

Comparison of Fit Accuracy between Procera® Custom Abutments and Three Implant Systems

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ABSTRACT

Background: Although increase of misfit has been reported when associating implant and abutment from different manufacturers, Procera custom abutment has been universally used in clinical practice.

Purpose: The purpose of this investigation was to compare the vertical gap of zirconia Procera® abutment associated with implants from the same manufacturer (Procera manufacturer) and two other implant systems.

Materials and Methods: Twenty-four zirconia Procera abutments were produced using computer-assisted design and manufacture and paired with (a) eight MK III, RP 4.1 × 10 mm implants (Nobel Biocare™, Göteborg, Sweden) – GNB group (Nobel Biocare group); (b) eight Try on, 4.1 × 10 mm implants (Sistema de Implantes, São Paulo, Brazil) – ES group (SIN experimental group); and (c) eight Master screw, 4.1 × 10 mm implants (Conexão® Sistema de Prótese, São Paulo, Brazil) – EC group (Conexão experimental group). A comparison of the vertical misfit at the implant–abutment interface was taken at six measuring sites on each sample using scanning electron microscopy with a magnification of 408×. One-way analysis of variance was used to test for differences, and Tukey's test was used for pair-wise comparison of groups ($\alpha = 0.05$).

Results: Significant differences relative to average misfit were found when Procera abutments were associated with other implant manufacturers. The ES group and EC group did not differ significantly, but both demonstrated significantly larger average misfit than the GNB group ($p = .001$). The average misfit was $5.7 \mu\text{m} \pm 0.39$, $9.53 \mu\text{m} \pm 0.52$, and $10.62 \mu\text{m} \pm 2.16$, respectively, for groups GNB, ES, and EC.

Conclusion: The association of Procera zirconia abutment with other implant systems different from its manufacturer demonstrated significant alteration of vertical misfit at implant–abutment interface.

KEY WORDS: dental implants, implant-supported prosthesis, misfit, prosthodontic planning

INTRODUCTION

The Procera® ceramic abutment is an excellent choice in single implant restorations, because of its

biocompatibility and better aesthetics, as it minimizes the gray color associated with metal components that is transmitted through the peri-implant tissues.^{1,2} Based on computer-assisted design/computer-assisted manufacturing technology, it also provides custom implant abutments, without casting procedures, reproducing body height, width, and taper of the abutment, as well as gingival margin height, width, and emergence profile.² These advantages would offer universal application for all Brånemark compatible implant systems, if an optimal fit could be obtained on the implant–abutment interface.

There are conflicting reports about misfit clinical effects. Some investigators have claimed a relation between clinical complications and poor fit of screw-retained implant prostheses. According to their findings,

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vertical and horizontal misfit applies loads to the implant assemblies and the bone, being directly related to several mechanical complications such as loosening or fracture of abutment and prosthetic screw, abutment fracture, and complete loss of osseointegration in the most severe cases.³⁻⁹ Although, marginal integrity at the implant–abutment interface is important to reduce stress transfer to bone and screw joint, preventing movement at the deep implant–abutment interface that causes peri-implant tissues irritation, and possibly bone loss surrounding implants.¹⁰⁻¹³ However, studies in animals reveal a positive bone response, with increased bone-to-metal contact at the tip of threads, in association with implants supporting misfitting frameworks.^{14,15}

Another consequence is the microbial colonization inside the implants, where the microgap is related to bacterial leakage that might play an important role in the etiology of peri-implantitis.¹⁶⁻¹⁹

Procera abutment is fabricated by Nobel Biocare™ and according to the manufacturer, besides Brånemark System® implants (Nobel Biocare, Göteborg, Sweden), they are also suitable only for 3i® 3.75 (Implant Innovations, West Palm Beach, FL, USA), Lifecore® Biomedical Restore 3.75 (Lifecore Biomedical LLC, Chaska, MN, USA), Zimmer® Dental Taper-Lock 4.0 (Zimmer Dental Inc., Carlsbad, CA, USA), and Sterngold® Implamed® 3.75 (Sterngold Dental LLC, Attleboro, MA, USA).

Combination of abutments and implant systems from different manufacturers may lead to poor marginal fit, comparing to implant–abutment interface from the same manufacturer.³

Consequences of misfit have been discussed in a great number of studies;²⁰⁻²⁸ however, little or no data have been published concerning association between Procera ceramic abutments made from zirconia and other Brånemark compatible implant systems, even though it has been widely used as an universal abutment.²²

The purpose of this study was to compare the vertical gap of zirconia Procera abutment associated with Brånemark System implants (Nobel Biocare) and two other implant systems widely used in Brazil.

The null hypothesis was that Procera abutments associated with its respective implant manufacturer and with other implant systems, clearly not listed as recommended by manufacturer, would not imply significant changes with respect to marginal gap.

