The “hybrid abutment”: a new design for implant cemented restorations in the esthetic zones

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Abstract

Cemented implant restorations are widely used by many dentists. The traditional abutment design resembles a natural tooth prepared for a crown with a similar taper and a chamfer finish line. A frequent complication associated with implant restorations in the esthetic zones is the recession of buccal gingiva over time. Abutment morphology, among several other prosthetic factors, may play an important role in the stability of the gingival margin in esthetically sensitive areas, but this has never been thoroughly analyzed. Recently, a prosthetic technique called biologically oriented preparation technique (BOPT) has been proposed, which utilizes a feather-edge preparation on natural abutments, and it has been claimed that applying the concepts of this technique to implant abutments could improve long-term gingival margin stability. At present, there is no available evidence to confirm this claim. Moreover, some concerns may arise if this particular design is implemented in every clinical situation. With these considerations in mind, this article proposes the “hybrid abutment” design (HAD), a new design that includes a combination of the two types of features – a feather edge on the buccal side, and a chamfer finish line on the lingual side. The article also presents a rationale for the use of different abutment designs for different situations.

Introduction

The restorative protocols for implant-supported restorations have changed significantly since the original protocols proposed for the treatment of fully edentulous mandibles,¹ and later for partially edentulous sites.² The connection between the prosthetic crown and the implant was strictly screw-retained, with the interposition of a transmucosal titanium abutment, either straight or angulated, depending on the axial divergence between the implant and the crown. Later, a direct connection of the crown to the implant platform was introduced,³,⁴ and the cement-retained modality of restoration became widely used.⁵ In this modality – which is similar to the method for restoring a natural tooth – the abutment, either prefabricated or customized, is connected to the implant by a retaining screw (some systems use a solid abutment, press-fitted or cemented into the implant body), and the crown cemented onto it.

Technically, implant abutments can be produced in several ways:

a) Prefabricated in some basic designs, usually straight or angulated, and then modified intraorally by the dentist (direct procedure) or in the laboratory by the dental technician on the working cast (indirect procedure).

b) Customized though a wax-up of a gold cylinder and cast with a metal noble alloy. This modality is less commonly used nowadays.

c) Digitally designed (or scanned from a wax or resin matrix) and milled in a CAD/CAM process.

The abutment morphology traditionally mimics a prepared natural abutment, with an axial wall convergence angle ranging from 6 to 20 degrees,⁶ depending on the different authors’ preferences. The intrasulcular part of the abutment emerges from the implant platform, expanding coronally to reach the buccolingual and mesiodistal dimensions of the prosthetic tooth to be replaced (Fig 1). The emergence profile of the abutment is continued into the emergence profile of the crown, and a defined finish line (usually a chamfer) is placed on the abutment and generally positioned subgingivally on the buccal (“esthetic”) side. Therefore, the buccal gingival contour is “shaped” by the abutment profile. The finish line is important for the verification of the crown’s margin adaptation during the try-in session and after cementation. Moreover, it acts as a vertical stop for the distribution of functional loads.

Fig 1  Traditional chamfer abutment design.
This traditional margin design has two main drawbacks:

a) The geometry of the finish line implies that the greater the angle of the shoulder (up to 90 degrees), the larger the marginal discrepancy after crown cementation. It has been suggested that this gap, which is colonized by bacteria, may be an important factor in buccogingival recession over time.7

b) The emergence profiles tend to “push” the peri-implant buccal soft tissue outward and in the apical direction. This can be easily observed, for example, when changing a healing abutment connected to an implant with a larger one that has a more divergent profile. It will be noticed that, after a short time, the vertical level of the gingival margin will recede in the apical direction, and the thickness of the buccal gingiva will be reduced. Reversing the procedure and connecting a straight (or even conical) abutment will determine a coronal repositioning of the gingival margin.

All other variables being equal, the combination of the above two factors (marginal gap and expanded profile) may explain the higher incidence of buccal gingival recession in cemented implant restorations in the esthetic zones8-14 (Fig 2). Therefore, modifications of the morphology of the abutment that could improve these two aspects have been considered.

Recently, a prosthetic restorative procedure called the biologically oriented preparation technique (BOPT) has been described in the literature.15-18 In this technique, the feather-edge preparation originally developed for periodontal prostheses19,20 is also applied.
to periodontally healthy teeth with the purpose of eliminating the horizontal component of an unprepared tooth (or any pre-existing finish line in an already prepared tooth), allowing the formation of a new “prosthetic” cement–enamel junction. This allows the creation of ideal esthetic contours of the crown, to which the gingiva adapts without the need for surgical intervention (Figs 3a to 3c).

