Application of 10 Keys for Replacement of Multiple Teeth in the Esthetic Zone

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Abstract: Ten keys for successful esthetic-zone single immediate implants encapsulate in an evidence-based manner the treatment planning and replacement of single hopeless teeth in the maxillary anterior sextant. These include two treatment-planning, five surgical, and three prosthetic keys, which, collectively, aim to minimize soft- and hard-tissue complications for an optimal esthetic implant restoration.
The Straightforward, Advanced, and Complex (SAC) classification is designed to aid clinicians in the treatment planning of dental implant cases. As per this classification, cases are stratified by the degree of surgical and restorative risk and complexity for both the surgical and prosthetic phases of treatment. A technique-sensitive and skill-demanding task, the replacement of multiple adjacent teeth in the esthetic zone poses significant challenges for clinicians and is considered a complex SAC procedure surgically and restoratively. This article presents a case report on the replacement of multiple adjacent teeth in the esthetic zone, demonstrating the use of 10 key principles to achieve an optimal esthetic outcome.

Replacement of multiple adjacent teeth in the anterior maxilla with implants represents a particularly difficult and challenging clinical situation and is classified as a complex procedure according to the International Team for Implantology's (ITI) Straightforward, Advanced, and Complex (SAC) classification of implant dentistry.[1]

Despite the high survival rate of immediate implants (≥96%), which is attributable largely to improvements in implant design and surface modification,[2] the success of such cases is highly dependent on—and the challenge to clinicians is—the harmonious integration of the restoration into the patient's overall appearance, ie, the esthetic outcome.[3] With considerable attention in recent years being paid to esthetically pleasing treatment outcomes, esthetic complications no longer are acceptable for contemporary implant success.[4]

In a systematic review Chen and Buser reported that midfacial soft-tissue recession (>1 mm) is common following single extraction and immediate implant treatment (range 9% to 41%; median 26% of sites at 1 to 3 years post-placement).[5] Cosyn et al, in a prospective clinical study, also reported that for immediate implant placement after single extraction even under ideal conditions there was a 30% risk at 1 year and a 47% risk at 5 years of significant facial gingival recession of >1 mm.[6] In addition to midfacial recession, loss of two or more adjacent teeth often leads to a flattened and diminished interproximal bone, making it especially challenging to maintain the interproximal papilla and scalloped facial gingival margin. To minimize such esthetic problems, it has been proposed to avoid placing two or more implants adjacent to each other.[7] Thus, the replacement of multiple adjacent teeth by implants in the anterior maxillary region should be done by fixed bridges, including a pontic between or adjacent to the supporting implants.

The present case report describes an oral rehabilitation that entailed extraction of multiple adjacent anterior maxillary teeth and replacement of each tooth by implant-supported single crowns. The esthetic outcome of the treatment was extraordinary, as interproximal papillae and scalloped facial gingival margin were maintained. The aim of this case report, therefore, is to evaluate the clinical conditions of the current case that allowed for the maintenance

of the interproximal papillae even after the replacement of multiple adjacent anterior teeth by single implant-supported crowns.

Case Report

A 66-year-old healthy nonsmoking female patient presented with failing maxillary anterior teeth due to recurrent caries (Figure 1 and Figure 2). It had been 2 years since her last dental check-up and periodontal maintenance. Her past dental history included mandibular advancement at age 50 with adult orthodontics. Her general health history was noncontributory (American Society of Anesthesiologists [ASA] II, controlled hypothyroidism).

The patient had been under the care of the primary author (RAL) in the past for surgical implant placement in sites Nos. 5, 12, 13, 18, 29, and 30 post-orthodontics; all replaced teeth had been previously lost due to recurrent caries. Multiple and multi-surface discolored composite restorations with recurrent caries associated with her anterior maxillary teeth (Nos. 6 through 11) were observed by clinical and radiographic examinations (Figure 3). Periodontal probing was 4 mm and less; 2-degree mobility was noted for teeth Nos. 7, 8, and 10; and 3-degree mobility was noted for tooth No. 9. Fremitus was seen in intercuspal and protrusive movements. The patient's occlusion was class I with a 2 mm overbite and overjet. The maxillary midline was in line with the facial midline, while the mandibular midline was shifted to the right side by 1.5 mm.

Several treatment options, including their correspondent characteristics, advantages, and disadvantages, were presented to the patient. She decided to have all the maxillary incisors replaced with implant-supported singe crowns.

The surgical and prosthetic planning of the case was carried out according to an updated 10-key approach for predictable, single, esthetic-zone immediate implants proposed by Levine et al in 2017.[8] The 10 keys include:

- two treatment-planning keys (1. esthetic risk assessment; 2. tomographic CBCT plan)
- five surgical keys (3. minimally traumatic tooth extraction using a flapless approach, if possible, with total maintenance of periodontally healthy buccal and palatal bone heights; 4. 3D implant placement in good available bone both apically and palatally along the palatal wall; 5. use of a narrower implant [from 3.3 mm to 4.1 mm] versus a wider-diameter [≥4.5 mm] implant based on the preoperative virtually planned anticipated buccal gap [>2 mm]; 6. buccal gap bone graft with a low-substitution grafting material; 7. palatal connective tissue grafting placed under the buccal flap for "phenotype conversion")
- three prosthetic keys (8. immediate or delayed contour management of the emergence profile with a custom healing abutment or single screw-retained provisional; 9. custom impression coping technique to duplicate the subgingival transitional zone; 10. screw-retained final prosthesis).

