body are aligned parallel to the direction of the magnetic field. At this point, the device sends an electromagnetic signal perpendicular to the main magnetic field. Hydrogen atoms, having the same frequency as the signal, get «excited» and generate their own signal, which is picked up by a tomograph. It is known that different types of tissues (bones, muscles, vessels, etc.) have a different number of hydrogen atoms and therefore they generate a signal with different characteristics. The main value that is recorded in a magnetic resonance study is the response of magnetic nuclei to the action of an alternating magnetic field, which depends on the density of nuclei and other parameters specific for each part of the human body. A magnetic resonance tomograph recognizes these signals, deciphers them and builds an image (Hamada Y. et al. 2000, et al.) [13, 14]. The clinical application of the MRI method is to study the spatial distribution of hydrogen nuclei and some other elements in the human body.

The difference between MRI and CT is that with MRI, the measured value is the magnetization of certain types of nuclei in the isolated volume element, while for CT, the coefficient of X-ray absorption by various biological tissues. MRI does not have any harmful effects on the patient.

With MRI, bone tissue is clearly visible, but more soft tissue is captured. Magnetic resonance imaging is the main method in modern diagnostics of degenerative, inflammatory and tumor diseases of joints and surrounding soft tissues. MRI allows a non-invasive way to visualize the soft tissue component of the joint (tendons, ligaments, articular disc, cartilage, periarticular bag). This method makes it possible to obtain thin sections in different planes with the subsequent setting of a three-dimensional image of the joint, which allows to establish accurately the presence or absence of pathological changes in the TMJ and / or surrounding soft tissues, and to establish their localization and timely and correctly choose the treatment tactics.

Absolute contraindication to MRI is the presence of a pacemaker or metallic foreign bodies in the area under investigation, because rough artifacts appear on the images, as well as in the presence of metal non-removable dentures in the oral cavity (for examining the maxillofacial region), i.e. the presence of foreign metal bodies causes the risk of their displacement by a magnetic field. Relative contraindication is pregnancy in the early term (the first 3 months) and claustrophobia.

Indications for MRI of the TMJ are: musculo-articular dysfunction, inflammatory-dystrophic diseases (arthritis, arthrosis), post-traumatic injuries, ankylosis, pain in the temporal region with movements of the lower jaw, clicks when moving (opening and closing the mouth) of the lower jaw, Opening of the mouth with movements of the lower jaw, defects of the lower jaw when planning reconstructive operations, planning orthodontic treatment, etc.

When planning a magnetic resonance imaging of the TMJ, they make marks (localizers), which are displayed on the images obtained (Figs 1, 2). The localizer in the axial projection (in the transverse plane of the body) shows the course and orientation of the slices in the planning of the parasagital (Fig 1) and paracoronal projection (Fig 2).

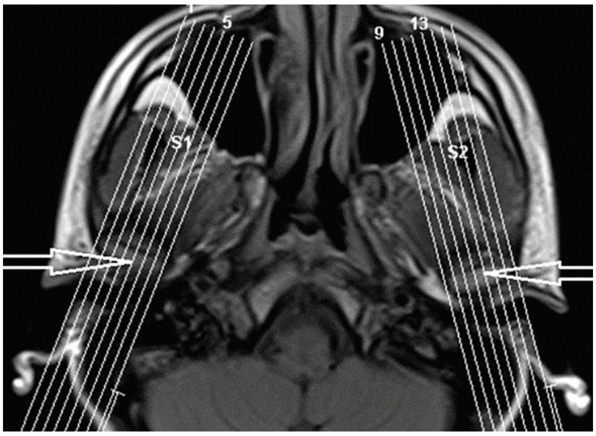

FIGURE 1. Localizer in axial projection. Shows the course and orientation of the slices when planning the parasagital projection (condylar heads are indicated by *arrows*). The ordinal numbers of the figures with the closed mouth correspond to the ordinal numbers of the slices on the localizer.

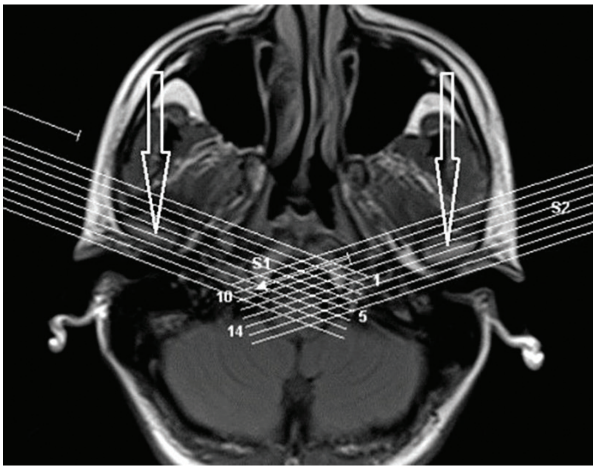

FIGURE 2. Localizer in axial projection that shows the course and orientation of the slices in the planning of the paracoronary projection (condylar heads are indicated by *arrows*). The ordinal numbers of the figures with the closed mouth correspond to the ordinal numbers of the slices on the localizer.

Now we will show the images of the TMJ made in different planes (Figs 3-16).

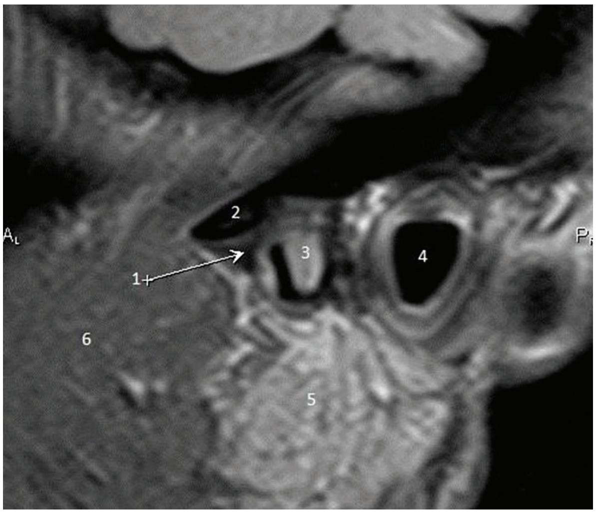

FIGURE 3. TMJ slice in the sagittal plane shows: 1 – TMJ disc, 2 – articular tubercle, 3 – the head of the condylar process of the mandible, 4 – the external auditory meatus, 5 – the parotid gland, 6 – the temporal muscle.

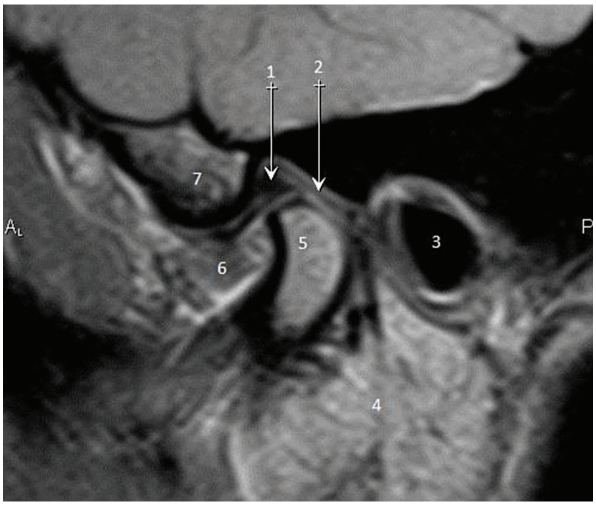

FIGURE 4. TMJ slice in the sagittal plane shows: 1 – TMJ disc, 2 – bilaminar zone, 3 – external auditory meatus, 4 – parotid salivary gland, 5 – head of condylar process of mandible, 6 – lateral pterygoid muscle, 7 – articular tubercle.

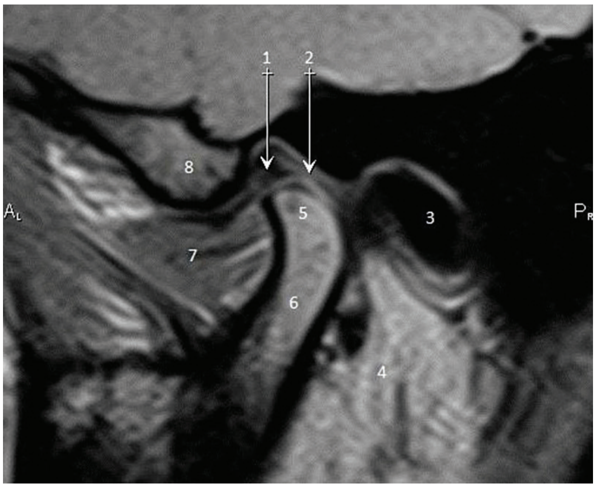

FIGURE 5. TMJ slice in the sagittal plane shows: 1 – TMJ disc, 2 – bilaminar zone, 3 – external auditory meatus 4 – parotid gland, 5 – head of condylar process of the mandible, 6 – ramus of the mandible, 7 – lateral pterygoid muscle, 8 – articular tubercle.

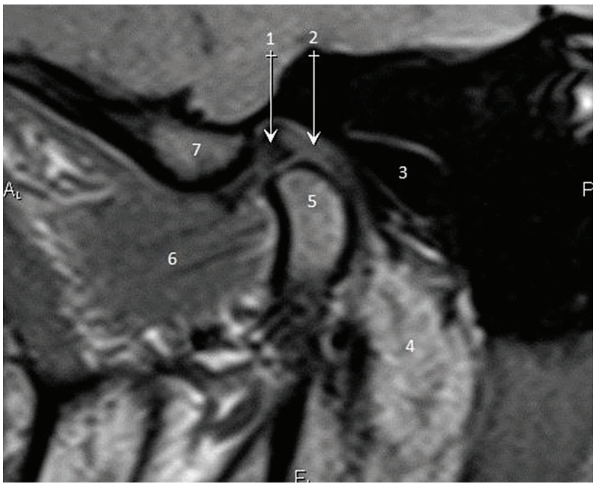

FIGURE 6. TMJ slice in the sagittal plane shows: 1 – TMJ disc, 2 – bilaminar zone, 3 – external auditory meatus, 4 – parotid salivary gland, 5 – condylar process of mandible, 6 – lateral pterygoid muscle, 7 – articular tubercle.

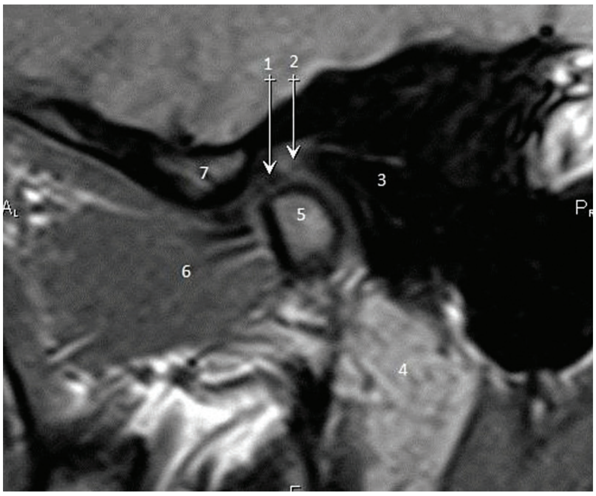

FIGURE 7. TMJ slice in the sagittal plane shows: 1 – TMJ disc, 2 – bilaminar zone, 3 – external auditory meatus, 4 – parotid salivary gland, 5 – condylar process of mandible, 6 – lateral pterygoid muscle, 7 – articular tubercle.