It has been claimed that this technique offers several advantages, a major one being a better marginal adaptation of the crown after cementation and a minimal microgap compared to traditional “horizontal” preparations, such as chamfer or shoulders. Moreover, the crown’s emergence profile supports and shapes the buccal soft tissue, which adapts itself to the tooth contour. The clinical consequences of this simple observation, which questions the traditional definition of prosthetic “overcontour”, are relevant: the gingival portion of the crown, in fact, can be designed as desired, being freed from the geometric limitation of the abutment’s margin line. As a consequence, increased stability of the gingival margin over time should be expected, with little or no buccal gingival recession.

The technical criticism of the weakness of the feather-edge margin of the crown in supporting the occlusal stress is overcome by designing a reinforced “strength collar”, either for porcelain fused to metal (PFM) or metal-free (zirconia) frameworks (Fig 4).

Similar restorative concepts have also been suggested for the implant abutment design, and have been applied by the authors in a case series, mostly in the esthetic zone (Fig 5), with positive
clinical results in terms of buccal gingival margin stability, compared to the more frequently experienced recession with the shoulder/chamfer design.

The principal reasons for these positive results are:

a) The minimal post-cementation gap (similar to what happens in natural teeth, as previously mentioned).
b) The elimination of the horizontal component of the traditionally designed shoulder abutment, which leaves a wider available space for soft tissue thickening (Figs 6a to 7b).

All other variables being equal (bone volume, gingival biotype, correct implant size and position, soft tissue enhancement), it seems that a shoulderless abutment and the corresponding crown margin may offer a better chance for the health and stability of the gingival margin. Even if clinical studies are needed to confirm this hypothesis, there is...
consistent clinical evidence supporting the application of this design for implant abutments.

However, some critical considerations must be borne in mind regarding the implementation of the feather-edge abutment in every case:

- The lack of a finish line could make it more difficult to control the fit of the crown, especially when multiple implants are splinted for mechanical reasons or simply as part of a cemented implant bridge.
- With the shoulderless abutment, the walls’ convergence angle tends to be reduced toward 0 degrees; otherwise, due to the presence of the internal screw access hole, a more tapered preparation would eliminate much of the retentive surface of the abutment. The retrievability of the crown is therefore almost impossible, even if temporary cement is used.
- Another common criticism of the feather-edge abutment design is the possible increased risk of undetected excess cement in peri-implant soft tissues. This complication seems to occur more frequently than expected in cemented implant restorations, in particular when a resin cement is used. A greater risk of peri-implant disease was found in periodontally compromised patients with cemented implant restorations when excess cement remained undetected in the peri-implant sulcus. Moreover, a positive correlation was found between a deeper subgingival margin and the amount of undetected cement.

In the authors’ opinion, the use of a shoulderless abutment design (Fig 8) may further increase the risk of residual excess cement, such as in molar teeth, where the difference in diameter between the implant platform and the crown (undercut) could lead to an inaccessible subgingival margin and to the persistence of undetected cement.
remnants with possible marginal bone loss (Figs 9a and 9b). For these reasons, a modified abutment is proposed which incorporates features of the two previously mentioned designs.

The hybrid abutment design (HAD)

There are three distinct zones in the HAD design (Fig 10):

a) The buccal zone: This portion (Figs 11 and 12) is flat, with no horizontal component. It resembles the buccal side of a natural tooth prepared with no finish line, and will receive the feather-edge margin of the crown. Therefore, the post-cementation gap will be minimal compared to a shoulder design. The crown margin will be positioned slightly subgingivally, between 1 and 1.5 mm, allowing the complete removal of excess cement. The crown emergence profile supports and shapes the gingival margin and can be contoured based on esthetic needs. The clinical advantage offered by the shoulderless design to maintain the buccal soft tissue margin indicates this design for esthetic zones.

b) The linguopalatal wall: This portion (Figs 12 and 13) presents a definite chamfer finish line that is located supragingivally or at the gingival level, if necessary, to increase retention in case of short abutments. For the same reason, one or two retaining grooves can be added in the palatal wall. The accessible margin is an important reference point when inspecting the crown’s seating, and the horizontal component of the chamfer helps to dissipate occlusal stress. No subgingival cement is expected in this area. The lack of esthetic relevance of this portion indicates the shouldered design.

c) The interproximal walls: In this portion (Fig 12), the palatal chamfer blends toward the interproximal surfaces of the smooth walls, with no horizontal...
Clinical indications for different abutment designs

Posterior quadrants

(1) When the edentulous area has a good soft tissue quality with an adequate dimension of keratinized gingiva ($\geq 3$ mm), a traditional abutment design with a definite margin can be used (Fig 14). Better control of the marginal adaptation of the restoration is facilitated, as well as the complete removal of excess cement.

