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Short Communication

Smart Injectable Hydrogels: Prospective for Oral and Maxillofacial Surgery

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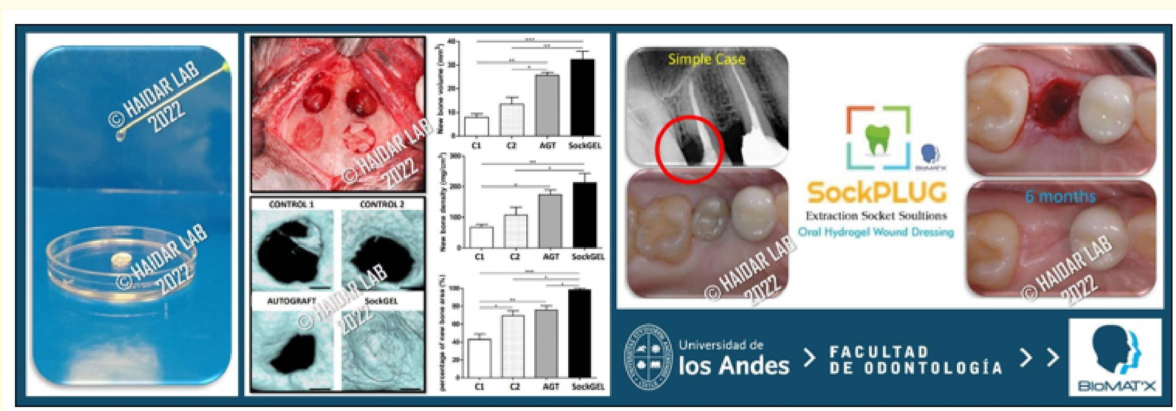
Graphical Abstract



Exodontia and loss of teeth impairs Quality of Life (QoL). Besides healthy psycho-socio-economic measures, a major criterion for successful ageing is a well-maintained dietary habit and un-compromised nutritional status, via a sustained ability to chew proper foods. Collectively, this becomes more significant in light of thriving life expectancy and rising longevity figures, globally. Whether due to caries, periodontal disease and/or trauma, exodontia or dental extraction continues to be one of the most commonly performed surgical procedures, globally. Chile is no exception. Importantly, tooth extraction ensue physiologic wound healing and bone remodelling processes of the resultant socket (hole in jaw bone) usually resulting in deformities of the alveolar residual ridge, including reduced height and width. Such voluminous changes render the placement of a conventional bridge, denture or even an implant-supported crown, particularly challenging and complicated. Further, most extractions continue to be performed with no regard for preventing the on-set of alveolar osteitis, also known as dry socket (a painful and difficult-to-treat/-manage condition post-exodontia), especially in the elderly with comprised wound healing capacity. Hence, such serious bone-resorptive morphological changes result in significant facial deformities, functional/eating complications and -ve impact on overall QoL. Current "solutions" continue to be lacking.

The art and science of oro-maxillo-facial reconstruction is of great interest for contemporary oral and maxillofacial surgeons; in search for better bioengineering strategies and biomaterials: a core driver for bio-dental research, today. Despite significant improvements, in reconstruction techniques and materials, during last decades, the regeneration, restoration and/or repair of oro-dental and maxillo-facial defects remains a challenge. Indeed, our current clinical armamentarium, strategies, procedures and approaches used to reconstruct and heal complex defects, including different bone grafting methods, such as autologous bone grafts, allografts, bone-graft substitutes, distraction osteogenesis, guided bone regeneration (GBR) and/or more recently, computer-/PC-aided GBR/implantology (and membranes), are deemed restricted, daily. This is often multi-factorial; whether due to limited self-renewal capacity of the defect and/or the limited donor supply, increased morbidity, risk of antigenicity and foreign body reactions, and limited mechanical strength (and/or inadequate space maintenance over time), all often associated with the grafts used. Accessibility, availability, and operative-associated time, cost as well as expertise, do contribute as well. It can be sturdily stated that regenerative medicine and tissue engineering significantly direct the ongoing design, development, evaluation, optimization, and translation efforts of/for novel biomaterial-based solutions for use or application in oro-dental and cranio-maxillo-facial surgery indications including, but not limited to, localized site development (post-harvesting), maxillary sinus floor lift (augmentation) and/or or extraction socket preservation, to list a few. Herein, nano-scaled injectable hydrogels as well as electro-spun nanofibers and/or 3D-bioprinted implantable scaffold matrices (or the combination thereof - considerable progress lately) are fine examples. Indeed, maxillary and mandibular alveolar bone regeneration and periodontal defect repair, have been, to a great extent the leading applied R&D&I focus, in clinical practice, through a series of major recent advancements. Injectable (biocompatible) hydrogels, for example, whether prepared using natural (alginate, chitosan, collagen, elastin, fibrin, gelatin, hyaluronic acid) and/or synthetic polymers (polyethylene glycol/PEG, polyvinyl alcohol/PVA, polylactic-co-glycolic acid/PLGA, polyhydroxyethyl methacrylate/PHEMA), and/or fabricated via physical (based on electrostatic forces) or chemical (cross-linking methods) processes, and or designed to combine favorable physico-chemico-mechanical properties as interpenetrating polymer network hydrogels (IPN), double-network hydrogels (DN), or even programmable hydrogels and 3D printed hydrogels (recently combined with electro-spinning fabrication), have led to the introduction of a novel class of "tunable" biomaterials; smart injectable hydrogels, which besides holding a porous framework mimicking the extracellular matrix thereby allowing for cellular encapsulation/transplantation and proliferation, can match any defect (irregular, in particular) and deliver/release the bio-load, in a controllable manner. Furthermore, such pharmaco-kinetics can be modulated by any specific stimuli. Today, for bone tissue engineering and osteogenesis per se, such innovative hydrogels and scaffolds to supplement our clinical armamentarium and platform, require further spatio-temporal optimization in terms of (a) cellular penetration/seeding control and (b) micro-/macro-scale or-level rheology (mechanical properties and biodegradation mechanism for different clinical indications/scenarios); aspects that are currently being investigated and technical challenges that will be addressed, for their safe and efficacious biomedical use [1-10].

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Conflict of Interest

The author of this article declares having no conflict of interest of any form or nature with any platelet concentrate product, protocol, technique or company.

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