The Morphological Substrate of the Sensory Pathways - Anatomy, Neurotransmission, Neurochemistry in Intraosseous Anaesthesia

ABDEL KARIM AL OWEIDI AL ABBADI, IULIAN CONSTANTIN*, AURELIA ROMILA**, ALINA MIHAELA CALIN*, LAURIAN LUCIAN FRINCU, CIPRIAN DINU*, ALINA MIHAELA ELISEI

1 The University of Jordan
2 Dunarea de Jos University Galati- Faculty of Medicine and Pharmacy, 47 Domenasca Str., 80008, Galati, Romania
3 Grigore T Popa University of Medicine and Pharmacy, 16 Univeritatii Str., 700946, Iasi, Romania

In order to apply the most accurate and efficient locoregional techniques, the knowledge of the anatomical characteristics of the oro-maxillo-facial territory becomes imperatively necessary, without which the installation and the effect of the locoregional anaesthetics may be poor. Due to the many advantages it presents, locoregional anaesthesia is considered as a current use method during routine dental care. A good local or locoregional anaesthetic must be harmless to the tissues, must have no local or general toxicity, must lead to a high quality and durable anaesthetic, must not cause lesions to nerve endings, to be subject to dental surgery or of oral surgery, can be satisfactorily solved by using locoregional anaesthesia techniques, which are used successfully in patients with balanced psychic, who are calm and cooperative. A good anaesthesia suppresses pain, prevents pain-induced shock, and allows the dentist to work in optimal conditions. Although modern anaesthesia techniques have greatly changed the working environment in dental surgeries or outpatient facilities of oral and maxillo-facial surgery, emotion and anxiety, fears continue to exist in patients who will have to undergo care treatments. In order to apply the most accurate and effective locoregional anaesthetic techniques, the knowledge of the anatomical characteristics of oro-maxillo-facial territory becomes imperatively necessary, without which the location and effect of locoregional anaesthetics may be poor. The study includes 114 patients studied in the period 2015-2017 on which we used Stabident system intraosseous anaesthesia of company Fairfax under two available systems: Stabident Regular and Stabident Alternative. Intraosseous anaesthesia reduces the amount of injected anaesthesia, thus reducing the toxicity of anaesthetic procedures; this technique allows the use of vasoconstrictors for the immediate delivery of anaesthesia to the teeth affected by pulpitis without the risk of necrosis. Intraosseous anaesthesia is an anaesthesia technique similar to the ideal anaesthesia technique.

Key words: locoregional anaesthesia, oro-maxillo-facial territory, intraosseous anaesthesia

The history of anaesthesia cannot be separated from the history of dentistry, and the evolution and progress of dental medicine cannot be conceived without the development and improvement of anaesthesia.

Although as a medical discipline anaesthesiology was officially recognized as a speciality only in 1948, its discovery and development took place in three periods, with beginnings which are lost in antiquity.

The oldest reference to anaesthesia is that of Saint Hillaire’s Trinity treaty-350 BC, which states that the soul may be put to sleep with the help of medicines that overcome pain and produce in the mind a state of forgetfulness of its power to feel, such as death.

Hua To (about 230 BC), the most famous physicist of ancient China, was skilled in the use of substances that caused general anaesthesia prior to surgery; he is probably the first doctor to use local anaesthesia.

Until the discovery of anaesthesia, surgical interventions were real technical performances, physicians being concerned about the speed of surgery and less of the diversification of treatment techniques [1-5].

The first discovered gas anaesthetic was nitrous oxide in 1776 by Joseph Priestley, and Humphrey Davy in 1799 communicated its ability to suppress pain during surgical manoeuvres. The use of nitrous oxide as an anaesthetic marks the beginning of the discovery of general anaesthesia.

The considerable advances made in the last decades in anaesthesia were possible due to the pharmacological, pathophysiological and clinical research that allowed both the discovery of new well-individualized substances with high efficiency and low toxicity, as well as more accurate indication to effectively prevent and deal with accidents at local and general level.

Anaesthesia nowadays allows the adaptation of individual methods and techniques to each patient so that the patient benefits from perfect anaesthesia and with as few risks as possible using substances as close as possible to the ideal anaesthetic.

Loco-regional anaesthesia is the method by which chemical, physical or electricity are used to temporarily make unresponsive the anatomical region on which doctors are intervening while intact consciousness is preserved. Because in this anaesthesia only pain sensitivity is abolished, thermal, tactile and pressure sensations being preserved, the American authors called it loco-regional analgesia.

