Prosthetic Gingival Reconstruction in a Fixed Partial Restoration. Part 1: Introduction to Artificial Gingiva as an Alternative Therapy

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The Class III defect environment entails a vertical and horizontal deficiency in the edentulous ridge. Often, bone and soft tissue surgical procedures fall short of achieving a natural esthetic result. Alternative surgical and restorative protocols for these types of prosthetic gingival restorations are presented in this three-part series, which highlights the diagnostic and treatment aspects as well as the lab and maintenance challenges. A complete philosophical approach involves both a biologic understanding of the limitations of the hard and soft tissue healing process as well as that of multiple adjacent implants in the esthetic zone. These limitations may often necessitate the use of gingiva-colored "pink" restorative materials and essential preemptive planning via three-dimensional computer-aided design/computer-assisted manufacture to achieve the desired esthetic outcome. The present report outlines a rationale for consideration of artificial gingiva when planning dental prostheses. Prosthetic gingiva can overcome the limitations of grafting and should be a consideration in the initial treatment plan. (Int J Periodontics Restorative Dent 2009;29:471–477.)

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Implant dentistry has evolved from a period when implant placement was predominantly "bone driven" by the remaining osseous architecture to the current standard of "restoration driven,"[1] in which the clinicians establish the ideal position of the restoration first, optimizing the desired functional and esthetic outcome prior to implant placement.[2] In many cases, this requires "site development" of the deficient ridge through bone and soft tissue regenerative procedures (Fig 1). The predictability of the final esthetic result is often determined by the patient's anatomy rather than the clinician's ability to manage state-of-the-art procedures (Figs 1 and 2).[3–5] Andersson et al[6] stated that 36% of patients studied presented osseous deficiencies that hindered prosthetically ideal placement of implants. Jemt[7] presented similar results, with only 60% of the patients in his study showing complete papillae after teeth extraction and implant replacement.

Alternatives to restore defective and deficient edentulous spans today should include prosthetic gingival restoration as an integral part of an overall esthetic reconstructive option in

Fig 1a *Preoperative situation showing the missing anterior dentition following trauma, along with severe vertical and horizontal defects of the maxillary anterior ridge. Replacement of these teeth will require surgical hard and soft tissue augmentation.*

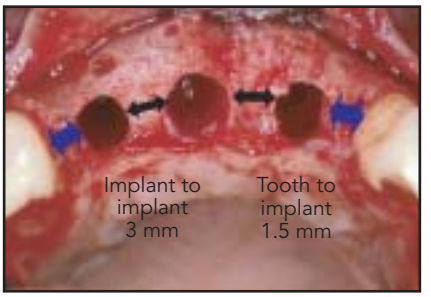

Fig 1b *The case was planned for surgical osseous and gingival reconstruction and placement of three single crowns over individual implants. An iliac graft was placed to restore vertical and horizontal proportions. Implant placement was performed, respecting the protocol of established measurements, followed by connective tissue grafting.*

Fig 1c *The definitive single implant crowns on the right incisors and left central incisor display a remaining deficiency of pink esthetics, with only partial reestablishment of the interdental papillae.*

the total decision-making process (Fig 2).[8–17] Prosthetic gingival restoration is typically not considered in the initial diagnosis and treatment planning, but when contemplated as part of the planning, it can be a trustworthy and predictable alternative or essential adjunct to therapy. To reestablish natural crown ratios and natural gingival profiles in complex situations, artificial gingival restorations can reduce the necessity of technique-sensitive surgical procedures, which are dependent on the individual pattern of biologic repair. They may also increase intraoral comfort because of the smooth, uniform interface of the prosthetic gingiva[16,18] with the remaining tissue, thereby simplifying and reducing the time and cost of treatment.

These artificial gingival restorations can correct maxillofacial defects, compensate for inadequate maxillomandibular relationships, and promote an air seal during speech[11] in severe cases. Its limited disadvantages are predominantly related to the psychologic issues of patient expectations when considering prosthetic artificial gingiva, as well as the necessary complex oral hygiene required for maintenance. As a general rule, those patients expecting individual crowns and who actually require artificial gingival replacement may then compare this modality to complete dentures. Other cited disadvantages are off-axis occlusal loading and more limited access for hygiene when not correctly planned, necessitating special devices and training for interdental hygiene.