Esthetic Risk Assessment (Key No. 1)

The patient presented with a low esthetic risk profile based on the esthetic risk assessment (ERA) (Figure 4).[9] It is critical to identify the degree of complexity and risk involved in each


Fig 1.


Fig 2.

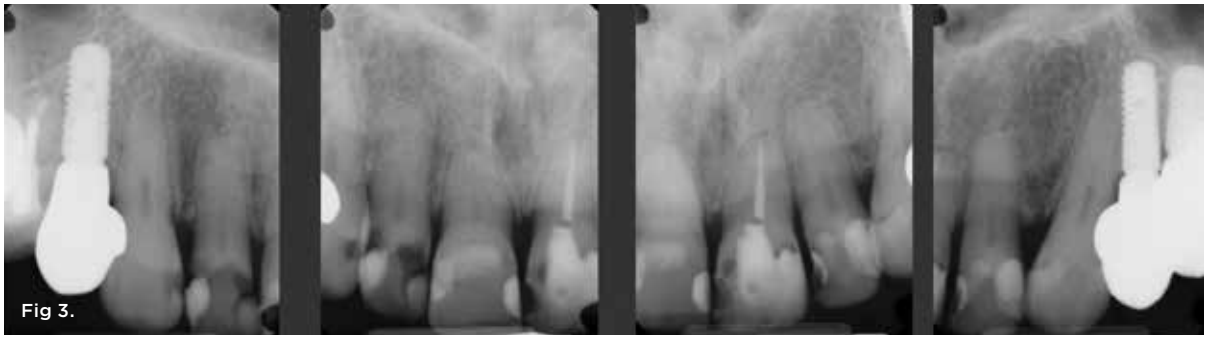
Fig 3.

Fig 1 and Fig 2. The patient's maxillary anterior teeth at presentation. A low lip line was noted upon a wide smile. **Fig 3.** Periapical x-rays of maxillary anterior teeth at presentation. Failing restorative dentistry was noted with blunted root apices from previous adult orthodontics. Prior posterior implants had been placed by the periodontist (RAL) in the past for teeth that were nonrestorable due to caries.

esthetic-zone case *prior to* implementing treatment. The ERA helps the whole treatment team be aware of the surgical risk from the start while facilitating patient communication and enabling the surgeon/restorative dentist to determine whether the patient's esthetic expectations are realistic or unrealistic.

The present case demonstrated from the outset to be a complex SAC case (surgically and prosthetically).[1] However, an experienced team (ie, periodontist, restorative dentist, and dental technician) who uses the ERA routinely as an esthetic checklist for aiding in the development of a final team treatment plan would be treating the patient. The ERA of the patient showed many "low esthetic risk" categories, which assisted the team in agreeing with the proposed patient-desired treatment plan of placement of four single implants to replace teeth Nos. 7 through 10.

Tomographic Plan (Key No. 2)

A site-specific CBCT scan (Carestream CS 9300, Carestream Dental, carestreamdental.com) of the maxillae showed an intact 1-mm to 2-mm thick buccal wall associated with Nos. 7 through 10. Based on the literature, a thick buccal wall (1 mm is considered thick) is seen in only approximately 10% to 15% of esthetic-zone teeth.[10,11] For anterior maxillae immediate implant placement, CBCT scans are invaluable and are considered a standard procedure to be used for all cases to assess whether the buccal and palatal walls are intact, as well as buccal wall thickness, sagittal root position of teeth, basal bone, alveolar form, adjacent teeth, and interproximal bone level.[12] Based on this information, the clinician can select the appropriate implant size and plan a virtual 3D implant position using the prosthetic-driven concept.[8] (*Note: When selecting implant diameter and length and the 3D virtual positioning of implants on the CBCT scan, Keys 4, 5, 6, 8, and 9 should be considered at this stage of planning.*)

Large-diameter implants (≥4.5 mm) should be avoided in the esthetic zone, because their usage reduces the width of the needed preplanned buccal gap width. Smaller-diameter implants (≤4.3 mm) are preferable to ensure a buccal gap of >2 mm width.[13] Maxillary anterior implants should be placed along the palatal wall with appropriate angulation to facilitate a screw-retained prosthesis, as shown in Figure 5 and Figure 6, which depict buccal and palatal views, respectively, of virtual CBCT planning (NobelClinician, Nobel Biocare, nobelbiocare.com). The vertical depth should be approximately 3 mm to 4 mm from the midfacial of the desired final gingival margin of the anatomically correct surgical guide, which the primary author (RAL) uses in all of his cases. This depth allows enough running room for an appropriate emergence profile.[8] If a narrower-diameter implant (3.3 mm to 3.5 mm) is anticipated, more running room is needed and the implant must be placed slightly deeper (0.5 mm to 1 mm deeper than a regular-diameter implant [Figure 5]).

