Replacing Four Missing Maxillary Incisors with Regular- or Narrow-Neck Implants: Analysis of Treatment Options

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Abstract

The restoration of the missing maxillary incisors is a complex and delicate treatment challenge. When implant therapy is used, proper treatment planning is critical, as selecting the proper number, location, and dimension of the implants is a difficult task. Thus, this article discusses the issues that must be addressed during diagnosis and treatment planning to achieve a predictable esthetic outcome when using implants to replace the maxillary incisors. The advantages and disadvantages of several implant-supported treatment options—using a combination of regular- and narrow-neck implants—are presented. Ultimately, the use of narrow-neck implants at the lateral incisor sites is presented as the best option for ensuring excellent esthetic outcomes, and the corresponding indications and contraindications are discussed. Further, all treatment options are ranked based on the predictability of their esthetic outcomes.

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Esthetics is a primary factor for judging restorations in the anterior maxilla. In patients who are missing all four maxillary incisors, the associated psychological trauma may be significant. The desire to restore the teeth as quickly as possible may lead to overly accelerated therapy. If implant therapy is selected, comprehensive treatment planning becomes of paramount importance, since the consequences of poorly placed implants are mostly irreversible and may have a major impact on the esthetic outcome.

In cases of multiple-unit implant restorations, questions related to the number, location, and dimension of the implants inevitably arise. Therefore, this article focuses on the fundamental issues that must be considered during diagnosis and treatment planning to achieve a predictable treatment outcome.

It is well documented in the literature that long-term survival and success rates of implants inserted in the anterior maxilla are similar to those reported for other regions of the dentition.[1–4] However, most studies do not include well-defined objective parameters related to esthetics. In this context, it should be noted that single-tooth implant restorations seem to have a superior esthetic potential compared to multiple adjacent implants, since they benefit from tissue support provided by the adjacent teeth.[1,5–11] When using adjacent implants, maintaining or reestablishing the interimplant papillary tissue is unpredictable and often leads to disfiguring open embrasures.

A variety of therapeutic options, all using implants, are possible for replacing the missing maxillary incisors. The respective advantages and disadvantages associated with each option will now be discussed.

Treatment option 1

This option comprises four implants (two regular-neck and two narrow-neck) restored with four individual implant crowns (Fig 1).

In the past, it was often thought that replacing each missing incisor with an implant was necessary. Today, such a concept is devalued not only because implants have proven their superior mechanical strength, but also because the esthetic outcome of multiple adjacent implant restorations in this particularly sensitive area of the arch is frequently disappointing. In the anterior region, especially in patients with a high smile line, it can be challenging to achieve a perfectly natural emergence profile of an implant-supported crown. Clinical experience has shown that placing fewer implants may reduce the incidence of esthetic complications.[1,12–14]

Advantages

From a purely restorative point of view, dealing with individual implant crowns may be advantageous, since achieving adequate marginal adaptation and performing a demanding porcelain stratifying protocol are clearly facilitated. Furthermore, any reinterventions later (eg, due to porcelain chipping) will be limited to single units rather than to complex multi-unit structures. The patient can use a simple flossing technique for interproximal plaque control during daily maintenance. Finally, replacing each missing root with an implant may be advantageous in preserving the alveolar ridge from resorption.

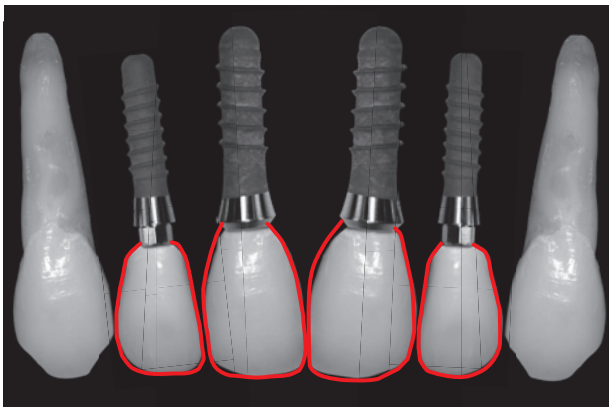

Fig 1 Schematic representation of treatment option 1: two regular-neck and two narrow-neck implants replacing the four maxillary incisors, restored with individual implant crowns.

