FEATURES OF THE TOPOGRAPHIC AND ANATOMICAL STRUCTURE OF THE INTRATEMPORAL FOSSA OCCURRING DURING BLOCKADE OF THE MANDIBULAR NERVE ADJACENT TO THE FORAMEN OVALE

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Abstract

During blockade (G. Brown, J. Bercher, V.M. Uvarov, J.S. Weisblat, V.A. Dubov, P.Yu. Stolyarenko) and surgical interventions in the area of the infratemporal fossa, difficulties in finding the mandibular nerve and its motor branches arise, the possibility of injury to the maxillary and middle meningeal artery emerges, while the applied spatial-layered description of the anatomical structures from the mandibular notch to the formations on the base of the skull (foramen ovale, spinous process and foramen of the same name) is absent. **Aim.** To carry out a spatial-layer-by-layer preparation with a description of the anatomical structures of the infratemporal fossa to ensure and develop a safe path for blockades of the mandibular nerve and its motor branches. Anatomical structure of the infratemporal fossa must be taken into account when blocking the mandibular nerve at the foramen ovale. Based on the analysis of the technology employed and on the results of 62 blockades of the mandibular nerve adjacent to the foramen ovale, data on the features of the topographic and anatomical structure of the temporal fossa which should be considered is presented.When advancing the needle in the infratemporal fossa, consider the following anatomical structures. Above shifting to the facial artery into the depth of the deep lobe of the parotid gland, the external carotid artery at the level of the articular process is divided into two branches: the superficial temporal artery and the maxillary. In order to systematize the branches of the artery in topographic anatomy, this is divided into three parts: mandibular, pterygoid and pterygo-palatine. In the mandibular part of the artery, the deep auricular and anterior tympanic artery departing from it are directed posteriorly, upward to the ear and the tympanic cavity, and in the projection of the mandibular notch the middle meningeal artery (a.meningea media) and the lower alveolar artery (a.alveolaris inferior) are present. Moreover, in the area of the mandibular notch a.maxillaris is presented in the form of a loop lowered downward and a.alveolaris inferior. This arcuate bend of the maxillary artery is designed for elasticity, relieving tension in the arteries when opening the mouth (high and complex range of mandible motion). For the same purpose, nature provides for loops of the lingual and mandibular nerves. The reasons for failures and complications are shown and discussed. The ways of preventing complications in these types of blockades are indicated.

Keywords: *blockade, mandibular nerve, foramen ovale, infratemporal fossa.*

1. INTRODUCTION

Access to the base of the skull through the mandibular notch for blockades and surgical interventions were proposed at the beginning of the 20th century [1-4]. Among the problems of blockades and surgical interventions in this area, there appear difficulties of finding mandibular nerve and its motor branches, the possible injury of the maxillary and of the middle meningeal artery, the absence of an applied spatial-layered description of the anatomical structures from the mandibular notch to the formations present on the base of the skull (foramen ovale, spinous process, and foramen of the same name).

A well-known method of blockade of the mandibular nerve was proposed by Brown (1905), with the injection point lying under the middle of the zygomatic arch, the needle moving in oblique direction to the pterygoid process of the sphenoid bone. After that, the depth of needle movement is noted, after which it is extended to the subcutaneous tissue, returns at a slight angle posteriorly and inserted to the marked depth [5]. The disadvantage is the inaccuracy of the injection point and the complexity of manipulation.

Later, Bercher (1922) proposed to block the motor branches of the mandibular nerve in reflexory contracture of the messeteric muscle from the side of the mandible notch. Uvarov (1929), using the elements of anesthesia of Bercher, in combination with the technique of Brown, suggested to insert the needle at a depth of 4-4.5 cm for achieving the blockade of the mandibular nerve [1]. It is known that the methods of anesthesia for determining the injection point in the middle of the zygomatic arch (G. Brown, 1909) and in the middle of the tragoorbital line (S.N. Weisblat, 1961) are not accurate [6].

