Implant-supported Fixed Prostheses with Integrated Artificial Gingiva for the Esthetic Zone: the *Pink Power Concept*

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INTRODUCTION

Since the advent of modern implant dentistry, related performance has been primarily assessed in terms of achievement of osseointegration and its long-term maintenance (Albrektsson et al. 1986; Buser et al. 1990). Nowadays, overall implant survival and success rates are expected in the range of 90-95% after 5 to 10 years of clinical service, regardless of their location in the jaws (Adell et al. 1981; Buser et al. 1997; Behneke et al. 2002; Giannopoulou et al. 2003; Esposito et al. 2009a; Grütter & Belser 2009).

One should be aware, however, that in the majority of the studies published to date that deal with implants placed in the *anterior maxilla,* mostly survival and traditional success rates, but no additional objective esthetic parameters were taken into consideration, leading clinicians and patients to the often erroneous assumption that replacing anterior teeth with implants is always an easy and highly predictable treatment (Grütter & Belser 2009). In fact, there is a growing body of evidence indicating that, particularly in the case of implant replacement of multiple missing anterior teeth (Mitrani et al. 2005; Mankoo 2008), the achievement of an esthetically pleasing outcome may be challenging and underlines the importance of including objective esthetic parameters in studies reporting data on anterior implant therapy (Belser et al. 1998; Grunder 2000; Belser et al. 2004; Buser et al. 2004; Higginbottom et al. 2004; Grunder et al. 2005; Fürhauser et al. 2005; Meijer et al. 2005; Evans & Chen 2008; Gehrke et al. 2008; Belser et al. 2009; Gehrke et al. 2009; Juodzbalys & Wang 2010).

If the esthetic success of anterior fixed implant-supported prostheses is to be judged based on their final resemblance to the adjacent natural dentition, the respective soft tissue integration of the implant-restoration complex becomes highly important. This is particularly true given that clinicians are increasingly facing a patient population seeking implant therapy that has shifted towards younger and esthetically highly demanding individuals. As a consequence, primary attention has shifted from implant-bone integration to implant-soft tissue integration (Hämmerle et al. 1996; Cochran et al. 1997; Salama et al. 1998; Kois 2001; Mitrani et al. 2005; Thoma et al. 2009; Schneider et al. 2011). In this context, numerous surgical soft tissue preservation/enhancement techniques, including facial contour augmentation (Buser et al. 2008a,b), have been developed for implementation either at the time of tooth extraction or later at the moment of implant placement. However, there is currently no consensus on how predictable some of the soft tissue preservation/enhancement techniques really are and data on long-term soft-tissue stability around implant-supported prostheses after implementation of such procedures are scarce (Esposito et al. 2009b; Thoma et al. 2009; Schneider et al. 2011).

At the other end of the therapeutic spectrum, i.e. trying to use purely technical-restorative measures to compensate for missing soft-tissue volume and compromised contours, one may consider successfully implementing tooth-colored material (Goodacre 1990; Duncan & Swift 1994; Hannon et al. 1994; Costello 1995; Zalkind & Hochman 1997; Greene 1998; Priest & Lindke 1998; Botha & Gluckman 1999; Jacques et al. 1999; Cura et al. 2002; Haj-Ali & Walker 2002; Barzilay & Irene 2003; Garcia & Verrett 2004; Capa 2007; Kamalakidis et al. 2007; Cascione et al. 2008; Mankoo 2008; Coachman et al. 2009; Kim et al. 2009; Salama et al. 2009; Coachman et al. 2010; Kim et al. 2010).

In the authors' opinion, the use of artificial gingiva, also termed *gingival epithesis,* as an integral part of a maxillary anterior implant-supported fixed dental prosthesis (FDP) should be reevaluated as an alternative, nevertheless essential tool to re-establish and predictably maintain visual harmony. Unfortunately, there is a general tendency among clinicians to reject consideration of artificial gingiva. As most such attempts made in the past led to FDPs that were literally impossible to clean when applying the patient's routine oral hygiene efforts, clinicians only accept its use as the last "desperate" resort in the case of major tissue deficiencies or after grafting failures. Similarly, oral surgeons tend to consider the need for artificial gingiva as

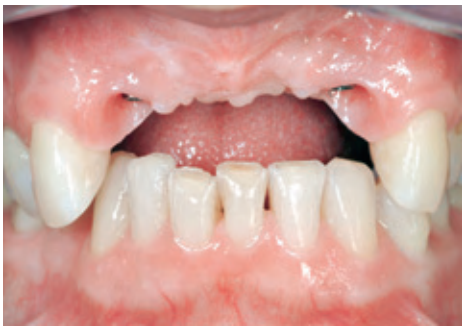

Fig. 1a

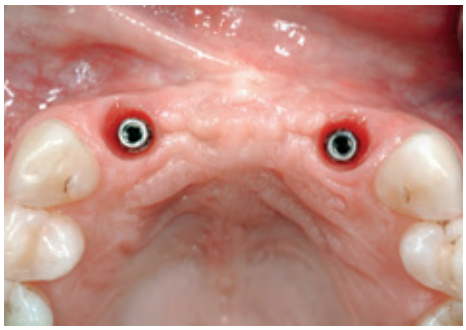

Fig. 1b

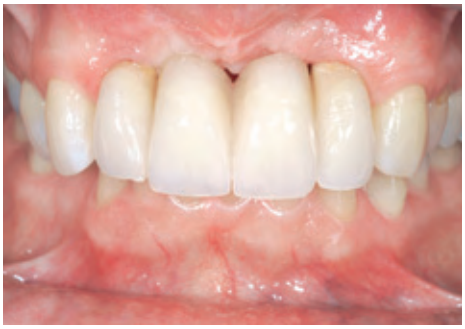

Fig. 1c

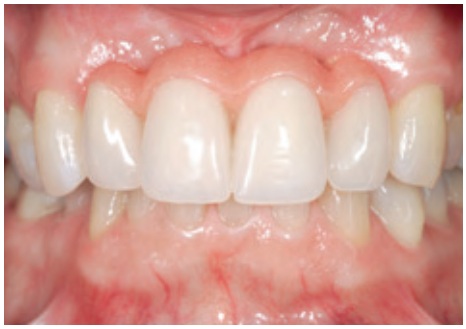

Fig. 1d

Figs 1a – d: Frontal and occlusal views of a 47-year-old female patient, displaying two NNI at positions 12 and 22 (A, B). Note that the altered width-to-length ratio of the clinical crowns and the long interdental contacts that have been chosen to reduce the size of the black triangles. A second temporary restoration comprising gingival-colored acrylic was necessary to regain visual harmony (d)

a "defeat" and consequence of poorly planned and/or performed implant surgery.

Finally, less-than-optimally informed patients frequently reject the idea of artificial gingiva, due to its emotional correlation with the removable prosthesis predicament.

