IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 22, Issue 9 Ser.2 (September. 2023), PP 07-11
www.iosrjournals.org

Soft Tissue Augmentation Around Dental Implants: A Narrative Review.

Harshada Patil[1], Jyoti Tembhurne[2], Arti Gangurde[3], Niraja Jiaswal[4]
Department of prosthodontics and crown & bridge, Government dental college and hospital, Mumbai

Abstract:
Oral soft tissue defects are a frequently encountered problem in dental praxis. Tooth loss, tooth root or implant recessions, infections, or trauma/accidents require soft tissue reconstruction. Over the course of decades, numerous techniques and research have been conducted in and around soft tissues to achieve functional and aesthetically satisfying solutions for the patient. An overview of the rationale for peri-implant soft tissue augmentation procedures in the oral cavity and different methods for correcting aesthetic and pathologic discrepancies associated with definitively restored implant crowns and other defects have been developed. Combining the gained knowledge from these studies may offer valuable cues on how to choose the best approach and means to curb daily challenges in dentistry.
Aim*- To provide a consolidated understanding of the current landscape of soft tissue augmentation strategies for improved clinical outcomes in implant dentistry.*
Objective*- this review article aims to comprehensively examine and synthesize the current state of knowledge regarding soft tissue augmentation around dental implants. By analyzing a range of studies, and clinical trials, this review aims to provide a comprehensive overview of the various strategies employed for enhancing soft tissue support and esthetic in implant dentistry. This article offers valuable insights to practitioners and researchers in the pursuit of optimal outcomes for implant based restorations.*
Key Word *:soft tissue augmentation, dental implant, ridge augmentation, esthetic dentistry*

Date of Submission: 26-08-2023 Date of Acceptance: 06-09-2023

I. Introduction

Peri-implant soft tissue augmentation aims to improve the aesthetic aspects of smile appearance and masticatory function. The article reviews the goals, importance, techniques, and significance of peri-implant soft tissue augmentation in dentistry.

Oral Soft tissue augmentation or grafting procedures are often necessary to achieve proper wound closure after placing implants, further for closure of defects such as tumor excision, clefts, trauma, and tooth recessions. Such defects can be curbed by managing the surrounding soft tissue, and for that soft tissue health is very important for the long-term success of dental implants.[1,3]

The oral mucosa or keratinized gingiva typically comprises a shiny red alveolar mucosa and a coral-pink masticatory mucosa. [1] The non-attached alveolar mucosa is thin and is mostly composed of loosely affiliated collagen fibers. In contrast, the attached mucosa is fixed, thick, keratinized, and composed of well-organized dense collagen fibers. Oral mucosa extends from the attached gingiva from which it is separated by the mucogingival line.[11] Being firm, stippled, and tightly attached to the periosteum, the masticatory mucosa can resist physical, thermal, and chemical insults. [1] Maxilla have a broader zone of attached gingiva than the mandible. It has been reported that a minimum of 2mm of keratinized gingiva with a minimum of 1mm of attached gingiva is necessary for maintaining gingival health. [4] The insufficiency of oral mucosa due to tooth loss, gingival recessions, infections, or trauma requires tissue reconstruction. Soft tissue augmentation is frequently used to regain reduced or lost tissue in edentulous patients, cover an exposed root or implant, increase buccal mucosal soft tissue thickness, coronal soft tissue height, and skin grafting. The treatment of choice has to comply with functional mastication, speech, and aesthetics. Depending on location and need, different techniques are used.[11]

II. Discussion

Techniques for soft tissue augmentation:

A variety of materials and techniques exist which are used in the oral cavity for grafting or restoring the width of attached gingiva, including grafts, local flaps, allogenic derived matrices, xenogeneic tissue matrices, synthetic materials, and many more.[1]

Autogenous soft tissue-
1)**Free gingival grafts**- mainly used to achieve a functionally adequate zone of keratinized gingiva in the oral cavity.
2)**Free buccal mucosa grafts**- a technique used for pre prosthetic surgery, after tumor ablation, for the closure of defects of tongue and cheek.
3)**Buccal fat pad grafts** (**BFP**)- used in supporting bone graft augmentations, sinus floor, and root coverage procedures.