This situation is illustrated, for example, by a mandibular posterior edentulous ridge (Fig 15), where the second premolar and the first molar were to be replaced by two implant-supported crowns. A single-stage surgery was performed (Fig 16). On the 5 mm-diameter implant in the molar area, a 4 mm healing abutment was placed in order to start a platform-switching restorative procedure (Fig 17), which has been demonstrated to be effective in peri-implant bone preservation.29

An impression was taken after 8 weeks, and two abutments were prepared on the sectioned master cast.
from a commercial titanium component (Tissuemax, Biomax) (Fig 18). The abutments were designed with a chamfer finish line, only slightly subgingival on the buccal side, and were duplicated on the master cast using the abutment duplication technique (ADT) technical protocol³⁰ (Fig 19), then digitally scanned with the Sirona InEos Blue laboratory scanner (Sirona) (Fig 20). The temporary acrylic crown milled from the digital dataset (Fig 21) was checked on the original abutments (Fig 22) and cemented at the time of abutment connection (Figs 23 and 24).

After two months, on the same dataset, the final ceramic on zirconia restorations were completed onto the ADT model (Fig 25) with no need for any further impression. The temporary crowns were removed (Fig 26) and the final restorations were cemented with TempBond (Kerr) (Fig 27). No abutment disconnection was made during the entire restorative protocol, which followed the “one abutment/one time” concept designed by the authors as part of a minimally invasive prosthetic protocol that has been proven to reduce peri-implant marginal bone loss.³¹ At the 3-year follow-up, the excellent hard and soft tissue levels were evident (Figs 28 and 29).

**Fig 18** Titanium abutments prepared with a circumferential chamfer finish line.
**Fig 19** Replicas on the original working model of the polyurethane abutments.
**Fig 20** Scan view of the original metal abutments.

**Fig 21** Digitally designed temporary crowns.
**Fig 22** PMMA (polymethylmethacrylate) crowns, milled.
(2) When the edentulous area has a poor soft tissue quality and volume, with a band of keratinized gingiva of < 3 mm, the shoulderless abutment design is indicated more frequently if a buccal subgingival margin is planned in cases where patients demonstrate particular esthetic demands.
In this case (2), the situation differs from that described above (1) as regards the limited amount of buccal soft tissue. Moreover, the implant platform is placed at crestal level (Figs 30 and 31), and therefore the transmucosal component of the abutment profile is minimal, except for the mesial side of the first implant (Fig 32). A hybrid design (Fig 33) is indicated to combine precision with an "esthetic" buccal margin with no finish line (Fig 34). The lingual chamfered portion (Fig 35) allows an increased cement-retained surface and an adequate taper to allow retrievability. The abutment duplication and the digital prosthetic process (Figs 36 to 38) are the same as in the preceding case (1), from abutment connection (Figs 39a and 39b) to temporization (Fig 40). Again, no further abutment disconnection is made, and the case is finalized without the need of a transfer impression (Figs 41 and 42).
Fig 36  Scan view of the abutments.
Fig 37  The profiles of the crowns are designed for both temporary and final restorations.
Fig 38  PMMA milled crowns before delivery.

Fig 39  (a) Single and final connection of the abutments. (b) Radiographic control.
Fig 40  Temporary crowns are cemented.

Fig 41  Zirconia/ceramic crowns completed on duplicated abutments.
Fig 42  Final restorations in place.
Esthetic zones

The primary indication for the HAD is the esthetic zone of the maxillary arch, which, depending on the smile line and the relative display of the buccal gingival margins, may extend back to the first molars, especially in “gummy” smiles. In the following clinical case, the hopeless central left incisor was planned for extraction and replacement with an implant-supported crown (Figs 43 and 44). The solution requested by the patient to the diastema problem involved the implementation of a veneer ceramic restoration on the contralateral incisor, on which a 1.5 mm buccal gingival recession was also present. At the time of extraction, a socket preservation technique was used (Figs 45 and 46), followed by a delayed implantation and delayed loading.

Fig 43  Hopeless left central incisor planned to be extracted.
Fig 44  Severe periodontal lesion is also documented by radiograph.