A good local or loco-regional anaesthetic must be harmless to the tissues, must have no local or general toxicity, must produce good and lasting anaesthesia, must cause no damage to the nerve terminals, must be water-insoluble and must not cause allergic phenomena.

Pain is viewed as a subjective phenomenon or as a perception of an unpleasant emotional or sensual
experience associated with a current or potential wound. Pain can only be perceived or experimented by an individual when certain impulses reach the level of the conscious mind interpreted as painful [7-10].

Specialists’ efforts to mediate the pain involve disrupting painful messages, preventing them from reaching the level of awareness as well as activating upward pathways to alter the emission of painful signals. The painful messages are related to the high brain structures in terms of processing the harmful sensory impulse.

According to Chung 2000, Main, Broker 2000, the pain threshold is the first barely perceptible painful sensation caused by a minimal stimulus and which can be signalled verbally by a prevented individual. Threshold can be quantified by the lowest intensity of the stimulus that evokes pain.

The lack of adaptation to pain is an important factor of alarm and protection against the possible damage to the body. Painful sensitivity generates a series of individual manifestations that constitute a complex behavioural act as a friend or enemy of the state of health, depending on the intensity and duration of the nociceptive exciting factor (Melzack, 1986).

The material substrate of painful sensitivity includes neuro-anatomical structures and neuro-chemical factors that achieve the mechanism of production, mediation and modulation of it at different levels, both ascending and descending, plus educational and motivational influences.

The morphological substrate of the sensory pathways-anatomy, neurotransmission, neurochemistry

Loco-regional anaesthesia represents the method by which a temporary unresponsiveness of the anatomical region occurs, the patient’s consciousness being preserved. This has indications for most dental interventions on teeth and periodontal area, as well as in a series of interventions at the soft parts level of the face and neck, the maxillary bones and the sinuses of the face. Classification of loco-regional anaesthesia methods are: local (terminal) anaesthesia (by refrigeration, of contact, by injection), regional (truncular) anaesthesia (truncular peripheral, basal, ganglionic).

Local anaesthesia was defined as the loss of sensation in a circumscribed area of the body caused by depression of nerve excitation of nerve endings or inhibition of conduction process in peripheral nerves.

The anatomy and physiology of the trigeminal nerve, the fifth cranial nerve, refers to its three components: sensory, motor and vegetative. The trigeminal nerve consists of three branches, ophthalmic, upper maxillary, sensory and lower maxillary, being mixed.

The sensory trigeminal nerve with the three branches originates in the semilunar nodule of Gasser in the Meckeli cavum in the subduction of the dura mater, between the inner carotid and the cavernous sinus near the top of the cliff, where the cells of the first sensory neuron that receives the exteroceptive excitations are found and then are led to the sensory nucleus of the bridge trigeminal which continues in the bulb and spinal cord (the first 3-4 cervical), thus forming an ascending root and a descending root. These nuclei have lateral and posterior localization in relation to the motor nucleus in the lateral side of the bridge cross-section; hence the fibres cross one another forming the qinto-thalamic fascicle, which is added to the spinothalamic fascicle (ventral posteromedial nucleus) and then by means of the thalamic-cortical fibres they reach the lateral panetal cover and the inferior part of the postcentral (parietal upward) circvinmulation.

The sensory trigeminal innervates the lacrimal, frontal and nasociliary nerves for the ophthalmic branch and after collecting the sensory impulses, the nerve passes through the sphenoid area together with III, IV – I VI, engages in the external wall of the cavernous sinus with the same nerves and then into the gasserian ganglion where the first sensitive cell is situated.

The second branch - the superior maxillary - passes through the small round hole, through the lower and lateral sides of the wall of the cavernous sinus; receives branches from the middle meningeal nerve which innervates dura mater from the middle cranial fossa and splits into the terminal branches of the lower eyelid, the internal and external nasal as well as the superior labial branch.

The third, mandibular branch, which is also motor, passes through the oval hole, then through the Gasser’s node, where the first sensitive cell is located for the mandibular branch. There are two main branches, one is the spinous (the recurrent branch) which enters the cranium through the foramen and innervates dura mater, the sphenoid bone and mastoid cells and another branch comes from the pterygoid internal muscle. From this nerve, a part comes through the buccinator nerve, and the posterior portion of the mandible is divided into three branches, two of them, the lingual and the auriculo-temporal being exclusively sensitive.

