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LATERAL MAXILLARY INCISOR IMPLANT:

— *Key issues for esthetic success*

PART II

— *Prosthetic stages and long-term issues*

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Having discussed in the previous article (see editorial note), all of the preprosthetic stages for the replacement of a lateral maxillary incisor and having explained the surgical procedures required to improve the final esthetic outcome, in this second part, we discuss the prosthetic stages. Observation of clinical cases over a period of almost 15 years has made it possible to assess, over the different links in the prosthetic chain, the impact of particular choices of components or clinical procedures on the final esthetic outcome of the gingival setting and the ceramic crown. As a result, for each clinical step, there are recommendations to help optimize and complete the surgical outcome and to ensure a long-lasting result.

In the last section, the esthetic outcome will be considered in relation to its medium- and long-term evolution, compared with the initial results. The effects of continuous tooth eruption and an analysis of different risk factors lead the authors to make clinical recommendations to minimize any negative effects.

Provisional prosthesis

A provisional prosthesis can be fabricated at different stages of treatment: when the implant is placed to provide an immediate temporary solution, when the implant is uncovered, or once the soft tissue has healed. A temporary abutment can be utilized, but this will involve greater manipulation of the subgingival components **(Figs. 1a & b)**.

– One abutment at one time

The concept of the single abutment being seated early and definitively during implant treatment in order to preserve the attachment of soft tissue around the abutment is based on a publication many years ago by Abrahamsson et al.[1] For these authors, the multiple connections and disconnections of healing screws resulted in apicalization of the periimplant bone. This study is now considered to be biased because of the cleaning of healing screws with alcohol (which destroys the attached fibroblasts); nevertheless, it provided the basis for the one-abutment–one-time concept (OAOT) put forward by Maurice and Henry Salama at conferences from 2007. At present, the medical literature is generally in favor of this concept, even though research results are mixed:

- In dogs, the results of Iglhaut et al.[2] showed a highly negative outcome of connection and disconnection at four and six weeks, while in Alves et al.[3] five such manipulations between six and 14 weeks had no negative consequences.

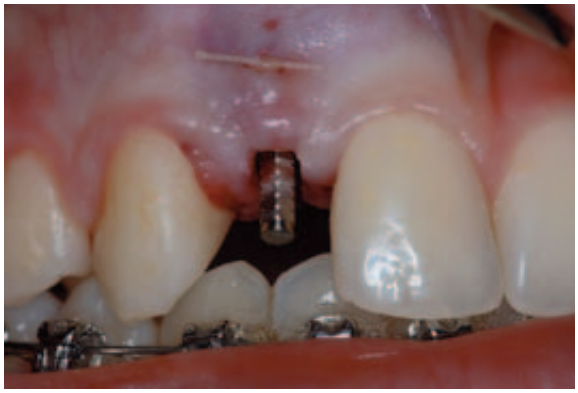


Fig. 1a

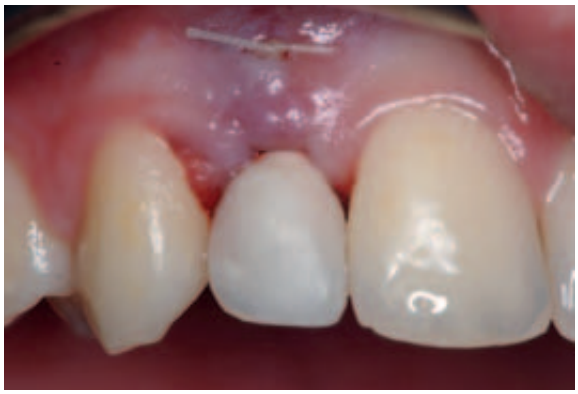


Fig. 1b

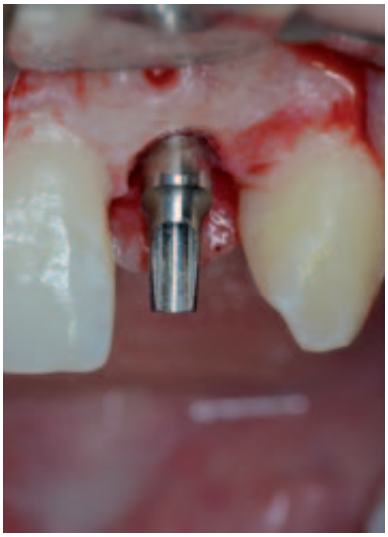


Fig. 2a

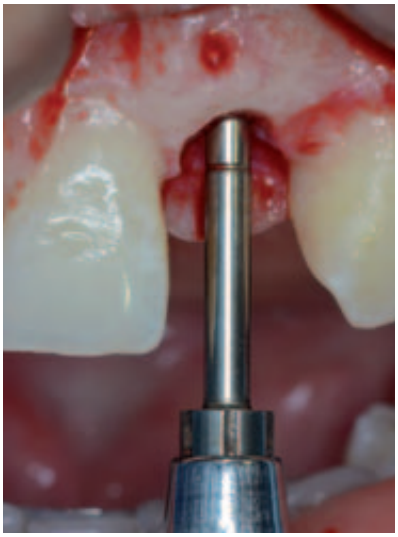


Fig. 2b

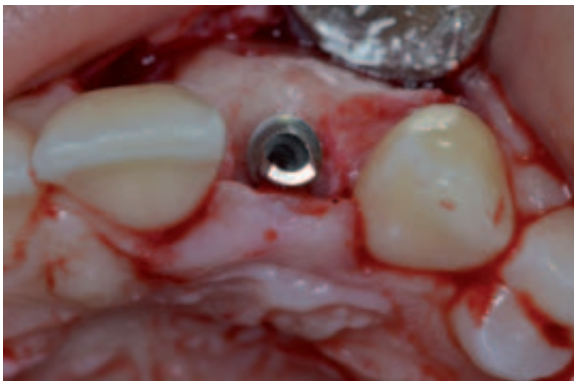


Fig. 2c

Figs. 1a & b
Provisional abutment after modified roll flap **(a)**. Temporary crown in place at the end of the surgical reopening **(b)**.