In contrast, the only dental professionals who seem to understand and appreciate its real potential are laboratory technicians. However, they often do not dare to propose to or impose an integrated gingival epithesis on the clinician. Instead they try to compensate for the problem of unsightly black triangles by lengthening the inter-dental contact area apically with tooth-colored ceramics, using different highly saturated colors, varying from whitish to yellowish to brownish. One should be aware, however, that corrections of this type adversely affect the normal length-to-width ratio of the clinical crowns involved (Sterrett et al. 1999; Magne et al. 2003). Thus the teeth will appear larger and by the same token less natural, while the embrasures will exhibit a darker color to give an impression of depth. In other words, the final prosthesis will to a certain extent reproduce the stigma of periodontally involved, too large teeth.

In order to revisit the use of integrated gingival epitheses in a modern context of implant-based FDPs, and to underline its powerful potential to its real value, the authors termed it the *"Pink Power Concept"*. Hence, the *Pink Power Concept* (PPC) is a well-defined new approach that fundamentally reevaluates the use of artificial gingiva not as the last resort in the case of severely compromised situations, but as part of a structured implant-restorative strategy applicable to the treatment of multiple-unit gaps (two or more adjacent missing teeth) in the esthetic zone, designed to facilitate esthetic predictability (Figs 1a – j). This presupposes meticulous treatment planning, comprising optimal implant selection in terms of type, size, number and position, ideally performed before teeth are extracted.

The aim of this article is to (1) provide clinical decision-making criteria to determine when integrated pink ceramics are the design option of choice; (2) present strict, well-defined design guidelines; (3) discuss the associated clinical and laboratory steps; and (4) confirm the esthetic potential of the *Pink Power Concept* by typical case documentations.

DIAGNOSTICS AND RELATED CLINICAL DECISION-MAKING

Communication between clinician, patient and dental technician

Patients are often quite unaware of certain biological limitations and their impact on esthetic appearance that still persist despite the continuous, remarkable scientific progress made during the past decades in clinical dental medicine in general and in implant dentistry in particular. A lack of communication over possible problems that are not operator-related but due to an independent variable (e. g. bone remodeling after tooth extraction), may lead to conflicts and misunderstandings. This comprehensive communication should therefore take place before starting any substantial treatment and is not only mandatory between the clinician and the oral surgeon responsible, but also has to include the patient and the laboratory technician.

Unfortunately, many laboratory technicians are not given the opportunity to see the patients and they traditionally try to design their restorations solely based on the information provided by stone models that are

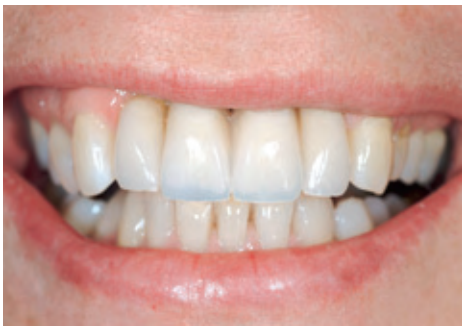

Fig. 1e

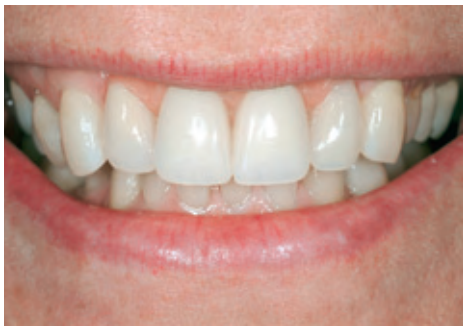

Fig. 1f

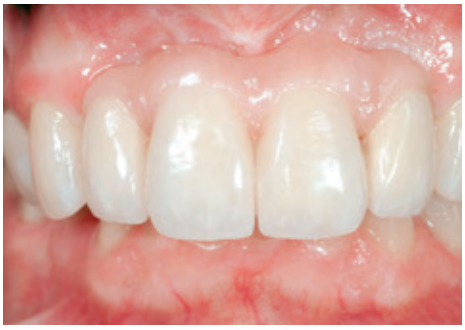

Fig. 1g

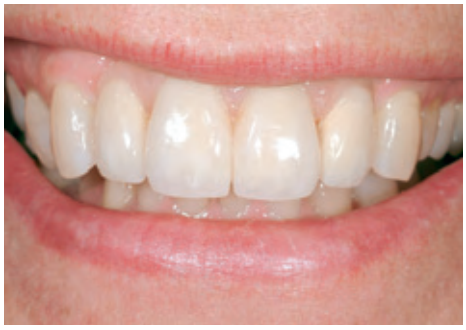

Fig. 1h

Figs 1e – h: Clinical pictures taken with the patient's natural smile: traditional provisional (e), provisional with added pink acrylic (f), final screw-retained ceramo-metal restoration (g – h). The gingival-colored ceramic features a distinctly pale shade and a border between artificial gingiva and alveolar mucosa more apical than the patient's smile line

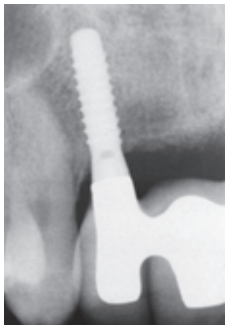

Fig. 1i

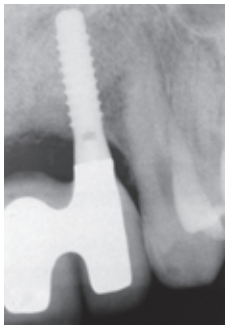

Fig. 1j

Figs 1i – j: The 4-year follow-up radiographs confirm stable osseointegration conditions

sometimes supplemented by non-standardized clinical photographs. The major limitation of this approach consists in the lack of visibility of the dynamic interaction between the lips and the dentition. Often what may appear perfectly harmonious on the stone cast does not match the patient's expectations.

The era when patients had total trust in the clinician's capacity to guess and decide on what constitutes the best final result in a given preoperative situation is long over. Not infrequently, patients today have a clear picture in mind of what they want, including high and sometimes unrealistic esthetic expectations. This calls for a careful preoperative evaluation of each individual patient before implant surgery, not only to determine what the patient likes and expects, but also to explain in an easy and visualized way some of the limitations inherent to this type of therapy (i.e. implant-based multi-unit FDPs), especially when taking place in the esthetic zone.

