

The Orthodontic-Periodontal Connection In Implant Site Development

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Implant-supported restorations have become an established treatment modality, well accepted by patients and clinicians. Regaining function is now routinely expected, and the focus of patient demand has shifted to aesthetics. Aesthetic restoration of the partially edentulous anterior maxilla can be particularly challenging. The learning objective of this article is to present a comprehensive multidisciplinary treatment protocol, developed to establish a foundation for optimal aesthetics in implant therapy, with emphasis on the role of orthodontics in the enhancement of deficient components. Periodontal orthodontics is used to increase the vertical osseous dimension and preserve papillae; restorative orthodontics optimizes the site through manipulation of supragingival restorative space. Two clinical cases are utilized to illustrate the principles and implementation of this protocol.

Faced with disease, trauma, or congenital deficiencies, the axiomatic goal of reconstructive therapy is the restoration of health, function, and aesthetics. As the use and effectiveness of osseointegrated implants continues to expand the treatment options for partially edentulous patients, the restoration of health and function has become a mat-

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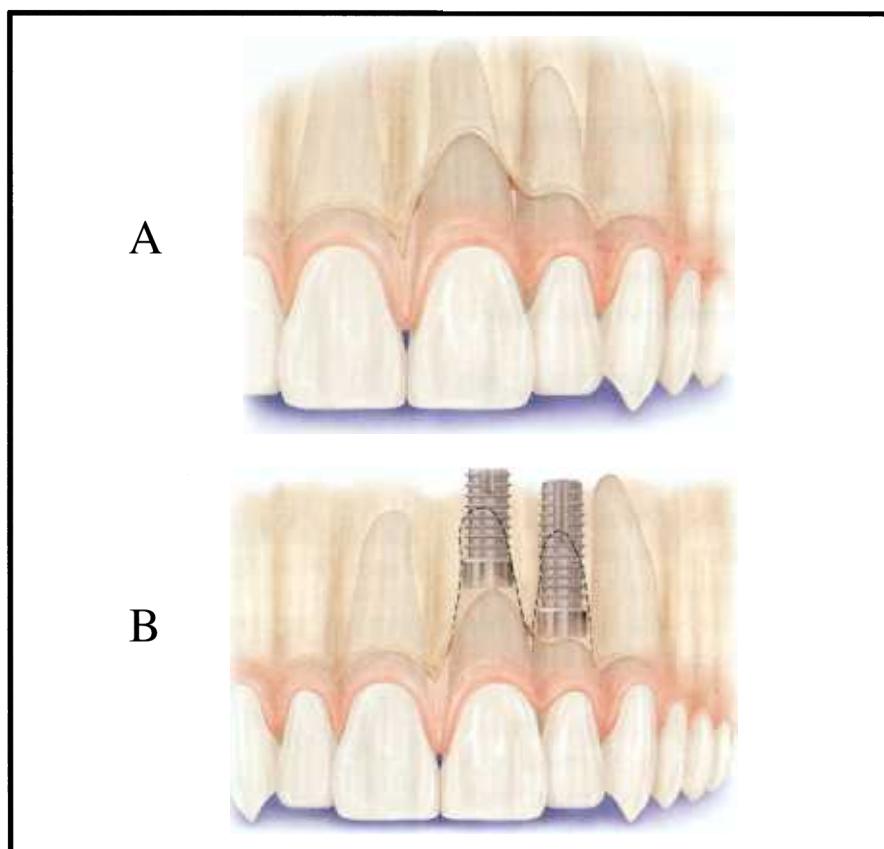


Figure 1A. Labial and vertical bone loss affects treatment planning options. **1B.** Placed without osseous defect augmentation, soft tissue health would be difficult to maintain.

ter of routine. However, in anterior implant-supported restorations, the successful achievement of the aesthetic goal can often be elusive. The task is made especially arduous when the potential implant recipient site lies within the lip perimeter and is compromised by significant hard and soft tissue defects and/or inhar-

nious occlusal combinations. Under such specific challenges, only a multidisciplinary treatment approach, which first identifies and then systematically develops the essential components of an inadequate "reconstructive zone" prior to, during, or following implant placement, can ensure optimized aesthetic results.

The osseous, gingival, and restorative triad and its relationship to the adjacent dentition constitute the foundation for the "aesthetic profile" in reconstructive dentistry.¹ The most successful and predictable treatments can be accomplished only when the optimal osseous dimensions are first reconstructed to support the regeneration of the optimal gingival contours, which, in turn, can sustain the development of an aesthetic restorative emergence profile. The critical interdependence of these components and the need for a systematic enhancement of any significant deficiencies within this triad constitute the principle of implant site development.²⁻⁵

The alliance between the surgical and restorative disciplines in optimizing potential implant sites continues to evolve with the development of more sophisti-

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cated surgical regenerative techniques and prosthetic components. However, as the complex and aesthetically demanding partially edentulous patient population is explored, a clear need to incorporate orthodontic therapy into a more comprehensive interdisciplinary treatment perspective is apparent. The purpose of this article is to outline the various therapeutic applications by which orthodontics may be synergistically combined with periodontal and restorative therapy to enhance the predictability of successful aesthetic results in implant dentistry. These applications include the following:

- Vertical augmentation of hard and soft tissues.
- Establishing more maintainable periodontal and aesthetic environments on adjacent teeth.
- Developing optimal interdental and interarch restorative space.