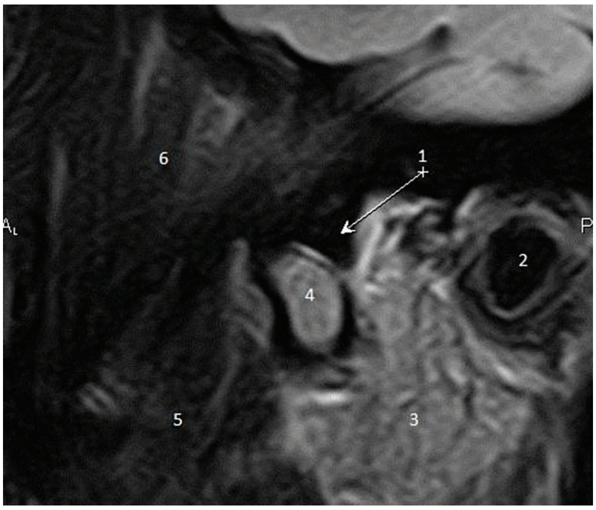

FIGURE 8. TMJ slice in the sagittal plane with an open mouth: 1 – TMJ disc, 2 – external auditory meatus, 3 – parotid salivary gland, 4 – condylar process of mandible, 5 – medial pterygoid muscle, 6 – temporal muscle.

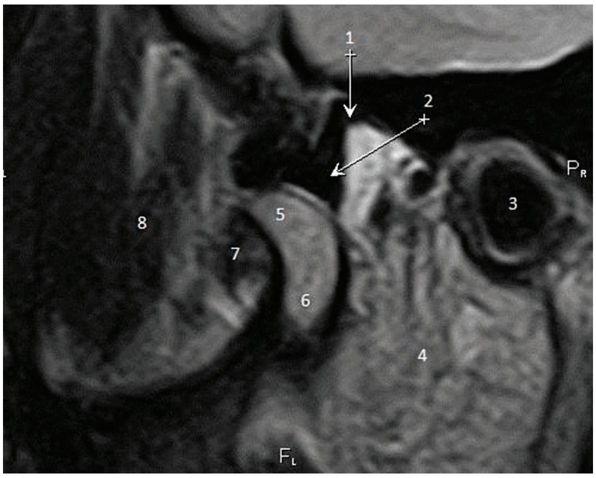

FIGURE 9. TMJ slice made in the sagittal plane with an open mouth shows: 1 – bilaminar zone, 2 – TMJ disc, 3 – external auditory meatus, 4 – parotid salivary gland, 5 – condylar process of mandible, 6 – ramus of the mandible, 7 – lateral pterygoid muscle, 8 – temporal muscle.

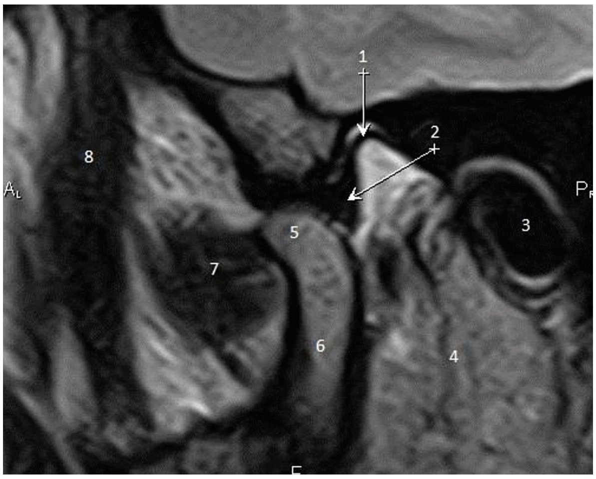

FIGURE 10. TMJ slice made in the sagittal plane with an open mouth: 1 – bilaminar zone, 2 – TMJ disc, 3 – external auditory meatus, 4 – parotid gland, 5 – condylar process of mandible, 6 – ramus of the mandible, 7 – lateral pterygoid muscle, 8 – temporal muscle.

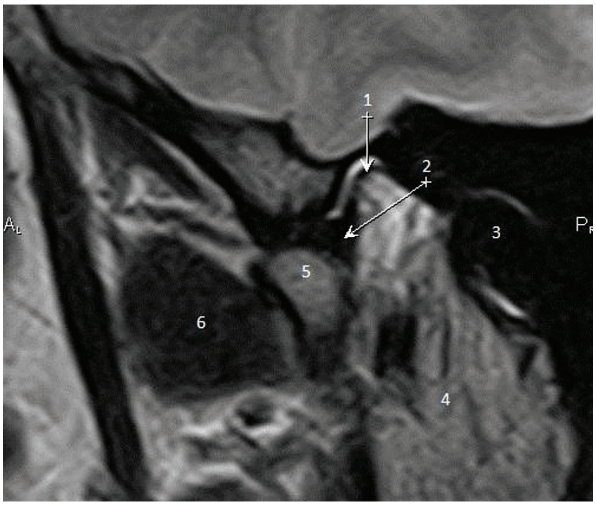

FIGURE 11. TMJ slice made in the sagittal plane with an open mouth shows: 1 – bilaminar zone, 2 – TMJ disc, 3 – external auditory meatus, 4 – parotid salivary gland, 5 – condylar process of mandible, 6 – lateral pterygoid muscle.

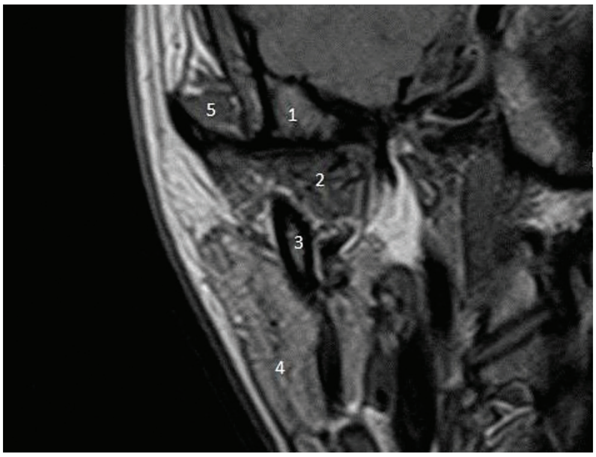

FIGURE 12. TMJ slice in the coronary (frontal) plane shows: 1 – articular fossa, 2 – lateral pterygoid muscle, 3 – ramus of the mandible, 4 – parotid salivary gland, 5 – temporal muscle.

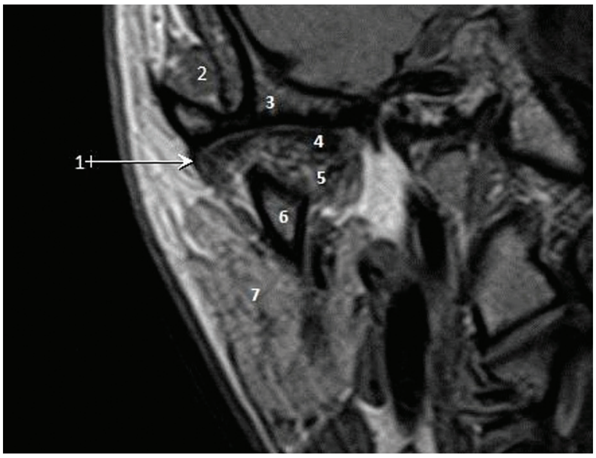

FIGURE 13. TMJ slice in the coronary (frontal) plane shows: 1 – articular capsule, 2 – temporal muscle, 3 – articular fossa, 4 – TMJ disc, 5 – lateral pterygoid muscle, 6 – ramus of the mandible, 7 – parotid gland.

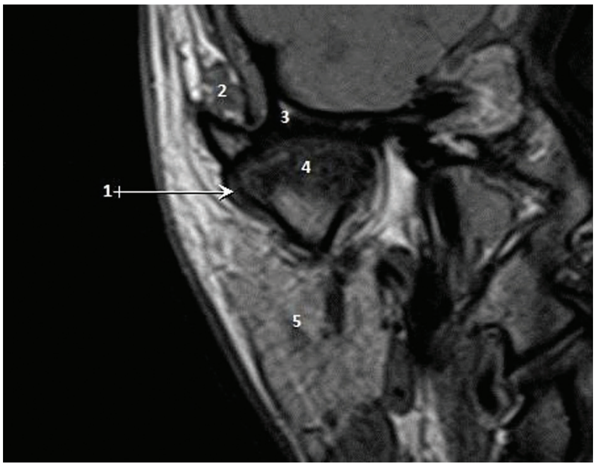

FIGURE 14. TMJ slice in the coronary (frontal) plane shows: 1 – articular capsule, 2 – temporal muscle, 3 – articular fossa, 4 – condylar process of mandible, 5 – parotid gland.

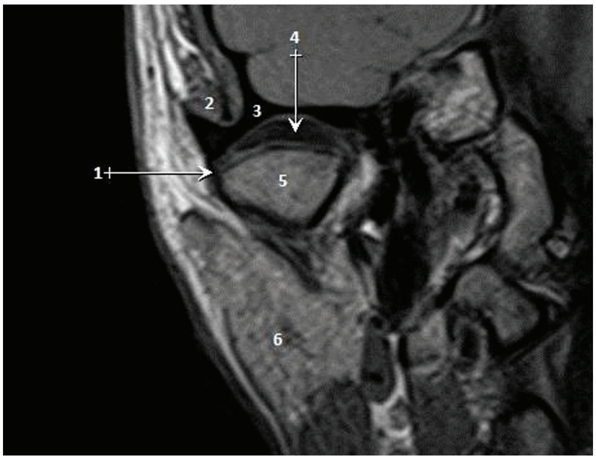

FIGURE 15. TMJ slice in the coronary (frontal) plane: 1 – articular capsule, 2 – temporal muscle, 3 – articular fossa, 4 – TMJ disc, 5 – condylar process of mandible, 6 – parotid gland.

