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Alan S. Herford

Basic Principles of Bioengineering and Regeneration 1
Tara L. Aghaloo and Danny Hadaya

In a quest to provide best-quality treatment, results, and long-term prognosis, physicians must be well versed in emerging sciences and discoveries to more favorably provide suitable options to patients. Bioengineering and regeneration have rapidly developed, and with them, the options afforded to surgeons are ever-expanding. Grafting techniques can be modified according to evolving knowledge. The basic principles of bioengineering are discussed in this article to provide a solid foundation for favorable treatment and a comprehensive understanding of the reasons why each particular treatment available can be the most adequate for each particular case.

Soft Tissue Regeneration Incorporating 3-Dimensional Biomimetic Scaffolds 9
Gaurav Shah and Bernard J. Costello

Soft tissue replacement and repair is crucial to the ever-developing field of reconstructive surgery as trauma, pathology, and congenital deficits cannot be adequately restored if soft tissue regeneration is deficient. Predominant approaches were sometimes limited to harvesting autografts, but through regenerative medicine and tissue engineering, the hope of fabricating custom constructs is now a feasible and fast-approaching reality. The breadth of this field includes tissues ranging from skin, mucosa, muscle, and fat and hopes to not only provide construct to replace a tissue but also to replace its function.

Applications of Mesenchymal Stem Cells in Oral and Craniofacial Regeneration 19
Pasha Shakoori, Quanzhou Zhang, and Anh D. Le

The field of tissue engineering and regenerative medicine has been rapidly expanded through multidisciplinary integration of research and clinical practice in response to unmet clinical needs for reconstruction of dental, oral, and craniofacial structures. The significance of the various types of stem cells, specifically mesenchymal stem cells derived from the orofacial tissues, ranging from dental pulp stem cells to periodontal ligament stem cells to mucosa/gingiva has been thoroughly investigated and their applications in tissue regeneration are outlined in this article.

Tissue Engineering for Vertical Ridge Reconstruction 27
Neel Patel, Beomjune Kim, Waleed Zaid, and Daniel Spagnoli

This article provides an overview of basic tissue engineering principles as they are applied to vertical ridge defects and reconstructive techniques for these types of deficiencies. Presented are multiple clinical cases ranging from office-based dentoalveolar procedures to the more complex reconstruction of postresection mandibular defects. Several different types of regenerative tissue constructs are presented; either used alone or in combination with traditional reconstructive techniques and
Emerging technologies and research into the science of biomaterials have developed exponentially and provide facial reconstructive surgeons with a plethora of options for a multitude of varying presentations. This article presents a comprehensive discussion in the ever-evolving field of material science and emerging biomaterials. A complete understanding of the current status of such materials is necessary for the appropriate incorporation and applicability to adequate clinical situations. The rapid progress seen in biomaterials is evidenced through the forward direction of bioengineered tissues, the incorporation of growth factors in varying scenarios, and the unique characteristics of 3-D printing of patient-specific scaffolds.

Tissue Engineered Prevascularized Bone and Soft Tissue Flaps

F. Kurtis Kasper, James Melville, Jonathan Shum, Mark Wong, and Simon Young

The complex shapes of skeletal components of the craniofacial region combined with the prominence of the face and paucity of overlying soft tissue create significant challenges for the reconstructive surgeon. The in vivo bioreactor strategy is a promising alternative to microvascular surgical techniques that combines tissue engineering principles with microvascular reconstructive techniques to create patient-specific, prevascularized bone flaps for reconstruction of complex maxillofacial defects. This article discusses the use of traditional vascularized bone flaps; preclinical studies using the in vivo bioreactor approach; case reports that have attempted this novel technique; and future challenges and considerations in the development of patient-specific, prevascularized bone flaps for maxillofacial reconstruction.

Maxillofacial Defects and the Use of Growth Factors

Alan S. Herford, Meagan Miller, and Fabrizio Signorino

The development and increase in knowledge of the benefits and applications of growth factors in craniofacial reconstruction adds a novel tool in the reconstructive surgeon’s armamentarium. The use of growth factors varies according to presentation. Growth factors help to promote healing, angiogenesis, and formation of bone of improved quality and quantity. Growth factors used with stem cells and scaffolds provide a solution or alternative to discomfort created by donor autograft sites. The application and results of these growth factors are displayed in various examples of maxillofacial defects in this article, including reconstruction of a premaxillary cleft and of maxillary augmentation.

Soft Tissue Engineering

Roderick Youngdo Kim, Sam Seoho Bae, and Stephen Elliott Feinberg

There is a recognized need to reconstruct and restore complex craniomaxillofacial soft tissues. The objective of this article is to focus on the role that tissue
engineering/regenerative medicine can play in addressing various barriers (vascula-
arity, tissue bulk, volitional control, and esthetics) and impediments (timing, regional
applicability/dissemination, and regulation by the US Food and Drug Administration)
to optimal tissue reconstruction of complex soft tissue structures. We will use the
lips as an example to illustrate our points.

New Frontiers in Biomaterials

R. Gilbert Triplett and Oksana Budinskaya

Scientific and technological advances have combined to lead the way into a new era
of the ever-developing science of biomaterials and tissue regeneration. This field has
rapidly grown and new frontiers have quickly been established. Despite obtaining
satisfactory results with current methods, improved techniques that lead to dimin-
ished patient discomfort, more favorable long-term prognosis, and decreased health
care costs continue to be the goals of researchers, patients, and surgeons. Bioma-
terials have undergone a rapid evolution from materials that simply replaced tissues
to factors that stimulate a biological response in the body.