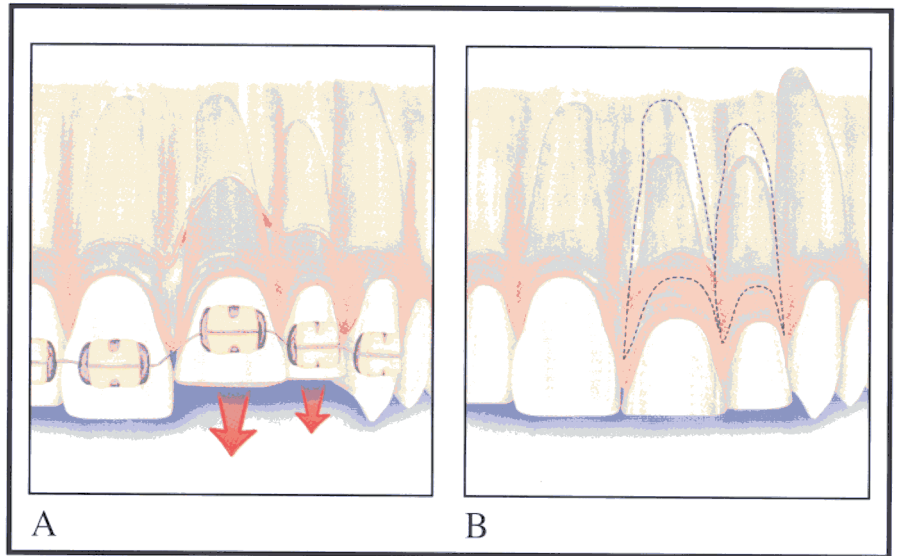


Figure 2A. Brackets are placed according to the underlying osseous crest. **2B.** Orthodontic extrusion coronally repositions the gingival margin as well as the underlying bone.



Figure 3. Case 1. Maxillary left incisor 6 months following endodontic therapy. Prognosis is poor to hopeless.

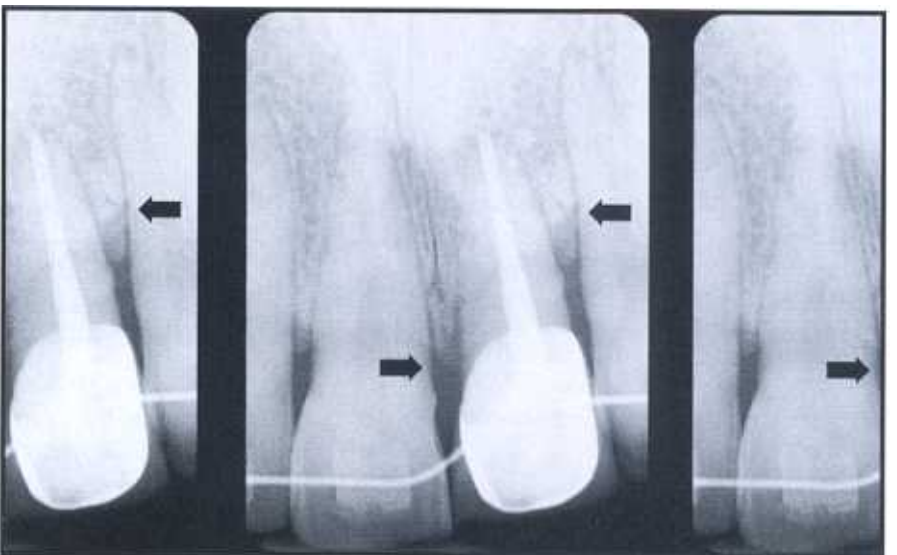


Figure 4. X-ray is taken at initiation of orthodontic eruption to vertically augment labial crest by relocating it coronally.



Figure 5. Facial view of bracket placement during the eruptive phase.