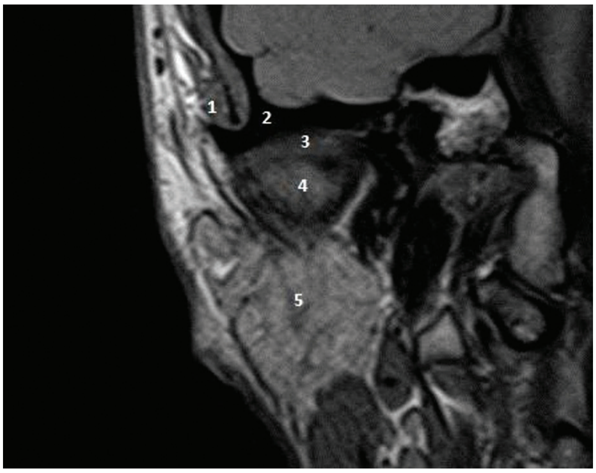

FIGURE 16. TMJ slice in the coronary (frontal) plane: 1 – temporal muscle, 2 – articular fossa, 3 – TMJ disc, 4 – condylar process of mandible, 5 – parotid gland.

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Conflict of Interests

The authors declare no conflict of interest.

Role of Author and Co-authors

Oleksii O. Tymofieiev (concept of the paper and writing).
Sergii V. Maksymcha (material collection).

Ethical Approval

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Patient Consent

Not required.

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Скронево-нижньощелепний суглоб здорової людини при проведенні магнітно-резонансної томографії

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ПРО СТАТТЮ

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Магнітно-резонансна томографія (МРТ)
Комп'ютерна томографія (КТ)
Диск скоренево-нижньощелепного суглобу
Біламінарна зона СНЩС

РЕЗЮМЕ

Мета. Представити анатомію скореневo-нижньощелепного суглобу здорових людей на підставі результатів проведеної магнітно-резонансної томографії.

Пацієнти та методи. Проведено обстеження 31 пацієнта без патології скоренево-нижньощелепного суглобу.

Результати. На підставі результатів проведеної магнітно-резонансної томографії у пацієнтів без патології скоренево-нижньощелепного суглобу представлена анатомія скоренево-нижньощелепного комплексу. Проведена порівняльна характеристика двох методів обстеження СНЩС: комп'ютерної томографії і магнітно-резонансної томографії. Представлені показання і противопоказання (абсолютні і відносні) до проведення МРТ.

Висновки. Проведеними обстеженнями скоренево-нижньощелепного суглобу у здорових людей встановлено, що застосування магнітно-резонансної томографії дозволяє більш ефективно проводити сучасну діагностику дегенеративних, запальних і пухлинних захворювань суглобів і оточуючих м'яких тканин.

Височно-нижнечелюстной сустав здорового человека при проведении магнитно-резонансной томографии

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Диск височно-нижнечелюстного сустава
Биламинарная зона ВНЧС

РЕЗЮМЕ

Цель. Представить анатомию височно-нижнечелюстного сустава здоровых людей на основании результатов проведенной магнитно-резонансной томографии.

Пациенти и методы. Проведено обследование 31 пациента без патологии височно-нижнечелюстного сустава.

Результаты. На основании результатов проведенной магнитно-резонансной томографии у пациентов без патологии височно-нижнечелюстного сустава представлена анатомия височно-нижнечелюстного комплекса. Проведена сравнительная характеристика двух методов обследования ВНЧС: компьютерной томографии и магнитно-резонансной томографии. Представлены показания и противопоказания (абсолютные и относительные) к проведению МРТ.

Выводы. Проведенными обследованиями височно-нижнечелюстного сустава у здоровых людей, установлено, что применение магнитно-резонансной томографии позволяет более эффективно проводить современную диагностику дегенеративных, воспалительных и опухолевых заболеваний суставов и окружающих мягких тканей.

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Prevention of Inflammatory Complications upon Surgeries in Maxillofacial Region

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ABOUT ARTICLE

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Contaminated surgeries
Purulent surgeries

ABSTRACT

Summary.
Conducting of prophylactic antibiotic therapy in patient after surgical interventions in oral and maxillofacial surgery reduces the incidence of postoperative infectious complications. The analysis of the clean, conditionally clean, dirty (potentially infected), and purulent surgeries is performed. The general questions of prophylaxis of infection complications in plastic, orthognathic, purulent surgeries, and oral microflora are considered. Consecutive cases of postoperative complications and purulent conditions at the head and neck areas are presented. Recommendations on the antibiotic prophylaxis in oral and maxillofacial surgery are given.

Recently, a number of patients with purulent-inflammatory complications in maxillofacial region is critically increased and the clinical course of the disease is aggravated [1, 2]. Despite of all comprehensive achievements of medicine the problem of inflammatory complications which manifests after performed operative interventions, is still actual. The frequency of postoperative wounds suppuration is directly dependent on the degree of purity of the surgical wound. It should be noted that after performance of the clean operations (removal of tumors, dental implantation, etc.) the incidence of infectious complications also remains at a high level. Clinical observation revealed that in the case of clean surgeries it is impossible completely eliminate the cases of suppuration of postoperative wounds. Despite the fact that performing of measurements associated with asepsis is obligatory in medical institutions, we cannot exclude microbial contamination of the surgical wound, because both the patient himself and the operating team may be a source of microbial contamination. Postoperative inflammatory complications should be considered as a factor leading to the significant aggravating of the postoperative period, and it increases the patient's risk of disability.

It is widely believed that the risk of postoperative inflammatory complications depends largely on the level of immunity and age, as well as associated pathology and chronic intoxication of the patient (alcohol and drug addiction). According to our observations the level of immunity in the maxillofacial patients is not at a high level. Many diseases of the maxillofacial region are likely to disrupt the power function and, consequently, reduce the patient's immunity. Due to the environmental problems and changes in the living conditions the doctors often have to deal with immunologically weakened patients. It should be noted that in recent years the increased contingent of elderly patients, as well as those after effects of stress, trauma and with concomitant diseases, is increased. Factors that may contribute to the development of postoperative infectious complications are: violation of aseptic conditions, elderly age, obesity, inadequate hemostasis, significant blood loss, the degree of tissue damage in the area of the surgical wound, use of electrosurgical cautery, violation of technique and the duration of the operation, use of drainage of postoperative wounds, and others.

All operations depending on the risk of postoperative infectious complications after surgical interventions in

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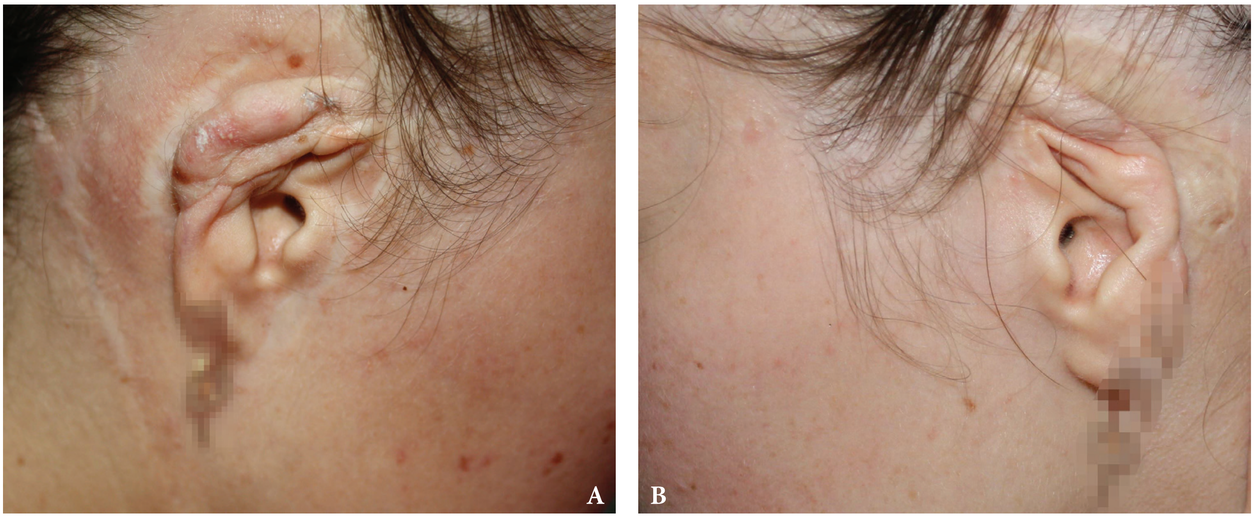

FIGURE 1. Clinical view of the patient after plastic surgery (clean surgery) resulted in postoperative infection complication and scar deformities. Noted the ears deformity and scars in the pre- and postauricular regions (**A**, **B**).

maxillofacial surgery can be divided into the following groups:

– Clean surgeries are an extraoral surgeries which do not penetrate into the oral cavity (blepharoplasty, plastic surgery of the face and neck (Fig 1), as well as removal of tumors and tumor-like formations of the parotid and submandibular glands, etc.)[4-7];

– Conditionally clean are the surgeries, which are performed by an extraoral approach, but there is a risk of penetration into the oral or nasal cavity, as well as operations after elimination of previously existing inflammation (osteosynthesis of the mandible, removing of branchial cleft cysts and fistulas, etc.)[8-11];

– Dirty or potentially infected (contaminated) are the surgeries which are performed by an intraoral approach (resection of teeth roots, dental implants, highmorotomy (Fig 2), removing of lesions in area of alveolar process and body of maxilla and mandible, surgical debridement of the wounds (Fig 3), etc.)[8, 12-16];

– Purulent surgeries are the surgical intervention on the lancing of purulent periostitis, abscesses (Fig 4), phlegmons, sequestrectomies, etc [17, 18].

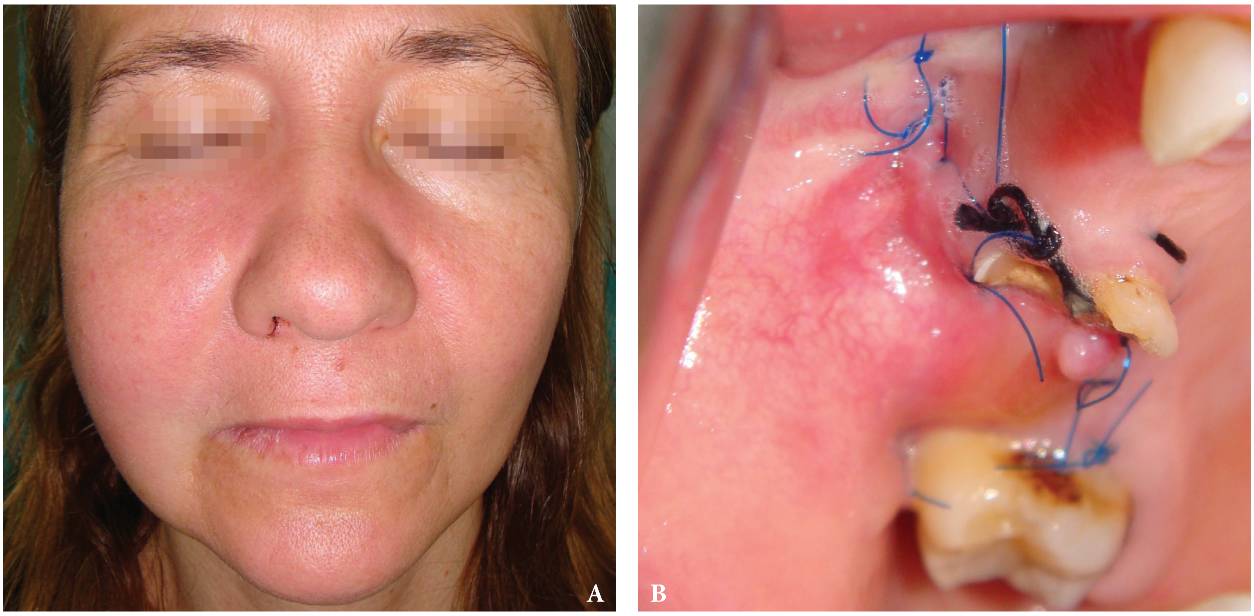

FIGURE 2. Suppuration of the blood clots in the maxillary sinus at 4 day after right-side highmorotomy. The patient complained of increasing of swelling at the right infraorbital and cheek regions, pain. At the clinical photograph of the patient noted hyperemia of the skin (**A**) and mucosa (**B**) at the area of surgery. The complication happened as a result of antibiotics rejection and inadequate treatment by non-steroid anti-inflammatory drugs by the patient.