MATERIALS AND METHODS

Fabrication of Specimens

For this experiment, an abutment (Nobel Biocare) was secured in one external-hexagon implant analog, and two vertical lines disposed 180° from each other were milled on lingual and buccal surfaces attempting to guide scanning electron microscopy (SEM) measurements.

The assembly was then positioned in the Procera scanner in order to obtain digitally scanned images. Based on the images processed, 24 zirconia abutments were produced identically in shape and placed in three groups of eight specimens each: (a) Nobel Biocare group (GNB) – MK III, RP 4.1 × 10 mm implants (Nobel Biocare); (b) Experimental group SIN (ES) – Try on, 4.1 × 10 mm implants (SIN-Sistema de Implantes, São Paulo, Brazil); and (3) experimental group Conexão (EC) – Master screw, 4.1 × 10 mm implants (Conexão Sistema de Prótese, São Paulo, Brazil).

Each implant and respective abutment formed one sample. Subsequently, each sample was placed in a rigid device to ensure stable fixation and tightened to 35 Ncm by a single examiner using a calibrated electronic torque controller with a precision of ± 2% (W&H Dentalwerk, Bürmoos, Austria).

SEM

The fit of all 24 samples was then measured by means of scanning electron microscope with a spatial resolution of 5 nm (LEO 1430 VP, Oberkochen, Germany). Initially, each implant–abutment samples were inserted in the SEM source, with the reference vertical line on the outer surface of the abutment oriented toward reader, and the gap areas were measured in three points (left edge, central, and right edge) with aid of a digital image software and analyzer from the SEM apparatus. Subsequently, the samples were rotated 180° in order to show the other vertical reference line and the same three measuring points were recorded. All measurements were made at a magnification of 408× at six predefined areas, resulting in a total of 48 measurements for each group. The mean value of the six measuring points was assumed as the gap width of each sample. Means and standard deviations (SD) were calculated for the vertical misfit in each of the three groups. Photomicrographs analysis also allowed observation of horizontal discrepancies between the external contour of abutment and implants.

TABLE 1 Descriptive Statistic for Vertical Misfit (μm)						
Groups	<i>n</i>	Minimum	Maximum	Mean	SD	<i>p</i>
GNB	8	5.32	6.22	5.7	$\pm 0.39^A$	
ES	8	9.08	10.25	9.53	$\pm 0.52^B$	0.005
EC	8	8.93	13.6	10.62	$\pm 2.16^B$	0.001

Different letters indicate statistical difference ($p < .05$).

EC – Procera abutment associated with implants from Conexão®; ES – Procera abutment associated with implants from SIN®; GNB – Procera abutment associated with implants from Nobel Biocare™.

Statistical Analysis

Statistical analysis was performed using the SPSS program (SPSS Inc., Chicago, IL, USA). Quantitative differences between the groups were assessed using analysis of variance (ANOVA). Tukey's test was used for pair-wise comparison of groups. A significance level of $\alpha = 0.05$ was used for all comparisons. All statistical analyses were performed at the 95% confidence level.

RESULTS

The mean gap widths and SD results for each group are presented in Table 1.

ANOVA showed differences between the means of the groups ($p = .001$). Tukey's test revealed statistical significant differences between experimental groups (ES and EC) and the GNB group, with smaller misfit values when implant and abutments were from the same manufacturer (GNB). The mean gap width for both experimental groups (ES and EC) were not significantly different, however, the ES group showed smaller mean values in comparison to the EC group.

The distribution of vertical misfit for each group is shown in Figure 1.

All GNB group specimens' photomicrographs were similar, showing relatively smaller marginal gap size distributed uniformly within the six measuring points (Figure 2).

Samples of the experimental group (ES) showed greater amount of misfit at the central area compared with the left and right edges (Figure 3). Group EC demonstrated larger average vertical misfit ($10.62 \mu\text{m} \pm 2.16$) distributed non-uniformly (Figure 4).

DISCUSSION

This study assessed changes at the implant–abutment interface when Procera ceramic abutments are associated with different implant manufacturers.

