A Multi-Disciplinary Approach to Managing the Unilateral Intra-bony Lesion in the Anterior Esthetic Zone

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One of the greatest challenges in cosmetic dentistry is the anterior esthetic zone, especially when the patient has a high smile line.[1, 2] No matter how carefully crafted and perfect the veneers or crowns, success inevitably hinges upon the long term stability and esthetics of the supportive tissues surrounding them. When there is a unilateral, severe, localized loss of soft and hard tissues in the upper anterior region, a multidisciplinary approach is required to resolve this esthetic dilemma.[3, 4, 5] Although there are many successful regenerative grafting procedures available, there is none that can restore the scalloping architecture of the hard and soft tissue better than what nature can provide. By utilizing the physiology and biology of orthodontic movements, the hopeless teeth with their periodontium and alveolar processes can be extruded to stimulate the growth of the lost tissues.[6, 7, 8, 9] Subsequently, implants can then be placed at the extraction sites, not only to replace the hopeless teeth but also to preserve the hard and soft tissues that have been generated. Afterward, a full mouth esthetic rehabilitation can be successfully completed to the patient's satisfaction.[10, 11]

Case Report

A 45 year old male, who had been avoiding recommended periodontal therapy for several years, presented with a sub-acute periodontal abscess on teeth #9 and #10. Substantial alveolar bone and periodontal attachment loss with associated pocket depths of 7mm contributed to a hopeless prognosis for these teeth (Fig.1 and 2). While his medical history was unremarkable, his chronic smoking habit of about a pack a day presented further complications to an already compromised situation.[12, 13] Furthermore, the patient's strong desire for avoiding either a removable denture or a fixed bridge posed the following questions:

1.) How can we prevent the collapse of hard and soft tissues after the extractions?
2.) How can we regenerate/replace the missing alveolar bone which is the scaffolding for the soft tissue drape?
3.) How can we preserve and enhance soft tissue esthetics and symmetry in the anterior region?
4.) How can we fabricate final restorations that will mimic the esthetics of the neighboring teeth across the midline, in spite of the unilateral nature of the defect?
5.) How can we ensure long term stability for all the tissues and restorations?

In addition, the patient expressed a great desire for "a bigger and whiter smile with no black holes in between my teeth, so that I don't have to clean out food after each meal. "

The following examinations/evaluations were performed:

- Posture and airway assessment.
- Facial symmetry and smile assessment using Divine Proportions.
- Evaluation of TMJ function and range of motion via Joint Vibration Sound Analysis and Jaw Tracker (JVA/JT – BioResearch Inc.).
- Dental/periodontal evaluation – bone sounding, charting and biotype.
- Evaluation of anterior and posterior planes of occlusion.
- Analysis of centric occlusion, centric relations and all excursive movements via Tekscan.
- Radiographic evaluations via panoramic, cephalometric and full mouth series.
- Cranial-mandibular muscle palpation and assessment.
- Anterior esthetic evaluation - hard and soft tissues.
- Phonetics – evaluation of freeway space/minimum speaking space.
- Diagnostic casts with face bow mounting and wax up.
- Diagnostic extra and intra oral photography.

Diagnosis:

1. Generalized chronic adult moderate periodontitis with localized intrabony defects.
2. Generalized gingival recession with open embrasure spaces.
3. Narrow dental arches.
4. Occlusal interferences in excursive movements.
5. Prolonged occlusal time and disclusion time.
6. Thick gingival biotype.
7. Parafunctional activity of clenching and grinding.

Treatment Plan:

1. Initial periodontal therapy and occlusal adjustment to control inflammation and eliminate predisposing factors.
2. Improved oral hygiene regimen and smoking cessation.
3. Progressive orthodontic extrusion of #9 and #10 to regenerate hard/soft tissues along with simultaneous modifications of the provisional restorations at their cervical/proximal contours and contact points in order to recreate natural-looking gingiva and interproximal papillae.
4. Modification of the facial contour of

Fig.1. Pre-op anterior and left lateral views. Note the severe loss of attachments and missing papillae, resulting in unsightly black triangles between #8/9 and #10/11.

