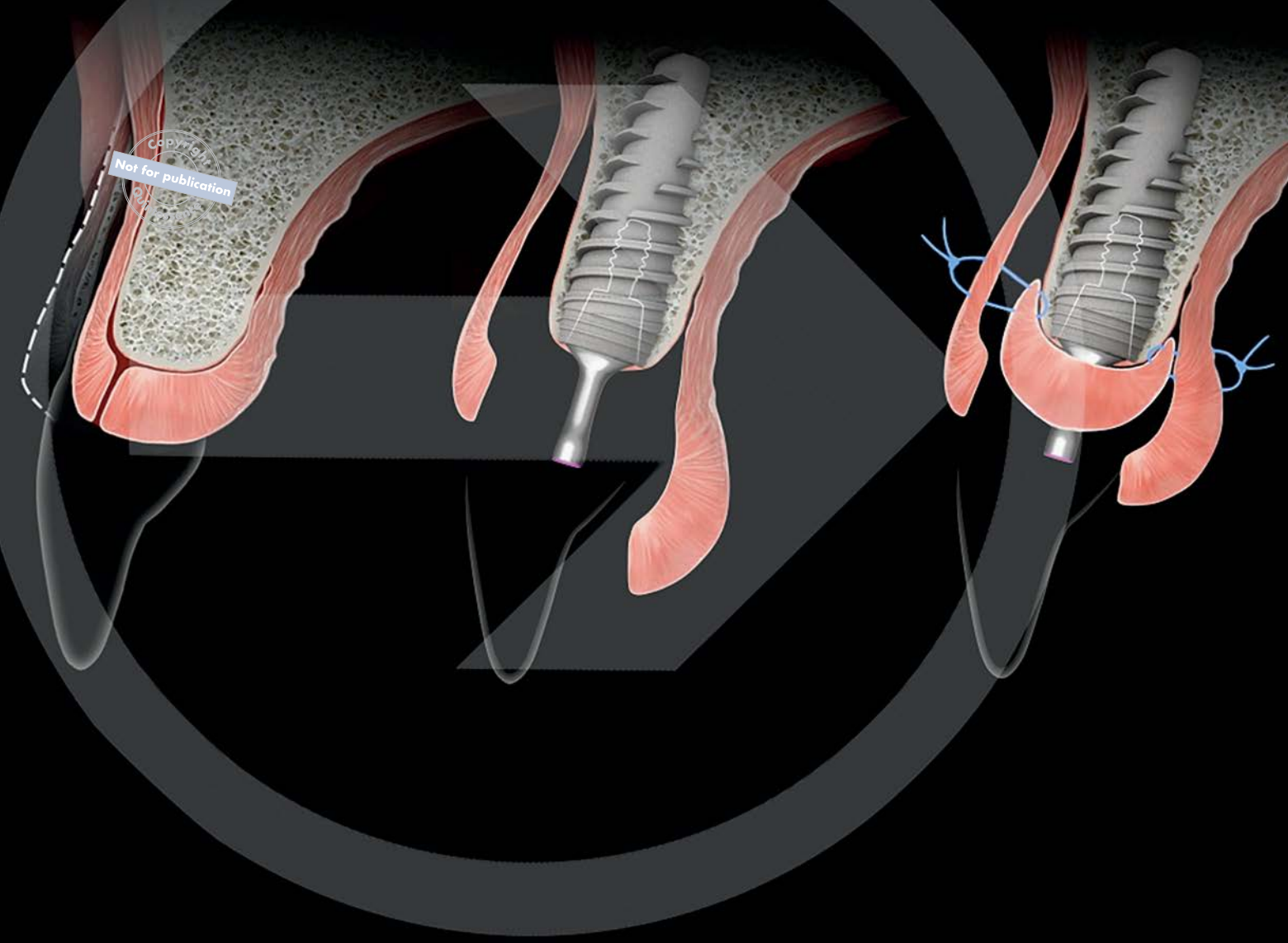


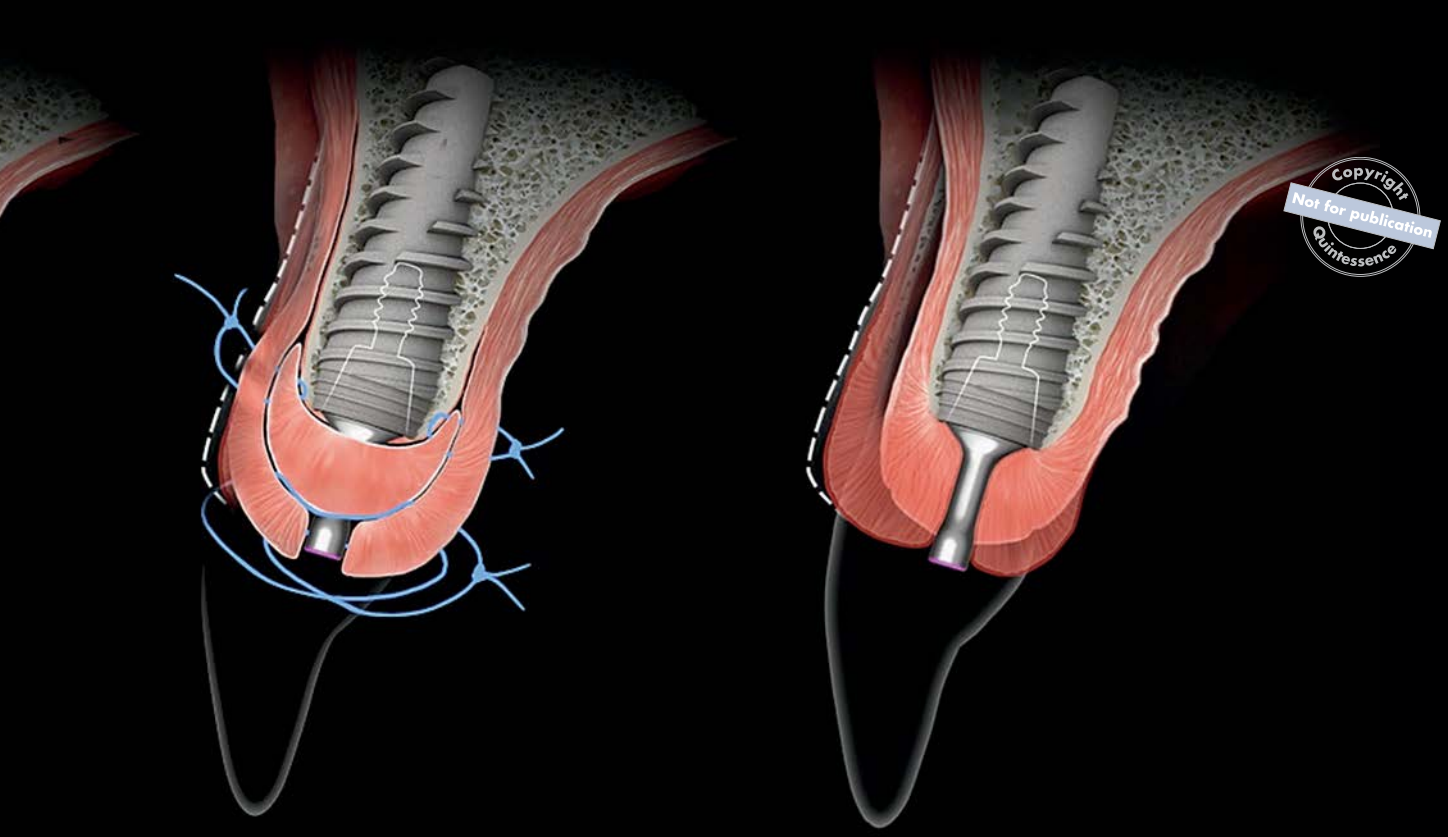
Iñaki Gamborena, DMD, MSD, FID[1]
Yoshihiro Sasaki, CDT[2]
Markus B. Blatz, DMD, PhD[3]