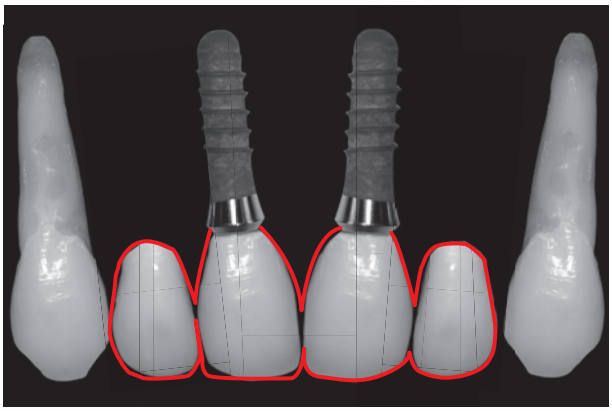

Fig 2 Schematic representation of treatment option 2: two regular-neck implants replacing the central maxillary incisors, restored with a four-unit FDP including 2 distal cantilever extensions.

Disadvantages

Sufficient space for four implants is often lacking, especially after bone remodeling following tooth loss has occurred. This may lead to implant shoulders that are located too close to each other or to an adjacent natural root (ie, less than 1 mm), which in turn will complicate the restorative procedures and increase the risk for interproximal tissue loss.

In other words, an adequate esthetic outcome cannot be guaranteed, because the risk for losing interproximal papillary tissue height is particularly elevated in cases of adjacent implants.[12,15–21] As will be demonstrated later, a more predictable esthetic result can be achieved if fewer implants are placed with pontic elements interposed between implants.

Finally, this treatment option is the most expensive in the short term, as it requires four implants and their respective restorative components.

Treatment option 2

This option comprises two regular-neck implants at central incisor sites, restored with a four-unit fixed dental prosthesis (FDP) with two cantilever elements replacing the lateral incisors (Fig 2).

Advantages

This option allows a minimum distance of at least 2 mm between the two adjacent implant shoulders, which is a key element in maintaining a maximum amount of interimplant crestal bone.[15–21]

From a mechanical point of view, replacing the lateral incisors with cantilevers is justified by their rather small size, as long as crucial occlusal parameters, such as contacts during mandibular excursions, are kept under control. For example, this option is typically not selected for patients with excessive overbite or significant occlusal parafunctions. Finally, due to the reduced number of implants (two), the costs are relatively contained.

Disadvantages

There is a risk of flattening of the soft tissue between the two implants, and the esthetic consequences are considerable. In addition, to guarantee the correct emergence profile and precise position of the line of emergence of the implant-supported suprastructures, the surgeon must keep three-dimensional implant positioning and symmetry under complete control. Finally, this treatment option also comprises the major restorative (complex fabrication and reintervention) and clinical (cleaning difficulty) disadvantages associated with a one-piece FDP.

Treatment option 3

This option comprises one regular-neck implant in the position of one central incisor and one narrow-neck implant in the position of the remote lateral incisor, restored with a four-unit FDP with a pontic replacing the contralateral central incisor and a distal cantilever replacing the second lateral incisor (Fig 3).

Advantages

This particular option combines several important esthetic, mechanical, and economic advantages. Specifically, this approach avoids adjacent implants and limits cantilever extensions to one unit. Further, precise three-dimensional implant positioning of the central implant is somewhat less crucial compared to two adjacent central implants, because the associated pontic offers some compensation.