Fig.2. Pre-op periapical radiographs of #9 and #10. There is significant loss of alveolar bone between the central and lateral incisors.

Fig.3. Orthodontic extrusion of tooth #9 and #10. Note the incredible flexibility of Bioefficient arch wire.

Fig.4. Implant placement and bone grafting (Puros Allograft with Cal Matrix binder) right after extraction. Neither flap nor sutures were placed.

the restorations to provide support for the lips and reduce the buccal corridor space.

5. Develop and fine tune the occlusal scheme prior to transitioning to final restorations.
6. Plan for long term periodontal and occlusal maintenance.

The greatest challenge in this case was the successful regeneration of the hard and soft tissues lost in the anterior esthetic zone unilateral to the dental midline. Once the periodontal status was stabilized and the patient's oral hygiene improved, a definitive treatment plan was formulated and modified with patient's consent.

Orthodontic Movements

Progressive orthodontic extrusion was used to reconstitute (remodel and regenerate) the lost alveolar bone and soft tissue prior to the implant placement therapy. [7, 8, 14] After the initial periodontal therapy, there were no presence of active inflammation or disease process, which made the conditions favorable for extrusion orthodontic therapy. The extrusion process was carefully controlled with pre-determined forces, using light wires and continuous light forces, so that the teeth and the surrounding periodontium moved as one unit.[15] Excessive force or rapid extrusion was to be avoided as it can cause the tooth to move out of its socket. By avoiding extensive hard and soft tissue grafting, we minimized the trauma, time, and expense to the patient. Furthermore, the resultant soft tissue was more natural and superior in color and texture than grafting. If necessary, minor grafting would be done at the time of the implant placement. During the extrusion process, the level of mucogingival junction remained the same but the amount of attached gingiva was increased coronally for symmetrical soft tissue scalloping and papilla formation.

Orthodontic brackets were placed from second bicuspid to second bicuspid on the upper arch to allow enough anchorage to move #9 and #10 incisally. Brackets were placed slightly more apically on #9 and #10 than the rest. Due to the curvature at the cervical one third on the clinical crowns, the torque value within the bracket slots were expressed more negatively. An initial wire, .016 round Nickel Titanium, was used for approximately one week and then was replaced with .020 x .020 rectangular NiTi (Bioefficient) orthodontic arch wire (Fig.3). Bioefficient is a heat sensitive, multi-modular broad arch wire. The heat sensitive feature allows the wire to be very flexible when chilled and capable of engaging varying bracket heights easily. It also offers a long range of movements without the need for accessory springs, elastics, or bending of the wires. In addition, it controls the tip and torque of the roots early on in the extrusion process so that the osseous tissue is directed in the right direction. The negative torque, as is prescribed into the bracket, directs the roots buccally which in turn engage and move with the alveolar ridge as one unit. The rigidity of the wire returns once the ambient temperature is reached. The multi-modular feature of the wire takes into consideration the various root surfaces and configurations along the arch, exerting 100-150 grams of force along the anterior portion of the wire, 150-200grams of force along the bicuspids, and 300-350 grams along the molar regions.

The extrusion rate was about 1-1.5mm per month. It took approximately 4 months to achieve a reasonable implant site development. Accelerated repair remodeling was induced at 2-week intervals by root planning the base of the defect next to the marginal bone. This intentional trauma induced Regional Acceleratory Phenomenon.[16, 17] (According to H.M. Forst, the repair rate can increase 400-600% for up to six months by traumatizing the site.) After about 4-5 mm of extrusion, the crest of buccal bone was at a position where it was possible for the implant shoulder level to be 2mm apical to the CEJ of the neighboring teeth. This allowed for an even gingival contour across both natural teeth and implant supported restorations.

Once the crest of alveolar bone on #9 and #10 were close to the CEJ of the neighboring teeth, active orthodontic movement was discontinued. Retention and stabilization was achieved with resin bonded, fixed orthodontic wire (Sandblasted round .018 round wire), allowing hard and soft tissue maturation and re-organization. Radiographic assessment, periodontal probing, and bone sounding helped to estimate how much, if any, grafting will be needed at the time of implant placement.