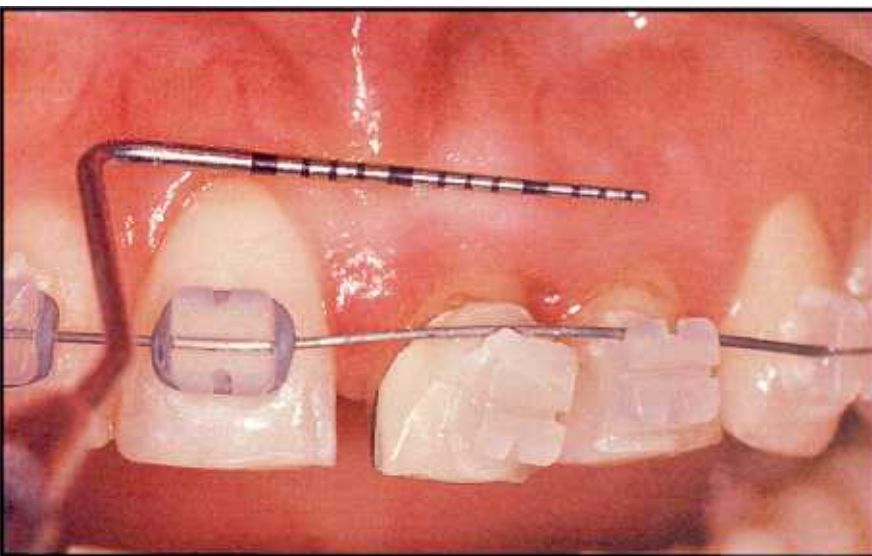


Figure 6. Facial view 6 weeks following commencement of orthodontic therapy. Tooth movement has been completed.

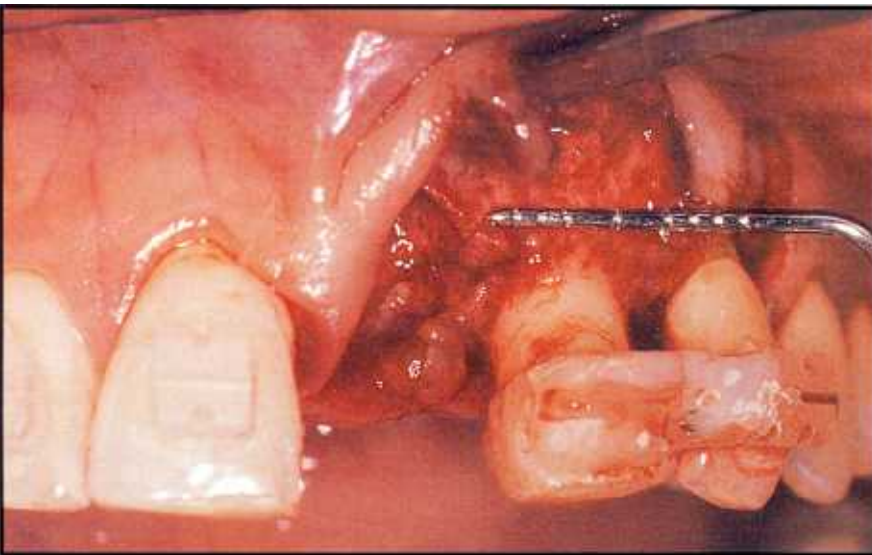


Figure 7. Following 7-week stabilization period, the flap is reflected for implant placement.

PERIODONTALLY ORIENTED ORTHODONTICS

The traditional use of orthodontics has been to modify the occlusal relationships and enhance aesthetic tooth arrangement. However, orthodontic therapy also has a well-established record of successful site development in periodontics^{6,7} and restorative⁸ therapy. The ability to predictably alter the adjacent periodontium by orthodontic tooth movement can dramatically improve the harmony and dimensions of the hard and soft tissue topography surrounding periodontally compromised teeth, provided that inflammatory control can be achieved.⁹ Utilized optimally, these attributes are capable of enhancing results in implant-related therapy.

Salama and Salama¹⁰ first described the application of orthodontic extrusion

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to implant dentistry. Prior to extraction, the authors orthodontically erupted selected hopeless teeth to augment the dimensions of future implant recipient sites. This controlled "orthodontic extraction" manipulates teeth, with as little as one-quarter to one-third of their apical attachment intact, by constructively increasing their local osseous dimensions in the vertical plane. Such vertical remodeling, especially of the strategic labial plate and crest, allows a more ideal placement of the implant (within 1 mm to 3 mm apically, depending on implant type) in relation to the cemento-enamel junction of the adjacent dentition. The more coronal the placement of the implant head, without compromising aesthetics, the more readily maintainable the peri-implant soft tissue environment is likely to be, due to the potential for decreased sulcular depth.

In addition to increasing the osseous dimensions of potential extraction sites

and enhancing implant placement, the orthodontic-surgical connection is extremely efficient in augmenting and developing soft tissue aesthetics.¹¹ This is most readily exhibited in one of the most difficult endeavors in anterior surgical intervention — the preservation or regeneration of critical papillae. In developing the site for papillae enhancement, orthodontic extrusion is effective in increasing the vertical height of the surrounding gingival tissues. The increased volume of soft tissue creates a strategic therapeutic reserve for safer anterior implant surgery, even in a thin and scalloped periodontium. The additional gingival dimension is also invaluable in performing delicate surgical procedures, directed specifically at regenerating lost papillae.