The lower alveolar branch (the third) has motor threads for the mylohyoid muscle and the digastra anterior bottom. Physiologically: the ophthalmic penetrates the skin of the forehead, of the temples and of the scalp to the vertex, the upper eyelid and the lateral side of the nose; also the ocular globe, the upper conjunctiva, the cornea, the ciliary body and the iris, as well as the mucous membranes of the frontal and partially the sphenoidal and ethmoidal sinus and the upper part of the nasal cavity. Gives some fibres to the ciliary lymph node, branches for the lacrimal gland, the brain cover, and the oculomotor nerves.

The upper jaw sensitively innervates the posterior half of the nose, the eyelid, the upper cheek, the anterior temporal region, and the upper lip; membranous mucosa and inferior conjunctiva of the maxillary sinus and partially of the sphenoidal and ethmoidal sinus, the inferior part of the nose, the upper lip and the cheek, the uvula and the nasopharynx.

The alveolar branches innervate upper gums, alveoli, and teeth. It also innervates the medial dura mater through the middle meningeal nerve and sends branches to the sphenopalatine ganglion where it communicates with the geniculate nerve (of nerve VII) and with the sympathetic nervous system via the vidian nerve and the greater superficial and petrous nerve.

The mandibular, sensual branch innervates the scalp, the posterior side of the cheek and the temporal areas, the anterior portion of the uvula, the upper wall of the external auditory canal, the anterior part of the eardrum, the lower lip and the chin, the membrane mucosa of the lower lip, the lower portion of the oral surface, the tongue and the floor of the mouth.

The lower alveolar nerve innervates the lower gingival area, with the alveoli and the teeth. Also, through the recurrent (meningeal) branch, it innervates the dura in the anterior middle fossa and the mastoid cells. Its branches further innervate the tempo-mandibular joint and send branches to the otic and sub-maxillary ganglia. The motor function is only for the mandibular branch which is mixed.

The trigeminal motor core is located in the anterior and medial protuberance the fibres of which go to the lateral side of the cross-linked formation near the fourth ventricle.
The leaving of the bridge is done laterally, with the emergence of the motor trigeminal nerve being the place where the anterior face meets the side of the bridge, then passes past Gasser’s ganglion, engages in the cranium base and through the oval hole goes to innervate the masticatory muscles.

In order to understand the neurophysiology elements on the transmission and perception of pain, we consider that two elements must be retained: First, there are no specific receptors and fibres for pain, as there is no centre of pain; secondly, the complex organization of pain behaviour cannot be reduced to a simple stratification, but should be regarded as an interrelational complex of modular relationships.

The decoding and awareness of a painful message, reached to superior nerve centres on various sensitive-sensory pathways, bears the generic term of pain.

Melzack and Wall (1983) proposed a Control Gate model that allowed the understanding of the multidimensional aspects of painful experience.

This model includes the idea of convergence between nociceptive and non-nociceptive information, placing the site of interaction in the spinal segment of the entire body except for the face and oral cavity for which interaction takes place in the trigeminal system.

Neurons in the gelatious substance receive both peripheral afferents through thick (A-alpha and B-beta) and thin (A-delta) myelin fibres, through myelin fibres (C) as well as from a downward central level.

The Control Gate theory has found a wide practical applicability because it provides a conceptual framework to diversify the pain control modalities. According to this theory, the pain control modalities must be directed both towards the sensory component as well as towards the affective and cognitive motivational dimensions (Anderson, 2004).

The notions of neurophysiology on the transmission and perception of pain in oro-maxillo-facial territory have been interpreted differently, but in 1986 Melzack proposed a new theory that has quickly become accepted by many authors.

According to Melzack-1986, pain is a multidimensional experience, proposed by characteristic features of neuromatrix type of nerve impulses, generated and distributed by a neuro-cerebral network: Body-self Neuromatrix. This Neuromatrix is genetically determined and modified by sensory experiences, representing the primary mechanism that induces the neural character of pain.

The brain exerts a downward control of the intensity of the painful signal through neurons containing opioid peptides, catecholamines, serotonin. It is very difficult to specify how much of the central nervous effect of a compound is to affect the nociceptive and non-nociceptive aspect of pain.

Regional analgesia by acupuncture or electroacupuncture is obtained by peripheral stimulation by means of needles inserted into the chosen points (in relation to the territory in which one will intervene).

Intraosseous anaesthesia technique involves three essential steps: anaesthesia of the attached gum, perforation of cortical area and injection of the anaesthetic solution into the spongy bone. The technique of intraosseous anaesthesia is easy and does not require long learning time, even for beginners.