Figs. 2a–c
Intraoperative placement of a 15° angled abutment **(a)**. Precise rotational adjustment of the implant **(b)**. Check of rotational adjustment in the axial plane **(c)**.

– In humans, several recent studies have concluded that there is a vertical advantage of 0.5 mm,[4] horizontal advantage of 0.3 mm,[5] vertical advantage of 0.2 mm[6] and nonsignificant[7] result for the OAOT protocol in different clinical situations.

In their 2014 review of the literature on factors influencing apicalization of periimplant tissue, Iglhaut et al.[8] documented interest in the concept of the single abutment and proposed recording the position of the implant at the time of placement. Thus, there is some evidence suggesting that it is desirable to limit the number of manipulations of the subgingival elements as much as possible, even though the literature is not unanimous in this regard.

The OAOT technique has a drawback (which was pointed out by Piñeyro and Tucker), however: the increased risk of cement overflow where the abutment–crown limit is deeply buried.9 Different clinical strategies make it possible to apply the OAOT concept:

– The fabrication, using 3-D imaging, of a surgical guide and a machined abutment prepared during the preoperative stage makes immediate placement possible, but it is also more risky, since any error in the guide or any lack of precision in the placement could make the prepared abutment unusable.

– The same technique, starting with an impression after the placement of the implant, is less risky, since the position of the implant has already been finalized.

Since these two techniques involve the collaboration of the laboratory, a simplified protocol was used for the majority of the 120 NobelActive implants (Nobel Biocare; 3 mm) placed over the past three years:

– Preoperative cone beam computed tomography imaging is used to determine whether a straight abutment or a 15° angulated abutment is the best choice for the specific clinical case.

– Radiographic monitoring makes it possible to check on the placement axis in the mesiodistal plane, and the use of a parallelism guide when the 2 mm drill is being used provides a check on the vestibular–palatal plane. Once the implant is in place, an angulated prosthetic abutment is seated to optimize the rotational position of the implant, which is done to avoid, as far as possible, any adjustment to the abutment by grinding **(Figs. 2a–c)**.

In order to assist with intraoperative fitting, the surgical kits contain sterile angled

Fig. 3
Surgical kit with 3.0, NP and RP angled abutments (NobelActive system).

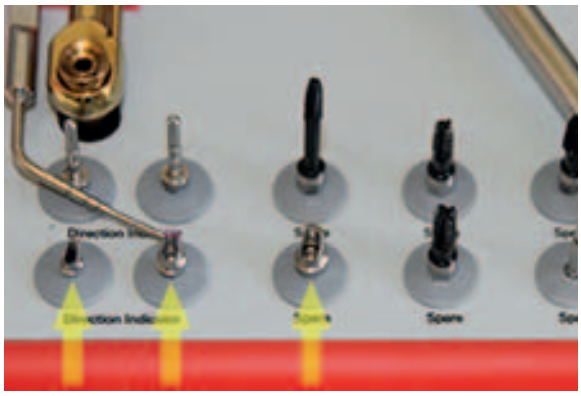


Fig. 3

Figs. 4a–c
Temporary coping created with a brush (UNIFAST III, GC) and a veneer **(a)**. Initial clinical situation with a 15° angled abutment in place **(b)**. Temporary coping in place **(c)**.


Fig. 4a

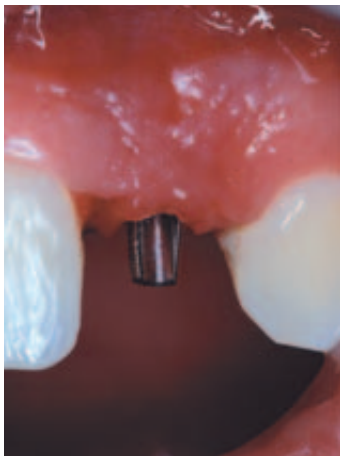


Fig. 4b

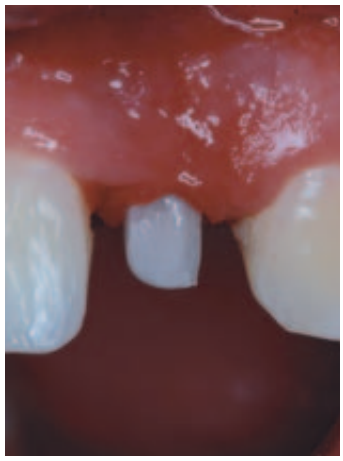


Fig. 4c

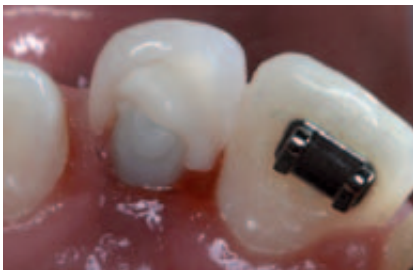
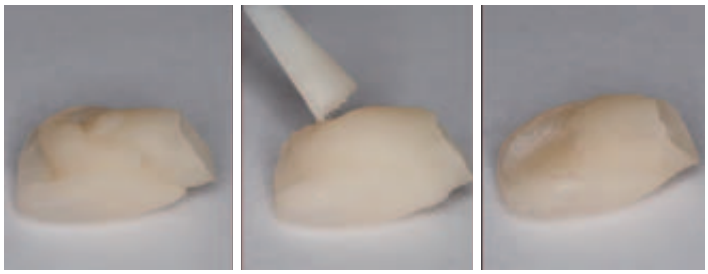