In a related application, the extrusion of periodontally compromised but

The alliance between the surgical and restorative disciplines in developing potential implant sites continues to evolve ...

maintainable teeth adjacent to implant sites can be utilized to enhance the contours of papillae bordering the future implant restoration. By erupting a tooth with a flat or even negative osseous profile, the interproximal bone is manipulated coronally, thereby creating an osseous peak, which will stimulate and support a corresponding peak of soft tissue or papilla. This positive osseous architecture creates a healthy gingival environment adjacent to the natural tooth. An increased predictability exists in the maintenance of soft tissue aesthetic results. They are intimately supported by underlying bone, 3 mm to 5 mm apical to the tissue margin, particularly where papillae are concerned (Figures 1 and 2).¹²

Integral to the success of this or any other treatment philosophy is the inherent need to develop a healthy and maintainable periodontium at the implant site as well as a healthy periodontal environment for the adjacent dentition.

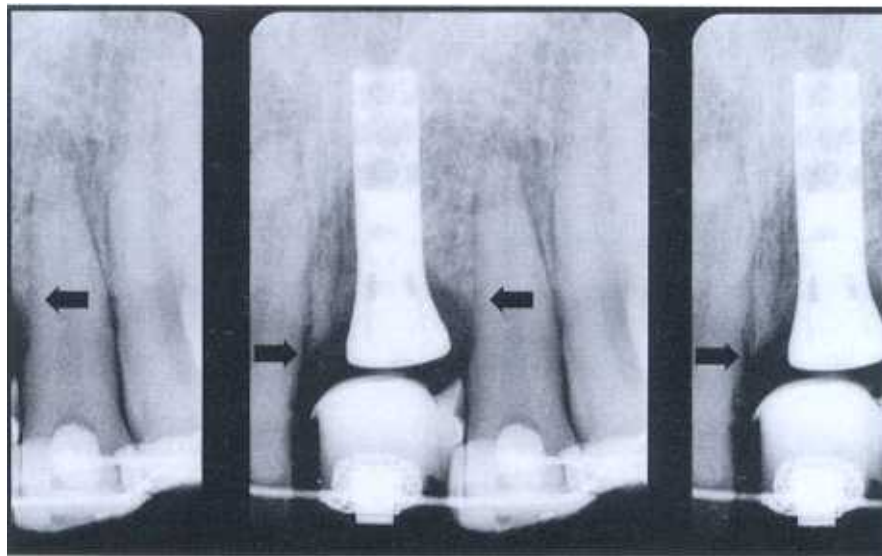


Figure 8. X-ray taken during the healing phase. Interproximal bone crest is now on the level of central incisors.



Figure 9. Six months following implant placement, a temporary cylinder is placed prior to fabrication of provisional restorations.



Figure 10. Aesthetic evaluation performed with provisional single crown restorations on maxillary left central and lateral incisors.



Figure 11. Central papilla was maintained. Note the healthy and harmonious gingival contour.

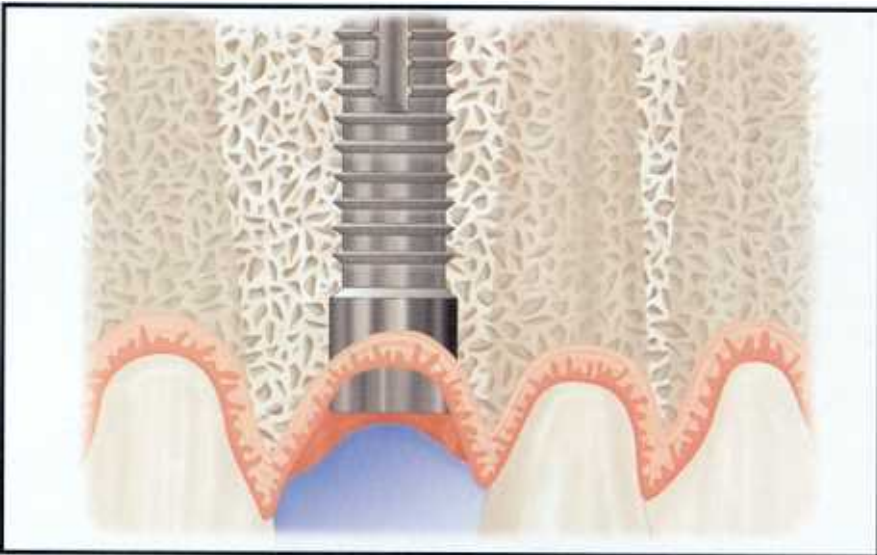


Figure 12. The most efficient and stable means of ensuring optimal papillae is by preserving or developing coronally positioned underlying interproximal peaks of bone to support them.