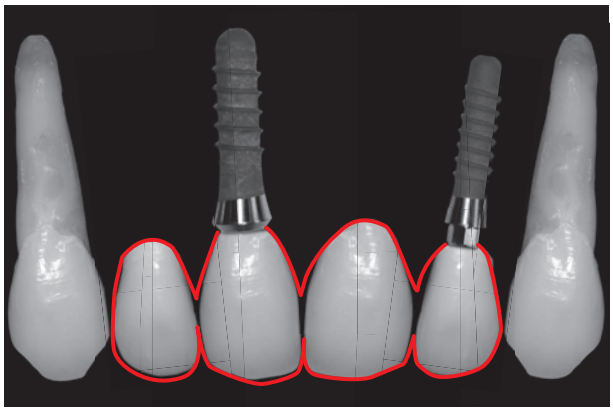

Fig 3 Schematic representation of treatment option 3: one regular-neck implant replacing one central incisors and one narrow-neck implant replacing the remote lateral incisor, restored with a four-unit FDP including one pontic and one distal cantilever extension.

Disadvantages

It should be noted that a free-standing implant at a central incisor site is not benefiting from tissue support from adjacent natural teeth, and still compares unfavorably to an ovate pontic in terms of esthetics.

This treatment option is possible in two variations, based on whether the right or left central incisor is selected as the primary implant site. The choice between these two options should be based on which site shows superior local crest anatomy.

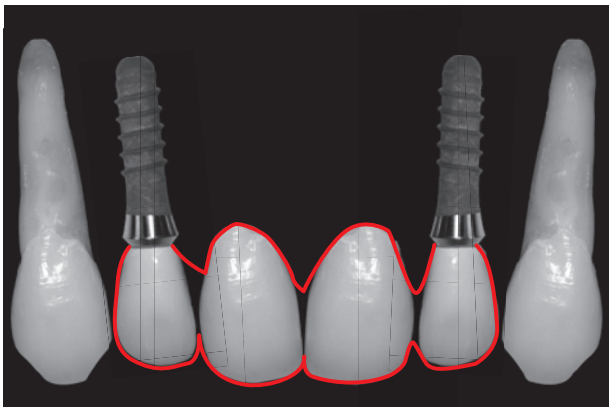

Fig 4a Schematic representation of treatment option 4a: two regular-neck implants replacing the two lateral incisors, restored with a four-unit FDP including two central pontics.

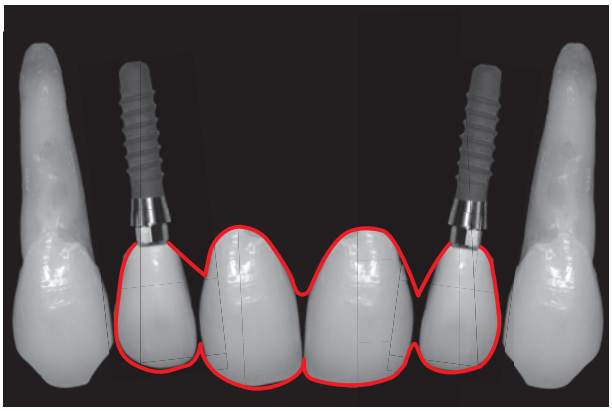

Fig 4b Schematic representation of treatment option 4b: two narrow-neck implants replacing the two lateral incisors, restored with a four-unit FDP including two central pontics.

Treatment option 4a

This option comprises two regular-neck implants at the lateral incisor sites, restored with a four-unit FDP with two pontics replacing the central incisors (Fig 4a).

Advantages

As with the last option, this solution avoids adjacent implants and their inherent esthetic shortcomings. Further, two implants with superior mechanical resistance are used in a traditional distribution, ie, representing end abutments for an FDP with central pontics. From an esthetic perspective, two ovate pontics replacing the central incisors have the best chance of creating a natural appearance. This is because no implants are inserted at the most esthetically sensitive area of the anterior maxilla: the zone next to the midline, where an observer's eye will usually focus. Finally, by using only two implants, the cost is reduced.

Disadvantages

The problem with this option is the use of relatively large regular-neck implants to replace the narrow lateral incisors. This issue will be addressed in detail in the next section.

Treatment option 4b

This option comprises two narrow-neck implants at the lateral incisor sites, restored with a four-unit FDP with two pontics replacing the central incisors (Fig 4b). This treatment is the gold standard of care at the University of Geneva School of Dental Medicine whenever the esthetic demands are high.