Fig. 5a


Figs. 5c–d

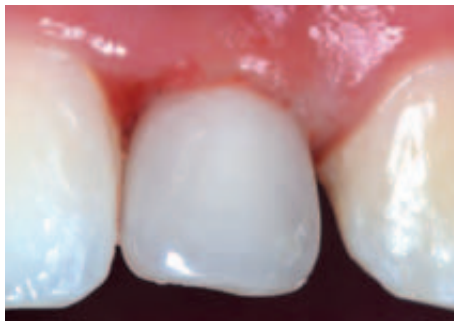


Fig. 5e

abutments, the incisal edges of which are slightly curved, which presents the rotational alignment of the implant better than a straight cylindrical abutment does **(Fig. 3)**. An adjustment of a few degrees and a check of the occlusion make it possible to position the vestibular gingival edge perfectly and, most often, to use the abutment without any alteration, which substantially simplifies the rest of the prosthetic chain.

Keep manipulations of the abutment to a minimum.

In order to respect the principle of OAOT during the fitting of the provisional crown, a provisional resin coping is prepared on a straight or angled abutment, depending on the clinical requirement, along with a resin veneer created from a prosthetic tooth **(Figs. 4a–c)**. The resin coping is bonded in the mouth to the veneer using a minimal quantity of resin in order to avoid direct pollution of the soft tissue by the cytotoxic resin monomer **(Figs. 5a–e)**. The use of a standard abutment and a provisional coping makes the fabrication of temporary crowns very quick and simple while also respecting the principle of OAOT.

– Emergence profile

When putting the provisional tooth in place, it is preferable to give it an initial emergence profile that is concave in order to allow healing of the papilla with the maximum space available. A convex profile

Figs. 5a
Bonding of the coping and veneer. Palatal view showing the small quantity of resin used.

Figs. 5b–d
Bonded veneer, then relined and finished.

Figs. 5e
Provisional crown after cementing.

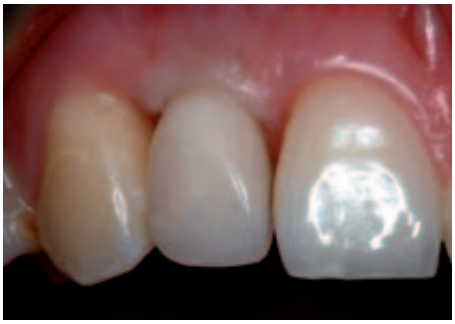


Fig. 6a


Fig. 6b

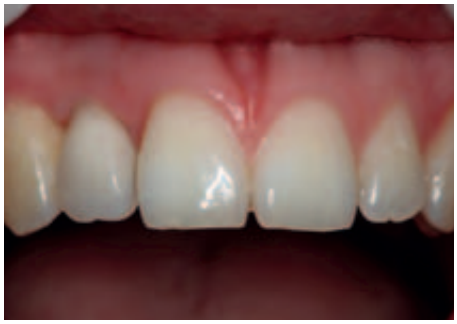


Fig. 6c

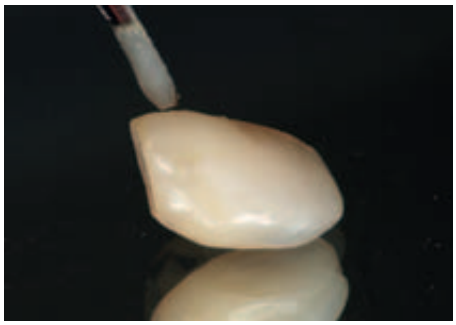


Fig. 6d

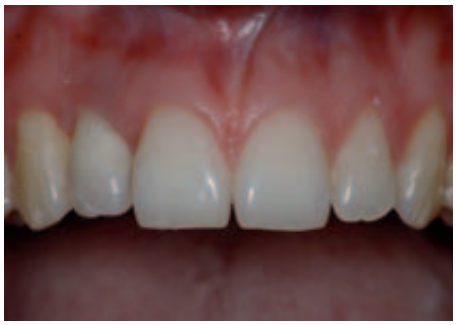


Fig. 6e

Figs. 6a–e
Buccal compression **(a)**. Creation of a concave profile on the provisional crown **(b)**. Provisional clinical outcome: The shape of the incisal edge also plays a role in the esthetic result **(c)**. Resin applied with a brush to distalize the zenith (UNIFAST III; **d**). Emergence profile optimized by the provisional crown **(e)**.

or an overcontour encourages apicalization of the gingival margin, which is generally deleterious buccally **(Figs. 6a–c)**. After stabilizing the soft-tissue margin, small amounts of resin placed mesially and distally with a brush on the temporary tooth allow some pressure to be placed on the papilla according to the cervical contouring concept of Bichacho and Landsberg[10] and, in this way, to optimize the filling of any gaps and the emergence profile.