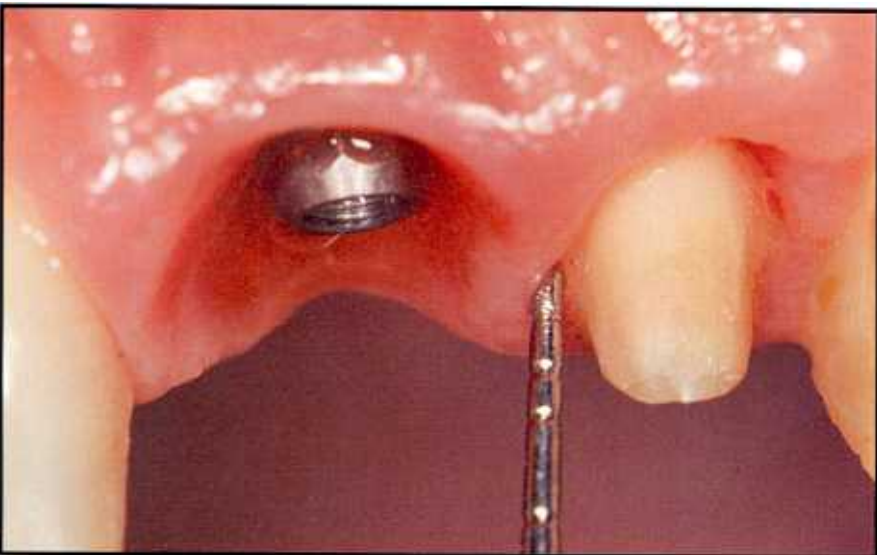


Figure 13. Probing depth of maxillary lateral incisor is now minimal.

The clinician must carefully balance the aesthetic benefit of heightened interproximal tissue against the competing and reasonable desire to maintain shallow sulci around an implant for maintenance.

RESTORATIVELY ORIENTED ORTHODONTICS

Surgically oriented orthodontics, as described above, focuses on developing the site through manipulation of the periodontium. Its sphere of influence lies within the hard and soft tissues. In contrast, restoratively oriented orthodontics emphasizes the optimization of the site through the manipulation of the supra-gingival restorative space. This type of therapy directly affects the shape, size, and form of the final abutment crowns

This article outlines therapeutic applications in which orthodontics may be combined with periodontal and restorative therapy ...

and pontics by modifying interdental and interarch space and by bringing harmony to the midline. In addition, orthodontic therapy has another important attribute. It can be a powerful tool in modifying occlusal relationships and the distribution and magnitude of the occlusal load, which is an important factor in planning the treatment for implant-supported restorations.

In the partially edentulous patient, adequate anchorage may not be available to perform the orthodontic therapy required. Under such circumstances, it may be possible to sequence implant placement in order to provide the benefits of osseointegrated anchorage.¹³ The treatment requires a complete diagnostic wax-up in order to envision the final tooth position. The placement of the first series of implants is always based on a stent, fabricated from the wax-up of the projected final tooth position in

that segment.¹⁴ It is generally more practical and efficacious to first place the implants to be initially utilized for anchorage in the posterior sextants. Once the implants are integrated and provisional restorations placed, more efficient orthodontic mechanics may be utilized to enable the clinician to optimize the anterior space arrangement for an improved aesthetic result. As orthodontics can enhance implant therapy, it, in turn, can enhance orthodontics.

CLINICAL PROCEDURE

Case 1

A 24-year-old female patient presented with a fractured maxillary left central incisor due to trauma and a subsequent unsuccessful endodontic treatment, based on a diagnosis of an endodontic-periodontal lesion. The interproximal papilla between the central and lateral

Orthodontic extraction manipulates teeth by constructively increasing their local osseous dimensions in the vertical plane.

incisors was compromised as well. Six months following the endodontic therapy, clinical examination still exhibited compromised but isolated periodontal sites, with 7 mm probing depth on the mesial aspect of central and lateral incisors, 9 mm on the distal aspect, and 10 mm on the labial aspect of the central incisor. The prognosis of the left central incisor was deemed to be poor to hopeless (Figure 3).

To facilitate a more optimal implant placement in relation to the adjacent teeth, an orthodontic eruption was effected with an objective to vertically augment the labial crest of bone by orthodontically relocating it coronally. An x-ray was taken at the initiation of orthodontic eruption (Figure 4). During the eruptive phase, the maxillary left central and lateral incisors were periodically occlusally adjusted and shortened to avoid interference with centric occlusion or eccentric movements of the mandible. Note that the bracket placement,

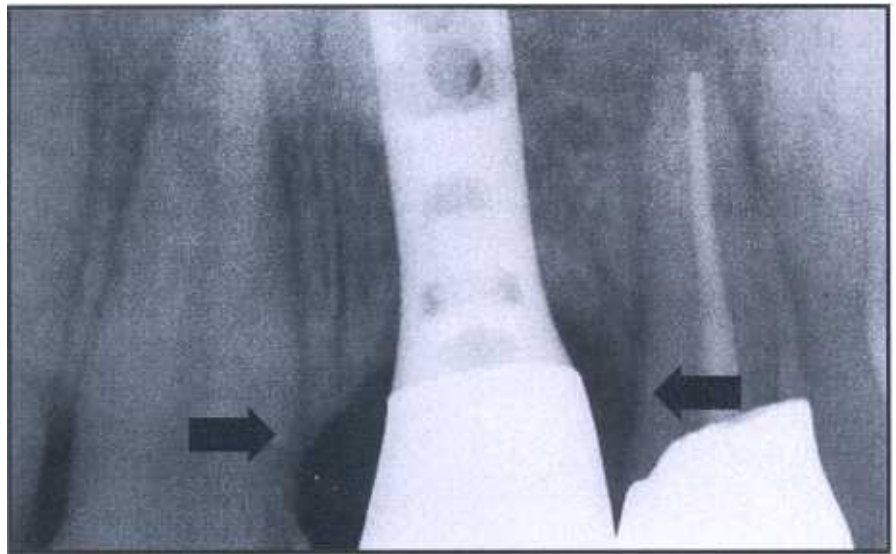


Figure 14. Final x-ray confirms orthodontic tissue adjustment and bone support.