Allogenic materials-
1) **Allogenic human acellular dermis** - used in reconstructive and general surgery for treatment of burns, breast reconstruction, etc.
Ex:-Matrix HD (RTI Biologics, Inc., Alachua, FL)
-Epiflex
2)**Allogenic acellular dermis**- used for soft tissue reconstruction before bone grafting to reduce the risk of exposure and failure of bone graft.
-examples: Alloderm (AlloDerm Regenerative Tissue Matrix; LifeCell Corporation, Bridgewater, NJ)
-Epiflex -product harvested from deceased human tissue donors used for reconstruction of deep soft tissue defects after severe trauma or resection of sarcomas.
-Puros Dermis Allograft Tissue Matrix (Zimmer Dental, Carlsbad, CA)
-AS210 (A-SkinBV, Amsterdam, The Netherlands)

Xenogenic materials- used for oral soft tissue augmentation
commonly used in the oral cavity are-
1)**porcine**-acellular dermal matrix act as a biodegradable scaffold for the delivery of cells, also preserving space and regeneration of new periodontal tissue.
2)**bovine**
3)**equine** origin
4)A scaffold composed of a **3D collagen** framework, porcine acellular dermal matrix treated with hydroxyapatite- (**HA-PADM**)
5)**porcine collagen matrix**- increases the amount of attached, keratinized gingiva *in vivo* (Mucograft; Geistlich organic material, Wolhusen, Switzerland)
6)**Mucoderm** (Botiss Dental Berlin, Berlin, Germany)-it is used for the treatment of oral dehiscence, ridge preservation, root coverage, sinus floor elevation, and vertical augmentations.
7)**acellularized xenogeneic tissues**- provide 3D structure.

Synthetic materials(alloplastic)- used in oral soft tissue augmentation and oral implant treatment in esthetic zone of maxilla, increases mucosa volume at recipient site.
1)Degradable poly-caprolactone-based polyurethane urea product, promotes ingrowth of native human tissue-Artelon (Artimplant, Stockholm, Sweden)

Tissue-Engineered Three-Dimensional(3D) Full thickness oral mucosal grafts-
1)Cultured epithelial sheets of human skin-used to close third degree burns.
2)Natural scaffolds(collagen)- either of cadaver or animal derived de-epithelialized acellular matrices or natural polymers extracted from animals are being used.
3)Synthetic and electrospun nanofibrous scaffolds- skin and oral tissue engineering
-Dermagraft (Advanced Tissue Sciences Inc., La Jolla, CA)- dermal substitute composed of a biodegradable polymer mesh with cryopreserved allogenic dermal fibroblasts.

Full-thickness oral mucosa substitutes- for closing small lesions where re-epithelization takes place from the wound margins.
1)**Apligraft** -a composite graft composed of an "epidermal" layer of allogenic skin keratinocytes grown on a "dermal" layer of fibroblast-populated bovine collagen. (Organogenesis, Canton, MA)
2)**acellular donor dermis**- patients own skin or oral derived fibroblast are seeded into the dermis scaffold, and epithelial cells are seeded on top. (AS210; A-SkinBV, Amsterdam, The Netherlands).

- Advance Therapy Medicinal Products (**ATMPs**)
- Self-inflating soft tissue hydrogel expanders have been used to acquire surplus amounts of soft tissue to cover bone grafts, has high biocompatibility, nongenotoxic, no immunoreactive.
- Collagen matrix- resembles the extra cellular matrix[1]

Connective tissue grafts:

- Epithelialized free gingival grafts (**FGGs**)- by Bjorn, 1963[4] -to create or widen attached gingiva around teeth and dental implants [4]
- Autogenous connective tissue graft (**CTG**)- esthetic result superior to those achieved with FGGs [4]
- Collagen Matrix (**CM**)- it is a sterilized porcine CM comprising types I and III collagen. -Mucograft; Osteohealth, Shirley, NY [4]
- Subepithelial connective tissue grafts (**SCTG**)- good for root coverage outcomes-autogenous technique [4]
- Acellular dermal matrix (**ADM**)- alternative to autogenous techniques for gingival augmentation.[2]
- Coronal flap advancement (**CAF**)
- Onlay-interpositional autogenous grafts- for soft tissue ridge augmentation, pontic site development over alveolar ridge[2]
- Bilaminar approach- for buccal soft tissue dehiscences- STD [2]

GBR techniques:

The peri-implant area primarily comprises the crestal bone and the healthy soft tissue around it. If these two parameters are respected, implant therapy becomes a reliable treatment with an impressive outcome. Guided bone grafting refers to the use of a barrier membrane in the treatment of alveolar ridge defects. Also called as ”membrane-protected bone regeneration”. GBR is used for both vertical and horizontal augmentation. Membranes used are of two types- resorbable and non-resorbable (reinforced by titanium structures). Bone substitutes are fillers combined with autologous bone grafts in mixed (composite) form.[12]

Novel techniques and methods:

