Case Report

POST-EXTRACTIVE IMPLANT INSERTION, XENOGRAFT, AND PALATAL CONNECTIVE GRAFT FOR REHABILITATION OF POSTERIOR MANDIBULAR RIDGE

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ABSTRACT

Endodontic disease occurs when the dental pulp becomes infected and inflamed. During the progression, inflammation in the periapical area and periodontal ligament leads to tooth loss. In all cases of tooth loss, alveolar bone volume is lost. Various surgical treatments use bone graft material to recover the ridge bone volume. Graft material can be obtained from the patient's body (autologous graft), animals (xenograft), human cadavers (allograft), and synthetic materials (alloplastic bone graft). Xenograft material is derived from equine, porcine, or bovine and is deproteinized and further processed. Here, we report a case of a post-extractive implant insertion with a xenograft and palatal connective graft to rehabilitate the posterior alveolar crest of the mandible. Moreover, the literature is discussed.

KEYWORDS: *connective, tissue, graft, mandible, lower jaw, implant*

INTRODUCTION

Osteoclasts and osteoblasts are the main components responsible for the highly dynamic equilibrium between bone resorption and formation. The association between the tooth and periodontium also increases the complexity of alveolar bone remodeling. Pathogen invasion from the oral environment or hematogenous spread, mechanical stress from orthodontic treatments, medication, and systemic pathological factors can induce inflammation, which dictates the activities of osteoclasts and osteoblasts in alveolar bone, shifting the balance of bone homeostasis to increase bone resorption and decrease bone formation (1). Endodontic disease occurs when the dental pulp becomes infected and inflamed. During the progression, inflammation in the periapical area and periodontal ligament leads to tooth loss.

The volumetric reduction of the maxillary and mandibular bone, caused by tooth loss, imposes limitations on dental implants, constituting a key challenge in implantology. Guided Bone Regeneration (GBR) is a suitable therapeutic option to address this issue (2). Bone volume loss, ranging from 29% to 63% horizontally and 11% to 22% vertically six months after tooth loss, has led to the development of various techniques and biomaterials to correct these discrepancies.

Different approaches have been suggested for horizontal gain, including autologous and allogeneic block bone grafts, particulate autologous, xenogeneic, and alloplastic grafts, alveolar ridge expansion, and GBR. For vertical loss, alternatives such as short implants (less than 7 mm), lateralization of the inferior alveolar nerve, autologous bone grafting, distraction osteogenesis, growth factors usage, tissue engineering, and GBR have been described (3).

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Among these techniques, GBR stands out for its ability to reduce morbidity, unpredictability, and surgical complications. Autologous block bone grafts, while osteogenic, often require a second surgical site, increasing morbidity. Homogeneous, heterogeneous, and synthetic grafts exhibit osteoconductive properties, but when combined with autologous bone or growth factors, they promote the adherence and proliferation of osteoprogenitor cells. Therefore, limitations associated with autologous block bone grafts, such as surface resorption, limited bone availability, and morbidity, have led to adopting GBR, which overcomes these obstacles.

GBR, based on barrier membrane use, is a technique that promotes predictable and stable alveolar bone gain. The fundamental principle involves isolating the surgical site with a mechanical barrier, allowing the proliferation of osteogenic cells and bone formation. A successful procedure is based on four basic principles that must be ensured during surgery and throughout the healing process, according to Wang and Boyapati (4): primary closure, angiogenesis, space maintenance, and wound stability, known as the PASS principle (Primary Closure, Angiogenesis, Space Creation/Maintenance, Stability).

The bone gain associated with GBR protocols that combine bone grafts, Platelet-Rich Fibrin (PRF), and membranes for vertical and horizontal bone augmentation are particularly interesting. Recently, the association of PRF with regenerative procedures has been proposed, showing an increase in the concentration of growth factors and other molecules involved in tissue regeneration (5, 6). The results of recent studies have indicated that the use of PRF improves graft manipulation and stability, promotes soft tissue healing, and reduces complications such as membrane exposure (3).

