Abstract
Rehabilitation of esthetics in advanced periodontal cases presents a major challenge in dentistry today. Patients with advanced disease affecting teeth in the esthetic zone, where significant asymmetrical bone loss and tissue recession are present, constitute a challenging treatment-planning dilemma when choosing the optimum therapeutic option for long-term maintenance.

This article reviews a novel interdisciplinary approach for vertical augmentation of bone and soft tissues by means of orthodontic extrusion of severely periodontally compromised teeth, facilitating the restoration of esthetics with improved bone and soft tissue volume around immediate implants.

Key Words: implants, advanced periodontitis, peri-implant tissues, orthodontic extrusion, asymmetric bone loss, soft tissue loss
Introduction

Dental implants are firmly established as a mainstream protocol for the restoration of missing and failing teeth. An improved understanding of the biology of the peri-implant tissues and the limitations of implant treatment facilitates more predictable restoration of implants in the esthetic zone, particularly in relation to single tooth restorations. Nevertheless, more complex cases where significant bone defects and multiple missing or failing teeth are present still present challenging dilemmas in selecting the optimum restorative strategy. Predictable restoration of the bone and soft tissue architecture around multiple adjacent teeth restored with implant-supported restorations remains an elusive goal. There are three strategies that are broadly applied; these have been described\(^1\) as preservation, reconstruction, and prosthetic replacement.

Strategy 1 (S1): Preservation

This is when the esthetics of the pre-treatment gingival anatomy are acceptable (e.g., by immediate placement protocols).\(^2\)-\(^5\) This strategy usually relates to periodontally healthy patients with teeth failing for structural or endodontic reasons.

Strategy 2 (S2): Reconstruction

This refers to surgical reconstruction of the bone and soft tissues by means of bone and soft tissue augmentation and grafting either prior to or at the same time as implant placement.\(^6\)-\(^10\) While good results for multiple tooth defects can be achieved in some cases, consistent esthetic outcomes are difficult to achieve in all cases and often require multiple and significant surgical interventions.

Strategy 3 (S3): Prosthetic Replacement

This is with pink acrylic, composite or porcelain. Certainly, good esthetics can be achieved quite readily with these protocols, but in practice, long-term hygiene maintenance and phonetics are not always ideal; this is of particular importance in the periodontally susceptible patient.

Advanced periodontal disease affecting teeth in the esthetic zone rarely leaves the teeth with an ideal pre-treatment anatomy, as the anatomic form and esthetics of both the interdental papillae and the labial gingival tissues are compromised by bone loss and tissue recession. Additional factors such as drifting of the teeth, hypermobility, and clinical attachment loss make these cases particularly difficult to solve from the point of view of good esthetics, function, and hygiene maintenance. This is especially true where the bone and tissue loss is asymmetrical and the prognosis of the teeth is poor or hopeless. Certainly we know that effective periodontal therapy can successfully maintain even severely periodontally compromised teeth\(^11\)-\(^14\) but often this can be esthetically compromised, with long clinical crowns and “black triangles” making esthetic rehabilitation difficult. Patients with a strong susceptibility to periodontal disease may still be treated successfully with dental implants,\(^15\)-\(^18\) albeit with a potentially increased risk of biologic complications\(^19\)-\(^22\).

Strategy 4 (S4): Orthodontic Ridge Regeneration

In addition to the strategies above (S1-S3), a fourth strategy (S4) has been presented\(^1\) for the esthetic rehabilitation of periodontally affected patients who have suffered significant and asymmetrical bone and soft tissues loss around failing teeth in the esthetic zone. This novel interdisciplinary treatment approach utilizes gentle orthodontic extrusion of failing teeth to achieve vertical bone and soft tissue regeneration/augmentation and facilitates conversion of the case from S3 or S2 to an S1.

Forced eruption and orthodontic extrusion have been suggested as viable options for implant site development\(^23\),\(^24\) but may also play a valuable role in the vertical augmentation of bone and soft tissues in advanced periodontal cases with failing teeth in the esthetic zone.\(^1\),\(^24\)-\(^26\) Careful sequencing of the treatment is important and involves the following:

- control and stabilization
- orthodontic extrusion of failing/compromised teeth
- extraction and implant placement
- restoration with fixed crowns and bridges.