[1]Adjunct Professor, Department of Preventive and Restorative Sciences, University of Pennsylvania School of Dental Medicine, Philadelphia, Pennsylvania, USA, and private practice, San Sebastian, Spain.

[2]Shinbi Laboratory, San Sebastian, Spain.

[3]Professor of Restorative Dentistry and Chairman, Department of Preventive and Restorative Sciences, University of Pennsylvania School of Dental Medicine, Philadelphia, Pennsylvania, USA.

Correspondence to: Dr Iñaki Gamborena, C/ resurrección M Azkue #6 -4, 20018 San Sebastián, Guipúzcoa, Spain.
Email: Gambmila@telefonica.net www.Drgamborena.com



The "Slim Concept" for Ideal Peri-Implant Soft Tissues

A common, grave misconception in today's dentistry is the notion that implant treatment in the anterior maxilla is a "slam dunk"—easy access and the tissues heal over time anyway. Such an attitude is a great disservice to our patients, many of whom are rather young and deserve excellent treatment that can be sustained for a good number of years. Especially in those patients, implant treatment in the esthetic zone may in fact be the most challenging of all clinical interventions, requiring thorough planning and meticulous execution. The clinical results must be stable not just for 5 or 10 years, but ideally many more years to prevent the devastating consequences of hard and soft tissue resorption for as long as possible. Unfortunately, more weight is typically being placed on the immediate result, without much consideration for longevity. Many influencing factors are not well understood but may have devastating consequences for the patient in the mid to long term.

The restorative outcomes are critically important, but the surrounding hard and soft tissues largely differentiate between success and failure. And for that, we must learn from early mistakes, critically assessing long-term outcomes and evaluating influencing factors and techniques. The excessive pressure traditionally applied to peri-implant soft tissues through overcontoured, convex-shaped implant abutments and healing components has often caused debilitating tissue recessions after time. Therefore, current implant concepts recommend the opposite: create an overabundance of soft tissues and allow for space, rather than squeezing and choking those tissues. The "Slim concept," introduced by the authors a few years ago,[1] offers protocols and components that create greater tissue thickness and provide space for the tissues to achieve long-term success, serving our patients in the best possible manner.

THE SLIM CONCEPT

The Slim concept embraces specific surgical techniques and implant components, most important being the Slim healing abutment.[1] It ensures space for soft tissue augmentation, which enables long-term esthetic and functional success. Key components are explained below and clinical protocols are detailed in the case report.

Connective Tissue Graft

The idea behind the Slim healing abutment was the concern that the diameter of the healing abutment should provide extra space for a connective tissue graft (CTG). Due to the fact that soft tissue recessions are continuous and occur in any tissue biotype, biotype enhancement and soft tissue augmentation with subepithelial CTGs should be considered for any, especially immediate, implant procedures and even for thick tissue biotypes.[2–7] The graft should ideally be placed at the time of implant placement and is usually covered with a coronally advanced flap[6,7] or inserted into an envelope flap or pouch.[8–10]

CTG Donor Site

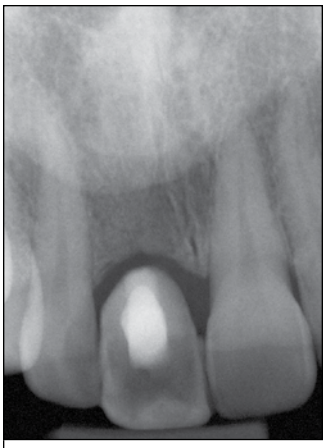
The long-term stability after soft tissue augmentation with a CTG is determined not only by the thickness of the graft, but also its quality. This is another key aspect of the Slim concept. The palatal mucosa has traditionally served as the favored connective tissue donor site.[11] Its thickness, however, varies significantly among patients and is limited by anatomical structures such as the greater palatine artery.[12–15] Healing is typically associated with significant discomfort, even when advanced surgical techniques are applied.[16] The area of the maxillary tuberosity as a donor site for subepithelial CTGs was first described in 2001.[17] It offers greater and more consistent tissue thickness, and its successful application has been confirmed both histologically and clinically.[18,19] Subepithelial connective tissue from the tuberosity has a higher density than that from the palate, which usually contains more fat.[18,20] It may, therefore, be less prone to postoperative shrinkage but more difficult to vascularize.[20,21] A split-thickness flap pouch technique,[8] where the periosteum remains on the bone, is preferred for CTGs from the tuberosity to ensure maximum vascularization.

Slim Healing Abutment

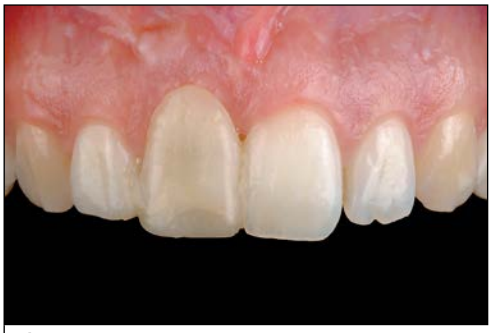
In the early 1990s, wider-diameter healing abutments were recommended to shape the desired emergence profile from day one, with the theory to create an ideal tissue topography for the definitive crowns and effortless results immediately after implant placement. Clinical long-term outcomes have shown that, while possibly successful in select patients with a thick soft-tissue biotype, this concept does not provide the desired outcomes in the majority of patients and certainly not in the esthetic zone. In addition, wide-diameter healing abutments do not allow coronal positioning of a CTG. This is, however, the area where a graft is usually needed the most to hide the implant-abutment-crown interface and create the required tissue volume.[1]

Wide-diameter healing abutments create a recession from the day of the surgery, even with a CTG, and displace the tissues toward the bone. Placing the CTG in a more coronal position and passively repositioning the soft tissue flap over the graft and the wide-diameter healing abutment is challenging, if not impossible. The healing abutment should always have the same or a smaller diameter than the respective implant or should be customized through grinding. The goal is to place a thick and dense CTG, harvested preferably from the maxillary tuberosity at the time of implant insertion.