According to the *Pink Power Concept* (PPC), there are four main phases of diagnostics, communication and elaboration of the final FDP:

- Analysis of the initial status
- Diagnostic wax-up/set-up before implant placement, comprising clinical try-in (e.g. diagnostic clinical "mock-up"), followed by mutual initial validation, and subsequently by fabrication of a logically derived surgical guide
- Provisional implant-based fixed dental prosthesis (FDP) and its subsequent optimization and mutual final validation
- Bisque bake try-in and finalization of the definitive FDP

For each of these steps, the practitioner should take standardized clinical images,

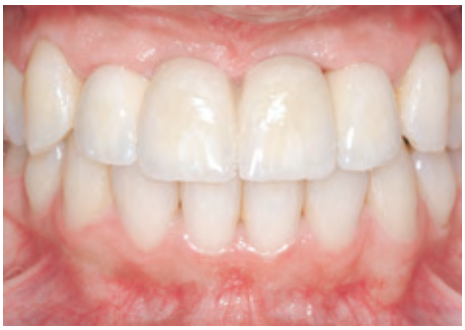

Fig. 2a

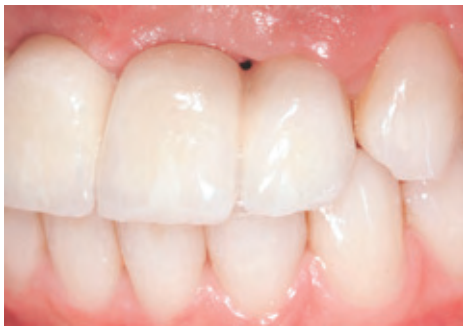

Fig. 2b

Figs 2a – b: Frontal (a) and oblique (b) views of a 30-year-old female patient with a 4-unit metal-ceramic FDP supported by two standard diameter solid screw tissue level implants (TLI) in position 12 and 22. The patient's concern is related to the "black triangle and shadow" visible at embrasure 21/22

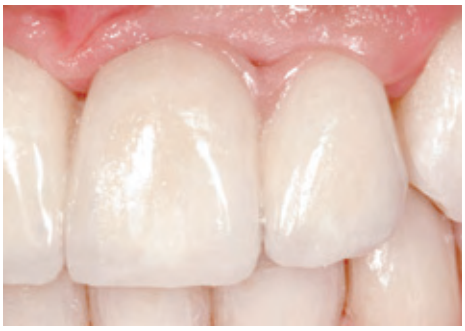

Fig. 2c

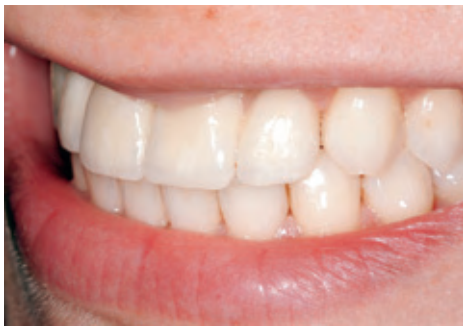

Fig. 2d

Figs 2c – e: A small amount of gingival-colored ceramic has been added locally (c) to correct the problem, as the patient's smile line only moderately exposes the gingival tissues in the papillary area, but not its cervical border. The combination of prolonged interdental contact lines and the adjunction of pink (d) was sufficient to reestablish visual harmony. Minimal access for dental floss is mandatory for adequate plaque control (e)

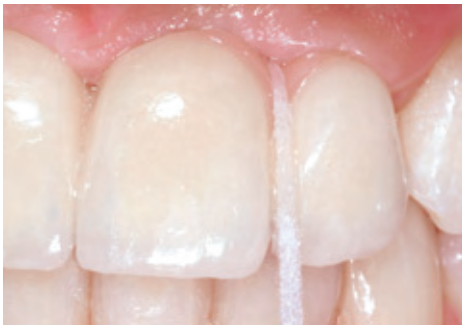

Fig. 2e

displaying both the teeth and the edentulous ridge and – even more importantly – the lips of the patient at various degrees of smiling (Magne et al. 1999), to document and guide the development of the envisioned treatment. The main goal being to evaluate and confirm in a first phase whether a given patient will significantly benefit from the use of artificial gingiva.

When dealing with a patient whose maxillary anterior teeth need to be extracted and replaced by an implant-supported FDP, it is clearly recommended to carry out this evaluation before tooth extraction. This first analysis will be essential to decide whether it is feasible to implement artificial gingiva, which in turn will determine type, size, number and position of the implants to be involved. This approach is termed *"backward planning"* and will lead to a *"restoration-driven"* decision, in contrast to the no-longer recommended *"bone-driven"* decision that is traditionally taken at the time of implant surgery, primarily based on the local bone anatomy and available volume (Garber 1995). A more detailed and extensive description of the PPC can be found elsewhere (Vailati & Belser 2012).

Analysis of the initial status

When it comes to implant therapy in the form of FDPs that are located in the appearance zone, a major concern is clearly the quality and the predictability of the treatment outcome from an esthetic point of view. Firstly, this calls for a structured, comprehensive preoperative esthetic risk assessment, as described in detail in ITI Treatment Guide Vol. 1 by Martin et al (2006). Secondly, the difficulty level of a given initial situation should also be assessed, based on the SAC classification system published and edited by Dawson & Chen (2009). These two preliminary diagnostic evaluations

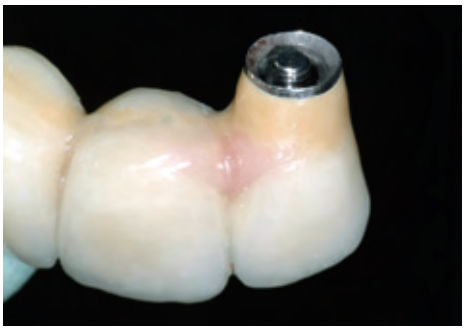

Fig. 2f

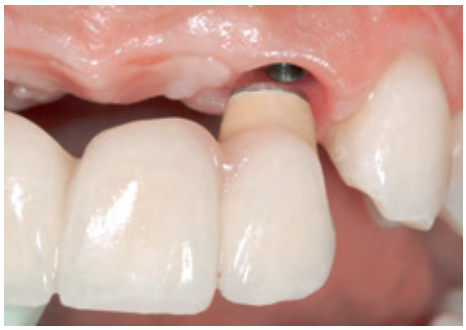

Fig. 2g

Figs 2f–i: Note the circular flat emergence profile, as well as the complete convexity in the area of the artificial gingiva and the ovate pontics

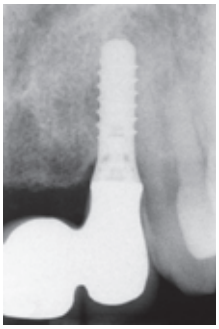

Fig. 2h

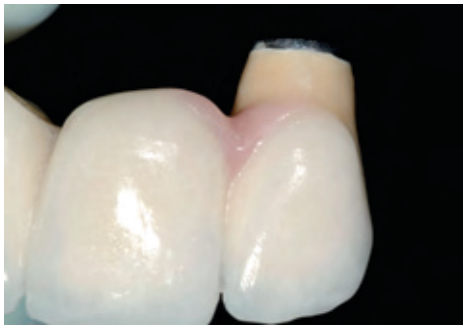

Fig. 2i

will clearly help to guide the clinician and significantly contribute to decreasing the incidence of complications. More specifically, the alveolar ridge alterations that occur following tooth extraction are well established (Atwood 2001; Araujo & Lindhe 2005). Summarized in a simple manner, tooth loss in the anterior maxilla normally leads to a flattening of the originally scalloped alveolar ridge in the frontal plane, and a loss of vertical and horizontal bone volume, both more pronounced on the vestibular aspect of the sites involved. All these elements clearly have their esthetic drawbacks.