Soft tissue grafting procedures are increasingly performed for various indications in conjunction with dental implant therapy, considering that the primary goal of implant therapy is to ensure long-term peri-implant health based on stable dimensions of peri-implant soft tissues, low bleeding indices, and stable levels of marginal bone (7).

The main clinical indications for soft tissue grafting include coverage of recessions, a gain of keratinized tissue (KT), and an increase in soft tissue volume. These periodontal surgical interventions are recommended to achieve favorable biological, functional, and aesthetic outcomes in the short and long term (7).

Plastic periodontal procedures to increase KT and augment soft tissue volume are well-documented (8). These interventions are indicated to establish biological and functional stability around teeth and implants, especially in conjunction with reconstructive therapies. The question of whether KT is necessary to maintain periodontal health around teeth and peri-implant health in dental implants has been a subject of controversy in the literature, citing various parameters to consider: stabilization and maintenance of biological health, prevention of recession, aesthetic aspects, and ease of cleaning the reconstruction (9).

For dental implants, previous reviews suggest that the lack of keratinized mucosa (KM) may not be crucial for maintaining the health of peri-implant soft tissues, may not be correlated with increased bone loss, or that, despite the presence of KM, peri-implantitis may occur (8). On the contrary, more recent clinical studies have concluded that a broader zone of KM may better preserve the stability of soft and hard tissues, may be more favorable for the long-term maintenance of dental implants, and that the lack of KM may lead to poorer oral hygiene (10), a higher risk of peri-implant alveolar bone loss, as well as clinical attachment loss and increased soft tissue recession (10).

Previous studies have highlighted that implant sites without an adequate band of KM exhibit increased susceptibility to inflammation and adverse peri-implant soft and hard tissue reactions (10). Furthermore, there is evidence that the width of peri-implant KM influences the immune response against external irritations (plaque accumulation) (10). This has led to a clinical recommendation of a 2 mm KM width, similar to the recommended keratinized gingiva zone as adequate around teeth (8). Therefore, surgical interventions to increase soft tissue volume are recommended, especially in aesthetically critical areas, to compensate for volume loss after tooth extraction and during implant therapy with immediate or delayed placement (7).

There are various effective methods and materials to increase KM at implant sites, yielding superior aesthetic results in peri-implant tissue color, maintenance or improvement of mucosal margin height, and preservation of papillae (8). This intervention can be performed before implant placement, simultaneously with the second surgical phase, or after the insertion of the final reconstruction (8). In general, there are two main methods to increase peri-implant soft tissue: 1. enlargement of KM width using an apically positioned flap/vestibuloplasty (in combination with a free gingival graft (FGG) or an allogeneic or xenogeneic graft material); 2. increase in soft tissue volume using a subepithelial connective tissue graft (SCTG) or soft tissue replacement grafts (10).

Four different time points can be distinguished to increase KM width or mucosal thickness around dental implants: (a) before implant placement, (b) during implant placement, (c) during the second surgical phase (re-entry), or (d) after the implant is osseointegrated, uncovered, and eventually already loaded (10). The first three protocols seem to lead to more predictable clinical outcomes, while the fourth may be challenged by aesthetic problems or complications such as mucositis or peri-implantitis (10).

Here we present a case of tooth extraction, implant insertion, xenograft placement, and palatal connective tissue graft is described, and the literature is discussed.

CASE REPORT

A 51-year-old woman presented with a vestibular lesion in element 4.4 and a swelling visible in Fig. 1. Elements 4.4, 4.5, and 4.6 presented good hygiene and a metal-ceramic prosthesis.

Fig. 1. *Intraoral photo of the fourth quadrant: visible vestibular swelling.*

Element 4.4 featured a metal-ceramic prosthesis and had a vestibular probing of 10mm. Nevertheless, the patient did not report pain on percussion, and the element had no mobility. As seen in Fig. 2, an endo-buccal X-ray was performed, highlighting appropriate root canal treatment with sealing of the root apex and reconstruction using a metal abutment pin. An area of radicular rarefaction was observed where the stump pin ended.

