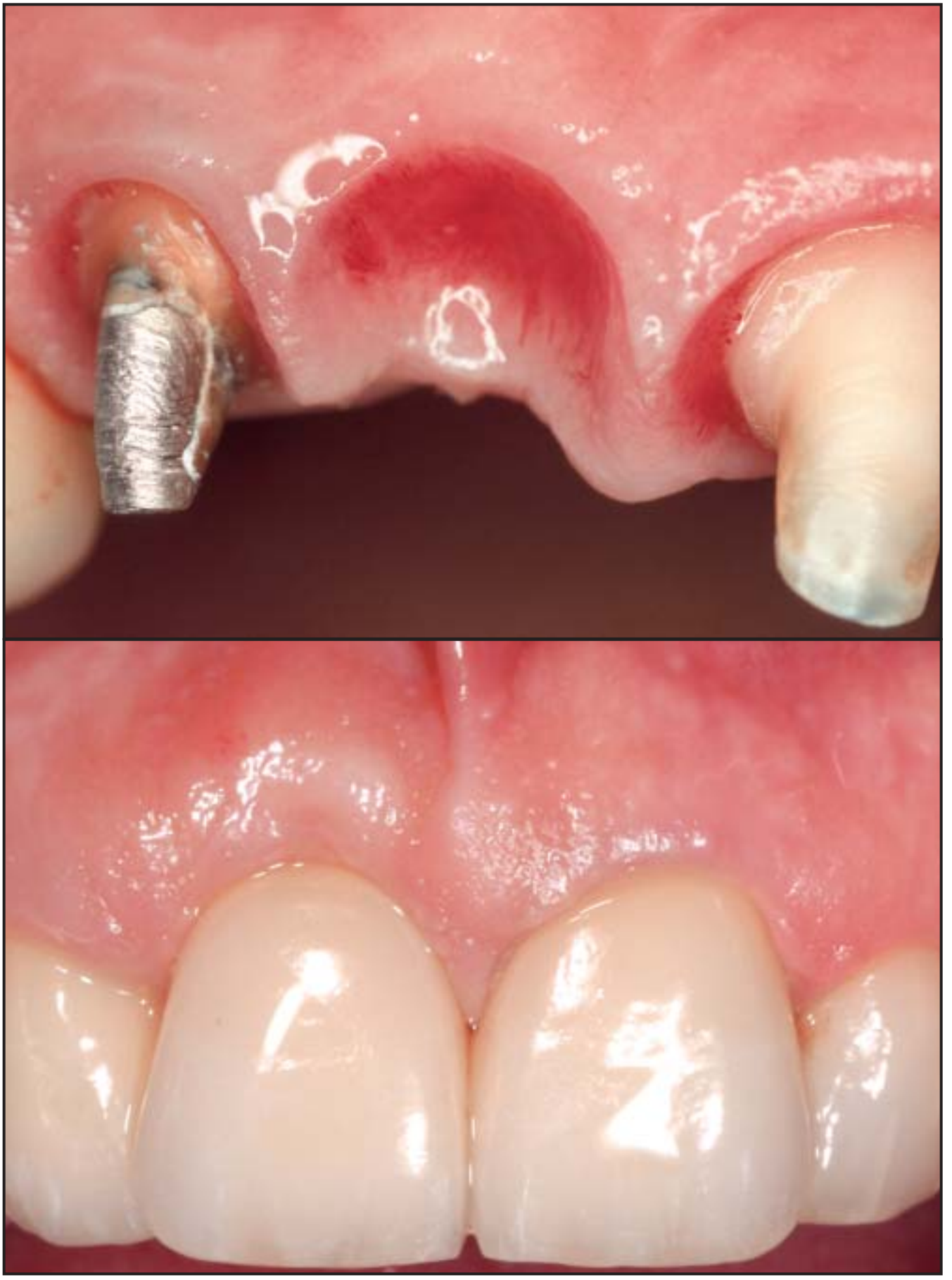

Edentulous Site Enhancement: A Regenerative Approach for the Management of Edentulous Areas. Part 1. Pontic Areas

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The successful esthetic integration of a prosthesis is dependent on the anatomic site in which the restoration is inserted. Edentulous site enhancement is a regenerative approach based on the following: (1) *anatomic evidence that the morphology of soft tissues is dependent on the underlying support (bone, roots, implants) but also significantly influenced by overlying structures (fixed or removable prostheses);* (2) *histologic evidence of the remarkable regenerative capacity of the newly formed tissue that develops during healing by secondary intention;* (3) *clinical evidence that it is possible to guide the formation of this new regenerative tissue by creating a support with proper morphology and a highly polished surface;* (4) *observations that positive pressure exerted by alimentary bolus and negative pressure produced by deglutition affect the growth of this tissue healing by second intention; and* (5) *the application of appropriate oral hygiene techniques to guide tissue healing and maintain its integrity. The edentulous site enhancement approach is simple, practical, and predictable and offers minimal postoperative complications. This paper describes the edentulous site enhancement approach as applied in the pontic areas.* (Int J Periodontics Restorative Dent 2008;28:517–524.)