The mesiodistal distance between an implant shoulder and tooth should be at least 1.5 mm; otherwise, attachment loss may occur on the tooth side, which may lead to papilla height reduction.[14,15] For multiple adjacent implants, the mesiodistal distance between implant shoulders should be more than 3 mm; otherwise, the interproximal bony peak cannot be maintained above the implant shoulder, and papilla loss will be the consequence.[16] If the mesiodistal distance is compromised

ESTHETIC RISK FACTOR	LOW	MEDIUM	HIGH
MEDICAL STATUS	Healthy, uneventful healing		Compromised healing
SMOKING HABIT	Non-smoker	Light smoker (< 10 cig/day)	Heavy smoker
GINGIVAL DISPLAY, FULL SMILE	Low	Medium	High
WIDTH OF EDENTULOUS SPAN	1 tooth (≥ 7mm) 1 tooth (≥ 6 mm)	1 tooth (< 7mm) 1 tooth (< 6 mm)	2 teeth or more
SHAPE OF TOOTH CROWNS	Rectangular		Triangular
RESTORATIVE STATUS OF NEIGHBORING TEETH	Virgin		Restored
GINGIVAL PHENOTYPE	Low-scalloped, thick	Medium	High-scalloped, thin
INFECTION AT IMPLANT SITE	None	Chronic	Acute
SOFT TISSUE ANATOMY	Soft-tissue intact (6,7)		Soft tissue defects
BONE LEVEL AT ADJACENT TEETH	≤ 5 mm to contact point	5.5-6.5mm to contact point	≥ 7 mm to contact point
FACIAL BONE WALL PHENOTYPE*	≥ 1 mm thickness		< 1 mm thickness
BONE ANATOMY OF ALVEOLAR CREST	No bone deficiency	Horizontal bone deficiency	Vertical bone deficiency
PATIENT'S ESTHETIC EXPECTATIONS	Realistic expectations		Unrealistic expectations

ERA: LOW

Fig 4.

Fig 4. The patient's esthetic risk assessment (ERA) was determined to be low.

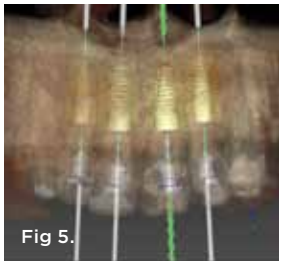
Fig 5.


Fig 6.

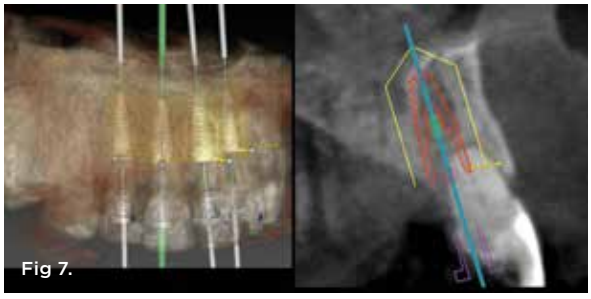
Fig 7.

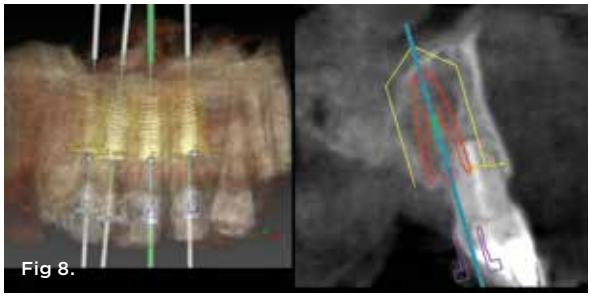
Fig 8.

Fig 5. Buccal view of virtual CBCT planning for sites Nos. 7 through 10 with bone-level tapered implants. The surgeon's goal is to place the implants at least 1 mm below the midbuccal of the intact buccal wall while placing the central incisor implants at the same horizontal level to each other. The lateral incisor implants were 3.3-mm narrow-diameter, requiring a 0.5 mm to 1 mm deeper placement than the central incisor implants, which were a regular-diameter 4.1 mm. Note adequate space between implants. **Fig 6.** Palatal view of virtual CBCT planning for sites Nos. 7 through 10. Note prosthetically good position along the palatal walls for final screw-retained restorations. **Fig 7 and Fig 8.** Cross-section view of site No. 8 (Fig 7) and site No. 9 (Fig 8) showing thick (>1 mm) buccal plate and favorable anatomy to place an immediate implant in each site along the palatal wall leaving a buccal gap of >2 mm.