Advantages

The reduced implant diameter and the implant distribution offer ideal base dimensions for the two implant crowns replacing the lateral incisors. They also provide in-

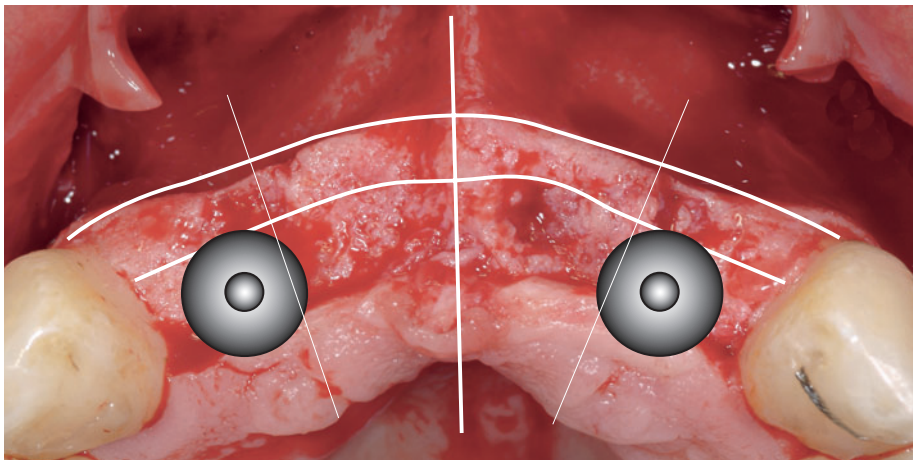

Fig 5 Occlusal view of the anterior maxilla at implant placement. The two curved lines represent the original (larger) arch of the alveolar bone crest and the current (narrower) arch used to determine the implant positioning. The slightly more palatal location of the regular-neck implants interferes mesially with the ideal embrasure position.

creased freedom for the laboratory technician to generate two adequately sized central pontics with an ovate configuration. In combination with an appropriate volume of keratinized mucosa in the area of the edentulous ridge, this permits the optimal replication of the size and emergence profile of the clinical crowns of the central incisors during provisionalization. The convex cervical aspect of these pontics will establish contact with the corresponding concave counterparts on the labial aspect of the edentulous ridge. This significantly contributes to the illusion of a harmoniously scalloped soft tissue line, compensating in part for the ridge flattening after tooth loss. Therein lies the fundamental esthetic difference between two adjacent pontics and two adjacent implant crowns. An additional advantage of this solution is that insufficient tissue volume can be easily corrected with a connective tissue graft, whereas an implant solution would also require grafting of the underlying bone.

Disadvantages

The major disadvantages of this option relate to the mechanical resistance and will be discussed in the next section.

Rationale for choosing treatment option 4b

The most commonly used implant at the University of Geneva School of Dental Medicine for multi-unit FDPs comprising one or several pontics is a regular-neck implant with a 4.8-mm shoulder diameter. This includes FDPs supported by implants at the lateral incisor sites. However, as a result of some poor esthetic outcomes using regular-neck implants, a different implant type has been proposed for this specific indication: a narrow-neck implant with a 3.5-mm shoulder diameter. Although the narrow-neck design was originally intended only for small single-tooth gaps in the anterior region (specifically, the replacement of mandibular incisors

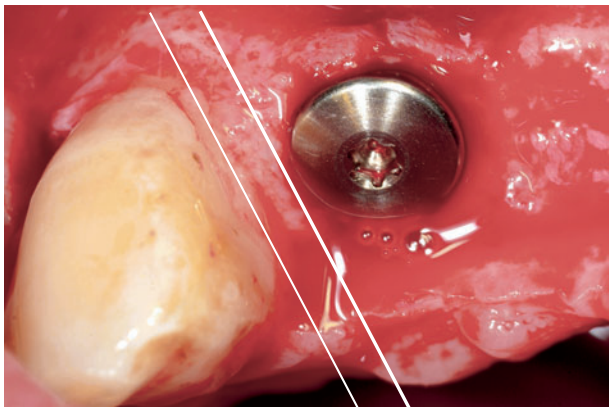

Fig 6a Occlusal closeup view after insertion of a regular-neck implant at the lateral incisor site. A minimum of 1.5 mm between the implant shoulder and adjacent root is established.