Contact point to interproximal bone height measurements		
Adjoining Elements	Vertical soft tissue Limits	Horizontal Proximity
Cl 1 : Tooth/Tooth	≤5mm	I mm min.
Cl 2 : Tooth/Pontic	6.75mm	N/A
Cl 3 : Pontic/Pontic	6.5mm	N/A
Cl 4 : Tooth/Implant	<4.5mm	1.5-2mm
Cl 5 : Implant/Pontic	5.75mm	N/A
Cl 6 : Implant/Implant	<3.5mm	3mm

Table 1. Contact point to interproximal bone height measurements.

Fig.5. Review of the Biologic Width.

Fig.6. Full maxillary arch preparation for final restorations. Open tray impression copings for implants #9 and #10.

Fig.7. UCLA custom gold abutments with gutta percha seal. Note the health and texture (stippling effect) of the surrounding tissue and increase in alveolar bone level as seen on the periapical radiograph.

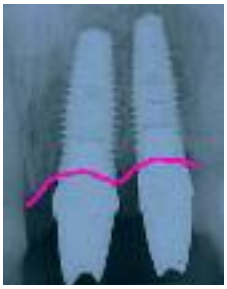

Fig.8. Periapical radiographs of final PFM restorations.

Implant Placement and Progressive Loading

Initially, patient's heavy smoking habit was of concern, especially considering the decrease in implant success rate for smokers. This concern was carefully explained to the patient prior to initial therapy. The patient, who was already motivated to become healthier, actually quit smoking. Furthermore, his thick gingival biotype also made the conditions more favorable for implant placement.

Immediately after the atraumatic extraction of teeth #9 and #10, Nobel Biocare (Steri-oss) Replace Select taper root form implants (5 x 13mm and 4.5 x 13mm, respectively) were placed. Small amount of particular allograft (Puros by Zimmer Dental) was mixed with Calcium Sulphate (Cal-Matrix binder) and was used to fill in the small defects around the implants (Fig. 4). No flap was raised and no sutures placed. The transmucosal healing abutments were placed with calcium sulphate to cover any exposed allograft. The implant positions, with respect to the neighboring tooth or implant, were determined in accordance to the guideline set by various researchers such as Tarnow, Salama, Garber, Kois and Esposito (Table 1).[7, 18, 19, 20]

The extracted teeth were decoronated/de-rooted and sealed at the apex with composite to be used as interim pontics in a resin bonded retainer. A rigid orthodontic wire with composite was used to bond these pontics to the lingual surfaces of the adjacent teeth, assiduously avoiding any direct pressure on the healing abutments.

After four months of healing and osteointegration, two temporary screw-on UCLA abutments with acrylic crown forms were placed for the progressive loading phase for 6 weeks. Radiographs were taken to confirm the seating of these temporary abutments. The subgingival contour of the screw-on crowns were refined and polished extra-orally. Progressive contour modification by addition and subtraction at the embrasure space allowed the re-establishment of papilla up to the contact point. The papillary formation was determined by the biological width (connective tissue attachment + epithelial attachment + gingival sulcus), the interproximal bone height, the embrasure space, and neighboring elements (tooth or implant) (Fig.5). [21, 22, 23] Gingival level and contour for #9 and 10 were finalized via provisional restorations prior to taking final impressions.

Fixed Restorations

After the loading phase, a full arch combination of veneer and crown preparations was completed (Fig.6). Feldspathic porcelain veneers were fabricated for all the anterior teeth and bicuspids while molars were restored with PFM crowns. Implants on #9 and #10 received UCLA custom gold abutments (Fig.7) and cementable PFM crowns were placed as final restorations (Fig.8). It is important to note that the gold color from the custom abutment imparted a warm, yellow halo to the overlying gingival tissue without the graying effect of the stock abutments.