In the esthetic zone, the currently recommended strategy is to limit the number of implants placed (Vailati & Belser 2007). This concept has evolved from bad experience with adjacent implants in the anterior maxilla, where the inter-implant tissue height often significantly diminishes after tooth extraction and implant surgery, leading to unsightly open embrasures termed "black triangles". For the time being, avoidance of adjacent implants and implementation of the superior esthetic potential of ovate pontics rather than the described highly problematic configuration associated with multiple adjacent implants appears to be a reasonable approach (Spear 2008; Spear 2009). One has to note, however, that this strategy is primarily based on prosthodontic common sense and anecdotal clinical experience rather than on formal scientific evidence.

Another key element of the initial diagnostic process consists in evaluating the patient's smile line in order to precisely determine whether and to which extent the gingival tissues and perhaps also the alveolar mucosa are exposed (Jensen et al. 1999). The following categories of soft tissue exposure during maximum natural smiling are distinguished:

A) NONE to MINOR soft tissue exposure
This refers to situations where during the most excessive smile the patient displays no or only minimal gingival tissue, i.e. only the coronal portion of the papillae, with no soft tissue apically of the clinical crowns. Attention should be paid to patients who may strongly dislike the appearance of their anterior maxillary dentition and may have "learned" to smile with a lip constriction. If there is a suspicion of that kind, the patient should be invited to produce a "grimace": an easy-to-understand "trigger expression", usually suitable to obtain a full smile. Once the presence of minimal soft tissue visibility has been confirmed, the authors recommend in most instances implementing a traditional type of FDP design, i.e. no addition of gingival-colored material, flat emergence profiles and accessible embrasures. The patient is informed that, at a later stage of the planned implant treatment, increased-length artificial clinical crowns, probably also featuring an altered length-to-width-ratio, will be present but not spontaneously visible. This will only be the case, if the patient actively pulls back the lips with his fingers.

B) MODERATE soft tissue exposure (Triangular Type)
During maximum smile, these patients show the papillae (or part of black triangles in the case of tissue recessions), whereas the junction with the apical mucosa is not visible. This configuration represents the most favorable initial condition for PPC, since in the context of the future prosthesis only the artificial

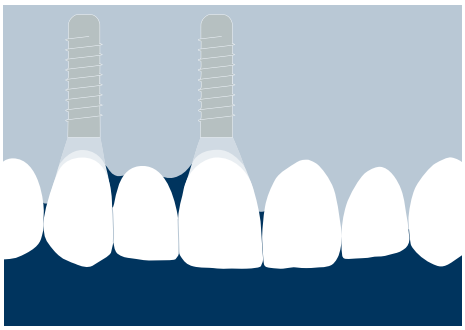

Fig. 3a

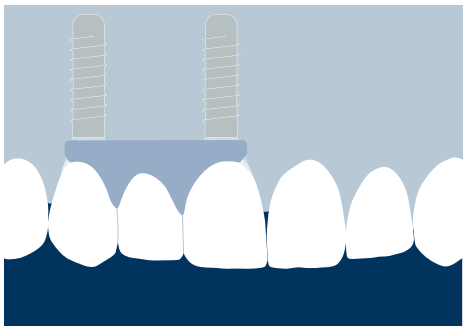

Fig. 3b

Figs 3a – b: Schematic frontal view representation of a hypothetical, traditionally designed 3-unit implant-supported FDP 13x11, and its comparison to an intact natural dentition in the region of 21, 22, and 23 (a). Note the impact on appearance of the flattened alveolar ridge: long interdental contact lines, black triangles, and altered width-to-length ratios. A similar FDP, comprising an integrated gingival-colored compartment (b), demonstrates the significant esthetic improvement associated with this design option

papillae, i.e. the vertical component, will be visible, while the horizontal junction between the natural mucosa and the gingival-colored ceramics will be hidden behind the upper lip. This condition is termed Triangular Type (T-Type), since frequently only the papillae will be reproduced in pink ceramic, and the sole challenge is in creating a perfect color match with the neighboring natural papillae (Figs 2a – i).

In a previously published article, in the case of four missing maxillary incisors the authors recommend, primarily for esthetic reasons, placing only two implants, preferably at the mesial and distal end of the prospective edentulous jaw segment (Vailati & Belser 2007). Furthermore, the use of reduced-diameter implants (narrow neck implants) was suggested to better reproduce the average size of the two lateral incisors in the final prosthesis. However, if the embrasure between the lateral and the central incisors involves artificial gingiva anyway, a mechanically stronger, regular neck implant could be used without any appreciable esthetic trade-off. Consequently, if the local conditions are classified as a T-Type, the FDP will be supported by mechanically stronger implants and the final esthetic outcome assured by the use of the artificial gingiva.

C) MODERATE to MAJOR soft tissue exposure
In this category, patients completely exhibit their anterior maxillary gingiva up to a maximum height of 2 mm apical to the cervical border of the clinical crowns. A situation also termed as "slight gummy smile". Under such conditions, it is advisable to extend the length of the future anatomic crowns of the prosthesis in an apical direction and by this measure to transform the category into a T-Type.

D) MAJOR soft tissue exposure
If the gingiva are completely exposed, including a visual extension of more than 2 mm from the cervical zenith of the teeth, the patient is classified as presenting major visibility of the soft tissue, also termed as "major gummy smile".

This configuration is clearly the most challenging when it comes to designing an esthetically pleasing and biologically acceptable implant-based multi-unit anterior maxillary FDP. This is in contrast to the previously discussed soft-tissue exposure categories, since the horizontal junction between gingival-colored ceramics and natural alveolar mucosa will be difficult or impossible to hide, unless a concave overlap of the artificial gingiva is used, which is unacceptable from an oral hygiene point of view.

PPC – DESIGN GUIDELINES

Most importantly, in addition to standard prosthodontic quality criteria, an adequately designed PPC restoration has to provide an optimum combination of both esthetic excellence and cleansability. This comprises the gingival-colored portion of the cervical aspect of the multi-unit implant-based FDP, i.e. the creation of an illusion of a harmoniously scalloped mucosal course with papillae, eliminating or significantly reducing any black triangles and reestablishing normal length-to-width ratios of the anatomical tooth crowns.