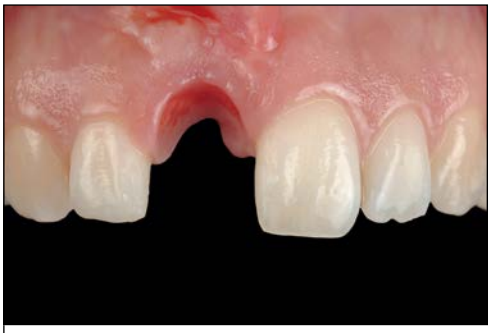
The Slim healing abutment provides the necessary three-dimensional space and offers the ability to place a thick CTG in the most coronal position, thereby improving the papillae in a manner not possible before. This “crestal grafting” augments the ridge and the papillae both vertically and horizontally. The Slim healing abutment also enables primary flap closure while providing support for an immediate fixed provisional restoration or a restoration bonded to the adjacent teeth. The option of a fixed immediate prosthetic solution is a great advantage for the patient and eliminates vertical loading of the grafted tissue during the healing phase.[1]



1a



1b



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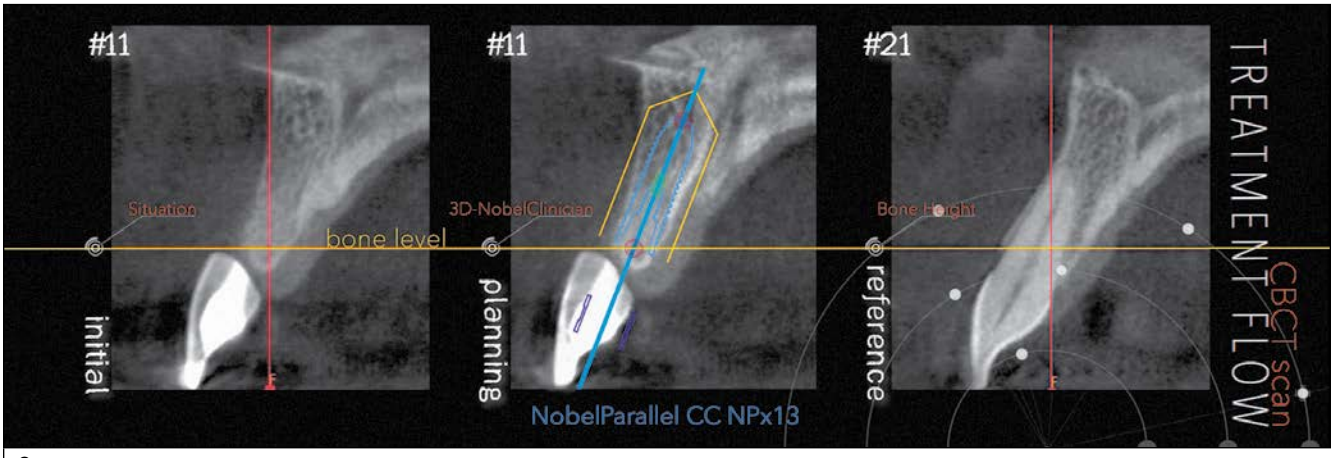

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Figs 1a to 1c Preoperative intraoral views and periapical radiograph. The maxillary right central incisor was lost during a bicycle accident several years before the patient presented to the clinic.

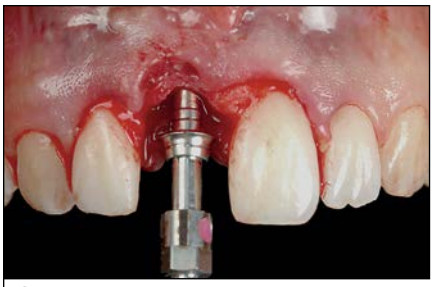
Fig 2 Assessment of the existing bone morphology and implant placement with CBCT and digital implant planning software. The yellow line indicates the bone level at the adjacent central incisor.

CASE PRESENTATION

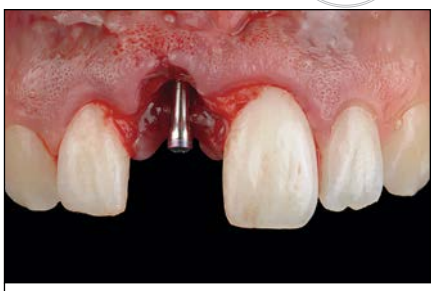
The patient's maxillary right central incisor was lost during a bicycle accident several years before presenting to the clinic. The periapical radiograph and cone beam computed tomography (CBCT) scan revealed the extent of bone loss, especially in comparison to the adjacent central incisor. The heights of interproximal papillae were almost ideal, except for the papilla on the mesial aspect of the pontic site, where some bone was lost. The extensive buccal and vertical tissue defects were caused by excessive pressure from the pontic of the existing restoration. The proximity of the pontic to the crestal bone might have caused additional volume loss (Figs 1a to 1c).

The existing bone morphology and the feasibility of implant placement were assessed with digital implant planning software (Fig 2). Virtual implant selection and placement suggested a NobelParallel CC implant (3.5 × 13 mm, Nobel Biocare). The decision to graft the deficient site with bone or only soft tissue depends on multiple factors. When the implant is placed exactly as planned and without damaging the buccal bone during the procedure, grafting with bone or bone substitute would provide only little additional support for the implant itself, while increasing the surgical complexity of the case. The yellow line in Fig 2 indicates the bone level at the adjacent central incisor and shows the extent of the vertical bone defect, which is helpful to determine if bone, soft tissue, or both are needed to graft the missing tissue volume.

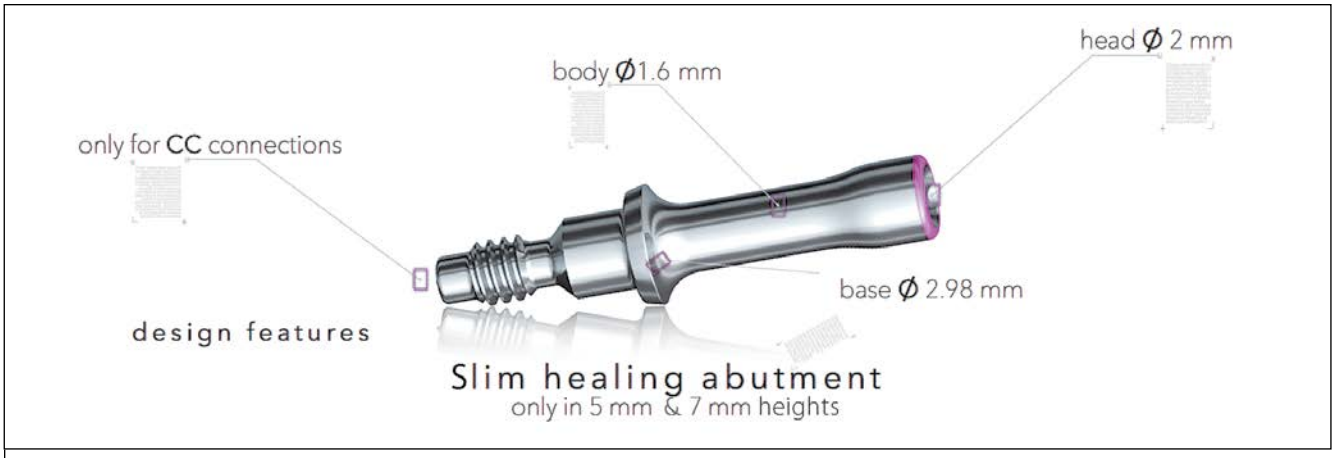
3a



3b



3c



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Figs 3a to 3c Partial-thickness flap was prepared and raised above the mucogingival junction. A NobelParallel CC implant (3.5 × 13 mm, Nobel Biocare) was placed and the 7-mm-high Slim healing abutment was connected to maximize crestal tissue grafting and facilitate primary flap closure.