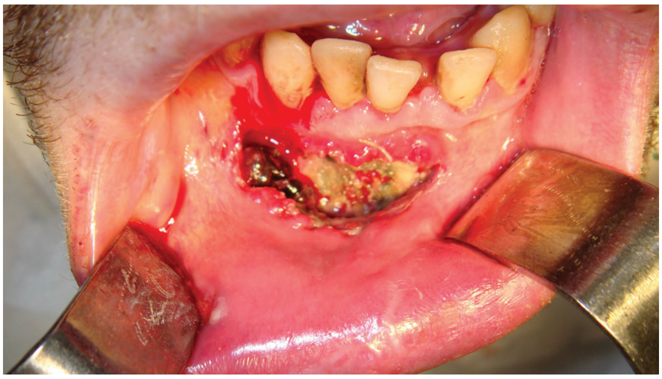

FIGURE 3. Clinical view of infected wound of oral vestibule 3 days after its primary surgical debridement. Sutures fail, suppuration with tissues necrotizing are observed because of violation of the surgeon's recommendations by the patient (rejection of antibiotics, bad oral hygiene, and alcohol abuse).

FIGURE 4. 42-year-old patient with two-week bilateral mandibular fracture complicated with osteomyelitis, skin necrosis and of abscess of soft tissues. On the clinical images (**A**, **B**) the skin necrosis with purulent discharge is indicated by *white arrows*, abscess – *black arrows*. Panoramic x-ray (**C**) shows mandibular fractures (*arrows*) with dislocations.

Antibiotic prophylaxis is intended to reduce the likelihood of surgical wound contamination by the pathogens and prevent further microbial growth.

Preoperative antibiotic prophylaxis is only a supplement, not an alternative to good surgical technique of operation. If the infectious process was already running at the time of surgery, the administration of prophylactic antibiotics 3-4 hours after its performance is already ineffective.

Considering the specifics of work of the maxillofacial and oral surgeons, we would like to dwell on the microflora of the mouth. Species composition of oral microflora in healthy people is fairly constant. The number of microorganisms varies depending on the salivation, consistency and nature of the food, oral hygiene, the state of the tissues and organs of the oral cavity and the presence of systemic diseases. In the oral cavity a large number of different species of bacteria is contained, much greater than in other parts of the gastrointestinal tract. A significant number of contained types of microorganisms can also be explained by the fact that the bacteria enter into the oral cavity with air, water, food, i.e. they are so-called transit microorganisms, stay of which is limited.

The oral microflora is permanent, contains nearly 30 microbial species, it forms a stable and fairly complex ecosystem of the oral cavity. Thus, the mouth is a type of ecological system, which is closely related to the internal medium of the organism and its environment. An integral part of micro-ecosystem of the oral cavity is normal microflora that provides colonization resistance, which is seen as the primary target for any factor which directly or indirectly affects the non-specific resistance of this ecosystem. Permanent microflora of the human oral cavity is formed as a result of mutual adaptation of the organism and microbes. Adaptive and related biological changes lead to «balance» between a human body and the microbial flora, and between the components of its species of microorganisms. This "equilibrium" is of dynamic type.

Disorders of salivation, chewing and swallowing always lead to an increase in the number of microorganisms in the oral cavity. The same effect is observed in a variety of anomalies, defects and diseases that hinder leaching micro-organisms by saliva flow (carious lesions, periodontal pockets, poorly manufactured non-removable dentures, inflammatory processes around the jaws, etc.).

The composition of the microbial flora of the oral cavity is not uniform. In different areas the various quantitative and qualitative composition of microorganisms are defined. The microflora of the oral cavity varies extremely and includes bacteria, actinomycetes, fungi, protozoa, spirochetes, rickettsia, viruses. It should be noted that some part microflora of oral cavity of adults are anaerobic species. There are obligate and facultative anaerobes. Obligate anaerobes are killed in the presence of free oxygen in the environment. Facultative anaerobes can persist and proliferate in oxygen or in oxygen-free environment. The facultative anaerobes are *E coli*, *staphylococcus*, *streptococcus* and other bacteria. Obligate anaerobes can be divided into two groups: bacteria, spores forming (*Clostridium*) and bacteria (*Non-clostridial*) anaerobes. Among the bacteria which form spores, anaerobic pathogens clostridial infections are distinguished, i.e., gas gangrene [21-25]. The non-clostridial anaerobes include: *Bacteroides*, *Fusobacteria*, *Veilonellas*, *Peptococcus*, *Peptostreptococcus*, *Eubacteria*, etc.

In the mouth, the saliva affects microorganisms, mechanically washing out bacteria and by containing antimicrobial agents (lysozyme). But in the oral cavity, there are always areas easily colonized by microorganisms (gingival pockets, gaps between teeth, teeth eruption). The highest concentrations of microbial colonies in adults are formed in the interdental spaces, physiological gingival pockets (gingival sulcus), dental plaque, in the retromolar space, in the area of the tonsils and back of the tongue, especially in its posterior parts.

The composition of oral microflora includes microorganisms, some of which are forms of autochthonous flora, while others – allochthonous (inherent in other areas). Autochthonous flora consists of local microorganisms which are characteristic of the oral cavity. Among the autochthonous microorganisms the resident (obligate) and transient species are distinguished. Allochthonous microflora of the mouth is represented by microbes inherent in other areas (it is composed of species that normally live in the intestines, nose and throat and other parts of the human body).

Microflora of the mouth also can be divided into two groups: a constant (physiological or normal) microflora, i.e. set of different species of microorganisms, which is characteristic of a healthy person; random (transient) microflora is a saprophytic and pathogenic microorganisms which enter the oral cavity from the outside (after surgery, etc.).

The qualitative composition of the resident microflora of the mouth of every healthy person varies in a limited extent. It is known that among the bacterial flora of the oropharynx the streptococci dominate. The majority of Gram-positive cocci oral represented a heterogeneous group of low virulence *viridans streptococci*, which are actively involved in the processes that lead to lesions of dental hard and periodontal tissues. This group includes *Streptococcus mutans*, *S sanguis*, *S mitis*, *S salivarium*. Often they are found jointly with *Fusobacteria* and Spirochetes during caries, pulpitis, periodontitis, abscesses of the maxillofacial region. The second group of Gram-positive cocci are *Peptococci*.

Less aerated areas are colonized by anaerobes – *Actinomycetes*, *Bacteroides*, *Fusobacteria Veilonellas*. The genus *Fusobacterium* is bacteroids with autochthonous flora of the mouth. *Fusobacteria* live in gingival pockets with Spirochetes association. Gram-negative anaerobic cocci are represented by genus *Veillonella* and are permanent inhabitants of the oral cavity of man. *Veillonella* concentration in saliva is approximately the same as that of *Streptococci viridans*. Most often there are two types of *Bacteroides – V melaninogenicus*, *B gingivalis*. B *melaninogenicus* is a regular inhabitant of the gingiva in adults and has a great pathogenetic importance in the development of periodontal diseases.

In oral cavity, there are the *Spirochaetes* genera of *Leptospira*, *Borrelia* and *Treponemas*, *Mycoplasmas* (*M orale*, *M salivarium*), Candida species and a variety of Protozoa (Entamoeba buccalis and *E dentalis*, *Trichomonas buccalis*). In the oral cavity, there are also genera *Actinomyces* and *Bifidobacterium*. *Actinomycetes* are on the oral mucosa, may participate in the formation of dental plaque and caries and periodontal diseases. Very often in these pathological processes A *viscosus* and A *israelii* are found. A viscosus is involved in the formation of subgingival calculus.

In the oral cavity, bacteria genus *Corynebacterium* is found. A characteristic feature of *Corynebacterium* is its ability to reduce the redox potential, thereby creating conditions for the growth of anaerobes. In case of periodontal diseases they are found in association with *Fusobacteria* and *Spirochetes*. Thus, the composition of microbial species, which are in oral cavity is complex one.

Relative ease of ingress of bacteria from the oral mucosa or other local purulent lesions in the blood stream determines the relatively high incidence of oral sepsis. The presence in the oral cavity of poorly cleaned cavities, gingival pockets and other areas contributes to the persistence of pathogenic microorganisms and causes the formation of a sufficiently high rate of chronic infection foci (*Staphylococcal*, *Streptococcal*, etc.) with following allergization of the body.

The main measures for reducing the number of postoperative inflammatory complications are as follows:

– Before carrying out operations it is necessary to sanitize the oral and nasal cavities;

– Special attention should be paid to the reduction of both exogenous and endogenous infections of surgical wounds during the operation, i.e. performing aseptic;

– During an operation it is necessary to take care of the tissues, which reduces the probability of formation of zones of ischemia, necrobiosis and necrosis in the surgical wound;

– Should be a rational and targeted preoperative antimicrobial prophylaxis.

Taking account of the leading role of microorganisms in causing inflammatory processes in maxillofacial area, the prescription of antibacterial therapy no one questiones. Antibiotic therapy is carried out both during the treatment of patients with already arisen abscesses and phlegmons [26-29], and for the prevention of inflammatory complications after a clean, conditionally clean and contaminated (potentially infected) surgical interventions. Routes of administration of antimicrobial drugs, their dosage and duration of prophylactic antibiotic therapy depends on the reactivity of the patient, the volume of the surgery, the presence of concomitant diseases, etc.

Rational prescribing of antibiotic prophylaxis, in terms of reducing the risk of postoperative inflammatory complications during the surgery, no one questiones. The choice of antimicrobial drug for the prevention of postoperative infectious complications is difficult because in the occurrence and development of these processes, usually not one microbial pathogen, but a few – microbial associations are involved. According to some authors – from 3 to 6 [1, 2]. When planning prophylactic antibiotics in outpatient it is advisable to focus on the purpose of oral antibiotics with high bioavailability, long half-life and minimal side effects of their actions. In carrying out preventive measures for patients in a hospital environment it is advisable to choose an antibiotic for sequential therapy, i.e. antibacterial drug, which has forms for the parenteral and oral routes of administration.