Objective. To conduct a spatial-layer-by-layer preparation, to describe the anatomical structures of the infratemporal fossa, to ensure and develop a safe path for blockade of the mandibular nerve and of its motor branches.

2. MATERIALS AND METHODS

Topographic and anatomical preparation of the infratemporal region, and comparison of the obtained data with known developments were performed. Analysis of outcomes and failures during blockade at the foramen ovale at the base of the skull in 62 patients (44 men and 18 women) hospitalized in the head and neck tumor department of the Podolsk Regional Oncology Center with tumors of the oral cavity and oropharynx was done. The mean age of the patients was (45.94 ± 1.74) years.

Comparative anatomical, anthropometric, and clinical methods were used for the study.

3. RESULTS AND DISCUSSION

The anatomy and size of the incisurae mandibulae are well understood. Of great importance is the distance from the bottom of the notch to the edge of the zygomatic arch, which is 1.0 to 1.5 cm in height and 2.7 to 3.1 cm in length, depending on the type of skull structure [3]. Measurements of the distance from incisurae mandibulae to foramen ovale revealed an almost stable ratio within 2.6-2.8 cm in all types of skulls.

The outer edge of the foramen spinosum is located somewhat closer to the notch; this hole is the entry point for the arteria meningea media, however the artery is reliably covered from the outside by the protruding edge of the angular spine of the main bone (*spina angularis os sphenoidalis*), so that injuring of the vessel with a needle in this area is hardly possible.

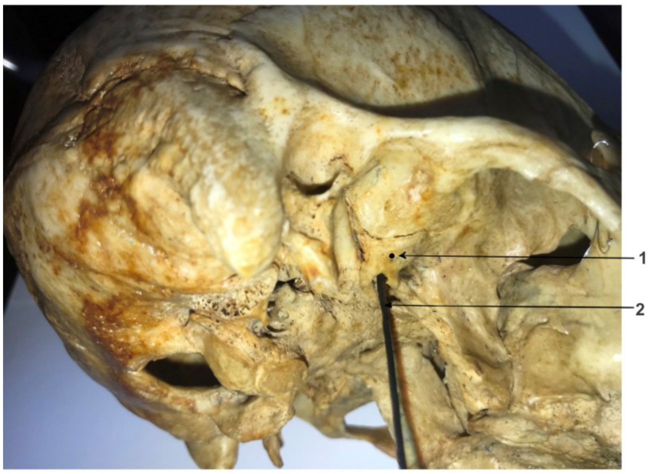

Fig. 1. The middle meningeal artery is covered with a spinous process along 1 cm to the entrance to the skull: 1 - *spinous process o f the main bone*; **2** *- conductor inserted in the spinous hole*

A.meningea media moves away from the maxillary artery upward, being completely covered by the articular process, and enters the spinous foramen so that, practically, for 1 cm it is covered by the spinous process and in fact cannot be injured by the needle in this area (Fig. 1). As known, the shape of the spinous process was compared by some anatomists of the 19th century with the Sphinx. Indeed, using figurative thinking, the spinous process can be compared in shape with the Sphinx, guarding a.meningea media from needle injury.

Most likely the damage occurs to the maxillary artery (a.maxillaris), which is almost closely adjacent to the base of the articular process, to the posterior edge of the mandibular notch and to its inner surface.

There are two main types of blockades in this zone: 1 - according to Brown-Weisblat (1905, 1925) and 2 - Bercher-Uvarov (1922, 1928). When the needle is directed according to the above methods, the following anatomical formations are involved: the incisurae mandibulae is closed by the temporal fascia (deep leaf). An arterial branch passes through this fascia to m.masseter from a.maxillaris and venous, going to v.retromandibularis, as well as to n.massetericus - motor branch to the masseter muscle. When the needle is passed through this fascia, no damage to these vessels, as a rule, is observed (Fig. 2).