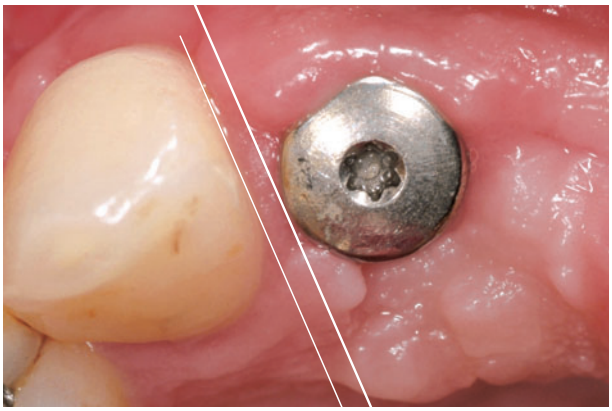

Fig 6b The same site 8 weeks after placement. The short healing cap has been exchanged for a longer one. Note the presence of interproximal soft tissue.

and maxillary lateral incisors), it has been used increasingly to support multi-unit FDPs replacing maxillary or mandibular incisors. This trend is primarily motivated by the superior esthetic potential of this design. However, the long-term mechanical performance of narrow-neck implants under the described conditions is still unconfirmed.

The criteria that should be assessed when choosing between the two implant types will now be discussed.

Narrowing of the dental arch

After tooth extraction, characteristic bone resorption/remodeling will occur to a degree based primarily on the number of teeth involved, reason(s) for their loss (caries, trauma, or periodontal pathology), and location.[10] As a general rule, 2 months are necessary to accurately assess the amount of remodeling that has occurred. In some patients, resorption following the loss of the four maxillary incisors will be considerable. Thus, if an imaginary line is traced over the alveolar ridges before and after tooth loss, the two arches will not coincide.

As a result of the facial resorption, the radius of the arch on the partially edentulous anterior maxilla will shift palatally and become smaller. Further, considering that the implants will be placed more palatally than the natural roots to establish a sufficient thickness of bone (minimum 1 mm) at the vestibular aspect (to prevent soft tissue recessions) and allow for occlusally screw-retained restorations, a third arch can be identified with an even smaller radius. This directly impacts the implant positioning during surgery, as well as the selection of implant dimension (ie, regular neck versus narrow neck) (Fig 5).

Distance from the natural dentition

To avoid damaging the periodontium of the adjacent dentition, it is generally recommended to place the implants at a distance of at least 1.5 mm from the natural roots (Figs 6a and 6b).

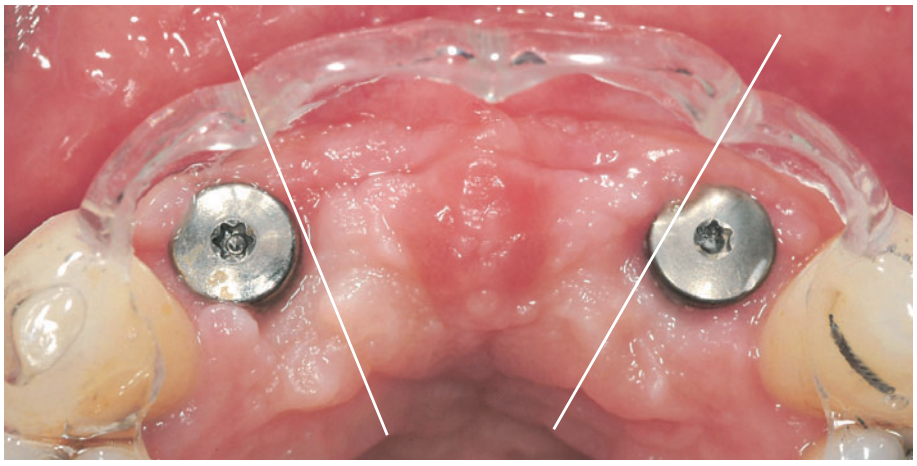

Fig 7 Occlusal view during implant restoration. The repositioned surgical guide demonstrates that the two implants slightly interfere with the ideal embrasure position.