1) **Self-inflating soft tissue expanders**- donor graft material available in the palate (Cylinder Dental; Osmed GmbH, Ilmenau, Germany) which offer enough *de novo* soft tissue for vertical bone augmentation, atrophic alveolar ridges, anterior palatal fistulas, cleft palate, congenital nasal hypoplasia, scalp reconstruction, congenital nevi reconstructions.[1]
2) **Electrospinning**- allows the production of ultrafine fibres in the nanometer or submicron range by electrically charging a suspended polymer droplet. Stem cells have been shown to proliferate and differentiate into keratinocytes on a synthetic electrospun scaffold.[1]
3) **Bio-degradable scaffolds**- autologous tissue for reconstructing oral mucosa.
4) **Biological scaffolds**- porous yet volume stable matrix, consisting of slightly crosslinked reconstituted collagen fibers, , increases soft tissue volume similarly to SCTG.[11]
5) **3D printing in soft tissue augmentation**- 3D printing allows the production of an individualized 3D object based on a material of choice and a specific computer-aided design (CAD).[11]

Factors influencing regeneration:

Use of plasma rich in growth factors of autologous origin is beneficial. The plasma is obtained by individual patients by plasmapheresis. Autologous Fibrin is used as osteoconductive material. This enhances and accelerates bone regeneration and more rapid and predictable soft tissue healing. Biopsies of the defects treated with plasma-reinforced growth factors(PRGF) showed more mature bone with better-organized trabeculae and greater bone regeneration. [9]

Emerging trends and future directions:

A) Advances in regenerative approaches for soft tissue augmentation- Freeze-dried skin allografts were initially used as a replacement for FGG in combination with an apically positioned flap for augmentation of keratinized tissue. Subsequently, allogenic dermal substitutes and xenogenic (porcine) collagen matrix were used. Recently, a novel, porous yet volume-stable matrix, consisting of slightly cross-linked reconstituted collagen fibers, has been introduced and shown to increase soft tissue volume, these biological scaffolds and delivered in standardized shapes and dimensions.[11]

B) Role of digital technology in treatment planning and execution- 3D printing technology offers presice production of an individualized 3D graft based on defined shape and inner structure via a specific computer aided design using a biomaterial of choice. Combined with smart biocompatible polymers (bioinks) that can be co-printed with cells in a specific architectural design, a more natural like tissues can be engineered. There are two types of printing approaches 1) direct (bioprinting), where cells are co-printed within scaffold, and 2) indirect, where scaffolds with the desired structure are printed to be subsequently populated with cells. Four leading 3D printing technologies employing hydrogels for soft tissue are extrusion, laser-assisted, inkjet bioprinting, and stereolithography. Biomaterials used for 3D printing of soft tissues mainly used are hydrogels, natural biomaterias compriseagarose, alginate, collagen, gelatine, hyaluronic acid,

chitosan, fibrin, cellulose and silk. Synthetic biomaterials comprise polyactide acid(PLA), polyglycolic acid(PGA), poly-lactic-co-glycolic acid (PLGA), polycaprolactone (PCL), methacrylated gelatine, pluronic-127 or polyethylene glycol (PEG). 3D printing approach could meet the challenge of allowing the production of various geometrics to match any defect while mimicking tissue complexity via the precise positioning of different materials and/or cell types. 3D printing has evolved into 3D printing of skin equivalents, gingival vasculature, 3D printing of complex vascularized structures. [11]

C) Novel materials and techniques for improved outcomes- to mimic the dynamic nature of tissues, a novel approach, named 4D bioprinting has emerged, where time has been added to 3D bioprinting as fourth dimension. 4D bioprinting will add to the possibilities of reconstructing complex, heterogenous tissues, including oral mucosa. [11]

D) **Tissue engineering (TE) of oral mucosa and gingiva-** it aims at rebuilding a functional tissue that could either replace or facilitate regeneration of the missing tissue. TE has three pillars biomimetic scaffolds as initial structural support, cells as tissue masons, and bioactive molecules as the signal instructors. The biomaterials developed and used in gingiva TE during past decades are 1) naturally derived such as acellular human dermis or amniotic membrane, 2) collagen-based, including combinations with chitosan, elastin or glycosaminoglycans, 3) fibrin-based, 4) gelatin-based, including combinations with chitosan and hyaluronic acid, 5) synthetic such as polycaprolactone or polyglycolic acid.