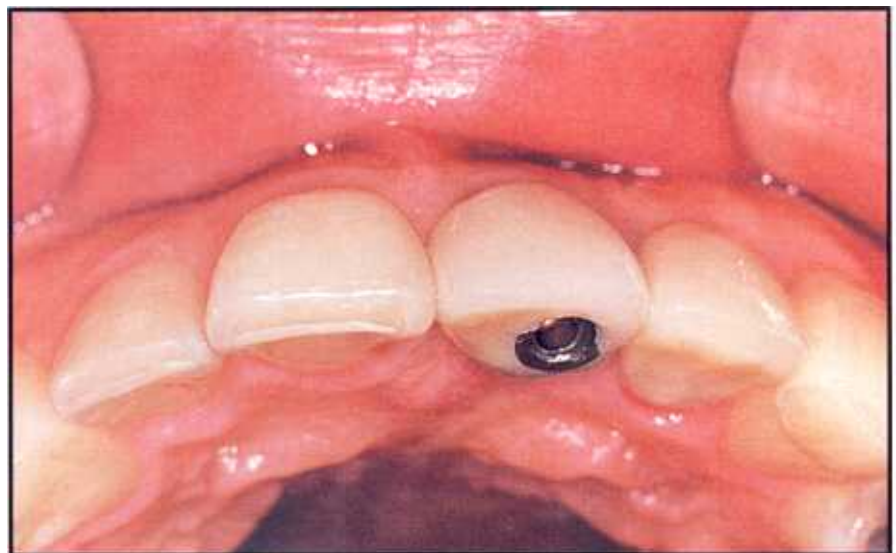


Figure 15. Incisal view of the maxillary arch. Natural flow is developed in the labial and palatal contours.



Figure 16. Left lateral view of the restoration at natural smile. Note aesthetics achieved.



Figure 17. Case 2. Preoperative facial view, with loss of numerous teeth.

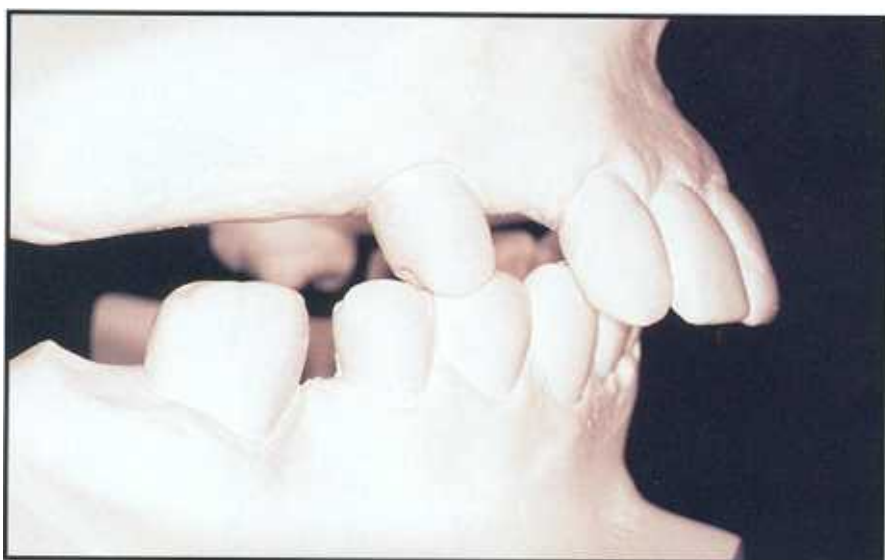


Figure 18. Diagnostic models display the degree by which the remaining maxillary incisal segment had flared.