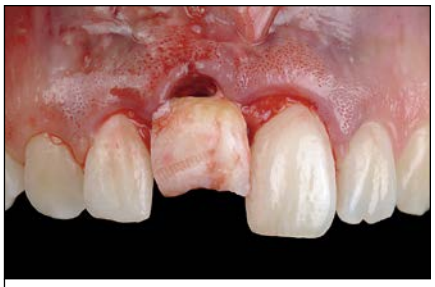
Fig 4 The novel Slim healing abutment is specifically designed for one-stage surgical approaches to create maximum space for soft tissue grafts at the restorative interface.

Connective Tissue Graft

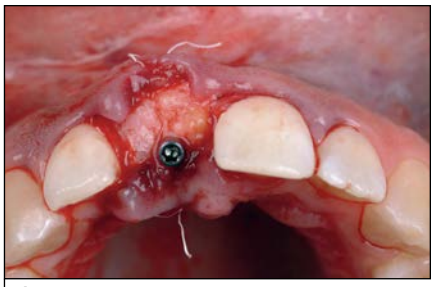
CBCT examination indicated sufficient soft tissue thickness in the areas of the maxillary tuberosities to serve as donor sites for harvesting subepithelial CTGs. It was decided to graft the deficient buccal bone with a CTG alone. A horizontal incision was made slightly toward the buccal aspect of the crest of the edentulous ridge, and a partial-thickness flap was elevated to increase the tissue volume in height as well as buccopalatally. A sulcular incision was made around the mesial and distal aspects of the teeth, and the papillae adjacent to the defect were elevated. Finally, the partial-thickness flap was prepared and raised above the mucogingival junction (MGJ) until it reached the desired coronal position. No vertical releasing incisions were prepared, and the periosteum was left attached to the bone. The implant was placed and the 7-mm-high Slim healing abutment was connected to maximize crestal tissue grafting and enable primary flap closure (Figs 3a to 3c).

The novel Slim healing abutment (Fig 4) is specifically designed for one-stage surgical approaches. It creates maximum space for soft tissue grafts where it is needed most—at the restorative interface. Following the concept "less can be more," its slender design ensures considerable space for soft tissue grafting while allowing primary flap closure. It allows for unprecedented grafting of the papilla areas both horizontally (buccolingual) and vertically, even in sites with reduced mesiodistal space.

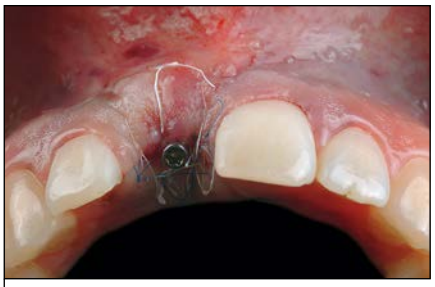
A large CTG was harvested from the maxillary tuberosity and carefully de-epithelialized. The graft measured approximately 14 × 8 × 7 mm, which was sufficient to compensate for the volume lost at the implant site. The CTG was sutured in position to the palatal aspect of the flap (Figs 5a and 5b). The buccal flap was then sutured to



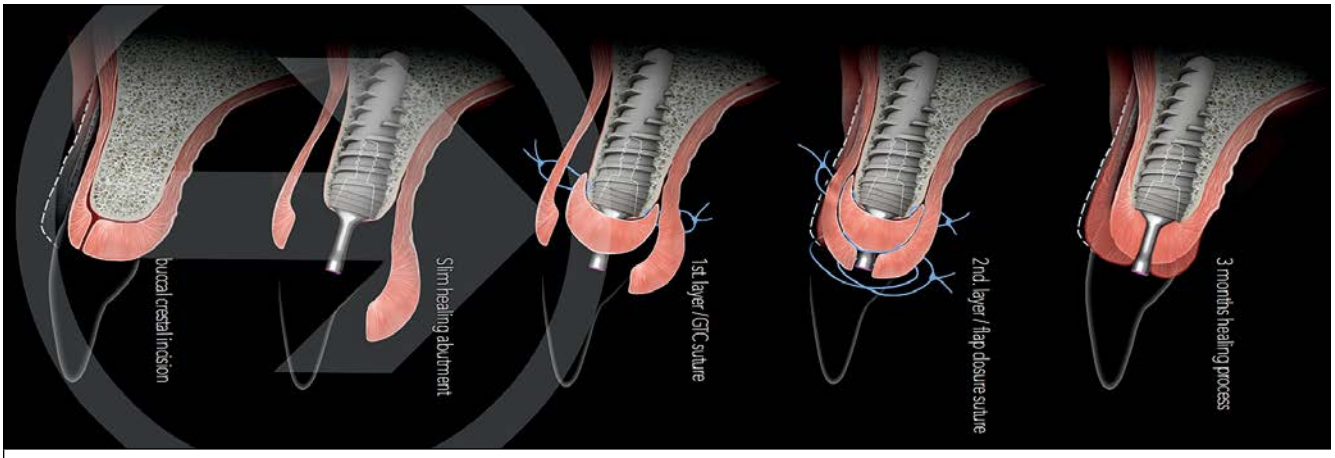
5a



5b



5c



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Figs 5a to 5c Connective tissue graft was harvested from the maxillary tuberosity and sutured in position.

Fig 6 Step-by-step schematic description of the surgical phase of the Slim concept.

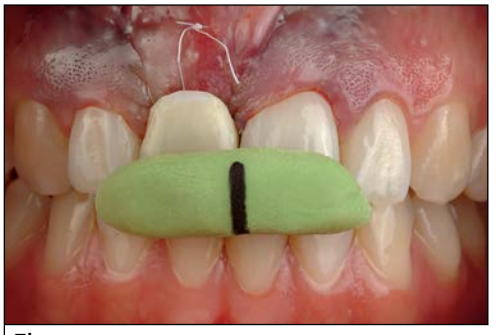
the palatal flap at the initial incision to close the wound (Fig 5c). A 6-0 polytetrafluoroethylene (PTFE) monofilament suture material was necessary to secure the tissues in place, while 6-0 monopropylene suture material was used to precisely adapt the flaps. This type of surgery should be performed in one stage whenever possible.