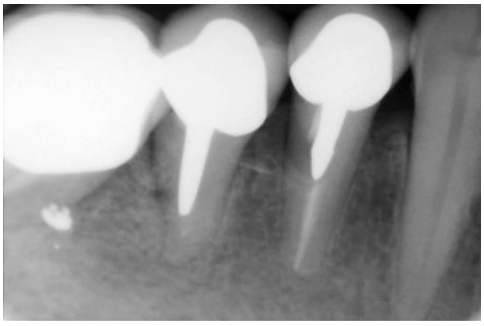

Fig. 2. *The Endobuccal X-ray included elements 4.3, 4.4, 4.5, and 4.6. Elements 4.4, 4.5, and 4.6 had a metal-ceramic prosthesis. In element 4.4, we saw a congruous root canal treatment is visible, with sealing of the root apex and a reconstruction using a metal abutment pin, with an area of root rarefaction where the abutment pin ended.*

Element 4.4 was difficult to recover as it presented an endodontic lesion, which manifested itself with a vestibular swelling. As seen in the X-ray, there was a rarefaction where the abutment pin ended. Furthermore, the lesion caused bone resorption at the vestibular level. For this reason, it was decided to extract the 4.4. The treatment plan was communicated to the patient, and element 4.4 was extracted and replaced with an implant. The metal-ceramic prosthesis on elements 4.5 and 4.6 were no longer suitable, and replacement was advised. The patient decided to proceed with the treatment of element 4.4 only.

The operation began with local plexus anesthesia with adrenaline. A full-thickness ridge flap was incised with a vertical mesial release incision at the level of 4.3. The flap was detached, and granulation tissue on the vestibular wall was noted (Fig. 3). Again, a bone lesion was observed at the vestibular level, highlighting a root perforation once the granulation tissue was removed. The extraction of element 4.4 was carried out to not damage the socket further (Fig. 4-6).

Fig. 3. *Full-thickness ridge flap with a vertical mesial release incision at the level of 4.3. There was granulation tissue with a bone lesion at the vestibular level.*

Fig. 4. *Granulation tissue was removed, and a root perforation was oberved.*

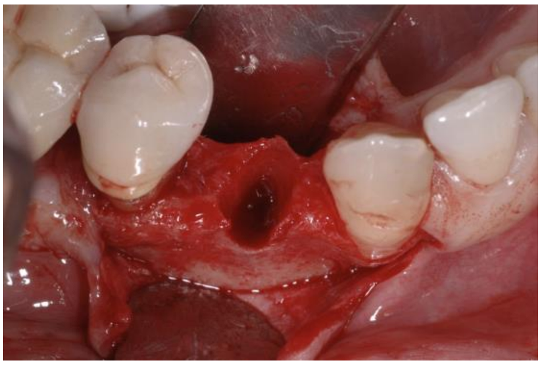

Fig. 5. *Post-extraction socket with a bone lesion in the vestibular wall.*

Fig. 6. *Element 44 with the metal-ceramic prosthesis.*

Immediately after the extraction, a 16 mm long conical implant with a 4.3 diameter from Nobel Biocare was inserted (Fig. 7).