when replacing multiple teeth in the esthetic zone, adjacent implants should be avoided to prevent interproximal bone and papilla loss. Considerations then need to be made for either an implant with a cantilever unit, orthodontic therapy to create adequate space, or an implant-supported fixed partial denture in cases of three or more missing teeth.[17] In addition, use of a platform-switched implant design is recommended to preserve crestal bone height and soft-tissue level.[18-20]

The four maxillary incisors were able to be centrally positioned in the alveolar ridge based on CBCT virtual planning. In addition, sufficient mesiodistal space was available for four implants designed for single-unit crowns based on a diagnostic wax-up. The ERA helped the team in examining important criteria that aided in the decision-making process. Significant favorable conditions on the patient's ERA that were present included: thick, intact buccal/palatal walls for sites Nos. 7 through 10; favorable bone anatomy of each individual site based on the CBCT analysis; absence of intraosseous infection; a low lip line; and a situation that enabled the placement of each implant virtually in a screw-retained position (Figure 7 and Figure 8). Also, perhaps most importantly, the ERA revealed realistic esthetic expectations of the patient. This assessment aided the experienced clinical team in agreeing to and presenting to the patient a treatment plan that she desired.

The case was planned for Straumann® Bone Level Tapered Roxolid® SLActive® implants (Straumann, straumann.com), 3.3-mm diameter x 10-mm long for sites Nos. 7 and 10, and 4.1-mm diameter x 10-mm long for sites Nos. 8 and 9.[20] The following treatment plan to replace teeth Nos. 7 through 10 was discussed, reviewed, and agreed to by the patient, restorative dentist, and periodontist: (1) The initial prosthetic appointment would include tooth preparation and provisionalization of Nos. 6 through 11 (Figure 9 and Figure 10). (2) The first surgical appointment would entail immediate implant placements in sites Nos. 7 and 10. (3) The second surgical appointment would involve immediate implant placements in sites Nos. 8 and 9. (4) The second prosthetic appointment would include contour management of Nos. 7 through 10 with screw-retained implant-supported single-unit provisional restorations (with adjustments in follow-up appointments). (5) The third prosthetic appointment would comprise a final impression, fabrication of the final crowns, and delivery. (6) Finally, the plan called for nightguard and recall appointments, alternating every 3 months.

Minimally Traumatic Tooth Extraction (Key No. 3)

Minimally traumatic tooth extraction aims to maximally protect the buccal plate and interproximal bony peak from surgical trauma. It is important to check the integrity of both the buccal and palatal walls before proceeding to the immediate implant placement. If the buccal wall is not fully intact, alternative treatment modalities, such as early implant placement (at 6 to 8 weeks post-extraction) with guided bone regeneration or socket preservation with later implant placement (at 3 to 6 months post-extraction), should be considered to minimize the risk of suboptimal esthetic outcomes that are associated with unpredictable soft- and hard-tissue dimensional changes.[3,5,21]

3D Implant Placement (Key No. 4)

An anatomically correct surgical guide template was fabricated by duplicating the provisional in clear acrylic resin (Figure 11). The guide was used in surgery to ensure that the implants were placed in prosthetically driven positions in line with the basic principles discussed in Key No. 2 when the case was virtually planned on the CBCT planning software.

With the advancement of computer-guided implant surgery, a 3D-printed or milled surgical guide or dynamic navigation implant surgery may be used to achieve the same purpose.[22] Implant malposition is a main reason for esthetic complications in implant dentistry.[23] Excessive or exaggerated buccal positioning of an immediate implant increases the chances of apical displacement of the buccal bone wall with resulting midbuccal gingival marginal loss and can result in three times more facial mucosal recession compared to immediate implants that are not buccally angulated.[24] For implants placed in anterior sockets, the manufacturer's bone profile drill needs to be used along the palatal wall *before* implant insertion to prevent buccal drifting of the implant. Based on thread design, the use of bone-level tapered implants with platform-switching design is recommended for immediate implant placement to bypass buccal concavities and improve insertion torque values.[20,25-27] Regardless, malposition can happen in any or all directions—buccolingually, mesiodistally, and coronoapically.

Treatment options to manage complications arising from implant malposition range from soft-tissue grafting, to the use of custom abutments, to implant removal.[23,28] In the present case, at the first surgical visit, immediate implant placement in Nos. 7 and 10 was attempted. Site No. 7 was uneventful, as all five surgical keys were used. In site No. 10, however, the implant osteotomy was tilted slightly mesially to the existing socket, and primary stability was suboptimal after further implant site preparation to correct the angulation. To ensure an optimal esthetic result, the periodontist (RAL) decided, based on the 10-key protocol, to abort the procedure for placement of No. 10. Alternatively, socket preservation with bone substitute and collagen (Bio-Oss® Collagen, Geistlich Pharma, geistlich-pharma.com) was completed, and the site was closed with a connective tissue graft (CTG). Implant placement for site No. 10 would be completed in a delayed placement protocol in the second surgical visit when both Nos. 8 and 9 were planned for immediate extraction and immediate implant placement.

