Chemical Reactions of Iodoform in the Study of Post-Extraction Alveolites

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Post-operative alveolitis is a topical issue in dental practice, which is also reflected by the etiopathogenic aspects. The conservative principle requires the maintenance of dento-periodontal units in the arch for as long as possible, but there are situations where dental extraction is required. The healing process of the post-surgical wound is complex and involves processes of gingival mucosal regeneration and bone reshaping, involving several local factors: wound size, presence of infection, alveolar vascularization, intraalveolar foreign bodies, and general factors, especially general condition, age and body reactivity. The quality, structure, maintenance, and retraction of the clot are key factors in the formation of connective tissue during the healing of the post-extraction would. At the Oral and Maxillofacial Surgery Clinic of Galaţi, during a 2-year period between January 2015 and December 30, 2016, 2780 patients that required surgery - dental extraction were consulted and diagnosed. We found that among those 2780 patients with dental extractions 105 (3.77%) had post-treatment alveolitis. No post-surgical alveolitis from the case study was complicated by osteomyelitis of the jaws or by suppurations of the superficial or deep compartments of the face. The prophylactic measures in each dental extraction, together with the correct and timely curative treatment, combined with the dentist's competence and responsibility, can shorten the time of suffering, actively combating the risk factor and accelerating the social reintegration of the patient with post-treatment alveolitis.

Keywords: surgery, dental extraction, lumen retraction, bone regeneration, healing process

Dental extraction is a radical intervention, by which the dental unit that erupted in the oral environment is removed using an instrumentation set specific to this work. It must be performed, when the presence of the tooth to be extracted causes negative repercussions on the optimal functionality of the dental system, which cannot be prevented by means of conservative procedures [1].

It is indicated in case of failure of conservative treatment methods, as well as in the case of teeth that determine and maintain local, regional or general pathological processes.

In case that the extraction took place without any difficulty or incident, i.e. that the roots were completely extracted, no pathological elements were left in the alveolus and the operatory trauma did not cause extensive bone and mucosa lesions, we can usually observe reduced bleeding with a rapid and clear tendency of organizing a clot, which is actually the only protection of the remaining and exteriorized alveolar bone [2].

A blood clot is formed immediately after surgery. It compresses the alveolar walls, stops the hemorrhage and prevents a secondary hemorrhage. The alveolar wound is *awakened* 1-2 h after surgery, which is clinically manifested by a slight pain, for which various analgesics are recommended.

The coming period is characterized by the retreat of the lumen of the alveolar space, even after several hours, as well as by the penetration of the blood clot with neoformation vessels and primitive vascularisation initiated from the gingival intraalveolar and apical arteries in the third and fourth day after the extraction [3].

The primary closure of the wound with peripheral epithelium takes place in the sixth and seventh day after the extraction, while the regeneration of the bone begins in the seventh or eighth day after the extraction. The vital elements of the clot are phagocytic [4].

During healing, clot formation is followed by the appearance of connective tissue and then bone tissue, which will be reshaped later.

After this stage, a *callus* slowly fills the alveolus, while the lips of the alveolar wound approach and *weld*, reaching thus the primary scarring stage of the alveolar wound. The endo-alveolar clot is the biological bandage that protects a wound against microbial aggression in the oral environment, but it is also the essential element, which leads to scar organization through successive transformations and ultimately to filling the alveolar cavity with connective tissue and then with bone tissue [5].

The healing process of wounds is specific to living organisms. It is part of the survival mechanism and not an isolated phenomenon, given that it involves multiple biological events. New biocompatible materials accelerate the repair process or diminish bone loss [6].

Tissue repair, as a phase of the inflammatory reaction, is closely interdependent with biochemical, vascular, metabolic phenomena in response to injuries.

The local repair phenomenon follows the inflammatory process and they are actually components of the same process. Cicatrization is closely related to the inflammatory reaction.