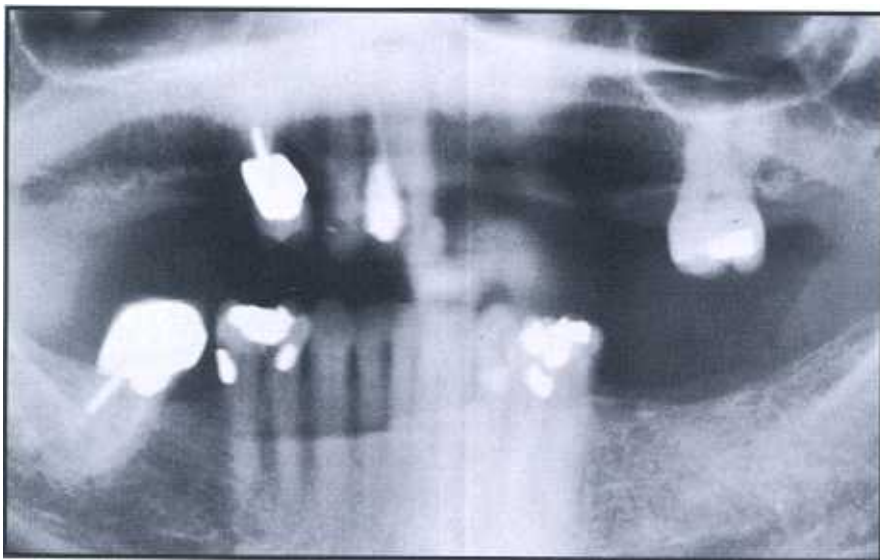


Figure 19. Preoperative panoramic radiograph.

unlike classic orthodontics, is aligned in relation to the bone level, not the incisal edges (Figure 5).

Six weeks following the commencement of orthodontic therapy, the gingival margins of central and lateral incisors were approximately 5 mm more coronal than the adjacent teeth (Figure 6). Tooth movement had ended. Following a 7-week stabilization period, the flap was reflected for implant placement (Figure 7). The mesial interproximal bone of the lateral incisor had moved coronally and was in harmony with the adjacent canine. The labial plate had also migrated coronally into position, which allowed a more optimal placement of the implant head.

An 11 mm hollow cylinder implant (Esthetic Plus, 15° ITI, Straumann, USA, Boston, MA) was placed, with the

Restoratively oriented orthodontics emphasizes optimization of the site through manipulation of supragingival restorative space.

head approximately 1 mm apical to the labial gingival margin of the adjacent central incisor. Such placement was made possible by coronal regeneration of the labial crest by the orthodontic eruptive process. An x-ray was taken during the healing phase (Figure 8), revealing that the interproximal bone crest of the lateral incisor had returned to near the same level as that of the right central incisor, which was never periodontally compromised.

At 6 months, prior to fabrication of a provisional restoration, a temporary cylinder was placed (Figure 9). Aesthetics was evaluated with provisional single crowns on central and lateral incisors at a broad smile (Figure 10), revealing a healthy and harmonious gingival contour (Figure 11). The central papilla was maintained, even in the thin-scalloped periodontium (Figure 12). An x-ray, taken during the provisional phase, reveals harmony of osseous support (particularly

from the interproximal bone) for a stable soft tissue topography with minimal probing depth (Figure 13).

At the try-in of the ceramometal undercastings, the subgingival contours displayed the emergence profile that was developed with the provisional restoration. The final x-ray (Figure 14) confirmed the stability of the implant and the development of a natural flow in the labial and palatal contours (Figure 15), resulting in an aesthetic smile (Figure 16).

Case 2

A 58-year-old female patient presented with a loss of numerous posterior teeth and ill-fitting removable restorations, which had resulted in loss of posterior support and an associated decrease in the vertical dimension of occlusion (Figures 17 through 19). Following the initial

Once the implants are integrated and provisional restorations placed, more efficient orthodontic mechanics may be utilized.

periodontal therapy, 2 screw-type implants (Implant Innovations, West Palm Beach, FL) were placed in each of the maxillary posterior sextants. Autogenous bone graft was harvested from the mandibular symphysis and utilized as part of a guided bone regeneration procedure to augment the maxillary left premaxilla. (At the initial presentation, this region was knife-edged and inadequate for receiving correctly oriented implants.) The remaining implants were placed months later (Figure 20), and orthodontic therapy was initiated. A fixed provisional restoration, bilaterally splinting the maxillary posterior implants, acts as anchorage for orthodontic therapy and protects the 3 implants in the augmented anterior region from transmucosal forces.

A vitallium bar, attached to the provisional restoration, was utilized to support pontics and create space for the natural teeth to be orthodontically repositioned (Figures 21 and 22).

