Clinical Recommendations for Implant Abutment Selection for Single-Implant Reconstructions: Customized vs Standardized Ceramic and Metallic Solutions

The present paper presents clinical guidelines for the selection of the abutment material and level of customization for single-implant reconstructions. A systematic literature search was conducted previous to a Consensus Conference, resulting in two systematic reviews. One review focused on esthetic clinical outcomes, including esthetic indices and linear measurements, and the second focused on peri-implant soft tissue color outcomes, evaluated with spectrophotometry. The outcomes of esthetic indexes and linear measurement were highly heterogenic, hence, a meta-analysis was not feasible. All-ceramic and customized solutions showed a trend for improved results of the esthetic outcomes. Regarding soft tissue color outcomes, all-ceramic abutments induced significantly less soft tissue color changes. Both metallic and all-ceramic abutments/standard and customized components may result in clinically and esthetically acceptable reconstructions.


The replacement of a single missing tooth with an implant-supported single crown is considered a valid treatment option due to excellent survival rates for both the implant and its reconstruction. Yet, with increasing patient expectations concerning the esthetic outcome of anterior reconstructions, this treatment remains a clinical challenge.

Providing an implant-supported reconstruction that blends in to the neighboring teeth and soft tissue architecture, in a harmonious and pleasant manner, is only possible after meticulous patient and site-specific risk analysis, consequent decision-making (implant, abutment, and reconstruction selection; surgical technique; treatment planning sequence), and subsequent excellent treatment execution.

It is the scope of this report to focus on recommendations for the use of abutments made out of different materials and the application of different types of implant-supported solutions, ie, the customized and standardized solutions.

Available materials for abutments supporting single-implant crowns include: metallic (titanium, precious/semi-precious alloys, non-precious alloys), all-ceramic (zirconia, alumina), and resin-based materials (polyetheretherketone).

Most published literature on implant abutments has focused on
survival rates and the biologic and technical complications of titanium and alumina/zirconia abutments.² It is widely accepted that titanium and zirconia abutments exhibit excellent biocompatibility²,⁸,⁹ and mechanical stability for the clinical application.¹⁰–¹² However, the degree to which material selection affects the esthetic outcome is still a recurrent question for the clinician, especially as there are several factors directly associated with abutment material selection that need to be considered, like the level of customization or the type of retention (cement- or screw-retained).

The objective is to provide comprehensive clinical guidelines to help clinicians in their decision-making between the different implant restorative options, based on the current evidence (two systematic reviews and unpublished data) and paired with the clinical expertise of those participating at the Consensus Conference.

### Material and Methods

A systematic literature search was conducted previous to the Clinical Consensus Conference on Abutment/Crown Design for Single Tooth Implant Restorations, held April 14 and 15, 2017, at the New York University College of Dentistry (NYU).

The Consensus Conference’s objective was to investigate the effect of different factors on the esthetic outcomes of anterior implant-retained single reconstructions. The factors evaluated were: peri-implant soft tissue “framework” (group 1), three-dimensional implant position (group 2), abutment insertion protocol (group 3), and the abutment type and material (group 4). Each participating group completed systematic reviews on their specific topic. The findings were presented, discussed, and debated with all the attending experts in plenary sessions. After the respective discussions, guidelines and recommendations were developed by the plenum.

The authors of the current manuscript were integrated into group 4, which aimed to evaluate the influence of abutment material selection and level of customization on the esthetic outcomes of single-implant–supported reconstructions. The systematic literature search and evaluation to address this topic resulted in two systematic reviews on single-implant reconstructions in the anterior region reporting on the abutment material and level of customization. One review focused on esthetic clinical outcomes, including esthetic indices and linear measurements, and the second focused on the peri-implant soft tissue color outcomes, evaluated with spectrophotometry (both reviews in preparatory stages).

The recommendations and clinical guidelines developed and discussed by the plenum on this topic are presented herein.
Results

Summary of the Systematic Reviews

Effect of Material and Level of Customization on Esthetic Indices

The available results are based on medium-term evaluation studies (minimum of 3 years of follow-up) composed of 16 included manuscripts.\textsuperscript{10,12–26} The selected esthetic outcomes were the following esthetic indices: (1) the Pink Esthetic Score (PES),\textsuperscript{27} (2) the Papilla Index (PI),\textsuperscript{28} and (3) the linear measurement of recessions.\textsuperscript{16} The results from the included studies were heterogenic in nature, which did not allow for a meta-analysis of the data. Hence, the weighted means were used for a narrative evaluation. All-ceramic and customized components showed a tendency for better esthetic outcomes as compared to metallic and standardized/stock components (outcome measure: PES). Meanwhile, the PI and recession values were independent of abutment material or level of customization to a similar extent (based on review 1, in preparation\textsuperscript{29}).

Effect of Material on Peri-implant Soft Tissue Color

The results are based in nine included studies.\textsuperscript{11,30–34} In these studies, soft tissue discoloration was evaluated by means of spectrophotometry. The data was extracted and a meta-analysis comparing metallic and all-ceramic abutments was performed. All-ceramic components demonstrated less soft tissue discoloration when compared to metallic abutments (based on review 2, in preparation).