The inflammatory phenomena that occur simultaneously with the healing process are: vascular, involving changes in caliber, reactivity, vascular permeability and rheodynamics; hemostatic, including denudation of collagen fibers in the wound and especially of the vascular collagen, which represents the most potent biological activator of coagulation factor XII (Hagemann factor); cytological, due to the action of phagocytes and immunocompetent cells that destroy microorganisms;

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metabolic, based on the catabolic and anabolic stages in the wound; and mechanic, i.e. the edema and increase in the hydrostatic pressure, which makes the tissue to bulge out towards the pole with minimum resistance, represented by the wound lips.

The fibrin mesh, which plays a role in hemostasis, in the defense reaction and the formation of exudate, as well as a mechanical role and the role of defending the cells denuded by irritation and death, is the *biological prosthesis* that obliterates the vacuum of the wound and is necessary for epithelial repair.

The ongoing process (as a reaction to injuries) involves an acceleration of metabolism proportional to the intensity of the aggression, being self-regulated.

Epithelial regeneration is considered the first temporal element of tissue regeneration. If the tissues are not placed in their anatomical position, leaving bone surfaces that are not covered by mucosa, the reappearance of tissue implies the appearance of neoformation tissue.

The increased duration of healing compared to healing *per primam* and the greater risk of cicatrization will result in the occurrence of infection.

In the case of healing *per secundam*, the physical and physiological characteristics of the newly formed tissue are altered and the functional readaptation is delayed and incomplete.

In spite of postoperative wound care, post-extraction complications appear very frequently due to local and general causes.

After haemorrhage, the most common complications are localized, regionalized or generalized infections. Infections are a matter of particular interest, although they do not have any more the frequency and severity that they used to have prior to the application of asepsis and antisepsis and the therapeutic use of antibiotics.

The most frequent complication in the healing of post-extraction wounds is *Post-extraction alveolitis*. Alveolitis, a complication of dental extractions, is a localized osteitis, in which the inflammation of the alveolus is associated with the superficial necrosis of its bone wall. It is often associated with traumatic or difficult extractions, but most often it follows the extraction of lower molars, especially lower wisdom molars]7].

One of the major thinking schools regarding the pathogenesis of alveolitis is based on the idea that the blood clot failed to appear. However, that concept is not eliminated by the clinical symptoms associated with the phenomenon of a wet alveolitis.

The second theory claims that the clot initially appeared, but it was subsequently lysed, giving rise to serious symptoms that characterize dry alveoli.

The pathogenesis of alveolitis or localized alveolar osteitis is a contradictory subject and the basic ideas are divided into two main streams.

The first trend is based on the assumption that there is an absolute absence of a blood clot and exhaustive efforts are channeled to elucidate the failure of clot formation. The second trend assumes the initial formation of a blood clot, which is, however, externalized and infected.

Most reports in specialized literature deny any connection between post-operative bleeding and alveolitis. It has been assumed that bone or root fragments that remain in the wound may also play an active role in the occurrence of alveolitis, given that such residues can cause post-operative bleeding and a reaction to a foreign body (*granulomatous epulis*).

Also, traumatic extractions have been incriminated as another cause leading to post-operative alveolitis.

One of the most widely accepted theories on the etiology of alveolitis is related to the occurrence of an infection in the post-extraction wound initiated by bacteria present in the normal oral flora. This argument is strongly supported by the frequent occurrence of alveolitis in association with pre-existing infections, especially with periodontal or pericoronary diseases, as well as by the reduced incidence of this condition after local or systemic antibiotic treatment [8, 9].

A bacteria that would be able to produce a alveolitis in small concentrations, must meet the following conditions:

- The bacteria must be isolated from an alveolitis;
- It must belong to the bacterial group that lyses the blood.
-It must not be pathogenic as defined by standard criteria, i.e. it must not produce swelling, redness or pus.
-The conditions of the post-extraction wound must be conducive to incubation and growth of the bacteria.

The organism that has these characteristics should be sought in the anaerobic microflora found in the oral cavity, where it remains latent until the appropriate conditions appear [10].

Clinical forms of post-extraction alveolitis

Suppurated alveolitis -the gingival mucosa that covers the alveolar bone is congested, swollen and often with flat edges. The open alveolus is filled with granular tissue, which bursts at the edge of the alveolus, bleeding to the smallest touch. The endo-alveolar clot is dirty, covered with fibrous, purulent and fetid deposits.