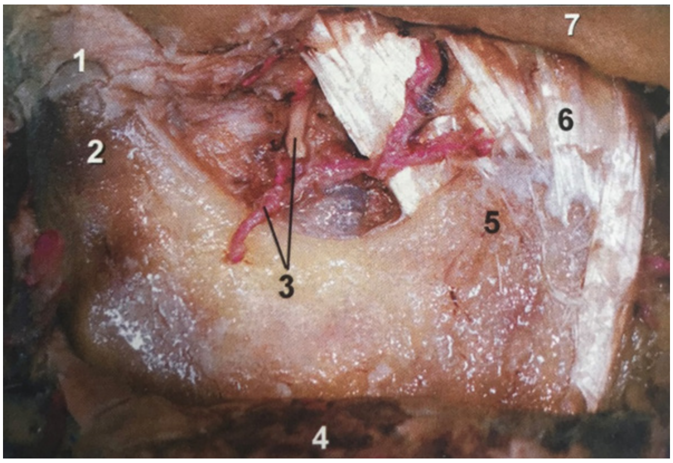

Figure 2. Lateral wall of the infratemporal fossa on the right. (Preparation of Putsillo, Vinokurov, 2004. Published with the permission of the authors)
1 - temporomandibular joint; 2 - condylar process of mandible; 3 - messeteric artery and nerve; 4 - messeteric muscle (turned down); 5 - coronoid process of the mandible; 6 - tendon of the temporal muscle; 7 - zygomatic arch

A layer-by-layer examination in the area of the notch behind the temporal fascia reveals a.alveolaris inferior branching off from a.maxillaris. At the same time, in this section, the mandibular nerve has a horizontal position, as shown in our anatomical preparation (Fig. 2). Sokolov describes its location as follows: “When we reach it, we will see that it lies in a strongly inclined, almost horizontal direction” [3].

The lingual nerve (n.lingualis), when projected onto the notch of the mandible, is located at a distance of 5-7 mm anteriorly to the mandibular nerve starting from its first turn and both nerves, for 2.0-2.5 cm, going horizontally, connecting together at the top only in front of the entrance to the foramen ovale (Fig. 3).

Fig. 3. Features of the course of the mandibular and lingual nerves in the infratemporal fossa. The direction of the needle travels through the mandibular notch with blockades at the foramen ovale: 1 - tip of the needle at the foramen ovale; 2 - mandibular nerve; 3 - lingual nerve

The needle in blockades at the base of the skull certainly often passes through the upper pole of the parotid gland but, in this case, the gland tissue and its large ducts are almost not injured and we did not observe salivation disorders.

In the structure of the mandibular nerve after leaving the oval hole, there are two types of its branches: network (loose) and main. With these types of differences, there are variants in the structure of its branches. Thus, in the main type of structure, the pterygoid nerve departs with one trunk from the mandibular nerve, slightly below the movement of the buccal nerve from it, which corresponds to the level of the lower edge of the zygomatic arch. Moreover, <u>the lateral pterygoid nerve</u> is directed to the base of the outer plate of the pterygoid process and the site of attachment of the lateral pterygoid muscle. In some cases, the lateral pterygoid nerve passes from the buccal nerve (Fig. 4).

Along some distance, t<u>he medial pterygoid nerve</u> goes down as part of the mandibular region together with the lingual one and, at the level of the bottom of the mandibular notch, passes from the main trunk and enters the upper portion of medial pterygoid muscle (Fig. 4).