Because of the flared shape of the collar of a regular-neck implant, it is difficult to precisely assess this distance during surgery. If the surgeon primarily considers the body of the implant, the shoulder may be placed too close to the adjacent tooth, thus compromising the maintenance of the papillary tissue and complicating the restorative procedures (eg, impression taking). However, if the implant shoulder is kept at a sufficient distance from the adjacent root surface, it may be too close to the embrasure of the future FDP (Fig 7).

In cases using two regular-neck implants, positioning is particularly crucial, because the implant diameter corresponds to the mesiodistal dimension of an average lateral incisor. Any shift toward the midline will lead to an implant crown that appears unnaturally large.

The narrow-neck implant, on the other hand, has a smaller diameter at the implant-to-restoration interface (3.5 mm versus 4.8 mm) and features a straight collar. Under these conditions, the surgeon may feel more comfortable placing the implant closer to the canines, while still respecting the minimum distance required for maintaining interproximal tissue. The use of this implant type is recommended when the size of the missing lateral incisors (mesiodistal dimension at the level of the emergence from the soft tissue) is less than 6 mm.

Invasion of the embrasure zone

In cases with a four-unit FDP supported by implants at the lateral incisor sites, the location and configuration of the embrasure between the implant crowns and pontics (interface between the lateral and central incisors) are of paramount importance. If the implants are placed too far toward the central incisor sites, the laboratory technician will be forced to "narrow" the two centrals and "widen" the laterals, thus compromising the overall esthetic appearance of the final prosthesis. Not only will the shape of the FDP be jeopardized, but also its color. An attentive eye will notice the more opaque aspect of the mesial surface of the implant crown replacing the lateral incisor (Fig 8).

Fig 8 Intraoral view of a four-unit FDP supported by two regular-neck implants at the lateral incisor sites. The line of emergence of the implant crown at the right lateral incisor is too large, and the connection between the implant crown and pontic displays excessive opacity, indicating that the respective implant components are interfering with the embrasure.

Fig 9 Intraoral view of a four-unit FDP supported by two narrow-neck implants at the lateral incisor sites. The line of emergence of the implant crown at the left lateral incisor corresponds perfectly with the average mesiodistal diameter of a lateral incisor.

Fig 10 Closeup view of the right incisor positions, displaying the cervical configuration of the implant crown (on a regular-neck implant) and adjacent pontic. The implant shoulder has been deeply inserted for better control of the emergence profile. Note the opaque aspect of the embrasure as a result of interference from the restorative components.

Fig 11 Using a narrow-neck implant, a more superficial implant shoulder location is possible and no interference with the embrasure zone is evident.

If the abutments are located too close to the embrasure zone, the laboratory technician will face significantly reduced space for the ceramic layering. The esthetic outcome will be further compromised at this level due to the reduced height of the interproximal (papillary) tissue, which is a frequent result of implant therapy in this highly sensitive area. Unfortunately, an unfavorable relationship between implants and embrasures becomes evident only once the restorative phase is initiated. During surgery, especially if a surgical template is not used or is used incorrectly, the only remaining reference points are the adjacent teeth (in this case, the two canines). Because surgeons have a tendency to avoid the natural dentition as much as possible, it is not surprising that many implants are placed too close to the pontic areas.

Regular-neck implants should be placed as deeply as possible to allow for "narrowing" of the emergence profile of the two lateral implant crowns already at the submucosal level. Keep in mind, however, that a deep implant placement may lead to additional crestal bone loss and restorative complications, such as difficulty in the impression taking or seating of the prosthetic components.

Therefore, narrow-neck implants have the potential to significantly reduce some of the shortcomings associated with regular-neck implants, since their diameter is sufficiently smaller and thus provides more space for natural, appealing embrasures (Figs 9 to 11).