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In recent years, patient demands for optimum function and esthetics of prosthetic restorations have increased. One of the major challenges facing prosthodontists is the rehabilitation of edentulous sites, where there is always a three-dimensional deficit in the residual bone and overlying soft tissue. These factors significantly influence the final esthetic result.

Crestal anatomy may be altered by various causes, including periodontal disease, trauma, tumors, genetic diseases, dental extractions, endodontic failures, and implant failures. The loss of teeth alters the form of the alveolar crest in 91% of cases.[1]

The unpredictable and often clinically significant changes occurring in alveolar ridge morphology following tooth extraction are well documented. The width of the alveolar ridge is generally reduced by half during the first 12 months, and approximately two thirds of this reduction occurs within the first 3 months.[2–4]

Even if the osseous volume is partially maintained apicocoronally or buccolingually, the loss of gingival root prominence and papillae is sufficient to cause anatomic problems that will

Table 1 Classification of crestal defects

Study		Classification
Seibert, 1983[7]	Class I	Buccolingual loss with crestal height maintained
	Class II	Vertical loss with buccolingual width maintained
	Class III	Combination of vertical and horizontal loss
Allen et al, 1985[8]	Type A*	Vertical loss with buccolingual width maintained
	Type B*	Buccolingual loss with crestal height maintained
	Type C*	Combination of vertical and horizontal loss

*Further classified into subgroups based on the depth of the defect: low = < 3 mm; moderate = 3 to 6 mm; and severe = > 6 mm.

influence the esthetic result of the prosthetic rehabilitation.[5,6]

From the morphologic point of view, Seibert[7] classified the alterations in crestal resorption into three groups on the basis of horizontal or vertical defects and their combination. Allen et al[8] later introduced a classification with subgroups to indicate the severity of crestal alteration in millimeters (Table 1).

Tissue management of the edentulous area

To improve the integration of pontics esthetically, phonetically, and functionally, it is often necessary to modify the anatomy of the edentulous ridges with tissue management techniques.

There are two possible clinical conditions: postextraction sites and stabilized edentulous sites. The most favorable clinical situation for conditioning the edentulous site is at the moment of extraction, allowing the immediate insertion of a provisional pontic.

When this is not possible, the result is a stabilized unconditioned edentulous site at which healing has already taken place. In this situation, corrective surgical techniques are indicated. These procedures, known as periodontal plastic surgeries, are defined as "surgical procedures performed to prevent or correct anatomic defects, defects due to trauma, development defects or defects arising from diseased bone, gingiva or alveolar mucosa."[9p550]

The surgical techniques for the reconstruction of soft tissue to reduce or eliminate crestal alterations may be divided into two subgroups: pedunculer flaps and free tissue grafts (Table 2).

Many surgical techniques have been proposed in the literature for the correction of soft tissue defects,[7,8,10–17] but they are largely based on empirical evidence presented in case reports. These results are not sufficiently followed up over time and are often dependent on the ability of the operator[17] and on host response.

The techniques based on grafts produce unstable results with contraction irrespective of the dimensions of the treated defect.[8] The postoperative complications may increase in the case of autologous grafts in the donor sites as well as the recipient site, with pain and eventual bleeding. The stabilization time of grafted tissue is also unpredictable.[7]

The roll-flap technique reduces the complexity of case management, but the results are still unpredictable and the management of the provisional restoration becomes more complex.

This article presents the early results of a long-term study examining the efficacy of a new technique that effectively creates optimum esthetic results in esthetically sensitive areas.

Table 2 **Surgical techniques for the correction of crestal defects of soft tissue**

Peduncular flaps	Roll flap[10]	
	Modified roll flap[11]	
Free tissue grafts	Connective tissue	Subepithelial connective tissue graft[12]
	Gingival or epithelialized[3]	Inlay graft[13]
		Onlay graft[14]
		Combination inlay/onlay[15]
	Alloplastic	Acellular dermal matrix[16]
		Biofillers[8]

Edentulous site enhancement

Indications

This article proposes an integrated surgical-prosthetic technique designed to modify the anatomy of stabilized edentulous sites that will receive pontics as an application of the edentulous site enhancement (ESE) approach.

This technique is indicated in all three classes cited by Seibert[7] and Allen et al.[8] Although the best result is obtained in the horizontal plane, the advantages can also be appreciated in the vertical and sagittal planes.