The Slim concept (Fig 6) starts with a horizontal buccal incision to graft the bony defect with a CTG from tuberosity. This way, the crestal tissue ridge can support the palatal wall of the newly created ridge. A partial-thickness flap is elevated without any vertical releasing incisions to maximize blood supply to the grafted tissue. The implant is placed in the optimal position and a Slim healing abutment is connected. The CTG is perforated with a small incision to place it around the Slim healing abutment like a saddle and is secured to the buccal and palatal flaps. After that first suture layer, a second layer is sutured after preparing releasing incisions of the buccal flap to provide primary closure. Sutures are typically removed after 15 days, and the implant is restored 3 months later.

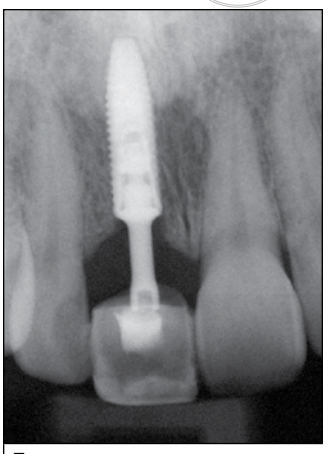
An acrylic jig (Fixspeed, GC) was fabricated before removal of the pontic tooth to simplify the bonding process to the adjacent teeth after the surgical procedure (Figs 7a and 7b). The pontic tooth was designed with a ridge lap to avoid vertical pressure on the grafted crestal ridge, which was verified with a radiograph (Fig 7c).

At 3 months postsurgery, the goals of coronally displacing the tissue and creating sufficient volume compared with the adjacent gingival margin were achieved (Fig 8). Palatal bone and tissue support are crucial to recreate buccal esthetics and provide tissue stability.

7a



7b



7c

Figs 7a to 7c An acrylic jig was fabricated before removal of the pontic tooth to simplify the bonding process to the adjacent teeth after the surgical procedure. Vertical pressure on the grafted crestal ridge should be avoided.

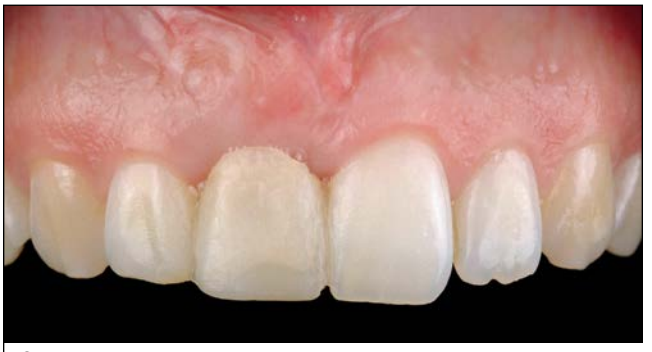


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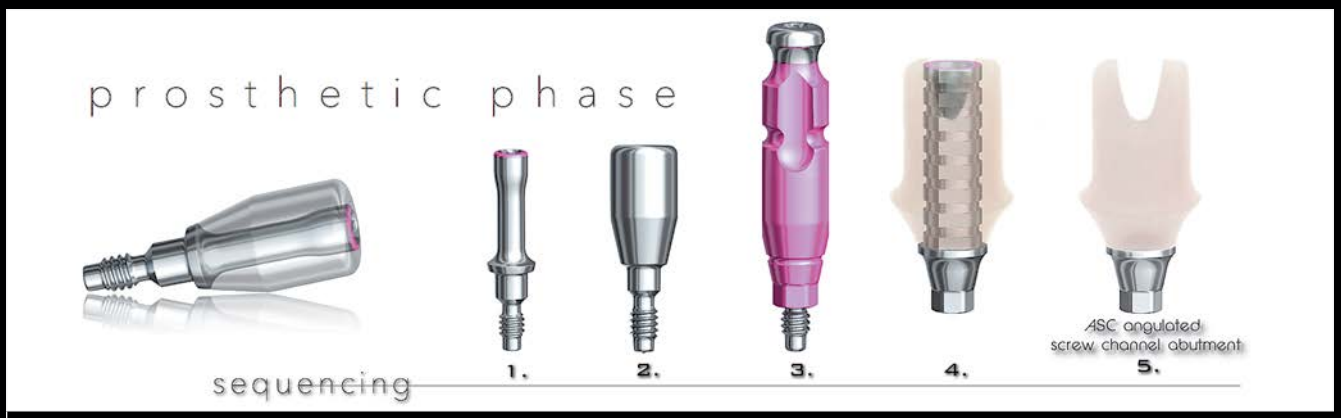
Fig 8 Intraoral situation 3 months postsurgery.

Prosthetic Phase

The prosthetic phase of the Slim concept (Fig 9) is equivalent to conventional surgical and prosthetic protocols. The Slim healing abutment is intended for surgical purposes and can be replaced after the initial healing phase with a conventional, prosthetically designed healing abutment. A customized healing abutment can be applied at this stage of the restorative phase if needed. The remainder of the prosthetic phase can be completed conventionally as preferred by the clinician, with an impression coping that has the same diameter as the healing abutment to avoid the need for local anesthesia. Proper soft tissue support is provided by a provisional or final abutment and a provisional crown made from the wax-up.

An impression of the implant was made under local anesthesia. Removal of the healing abutment and connection of the impression coping require a careful approach due to the large amount of tissue that has to be displaced and the diameter of the impression coping, which should be as small as possible. The Slim healing abutment has a wider base at the implant connection level and, therefore, has to be removed with pliers (Figs 10a and 10b). The impression coping must be seated with some vertical pressure (Fig 10c), and perfect adaptation should be verified radiographically (Fig 10d).

A polyvinyl siloxane (PVS) implant impression was made with the corresponding narrower impression coping, and a master cast was fabricated. A diagnostic full-contour wax-up was made to replicate the natural tooth and duplicate its diameter, especially in the gingival third. A line was drawn on the master cast following the ideal scallop of the wax-up and desired emergence profile to carve a cone from that line to the abutment head (Fig 11). PVS matrices were made to visualize the full-contour wax-up and fabricate the composite abutment. The stone was carved with hand instruments until an ideal, divergent cone was created. An ASC angulated screw channel wax-up sleeve (Nobel Biocare) and the corresponding laboratory screw were selected (Figs 12a and 12b).