Phase 1: Control and Stabilization

Periodontal and anti-infective therapy, caries treatment, and structural control along with any necessary endodontic treatments are performed to eradicate disease and stabilize the teeth. The periodontal treatment would usually involve root surface debridement, oral hygiene instructions, anti-microbial therapy, and necessary extractions.

Phase 2: Orthodontic Extrusion of Failing/Compromised Teeth

This is gentle orthodontic extrusion of the periodontally compromised teeth in the esthetic zone, as well as bucco-lingual and mesio-distal alignment. This may also necessitate adjunctive endodontic treatments and implant placement in the posterior segments for anchorage. Vertical
bone and soft tissue volume gain is achieved through coronal repositioning of clinical attachment levels. Treatment typically takes some three to six months of active movement and a minimum of three months of fixed retention (with continued periodontal supportive therapy) to allow full mineralization of healthy, mature bone and maturation of soft tissue contours around the compromised teeth. These in turn provide appropriate extraction sites for the next phase.

**Phase 3: Extraction and Implant Placement**
This involves surgical and prosthetic protocols to preserve the bone volume and thicken the labial soft tissues in order to maintain stable soft tissue esthetics.

**Phase 4: Restoration with Fixed Crowns and Bridges**
This refers to restoration of the teeth and implants with single units or small bridges following current biologic principles with simple prosthetic designs optimized for easy home care and maintenance. Regular and ongoing supportive periodontal/peri-implant care and maintenance is essential.

The aim of this treatment (S4) is to enable restoration of failing teeth with implant-supported crowns and/or bridges with a more or less “normal” and harmonious gingival architecture. It involves a careful systematic interdisciplinary approach to treatment planning and case management. This concept would seem to be of particular benefit in cases of asymmetric bone and soft tissue loss in the esthetic zone (as illustrated by the two clinical cases to follow).

**Benefits**
The substantial benefits with the use of this approach are as follows:

- A less invasive surgical approach. The surgical experience for the patient is significantly reduced by the avoidance of large and complex grafting procedures and hence reduced morbidity (e.g., preservation rather than reconstruction or replacement).
- Ease of prosthetic design and fabrication. As the prosthetic restoration essentially restores only the clinical crown contours, then technical fabrication of the restorations is straightforward, with fewer technical complications.
- Biomechanical. Crown-to-implant ratios are optimized and large complex prosthetic reconstructions involving cantilevers are avoided.
- Facilitated oral hygiene and maintenance. Achieving the final prosthesis design (i.e., single crowns or short-span bridgework with ovate pontics) and the symmetrical soft tissue contours certainly facilitates simple maintenance and hygiene procedures for the patient, with obvious long-term benefits in terms of maintaining healthy peri-implant tissues.
- Phonetics. The reconstitution of a more or less normal or “ideal” relationship of the teeth and soft tissues avoids phonetic complications found in large-span implant-supported bridgework in patients with advanced bone loss.
- Biological. It could be argued that a more biologically ideal restoration of bone and soft tissues contours is achieved in contrast to more complex grafting procedures (i.e., regeneration of the patient’s own bone and tissue volume with minimal surgical intervention and bone grafting).
- Stability. This approach negates the risk of resorption and gradual loss of graft volume seen with most surgical grafting techniques used to rebuild large volumes over multiple tooth spans. Both the clinical cases discussed below show excellent maintenance of soft tissue and bone volume over time despite being complex and difficult at presentation.

However, the concept is not without its limitations, the most obvious of which is the need to still have teeth present with some clinical attachment in the affected areas (i.e., the esthetic zone). In addition, the interdisciplinary treatment required necessitates well-coordinated, systematic management of the case with excellent communication within the team.

The advantages/limitations of this concept are summarized in Table 1.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Limitations</th>
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<tr>
<td>Abundant vertical and horizontal augmentation/regeneration of bone and gingival tissues is possible.</td>
<td>The failing teeth must have some clinical attachment still present and must be maintainable for the duration of the orthodontic treatment and retention/stabilization.</td>
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<td>Minimizes the surgical intervention for the patient and reduces morbidity of the procedures.</td>
<td>Any periodontal disease or endodontic involvement needs to be controlled prior to orthodontic extrusion.</td>
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<td>Facilitates ideal implant positioning and biomechanics (crown-to-implant ratio).</td>
<td>The interdental papillae will not be “perfect” (i.e., fully regenerated to pre-disease levels); however, the soft tissue result is as good as/or better than that achieved with any surgical reconstruction.</td>
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<td>Simplifies the design and fabrication of the prosthetics.</td>
<td>The patient must still have teeth in the affected areas.</td>
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<td>Creates a near-optimum, stable, esthetic soft tissue outcome.</td>
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<tr>
<td>Facilitates oral hygiene and maintenance procedures for the patient as normal tooth contours and simple ovate pontics are utilized.</td>
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<tr>
<td>Provides predictable, stable regenerated bone and tissue volume.</td>
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<td>There is little or no resorption of grafts as the regenerated volume is essentially normal (not grafted) host tissue.</td>
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<td>There is little or no difference in overall treatment time.</td>
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Clinical Cases
The treatment concept is illustrated by two clinical cases.