Use of a Narrow-Diameter (≤4.3 mm) Implant (Key No. 5)

In this case, 3.3-mm diameter implants were chosen for the lateral incisors and 4.1-mm diameter implants were used for the central incisors (Figure 12 and Figure 13). In both animal and human studies, it has been shown that immediate implant placement alone cannot prevent bone remodeling and ridge reduction following extraction.[29,30] While bone resorption is more pronounced on the buccal wall


Fig 9.


Fig 10.


Fig 11.


Fig 12.


Fig 13.

Fig 9. Post-tooth preparation by restorative dentist. **Fig 10.** Fabrication/delivery of laboratory-processed fixed temporary restorations Nos. 6 through 11 (restorative therapy: Dr. Zola A. Makrauer). **Fig 11.** Provisional restoration was duplicated to create an anatomically correct surgical guide with palatal cutout to allow for palatal wall placement in all sockets. **Fig 12.** Palatal view of surgical guide in place with final implant placement for sites Nos. 7 and 10 (3.3-mm diameter implants) and 3.5-mm indicators in place for 4.1-mm diameter implants for sites Nos. 8 and 9. **Fig 13.** Sites Nos. 8 and 9 with 3.5-mm diameter indicators in place with buccal gaps measured >2 mm.

Fig 14. After placement of implants in Nos. 7, 8, and 9, buccal gaps and interproximal areas were filled with low-substitution bovine bone graft material to the bony heights circumferentially and packed (surgical visit #2, February 15, 2017: placement of implants Nos. 8, 9, and 10; surgical visit #1, August 30, 2016: placement of implant No. 7 with ridge preservation at No. 10). **Fig 15.** Palatal subepithelial CTGs harvested from premolar areas bilaterally and overlaid on the buccal aspects of the implanted sites. The CTGs were tucked under the tissues to cover the buccal walls of each implant and sutured to the undersurface of the flaps Nos. 7 through 10 with 6-0 plain gut sutures. **Fig 16.** Final suturing with 6-0 polypropylene sutures. Light pressure should be applied when knotting to prevent collapse of the papillae.

than the palatal wall due to the presence of bundle bone, it often leads to buccal plate resorption, bony dehiscence, and facial mucosal recession.[31] This facial wall collapse can lead to facial implant exposure in a worst-case scenario.

To preserve the buccal wall, Rosa et al proposed measuring the buccolingual dimension of the socket and considering a 3 mm gap to the buccal wall when selecting implant diameter.[13] The present authors share the same principle of leaving a 2 mm to 3 mm buccal gap when selecting the implant size (Figure 7, Figure 8, Figure 13). In the anterior maxilla, the choice would be either a regular or a narrow-platform implant. For multiple implants, when selecting implant diameter the mesiodistal dimension also needs to be considered so that the minimal 3 mm distance between implants and 1.5 mm distance between implant and tooth is respected.[18]

Buccal Gap Bone Graft With Low-Substitution Grafting Material (Key No. 6)

Following implant insertion, the buccal gaps were grafted with a low-substitution bovine bone mineral (Bio-Oss Collagen) and packed (Salvin Pocket Packer, Salvin Dental Specialties, salvin.com) (Figure 14). The rationale for choosing the slow resorption graft material is to compensate for the modeling and remodeling process the socket will undergo following tooth extraction.[31,32] In addition, a stable buccal wall can support the overlying soft tissue for the long term. In a 6-month dog study (equivalent to 1.5 years in humans) the placement of a xenograft (Bio-Oss Collagen) in the buccal gap was shown to compensate for the bone resorption following tooth extraction, and it created a thicker and more crestally positioned buccal wall when compared to the control sites where only immediate implants were placed with no bone grafting of the buccal gap.[33] A randomized controlled clinical trial also demonstrated similar findings in humans whereby placing a xenograft (Bio-Oss Collagen) significantly reduced the horizontal bone resorptive changes occurring in the buccal bone after extraction and immediate implantation.[34]

Facial Gingival Grafting (Key No. 7)

For each implant site, a CTG was harvested from the palate in the premolar areas and placed in the buccal envelope under the buccal marginal tissue and facial to the intact buccal plate (Figure 15 and Figure 16). While bone is the underlying supportive structure responsible for the overall soft-tissue contour, the overlying soft-tissue thickness has been shown to influence the crestal bone behavior in the process of biologic width formation and is an important factor for determining the crestal bone stability around implants.[35] Both animal and prospective controlled human studies have shown that thin soft tissue leads to increased marginal bone loss compared to thick soft tissue, regardless of the implant platform design (platform switching or not).[36-40] A 2-year randomized controlled trial (RCT) reported that a gain of [34.3 ± 20.8]% in soft-tissue thickness was found in the CTG group compared to a [9.9 ± 13.8]% reduction in the non-CTG control group when implants were immediately placed and the buccal gap was filled with Bio-Oss Collagen in both groups.[41] Kan et al observed no significant difference in facial mucosal level after a mean follow-up of 2.15 years when bone grafting the buccal gap and a CTG was performed in conjunction with immediate implant placement and provisionalization for both thin and thick phenotype cases. In addition, all implant sites exhibited thick periodontal phenotypes at follow-up examinations regardless of the initial phenotype.[42]