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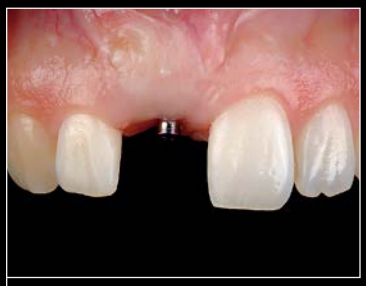
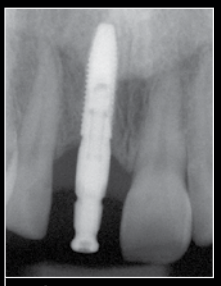


10a

10b

10c



10d

11

12a

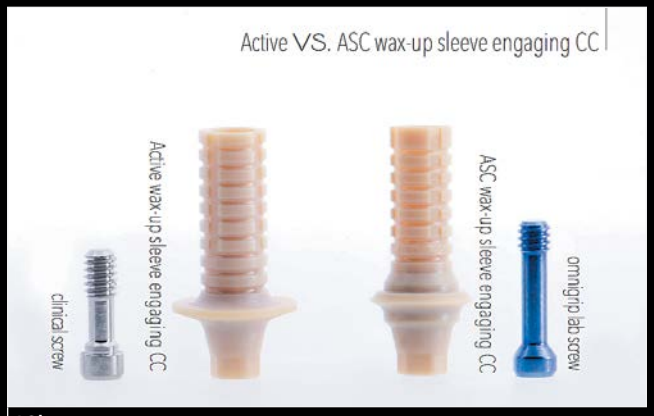
Fig 9 Schematic description of the prosthetic phase of the Slim concept.

Figs 10a to 10d Three months after surgery, an impression of the implant was made. Due to the difference in dimensions, the impression coping was seated with vertical pressure and adaptation was verified radiographically.

Fig 11 Diagnostic full-contour wax-up was made to replicate the natural tooth and duplicate its diameter, especially in the gingival third. The line on the master cast indicates the ideal scallop of the wax-up and desired emergence profile.

Fig 12a ASC angulated screw channel wax-up sleeve (Nobel Biocare) and the corresponding laboratory screw were placed.

Fig 12b Active *(left)* vs ASC *(right)* wax-up sleeve engaging CC and respective screws.



12b

13a

13b

Figs 13a and 13b The plastic ASC wax-up sleeve engaging CC abutment was connected to the laboratory analog, and composite resin was placed between the conically carved stone and the plastic sleeve. The composite abutment was prepared and scanned to fabricate a duplicate zirconia abutment.

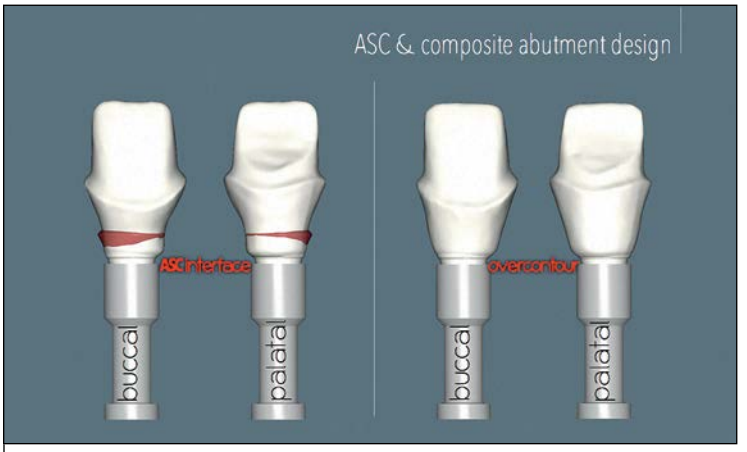


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Fig 14 *(left)* The composite abutment was too thin *(marked in red)* in the areas of the titanium connector. *(right)* The abutment was modified to provide sufficient support.

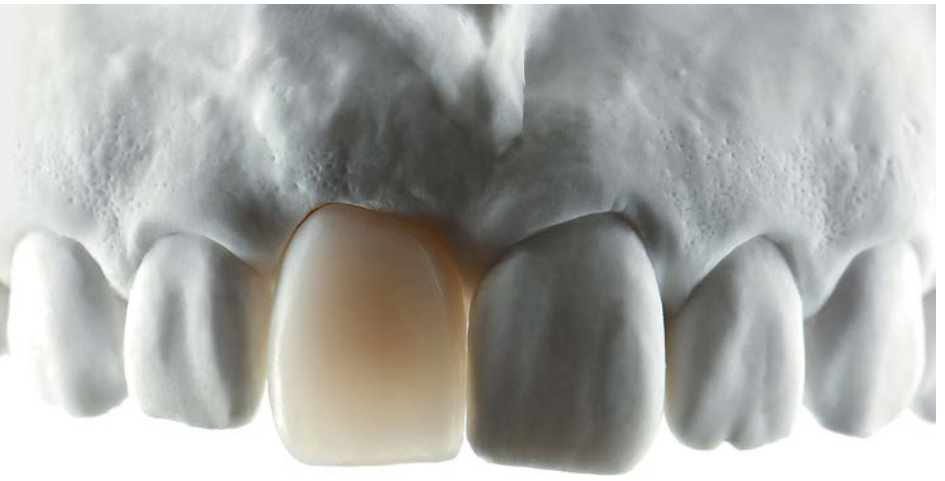
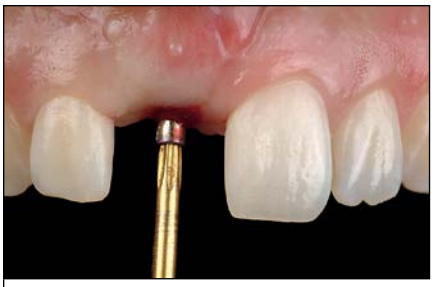


Fig 15 Provisional crown on the definitive Zr abutment and master cast.

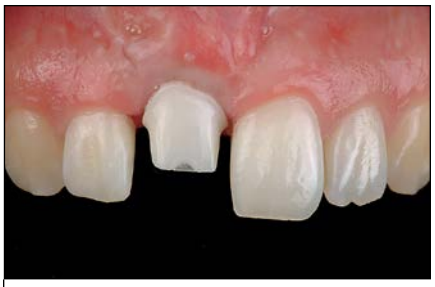
The plastic ASC wax-up sleeve engaging conical connection (CC) abutment was connected to the laboratory analog. Composite resin was placed between the conically carved stone and the plastic sleeve until the entire contour was filled. The composite abutment was light cured and prepared to create, in reference to the ideal contour, a 1-mm subgingival margin on the labial aspect and supragingival margin on the lingual aspect (Figs 13a and 13b). The composite abutment was then scanned to fabricate a duplicate zirconia (Zr) abutment from the provisional abutment. Figure 14 depicts areas (marked in red) in the first composite abutment that did not provide sufficient support for the titanium connector, which retains the definitive Zr ASC abutment on the implant. A thin layer of wax was added in the critical areas and the modified abutment was scanned again, now providing ideal support for the metal connector.