Dry alveolitis - the perialveolar gingival mucosa is pale and slightly edematous. The alveolus is empty or covered with a brownish-gray clot that detaches very easily.

Postoperative alveolitis is characterized by the presence of bone necrosis and localized osteitis. If it is not treated, the alveolitis may lasts for a month or more, after which it is spontaneously cured or complications appear.

Concomitantly with the alveolitis, local infectious complications or extensive haematomas may occur, which are related to poorly performed local anesthesia [11].

Their correct and appropriate recognition and treatment lead to healing without sequelae.

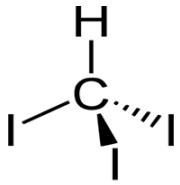
The curative treatment aims to combat pain and infection, stimulating later the process of tissue regeneration and cicatrization.

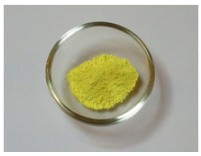
The alveolitis will be protected on the surface by an iodoform mesh.

Triiodomethane = iodoform

Iodoform (from Greek *ioeides* = violet, iodine + latin *formica* = ant) or *triiodmethane* is a halogenated organic compound with iodine. Its formula is CHI_3. It was frequently used, in the past, as a local antiseptic in the form of a paste for the treatment of wounds and abscesses, and also as sterile gauze impregnated with paste for filling cavities after oral surgery. It is a crystalline yellow powder, with a characteristic, unpleasant and persistent odor, with a very low solubility in water, but soluble in alcohol, chloroform, ether, glycerin, benzene and acetone. Synthetically produced from sodium iodide (NaI), acetone and alkaline hypochlorite solution. It was discovered in 1822 by Georges Serullas. Iodoform is used today in dentistry (in the form of iodoformed meshes or pastes). Due to its side effects (encephalopathy and erythematous rash), it has been replaced nowadays by more effective and less toxic antiseptics.

Iodine is primarily used in medicine for its antiseptic properties. It is a bactericidal, sporicidal, protoacid, cysticide and virucide agent. Given that it has a very low

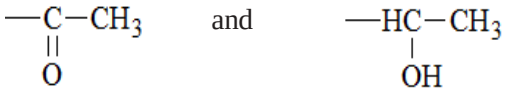




Chemical formula of iodoform

solubility in water, the solutions are prepared as tinctures in ethanol. Iodoform, iodochlorohydroxyquinoline, iodophore, as well as sodium and potassium iodides, also exert bactericidal effects by releasing iodine.

The haloform reaction is a synthesis method for organic acids from methyl ketones (it is also an analytical method). When using iodine in aqueous NaOH, the reaction is called

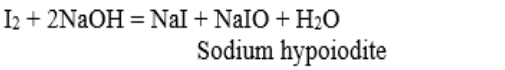


the iodoform test. The reaction is useful to determine the structure of two groups:

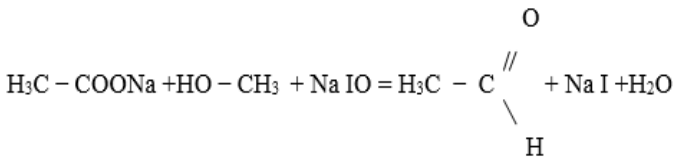
Reaction of ethanol with iodine in alkaline medium

This reaction may be used to identify alcohols that have in their structure a methyl group attached to a primary or secondary carbon atom, to which the hydroxyl functional group is attached, as follows:

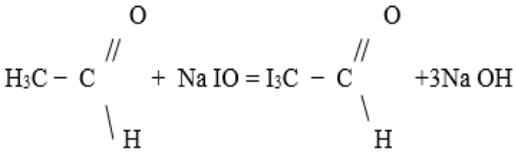
In an alkaline solution, iodine is transformed into hypoiodite, a powerful oxidant that transforms ethyl alcohol to acetic aldehyde. In case of excess of hypoiodite, the



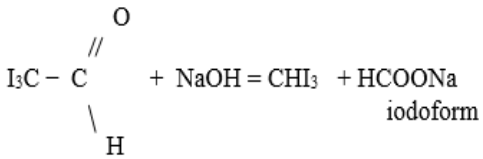
Sodium hypoiodite



acetaldehyde



triiodacetaldehyde



iodoform

acetic aldehyde is transformed into triiodoacetaldehyde which, in an alkaline medium, splits producing iodoform:

Required reagents and materials: - Ethyl alcohol pa; - iodine solution; - sodium or potassium hydroxide pa; - test tubes; - water bath.

