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

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In order to apply the most accurate and efficient locoregional techniques, the knowledge of the anatomical characteristics of the oro-maxilo-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-maxilo-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 anaesthesi*a

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 Humprey 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

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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 paths 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 (troncular) anaesthesia (troncular 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 Mekeli 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 quinto-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 parietal cover and the inferior part of the postcentral (parietal upward) circumvolution.

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 digastric 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 Vll) 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 temporo-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 gelatinous 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 *neuroamprenic* 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 substance is due to the direct influence of pain or to related effects on vigilance or affectivity [11-14, 15].

All this causes the pain to be felt on a case-by-case basis.

Intraosseous anaesthesia technique involves three essential steps: *anaesthesia of the attached gum* can be completely painless without topical application of anaesthesia if the practitioner controls the penetration of the needle and if the injecting is slow and progressive; the *cortical bone perforation* is completely painless because at this level there is no innervation, and it is performed using the punches with which the kits accompanying each system are fitted; *determining the puncture and injection site* - allows the placement of the more apical puncture point (5-6 mm from the gingival edge), the puncture hole being placed in a broader interradicular space and in a more spongy bone. As a general rule, the puncture point is 2 mm below the point where the horizontal line passing through the free gingival margin intersects the vertical line passing through the interdental papillae.

Experimental part

Materials and methods

The study includes a number of 114 patients, studied between 2015-2017, in case of whom intravenous anaesthesia in the Stabident system of company Fairfax was used, which is presented under two systems available: Stabident Regular and Stabident Alternative.

Results and discussions

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.

The method is less painful for the patient, who will return to the dental practice with less distraught and more confident.

Intravascular anaesthesia technique requires low doses of anaesthetic solution, which greatly reduces the likelihood of complications and toxicity generated by local anaesthetics.

Although the duration of anaesthesia installed by the intraosseous anaesthesia technique is smaller than the duration of anaesthesia installed by conventional loco-regional anaesthesia techniques, this is sufficient for the vast majority of the manoeuvres being carried out.

Intraosseous anaesthesia reduces the amount of anaesthesia 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.

It is a technique of anaesthesia that approaches the technique of ideal anaesthesia. Due to the multiple advantages it presents, it can be a real and viable alternative to the combined anaesthetic method, the main argument being the solving of the limits of the dental practice.

Intraosseous anaesthesia on one hand reduces the amount of anaesthetic substance injected and on the other hand enables the immediately anesthetising of a number of 6 teeth by a single anaesthetic puncture in which an anaesthetic capsule is injected, namely 0.3 ml per tooth. This is a way of reducing the toxicity of anaesthetic procedures.

Regional analgesia by acupuncture or electroacupuncture

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

In order for this method to be successful, it is necessary to collaborate with the patient, to make him/her part of the success of the method.

This is why particular attention is paid to selecting patients based on their psychological training and sometimes to applying good premedication. The stimulation of needles can be done manually by rotating or back and forth movements or electrically, using low intensity electricity. Analgesia is set at 15-30 °.

Conclusions

Potentialized loco-regional anaesthesia is the most physiological method of anaesthesia and has the widest indications in dentistry and oral surgery; has no formal contraindications, but in terms of its recommendation and 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.

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