These studies suggest that a thinner phenotype can be converted to a thicker phenotype morphologically and behaviorally through "phenotype conversion."[26,42] Van Nimwegen et al in a RCT compared immediate implant placement and provisionalization in the esthetic zone with and without CTG and found a significantly more coronally located midfacial

mucosa level when a CTG was placed.[43] In a retrospective study where pink and white esthetic scores (PES/WES) were evaluated in a total of 98 maxillary anterior implants (type 1 through type 4 placement protocols) it was found that use of a CTG (33% of the cases) improved the esthetic outcome mainly by increasing the alveolar process contour.[44]

An additional benefit of soft-tissue thickening is the masking of the underlying restorative material and/or implants. Studies have demonstrated that the thickness of mucosa plays an important role in preventing the peri-implant soft-tissue color mismatch caused by shine-through effects of restorative materials.[45] When soft-tissue thickness is less than 2 mm, the influence becomes more clinically visible.[45-47]

Immediate or Delayed Contour Management of the Emergence Profile (Key No. 8)

In this case, active care started with the fixed provisionalization of tooth Nos. 6 through 11 prior to extractions and implant placement. The decision was made initially for transmucosal healing of all four implants and delayed contour management until all four implant sites were healed (Figure 17 through Figure 20). Cosyn et al demonstrated that in the esthetic zone the average papilla height at the embrasure between implant–implant (3.3 mm), implant–pontic (3.2 mm), and pontic–pontic (3.7 mm) was less than that of tooth–pontic (4.2 mm) and tooth–implant (4.1 mm).[48] In situations of multiple adjacent missing teeth, the implant–implant and implant–pontic embrasures showed comparable papilla height, embrasure fill, and papilla index, indicating that an implant with a pontic may not perform better than adjacent implants.[48]

In the present case, the converted single provisional crowns were deliberately undercontoured subgingivally, and interproximal embrasures were intentionally left open to allow for papilla regeneration. The individual temporary crowns were fabricated from the original six-unit fixed temporary in acrylic resin. Contour management was completed with flowable composite (Beautifil Flow Plus®, Shofu, shofu.com) and temporary abutments bonded to the acrylic temporary crowns with a bonding agent (Anaxblend Bond LC, Anaxdent, anaxdent.com). The temporary cylinders were micro-etched (MicroEtcher™, Zest Dental Solutions, zestdent.com), and opaque flowable composite was applied to block out the titanium metal color (Beautifil Flow Plus) to prevent a gray hue in the temporary crowns. The contours of the individual provisional crowns were adjusted by the restorative dentist (ZAM) at the two follow-up visits. Soft tissues were left to mature for more than 2 months prior to the start of definitive restoration fabrication, which would begin with the creation of custom impression copings (Key No. 9).

Custom Impression Coping Technique (Key No. 9)

When the desired shape and emergence profile was achieved after 2 months (Figure 21), individual custom impression copings were fabricated in order to precisely register the transitional zone of the individual provisional crowns (Figure 22 through Figure 25). The custom impression copings were fabricated by copying the subgingival contours of the temporary crowns in their respective transitional zone. Then, quick-setting resin (Pattern Resin™, GC Corp.,


Fig 17.


Fig 18.


Fig 19.


Fig 20.

Fig 17. Titanium temporary cylinders in place and shaded tooth color (Nos. 7 through 10). **Fig 18.** Provisional was sectioned at the midline in two sections, and palatal aspects were removed. **Fig 19.** Provisionals were brought into the mouth and luted to the titanium temporary abutments with flowable composite. **Fig 20.** The two splinted sections were then separated into single provisionals using a diamond separating disc and polished to start the delayed contour management phase of the emergence profile. Because there was an abundance of tissue, the facial tissues were pushed slightly facially with subgingival contours while the flat subgingival interproximal contours helped in developing the interproximal papillae.

gcamerica.com) was added to the impression posts. This technique allows the laboratory technician to duplicate the transitional zone of the temporary crowns as blueprints for the final restorations.[3,8,49]

Screw-Retained Final Prosthesis When Possible (Key No. 10)

The patient was very pleased with the final treatment outcome, which consisted of four individual implant-supported pressed ceramic screw-retained crowns on ti-base abutments (Straumann® Variobase®, Straumann) and two full-coverage porcelain-fused-to-zirconia crowns on canines cemented with resin-modified glass-ionomer cement (RelyX™ Luting Plus, 3M Oral Care, 3m.com) (Figure 26 through Figure 30). The scalloped and symmetrical gingival margin, interproximal papilla, root prominence, and buccal plate were well-maintained at 2.5 and 3.5 years post-implant placement (Figure 28 through Figure 35).