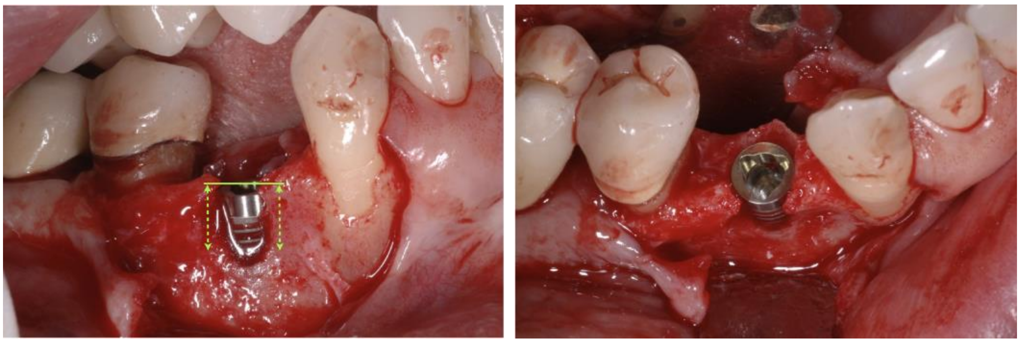

Fig. 7. *Intraoral photos of the positioned implant: On the left, the vestibular view highlighted the exposed part of the implant due to the bone lesion, and on the right, the implant from the occlusal point of view.*

The patient decided not to replace the prostheses in elements 4.5 and 4.6 yet; therefore, it was decided to submerge the implant and not carry out immediate loading. The bone lesion on the vestibular wall of element 4.4 was reconstructed with a xenograft of bovine origin stabilized with platelet derivatives (PRF) (Fig. 8).

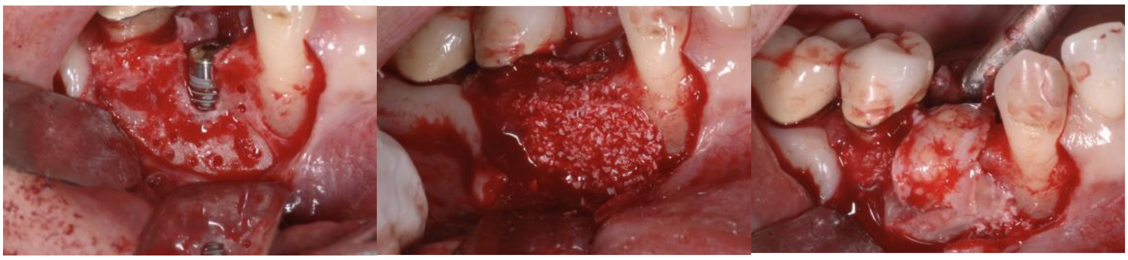

Fig. 8. *Reconstruction of the vestibular wall 4.4 with a xenograft of bovine origin stabilized with PRF*.

The aim was to close the alveolus without mobilizing the vestibular flap to avoid decreasing the depth of the vestibule and obtaining passive closure of the wound. For this reason, it was decided to add subepithelial connective tissue, which connects the lingual flap to the vestibular flap, to guarantee the primary intention of healing the wound.

A connective tissue sample was taken from the palate positioned over the fixture and sutured with the buccal and lingual flap (Fig. 9).

Fig. 9. *Subepithelial connective tissue was taken from the palate, positioned over the implant fixture, and sutured with the buccal and lingual flap.*

One month after the operation, the area of the fourth quadrant affected by the operation is visible. In Fig. 10, a good amount of keratinized gum has completely closed the wound by primary intention.

Fig. 10. *Healing after a month: a good amount of keratinized gum completely closed the wound by primary intention.*

After two months, the implant was uncovered, and a cemented metal-ceramic crown was made. For control, an endobuccal X-ray was performed, and an intraoral photo was taken (Fig. 11, 12).

Fig. 11. *Endobuccal X-ray after placing a cemented metal-ceramic crown on the implant in position 4.4. The old prostheses on elements 4.5 and 4.6 was still visible.*

Fig. 12. *Intraoral photo after treatment.*

DISCUSSION

Alveolar bone atrophy is a challenging problem in implantologists' daily practice. Several options are available to restore the alveolar crest. All aim to restore bone quantity and keratinized gingival amount around the fixture in order to guarantee long-term clinical success. Consequently, bone, membrane, and autologous tissue are managed to reach an appropriate alveolar ridge restoration.