Requirements to the antibiotic that is used for the treatment and prevention of inflammatory complications are:

– The antibiotic should be active against micro-organisms groups, which are most often found in chronic odontogenic inflammatory foci;

– Spectrum of antibiotic activity must comply with possible representatives of microflora characteristic of the treated area;

– The drug must have the least ability to induce resistance of microorganisms;

– Antibiotic should well penetrate into the tissues in which surgery is performed (in operations for opening abscesses and abscesses - in soft tissue, jaw operations - the bone);

– The level of the antibiotic in abnormal foci must reach minimum inhibitory concentration and maintain at that level for the required time;

– Antibiotic should provide minimal side effects and does not adversely interact with other medications that may be concurrently used (anesthetics, analgesics, etc.).

It was found that the activity of antibiotics against pathogenic microorganism is not constant; it decreases with time due to formation of antibiotic resistance – microbial resistance to antibacterial drugs.

An important requirement for adequate prophylactic antibiotic therapy is the ratio of the value and effectiveness of the antimicrobial agent. For the treatment and prevention of inflammatory complications in maxillofacial region the parenteral route of administration of antibiotics is the most commonly used. At cost indicators, the frequency of side effects and convenience of use oral dosage forms possess significant advantage. In the last decade, we have increasingly observed high efficiency of "stepped" antibiotic therapy (synonyms: sequential, step-down, switch therapy), which occupies an increasingly strong position in the practice of medicine. Under step antibiotic therapy the gradual transition from parenteral to oral route of administration for the improvement of the patient's condition is implied. The main criterion for the transition to the reception of the drug inside is the normalization of body temperature or its significant reduction. The transition to the oral route of administration has a number of advantages: reducing the load on the medical staff, material savings, the disappearance of the risk of postinjective complications development (inflammatory infiltrates, phlebitis, etc.) and others. However, the antibiotic, which can be used for sequential therapy must meet certain requirements. The main one is the maximum range of the proximity antibacterial preparations for parenteral or oral route, as well as their high bioavailability (in the serum virtually the same concentration of the drug, regardless of its route of administration, to be created).

Conclusions

With prophylactic aim the antibiotics should be used in the following surgical interventions: removal of impacted teeth, the apices of the teeth roots resection, cystectomy, dental implants placement, removal of tumors and tumor-like formations, uncomplicated fractures without displacement of jaw fragments, plastic and reconstructive surgeries and other diseases. Assuming division of operations in terms of surgical wound purity, it should be noted that for prophylactic antibiotics for clean, relatively clean and contaminated (potentially infected) operations are indicated. The appointment of antibiotics for purulent operations (abscess and phlegmons treatment, mediastinitis etc.) (Fig 5) [30, 31] is indicated for the prevention of secondary complications that may arise as a result of the progression of already developed chronic inflammatory diseases.

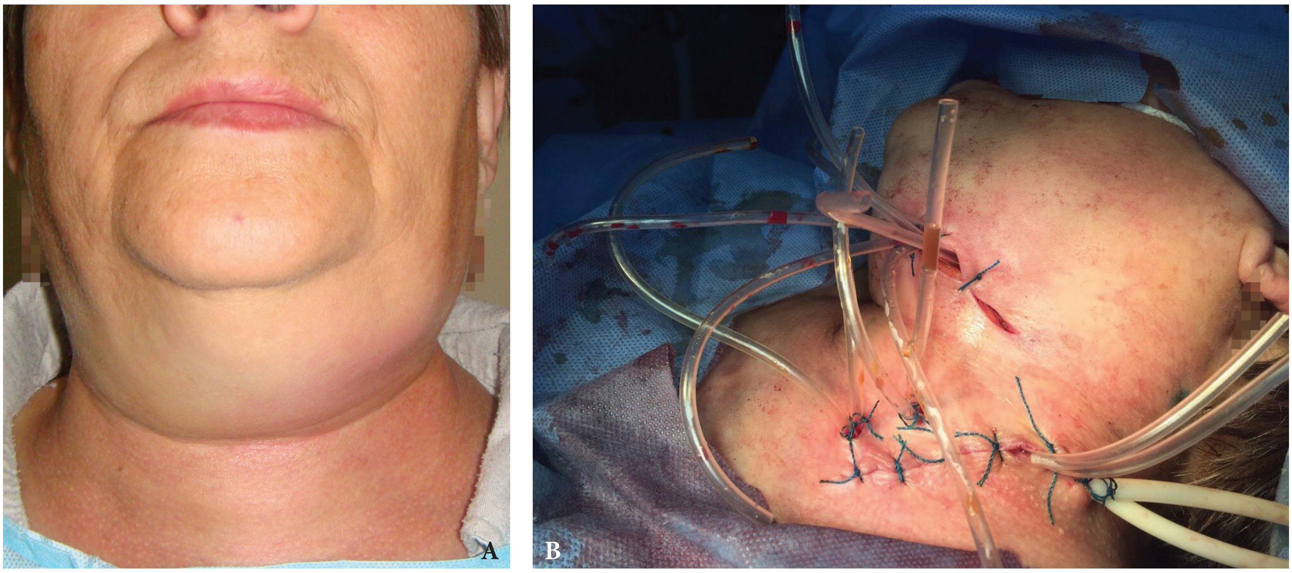

FIGURE 5. 63-year-old woman with the odontogenic phlegmone of tissues of the mouth floor on the left, left neck, and acute purulent anterior superior mediastinitis. Preoperative image (**A**) shows significant swelling of tissues at the left submandibular region, and left neck. Postoperative image (**B**) shows fixed surgical drains. (Images of **Figure 5** are courtesy of Yurii V. Chepurnii, *PhD*, *Assoc Prof*, Dr. Andrii M. Karnuta, Dr. Ievgen I. Fesenko, *Assis Prof*, Dr. Anna Yu. Romanova; Kyiv, Ukraine)

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Conflict of Interests

The authors declare no conflict of interest.

Role of Author and Co-authors

Oleksii O. Tymofieiev (concept of the paper and writing).
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Ethical Approval

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Written patient consent was obtained to publish the clinical images.

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Профілактика запальних ускладнень при операціях в щелепно-лицевій ділянці

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"Ступенева" антибактеріальна терапія
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"Чисті" операції
"Умовно-чисті" операції
Потенційно чисті операції
Гнійні операції

РЕЗЮМЕ

Проведення профілактичної антибіотикотерапії у пацієнтів після хірургічних втручань в хірургічній стоматології та щелепно-лицевої хірургії знижує частоту післяопераційних інфекційних ускладнень. Проводиться аналіз "чистих", "умовно-чистих", "брудних" (потенційно інфікованих) і гнійних операцій. Розглянуто загальні питання профілактики інфекційних ускладнень при проведенні пластичних, ортогнатичних, гнійних операцій і проаналізовано мікрофлору ротової порожнини. Послідовно представлені ряд випадків післяопераційних ускладнень та гнійно-запальних процесів в області голови та шиї. Дані рекомендації по антибіотикопрофілактики в хірургічній стоматології та щелепно-лицевої хірургії.

Профилактика воспалительных осложнений при операциях в челюстно-лицевой области

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Потенциально чистые операции
Гнойные операции

РЕЗЮМЕ

Проведение профилактической антибиотикотерапии у пациентов после хирургических вмешательств в хирургической стоматологии и челюстно-лицевой хирургии снижает частоту послеоперационных инфекционных осложнений. Проводится анализ "чистых", "условно-чистых", "грязных" (потенциально инфицированных) и гнойных операций. Рассмотрены общие вопросы профилактики инфекционных осложнений при проведении пластических, ортогнатических, гнойных операция и микрофлора ротовой полости. Последовательно представлены ряд случаев послеоперационных осложнений и гнойно-воспалительных процессов в области головы и шеи. Даны рекомендации по антибиотикопрофилактике в хирургической стоматологии и челюстно-лицевой хирургии.

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Treatment of Postoperative Neuropathy of the Trigeminal Nerve

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ABOUT ARTICLE

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ABSTRACT

Purpose.
Study the possibility of using hardware-software complex "DIN-1" in the complex treatment of neuropathies of II and III branches of the trigeminal nerve of varying severity (contusion, stretching, partial, and complete rupture of the nerve) after tumor and tumor-like formations of jaws removal.
Patients and Methods.
Treatment of neurological complications of 146 patients after surgical interventions associated with the removal of tumors and tumor-like formations of the upper and lower jaws using a hardware-software complex "DIN-1".
Results.
Based on the examination, found that the use of hardware-software complex "DIN-1" has a high therapeutic efficacy in the complex treatment of trigeminal nerve neuropathy after removal of tumors and tumor-like formations of jaws.
Conclusions.
Our findings can be used in treatment of neuropathies of II and III branches of the trigeminal nerve of varying severity (contusion, stretching, partial, and complete rupture of the nerve) after removal of tumors and tumor-like formations of jaws.

Introduction

In our last published article we have undertaken an analysis of postoperative complications, that show up after removal of tumors and tumor-like formations of jaws [1]. There are a lot publications dedicating to the trigeminal nerve injuries upon third molar removal [7, 8], dental implants placement [9-13], orthognathic surgeries [14-19], distraction procedures [20, 21], zygomaticomaxillary complex fractures [22, 23], but only a little amount of papers dedicating to the problem of post-operative disturbances after tumors removal [24]. We have found out that by defining electrophysical index of soft tissues, which are innervated by II and II branches of trigeminal nerve, after operations of neoplasm removal you can define the severity of injury of trigeminal nerve during operation. It's a fact that indexes of conductivity and resistance are reduced during the first few days after the operation if the trigeminal nerve is contusion or stretched, while the recovery of electrophysiological indexes takes 1-2 months after the operation [1]. If trigeminal nerve is completely or partially ruptured can be observed that indexes of conductivity and resistance are greatly reduced, while the tone rises. If trigeminal nerve is partially ruptured recovery of all electrophysiological indexes takes at least 6 months after the operation. If it is completely ruptured its electrophysiological indexes will not normalize even after 12 months since the operation.

That way we revealed that during postoperative period neuropathies of corresponding branches of trigeminal nerve with various severity and duration are observed and require adequate treatment.

Purpose of this undertaken research is to study the possibility of using hardware-software complex "DIN-1" in the complex treatment of neuropathies of II and III branches of the trigeminal nerve of varying severity (contusion, stretching, partial and complete rupture of the nerve) after tumor and tumor-like formations of jaws removal.

Material and Methods

We have made a research of neurological complications (neuropathies) of 146 patients after surgical interventions associated with the removal of tumors (ameloblastoma, osteoblastoma) and tumor-like formations (epidermoid, radicular, and folicular cysts, etc.) of upper and lower jaws. All of the 146 patients from the main group were divided into 4 groups: I group – 34 patients after operative intrusion (18 –

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upper jaw and 16 – lower jaw) with a nerve contusion; II group – 42 patients after surgeries (19 – upper jaw and 23 – lower jaw) with a stretched branches of trigeminal nerve; III group – 39 patients after operative intrusion (16 – upper jaw and 23 – lower jaw) with a partial rupture of one of the branches of trigeminal nerve; IV group – 31 patient after jaw resection operation (15 – upper jaw, and 16 – lower jaw) with a complete rupture of one of the branches of trigeminal nerve.