If the option for artificial gingiva is adopted from the outset, the esthetic results tend to be significantly better than when it is used as the last resource or simply as a repair tool. Specific planning for this type of restoration must be followed to ensure optimal results. The present series of papers will describe the diagnostic and treatment planning aspects of artificial gingiva in fixed prosthetics.

In this suggested proactive approach, prosthetic gingival restoration will not be perceived as a secondary patch or fix for unsuccessful therapy, but as the most appropriate solution to a complex situation. Thus, the reconstruction of the gingival architecture is, from the outset, achieved not solely by surgical or orthodontic means, but with a planned artificial

Fig 2a *Patient showing ridge deficiency in the esthetic zone. This is an ideal situation for artificial gingiva, since the option of restoring the "pink esthetic" with surgical procedures alone has some disadvantages, including low predictability of the definitive esthetic result, longer treatment time, higher cost, and additional stress for both patient and practitioner.*

Fig 2b *Diagnostic wax-up following the esthetic guidelines established during the treatment plan. Ideal white and pink esthetics were the goal.*

Fig 2c *Site prepared to receive the restorations. A porcelain veneer was planned for the left central incisor and an alumina crown for the right central incisor. Implants would be placed in the right canine and first premolar areas, with a cantilever pontic extending to the right lateral incisor area including artificial gingiva.*

Fig 2d *Implant-supported prosthesis with artificial gingiva is designed to combine esthetics and function.*

Fig 2e *Restoration seated showing a nice integration between natural and artificial tissues and between white and pink esthetics. A veneer was placed on the left central incisor, a Procera crown on the right central incisor, and a porcelain-fused-to-metal implant-supported prosthesis restored the right lateral incisor, canine, and first premolar.*

Fig 2f *Definitive prosthesis in place, showing a good match of the natural teeth and gingiva with the ceramic crowns and gingiva. The overall esthetic look follows the guidelines and creates an esthetic balance among teeth, papillae, and lips.*

gingival restoration. Additionally, this approach still requires hard and soft tissue grafting but with different and more specific guidelines and goals. Ridge augmentations in such situations are aimed at restoring vestibular depth, with keratinized gingiva and horizontal ridge width ideally established beyond the lip perimeter.

This type of restoration may be indicated for many commonly found clinical situations, from patients with individual papillae loss to situations of major horizontal and vertical tissue deficiencies of the anterior region. Recognition of the surgical limitations of augmentation and then planning this treatment from inception can enable clinicians to meet patients' expectations in a reduced timeframe and at a lower cost.

Prosthetic ramifications of tooth loss

There are many prosthetic implications resulting from the loss of teeth.[19–21] Following extraction, osseous resorption of the anterior superior alveolar crest occurs in much the same direction and inclination of the extracted roots, which is apicopalatal. Because the buccal plate is thinner than the palatal plate, resorption will be faster in the area of the former, moving the ridge lingually toward the palate.[22] A shortening of the perimeter of the dental arch occurs, leaving less mesiodistal space for the adequate reconstruction of teeth with normal anatomy. Thus the restorative dentist and technician are often forced to modify tooth alignment and anatomy to compensate for the deficiencies. Aiming to fabricate proportional tooth form and an ideal anatomy without artificial gingiva, the implant team may undertake bone and gingival grafting in an attempt to add ridge height. In many instances, even when the surgical procedures are essentially successful, they may not completely resolve the esthetic dilemma. Even when the height of the ridge is recovered, it is still very difficult to reestablish optimal papilla form[13] (see Fig 1c). When this occurs, clinicians may find themselves at a crossroads where none of the existing alternatives are ideal. A restoration without artificial gingiva will incur several definitive esthetic problems, including less-than-ideal tooth form and an inadequate volume of gingival tissues in all three dimensions for esthetics and lip support. Even if a decision is made to add artificial gingiva to the existing restoration after the problem has become apparent, the resulting solution will often be less effective owing to the lack of preemptive planning.

In much the same way that implant dentistry evolved in the 1990s from the bone and "surgically driven" to the gingiva and "restoratively driven,"[23] the present authors believe that the next evolution will lead clinicians to consider "prosthetic gingiva–driven" implant therapy. The philosophy suggested in this series suggests that *the artificial gingiva be the guide.*

Why prosthetic gingival reconstruction?