Fig 45  Socket is grafted with osteoconductive material.
Fig 46  A Leukocyte-Platelet Rich Fibrin (L-PRF) membrane is used to seal the socket.
After 3 months, an implant-level impression was taken (Figs 47a and 47b), and a resin matrix of the abutment with hybrid features was prepared (Fig 48), scanned, and milled in the laboratory in titanium (Fig 49), together with the digitally designed and milled polymethylmethacrylate (PMMA) crown and the zirconia framework for the final restoration (Figs 50a to 50c). Both had a feather-edge buccal margin and a chamfer lingual margin, and exactly the same emergence profile. Note how the “strength collar” has an intrasulcular component with a maximum of 1 mm, which ensures the complete removal of excess cement.

**Fig 47**  (a) Healing at 3 months, after a delayed implant placement and osseointegration. (b) Coping in place for pick-up impression.

**Fig 48**  A resin framework abutment is built for scanning.

**Fig 49**  Titanium-milled hybrid abutment is produced and duplicated.
Fig 50  (a) The crown is digitally designed. (b) Temporary PMMA crown is produced by milling. (c) Final zirconia framework is also milled.

Fig 51  Abutment connection.

Fig 52  Temporary crown cemented.

Fig 53  Radiographic control.

Fig 54  After 6 weeks, soft tissues are shaped by the crown's profile.

Fig 55  Veneer preparation on right incisor, ready for impression, together with zirconia framework on left incisor hybrid abutment.
The abutment was connected (Fig 51) and the acrylic crown cemented, while an interim composite restoration was applied to match the contralateral interproximal contour and to close the diastema (Figs 52 and 53).

After 6 weeks, the right central incisor was prepared for a ceramic veneer (Fig 54). A polyvinylsiloxane impression was taken, incorporating the zirconia framework for the implant restoration (Figs 55 and 56).

**Fig 56** Impression incorporating the zirconia framework.

**Fig 57**  
(a) Abutment replica ready for the extraoral cementation procedure.  
(b) Eugenol-free zinc oxide cement is mixed and applied into the crown.  
(c) The crown is placed firmly on the abutment replica and immediately removed.  
(d) Excess cement is wiped out of the crown margin, and this is placed intraorally.  
(e) The abutment replica is then cleaned and stored in the clinic.
In the final clinical session, the veneer was bonded on the left incisor and the finalized ceramic zirconia restoration was cemented on the implant abutment. A temporary cement was used for this procedure to maintain the retrievability of the restoration and reduce the risk of leaving remnants of excess cement in the peri-implant sulcus.\textsuperscript{32,33} Moreover, a controlled cementation technique, more effective for eliminating the residual excess cement, was applied.\textsuperscript{34,35} In the original technique, a silicon putty replica of the abutment is prepared. The crown is then filled with cement and placed onto the replica. The excess cement is extruded and removed from the crown, which is immediately positioned on the abutment intraorally. In the authors’ protocol, the abutment replica in polyurethane resin, which is more precise, serves the same purpose (Figs 57a to 57e). No residual excess cement is left in the peri-implant sulcus, thanks to the cementation procedure and also to the peculiar abutment design, which minimizes the intrasulcular component of the restoration.

The final, positive result (Figs 58 and 59) is confirmed after 2 years (Fig 60).
Discussion

The achievement of a long-term esthetic result in implant-supported anterior restorations depends on the combination of several conditions, among which an adequate hard and soft tissue volume at implant site and precise tridimensional implant placement are of paramount importance. If these factors are not correctly implemented, very little can be done through the restorative procedures alone to improve the poor esthetic result.

These restorative procedures – e.g., implant-level impression, extended use of temporary abutments and crowns to progressively shape the soft tissue architecture, transmucosal customizations of the final impression coping, final abutment, crown try-ins – are often very complex and time-consuming, especially in cemented prostheses. All these procedures involve multiple disconnection at implant level, with a possible detrimental effect on peri-implant tissue stability. For this reason, the simplification of the procedures for cemented restorations based on the “one abutment/one time” concept, which is shown in all of the three cases presented in this article, may be of significant value, from both a biologic and a practical perspective.

Cemented implant restorations, although widely used, present some complications, the most frequent being the loosening of the abutment screw. The next three most frequent complications are related to the cemented retention mechanism: a) loss of retention; b) its opposite, difficult retrievability; and c) residual intrasulcular cement. The abutment morphology is involved in all of them, but all its aspects have not been thoroughly analyzed.