Control group was made of 179 patients after similar operative intrusions, but without hardware-software complex "DIN-1" used in complex treatment and 35 practically healthy patients (without any pathological processes in maxillofacial area).

Both main and control groups have received their surgical and postoperative medicated treatment in the Department of Maxillofacial Surgery of Shupyk National Medical Academy of Postgraduate Education.

All patients have undergone clinical methods of diagnosis which included: observation, palpation, anamsesis taking, jaw x-ray, etc. After operational intrusion selection of patients with corresponding postoperative injuries of trigeminal nerve branches was performed according to data received from "DIN-1" device. As was already said, hardware-software complex "DIN-1" was used for static and dynamic parameters of soft tissues, which are innervated by trigeminal nerve, measurement and complex treatment of neuropathies. All of the special examination of trigeminal nerve methods were made both during hospitalization and postoperative period.

Different treatment tactics are possible accordance to the world publications [29-33]. For treating neuropathies (from stretches, complete and partial rupture of trigeminal nerve) was used not only hardware-software complex "DIN-1" (in corresponding groups) but also a conventional medical therapy. Following medicaments were used: Nucleo CMP forte (Grupo Ferrer Internacional, S.A., Spain) and Neurovitan (Milgamma) (Hikma Pharmaceuticals PLC, Jordan)). These were appointed to our patients after consultation with neurologist. Nucleo CMF Forte in ampoules was adninistered intramuscularly once per day. Course lasted from 3 to 6 days. After that, treatment course was continued by taking the same medicament per os. Nucleo CMF Forte in 1-2 capsules 2 times per day for 10-20 days (10 – partial rupture, 20 – complete) was prescribed. Milgamma treatment went this way: we started from ml intramuscularly once per day, then switched to supportive therapy – 2 ml 2-3 times per week. There is a possibility of treatment with oral form of medicine (1 pill 3 times per day). Duration of treatment was 1 month. Neurovitan was appointed 2-4 pills per day to adults. Treatment course lasted 2-4 weeks.

I group did not take any medicine, they only were treated with hardware-software complex "DIN-1" (7 days per course). This complex was appointed only after 5-6 days since surgery, i.e. after postoperative edema of soft tissues greatly reduces. II group went through general medication course of early mentioned medicines 1 time (during 1st month). Hardware-software complex "DIN-1" was used 2 times during 1st month after the operation for this group (every electrostimulation course lasted 7 days with a 7 day break). III and IV groups went through general medication course 2 times during rehabilitation period, while trigeminal nerve electrostimulation courses, with use of "DIN-1" device, was performed 2 times during first month after operation and once per month afterwards. During few months we repeated electrostimulation course till electrophysiological indexes and clinical symptoms of neuropathies normalized. When weachieved full recovery of injured trigeminal nerve branch's sensitive functionwe stopped hardware-software complex "DIN-1"treatment [2-6]. After half a year since operation, we recommended those who did not completely recover from IV group to undertake 1 more general medication treatment course and pass electrostimulation course, with use of "DIN-1" device, monthly for 3 months.

Acquired patient examination data was processed using conventional variation-statistical method with personal computer and statistics program package "SPSS 11.0 for Windows" and "Microsoft Excel 2000". Reliability of results was estimated by Student criteria. Difference was considered reliable – $P < 0.05$.

Results

Earlier we found out electrophysiological indexes of soft tissues innervated by II and III branches of trigeminal nerve of generally healthy people. II branch conductivity index was 113.0 ± 2.8 conventional units (CU), resistance – 5.0 ± 0.7 CU and tone – 2.2 ± 0.1 CU. III branch conductivity index was 113.0 ± 2.8 CU, resistance – 5.0 ± 0.7 CU, and tone – 2.2 ± 0.1 CU [1].

That way you can see that indexes of conductivity, resistance and tone of II and III branches of trigeminal nerve of generally healthy people are almost identical. *Reliability of changes of electrophysiological indexes was measured according to those of generally healthy people.*

In I group (trigeminal nerve contusion) we saw changes of electrophysiological indexes during postoperative period of treatment. Indexes of conductivity (Fig 1) during hospitalization (before operation) were 117.3 ± 2.9 CU ($P > 0.05$), after 3 days – 79.9 ± 3.8 CU ($P < 0.001$), 7-8 days since the operation – 92.1 ± 2.9 CU ($P < 0.001$), 14-15 days – 107.8 ± 3.7 CU ($P > 0.05$). Indexes of resistance (Fig 2) during hospitalization were 5.3 ± 2.0 CU ($P > 0.05$), after 3 days – minus 8.1 ± 3.9 CU ($P < 0.001$), 7-8 days since the operation – minus 1.1 ± 0.3 CU ($P < 0.001$), 14-15 days – 4.9 ± 2.1 CU ($P > 0.05$). Indexes of tone (Fig 3) during hospitalization were 2.0 ± 0.3 CU ($P > 0.05$), after 3 days – 2.2 ± 0.4 CU ($P > 0.05$), 7-8 days since the operation – 2.3 ± 0.3 CU ($P > 0.05$), 14-15 days – 2.1 ± 0.2 CU ($P > 0.05$).

That way, with usage of hardware-software complex "DIN-1" in treatment of postoperative neuropathies, caused by bruise of II and III branches of trigeminal nerve, studied indexes of conductivity and resistance recovered after 14-15 days since the operation, not 1 month if treatment went without hardware-software complex "DIN-1" [1]. This means that complete recovery

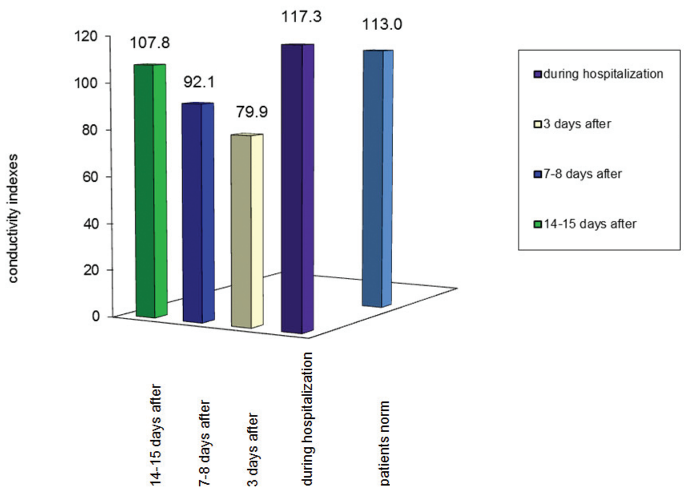

FIGURE 1. Indexes of conductivity of trigeminal nerve branches during treatment (I group).

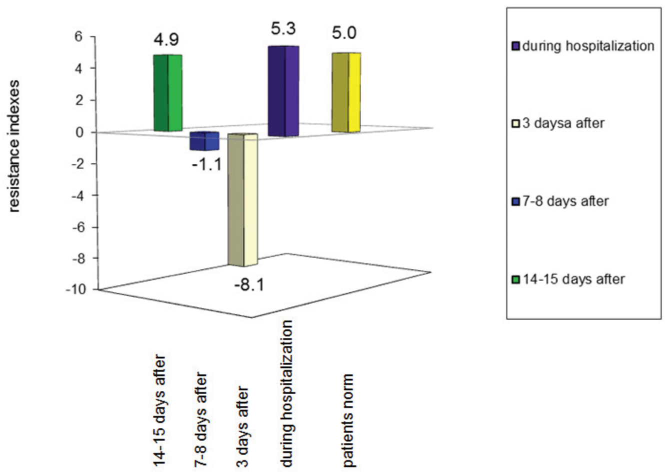

FIGURE 2. Indexes of resistance of trigeminal nerve branches during treatment (I group).

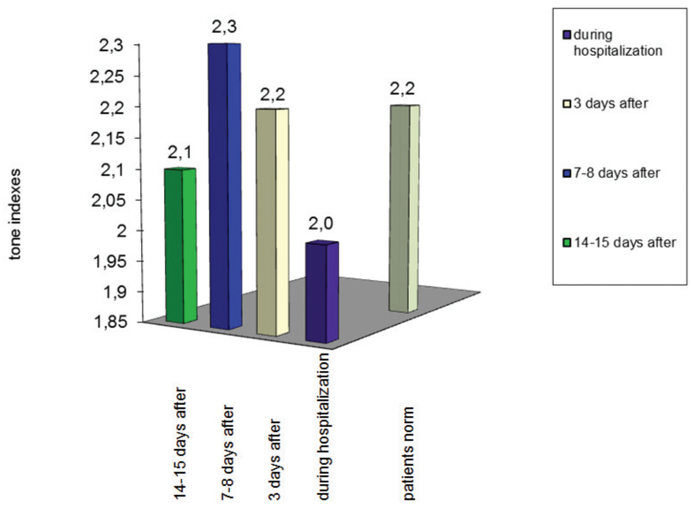

FIGURE 3. Indexes of tone of trigeminal nerve branches during treatment (I group).

of neuropathies, caused by bruise of II and III branches of trigeminal nerve, went twice as fast if hardware-software complex "DIN-1" was used during treatment.