New advancements in tissue engineering of oral mucosa and gingiva equivalents- layer-by-layer technology to deposit nanofilms on the cell surface was developed and employed to generate vascularized oral mucosa equivalents. Another more natural gingival equivalent was the use of gingival cells immortalized through the expression of Telomerase Reverse Transcriptase (TRET) and combined with a collagen gel.[11]

E) **3D printing approaches for vascular tissue regeneration**- 3D printing of complex vascularized structures comprised the use of dissolvable/removable materials such as carbohydrate glass, Pluronic F127, gelatine, and agarose, for fabrication of tubular structures laden with viable cells. Bioprinting of cross-linked methacrylated gelatine (GelMa) blended with type1 collagen resulted in a capillary-like network with optimal rheological and shearing properties, allowing high viability of human bone marrow mesenchymal stem cells (MSC) and HUVEC. A different type of bioprinting technique, namely a rapid digital light processing (DLP) bioprinting method, is based on microscale continuous optical bioprinting and relies on computer aided photopolymerization.[11]

III. Conclusion:

A number of studies were conducted to prove the importance of oral mucosa thickness, its attachments, and osteology around implants. Underlying hard tissue morphology dictates soft tissue treatment outcome.[2] The long-term prognosis of the function and esthetics of dental implants can be improved by correctly classifying alveolar ridge defects, and by adhering to proper techniques for alveolar ridge and soft tissue augmentation.[3] The soft tissue of the thin biotype on the midfacial surface causes recession and loss of clinical attachment levels.[10] Absence of keratinized mucosa(KM) was associated with significantly higher plaque index(PLI), modified sulcus bleeding index(mBI), mucosal recession(MR), probing pocket depth(PPD), plaque accumulation(PA), and gingival recession(GR). A wide band of KM and careful oral hygiene around dental implants with platform switching proves to have improvement of the indices and periimplantitis conditions [5,7,8]. Gingiva/oral mucosa augmentation is a daily challenge in dental clinics. The currently available graft substitutes provide moderately satisfactory functional and esthetical results. Further going development of 3D bioprinting procedures could pave way towards spectacular results.[11]

References:

[1]. Jan Wolff, Elisabet Farre-Guasch, George K. Sandor, Et Al. Soft Tissue Augmentation Techniques And Materials Used In Oral Cavity: An Overview. Implant Dentistry / 2016;25(3):427-434
[2]. Lauren E. Anderson, Marita R. Inglehart, Karim El-Kholy, Et Al. Implant Aasociated Soft Tissue Defects In The Anterior Maxilla: A Randomized Control Trial Comparing Subepithelial Connective Tissue Graft And Acellular Dermal Matrix Allograft. Implant Dentistry, 2014;23(4):416-425
[3]. Patrick Palacci, Hessam Nowzari. Soft Tissue Enhancements Around Dental Implants Periodontology 2000, 2008;47:113-132
[4]. Jimmy Vellis, Ahmad Kutkut, Mohanad Al-Sabbagh. Comparison Of Xenogeneic Collagen Matrix Vs. Free Gingival Grafts To Increase The Zone Of Keratinised Mucosa Around Functioning Implants. Implant Dentistry, 2018;28(1):20-27
[5]. Sculean Et Al. Soft-Tissue Management As Part Of The Surgical Treatment Of Periimplantitis: A Narrative Review. Implant Dentistry, 2019;28(2):210-216
[6]. Jun-Beom Park. Increasing The Width Of Keratinized Mucosa Around Endosseous Implant Using Acellular Dermal Matrix Allograft. Implant Dentistry, 2006;15(3):275-281

[7]. Daisuke Ueno Et Al. Effect Of The Keratinized Mucosa Width On The Health Status Of Periimplant And Contralateral Periodontal Tissues: A Cross-Sectional Study. Implant Dentistry, 2016;25(6):796-801
[8]. Georgios-Romanos Et Al. Association Of Keratinized Mucosa And Periimplant Soft Tissue Stability Around Implants With Platform Switching. Implnat Dentistry, 2015;24(4):422-426
[9]. Eduardo Anitua. Plasma Rich In Growth Factors: Preliminary Results Of Use In The Preparation Of Future Sites For Implants. The International Journal Of Oral & Maxillofacial Implants, 1999;14(4):529-535
[10]. James Mailoa Et Al. The Association Between Buccal Mucosa Thickness And Periimplant Bone Loss And Attachment Loss: A Cross-Sectional Study. Implant Dentistry, 2018;27(5):575-581
[11]. Dobrila Nesic, Stephane Durual, Laurine Marger, Et Al. Bioprinting, Elsevier, 20 2020;1-10
[12]. L. Cordaro, H. Terheyden Ridge Augmentation Procedures In Implanttreatment. A Staged Approach ITI Treatment Guide. Vol.7