Loss of retention has been advocated as a reason for the use of permanent or semi-permanent cements (resin-based cements, zinc phosphate, glass ionomer, polycarboxylate) instead of “temporary” cements (calcium hydroxide, zinc oxide), the performance of which is considered “very unpredictable.” This may not be true if an adequate taper is used. Moreover, altering the abutment surface through airborne-particle abrasion can enhance retention, reducing the need for a permanent cement. The opposite protocol must be used if a retrievable cemented restoration is preferred (increase taper, smoother surface), and a balance should be achieved between insufficient retention of the prosthesis and retrievability, which is an advantage for many reasons (repair, cleaning, etc). Another important reason for the use of a temporary cement is the better radiological identification of zinc-based cements compared to permanent ones, which helps to detect intrasulcular remnants, at least interproximally.

Surprisingly, in the vast body of available literature on implants and esthetics, there are few articles about the abutment morphology as a possible contributing factor when solving the problem of buccal gingival recession. Although several articles deal with this problem, most of them are unclear about the restorative aspects of the treatment.

The feather-edge abutment has shown positive effects in terms of gingival margin stability due to the reduced post-cementation gap geometrically associated with this design, and also due
to the effective thickening of the buccal gingival tissue. This has yet to be confirmed by clinical studies. Yet, irrespective of the kind of design, the risk of cement remnants in the peri-implant sulcus, followed by soft tissue inflammation and eventual mucosal and peri-implant disease, must be seriously considered. However, with a feather-edge design, the subgingivally reversed emergence profile (coronally convergent) is far more accessible for cement removal than with a traditional shoulder design (coronally divergent). With the latter, when the margin is placed subgingivally, excess cement may be trapped beyond and below the abutment finish line. In fact, all the articles in the literature about the role of excess cement in peri-implant disease are based on clinical observations where the traditional shoulder design was used. While one study claims that a particular abutment morphology with a concave neck increases the soft tissue thickness above the implant platform, two other studies fail to confirm this claim. Moreover, the shoulder margin is still present in this design, which, in the authors’ opinion, is a fundamental difference in soft tissue behavior.

Intrasulcular cement excess can also be a problem with the marginless design in some situations where the margins may end up restoring regular implant diameters with large diameter crowns, like in the molar areas. Therefore, it seems reasonable to use the traditional shoulder design in non-esthetic zones and keep the margin above the gingiva or at a minimal intrasulcular depth. However, public awareness is growing concerning the possible display of unesthetic metal margins, even in areas that are not normally visible. For this reason, the margin of the crown is more frequently positioned by clinicians within the gingival sulcus, including in nonesthetic zones. The features of the HAD combine a limited intrasulcular position (1 to 1.5 mm) of the margin on the shoulderless buccal side with a precise reference point of a chamfer finish line on the non-esthetic side of the cemented restoration. This design is indicated only in esthetic areas of the mouth, where it might result in positive clinical effects while, together with the use of a temporary cement and a controlled cementation protocol, reduce the risk of residual undetected cement in the peri-implant sulcus.

Finally, the use of titanium abutments needs to be considered. In the present study, the specific use of titanium as the material of choice was intended to defy the “conventional” opinion that titanium abutments cannot be used in the esthetic zone and that only zirconia should be allowed. On the contrary, in our clinical practice we have treated only a few cases with zirconia abutments, those being patients with scalloped, thin buccal gingiva. The “consensus” about using only zirconia in the esthetic zones is not supported scientifically; nevertheless, it has become a habit to do so, probably because there has been no possible alternative. It should be borne in mind that zirconia abutments also have certain drawbacks that are very well known in clinical practice. If the zirconia abutment is completely metal-free, the connector part is less precise and is not strong enough to ensure long-term performance. On the other hand, a metallic connector glued to a zirconia post makes disconnection between the
components likely. This failure is due to it being mechanically weaker compared to a full titanium abutment. The authors' intention in this article has been to open a discussion on this topic by proposing a possible alternative, ie, the hybrid abutment.

Conclusions

Cemented implant-supported restorations are still widely used in the treatment of edentulous sites. The commonly used abutment design with a definite finish line poses some problems when an intrasulcular crown margin is indicated for esthetic reasons. One major complication is the gingival recession at the buccal margin. There is some evidence in the literature that a shoulderless, feather-edge abutment design in fixed dental restorations could improve soft tissue stability over time.\(^\text{15-18}\) While the assumption that these positive results may be transferred to the implant abutment is presently not supported by published data, the assumption is supported by the long-term clinical results obtained by a group of experienced clinicians. Moreover, a generalized application of this design may raise some concern about the possibility of intrasulcular cement remnants. The hybrid abutment – a variation of the shoulderless design – is proposed, in which a chamfer margin is maintained on the palatal side and the intrasulcular component of the restoration is limited only to the buccal (“esthetic”) side, practically combining the clinical advantages of the two designs. A 5-year retrospective case analysis is underway in order to evaluate the clinical outcome of this specific design.

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References