Recent systematic reviews conducted on vertical augmentation with GBR and bone grafts have found that in patients with vertical atrophy of the mandibular ridges undergoing onlay-type bone augmentation, GBR with particulate grafting leads to greater bone gain and less superficial bone resorption compared to intraoral autologous bone grafts. This assessment was initially based on measurements of bone gain and resorption rates, followed by an examination of complications, implant survival, success, and peri-implant marginal bone loss through radiographic analysis (2). Despite its limitations, GBR appears to be the most effective technique for bone regeneration, achieving greater bone gain with less superficial resorption and fewer complications.

The choice of membranes in GBR is crucial for treatment success, with current efforts focused on creating new membranes using natural materials or tissue engineering principles. Once bone particles can support space maintenance and stability of the fibrin clot formed at the surgical site, membranes are typically used over the grafted material. A recent study suggests that the membrane is a bioactive compartment facilitating cell attraction, releasing signals and growth factors for remodeling, regeneration, and vascularization (11).

Membranes are classified as resorbable or non-resorbable based on the type of material used: synthetic (polymer-derived) or animal-derived. The most commonly used resorbable membranes are obtained from type I collagen or a combination of type I and III collagens from bovine tendons, bovine dermis, sheepskin, or porcine dermis. The most used non-resorbable membranes are high-density polytetrafluoroethylene (PTFE-d) with or without titanium reinforcement, providing effective barrier function, supporting space maintenance, and being biocompatible. Still, they need to be removed, resulting in the disadvantage of a second surgical intervention (3).

Some studies (12) comparing bone gain after GBR procedures in sites with and without membrane exposure reveal that sites without membrane exposure achieved significantly more horizontal bone gain in edentulous ridges and a more significant reduction in peri-implant bone dehiscence compared to sites with exposed membranes. In GBR, grafts are combined with a barrier that can be either a non-resorbable membrane (13) or a resorbable membrane (14). One such technique uses a block bone graft (9) and a ridge-split technique (15). Subsequently, the use of distraction osteogenesis to increase the edentulous crest was proposed (16, 17), and recently, the "sandwich" technique has been described to regenerate horizontal and vertical bone defects in peri-implant sites (18). Furthermore, a novel strategy of this surgery was introduced to improve unsuccessful attempts to correct severely resorbed mandibles: soft tissue matrix expansion grafting, otherwise known as “tent pole graft”. The problem was the inadequate soft tissue volume, which contracts following surgical expansion when a graft is introduced.

Onlay grafts underwent physiological resorption due to the remodeling process, resulting in a net loss of bone caused by the soft tissue's contraction around the graft. With Tent Pole technique, bone grafts consolidate and maintain their volume with dental implants, creating a tenting effect. This offers a predictable long-term reconstruction of the severely resorbed mandible without the complications observed with other approaches (19).

Long-term follow-up studies have confirmed the stability of grafts and their ability to maintain bone height. In a report, 64 cases of bone grafts utilizing the tenting graft concept were described, each with a minimum 3-year follow-up. No fractures occurred, and all bone grafts maintained their height, exhibiting increased radiographic density over time. Of these 64 cases, 356 dental implants were placed, with 354 (99.5%) successfully osseointegrated and laoded (20). The authors have highlighted the effectiveness of the tenting graft in various situations, including implant site preparation and reconstruction of severely resorbed mandibles. In conclusion, this method involves a surgical expansion of soft tissue, preventing contraction around grafts and ensuring a stable increase in vertical bone height over time (20).

In addition to bone graft, thick, soft tissues play a crucial role: thicker soft tissues have a greater volume of extracellular matrix and collagen and increased vascularity, which promotes the elimination of toxic products and enhances the immune response. Therefore, it has been demonstrated that thicker soft tissues respond more favorably to wound healing, flap management, and restorative trauma, especially in implant surgery (21-24). Therefore, surgical procedures to increase soft tissue volume are recommended, especially in aesthetically critical areas, to compensate for volume loss after tooth extraction and during implant therapy (7).