While examining patients from II group (stretched trigeminal nerve) we have noticed changes to electrophysiological indexes during treatment. Indexes of conductivity (Fig 4) during hospitalization were 112.5 ± 3.8 CU (P > 0.05), after 3 days – 75.9 ± 4.7 CU (P < 0.001), 7-8 days since the operation – 86.7 ± 3.6 CU (P < 0.001), 1 month – 92.1 ± 2.1 CU (P < 0.001), 1,5 month – 115.2 ± 2.2 CU (P > 0.05). Indexes of resistance (Fig 5) during hospitalization were 7.4 ± 2.1 CU (P > 0.05), after 3 days – minus 8.3 ± 3.4 CU (P < 0.001), 7-8 days since the operation – minus 15.1 ± 2.7 CU (P < 0.001), 1 month – minus 1.2 ± 1.4 CU (P < 0.001), 1.5 month – 5.4 ± 2.9 CU (P > 0.05). Indexes of tone (Fig 6) during hospitalization were 2.2 ± 0.3 CU (P > 0.05), after 3 days – 2.7 ± 0.5 CU (P > 0.05), 7-8 days since the operation – 2.4 ± 0.6 CU (P > 0.05), 1 month – 2.2 ± 0.2 CU

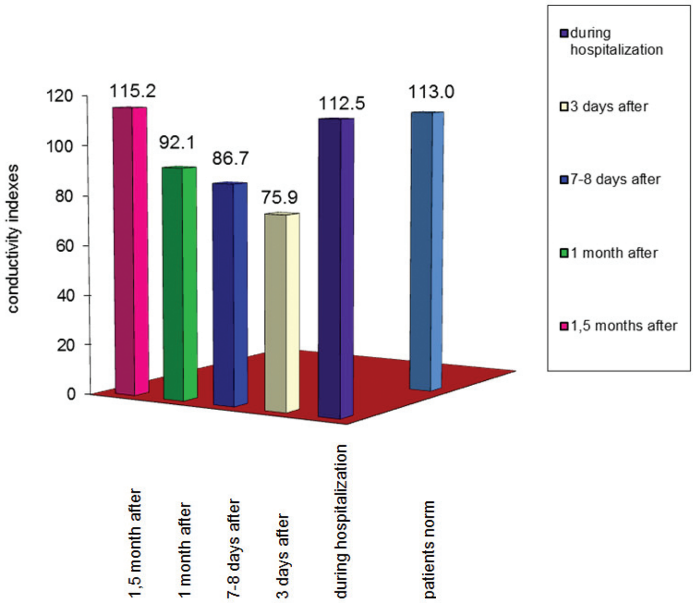

FIGURE 4. Indexes of conductivity of trigeminal nerve branches during treatment (II group)

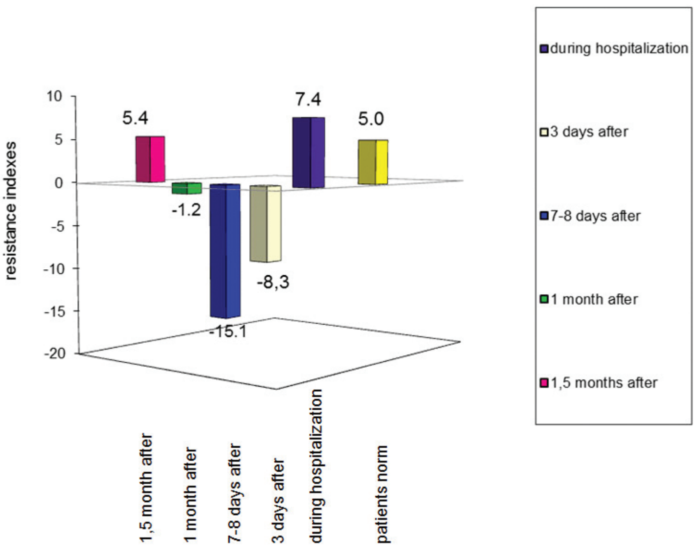

FIGURE 5. Indexes of resistance of trigeminal nerve branches during treatment (II group)

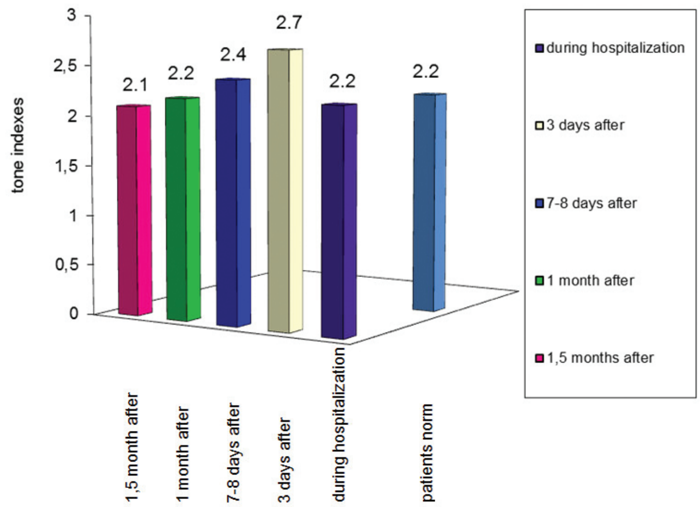

FIGURE 6. Indexes of tone of trigeminal nerve branches during treatment (II group)

(P > 0.05), 1.5 month – 2.1 ± 0.6 CU (P > 0.05).

That way, with usage of hardware-software complex "DIN-1" in treatment of postoperative neuropathies, caused by strain of II and III branches of trigeminal nerve, studied indexes of conductivity and resistance recovered after 1.5 month since the operation, not 2 months if treatment went without hardware-software complex "DIN-1" [1]. This means that complete recovery of neuropathies, caused by strain of II and III branches of trigeminal nerve, went 1.5 faster if hardware-software complex "DIN-1" was used during treatment.

While treating patients from III group (partially ruptured trigeminal nerve) we have noticed changes to electrophysiological indexes. Indexes of conductivity (Fig 7) during hospitalization – 117.2 ± 3.8 CU (P > 0.05), 3 days since the operation – 63.4 ± 4.9 CU (P < 0.001), after 14-15 days – 82.3 ± 3.1 CU (P < 0.001), 1 month since the operation – 88.3 ± 4.3 CU (P < 0.001), 3 months – 94.5 ± 4.3 CU (P < 0.02), 4 months – 111.5 ± 3.2 CU (P > 0.05). Indexes of resistance (Fig 8) during hospitalization – 5.3 ± 0.4 CU (P > 0.05), 3 days since the operation – minus 10.2 ± 3.7 CU (P <0,001), 14-15 days – minus 8.1 ± 2.6 CU (P < 0.001), 1 month since the operation – minus 3.9 ± 2.5 CU (P < 0.001), 3 months – 2.1 ± 1.7 CU (P < 0.01), 4 months – 4.9 ± 0.9 CU (P > 0.05). Indexes of tone (Fig 9) during hospitalization – 2.0 ± 0.3 CU (P > 0.05), 3 days since the operation – 3.1 ± 0.3 CU (P < 0,001), 14-15 days – 2.9 ± 0.2 CU (P < 0.001), 1 month since the operation – 2.6 ± 0.2 CU (P < 0.02), 3 months – 2.2 ± 0.1 CU (P > 0.05), 6 months – 2.1 ± 0.2 CU (P > 0.05).

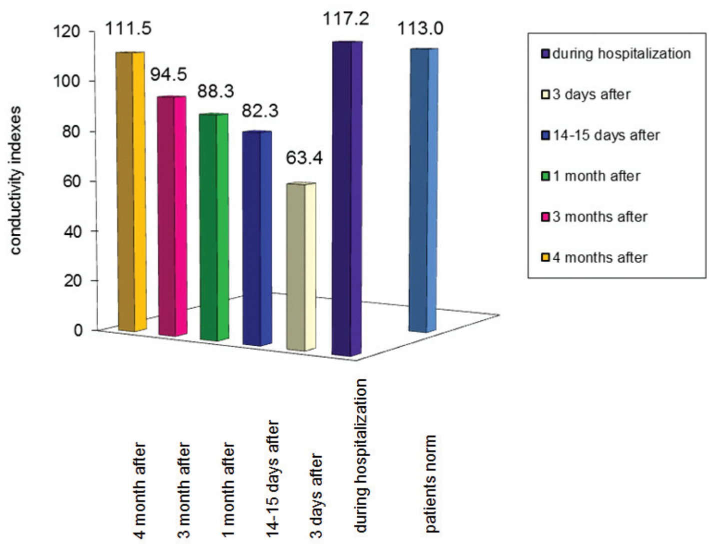

FIGURE 7. Indexes of conductivity of trigeminal nerve branches during treatment (III group)

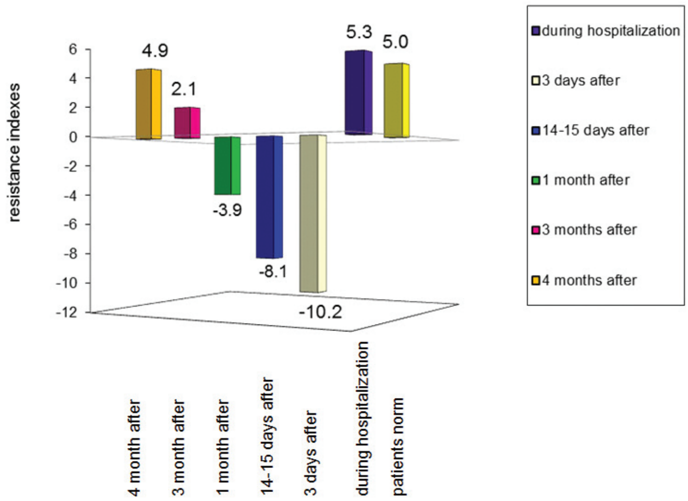

FIGURE 8. Indexes of resistance of trigeminal nerve branches during treatment (III group)

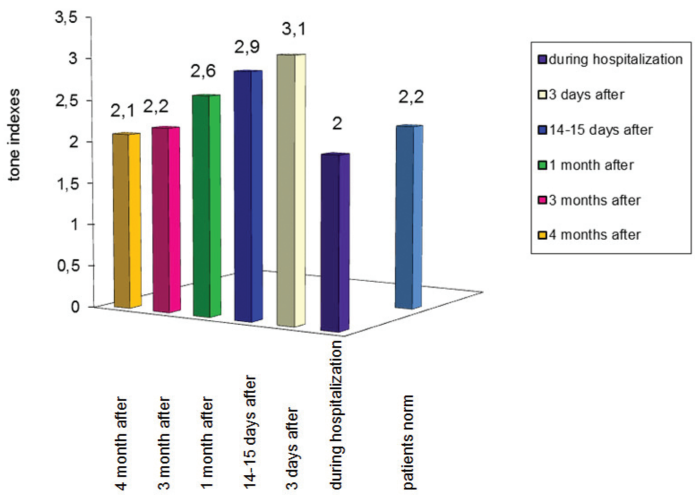

FIGURE 9. Indexes of tone of trigeminal nerve branches during treatment (III group)

That way, with usage of hardware-software complex "DIN-1" in treatment of postoperative neuropathies, caused by partial rupture of II and III branches of trigeminal nerve, studied indexes of conductivity, resistance and tone recovered after 4 months since the operation, not 6 months if treatment went without hardware-software complex "DIN-1" [1]. Usage of hardware-software complex "DIN-1" during medicated treatment allowed 97.4% of patients with partial trigeminal nerve rupture to completely recover after the operation. This means that recovery went 1.5 faster if hardware-software complex "DIN-1" was used. And only 2.6% of patients recovered after 6 months since the operation.

During our examination of IV group (complete rupture of one of the trigeminal nerve branches) patient we have noticed a substantial change of electrophysiological indexes during treatment. Indexes of conductivity (Fig 10) during hospitalization – 114,8 ± 3,9 c.u. ($p > 0,05$), 3 days after the operation – 54.2 ± 4.7 CU ($P < 0.001$), 14-15 days – 52.7 ± 6.9 CU ($P < 0.001$), 1 month since the operation – 68.6 ± 5.8 CU ($P < 0.001$), 3 months – 89.4 ± 6.5 CU ($P < 0.001$), 6 months – 99.3 ± 11.2 CU ($P > 0.05$). Indexes of resistance (Fig 11) during hospitalization – 5.2 ± 0.7 CU ($P > 0.05$), 3 days after the operation – minus 19.9 ± 4.1 CU ($P < 0.001$), 14-15 days – minus 22.6 ± 6.1 CU ($P < 0.001$), 1 month since the operation – minus 27.9 ± 6.0 CU ($P < 0.001$), 3 months – minus 10.2 ± 5.8 CU ($P < 0.001$), 6 months – minus 4.3 ± 4.8 CU ($P < 0.02$).

