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Editorial

Re-visiting Alveolar Osteitis: The "Post-Extraction Socket Lavage" Dilemma!

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Exodontia is one of the most common dental procedures, practiced daily in clinics and hospitals around the World. Generally, the resulting extraction socket (following the removal of a tooth or teeth from the dental alveolus within the alveolar bone of the maxillary and mandibular jaws) heals uneventfully; where a properly formed fibrin clot undergoes organisation, vascularisation and gradual replacement with bone through an osteoproliferation process, post-extraction. However, alveolar defects will still only become partially restored. This is due to the fact that most extractions are traumatic and are done with no regard for maintaining the integrity of the alveolar ridge; especially common, in under-developed and developing countries. Whether due to caries, trauma or advanced periodontal disease, which are often present in all oral cavities, exodontia and subsequent healing of the socket will result in osseous deformities of the alveolar ridge. There is well-documented, resorption of the alveolar bone ridges and loss of vertical ridge height and width, which is known to result in a narrower and shorter ridge, and consequently, deformation of facial aesthetics. As aesthetics have received more emphasis with treatment planning, within the past decade, resorption of the alveolar ridge following tooth extraction, especially in the anterior region has become a significant problem. For example, after tooth removal, the dental team faces the challenge of creating a prosthetic restoration (conventional bridge or an implant-supported crown) that blends with the adjacent natural dentition. Such clinically-significant challenges often result in requiring time-consuming secondary surgeries and the use of costly barrier membranes, bone grafts and/or bone grafting substitutes, prior to finalizing the prosthetic restoration. Furthermore, alveolar osteitis or fibrinolytic alveolitis, referred to as "dry socket" (a term first used by Crawford in 1896), remains amongst the most commonly encountered complications following routine extraction or even the surgical removal of teeth by general dentists as well as specialists. The most recent definition of dry socket describes the condition as post-operative pain inside and around the extraction site, which increases in severity at any time between the first and third day post-extraction, accompanied by a partial or total disintegration of the blood clot within the alveolar socket (due to an increased fibrinolytic activity or fibrinolysis that destroys the blood clot early). The development of this condition leads to excruciating pain, foul breath or halitosis, unpleasant taste, empty socket, gingival inflammation and lymphadenopathy. While the exact pathogenesis of dry socket is not well understood rendering no possible treatment, incidence is mainly attributed to difficulty of extraction procedure (i.e. trauma), lack of dentist's experience, association with systemic diseases, smoking, bacterial infection due to poor oral hygiene, among other factors. Hence, the frequency of the condition continues to increase; for routine dental extractions (around 5% - 25%), after extraction of mandibular third molars (around 40% - 55%) and surgical extractions resulting in about 10 times higher incidence.

Given the high numbers and the fact that dry socket remains the most common and often self-limiting process and post-operative complication after extraction, various pre- and post-operative attempts have been invested to find a successful method for prevention and

treatment, including primary versus secondary closure of the socket, the prescription of topical and systemic antibiotics, chlorhexidine (0.12%) mouth-wash and intra-socket chemotherapeutic agents and steroids. However, this area remains a controversial topic as no single method has gained Universal acceptance. Careful follow-up and management via pain control using local and systemic analgesics and antibiotics until the commencement of normal (highly rare) healing is the common practice or 'gold standard' today. The development and use of intra-alveolar dressing materials has been widely suggested in the literature, in combination with different medicaments (anesthetics, analgesics and antimicrobials). For example, Alveogyl (Septodent, Inc, Wilmington, DE) has been commercially available for years and is considered the most common intra-alveolar dressing for the post-extraction management of dry socket. Nonetheless, it is frequently mentioned in the literature that little scientific evidence supports its success in light of clinicians and researchers reporting recurrent retardation of healing and inflammation (delayed healing leading to additional complications and negative prognosis of alveolar osteitis resulting in severe alveolar bone resorption and loss) when the sockets were packed with Alveogyl. Thus, not recommending its clinical use in extraction sockets. While other numerous types of graft materials, such as calcium phosphate, hydroxyapatite, borosilicate, chitosan, and gelatin have been proposed as candidates for graft materials based on the ability to promote bone healing; an ideal bone graft material has not been identified.

to prevent the development of localized Alveolar Osteitis or Dry Socket, it is recommended to allow and facilitate "natural socket bleeding and healing" at the extraction site(s) via creating a favorable environment for the formation of a blood clot necessary for normal and accepted osseous healing of the extraction socket.