Buccally, the gingival level or the crown zenith can be moved by modifying the temporary tooth (Figs. 6d & e). In order to reduce any excess cement and to allow it to escape during setting, a 0.75 mm hole can be drilled on the palatal side in the incisal half of the temporary crown.[11]

Optimize the emergence profile by progressive modification of the temporary crown.

Taking impressions

In order to comply with OAOT, the ideal, provided that the abutment has not been adjusted, is to take an impression of the abutment. A resin impression coping fabricated over an abutment identical to the one seated in the mouth makes it possible to transfer the position of the abutment without unscrewing it **(Figs. 7a & b)**. An abutment and a laboratory copy are positioned in the impression and, if it is thought that the abutment is not suitable for the permanent prosthesis, one could opt for a NobelProcera abutment (Nobel Biocare) or a modified abutment **(Fig. 7c)**.

Take an impression of the abutment without removing it.

– Abutment

Material

According to several publications,[9,12,13] titanium and aluminum and zirconium oxides are the only materials that allow new attachments of soft tissue on to the abutment. For Van Brakel et al.,[14] in a study on humans, there is no difference between titanium and zirconia regarding biology, with just a slight advantage in favor of zirconia for sulcular depth after three months. Gold alloys cause apicalization of the attachment to the titanium[12] in the implant, but this conclusion has been contested by Linkevicius and Apse.[15] A gold alloy supports less dental plaque after 4 h in vitro,[16] but more than titanium or zirconia does after four days in vivo.[17] Thus, there is no consensus yet in the medical literature concerning the superiority of one material over another in terms of biology.

Zirconia and gold alloys have superior esthetic qualities when the abutment supports a glass-ceramic crown in vitro[18] or in vivo[19], compared with titanium. When the implant site of the lateral incisor is wide (> 6.5 mm), selecting a 3.3 or 3.5 mm diameter implant makes it possible to use zirconia abutments. However, the majority of small-diameter implants on the market do not include zirconia abutments in their prosthetic ranges for reasons of mechanical strength. In such cases, commercial titanium abutments or abutments made by 3-D machining are used. In this situation, the thickness of buccal soft tissue must exceed 2 mm, which is the requisite dimension specified by Van Brakel et al.[20] to avoid there being any difference in light reflection discernible by the human eye between a titanium and a zirconia abutment.

Shape

In cement-retained prostheses, excess cement has been found to be a cause of periimplantitis.[21–28] Linkevicius et al.[29] have demonstrated in an in vitro experiment that there is a correlation between the

depth of the abutment–crown joint and the amount of excess cement on the surface of the abutment. This is an argument in favor of the use of NobelProcera individual abutments. However, these individualized abutments often have significant undercut areas, which are recognized risk factors for the retention of intrasulcular cement.[30] On small-diameter implants, the reduced dimensions of the abutments diminish the friction surface of the implant-supported crown and the creation of two small mechanical retentions in the incisal zone of the abutment reduces any loosening **(Fig. 8)**.

Maximize retention of small-diameter abutments.

– Crown

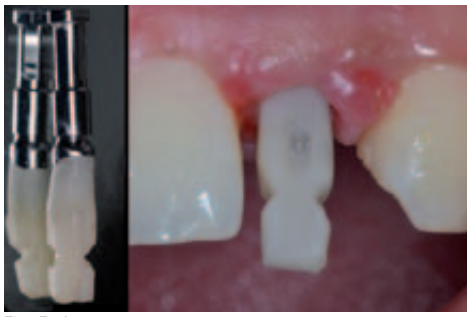
Where gaps were narrow, 3 mm Nobel Active implants were placed and only titanium abutments, standard or NobelProcera, were used. Two types of crown are possible: metal–ceramic crowns or all-ceramic crowns.

– IPS e.max (Ivoclar Vivadent)

If the abutment is titanium, using an all-ceramic system can present restrictions related to the bucco-palatal thickness of the lateral incisor. When the tooth is thick, this prosthetic solution makes it possible to achieve an acceptable esthetic outcome **(Figs. 9a–d)**. Conversely, when the thickness is less, this type of all-ceramic crown can sometimes result in more disadvantages than advantages from an esthetic perspective. In such a case, for the coping in lithium disilicate, one has to use high-opacity ceramic of significant thickness in order to hide the titanium abutment as much as possible. This has the effect of reducing the thickness of the cosmetic ceramic and thus reduces its ability to mimic the appearance of adjacent teeth **(Figs. 10a–d)**.

– Metal–ceramic crowns

Conversely, using metal-fused-to-porcelain crowns on narrow and small teeth makes it possible to reduce the thickness of the copings made from precious alloys or palladium (to 0.3 mm or 0.4 mm) and in this way to increase stratification **(Figs. 11a–c & Figs. 12a–d)**. However, the transgingival area remains the weak point in this type of restoration with a risk of the grey color of the titanium abutment showing through when the periimplant mucosa is thin (*see Fig. 33 in Russe & Limbour*).[31]



Figs. 7a–b

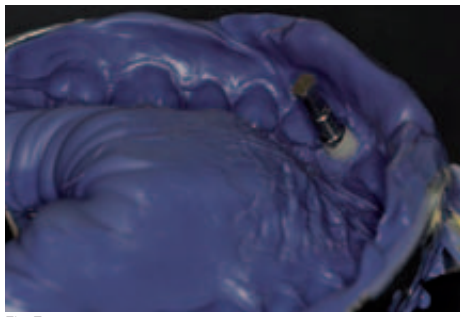


Fig. 7c

Figs. 7a–c
Resin transfer coping on a standard abutment **(a)**.Transfer coping on an abutment that has never been removed **(b)**. Transfer and analog repositioned in a polyether impression (Impregum, 3M ESPE; Rim-Lock dental impression tray, Zhermack; **c**).