Indexes of tone (Fig 12) during hospitalization – 2.4 ± 0.2 CU ($P > 0.05$), 3 days after the operation – 3.1 ± 0.2 CU ($P < 0.001$), 15 days – 3.2 ± 0.3 CU ($P < 0.001$), 1 month since the operation – 2.9 ± 0.3 CU ($P < 0.001$), 3 months – 2.7 ± 0.2 CU ($P < 0.001$), 6 months – 2.6 ± 0.1 CU ($P < 0.05$).

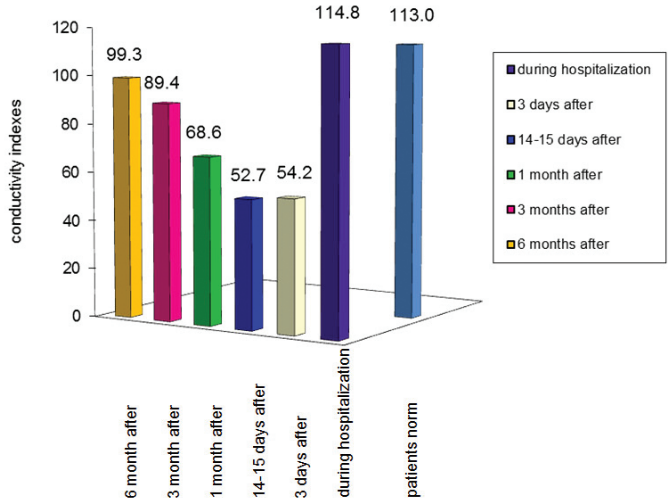

FIGURE 10. Indexes of conductivity of trigeminal nerve branches during treatment (IV group)

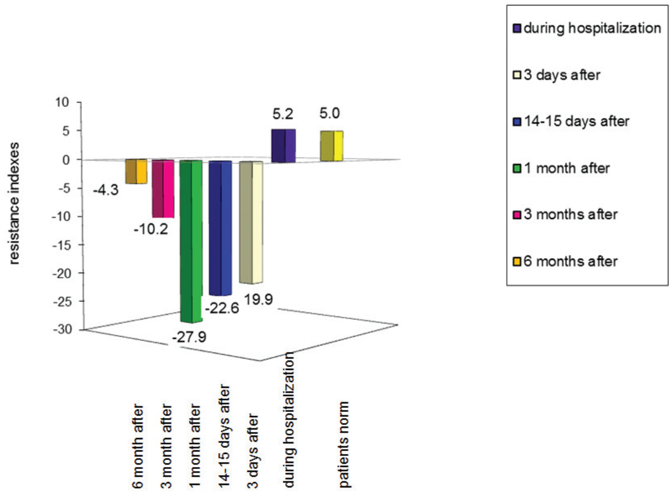

FIGURE 11. Indexes of resistance of trigeminal nerve branches during treatment (IV group)

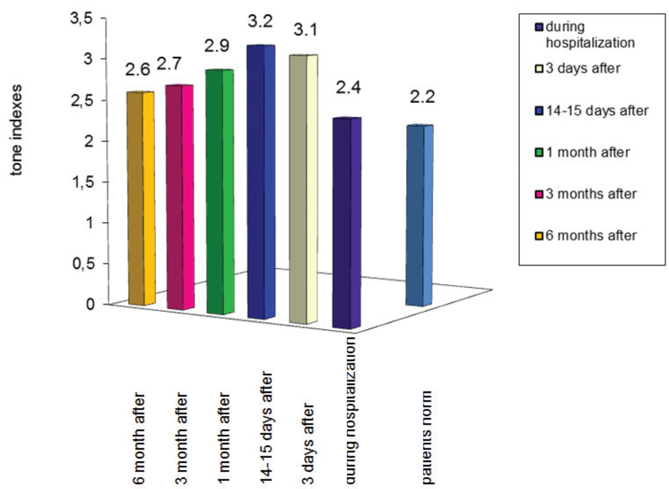

FIGURE 12. Indexes of tone of trigeminal nerve branches during treatment (IV group)

That way, with usage of hardware-software complex “DIN-1” in treatment of postoperative neuropathies, caused by complete rupture of II and III branches of trigeminal nerve, 17 of 31 (54.8%) patients recovered the studied indexes of conductivity, resistance and tone after 6 months since the operation. 45.2% of patients continued the treatment. We repeated clinical examination of these patients after 1 year. 8 more patients (25.8%) had recovered their electrophysiological indexes. Therefore, we registered that 80.6% of patients have recovered after complete postoperative rupture of trigeminal nerve branches 1 year since the operation, using our recommended method. It should be noted that according to literature [4, 5] using conventional treatment normalization of skin and oral cavity mucosa sensitivity after complete rupture of trigeminal nerve branches (1 year since the operation) was registered in less than 20% of cases.

While analyzing the results of examination of patients with postoperative neuropathies of II and III branches of trigeminal nerve of varying severity (contusion, stretching, partial and complete rupture) we have come to the conclusion that our recommended method of treatment is highly efficient.

Usage of hardware-software complex “DIN-1” allowed patients with neuropathies, caused by bruised trigeminal nerve, to completely recover after 14-15 days since the operation and the treatment went 2 times faster than without it.

Usage of hardware-software complex “DIN-1” in complex medicated treatment allowed patients with neuropathies, caused by strained trigeminal nerve, to completely recover after 1.5 month since the operation and the treatment went 1.5 times faster than without it.

Usage of hardware-software complex “DIN-1” in complex medicated treatment allowed 97.4% of patients with neuropathies, caused by partial trigeminal nerve rupture, to completely recover after 4 months since the operation and the treatment went 1.5 times faster than without it. Only 2.6% of the cases we registered complete recovery after 6 months since the operation.

Usage of hardware-software complex “DIN-1” in complex medicated treatment allowed 54.8% of patients with neuropathies, caused by complete trigeminal nerve rupture, to completely recover skin and oral cavity mucosa sensitivity after 6 months since the operation. 1 year after 25.8% more patients have recovered. That way, using or recommended method of treatment, we have registered that 80.6% of the patients have recovered after complete rupture of trigeminal nerve branches 1 year since the operation. While according to literature [4, 5], complete recovery of skin and oral cavity mucosa sensitivity after complete trigeminal nerve rupture 1 year since the operation is observed in less than 20% of the cases.

Conclusion

Based on examination, it was found that using hardware-software complex “DIN-1” in treatment allowed to shorten the treatment of patients with neuropathies caused by bruise of II and III trigeminal nerve branches by 2 times. Using hardware-software complex “DIN-1” in treatment allowed to shorten the treatment of patients with neuropathies caused by strain of II and III trigeminal nerve branches by 1.5 times and 97.4% of patients with neuropathies caused by partial rupture of this nerve recovered after 4 months since the operation. Usage of hardware-software complex “DIN-1” in treatment allowed 80.6% of patients with neuropathies caused by complete rupture trigeminal nerve branches to achieve clinical recovery (54.8% – after 6 months, and 25.8% – 1 year since the operation).

That way, usage of hardware-software complex “DIN-1” in treating neoplasms of the jaws has not only diagnostic and prognostic meaning but also drastically increases effectiveness of treating patients with neuropathies of trigeminal nerve, which occur in postoperative period.

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Conflict of Interests

The authors declare no conflict of interest.

Role of Author and Co-authors

Oleksii O. Tymofieiev (concept of the paper and writing).
Natalia O. Ushko (material collection and editing).
Olena P. Vesova (material collection).
Mariia O. Yarifa (material collection).

Ethical Approval

Approval was obtained from the Medical Ethics Committee of the Shupyk National Medical Academy of Postgraduate Education, Kyiv, Ukraine.

Patient Consent

Not required.

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Лікування післяопераційних нейропатій трійчастого нерва

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Онлайн з: 30 червня 2017 року

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Електрофізіологічні показники
Забій трійчастого нерва
Розтягнення трійчастого нерва
Повний і неповний розрив нервів
Неврологічні ускладнення
Пухлини щелеп
Пухлиноподібні утворення щелеп

Р Е З Ю М Е

Мета. Вивчити можливості застосування апаратно-програмного комплексу "ДІН-1" в комплексному лікуванні нейропатій II і III гілок трійчастого нерва різного ступеня тяжкості (при забитті, розтягу, частковому та повному розриві нерва) у хворих після проведення операцій видалення пухлин і пухлиноподібних утворень щелеп.

Методи. Проведено лікування неврологічних ускладнень у 146 пацієнтів після проведення оперативних втручань, пов'язаних з видаленням пухлин і пухлоподібних утворень верхньої та нижньої щелеп з використанням програмно-апаратного комплексу "ДІН-1".

Результати. На підставі проведеного обстеження встановлено, що використання апаратно-програмного комплексу "ДІН-1" у комплексному лікуванні нейропатії трійкового нерва у хворих після проведених операцій видалення пухлин і пухлиноподібних утворень органів має високу терапевтичну ефективність.

Висновки. Отримані нами дані можна використовувати в комплексному лікуванні нейропатий II і III гілок трійчастого нерва різного ступеня тяжкості (забиття, розтягнення, частковий і повний розрив нерва) у хворих після проведення операцій видалення пухлин і пухлиноподібних утворень щелеп.

Лечение послеоперационных нейропатий тройничного нерва

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Растяжение тройничного нерва
Полный и неполный разрыв нерва
Неврологические осложнения
Опухоли челюсти
Опухолевые образования челюстей

Р Е З Ю М Е

Цель. Изучить возможности применения аппаратно-программного комплекса "ДИН-1" в комплексном лечении нейропатий II и III ветвей тройничного нерва разной степени тяжести (при ушибе, растяжении, частичном и полном разрыве нерва) у больных после проведения операций удаления опухолей и опухолеподобных образований челюстей.

Методы. Проведено лечение неврологических осложнений у 146 больных после проведения оперативных вмешательств, связанных с удалением опухолей и опухолеподобных образований верхней и нижней челюстей с применением аппаратно-программного комплекса "ДИН-1".

Результаты. На основании проведенного обследования установлено, что использование аппаратно-программного комплекса "ДИН-1" в комплексном лечении нейропатий тройничного нерва у больных после проведенных операций удаления опухолей и опухолеподобных образований челюстей имеет высокую терапевтическую эффективность.

Выводы. Полученные нами данные можно использовать в комплексном лечении нейропатий II и III ветвей тройничного нерва разной степени тяжести (ушиб, растяжение, частичный и полный разрыв нерва) у больных после проведения операций удаления опухолей и опухолеподобных образований челюстей.

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