There are contradictory reports about effects of implant–abutment interface gap space. Considering the lack of *in vivo* studies regarding bone response to misfit, no scientific support can be found for clinical belief that misfit alone contributes to clinical problems. Although

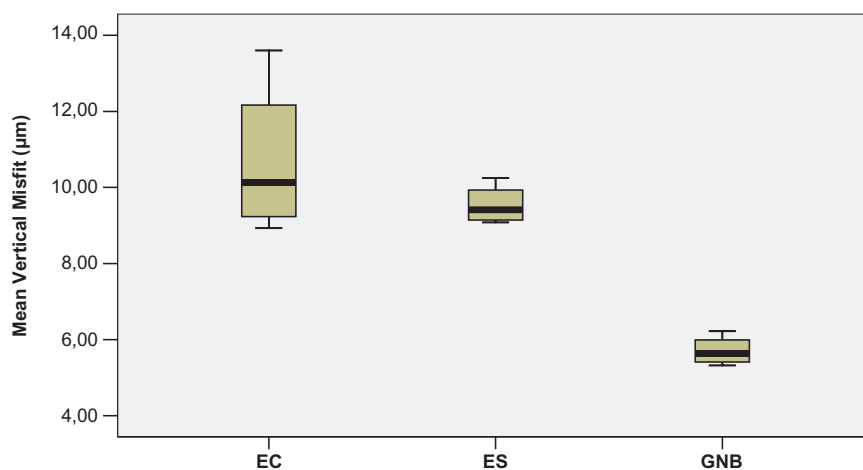


Figure 1 Box plot comparing misfit at implant–abutment interface for each group. EC – Procera abutment associated with implants from Conexão®; ES – Procera abutment associated with implants from SIN®; GNB – Procera abutment associated with implants from Nobel Biocare™.

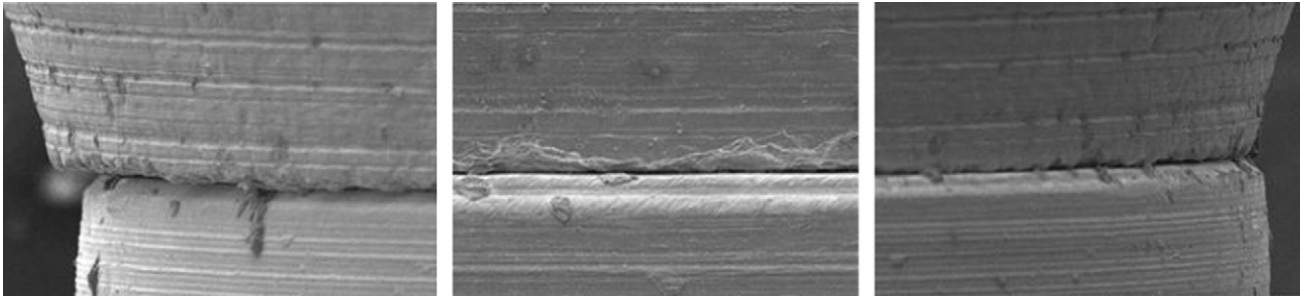


Figure 2 Photomicrographs from group GNB (implant manufactured by Nobel Biocare™) showing microgap distributed uniformly among all measured sites. Note the absence of horizontal discrepancies.

the ideal level of accuracy of fit at implant–abutment interface has yet to be determined, some authors claim that controlling the amount of misfit is important to prevent mechanical and biologic failures, as well as to maintain osseointegration.^{12,19,21,23} In the absence of an ideal level of misfit, the recommendation is to choose implant–abutment combinations that have demonstrated acceptable fit in research investigations.

The current study findings are in accordance with other SEM evaluations using similar methodology. Jansen and colleagues¹⁹ analyzed 13 different implant–abutment combinations and demonstrated that implant

misfit averaged less than 10 μm in all systems. Piattelli and colleagues²¹ showed mean misfit values ranging from 2 to 7 μm for the same implant system. A previous investigation, evaluating implant–abutment interface between Brånemark System implants (Nobel Biocare) and Procera abutments, demonstrated mean microgap measurements of 3.15 μm , 2.52 μm , and 3.19 μm , respectively, for alumina, zirconia, and titanium abutments.⁴

In the present study, SEM examination revealed statistical significant differences between tested groups, regarding misfit at implant–abutment interface. The

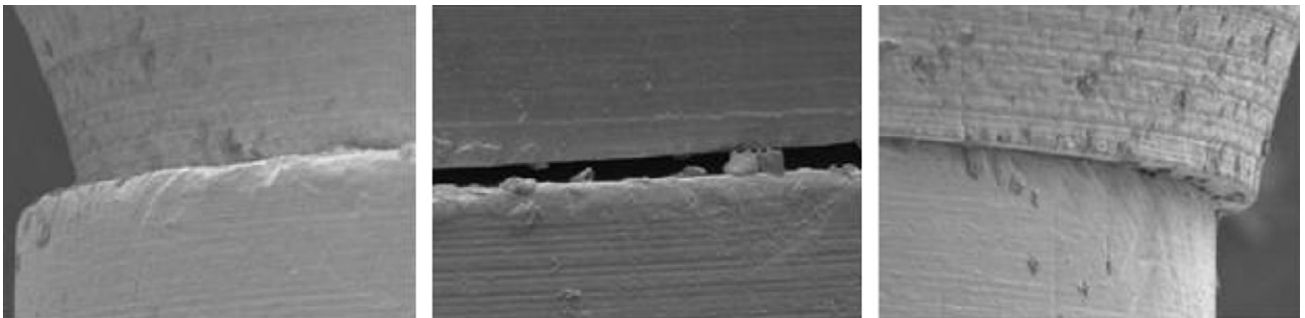


Figure 3 Photomicrographs from group ES (implant manufactured by SIN®) showing a greater misfit in the central area compare to the left and right edges. Note the presence of horizontal overcontour and undercontour.