The provisional crown (Fig 15) was fabricated with a sandwich technique on the final Zr abutment with the PVS matrices. The subgingival aspect of the abutment was



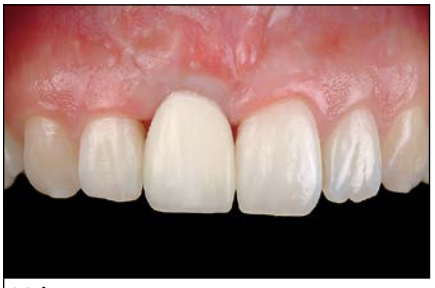
16a

16b

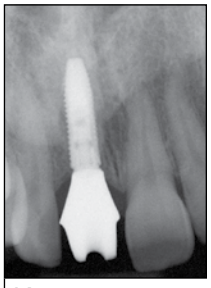


16c

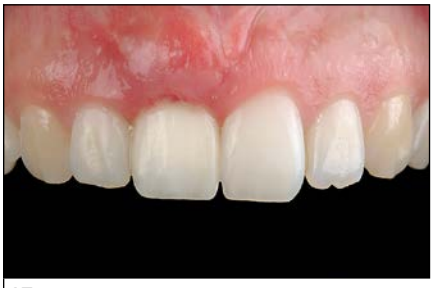
Figs 16a to 16e Slim healing abutment was removed and the final Zr abutment as well as the provisional crown were connected and verified with a periapical radiograph.



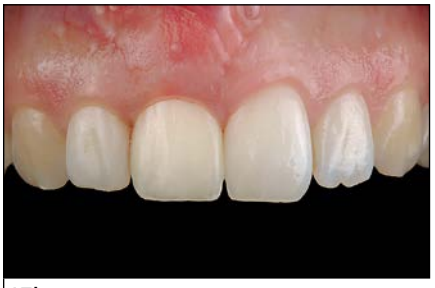
16d



16e



17a



17b

17c

Figs 17a to 17c Healing and soft tissue maturation after *(a)* 5 days, *(b)* 1 month, and *(c)* 3 months.

slightly modified from a divergent to a more concave design to allow a thicker band of peri-implant connective tissue. The subgingival aspect was slightly roughened with a fine diamond to create a surface roughness that favors soft tissue adhesion.

The Slim healing abutment was removed using local anesthesia and the final Zr abutment was connected (Figs 16a to 16d), its definitive seating verified with a periapical radiograph (Fig 16e). The physical pressure of the prosthetic components causes the typical blenching of the surrounding soft tissues by reducing the blood flow and eventually causing necrosis. In the authors' clinical experience, no recessions have been observed in any cases grafted with CTGs from tuberosity, which is due to the quality and density of the connective tissue as compared to CTGs from the palate. The provisional crown is then relined chairside to establish ideal fit and proper interproximal contact points. The abutment can be disconnected to adjust the margins and polish the provisional crown restoration extraorally.

During the healing process, inflammation and a creeping effect of the tissues around the final Zr abutment and provisional crown restoration were observed from 5 days (Fig 17a) and to 1 month (Fig 17b) after abutment connection. Three months after insertion of the provisional restoration, the soft tissue situation around the restoration in terms of volume, interproximal height, and buccal/palatal support was ideal (Fig 17c). However, the level of the gingival margin on the labial aspect required additional pressure to control and blend the scallop of the tissue on the implant restoration to the adjacent central incisor.

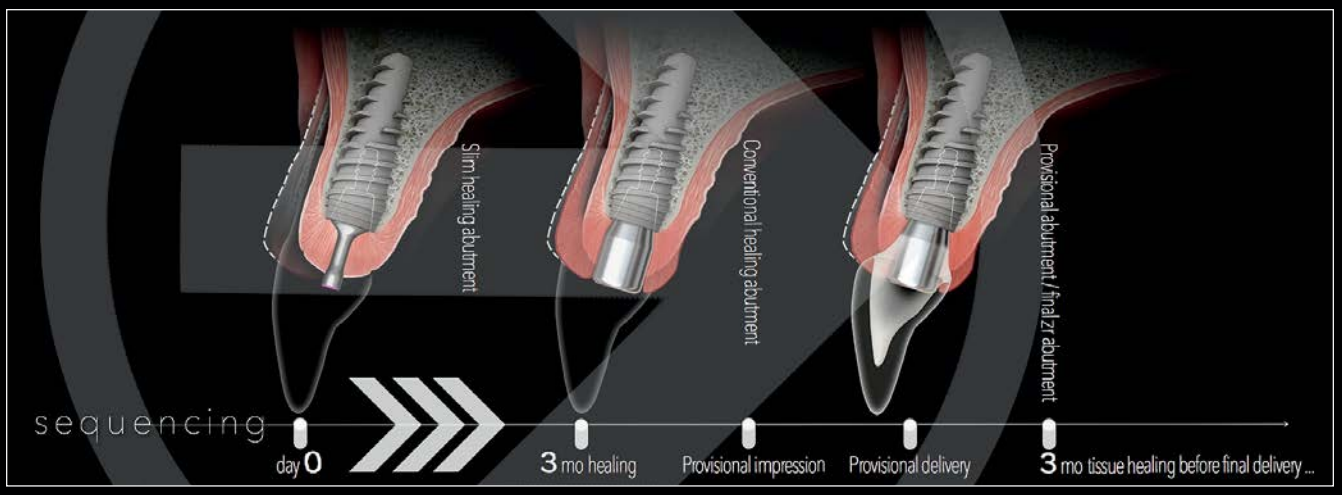
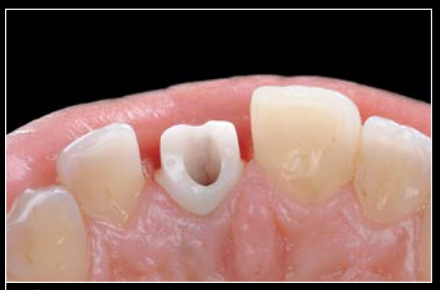


Fig 18 Sequencing of the prosthetic phase of the Slim concept.

19a

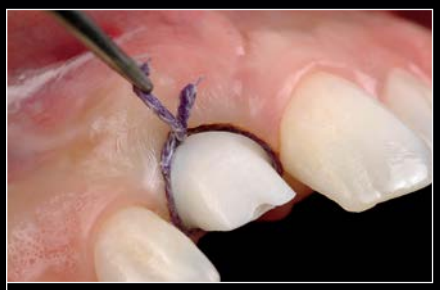


19b

Fig 19a and 19b Palatal support is critical for buccal and interproximal soft tissue esthetics and stability.

20a

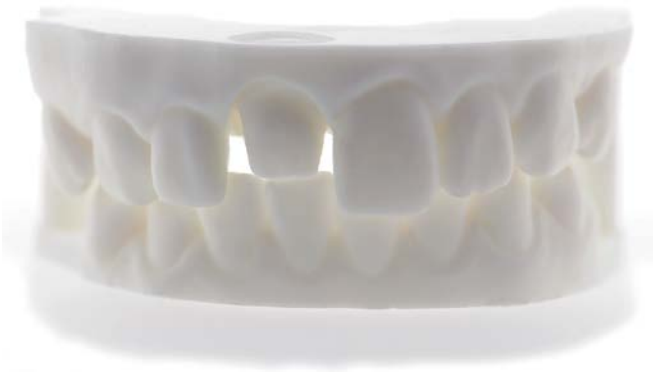
20b



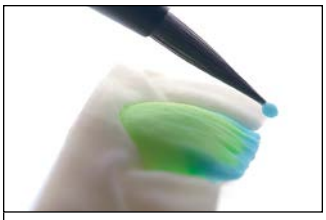
20c

20d

Figs 20a to 20d Digital final impression was made after placing a retraction cord.