Good communication with your laboratory is critical, especially for such a complex esthetic case. My technician was able to perfect the emergence profile on #9 and #10 and prepare the finishing margins on the crowns to about 1-2mm below the level of the gingiva. At final insertion, the UCLA abutments were torqued to 35Ncm and the implant crowns were cemented with Improv (temporary implant cement by Nobel Biocare). [2] All ceramic restorations were inserted with Insure resin cement by Cosmedent (Fig.9). The use of retraction cords made clean up easier and prevented subgingival iatrogenic cement irritation which is one of the main causes of bone loss around the implants. Occlusion was adjusted and balanced via use of Tekscan.

Fig.9. Full maxillary arch restorations.

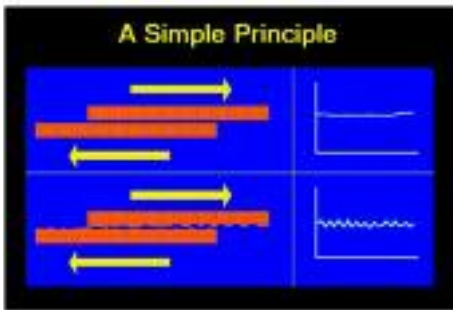

Fig.10. A simple principle regarding joint vibrations.

Fig.11. Joint Vibration Sound Analysis (Photo courtesy of BioResearch Associates Inc.).

Fig.12. Jaw tracker (Photo courtesy of BioResearch Associates Inc.).

Fig.13. Tekscan sensor with handle and its usage in the operatory (Photo courtesy of BioResearch Associates Inc.).

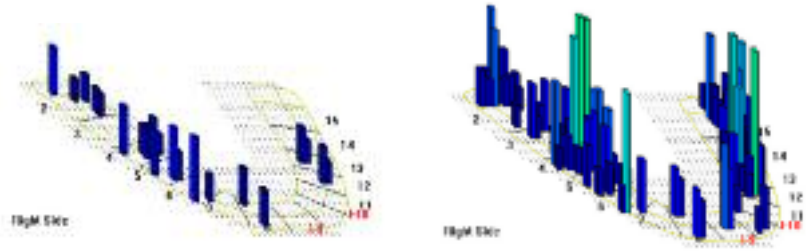

Fig.14. Computer graphics showing early initial contact (fig.14a) and delayed implant loading on #9 and #10 towards maximum intercuspation (fig.14b).

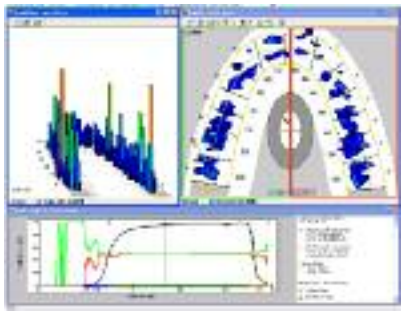

Fig.15. Tekscan software graphics (Photo courtesy of BioResearch Associates Inc.).

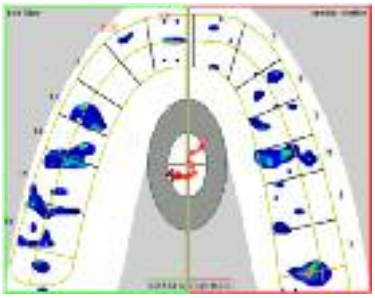

Fig.16. Tekscan of maximum intercuspation after adjustment. Note minimal contacts on #9 and 10.

Joint Vibration Sound Analysis/ Jaw Tracker (JVA/JT)

Without knowing the condition of temporomandibular joints, everything we do for occlusion become guess-work. Without a stable end-point stop (centric relation), any occlusal design created can become unstable. Joint Vibration Sound Analysis (JVA) is based on the principle that friction produces vibrations (Fig.10). Within the joint, different surface interactions produce unique signature vibration patterns that can be used to identify various joint pathologies - i.e. disk mobility, disk displacement with or without reduction. Arthritis, perforation of the disk, or degenerative diseases can also be diagnosed non-invasively. [35] The surface accelerometers detect the vibrations, which are then sent to the computer where the data is measured and recorded by the software (Fig.11). The analyzed data are interpreted by the clinicians. The accuracy and specificity is within 75- 90% range.[33] The reliability and accuracy is far superior to auscultation or palpation.[34] The procedure can be done in the office by auxiliary staff in about 3 to10 minutes.