Two particular regions are of paramount importance: first the zenith of the prosthetic dental unit that is immediately adjacent to the first natural tooth, normally at both ends of the described FDP, and second the apical transition between the gingival extension and the alveolar mucosa. The pink ceramic has to end at the zenith of the mesial and distal FDP units as it cannot be prolonged through the interdental embrasure to reach the mesial surface of the neighboring tooth, because this would either severely jeopardize access for efficient oral hygiene or, if limited to half of the embrasure, lead to a so-called "double-papilla" situation with its obvious esthetic drawback.

Where to precisely locate the transition between artificial gingiva and alveolar mucosa in an apical direction depends primarily on the amount of tissue exposed during the patient's maximum natural smile (ref. minor-moderate-major tissue visibility), but also on the clinician's ability to create sufficient crestal concavity up to this border to harbor the artificial gingival extension that has a convex profile similar to that of an ovate pontic. This profile is mandatory to assure effective plaque control/removal during flossing. The patient has to be instructed accordingly and tested for his respective ability and compliance during the phase of the temporary restoration. Ideally, the transition between the pink compartment of the FDP and the alveolar mucosa should be located outside the zone of visual exposure. The design criteria described in this paragraph and their quantitative

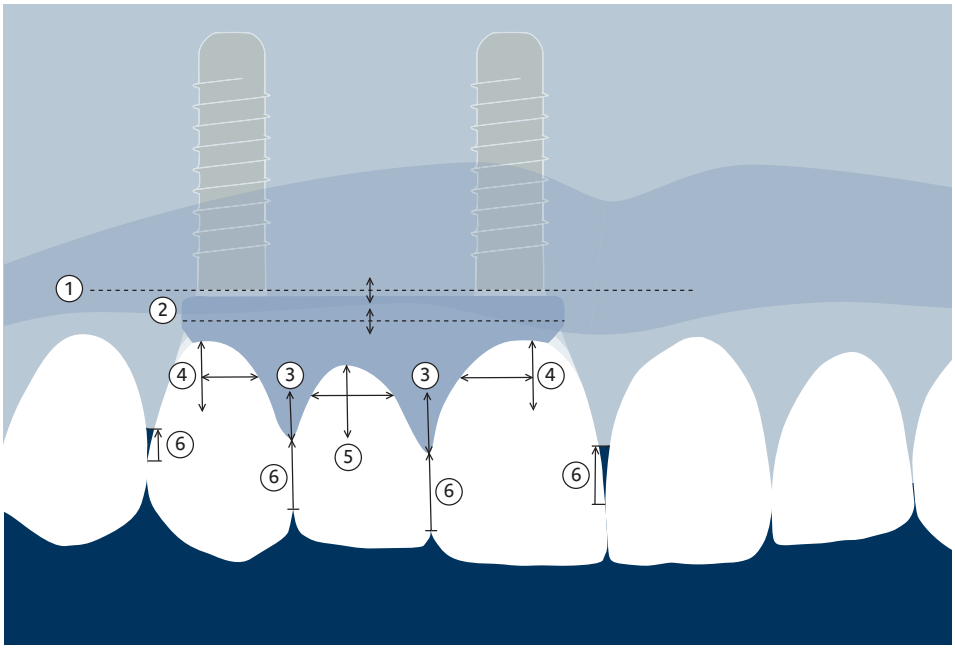

Fig 3c: Schematic frontal view representation of the PPC design principles and the variables that can be modified to optimally adapt to the patient's individual smile line (minimal, moderate or major soft tissue exposure). 1: implant shoulder sink depth; 2: apical border between pink ceramic and alveolar mucosa; 3: height of artificial papillae; 4: cervical border of pink ceramic on implant crown adjacent to natural tooth; 5: cervical border of pink ceramic on pontic; 6: apical limit of interdental contact area

Fig. 3c

latitude/range of freedom are schematically represented in Figs 3a – c.

PPC – CLINICAL & LABORATORY STEPS

As stated in the second paragraph of this article, the PPC process starts with initial diagnosis in order to rapidly verify if a gingival-colored compartment of the planned implant-based multi-unit FDP will significantly contribute to an esthetically pleasing treatment outcome. Once this has been confirmed, three distinct treatment phases will be necessary to (1) determine the design details, (2) permit continuous refinement, and (3) reach an optimum treatment outcome in the form of the final ceramic FDP.

After initial validation, the protocol currently followed predominantly at the University of Geneva for the anterior maxilla, proposes extracting the teeth with as little trauma as possible without flap elevation and then waiting 6 to 8 weeks for soft tissue healing before implant placement. This protocol is termed *Early Implant Placement Concept* and has been described and documented in detail in the literature (Buser et al. 2008a,b). When two or more adjacent teeth cannot be maintained in the anterior maxilla, and implant placement after tooth extraction is slightly delayed as previously mentioned, respective changes at both the bone and the soft tissue level should be expected, especially if the teeth to be extracted are periodontally involved. At the end of the six-to-eight-week soft tissue healing period, i.e. when the prospective sites are ready for implant surgery, the edentulous alveolar ridge has most likely flattened, lost vertical height and oro-facial width.

Therefore, using a duplicate of the patient's existing provisional removable partial denture (RPD) to fabricate the surgical template could be misleading. If one carefully examines the base of the RPD, the discrepancy between the original and the post-extraction position of the buccal bone plate of the anterior maxillary ridge becomes apparent. Additionally, RPDs mostly comprise a buccal flange, which may mask important soft tissue deficiencies that result after tooth loss. For all the above reasons, a comprehensive and meticulous reevaluation of the crestal tissue anatomy, volume and height is recommended before implant surgery.

Diagnostic wax-up/set-up/ clinical mock-up/surgical stent

In most instances, mounting study casts in an articulator is recommended and, based on the information gathered during the clinical examination, proceeding with a first wax-up/set-up of the missing teeth. The laboratory technician, who ideally was present at the clinical examination, is instructed to set case-adapted teeth in the most acceptable position and leave the cervical part without a flange. At that point, one of the most common mistakes is to choose a non-physiologic axial inclination of the teeth to reach the remodeled alveolar crest with their cervical third. The respective outcome from an esthetic point of view is normally poor. It is preferable to choose a normal axis inclination and, during a clinical try-in appointment, show the patient how far from the alveolar ridge the cervical aspect is and then to decide together with the patient if this discrepancy should be resolved by additional surgical interventions or by prosthodontic means alone. Furthermore, the diagnostic set-up without flange allows the practitioner to evaluate the necessity for additional lip support and to demonstrate to the patient the consequences of tooth loss and the associated significant bone remodeling.