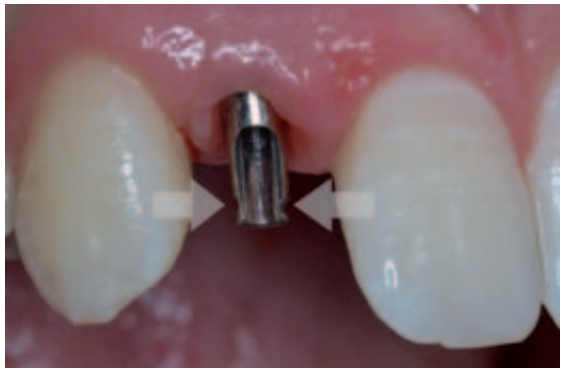


Fig. 8

Fig. 8
Creation of cement retentions on a titanium abutment.

Do not hesitate to use metal–ceramic crowns for small lateral incisors.

– Monoblock screwed zirconia crown

The use of hexagonal implants measuring 3.3 mm externally or with an internal connection measuring 3.5 mm makes it possible to use zirconia abutments. In these circumstances, two options are possible, depending on the emergence position of the abutment screw: either a two-stage solution of a zirconia abutment supporting a cemented ceramic crown **(Figs. 13a–d)** or a monoblock crown screwed directly on to the implant **(Figs. 14a & b)**. In these situations, the semitranslucent character of the material makes it possible to ensure optical continuity in both the coronal section and the gingival section, resulting in better esthetic integration.

– Cement

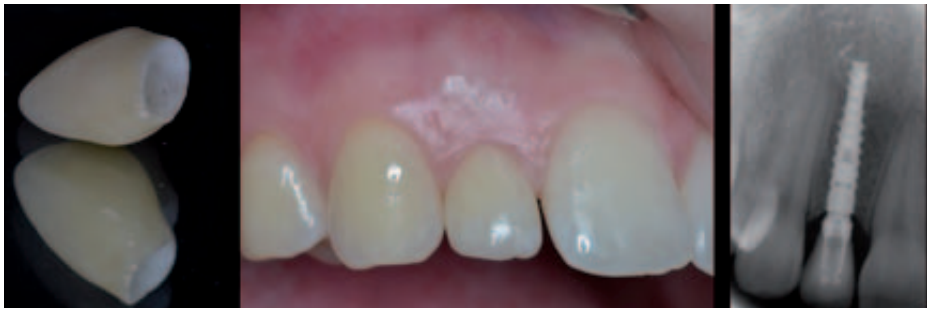
In order to reduce the visibility of titanium showing through when a glass-ceramic crown is used, an opaque white cement should be employed according to Dede et al.18 This involves a polycarboxylate cement (Poly-F, DENTSPLY DeTrey), selected initially for its theoretical ability to potentially allow detachment of the crown. Recent studies have demonstrated that polycarboxylate has greater tensile strength than does zinc oxyphosphate or glass ionomer.[32] At the time of cementing, the cement-coated crown is placed on a replica abutment; any excess is removed before placing the crown in the mouth.[33] This clinical technique has been proven beneficial for both its qualities of retention and reducing excess cement.[34]

If standard abutments are used, then the crown limit can be considerably subgingival and it is then vital to use a minimum amount of cement and to remove any excess immediately. The washable nature of polycarboxylate cement immediately after placement can be an advantage for its removal.

Avoid any excess of cement

– Esthetic outcome

When the esthetic outcome is evaluated according to the criteria specified by Fürhauser et al.[35] and when particular attention is paid to the score for the papillae



Figs. 9a–c

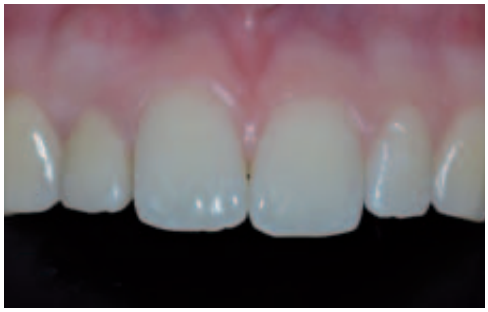
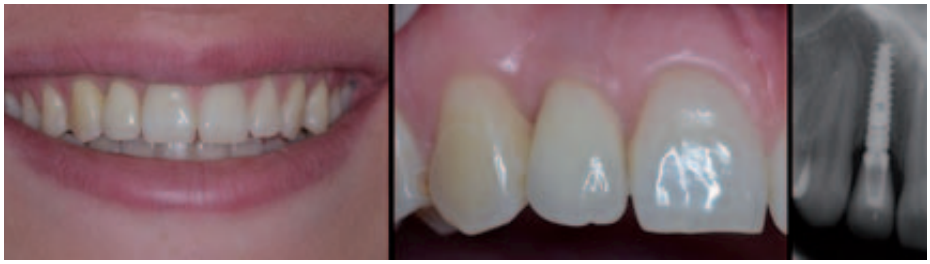