Jaw Tracker (JT) is used to track the mandibular movement in 3-D by attaching a magnet to the lower incisors (Fig.12). The range of motion, velocity of the mandibular motion, vertical dimension, deviation or deflection can be measured and recorded easily. These parameters are then used to assess and diagnose the TMJ conditions before, during and after the treatment. [36, 37]

Tekscan

Tekscan is a computer-assisted dental occlusion analyzer. Traditional articulating paper, foil, wax, or shim stocks only show the end results of occlusal contact but are clearly incapable of recording whether which contacts hit first or the relative strengths of these contacts. Research has demonstrated repeatedly that the size and intensity of the markings are not directly related to the force. [24] The longevity of restorations and alveolar bone maintenance are directly related to the dynamic occlusal function. A properly balanced and harmonious occlusal scheme, not the strengths of the restorative materials or luting cements, is the key to long term stability of the restoration. [31, 32]

T-scan III, manufactured by Tekscan, has a revolutionary handle that is fitted with a thin, bilayer, full arch sensor and is used to register functional occlusion (Fig.13). It measures occlusal contact time sequences and the relative forces of all the contacts to be recorded and analyzed with the use of computer software. The full sequence of events can be saved and played back in 2-D or 3-D graphics (Fig.14). It also measures the time it takes from initial occlusal contact to maximum intercuspation. The average **occlusal time**, the shortest possible time for all the teeth to mesh together, for a balanced occlusion is 0.2 seconds. In this ideal setting, all closing and balancing muscles need less effort and adjustment to get to maximum intercuspation. The time it takes for all posterior teeth to be discluded once excursive movement is initiated is the **disclusion time**. The ideal disclusion time is 0.4 seconds. It is synonymous to canine protected occlusion with a time factor.

Occlusal forces affect natural teeth and implants to a different degree. [25,26,27,28] Natural teeth go through primary intra-socket and secondary intra-alveolar movements while implants only go through secondary intra-alveolar movements. During maximum intercuspation, natural teeth allow combined movement or "give" of 28µm while implants only allow 5µm of flexibility.[29] Because of the rigidity of the implant and the need to protect the osteointegration, the occlusion must be adjusted to compensate for the difference between movement of natural teeth and movement of osteo-integrated implants. Tekscan can help to produce precise contacts on implants in this time-delayed occlusal scheme (Fig.15 and 16).

After the occlusion and esthetic adjustment were completed on the upper arch, the lower arch was restored similarly with Feldspathic porcelain veneers and PFM crowns, while carefully maintaining the occlusion, vertical dimension, and the esthetics of the overall case (Fig.17).

The patient was recently seen for his 4 ½ year post-op. His conditions were stable and contributing to his overall health, he is still smoke-free.

Conclusion

Witnessing the ongoing periodontal deterioration in a non-compliant patient is a distressing experience for the attending den-

tist. To treat such a chronic patient, taking the time to explain and educate the patient so that he understands and becomes responsible for his present and future dental health is as vitally important to the success of the treatment as the carefully crafted diagnosis and treatment planning.

A complex periodontal/esthetic case was made simple and predictable by using orthodontic extrusion to regenerate severe soft and hard tissue lost in the esthetic zone. Utilizing the physiologic and biological interplay between the hopeless teeth and their periodontal housing, a suitable implant site was developed before the extraction. Through the manipulation of contact points and interproximal bone height, soft tissue papilla were successfully regenerated and all open embrasure spaces were eliminated. The use of Joint Vibration Sound Analyzer and Jaw Tracker to monitor the function of the temporomandibular joints before, during, and after treatment ensured that our hard earned occlusal scheme was compatible with all the surrounding musculature and dentition. Tekscan has changed our concept of occlusal analysis and adjustment, making the sole use of articulating paper a thing of the past. A beautiful esthetic result was achieved and longevity ensured with harmonized occlusion.

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Fig.17. Before.

Fig. 18. After.

Fig.19. Final restorations.

Fig. 20. Patient after completion of treatment.

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