Case 1
The first case involved a 35-year-old female with generalized aggressive periodontitis (Figs 1-3). She had been a smoker but had quit some 18 months before presentation, and had no other relevant medical history. Achieving restoration of the patient’s oral health, function, and esthetics is obviously a complex challenge. From an esthetic standpoint, the asymmetrical pattern of bone and soft tissue loss in the anterior maxilla creates a dilemma in terms of treatment options that requires careful consideration, as follows:

• Is there a way to treat and maintain the severely compromised anterior teeth and achieve an esthetic outcome? Can gingival harmony be achieved predictably in this way? Can further gingival recession be prevented if we are to successfully eradicate the pocketing and disease in the area? The answer is clearly “no,” unless the maxillary left incisors and canines are crown-lengthened and we accept long teeth across the entire anterior maxilla with permanently splinted crowns to stabilize the hyper-mobile teeth.

• Should a complete clearance be performed, followed by osseous resection and a complete implant restoration in order to reduce the maxillary ridge so that the gingival tissues can be recreated prosthetically? While a possible option, it also is a drastic one in light of the patient’s age; we cannot underestimate the psychological impact of losing all of one’s teeth at the age of 35. Second, complete implant-supported restorations where there is significant vertical tissue loss or reduction do present long-term challenges in terms of maintenance and oral hygiene procedures. Third, there are definitely teeth in the patient’s mouth that could be saved and maintained for the long term with the correct treatment and maintenance, so should these be extracted?

• Can we remove the maxillary incisors and predictably recreate the ridge to create ideal esthetics, restoring the teeth with bridgework on teeth or implants? What is the long-term stability of vertical augmentation in terms of durable soft tissue esthetics, particularly in a relatively young patient?

After initial periodontal and anti-infective therapy and removal of most of the hopeless posterior

Figure 1: Case 1 smile at presentation. Note postured upper lip to try to hide the unattractive teeth and “black triangles.”

Figure 2: Frontal view at presentation with lateral periodontal abscess on #11, gingival inflammation, and recession with triangular tooth form and asymmetric gingival contour.

Figure 3: Orthopantogram (OPG) at presentation showing widespread bone loss. There were deep probing depths of 9 mm or more on many teeth.
teeth, orthodontic treatment was commenced using lingual appliances to align the mandibular anterior teeth and extrude and align the maxillary anterior teeth with careful control of the vector of extrusion (Figs 4 & 5). Extremely gentle forces were utilized along with supportive periodontal therapy throughout the treatment time. Implants were placed in the posterior healed sites with an osteotome technique to lift the maxillary sinus floor.

After six months of orthodontic treatment, extrusion was still needed on teeth #12-21 but maintaining esthetics was becoming difficult as treatment progressed. The teeth were further extruded using magnets in the roots of the incisors and in the provisional bridge (Figs 5-8). Cementing magnets (American Dental Systems; Vaterstette, Germany) into the base of the pontics and into the roots leaving space between allows for gentle extrusion to occur. As the teeth are extruding, further clearance is obtained by reducing the magnets and roots with diamond burs until the desired extrusion is achieved. A retention period of three months was allowed for full mineralization of the bone around the extruded teeth and maturation of the bone and soft tissues before removal of the incisors and placement of the immediate implants into the sockets. The sockets were naturally very shallow and the implants (NobelReplace Groovy, Nobel Biocare; Yorba Linda, CA) were placed toward the palatal aspect of extraction sockets. Labial voids were filled with anorganic bone mineral (Bio-Oss, Geistlich AG; Wolhusen, Switzerland), with connective tissue grafts sandwiched between the buccal gingivae and the healing abutments (Fig 9). After the provisionalization phase (Fig 10), the final crowns and bridges were fabricated (Figs 11 & 12). The final results at five-year follow-up show the excellent maintenance of a good functional, biologic, and esthetic outcome with stability of the vertical regenerated bone and soft tissues contours (Figs 13-16).
Figure 9: Implants placed into extraction sites 3 mm apical and 2 to 3 mm palatal to final labial gingival margins with grafting of anorganic bovine bone mineral into labial voids, and small connective tissue grafts sutured between labial gingivae and healing abutments.