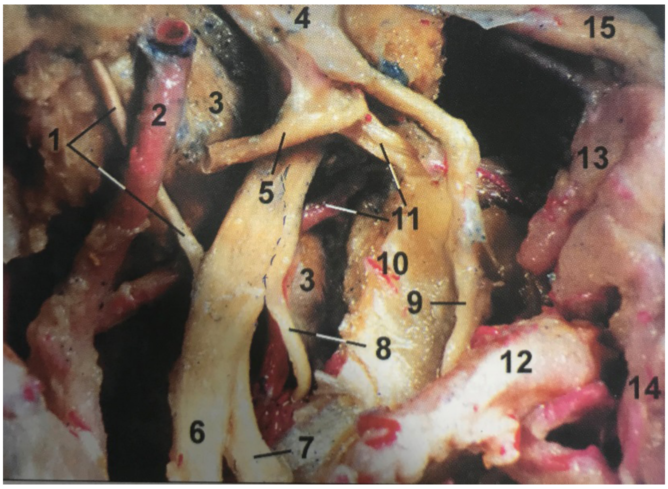

Fig. 4. Medial and lateral pterygoid (8, 11) and other branches of the mandibular nerve (Preparation of Putsillo, Vinokurov, 2004. Published with permission of the authors) *1 – cord of tympanum; 2 - middle meningeal artery; 3 - tensor muscle of the soft palate; 4 - mandibular nerve;*

5 - auricular-temporal nerve; 6 - lower alveolar nerve; 7 - lingual nerve; 8 - medial pterygoid nerve; 9 - buccal nerve; 10 - lateral plate of the pterygoid process; 11 - ascending palatine artery and lateral pterygoid nerve; 12 - maxillary artery; 13 – sphenopalatine artery; 14 - posterior superior alveolar artery; 15 - maxillary nerve.

The masticatory nerve passes from the main trunk of the mandibular nerve at almost the same level, but over the lateral pterygoid muscle, through the notch of the mandible to the masticatory muscle (Fig. 2).

Thus, the motor branches of the mandibular nerve are separated against each other by a mandibular notch almost completely closed by the ligaments of the temporomandibular joint and tendon attachment of the temporalis muscle to the coronal process.

During the Bercher blockade, we began to apply its simple modification, taking into account the location of the motor branches. Determining the point of injection on the skin of the parotid region (2 cm from the base of the antilobium according to Bercher-Uvarov) in centimeters is usually not accurate, as there are significant differences in facial shapes in different populations - men and women. We propose to determine the point of injection, taking into account the peculiarities of the anatomical formations of this area. The point of the needlestick is found as follows: with clenched teeth and contraction of the messeteric muscle under the zygomatic arch in the projection of the incisurae mandibulae the posterior edge of the surface layer m.masseter is palpated, and further, slipping from it, we get to a hole, the bottom of which is a deep layer of this muscle. At light pressing on this site there is a small deepening and the deepest part of it (bottom) in the center of a hole is an injection point (Fig. 5). We called this deepening «subzygomatic» [7,8].

Fig. 5. Determining the point of injection on the skin in blockade according to Bercher-Uvarov

Thus, to block the messeteric nerve, we introduce 0.5 - 1.0 ml analgesic solution in the area of the mandibular notch (aditus of n.massetericus), which is located at a depth of about 1.0 cm. Then the needle is conducted to a depth of 2.0 cm where, according to received opinions, blockade of the motor branches of the nerves going to the messeteric muscles is achieved. However, analyzing the features of the anatomical structure of the neuromuscular apparatus in the temporal fossa and taking into account the location of motor branches in the pterygoid muscles in their initial portion on the infratemporal crest and pterygoid process, the needle and analgesic solution are unlikely to reach their initial portion. Most likely, relaxation of the pterygoid muscles occurs in intramuscular anesthetic injection.

For the introduction of anesthetics in the area of passage of a medial pterygoid nerve it is necessary to move a needle in the same position, 3.0-3.5 cm deeper, where it is also expedient to introduce 0.5-1.0 ml of anesthetic.

Thus, the introduction of anesthetics in small doses at depths of 1-2-3 cm can achieve a more pronounced relaxation of the messeteric muscles, as confirmed by our preliminary observations in patients with inflammatory-reflexory contracture. In many ways, this resembles the procedure of Dubov (1947), however, it does not suggest blockade of the mandibular nerve as, usually, this does not occur [5].