Mechanical concerns

Intraoral mechanical failure of an osseointegrated dental implant is a rare but traumatic event for both the patient and clinician.[22–24] Theoretically, a reduced-diameter implant would be more susceptible to this complication, since the narrow-neck design features a built-in octagonal abutment to which the various prosthetic components are screw-fastened. The external an-

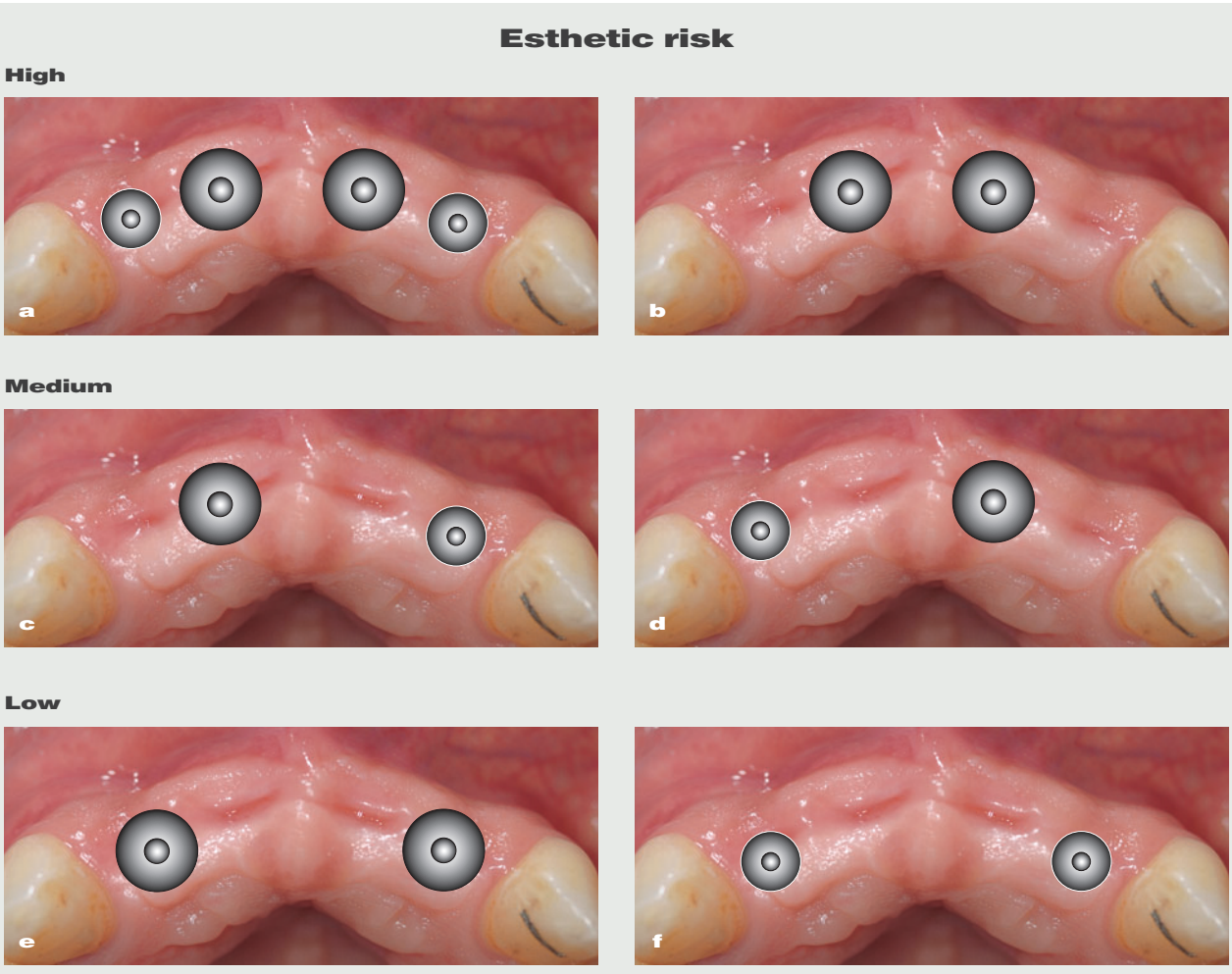

Fig 12 Schematic representations of all treatment options to replace four missing maxillary incisors with an implant-based restoration, categorized based on the predictability of their esthetic outcome. Two narrow-neck implants at the lateral incisor sites **(f)** is the most favorable, whereas four implants restored with single crowns **(a)** is not recommended.

nular platform that carries the load has a diameter of only 3.5 mm, compared to 4.8 mm for regular-neck implants. This difference is cause for concern, since standard beam theory states that resistance to bending loads is dependent on the third power of the radius of the tube.