Procedure Put in a test tube 2-3 mL of ethyl alcohol and 2-3 mL of distilled water. The obtained solution is heated in a water bath at a temperature of approximately 60°C, after which 0.5-1 mL of iodine solution (2 g of iodine and 5 g of potassium iodide are dissolved in a small amount of distilled water, after which the solution is brought up to 100mL) is added dropwise until the iodine coloration disappears, obtaining thus a 5% alkaline solution (NaOH or KOH). The formation of iodoform is recognized due to the appearance of a light yellow precipitate with a characteristic drug odor [12, 13]. The experiment may also be conducted by alkalinizing in excess the ethyl alcohol, heating the mixture to approximately 60°C and treating it with a iodine solution in potassium iodide, until obtaining a persistent yellow coloration. Additional alkalization causes the appearance of specific iodoform crystals.

Experimental part

Materials and methods

In a period of 2 years, between December 1, 2015 and December 30, 2016, there were consulted and diagnosed, at the Oral and Maxillofacial Surgery Clinic of Galaþi, a number of 2780 patients that required dental extraction.

Out of the 2780 patients, 1640 (59%) were women, and 1140 (49%) were men.

After a careful and thorough study, initially statistic and later clinical in the last two years, we established that, out of the 2780 patients with dental extractions, 105 (3.77%) had post-extraction alveolitis. Out of them, 72 (68.57%) were men and 33 (31.43%) were women. They predominantly came from urban areas - 83 (79.04%) versus 22 (20.96%) patients from rural regions.

Regarding the age distribution of post-extraction alveolite, it oscillated between 19 and 70 years with a maximum incidence in the fourth and fifth decade of life.

From the anatomical-pathological point of view, suppurated wet alveolitis was the most common form of alveolitis, namely out of 105 cases of post-extraction alveolitis, 89 (84.76%) were cases of wet suppurated alveolitis, while only 16 (15.23%) were cases of dry alveolitis.

By studying the location of post-extraction alveolitis, we determined that the highest incidence was at the level of the post-extraction alveoli of lower molars and premolars, with 77 (73.33%) out of 105 cases, especially lower molars, followed by post-extraction alveoli of the first, second and third superior molars -19 (18.09%).The least affected were the alveoli of the upper and lower incisors - 9 (8.57%).

The etiology of the post-extraction alveolitis was categorically dominated by careless, traumatic extractions, without a preliminary recovery of the oral cavity, 65 (61.90%), followed by insufficient cure of the intraalveolar pathological tissues, -27 (25.71%), the non-observation of post-surgical indications by the patient -8 (7.61%) and the *warm* extractions in a stage of acute apical periodontitis -5 (5.25%).

The constant and characteristic symptom of the patients studied by us was the pain that occurred generally on the second and fourth days after the extraction. It was a continuous, shooting, very vivid and obsessive pain with irradiation on the side of the hemimaxillas and the hemicranium on the same side.

The curative treatment for the 105 patients with post-extraction alveolitis was aimed at: fighting pain with local and general analgesics; fighting local infections; by stimulating the process of tissue regeneration and cicatrization.

In the case of wet alveolitis, we removed the infected clot by abundantly irrigating the alveolus with a warm saline solution or oxygenated water. We applied a mesh soaked in trypsin and streptomycin powder onto the surface of the cleansed alveolus . In the case of some patients with wet alveolitis, clinical phenomena did not improve even after 24 hours. That is why; we performed an alveolar curettage under local-regional anesthesia, after which we introduced

into the alveolus one of the preparations used in the treatment of post-extraction alveolitis: Apernyl, Neocone.