The following anatomical formations must be taken into account when moving the needle in the temporal fossa. Above moving of the facial artery in the depth of the deep lobe of the parotid gland, the external carotid artery at the level of the articular process is divided into two branches: the superficial temporal artery and the maxillary. In order to systematize the branches of the artery in topographic anatomy, this is divided into three parts: mandibular, pterygoid and pterygopalatine. In the mandibular part of the artery, the deep auricular and anterior tympanic arteries extend posteriorly, upwards to the ear and the tympanic cavity, while in the projection of the mandibular notch there appear the middle meningeal artery (a.meningea media) and the inferior alveolar artery (a.alveolaris inferior), as shown in Figure 6. Also, in the area of the mandibular notch, a.maxillaris is represented as a lowered down loop, from its lower pole passing the a.alveolaris. This arcuate bend of the maxillary artery is designed for elasticity, relieving tension in the arteries when opening the mouth (high and complex amplitude of movements of the mandible). For the same purpose, the loops of lingual and mandibular nerves are provided by nature (Fig. 3).

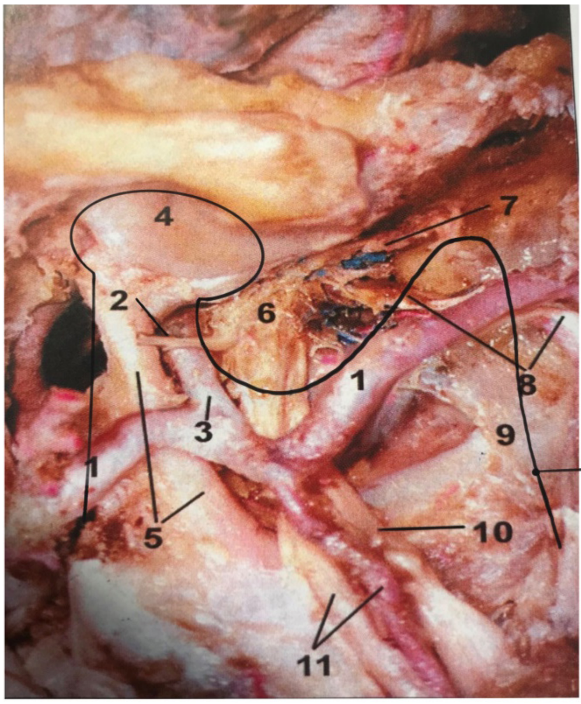

Fig.6. Arteries and nerves of infratemporal fossa (view after removal of the lateral pterygoid muscle and temporomandibular joint on the right) - Preparation of Putsillo, Vinokurov, 2004. Published with permission of the authors. We have drawn the contours of the mandible. 1 - maxillary artery; 2 - auricular-temporal nerve; 3 - middle meningeal artery; 4 - mandibular fossa and contour of the articular head; 5 – middle andibular ligament; 6 - mandibular nerve; 7 - deep temporal nerve; 8 - buccal nerve; 9 – inter-pterygoid fascia; 10 - lingual nerve; 11 - lower alveolar artery and nerve; 12 - contour of the mandibular notch, articular and coronal processes

The mandibular segment of the maxillary artery coming out of the deep lobe of the parotid gland passes between the base of the neck of the condylar process and the cuneiform ligament, and then at the level of the lower edge of the mandibular notch. The mandibular part of a.maxillaris lies on the outer surface of the medial pterygoid muscle and branches of the mandibular nerve (lingual and inferior alveolar), then on the outer surface of the lower part of the lateral pterygoid muscle (pterygoid part of the artery), entering between the heads of this muscle in the pterygopalatine fossa, where it gives back the terminal branches (pterygopalatine part) to the maxilla and palate [9]. It should also be noted that, in 33-50% of the persons, the maxillary artery is located deeper than the lateral pterygoid muscle [10,11].

If the sequence of formation and going from the main trunks of vessels and nerves can be represented by a diagram on the plane, then spatially, anatomically and topographically their relationship is quite difficult to depict and describe. In this regard, the medial and lateral pterygoid muscles are used to divide the volume of the infratemporal space (Fig. 7).