The technique is based on anatomic, histologic, and physical evidence. Anatomically, the morphology of soft tissues is dependent on the underlying support (bone, roots, implants) but also significantly influenced by overlying structures (fixed or removable prostheses). Histologically, the remarkable regenerative capacity of the newly formed tissue occurs during healing by secondary intention. Physically, it is possible to guide the formation of this new regenerative tissue by creating a support with proper morphology and a highly polished surface; further, the positive pressure exerted by alimentary bolus and the negative pressure produced by deglutition affect the growth of this tissue healing by secondary intention. The application of appropriate oral hygiene techniques will guide healing tissue and maintain tissue integrity.

Objectives

The ESE approach aims to obtain optimal prosthetic integration through the improvement of the local anatomy. Specifically, the technique aims to provide the following: horizontal and vertical increase in the band of keratinized tissue in edentulous sites, simulation of gingival root prominence, restoration of the mucogingival line, creation of conditions to favor development of the interproximal papillae, creation of a peripontic sulcus, and stabilization of the anatomic results over time.

Basis

Scar formation and wound healing

Healing is a combination of reactive mechanisms in which the organism repairs the loss of substance as the result of tissue damage. There is a continued sequence of inflammation and reparation that occurs in the same fashion regardless of tissue type. This is characterized by the formation of fibrous connective tissue, a poorly differentiated supporting tissue with low metabolism. The result is a principally reparative and substitutive tissue.[18]

Healing can take place by primary or secondary intention, the difference being in the quantity of lost tissue and the proximity of the margins of the wound. However, the fundamental mechanism is qualitatively the same, ie, a continued and integrated process

in which there are three phases[19,20]: inflammation (days 1 to 5), proliferation (days 3 to 14), and maturation (days 7 to 14). The scar may be considered solid after 2 weeks, but its initial organization occurs within 6 months, after which it slowly assumes its final aspect by approximately year 2.[19]

It is the connective tissue, newly formed by granulation tissue, that genetically determines the specificity of the overlying gingival epithelium.[21] The inherent characteristics of healing by secondary intention present the possibility of directing connective tissue proliferation in the desired fashion. The ESE approach exploits this unique quality by the insertion of a specific guiding pontic, obtaining optimum tissue form with homogeneous characteristics and relative stability at maturation. This technique takes advantage of the embryonic derivation of connective tissue from mesenchymal origins, the cells of which—present in the derma and hypoderma—are capable of proliferating and differentiating into fibroblasts.[22]

The use of a connective tissue medium as a vehicle for the coagulum increases the possibility of having organized granulation tissue, which is fundamental for harmonious healing. It should be noted that nicotine inhibits the differentiation of fibroblasts.[23]

Physical conditioning

Negative pressure present in the oral cavity favors the neoformation of connective tissue.[24] The response to functional demands and a guiding prosthesis that is specifically contoured, such as a properly formed pontic, is a significant factor in the size and shape of the newly formed tissue. The entire surface of this pontic is highly polished to discourage colonization of microorganisms.

The creation of interfaces with acute angles between gingival portions of the pontic and newly formed connective tissue favors the desired hyperplastic response, which can be further enhanced by oral hygiene techniques followed by the patient at home. It is recommended that patients apply the Bass brushing technique along with the Stillman technique and dental floss around the pontic, treating it as a natural tooth, without passing the floss under the pontic.

Operative technique

Figure 1 shows a schematic representation of the operative technique. The ESE approach is defined as a surgical-prosthetic conditioning method. Its advantage is derived from the neoformation of connective tissue obtained from healing by secondary intention and the successive physical conditioning of that tissue with the help of provisional acrylic resin or definitive ceramic pontics.

The technique is a modification of the classic flap procedure. Since the incision does not extend beyond the mucogingival junction, it may be considered a modified partial-thickness flap with maintenance of the corion of the keratinized connective tissue and the periosteum to protect the osseous crest.

The design of the incision is trapezoidal, with the longer base placed buccally and the parasulcular incisions placed crestally in the thickness of the keratinized gingiva, since the underlying

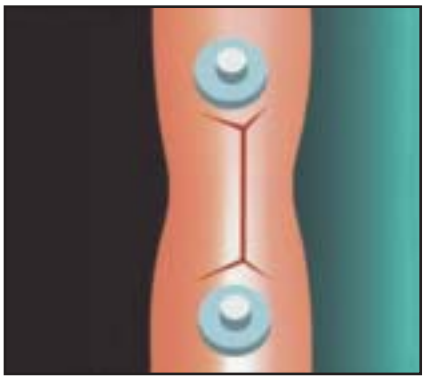
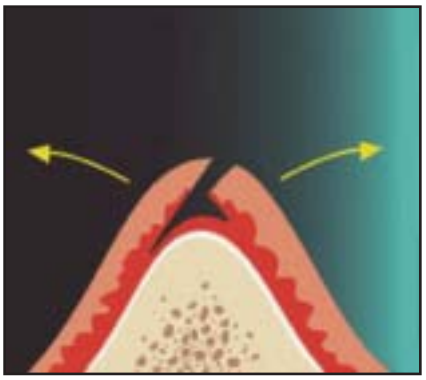