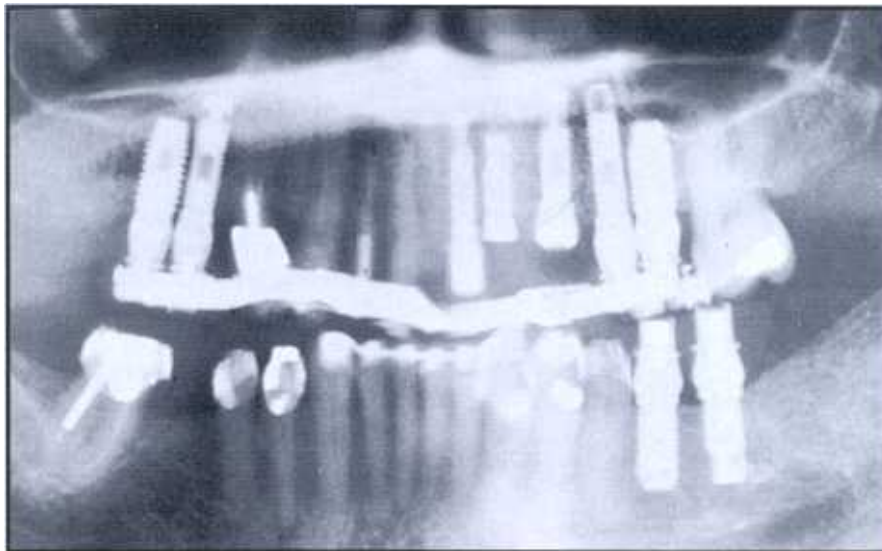


Figure 20. Radiograph following placement of all implants and initiation of orthodontic therapy.



Figure 21. Maxillary arch displays vitallium bar, used to support pontics and to bilaterally splint and create space for retraction.



Figure 22. Occlusal view following orthodontic retraction.



Figure 23. Following retraction, the anterior teeth are moved laterally to the right to harmonize the midlines.



Figure 24. Clinical facial view following exposure of the implants and initiation of the second provisionalization phase.



Figure 25. Occlusal view at 3-month evaluation during the provisional phase. Gingival-restorative interface is acceptable for the definitive restoration.

Orthodontic treatment was instituted immediately following placement of the provisional restoration, approximately 7 months after posterior implant placement. Following retraction, the anterior teeth were moved laterally to the right to harmonize the midlines and bring the maxillary right canine into a Class I position (Figure 23).

Following exposure of the implants in the maxillary left anterior region, a provisionalization phase was initiated to develop the health and contours of the gingival-restorative interface and test potential aesthetic arrangements, occlusion, and access to hygiene and maintenance (Figure 24). At the 3-month evaluation during the provisional phase, the gingival-restorative interface was deemed to be acceptable (Figure 25) for receiving the definitive restoration, the

The most important parameter is the creation of balance, harmony, and continuity of form.

design of which did not require splinting of the implants and natural teeth (Figures 26 through 28).

CONCLUSION

It is generally understood that among the parameters which define an aesthetic profile in reconstructive dentistry, the most important is the creation of balance, harmony, and continuity of form between the adjacent dentition, the gingival contour, and the lip line. Achieving such an objective in implant therapy requires that treatment planning places an emphasis on the phase of site development. To date, the surgical and restorative components of site development have received the focus of attention. This paper highlights the important role of orthodontics in developing the foundation for health, function, and aesthetic results in restorative implant therapy.

The orthodontic component of the site development includes the vertical



Figure 26. Facial view of the maxillary arch. The design of the definitive restoration does not require splinting of implants and natural teeth.



Figure 27. Postoperative clinical view of the definitive restoration in place. Note gingival health, harmony, and balance of form.

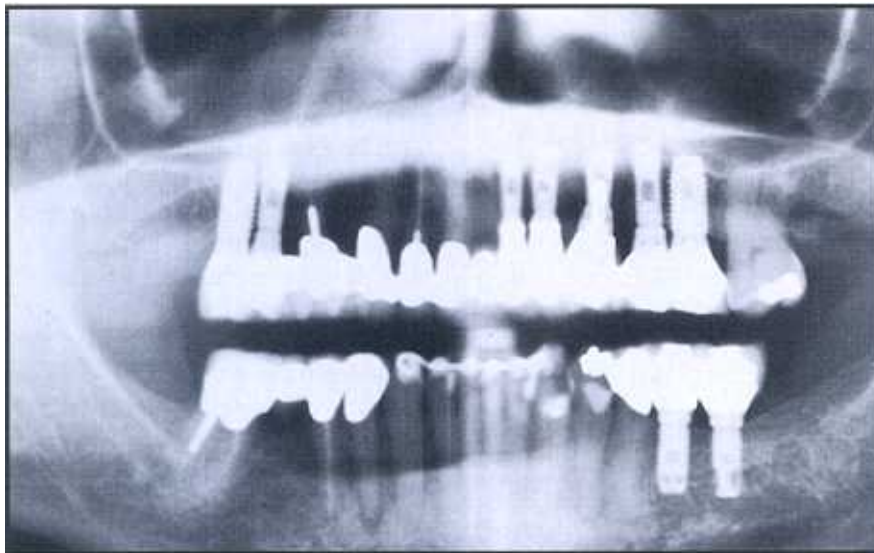


Figure 28. Postrestorative panoramic radiograph.

enhancement of the hard and soft tissue topography at potential implant recipient sites through orthodontic extrusion of selected hopeless teeth. Therefore, where feasible, orthodontic site development can be expected to achieve predictable osseous and gingival augmentation and accomplish it without surgery. In addition, space management for the final implant-supported restoration, including interdental and interarch space, may be optimized through orthodontic intervention. The adjunctive utilization of implants to anchor units for targeted orthodontic therapy has also been illustrated.

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