After the extractions, the apposition in the alveolar bone was influenced by the change in functional pressure (Douglass 2005).

The bone healing process can be guided by applying an immediate or precocious prosthesis and exerting a functional modeling action of the alveolar ridge. By prosthetization, bone resorption and apposition processes are routed and functionally stimulated and the dental prosthesis transmits a normal mastricatory pressure to the alveolar ridge.

Alveo-Penga (paste) is used for the prophylaxis of post-extraction alveolitis. It contains: iodoform 10g, butylaminobenzoate 4g, Balsam of Peru 5.60g, penghawar Djambi 4g, mento 1g, titanium dioxide 5g, lactose 5g and aromatic excipients 100g.

Results and discussions

The curative treatment for the 105 patients with post-extraction alveolitis was primarily aimed at combating pain and infection, as well as at stimulating the process of tissue regeneration and cicatrization. In the studied cases, no post-extraction alveolitis was complicated by osteomyelitis of the jaws or suppurations of the superficial or deep compartments of the face.

At the Oral and Maxillofacial Surgery Clinic we encountered post-extraction alveolitis in 105 cases.

By analyzing the etiopathogenic mechanism and the identified cases of post-extraction alveolitis, we found out that the acute periradicular process was the least frequently incriminated. Most often, alveolitis occurred after traumatic extractions, with significant tissue damage, without proper wound protection and in patients with poor oral hygiene.

Post-extraction alveolitis is, in fact, a iatrogenic condition, determined by a surgical operation, namely a dental extraction, which was, in most cases, incorrectly indicated or performed. It is less frequently caused by affections arising from the patient's failure to follow indications.

The constant and most characteristic symptom of the studied patients was pain, while the other symptoms for both wet and dry alveolitis were not different from those described in any specialized textbook. We have noticed that there is no significant link between the patient's state of health and the occurrence of post-extraction alveolitis.

Alveolitis is extremely painful and its evolution is slow. The affected alveolar wall is necrotic and the seizure of small fragments is common.

The healing of such infected wounds is extremely slow, and very little can be done for the patient, except for eliminating the subjective symptoms.

Prophylactic measures have long preoccupied specialists, who wish to reduce the frequency of this particularly unpleasant post-extraction complication.

One of the proposed prophylactic measures was to insert an agent into the tooth alveolus during the extraction. It is considered that some of the agents that have been used so far accelerate the formation of a blood clot that protects the alveolus from bacterial infections and promotes healing.

It seems that the most widely used treatment method for post-extraction alveolitis is palliative medication, which allows the normal healing of the alveolar wound. There are many palliative drugs that have been used, such as meshes with iodoform.

Thanks to the prompt, correct and efficient curative treatment, no post-extraction alveolitis in the studied cases was complicated by osteomyelitis or suppuration in the wet perimaxillary parts or in the superficial or deep compartments of the face.

Conclusions

Post-extraction alveolitis occurs more frequently in molar and bicuspid alveoli and its most frequent cause is the traumatic and careless extraction of teeth, with significant tissue degradation, in patients with poor oral hygiene.

The pathogenesis of post-extractional alveolitis is a subject still incompletely elucidated and the basic ideas are divided into two main streams. The first trend is based on the assumption that there is an absolute absence of a blood clot and exhaustive efforts are channeled to elucidate the failure of clot formation. The second trend involves the initial formation of a blood clot which, however, is subsequently lysed and infected.

The clinical picture of the alveolitis is dominated by pain. A persistent fetid odor is characteristic, as well. The condition of the patient is affected: Moderate fever, curvature, enlarged loco-regional lymph nodes and pressure.

One of the most important factors in the prophylaxis of alveolitis, besides the thorough care of the oral cavity, is to manipulate the living tissues gently. The prophylactic measures in each dental extraction, together with the correct and timely curative treatment, combined with the dentist's competence and responsibility, can shorten the time of suffering, actively combating the risk factor and accelerating the social reintegration of the patient with post-treatment alveolitis.

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