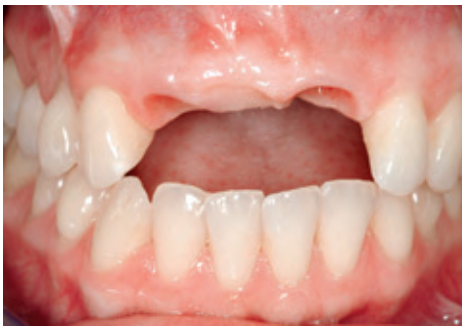

Fig. 4a

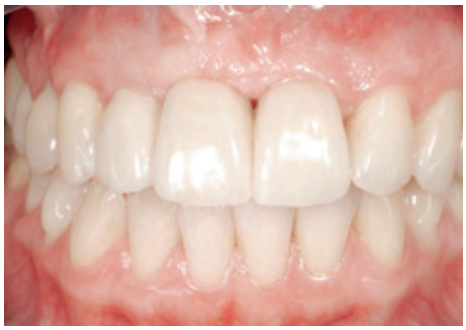

Fig. 4b

Figs 4a – b: Frontal view of a 23-year-old female patient without and after insertion of a provisional 3-unit FDP supported by 2 RC-BLI implants 12 and 21. The amount of soft tissue exposure corresponds to the moderate type

If correctly performed, the diagnostic set-up is an efficient tool to avoid any surprises for the patient at the time of the delivery of the final prosthesis, since, without the buccal flange, the patient can appreciate and understand at an early stage that the supporting tissues are lacking. Instead of the described clinical try-in of a wax-up/set-up of teeth, one may proceed at a first stage to a so-called "diagnostic mock-up" (Magne & Belser 2004), using a silicon key derived from the wax-up and directly press tooth-colored acrylic over the previously isolated edentulous area including the two adjacent teeth. This fast and less costly approach is chosen if there are any doubts related to the correctness of the preliminary wax-up/set-up.

If the patient does not need supplementary lip support or refuses additional surgery, the use of artificial gingiva may represent an elegant alternative approach. In further pursuing diagnostics during the clinical try-in of the described set-up, the clinician may add some gingival-colored flowable composite (e.g. Symphony no 19, 3M-Espe, Minneapolis, MN, USA) to rapidly reproduce the missing papillae and to discuss with the patient the issue of the visibility of the junction between the real alveolar mucosa and the artificial gingiva. Finally, a new set of relevant, standardized pictures is taken, with the completed diagnostic set-up in place, always including the lips.

At this stage, the final decision whether to go for more invasive surgery in order to avoid artificial gingiva or to limit the surgery and use the latter will be taken and the surgical guide fabricated accordingly. This decision can have a beneficial impact when it comes to the precise positioning of the future implants, as FPDs with integral gingival epitheses may allow for a little additional liberty, because the connection to the suprastructure will be partly masked by the gingival-colored compartment. This refers particularly to safety distances between implants and adjacent teeth while also favoring standard implant diameters rather than reduced-diameter implants.

Provisional implant-based FDP

The second phase of confirmation and refinement of the envisioned treatment objective consists of the fabrication of an implant-borne, one-piece multi-unit provisional FDP. The laboratory technician will have to pay particular attention to several elements, namely to create a sufficiently mechanically resistant structure in the area of the pontics and the interdental connections, as this temporary restoration will have to stay in place for several weeks or even a few months, during which time a series of modifications will be performed. It is particularly challenging to provide mechanical resistance on the one hand and additional space for the chairside application of gingival-colored light-curing composite on the other (Figs 4a – j).

As only limited brands of light-curing "pink-colored" (mostly too saturated and reddish) materials are currently available, one needs to prepare a mix of the most suitable pink and a flowable incisal composite (Fig. 4e). The goal is to obtain a rather pale gingiva-like color that will blend into its environment discreetly. Prior to the application of minute portions of the described composite with an explorer, the area should be slightly isolated with glycerine gel (e.g. air-block or oxyguard), to permit easy removal. As described in the design principle paragraph, one starts by determining the coronal limit of the papillae involved. It is important that this level is realistically chosen and does not lead to abrupt discrepancies when compared to the respective height of the first mesial and distal natural papillae of the adjacent dentition.

The described papillary fill-in is then extended cervically to cover part of the two adjacent clinical crowns/pontics gradually, and at the same time provide both with a normal length-to-width ratio and a distinct triangular appearance of the neck portion with the zenith placed slightly distally to the long axis of the teeth. These two elements are key factors when it comes to the implementation of visual harmony. Finally, and probably the most challenging to perform, the precise location and profile of the cervical border between gingival-colored acrylic and the natural alveolar mucosa has to be established. This border location is determined by the amount of tissue exposure during maximum natural smile and by the possibility to create a flat or slightly concave mucosal contact surface on the ridge side for the gingival extension to provide adequate oral hygiene conditions.

Once the described procedure is complete, the patient is asked to get up from the dental chair and stand in front of a wall mirror for a first subjective appreciation of the proposed FDP design. This will initiate

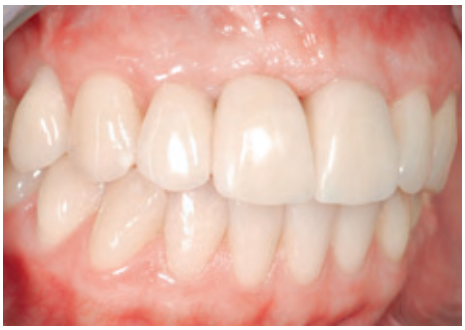

Fig. 4c

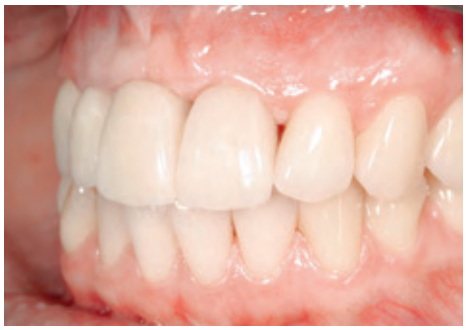

Fig. 4d

Figs 4c – d: The implant-prosthetic elements appear too voluminous due to the technician's attempt to narrow down the open embrasures to a maximum, leading to insufficiently triangular cervical configuration and a slightly altered width-to-length ratio of the three artificial clinical crowns