Clinical evidence indicates that the majority of fractures of dental prostheses occur after a period of several years. Such failures generally do not result from acute overload, but from fatigue failure (high numbers of relatively low loads). Still, there are reasonable concerns when subjecting narrow-neck

Fig 13 Final clinical and radiographic images of a four-unit FDP supported by two regular-neck implants at the lateral incisor sites. The frontal view in centric occlusion **(a)** reveals an overall acceptable result from an esthetic point of view. Note, however, the negative impact of the implant platform diameter on the line of emergence of the crowns at the lateral incisors, as well as the papillary tissue loss at the embrasure of the central incisors. The corresponding radiographs **(b and c)** confirm stable peri-implant bone levels and adequate marginal adaptation of the metal-ceramic implant-supported crowns.

implants to higher occlusal loads (eg, to support a multi-unit FDP). Presently, few in vitro studies of the mechanical performance under fatigue loading of narrow-neck implants are available.[22,25–32] Clinically, the complication rate that should be expected when using narrow-neck implants to sustain multi-unit FDPs for at least 5 years still needs to be determined.

Conclusions and clinical recommendations

Three decision-making parameters should be considered before selecting any of the therapeutic options discussed in this article: *(1)* local ridge anatomy, *(2)* patient's smile line, and *(3)* associated esthetic risk. In Fig 12, the authors propose a hierarchic

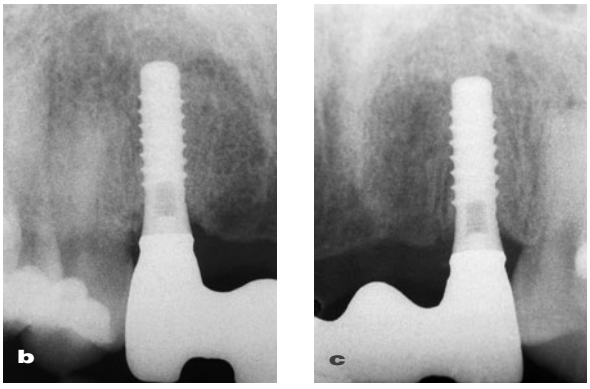

Fig 14 Final clinical and radiographic images of a four-unit FDP supported by two narrow-neck implants at the lateral incisor sites. The frontal view in centric occlusion **(a)** reveals an excellent esthetic result. Note the remarkable level of harmony, particularly at the soft tissue line. No obvious differences are apparent between the implant crowns and pontics. The corresponding radiographs **(b and c)** confirm stable peri-implant bone levels and adequate marginal adaptation of the metal-ceramic implant-supported crowns.

order of choice based on the predictability of the esthetic outcome when implant therapy is used to replace four missing maxillary incisors.

From a primarily esthetic point of view, the solution using two narrow-neck implants at the position of the lateral maxillary incisors is the most predictable (ie, low esthetic risk), followed by the solution with an identical implant distribution but using regular-neck implants. The solutions labeled as a medium risk in Fig 12 should be considered if mechanical concerns arise. Finally, the solutions using either two central implants or four implants are not recommended and should only be considered as exceptions, since they are associated with a high esthetic risk. Figures 13 and 14

show the differences related to the esthetic outcome between a four-unit FDP based on either two regular-neck implants or two narrow-neck implants placed at the lateral incisors. Since it is still not proven that narrow-neck implants can be used predictably to replace four missing maxillary incisors, it would be wise for the time being to limit this treatment to patients with high esthetic demands, a high smile line, and a reduced expected load on the implants, ie, a normal overbite and overjet, with no significant occlusal parafunctions.

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