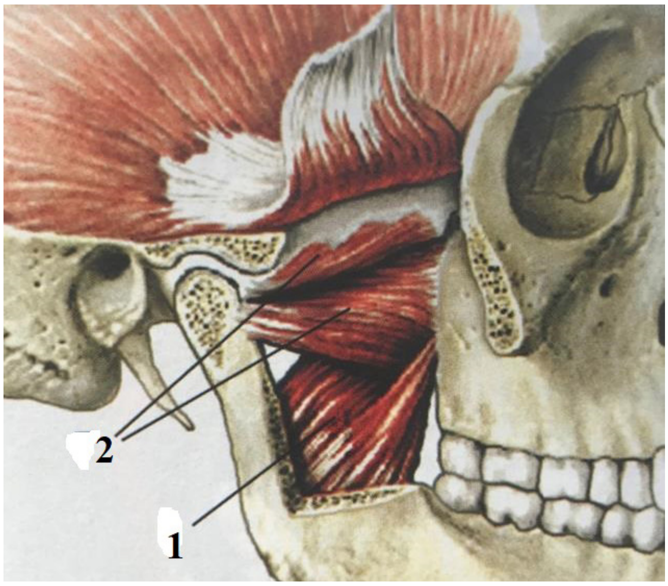

Fig. 7. Muscles of infratemporal fossa
***1 – medial pterygoid muscle; 2 – lateral pterygoid muscle* [9]**

Thus, <u>the outer surface of the lateral pterygoid muscle</u> includes: the mandibular branch, maxillary artery, temporalis tendon, masticatory muscle (through the mandibular notch), masticatory and deep temporal nerves, buccal artery, veins and nerve which, initially, after going from the main trunk of the mandibular nerve, are located on the outer surface of the outer plate of the pterygoid process. Then the buccal neuromuscular bundle passes between the heads of the lateral pterygoid muscle (at the base of the skull) and under the temporalis tendon there exit the buccal muscle, supplying blood, innervating it, as well as the vestibular mucous membrane in the projection of the lower 3.5-3.7 and 4.5-4.7 teeth and skin of the mouth angle. In some cases, with a failed technique to block the mandibular nerve at the foramen ovale, the needle is against the base of the outer plate of the pterygoid process, *i.e.*, where the buccal nerve passes and, the anesthetic aspect being released in this place, it leads to anesthesia of the skin of the corresponding angle of the mouth, while anesthesia of the mandibular nerve does not occur. This is one of the most common failures in these blockades.

To the inner surface of the lateral pterygoid muscle successively adjacent there are present: the upper part of the medial pterygoid muscle, the cuneiform-mandibular ligament, the middle meningeal artery, the mandibular nerve.

From the outer surface of the upper medial pterygoid muscle there are: wedge-mandibular ligament, maxillary vessels, lower alveolar vascular-nervous bundle, lingual nerve, deep (pharyngeal process of the parotid gland).

On the inner (medial) surface of the medial pterygoid muscle there are located: the tensor muscle of soft palate, styloglossus muscle and stylopharyngeal muscles, loose adipose connective tissue (adipose tissue), upper constrictor of the pharynx [5].

Thus, movement of the needle to the foramen ovale of the skull base during the Bercher-Brown-Uvarov blockade (with modification of the point of a needlestick by Shuvalov, Malakhovska) is associated with the layer-by-layer passage of the following anatomical formations [7,8,12,13].

The needle passes through the skin, parotid fascia, the upper pole of the parotid gland, the masticatory muscle and appears in the mandibular notch (at a depth of about 1 cm from the skin), where the masticatory artery and nerve are located. In this area, its blockade is appropriate, as one of the stages of blockade of the motor branches of the masticatory muscles (Fig. 4).