Fig 1a (left) *Occlusal view of the trapezoidal incision.*

Fig 1b (right) *Edentulous crest after the displacement of the connective tissues. The coronal portion of the osseous crest is protected by periosteum and a layer of connective tissue. The greater the amount of tissue loss that must be compensated for, the greater the palatal/lingual inclination of the incision should be.*



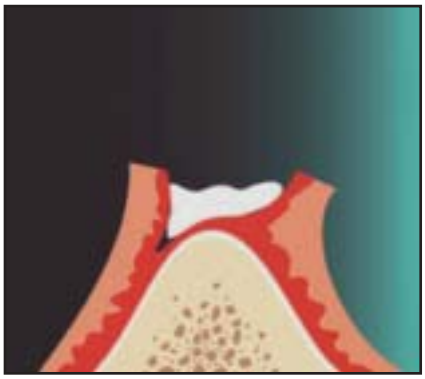


Fig 1c *Placement of collagen.*

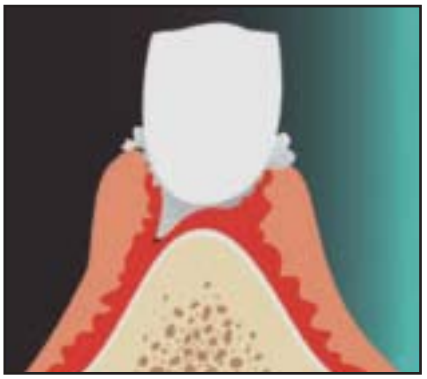


Fig 1d *The pontic positioning supports the connective tissue, adequately influencing the form and volume.*

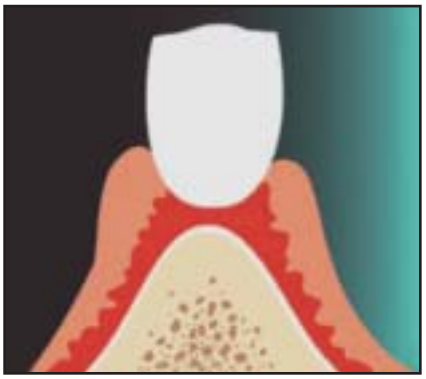


Fig 1e *Time and function will improve the integration of the prosthetic restoration into the new anatomic environment.*

connective tissue is programmed to produce keratinized tissue.

The crestal incision is to be placed palatally/lingually depending on the extent of the vertical defect to be corrected.

In cases in which there is an absence of attached gingiva, it may be necessary to proceed with an initial free connective tissue graft, after which the ESE approach can be employed if further improvement of the site is needed.

To stabilize the coagulum and permit rapid healing, a small portion of equine lyophilized and resorbable collagen (Gingistat, Vebas) is placed between the exposed crestal connective tissue and the apical portion of the pontic.

The mobilized tissue, displaced buccally and lingually/palatally, will be supported by the apical contours of the pontic. Time and function will further improve the new anatomic environment and enhance the esthetic integration of the prosthetic restoration. Sutures are contraindicated regardless of the material or the tension, because they would obstruct the vascularization of the dislocated tissue and the blood supply necessary for the neoformation of supracrestal connective tissue. Clinical views of a complete case are shown in Fig 2.

Fig 2a (left) *Stabilized edentulous site in need of regenerative procedures.*

Fig 2b (right) *Trapezoidal incision and placement of collagen.*

Fig 2c (left) *Buccal view of the site treated with the ESE approach after placement of the provisional restoration.*

Fig 2d (right) *Occlusal view of the site after 4 weeks.*

Fig 2e (left) *Buccal view of the site after 4 weeks.*

Fig 2f (right) *Buccal view of the site after 40 months.*

Fig 2g *Occlusobuccal view of the site after 40 months in function. The anatomic objectives were obtained and maintained using the ESE approach.*

Conclusions

Although the proposed technique is based on the rigorous revision and application of the mechanisms of physiologic healing, it is innovative relative to the current literature. The authors have been successfully applying the ESE approach since 1998. A further validation of the ESE approach is in progress to evaluate a series of consecutive cases followed for at least 2 years, supported by biometric measurements of the tissues involved. This protocol will be the subject of future articles by the authors. From a clinical point of view, the ESE is simple, reliable, and well accepted by patients, since it uses the reparative potential of the host, does not increase the time or cost of treatment, and does not cause postoperative problems.

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