The technique of bone anaesthesia involves the following steps: anaesthesia of the attached gum, perforation of cortical area and injection of the anaesthetic solution into the spongy bone. The technique of intraosseous anaesthesia is easy and does not require long learning time, even for beginners.

Intraosseous anaesthesia reduces the amount of anaesthetic injected, thus reducing the toxicity of anaesthetic procedures; this technique allows the use of vasoconstrictors for the immediate delivery of anaesthesia to the teeth affected by pulpitis without the risk of necrosis.

Intraosseous anaesthesia reduces the risk for the patient, who will return to the dental practice later without feeling pain.

During the anaesthesia, the pain control modalities must be directed both towards the sensory component as well as towards the affective and cognitive motivational dimensions.
administration, in order to avoid failures, accidents and complications, the practitioner is obliged to take into account the patient's mental, general and local condition.

Today's numerous anaesthetic substances have many common properties, differing only by the rapidity of the installation, the power of action, the duration over time, the side reactions and the maximum posology of each of them.

Regarding the recommendation and administration of loco-regional anaesthesia in dentistry, in order to avoid its failures, accidents and complications, the practitioner is obliged to take into account that unitary whole called patient.

References
1. AL-MELH M., ANDERSSON L., BEHBEHANI E., 2005. Reduction of pain from needle stick in the oral mucosa by topical anesthetics: a comparative study between lidocaine/prilocaine and benzocaine. The Journal of Clinical Dent., 16(2):53-56.
2. ADLER R., 2007. Intraosseous Dental Anesthesia, Patent Cooperation Treaty Application.
3. AGGARWAL V., JAIN A., KABI D., 2009. Articaine added to inferior alveolar nerve block. Dental Abstracts, 54(4):190-191.
4. GRIGORE, M, COJOCARU, C, MARES, A, INGREI, A. Mullerian Duct Anomalies: Clinical Issues and of 3D Ultrasound Diagnosis. GINECO RO, 2009, 5, no.2, p. 100-105.
5. AGGARWAL V., JAIN A., KABI D., 2009. Anesthetic Efficacy of Supplemental Buccal and Lingual Infiltrations of Articaine and Lidocaine after an Inferior. Journ. of Endodontics, 35(7):925-929.
6. BALUGA J.C., 2003. Allergy to local anesthetics in dentistry. Rev Alerg. Med. 50(5):176-181.
7. GRIGORE, M, TELEMAN, SI, PRISTAVU, A, MATEI, M, Awareness and Knowledge About HPV and HPV Vaccine Among Romanian Women. JOURNAL OF CANCER EDUCATION, 2018, 33, no.1, p.154-159.
8. BUCUR A., VILA C.N., LOWRY J., ACERO J., 2009. Compediu de chirurgie oro-maxilo-faciala. Edit. Q Med Publishing. Bucuresti.
9. CAVIDES-BUCHELI J., 2009. The effect of different vasoconstrictors and local anesthetic solution on substance P expression in human dental pulp. Journ. of Endodont., 35(5):631-633.
10. DINESCU I., VORONEANU M., CATARGIU O., 2003. Contributii la studiul neuralgiiilor de trigemen de cauza dentara. Supl. Med. Stomatologica, 7(7):145-150.
11. FARACO N., SHIBLI J.A., 2007. Effect of anesthetics containing lidocaine and epinephrine on cardiovascular changes during dental implant surgery. Journ. of Oral Implantology, 33(2):84-88.
12. GRIGORE, M, BLIDARU, I, IORDACHE, F. Intrauterine foreign bodies, other than contraceptive devices and systems, may affect fertility - Report of two very different cases. EUROPEAN JOURNAL OF CONTRACEPTION AND REPRODUCTIVE HEALTH CARE, 2014, 19, no. 2, p. 141-143.
13. GRATZ I., DEAL E., LARJANI G.E., 2008. Articaine and epinephrine for lower third molar extraction. Dental Abstracts, 53(4):194-2001.
14. CARAIANE, A., SZALONTAY, A., MACOVEI, L., A., et al. Oral-Facial Manifestations Caused by the Use of Psychotropic Medication in Psychiatric Patients., Rev. Chim. (Bucharest), 69, no.6, 2018, p. 1581-1584.
15. HILA EPSTEIN- BARASH I., KWON A.H., 2009. Prolonged duration local anesthesia with minimal toxicity. Proceedings of the National Academy of Sciences.

Manuscript received: 6.12.2017