High survival rates can be achieved with both cement- and screw-retained fixed implant-supported prostheses. However, in pooled data, cement-retained prostheses exhibited higher rates of technical complications and fistula formation and suppuration.[50] An in vitro laboratory bench study demonstrated the extreme difficulty of complete removal of excess cement after cementation of a single implant crown. The deeper the restorative margins were located, the more excess cement was left behind.[51] When single or multiple adjacent implants are placed in the esthetic zone, they need to be placed approximately 1 mm below the intact buccal wall subcrestally, which presents as more challenging, if not impossible, to completely remove excess cement because this makes the interproximal areas


Fig 21.

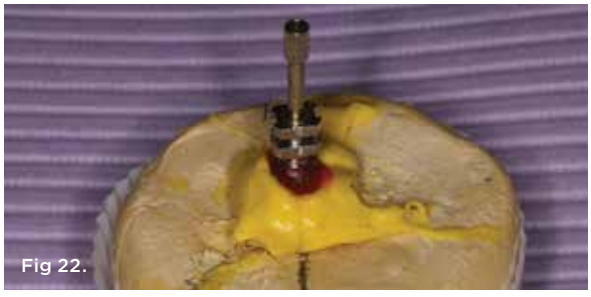
Fig 22.


Fig 23.


Fig 24.


Fig 25.


Fig 26.

Fig 21. The patient was in the single temporaries for 2 months with two adjustment appointments to finalize soft-tissue position. The temporaries are used as the "blueprint" for the final restorations. After the 2-month period, the restorative dentist deemed the final soft-tissue contours acceptable for final restorations. Note the interproximal areas were left open for papilla fill. **Fig 22.** Fabrication of individual custom impression copings for each implant restoration. **Fig 23.** Buccal view of custom impression copings in situ for Nos. 7 through 10. **Fig 24.** Occlusal view of custom impression copings in situ for Nos. 7 through 10. Note the amount of buccal aspect red inlay pattern resin signifying that this was the subgingival transitional zone that was supported by the palatally placed implants along the palatal walls with the aid of the anatomically correct surgical guide template. **Fig 25.** Complete maxillary arch open-tray impression with polyvinyl siloxane impression material with custom impression copings imbedded. **Fig 26.** Master model showing the subgingival depth of the palatally placed implants and the duplicated transitional zone that was copied by the custom impression coping technique.

even deeper due to the bony socket scalloping more coronally in a flapless or minimally invasive surgical procedure. Thus, a screw-retained prosthesis is recommended in single as well as multiple adjacent implants with a possible need for angulation correction.

In order to be able to deliver a screw-retained prosthesis, however, implants must be placed in their correct prosthetic positions as described in the diagnosis and surgical keys above (even with the help of angulated screw channel) and with the aid of an anatomically correct surgical guide. To ensure esthetic success, meticulous planning and execution beginning at the initial visit is necessary; this was the authors' impetus for the development of the 10-key concept. This concept is used in sequential order to facilitate success.

In cases where cementing cannot be avoided, the restorative margin on the abutment needs to be placed no more than 1 mm subgingivally on custom abutments. The peri-implant mucosal seal, a junctional epithelial attachment with circular connective tissue fibers, is more fragile compared to the biologic width with attaching perpendicular connective tissue fibers on natural teeth. Cement extrusion from seating an implant crown can disrupt this cellular attachment to the implant and the cement may flow far underneath. Resin and other radiolucent cements should be avoided, as their radiolucency makes them undetectable for early detection on post-cementation radiographs.[52] Resin cements are also bacteriophyllic, which can play an etiological role in peri-implantitis.[53] On the contrary, radiopaque cements, such as those containing zinc, enable easy detection and have antimicrobial pharmaceutical properties and are, therefore, recommended.[52,54]

Conclusion

Immediate implant placement in the esthetic zone provides the obvious advantages of shortening treatment time with fewer surgical visits and reduced surgical morbidity, and exceptional pink and white esthetic results can be achieved.[55] A complex SAC, technique-sensitive, and skill-demanding procedure, it should be performed by an experienced team (implant surgeon, restorative dentist, and dental laboratory technician).[8,20]

This case report showed that superior esthetic results can be achieved when replacing multiple adjacent teeth in the esthetic zone if the aforementioned 10 keys are followed *sequentially* while respecting the minimum horizontal inter-implant distance under the right anatomical and patient conditions. All esthetic-zone cases start with a risk assessment, which is shared among the whole team so that the complexity of each individual team member's assignment is understood along with the patient's desires and expectations (Key No. 1). (*The present case offered an excellent clinical situation anatomically to place four individual implants: low lip line, thick buccal plate (>2 mm), and good anatomical conditions in a buccal-lingual as well as an apico-coronal direction.)*. This is followed by meticulous CBCT 3D virtual planning with a restorative-driven approach along the palatal wall to provide an implant diameter that meets the >2 mm buccal gap dimension for a screw-retained prosthesis using an anatomically correct surgical guide (Key No. 2); a minimally invasive tooth extraction to maintain the complete integrity of the extraction socket (Key No. 3); placement of a narrower-diameter


Fig 27.


Fig 28.


Fig 29.


Fig 30.