Fig. 9d



Figs. 10a–c

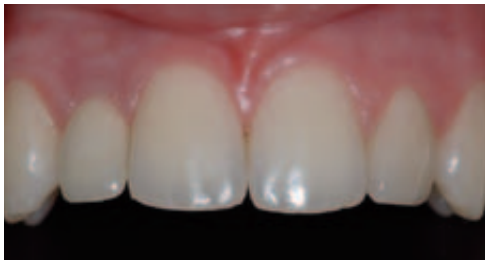
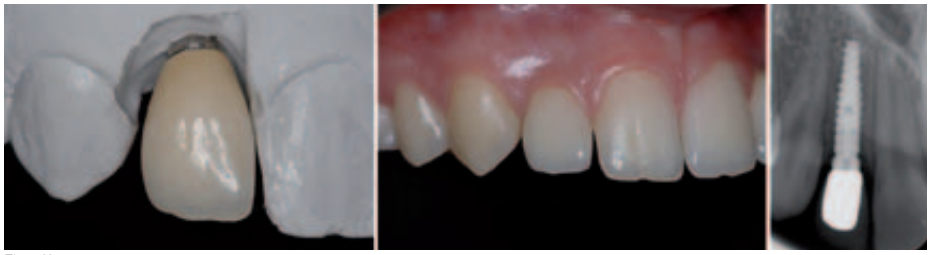
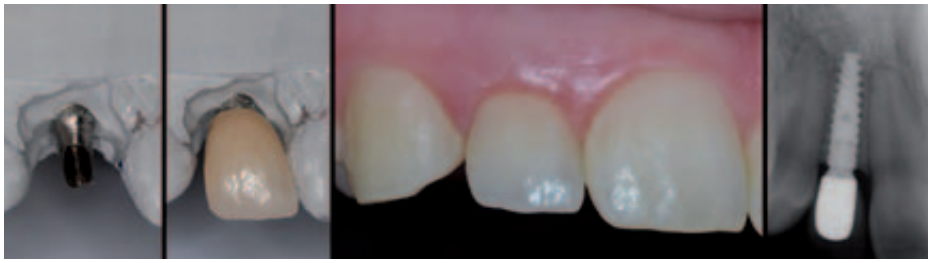


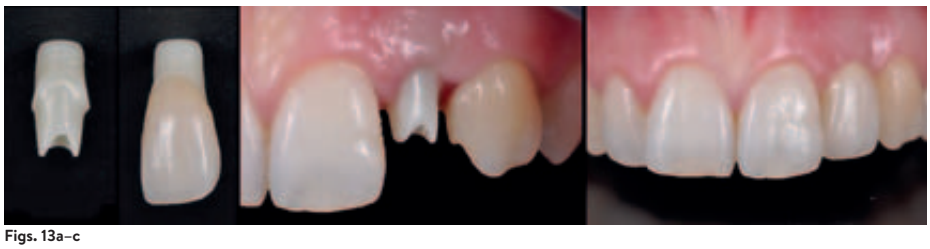
Fig. 10d



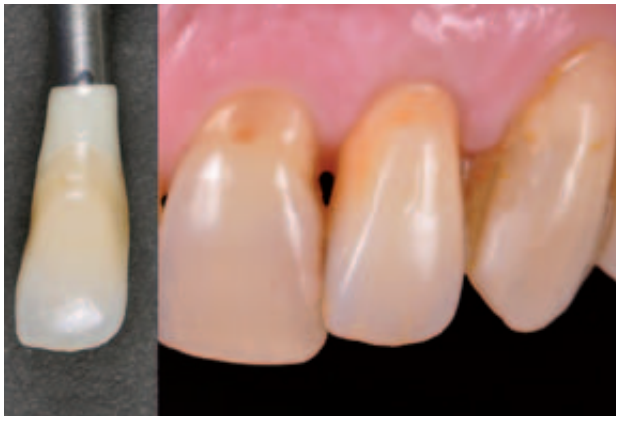
Figs. 11a–c



Figs. 12a–d



Figs. 13a–c



Figs. 14a & b

Figs. 9a–d
IPS e.max high-opacity crown coping **(a)**. Initial clinical result and radiograph **(b & c)**. Result after one year **(d)**.

Fig. 10a–c
Smile of female patient showing restoration of tooth #12 with IPS e.max **(a)**. Close-up photograph: The opaque armature is visible **(b)**. Radiograph **(c)**.

Fig. 10d
The esthetic finish of the veneer on tooth #22 is superior to that of IPS e.max on tooth #12.

Figs. 11a–c
Metal–ceramic crown on master cast **(a)**. Clinical result: The mesial and distal papillae are aligned **(b)**. Radiographic result **(c)**.

Figs. 12a–d
Master cast with the metal–ceramic crown on a modified abutment **(a & b)**. Clinical result: The papillae are aligned **(c)**. Radiographic result **(d)**.

Figs. 13a–d
NobelProcera screwed zirconia abutment **(a)** and all-ceramic crown **(b)**. Screwed abutment in the mouth **(c)**. Esthetic outcome **(d)**.

Figs. 14a & b
One-piece zirconia crown **(a)**. Esthetic integration **(b)**.