Figure 1

Tissue engineering aims to replace or facilitate the re-growth of damaged or diseased tissue mainly by applying a combination of biomaterials, cells and bioactive molecules. Compared to replacing damaged tissues with grafts; tissue engineering and regenerative medicine, aim to regenerate damaged tissues by developing biological substitutes that restore, maintain, or improve tissue function. In the last two decades, research and development efforts among the tissue engineering scientific community has progressed at a rapid rate. Biodegradable polymeric scaffolds have received much attention because they provide a temporal and spatial environment for localized cellular growth and tissue in-growth. Scaffold is the central component that is used to deliver cells, drugs, and genes into the body, when and as required. Likewise, specialized scaffolds (smart/intelligent) can recruit specific cells, proteins and genes into the implantation or injection site to support three-dimensional (3D) tissue formation, *in situ*. Different forms of polymeric scaffolds are available: (1) a typical 3D porous matrix, which is a highly porous and well inter-connected open pore structure allowing high cell seeding density and tissue in-growth; (2) a nanofibrous matrix that is prepared by electrospinning or self-assembly providing a better resemblance of the physiological environment; (3) a thermosensitive sol-gel transition hydrogel; and (4) a porous microsphere. These are already widely utilized as sustained protein-release formulations and have been applied in bone tissue engineering for the potential use as a cell delivery carrier or supportive matrix. Of those polymeric scaffolds, a typical 3-D porous matrix and/or nanofibrous matrices are the implantable forms while a thermo-sensitive sol-gel transition hydrogel and/or porous microspheres are the injectable forms.

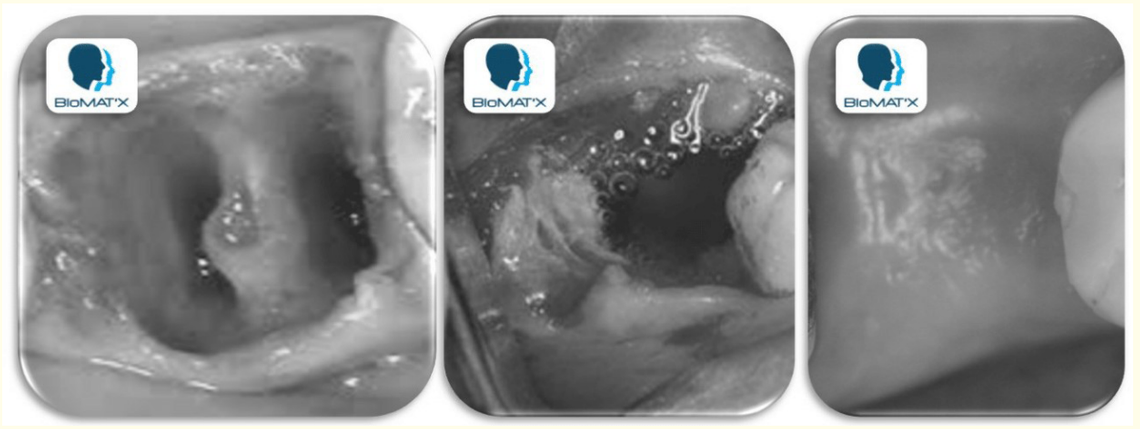

Figure 2

At BioMAT'X, our approach towards solving this problem is primarily combinatorial in nature. Stable stock solutions of natural, well-characterized and studied, polymers such as cationic chitosan and anionic hyaluronic acid were prepared prior to blending according to specific ratios and concentrations with well-identified glycerophosphate lipids and hydroxyethyl cellulose, to formulate stable, biocompatible, biodegradable, highly-porous (or soft) and highly-viscous (or sticky) sol-gel (25oC - 37oC) using the layer-by-layer (L-b-L) self-assembly technique which is based on alternate electrostatic interactions between the different polymers and lipids. The resulting injectable formulation, post-introduction and gelation to/within the extraction socket, without the need for suturing the defect, has been demonstrated to protect the site, promote angiogenesis, allow high cell-seeding density, enhanced tissue in-growth, timed osteogenesis and in consequence, discomfort and pain alleviation. The hydrogel, currently undergoing patenting, is designed and formulated to be further advanced into an agent delivery carrier and supportive matrix (with other applications in mind); via the simple incorporation of cell-/drug-loaded nanoparticles possessing attractive localized, load- and time-controlled release pharmacokinetics into the defect site via injection.

Despite ample investigations and attempts in preventing or treating dry socket, it is noticed that dentists continue to question the effect of "lavage" or a sterile saline irrigation step at the end of the extraction procedure and/or how it would affect the extraction site(s) and post-extraction socket healing; especially in terms of development of alveolar osteitis.

Based on personal experience, literature review (few studies available) as well as further consultation with senior clinicians, to the best of knowledge, lavage or irrigation with a sterile normal saline solution delivered usually by a hand monoject syringe seems to play a major role in washing away and removing the *in situ* fresh blood thereby decreasing intra-socket bleeding and leaving it empty (or full of saline – not blood).

try to avoid post-extraction socket lavage or irrigation no matter the temperature or delivery method of the prepared saline solution.

Figure 3

It was concluded a less need for immediate post-extraction lavage; however, some studies reported the effect of irrigation volume in reducing the incidence of dry socket; thereby fueling the dilemma. It is worth-mentioning that many studies are limited by the studied sample size and characteristics (such as patient age and condition at time of extraction) as well as procedure difficulty and expertise level of the clinician. Collectively, it can be stated that immediate post-operative irrigation of the fresh extraction socket commonly performed as a part of the surgical exodontia technique is a direct contributing factor to the development of localized dry socket.

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