Consensus Statements

In the presence of a thin phenotype, all-ceramic materials should be used for abutments and/or crowns.

When all-ceramic materials are used, the use of a titanium base abutment/connection is advised.

Customized abutments provide improved soft tissue support and should hence be preferred in esthetically demanding situations.

The customized abutments improve site-respective cement-line positions for cement-retained crowns.

Crowns can be connected to implants either by screw or cement retention. However, when using a cementation protocol, pronounced care must be taken to remove residual excess cement to avoid biologic complications.

Discussion and Clinical Guidelines

The selection of the abutment for single-implant reconstructions involves several levels of decision-making. The type of retention, the customization level, and the type of material are three relevant parameters to be considered, which are shown in a comprehensive decision tree in Table 1 and illustrated in Figs 1 to 4.

Type of Retention

Both screw- and cement-retained single-implant–supported reconstructions result in clinically acceptable outcomes, exhibiting high survival rates and low complication rates, as reported in previous systematic reviews.\textsuperscript{35,36} It was discussed that it may not be clearly
Level of Customization

At cement-retained reconstructions, it is highly recommended to use customized abutments, as shown in Fig 2. It is well documented that no matter how meticulous the efforts to remove the excess cement are, cement remnants can be found in subgingivally placed reconstruction margins in both clinical and in vitro settings. The amount of cement excess increased significantly for each millimeter of depth that the crown margin was placed underneath the peri-implant mucosal margin. It is for this reason that, when cementing, it is highly advisable to place the margin as shallow as possible in the esthetic area (e.g., epi- or supramucosally in the palatal/lingual aspect and 0.5 to 1 mm submucosal in the buccal aspect of the implant-supported reconstruction).

Material

In respect to biocompatibility, titanium- and zirconia surfaces showed colonization patterns by a bacterial community similar to those found in the remaining adjacent teeth as well as low clinical inflammation parameters in the clinical setting. Despite the good clinical performance of zirconia abutments, caution should be taken when selecting this restorative material. Zirconia as a brittle ceramic abutment material is mechanically weaker than metals like titanium.
Zirconia abutments were more prone to fracture than titanium abutments, as demonstrated in several in vitro studies. In a 5-year follow-up clinical prospective study, a 7.8% abutment fracture rate was reported, specifically at narrow implant diameters (four of the five fractures were narrow platforms). For good clinical stability of the zirconia abutments, the manufacturer recommended respecting the material thicknesses. Consequently, zirconia abutments should be avoided when high occlusal forces are expected or in cases where a lack of space does not allow for an adequate material thickness.

Concerning the esthetic outcomes, the results from this Consensus Conference showed that all-ceramic abutment materials tended to lead to improved soft tissue esthetics (PES) as compared to metallic abutments. However, ceramic abutments lead to similar papilla fill (PI) and recession occurrence as metallic abutments. At the soft tissue color evaluation, performed by means of the spectrophotometry, all-ceramic abutments showed significantly better results compared to metallic abutments.

The Consensus Conference experts agreed with these findings. It is evident that the beneficial influence on soft tissue color is the most pronounced advantage of all-ceramic implant abutments and reconstructions. The PES includes color as one of the evaluated parameters, which explains the improved results for all-ceramic abutments, while recession and PI evaluations are influenced by abutment shape rather than by material, explaining the lack of differences between the all-ceramic and the metallic abutments.

**Conclusions**

In clinical situations with high esthetic demands (high esthetic expectations, high smile line), with anatomically demanding factors (high scalloping of the soft tissues, triangular teeth) and mechanically low challenges (regular-platform implant, low occlusal forces), customized all-ceramic implant abutments/solutions are recommended.

In clinical situations with low esthetic demands (esthetics of less importance, low smile line) and mechanically challenging situations (narrow-diameter platform, high occlusal forces), metallic abutments are recommended.

In high esthetic cases that are also mechanically challenging, the patient should be carefully informed, as the decision has to be mutually made between: (1) a more

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**Fig 3** Case 3. Screw-retained porcelain-fused-to-metal crown. (a) Front view of the initial situation. (b) Porcelain-fused-to-metal implant crown. (c) Final implant reconstruction in place.

**Fig 4** Case 4. (a) Hybrid abutment crown. (b) Titanium base and crown, not connected. (c) Final implant reconstruction in place.
esthetic solution with compromised mechanical stability (all-ceramic narrow-diameter abutment in a patient with high occlusal forces), or (2) a possible esthetic challenge that delivers more mechanical stability, i.e., the application of a metallic abutment. Soft tissue grafting may be needed in order to increase tissue thickness and decrease the risk of tissue discoloration.

The use of titanium-base hybrid abutments may help combine the advantages of all-ceramic and metallic abutments, for both improved esthetics and mechanically stable outcomes.

In situations where cementation of the implant reconstruction is required, the use of customized abutments/solutions for an individualized cement margin line is mandatory (specifically in situations with highly scalloped soft tissues).

Acknowledgments

The authors would like to thank the excellent work and contribution in the form of clinical cases of Master Dental Technician Vincent Fehmer and Dr Stefan Hicklin. The authors also thank Dr Hyeonjong Lee for his valuable support with photo conversion and editing. The authors declare no conflicts of interest.

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