The needle then passes through a deep leaf of the temporal fascia and finds itself in the interwing-wing space above the pterygoid-mandibular, in which the downward loop a.maxillaris is located. It is closed by the branch of the mandible, the base of the articular process, being very rarely injured and, as a rule, due to violation of the technique of blockade (injection made close to the lower edge of the notch and the base of the articular process). We know two cases of a.maxillaris injury which were stopped, according to doctors, by pressing the injection site with a finger.

Then the needle reaches the lower fragment of the external (lateral) pterygoid muscle where, on its outer surface, the masticatory, buccal nerves, as well as the deep temporalis are present (Figs. 4,6). The needle passes through the lateral pterygoid muscle, and behind its inner surface at a depth of 4.0-4.5 cm is an oval hole and n.mandibular. Thus, with proper mandibular nerve blockage, advancing the needle toward the oval hole is a safe surgical procedure.

4. CONCLUSIONS

1. Blockade according to Bercher (1922) is primarily an intramuscular injection in the lateral and medial pterygoid muscles, providing muscle relaxation.
2. Blockade of the motor branches of the mandibular nerve can be successfully performed at 3 levels: in the area of the mandibular incision (at a depth of 1 cm for blockade n.masseter), behind the incision at a depth of 2 cm from the skin (for injection into the lateral pterygoid muscle) and deeper at 3.0 - 3.5 cm for injection into the upper medial pterygoid muscle and n.pterygoideus medialis.
3. In order to improve the Bercher-Uvarov blockade, it is advisable to determine the point of injection over the inner layer of m.masseter, at the lower point of the subzygomatic recess.
4. When carrying out blockade according to Bercher-Uvarov, the needle reaches the foramen ovale without damaging the maxillary and middle meningeal arteries.

References

1. Braun H. Local anesthesia, its scientific basis and practical application. London: Forgotten Books. 1909
2. Kupriyanov PA. Surgical anatomy basis cranii ext. (Doctoral dissertation) [in Russian]: Leningrad: Medical Academy;1929.
3. Sokolov BM. Online access to a. meningea, a. maxillaris interna, a. alveolaris inferior, n. lingualis,

n. alveolaris inferior through incisurae mandibulae with partial resection of the edge of this notch, without resection of the zygomatic arch and preliminary isolation of rami temporo-orbicularis n. facialis. Jubilee surgical collection of prof. ON. Bogoraz. Rostov-on-Don:Peter;1928.

4. Konovalov AN, ed. Surgery of tumors of the skull base. Moscow: Mozhaisk Printing House;2004.
5. Stolyarenko PY, Shakirov MN, Gafarov KO. Comparative assessment of the effectiveness of narcotic drugs and prolonged regional blockade of the branches of the trigeminal nerve in the relief of chronic pain syndrome in cancer patients. Pract dent. 2014;12(1):44–7.
6. Vaysblat S.N. Local anesthesia for operations on the face, jaws and teeth. Ukrain Dent Almanac. 2006; 24(2):15-8.
7. Shuvalov S.M., Malakhovska A.O. Adequate provincial health of operations in the bottom of the empty company and the upper third of the shia. *Ukrainian Dentistry Almanac*. 2006; 2: 15-18.
8. Shuvalov SM, Malakhovska AO. Adequate technique for carrying out basal anesthesia for an oval opening. Dent news. 2008;1:84-5.
9. Mikhailov SS, ed. Human Anatomy, 2nd edition. Moscow:Medicine;1984.
10. Parviz Yanfaza, Joseph B. Nedol, Robert Gala et al. Surgical anatomy of the head and neck. Cambridge: Harvard University Press; 2014.
11. Driscoll P. Gray’s anatomy, 39th Edition. Emerg Med J. 2006;23(6):492.
12. Shuvalov SM. Selected works on maxillofacial surgery. Vinnitsa: PrAO Vinobltipografiya; 2018.
13. DeGruttola AK, Low D, Mizoguchi A, Mizoguchi E. Current understanding of dysbiosis in disease in human and animal models. Inflamm Bowel Dis. 2016;22(5):1137–50.