Techniques for soft tissue augmentation using different materials, such as subepithelial connective tissue grafts, xenogeneic collagen matrix, or acellular dermal matrix, are discussed. Various studies compare the effectiveness of these techniques in improving peri-implant tissue parameters, such as buccal tissue thickness, mid-buccal gingival level, marginal bone loss, KT width, and Pink Esthetic Score. Subepithelial connective tissue grafts and immediate or delayed implant placement have shown significant improvement in buccal tissue thickness (24).

Furthermore, subepithelial connective tissue can be used not only to increase the quantity and quality of soft tissues around natural teeth or implants but also to close flaps passively without resorting to apical repositioning of the flap, with possible consequences of decreasing vestibular depth and scarring of vertical incisions, which can be aesthetically challenging, especially in the anterior areas where aesthetics plays a crucial role.

CONCLUSIONS

In conclusion, rehabilitating edentulism through bone reconstructions, soft tissue grafts, and osseointegrated implants has transformed dentistry and improve patients' quality of life.

REFERENCES

1. Li Y, Ling J, Jiang Q. Inflammasomes in Alveolar Bone Loss. *Frontiers in Immunology*. 2021;12. doi:https://doi.org/10.3389/fimmu.2021.691013
2. Robert L, A. Aloy-Prósper, S. Arias-Herrera. Vertical augmentation of the atrophic posterior mandibular ridges with onlay grafts: Intraoral blocks vs. guided bone regeneration. Systematic review. *Journal of Clinical and Experimental Dentistry*. 2023;15(5):e357-365. doi:https://doi.org/10.4317/jced.60294
3. Amaral Valladão CA, Freitas Monteiro M, Joly JC. Guided bone regeneration in staged vertical and horizontal bone augmentation using platelet-rich fibrin associated with bone grafts: a retrospective clinical study. *International Journal of Implant Dentistry*. 2020;6(1). doi:https://doi.org/10.1186/s40729-020-00266-y
4. Wang HL, Boyapati L. “PASS” Principles for Predictable Bone Regeneration. *Implant Dentistry*. 2006;15(1):8-17. doi:https://doi.org/10.1097/01.id.0000204762.39826.0f
5. Miron RJ, Fujioka-Kobayashi M, Bishara M, Zhang Y, Hernandez M, Choukroun J. Platelet-Rich Fibrin and Soft Tissue Wound Healing: A Systematic Review. *Tissue Engineering Part B: Reviews*. 2017;23(1):83-99. doi:https://doi.org/10.1089/ten.teb.2016.0233
6. Al-Hamed FS, Mahri M, Al-Waeli H, Torres J, Badran Z, Tamimi F. Regenerative Effect of Platelet Concentrates in Oral and Craniofacial Regeneration. *Frontiers in Cardiovascular Medicine*. 2019;6(1). doi:https://doi.org/10.3389/fcvm.2019.00126
7. Thoma DS, Naenni N, Figuero E, et al. Effects of soft tissue augmentation procedures on peri-implant health or disease: A systematic review and meta-analysis. *Clinical Oral Implants Research*. 2018;29:32-49. doi:https://doi.org/10.1111/clr.13114
8. Thoma DS, Buranawat B, Hämmerle CHF, Held U, Jung RE. Efficacy of soft tissue augmentation around dental implants and in partially edentulous areas: a systematic review. *Journal of Clinical Periodontology*. 2014;41:S77-S91. doi:https://doi.org/10.1111/jcpe.12220
9. Misch CM. Comparison of intraoral donor sites for onlay grafting prior to implant placement. *The International Journal of Oral & Maxillofacial Implants* . 1998;12(6):767-776.
10. Bassetti RG, Stähli A, Bassetti MA, Sculean A. Soft tissue augmentation around osseointegrated and uncovered dental implants: a systematic review. *Clinical Oral Investigations*. 2016;21(1):53-70. doi:https://doi.org/10.1007/s00784-016-2007-9