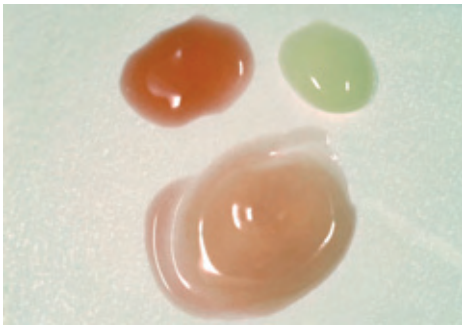

Fig. 4e

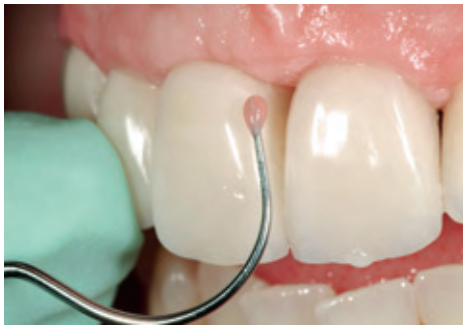

Fig. 4f

Figs 4e – h: The chairside application of lightcuring gingival-colored composite is preferably carried out using an explorer and very small increments of material, normally starting by positioning the coronal limit of the artificial papillae. As the choice of respective colors is currently very limited, a mix with an incisal flowable composite is advisable to obtain a sufficiently pale shade (e). If one has previously isolated the area concerned with glycerine gel, the pink composite can easily be removed (h) to show to the patient the look with or without the artificial papilla

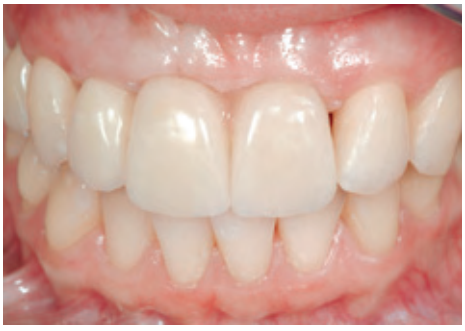

Fig. 4g

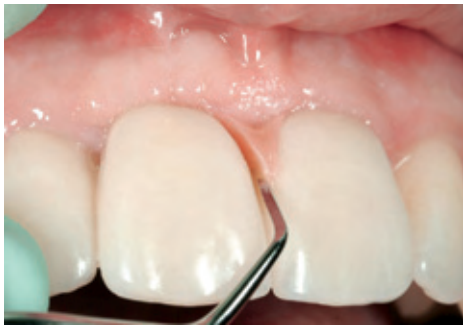

Fig. 4h

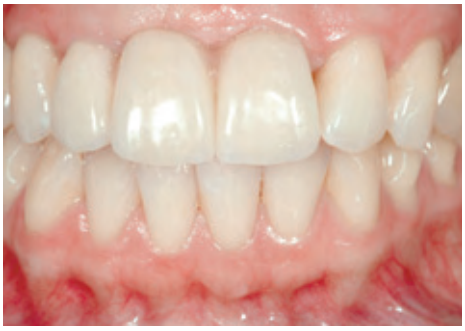

Fig. 4i

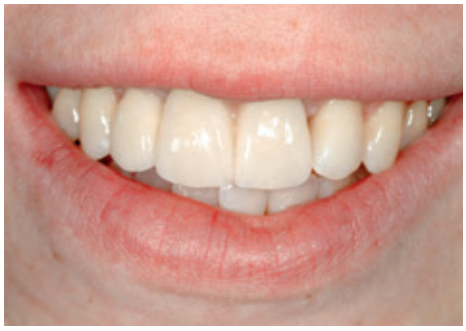

Fig. 4j

Figs 4i – j: The frontal and the lip-framed views document the postive impact on esthetic appearance following adjunction of small but strategically significant amounts of gingival-colored material

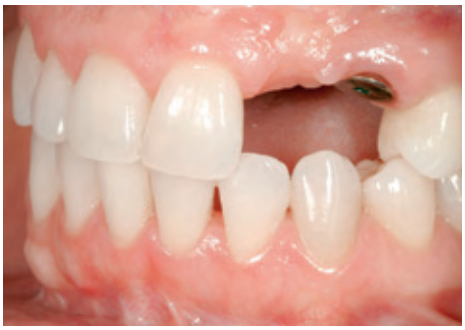

Fig. 5a

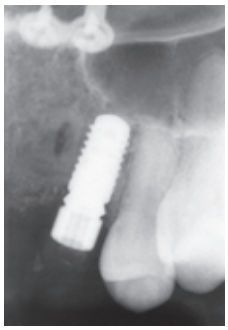

Fig. 5b

Figs 5a – d: Lateral clinical view (a) and corresponding x-ray control (b) of a 35-year-old female patient after placement of a RC-BLI implant in region 23. After insertion of a provisional FDP featuring a mesial cantilever (c), one can observe three minor shortcomings from an esthetic point of view: a short papilla in embrasure 22/23, a too apically located emergence of the ovate pontic 22 from the alveolar mucosa, and a black triangle in embrasure 21/22

Fig. 5c

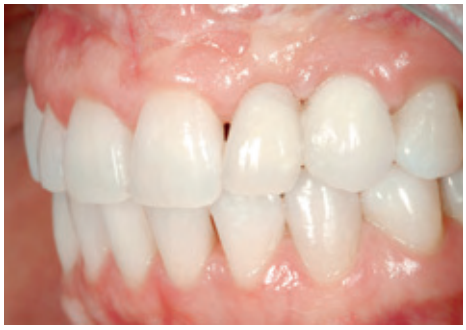

Fig. 5d

a reaction from the patient's side, followed by a usually efficient discussion that is based on visible and tangible elements that may be followed by some modifications. After having given appropriate oral hygiene instructions, most often based on optimal use of super-floss, and verification of the patient's manual ability, the temporary FDP is inserted and the patient re-scheduled for a first control appointment in the near future.

Several follow-up appointments with major or minor modifications may be necessary before the final design is established and mutual agreement has been reached. At that point, new clinical photographs are taken and a study cast fabricated to optimally guide the laboratory technician during the production of the final metal-ceramic or all-ceramic FDP.

Bisque bake ceramic try-in

It is the laboratory technician's responsibility to produce a definitive implant-borne one-piece multi-unit FDP that comprises the key elements developed by the provisional restoration and that fulfills current standards relative to precision, marginal fidelity, passive fit, mechanical resistance, occlusion, axial contours including flat emergence profiles, optical properties, esthetics and, last but not least, cleansability. A particular challenge consists in optimally designing the inter-dental connections, as they have to assure sufficient mechanical resistance while also providing adequate space for the artificial gingiva portion. It is therefore recommended to lingualize the connections as much as possible, so that there is enough room to mask their opaque appearance and also introduce the pink ceramic as deep interdentally as is possible to assure a natural appearance. Furthermore, adequate room and support has to be provided for both the adjunction of gingival-colored ceramics at the neck portions of the clinical crowns and in the area of the cervical extensions in order to reach the determined transition border with the alveolar mucosa. Again, establishment of translucency and physiologic contours are key elements for success.