Fig 27. Final single screw-retained crowns Nos. 7 through 10 and single porcelain veneers Nos. 6 and 11 (September 26, 2019: 1 year after delivery and 2.5 years after implant placement) (laboratory procedures: Tony Cirigliano, CDT). **Fig 28.** Final case at 2.5 years post-implant placement. Future full-coverage restorations are planned for teeth Nos. 21 through 28. Teflon tape and composite resin was used to close off the screw-access holes (final case delivered August 1, 2018). **Fig 29.** Completed maxillary case in situ. Nos. 4, 5, and 12 are previously treated single-tooth implants placed by RAL. **Fig 30.** The patient's smile at 2.5 years post-implant placement. Note low lip line and low gingival display.

platform-switched implant in a 3D correct position to ensure a >2 mm buccal gap dimension upon insertion (Key Nos. 4 and 5); grafting of the buccal gap with a low-substitution bone graft to moderate the effects of buccal bone loss (Key No. 6); use of a CTG to prevent labial mucosal recession, increase soft-tissue thickness, and improve buccal contours while enabling a "phenotype conversion" to a thicker periodontal phenotype (Key No. 7); immediate or delayed contour management to create an ideal emergence profile and transition zone (Key No. 8); use of a custom impression coping technique to accurately register the developed transitional zone (Key No. 9); and, finally, insertion of a screw-retained final prosthesis whenever possible to prevent cement-related complications (Key No. 10).

Each of the sequential 10 keys is crucial to achieving success in the esthetic zone. If an intrasurgical complication occurs (Key Nos. 3 through 7), the surgeon should consider aborting the procedure and choosing either a type 2 (6- to 8-week delay) implant placement approach or ridge preservation (as was done with site No. 10 in the present case).

A team approach is highly recommended to combine the individual expertise and experience of the implant surgeon, restorative dentist, and dental technician to deliver an esthetic treatment outcome. For patients who present with a low esthetic risk based on the ERA, as the patient in this case did, an experienced dental team should be able to duplicate the result achieved herein in most cases. However, the patient should be cognizant of the complexity of their case and the potential consequences of a less-than-ideal result. The ERA enables the team to determine how realistic it is to achieve the patient's esthetic expectations (eg, gingival margins or interproximal papillae not fully able to return to presurgical positions). If strictly followed, the 10-key approach provides a sequential checklist or "layered security" for achieving a successful, complication-free outcome.[56]

DISCLOSURE

Dr. Levine has received honoraria from Geistlich Pharma.

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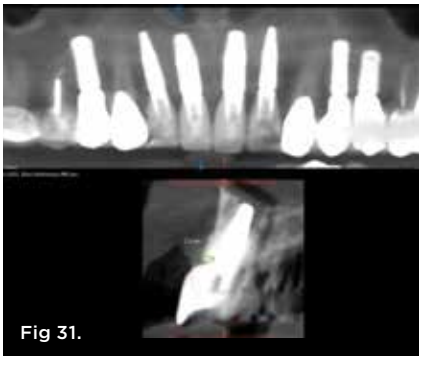
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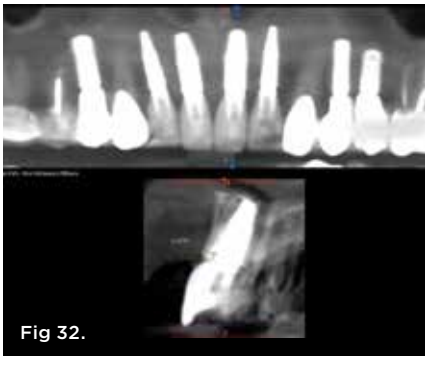
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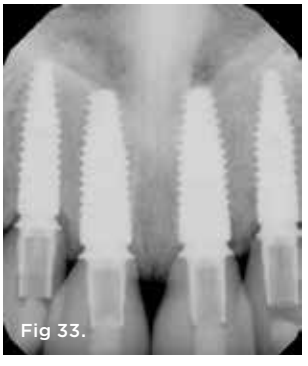
Fig 33.


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Fig 35.

Fig 31. CBCT slice No. 8 at 2.5 years post-implant placement (September 26, 2019); 2 mm buccal thickness was maintained with the use of slowly resorbing biomaterial. **Fig 32.** CBCT slice No. 9 at 2.5 years post-implant placement (September 26, 2019); 2.2 mm buccal wall was present. **Fig 33.** Periapical radiograph at 3.5 years post-implant placement (July 2020). Interproximal heights of bone were maintained with the use of the slow-resorbing biomaterial that was packed to the bony wall heights of the individual sockets at the time of implant placement. **Fig 34.** Final case at 3.5 years post-implant placement. The papillae remained in the same positions as the 2.5-year photograph (Fig 28) because of the interproximal bone maintenance that was achieved. Slight marginal recession is noted on the facial aspect of the No. 6 porcelain crown. **Fig 35.** Facial-occlusal view showing the thickened "phenotype conversion" maintained after 3.5 years, Nos. 7 through 10.

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