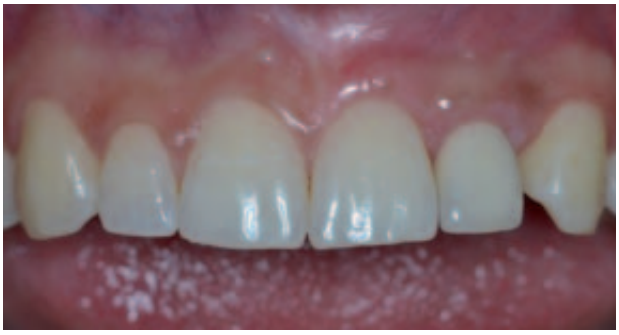


Fig. 15

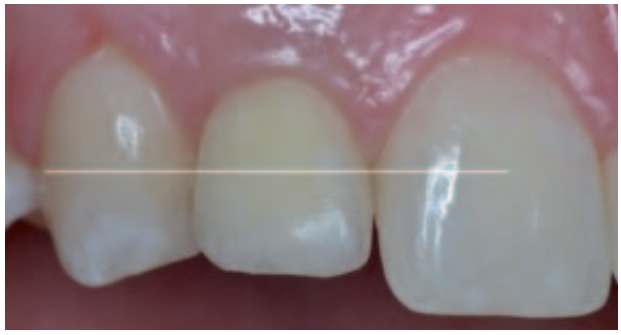


Fig. 16

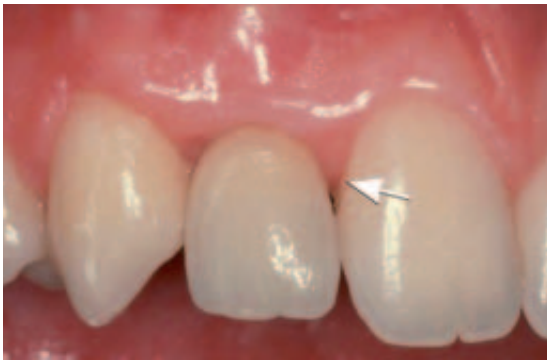


Fig. 17a

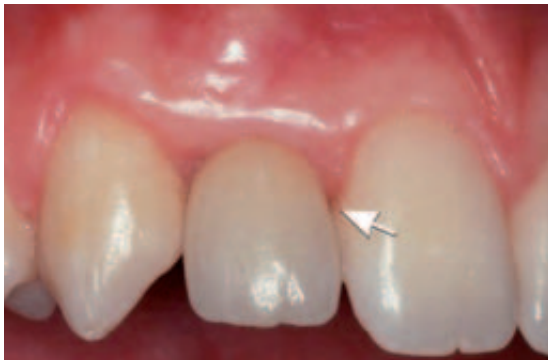


Fig. 17b

Fig. 15
The collar level of tooth #22 is ideal, but the papillae are slightly truncated.

Fig. 16
The distal papilla is slightly shorter than the mesial papilla (line shows difference in level).

Fig. 17a
Initial situation.

Fig. 17b
After three years, the papillae are slightly longer.

and the gingival level, use of small-diameter implants for replacing lateral maxillary incisors appears to result in an improvement compared with wider implants. The height of the papilla and the position of the collar, in relation to the contralateral incisor, are the two principal issues presented by implant replacement of a lateral incisor **(Fig. 15)**. In most cases, the mesial papilla, between the central incisor and the lateral incisor, is at an almost normal height, whereas the distal papilla, between the lateral incisor and the canine, is often shorter and displays a slight vertical deficit **(Fig. 16)**.

– *Initial evolution*

When the implants are well positioned and the buccal soft and hard tissue are thick, the esthetic outcome is lasting. In the early years, an improvement of the outcome may occur owing to the soft tissue filling the prosthetic embrasure **(Figs. 17a & b)**.

– *Continuous eruption*

Since the 1980s, authors such as Levers and Darling[36] have described the phenomenon of continuous eruption, which results in a verticalization of the maxillary incisors. The osseointegration of implants prevents them from following this migration and, over time, the lateral incisors can end up in a more apical and buccal position than the central incisors. This phenomenon is sometimes perceptible after some years have passed, whatever the age when the implants were placed **(Figs. 18a & b)**.

Thus, the organization of anterior guidance becomes particularly important, since rapid movement of the central incisors can occur if these are not in occlusion when the implants are placed. During orthodontic treatment, balanced anterior guidance for the central incisors and the canines will be one of the major objectives for the orthodontist. If there is bilateral agenesis, the symmetry of the smile will be maintained and the situation will be esthetically more favorable than for a unilateral replacement. After some years, the discrepancy may become quite significant and may be present just in the vertical plane or may be a combination, both vertical and horizontal **(Figs. 19a–c)**. It was thought that this phenomenon was the result of placing implants too early, but in 2004 Bernard et al.[37] showed that there was no difference between a group of young adults and a group of adults in terms of infraocclusion of implant-supported crowns in the esthetic region. In describing the problems found in implant-supported anterior restorations (bluish gingiva, infraocclusion, exposure of abutment), Zachrisson[38] poses the question: Is an implant the best solution for treating agenesis?

Warn the patient of the negative impact of continuous eruption on the esthetic outcome.