The authors recommend carrying out a bisque bake try-in for verification at an early stage of the fabrication process, still permitting modifications if necessary. Some technicians prefer to mimic at this stage the future pink ceramic compartment by the use of gingival-colored acrylic instead of porcelain in order to limit the number of sintering cycles. During the clinical try-in, the pink part is verified and may be directly modified chair-side by the clinician. The technician will then utilize respective keying for its duplication in pink ceramics. If, however, the technician believes that sufficient precise information has been gathered from the thorough analysis of the finalized provisional FDP (study cast and standardized clinical photographs), he may decide to produce the complete sintered ceramic structure directly, comprising the gingival-colored compartment, and deliver it to the clinician for a chair-side bisque bake try-in. In this case, the authors recommend that the technician should add a minor increment of excess volume to the "pink" in order to facilitate the last subtle adjustments to be performed chair-side by the clinician during that ultimate try-in appointment (Figs 5f – l).

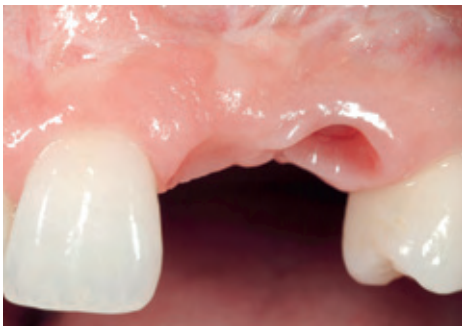

Fig. 5e

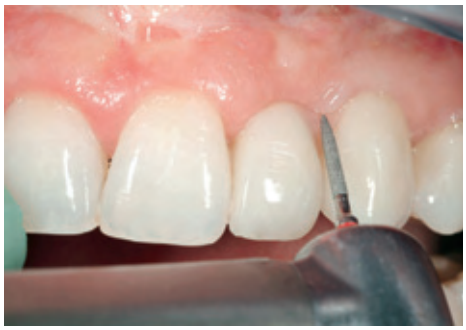

Fig. 5f

Figs 5e – f: The edentulous ridge confirms presence of harmoniously configured soft tissue on both the implant site 23 and the concave contact area for the ovate pontic 22. This soft tissue configuration was established during the provisional phase of treatment. The last step to be performed chairside, is the final adaptation of the "pink"

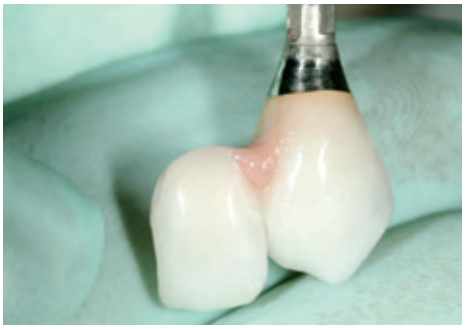

Fig. 5g

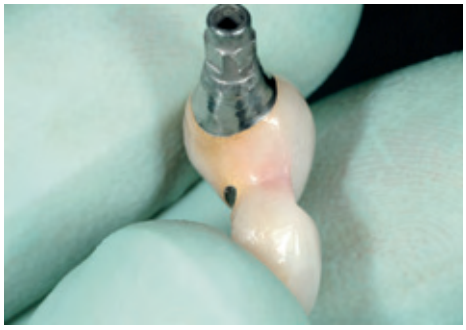

Fig. 5h

Figs 5g – j: Various detailed views depicting the initial aspect, displaying a small amount of excess ceramic permitting the clinician to perform minimal chairside adaptation, corrections carried out with a fine-grain, flame-shaped diamond bur, and finally the labial and cervical aspects of completed restoration, confirming a entirely convex profile

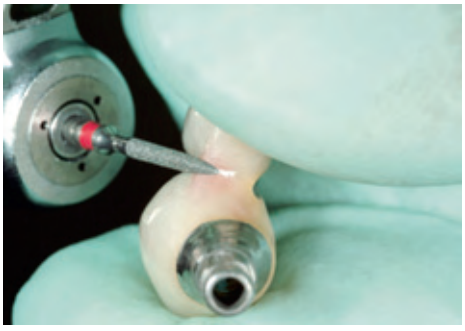

Fig. 5i

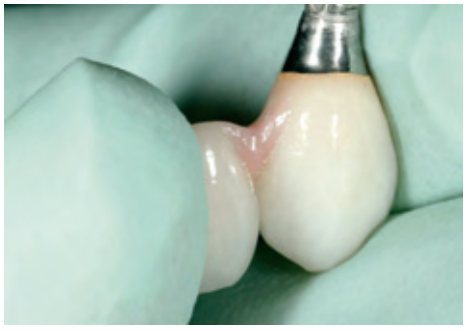

Fig. 5j

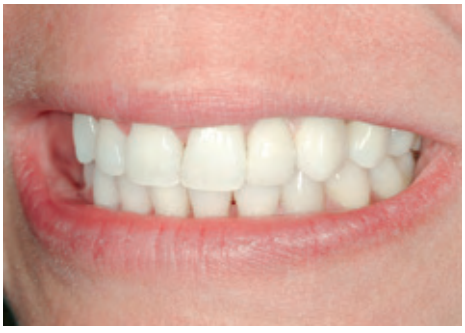

Fig. 5k

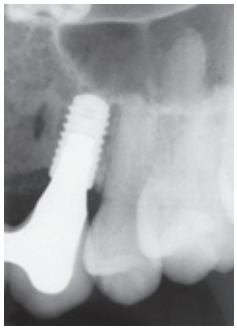

Fig. 5l

Figs 5k – l: The final clinical buccal close-up view confirms the presence of a T-Type soft tissue exposure situation. Embrasure 22/23 has been esthetically optimized by adding a minimal amount of gingival-colored ceramics, whereas the originally open embrasure 21/22 was reduced by adding tooth-colored volume to the mesial aspect of the cantilever 22. The 2-year follow-up radiograph (l) documents stable peri-implant bone conditions

DISCUSSION & CONCLUSIONS

The adjunction of gingival-colored ceramics in the context of anterior maxillary multi-unit implant-supported FDPs can be considered nowadays as an established part of the restorative spectrum, frequently permitting significantly simplified treatment, particularly in terms of complex surgical interventions. In the same way, overall treatment time and associated costs may be significantly reduced as well. In order to ensure that longstanding fundamental prosthodontic paradigms, such as cleansability and flat cervical emergence profiles are not put at risk, well-defined design principles have been put forward and were revisited in this article. It is recommended that any still reluctant clinicians should start, together with their laboratory technician, to build up a personal learning curve, starting with clinical situations corresponding to the minor-to-moderate soft tissue exposure categories, particularly the T-Type configuration. Such cases require only small volumes of gingival-colored ceramic adjunctions, are easy to design in terms of adequate access for oral hygiene, but may often provide a quite spectacular improvement when it comes to esthetic appearance and patient satisfaction. In order to fully benefit from the powerful potential of the *Pink Power Concept* that is based on a structured diagnostic approach, including wax-up/set-up of teeth, followed by clinical try-in to objectively confirm its indication, the meticulous application of the related design principles must be assured.

Acknowledgement
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