As discussed, maxillary anterior tooth loss results in bone resorption in the direction and inclination of the roots, shortening the ridge and reducing the perimeter of the arch.[22] To compensate for this vertical loss of the ridge and gingiva, the surgeon will typically first place grafts to gain essential height in hopes that this will recreate satisfactory papilla form for the restorative phase (Figs 1 to 4). What the authors have seen most often is a shortened arch horizontally and vertically reestablished height, but unsatisfactory papilla and gingival esthetics (Fig 5a).[24] This is the worst-case scenario for the ceramist. Usually in these situations, if the restorative dentist and ceramist opt for a conventional partial prosthesis without prosthetic gingiva, the following problems are likely (Fig 5).

Fig 3 *This patient was treated with grafts, implants, and single crowns (all four maxillary incisors). Even after "successful augmentation," however, less-than-ideal papilla height and distorted tooth morphology are apparent.*

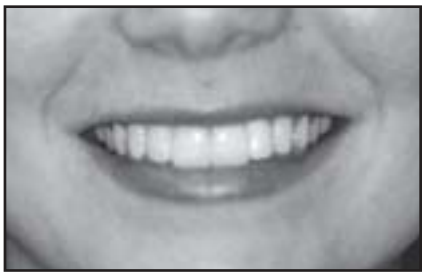

Fig 4 *This patient was treated without vertical bone and gingival grafting. The definitive prosthesis extends from canine to canine and incorporates ceramic gingiva. The final result shows an ideal blend of tooth morphology, papillae, and lip form.*

Fig 5a to 5c *Examples of inadequate tooth morphology following restorations that did not incorporate artificial gingiva.* (left) *Inverted teeth axes and wrong zenith positions.* (center) *Inverted smile line and wrong tooth proportions.* (right) *Rectangular teeth and long contact areas.*

- Narrower teeth caused by reduced mesiodistal circumference and arch space.
- Longer teeth toward the apical aspect that appear to reach out to the still-inadequate ridge height, even after surgical augmentation.
- An inverted smile line. Because the crown is longer apically, the technician typically must compensate by shortening the incisal edges of the anterior teeth as he or she seeks to retain reasonable tooth proportions. This makes the anterior teeth shorter than ideal and leads to poor lip/tooth esthetic form.
- Rectangular teeth without correct natural tooth anatomy because of longer extended contact points in the interproximal area. This lack of papilla volume often requires the ceramist to create these longer contact areas in an effort to avoid the "black triangles" interproximally.

Fig 6 *Six years posttreatment of case shown in Fig 4. Adequate tooth morphology is recaptured because of the use of artificial gingiva.*

- Inversion of the tooth axes. Instead of converging toward the incisal half of the tooth, the tooth axes will diverge. This is typically observed when conventional partial prostheses are fabricated over resorbed ridges. This occurs when the ceramist tries to keep the incisal third on the occlusal plane, guided by the mandibular teeth, and at the same time tries to take the cervical third of the tooth form toward the reduced ridge, modifying the natural tooth axis. Interestingly, when the correct modifications are made on the crowns to give them the correct axis, spaces for the artificial papilla will appear naturally. The correct positioning of the crowns in the arch will therefore lead to the need for prosthetic gingiva.
- Unsupported upper lip. When a prosthesis is fabricated with a lack of adequate arch perimeter, appropriate support is lost and the upper lip will tend to move down and backward. Less of the maxillary teeth are shown, giving the patient an aged appearance.

The missing tissues and the incorrect position of the buccal surface of the crowns, in severe cases, will generate a lack of lip support and functional changes to the orbicularis oris muscle. The muscle will not contract in a normal manner, causing a lack of tension on the upper lip and enhancing surrounding wrinkling in the skin line. The lip will also look thinner and generate a false prognathism.

Conclusion

The individual problems necessitating the alternative of prosthetic gingival reconstruction include narrow and longer prosthetic teeth, an inverted smile line, misalignment of the tooth axes, and an unsupported lip profile. These are obvious functional and esthetic dilemmas for the patient, as well as the clinical team, that are often not manageable with surgical solutions alone (Fig 6). This first part of a planned three-part series introduces the problems often encountered with deficient ridges in the partially edentulous patient. Part two will discuss the critical diagnostic and treatment-planning phase for preemptive decision making as well as the requirement for the individual surgical procedures. Part three will incorporate the actual laboratory procedures, the related clinical procedures, and the all-important maintenance phase.

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