21



22a

22b

22c

22d

23a

23b

23c

Fig 21 Printed model.

Figs 22a to 22d Veneer porcelain layering of the definitive crown.

Figs 23a to 23c Glycerin gel delays desiccating of the teeth during bisque bake try-in. A pick-up impression of the crown was made.

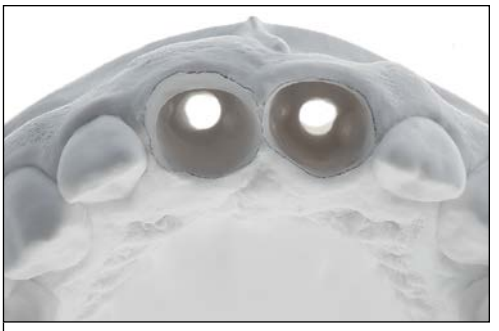
After 3 months of tissue maturation, the prosthetic phase and sequencing of the Slim concept is rather simple (Fig 18). A conventional or customized healing abutment can be attached to the implant once the initial healing phase has been completed, and the patient is sent to the restorative dentist for the provisional and final restoration. A minimum of 3 months is needed to ensure that soft tissue stability, adequate volume, and ideal scallop have been achieved before final impressions.

Palatal support is critical to improve buccal esthetics and to ensure sufficient blood supply for the crestal and the interproximal soft tissues 3 months after final Zr abutment connection (Figs 19a and 19b).

The preparation finish line width and depth were carefully evaluated to give the technician the ability to create more pressure by adding porcelain subgingivally and creating a nice emergence profile. A digital final impression was made (IOS, AADVA system, GC), as demonstrated in Figs 20a to 20d. A retraction cord was placed to capture the finish line. A 3D-printed model and a Zr coping were ordered through the respective software.

After the printed model (Fig 21) and the Zr coping were received from the manufacturer, the technician layered the veneering porcelain onto the coping to match the implant restoration to the adjacent tooth. Staining was used during the porcelain build-up to visualize the layer positioning of the different porcelain masses and perform a more precise layering technique (Figs 22a to 22d).

The anterior teeth were covered with a thin layer of glycerin gel for the bisque bake try-in (Figs 23a to 23c). This keeps the teeth moist for a longer period of time and provides additional time to evaluate the value and color of the bisque bake restoration before the teeth desiccate. Additional pressure was needed on the facial aspect of


24a


24b


24c


24d


24e

Figs 24a to 24e Emergence profiles of the natural tooth and the crown were evaluated.

the restoration to match the scallop of the left central incisor. The bisque bake crown was then cemented with a temporary cement mixed with petroleum jelly, and a pick-up impression was made.

A "Geller model" was fabricated from the pick-up impression to visualize the emergence profile of the restoration, the grafted tissue volume, the adjacent tooth diameter, and other necessary information to blend the restoration into the respective site. The slight lack in volume required a specific 90-degree profile to provide the desired tissue support and esthetics (Figs 24a to 24e).

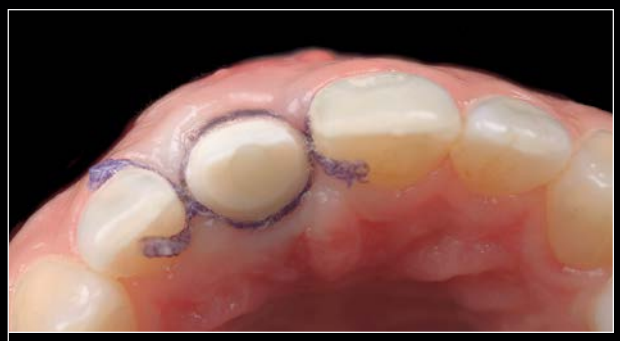
Whenever a definitive abutment is placed together with a provisional restoration, it should be completely removed before final cementation of the definitive restoration to check for any excess cement that may have remained on the soft tissue or abutment surface. If necessary, cement remnants should be removed by thorough rinsing of the tissue with saline and chlorhexidine. The abutment should be cleaned with sterile gauze and saline to remove all cement and debris remnants. After cleaning, two retraction cords were placed independently, one on the buccal and the other on the palatal aspect of the abutment (Fig 25a). The cords were extended into the sulci of the adjacent teeth, which allows for easy retrieval of the cords and control of cement removal from both sides, the labial and lingual, independently (Fig 25b). A periapical radiograph was taken after cleaning of the cementation site with dental floss.

Key stages of the implant treatment in this patient with a high smile line are presented in Figs 26a to 26d. The clinical situation and radiograph 1 year after treatment (Figs 27 and 28) indicate ideal and stable soft tissue conditions, validating the concepts and materials applied in this case.

CONCLUSION

The Slim concept provides the unique ability to create an abundance of soft tissue volume in the early surgical stages. This abundance is necessary to achieve the desired esthetic outcomes and ensure their long-term stability.

Note: The Slim healing abutment is not currently available in the United States.



25a

25b

26a

26b

26c

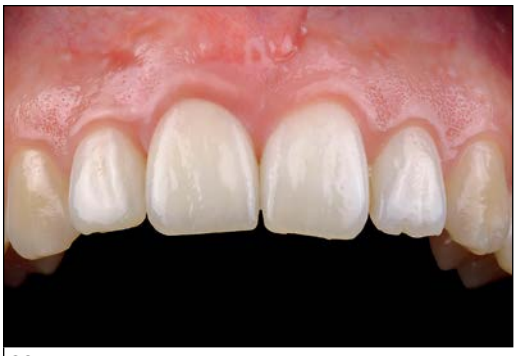
26d

27

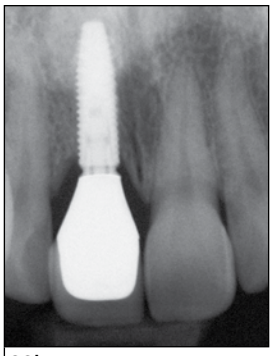
Figs 25a and 25b After cleaning of the abutment, two retraction cords were placed to contain excess cement: one on the labial and the other on the lingual aspect.

Figs 26a to 26d Key treatment stages of the single-tooth implant restoration.

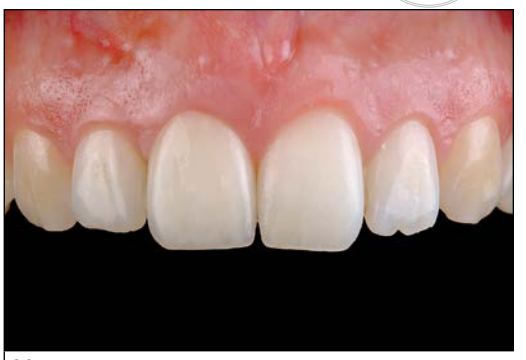
Fig 27 Situation at 1-year follow-up.



28a



28b



28c

Figs 28a to 28c Stable soft tissue conditions at 1-year follow-up.

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