Figure 10: Provisional bridge after three months with additional implant placed at #22.

Figure 11: Retraction cord placed at cementation of crowns to prevent cement violating peri-implant tissues.

Figure 12: Final result at two-year follow-up showing excellent esthetics and symmetrical gingival contours.
Figure 13: Two-year follow-up shows excellent maintenance and stability of the soft tissue contours.

Figure 14: OPG at five-year follow-up.

Figure 15: Five-year close-up of maxillary anterior teeth showing the quality of the soft tissue outcome and excellent esthetics around implant restorations.

Figure 16: Periapical image at five years shows stable or improved bone levels and density around implants.
Case 2
The second patient, a 53-year-old female, was referred to the practice in May 2006 suffering from generalized chronic advanced periodontitis with generalized bone loss, deep pocketing, gingival recession, and tooth mobility along with significant drifting and splaying of the teeth (Figs 17-20). She had a history of smoking 25 cigarettes a day for 25 years but had quit in 2001 with no other relevant medical history. Many teeth were also structurally and endodontically compromised and again there was an uneven pattern of bone loss with many of the teeth clearly hopeless with the exception of the lower anterior teeth and maxillary right second premolar. In the anterior maxilla, there was significant bone loss with a “bell-shaped” pattern.

The considerations for treatment options here are somewhat more straightforward than in the previous case. Certainly a clearance followed by a complete implant restoration with the gingival tissues recreated prosthetically would be a feasible option and many might consider this the option of choice. However, the S4 approach in cases of this kind may also have considerable merit. It would aim to create the basis for an S1-type restoration wherein the clinical crown is restored with more or less normal tissue and alveolar ridge height. This facilitates many of advantage outlined in Table 1.

Figure 17: Case 2 smile at presentation.
Figure 18: Frontal view of pre-treatment situation. Note the poor periodontal condition, splaying and drifting teeth.
Figure 19: Preoperative OPG shows generalized severe bone loss.
Figure 20: Pre-treatment periapical image of maxillary incisors.
Treatment was staged in a similar way to that discussed above, including periodontal therapy, and the maxillary teeth were extruded to bring the bone and soft tissues to a more favourable coronal position using very light forces and gentle extrusion over six months, with a further three months' retention to allow full mineralization of the bone (Figs 21-24). Implants were placed in the posterior mandible and periodontal supportive therapy was continued throughout the treatment. Immediate implants were placed as described above and an immediate provisional bridge was fabricated for the maxilla (Figs 25 & 26). The final restorations were then fabricated (Fig 27). Given the starting point, an exceptional result was achieved and the four-year follow-up images (Figs 28-30) demonstrate the excellent maintenance of health, function, and esthetics with stability of the soft tissue esthetics and gingival contours.

This novel interdisciplinary treatment approach utilizes gentle orthodontic extrusion of failing teeth to achieve vertical bone and soft tissue regeneration/augmentation and facilitates conversion of the case from S3 or S2 to an S1.
Figure 25: Postoperative view of maxilla with provisional bridge fitted over implant heating abutments retained on the upper right premolar and implant in #24 position. CT grafts and frenectomy were also performed.

Figure 26: Postoperative OPG of provisional bridge and implants.

Figure 27: Frontal view of completed case. Note harmonious gingival contours and normal tooth dimensions with vertical gain of tissue height in the maxilla.

Figure 28: Four-year follow-up showing excellent maintenance of soft tissue levels and esthetics.

Figure 29: OPG at four-year follow-up shows maintenance of bone levels around implants.
Summary
In patients affected by advanced periodontal bone and tissue loss, an interdisciplinary approach, which involves periodontal therapy, followed by orthodontic extrusion of compromised or failing teeth prior to extraction and replacement with implants, may offer an excellent method for esthetic rehabilitation particularly in the vertical augmentation and regeneration of bone and soft tissues. This may improve the functional, biologic, and esthetic outcomes of implant-supported restorations in these cases. Meticulous surgical and prosthetic management and excellent hygiene and maintenance are essential.

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