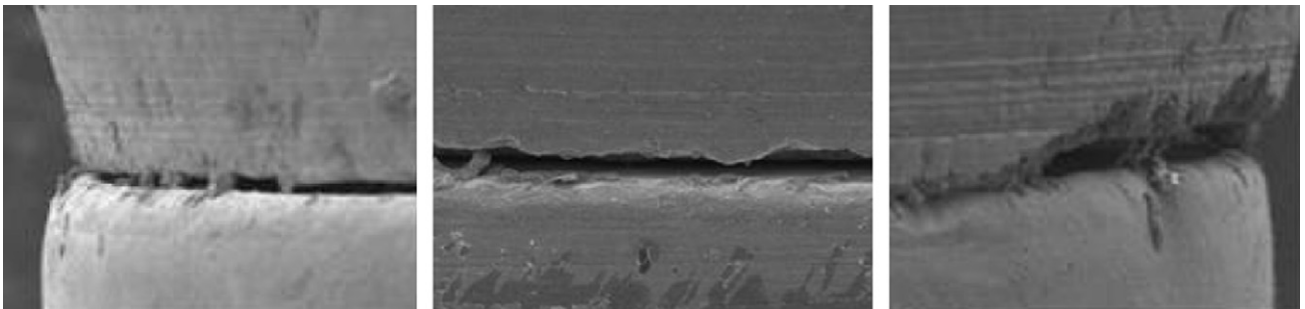


Figure 4 Photomicrographs from group EC (implant manufactured by Conexão®) showing microgap at all measuring sites, distributed non-uniformly.

GNB group showed smaller amounts of misfit distributed uniformly in all measured sites. The average vertical gap width was $5.7 \mu\text{m} \pm 0.39$.

Compared with the GNB group, the experimental groups ES and EC were significantly different, showing average misfit of $9.53 \mu\text{m} \pm 0.52$ and $10.62 \mu\text{m} \pm 2.16$, respectively. These findings are consistent with some studies that have assessed implant–abutment vertical misfit when implants and abutments from different manufacturers are associated.³ It may be explained by differences in machining tolerances of implant systems.

The range of misfit reported in the current study is considered, by many authors, clinically acceptable.^{22–26} Although, certain biologic tolerance for misfit may be present,^{19,28} these entire investigations evaluated abutment–cylinder misfit in partial implant-supported frameworks.^{21–29} This observation is important because, in case of multiple implants, stresses generated by occlusal forces can be well distributed within implants and subsequently, between abutments and cylinders. It may explain the biologic tolerance to certain levels of misfit.

Consequences of misfit in single-tooth restorations using abutments designed to engage the implant directly, as Procera abutments have to be further investigated, because loads are applied directly to implant/bone interface. Assunção and colleagues³⁰ demonstrated by means of finite element analysis that different misfit patterns influences stress distribution of single implant-supported prosthesis. Changes in implant system, position, bone classification, axis of loading and loading condition also influence on biomechanical response of a single-unit implant-supported restoration.^{31,32} However, considering external forces from function and the presence of microbial colonization, the amount of misfit may be considered as a contributing, but probably not significant, factor for complications and failures.¹⁴

In the ES group, all specimens showed horizontal discrepancies at both left and right edges, with combination of overcontour and undercontour. It demonstrates that proper part alignment was not achieved. Photomicrographs also demonstrate larger amount of misfit at the central area compared with the left and right edges. Although compatibility is claimed by this manufacturer for Brånemark system implant, these evidences suggest that this assumption is inconsistent.

Studies evaluating implant–abutment misfit demonstrate different results because of differences in

measurements using SEM analysis.⁴ A limitation of the current study is that the microgap was measured around the outer perimeter of the implant–abutment interface and no information about inner regions were provided. However, this approach has been used in similar investigations, therefore justifying the methodology utilized.

In view of Procera ceramic custom abutments benefits, more studies assessing interchangeability with implant systems that include rotational freedom, preload, and stress transfer will likely provide better information about Procera universality.

CONCLUSION

Within the limitations of this in vitro study, it was found that the association of Procera zirconia abutment with other implant systems different from its manufacturer results in a significant alteration of vertical misfit at implant–abutment interface.

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