– *Risk factors*

Andersson et al.,[39] who followed 34 patients over a period of 17–19 years, showed that severe infraocclusions (> 1 mm) affected 35% of the patients. They made several findings, including the following:

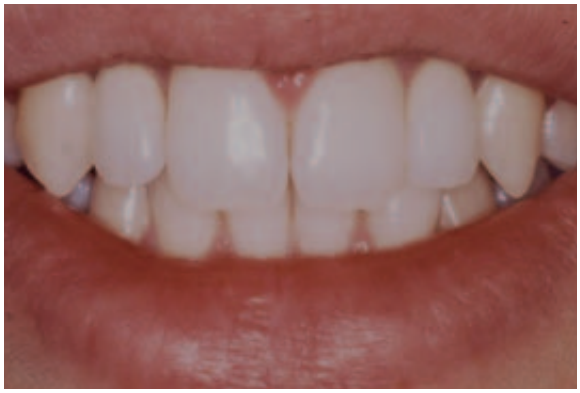


Fig. 18a

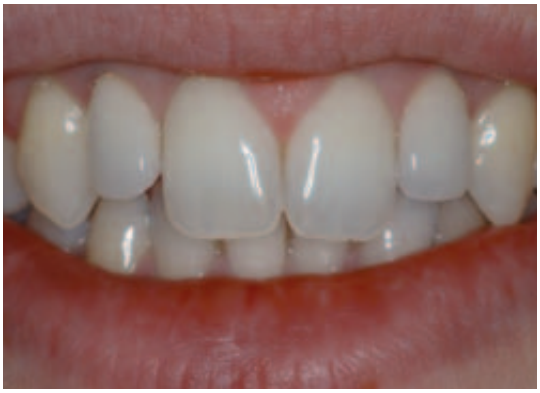


Fig. 18b

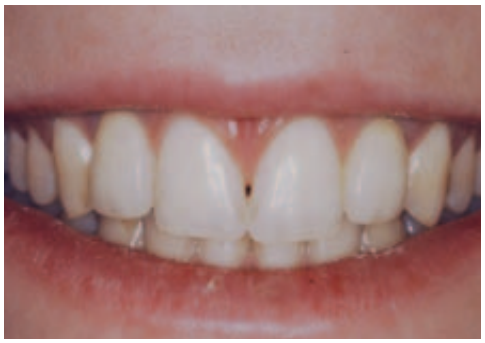


Fig. 19a

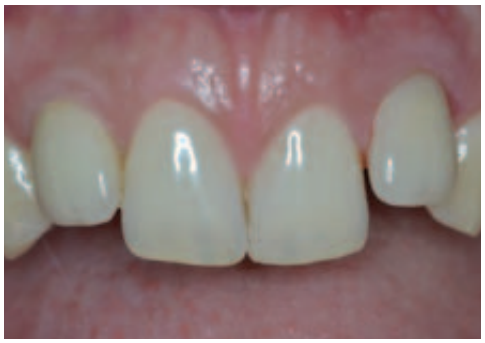


Fig. 19b

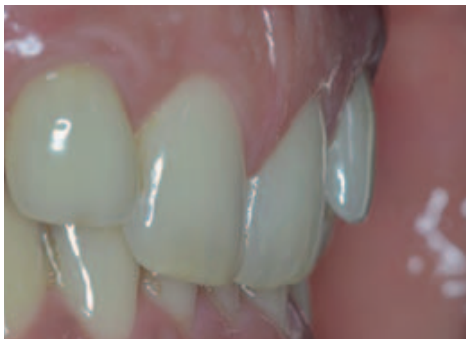


Fig. 19c

Figs. 18a & b
Smile of female patient in 1998 **(a)**. Smile of female patient in 2014. Egression of natural teeth **(b)**.

Figs. 19a–c
Smile of female patient in 2001 **(a)**. Clinical situation in 2013 **(b)**. Verticalization and egression of central incisors, lateral view **(c)**.

Editorial note: A list of references is available from the publisher. The first part of this article series, titled "Lateral maxillary incisor implant: Key issues for esthetic success," was published in Clinical Masters™, March 2015, Volume 1, Issue 1.

Conflict of interest: The authors declare that they have no conflict of interests relating to this article.

– Women were affected more than men.
– It was more noticeable in long rather than short faces.
– There was no correlation with age.
– The patients were more satisfied with the results than were the practitioners.

The findings of the same researchers were presented at the 2012 Academy of Osseointegration annual meeting in Phoenix, Ariz., U.S., by Torsten Jemt, who attributed implant-supported crown infraocclusions to posterior mandibular rotation resulting in verticalization of natural incisors that is not followed by the crowns on the implants. In the results reported, 19 out of 69 cases presented infraocclusions of more than 1 mm and the phenomenon affected twice as many women as men.

A recommendation has been made by the practitioners of the Brånemark clinic in Gothenburg, Sweden, to place implants in a palatal position in anticipation of possible verticalization of the central incisors. Such placement also facilitates any prosthetic adjustment.[39]

Favor a palatal positioning of implants.

– *Conclusion*

Replacement of a lateral maxillary incisor is a difficult task. The great visibility of the tooth in the smile and comparison with the contralateral tooth in the same view are factors with intrinsic esthetic risks. In both parts of this article series, emphasis has been placed on the most difficult situations when the lateral incisor is small. In such circumstances, any lack of precision in the positioning has powerful implications for the esthetic plan. In this situation, using small-diameter implants would appear to offer advantages for the height of the papillae around the implant.

In about one-third of cases, continuous maxillary eruption undermines the initial esthetic outcome, which may result, at the very least, in having to change the crown on the implant. This change to the esthetic outcome should form part of the information provided to patients before starting treatment.[40]