11. Elgali I, Omar O, Dahlin C, Thomsen P. Guided bone regeneration: materials and biological mechanisms revisited. *European Journal of Oral Sciences*. 2017;125(5):315-337. doi:https://doi.org/10.1111/eos.12364
12. Garcia J, Dodge A, Luepke P, Wang HL, Kapila Y, Lin GH. Effect of membrane exposure on guided bone regeneration: A systematic review and meta-analysis. *Clinical Oral Implants Research*. 2018;29(3):328-338. doi:https://doi.org/10.1111/clr.13121
13. Buser D, Bragger U, Lang NP, Nyman S. Regeneration and enlargement of jaw bone using guided tissue regeneration. *Clinical Oral Implants Research*. 1990;1(1):22-32. doi:https://doi.org/10.1034/j.1600-0501.1990.010104.x
14. Mellonig JT, Nevins M. Guided bone regeneration of bone defects associated with implants: an evidence-based outcome assessment. *The International Journal of Periodontics & Restorative Dentistry* . 1995;15(2):168-185.
15. Simion M, Baldoni M, Zaffe D. Jawbone enlargement using immediate implant placement associated with a split-crest technique and guided tissue regeneration. *The International Journal of Periodontics & Restorative Dentistry*. 1992;12(6):462-473.
16. Chiapasco M, Romeo E, Vogel G. Vertical distraction osteogenesis of edentulous ridges for improvement of oral implant positioning: a clinical report of preliminary results. *The International Journal of Oral & Maxillofacial Implants*. 2001;16(1):43-51.
17. Chin M. Distraction osteogenesis for dental implants. *Atlas of the Oral and Maxillofacial Surgery Clinics of North America*. 1999;7(1):41-63.
18. Wang HL, Misch C, Neiva RF. “Sandwich” bone augmentation technique: rationale and report of pilot cases. *The International Journal of Periodontics & Restorative Dentistry*. 2004;24(3):232-245.
19. Marx RG, Shellenberger TD, Wimsatt JI, Correa P. Severely resorbed mandible: Predictable reconstruction with soft tissue matrix expansion (tent pole) grafts. *Journal of Oral and Maxillofacial Surgery*. 2002;60(8):878-888. doi:https://doi.org/10.1053/joms.2002.33856
20. Daga D, Mehrotra D, Mohammad S, Singh G, Natu SM. Tentpole technique for bone regeneration in vertically deficient alveolar ridges: A review. *Journal of Oral Biology and Craniofacial Research*. 2015;5(2):92-97. doi:https://doi.org/10.1016/j.jobcr.2015.03.001
21. Chappuis V, Araújo MG, Buser D. Clinical relevance of dimensional bone and soft tissue alterations post-extraction in esthetic sites. *Periodontology 2000*. 2016;73(1):73-83. doi:https://doi.org/10.1111/prd.12167
22. BY. Herrera-Serna, OP. López-Soto, T. Chacón, AM. Montoya-Gómez, D. Agudelo-Flórez, OH. Zuluaga-López. Relationship between the gingival biotype and the results of root covering surgical procedures: A systematic review. *Journal of Clinical and Experimental Dentistry*. 2022;14(9):e762-e768. doi:https://doi.org/10.4317/jced.59783
23. Younes F, Eghbali A, Raes M, De Bruyckere T, Cosyn J, De Bruyn H. Relationship between buccal bone and gingival thickness revisited using non-invasive registration methods. *Clinical Oral Implants Research*. 2016;27(5):523-528. doi:https://doi.org/10.1111/clr.12618
24. Aldhohrah T, Qin G, Liang D, et al. Does simultaneous soft tissue augmentation around immediate or delayed dental

implant placement using sub-epithelial connective tissue graft provide better outcomes compared to other treatment options? A systematic review and meta-analysis. Al-Moraissi E, ed. *PLOS ONE*. 2022;17(2):e0261513. doi:https://doi.org/10.1371/journal.pone.0261513