

Assessing compatibility and vertical fitting between implants and prosthetic components of different brands

Abstract / Introduction: Dental implants have been successfully used and increasingly included in oral rehabilitation and planning. Several dental companies are responsible for fabricating implants and prosthetic components. **Objective:** This paper aims at assessing the fitting between prosthetic components and external hexagon implants (Brånemark) used in a single system or between systems. **Methods:** The following brands were assessed: Signo Vinces, Sin and Conexão. The implants were placed in acrylic resin, whereas the prosthetic components underwent a 20 N/cm² torque following the manufacturer's instructions. Torque was measured by means of a digital torque gauge and both implants and prosthetic components were assessed by means of a light microscope. **Results:** The combinations between different brands had good average fitting values between the prosthetic component and the implant. The group with the highest values had 16.83 mm of unfitting, probably due to the fact that one out of the six samples of this group had incompatible measures in comparison to the other samples as a result of an isolated alteration in the sample. **Conclusion:** There were no statistically significant differences in terms of unfitting between the prosthetic component and the implant which were all considered compatible. **Keywords:** Dental implants. Fitting. Dental prosthesis.

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INTRODUCTION

Due to great clinical success, osseointegrated implants have become more frequently used and prescribed for rehabilitation in several dental treatments.

The greater demand has opened up a market for several companies in that industry, making it difficult for clinicians to obtain information about the quality of implants and components.

By means of analyzing several multicentric works, it has been observed that poor adaptation of the prosthesis over the implant might influence treatment success, and present some issues, including loosening or fracture of both prosthetic screw and implant,^{1,2} bacterial plaque retention, and loss of osseointegration.³ Due to a supposed compatibility between external hexagon implant system brands, the possibility of using different brands of implants and components is arising. However, when assessing implant brands said to be compatible with the Brånemark system, some studies have shown that not all components can be considered compatible,⁴ thereby recommending the use of new components pertaining to the same system.⁵ Nevertheless, some researches conclude that there are no significant differences between the micro cracks found when there is an exchange between implant and component brands, and that those systems may be considered compatible, as shown by scanning electron microscopy.⁶

Faced with the numerous companies offering external hexagon systems said to be compatible with the Brånemark system, in addition to the supposed possibility of performing rehabilitation treatment by means of components and implants of different brands, and after observing some

divergence in the results of previous research, this study aimed to assess the vertical unfitting between external hexagon implants and prosthetic components fabricated by the same manufacturer. It also aimed to assess potential unfitting between implants and prosthetic components from different manufacturers.

MATERIAL AND METHODS

A case-control, quantitative laboratory study was conducted. A total of 18 samples consisting of implants and prosthetic components from three different manufacturers (6 samples each) were used.

The tested material are described on Table 1.

DEVELOPMENT OF THE DEVICE USED FOR IMPLANT PLACEMENT

The device was developed based on an interchangeable articulator (Bio-art / B2) which underwent a few alterations.

Initially, a white adhesive (Con-Tact) was installed at the base of the articulator and on its table. A wooden device was handcrafted in order to offer some stability to the internal plastic 20 x 20 ferrule (Masticmol), which functioned as a mold for implant placement.

The plastic ferrule was initially filled with colorless self-curing acrylic resin (Clássico JET - Batch 823011 - Date of manufacture: 05/11/2013). On its surface, it had a mark made so to determine its center (Fig 1).

After stabilizing the ferrule on the articulator table, and after making the mark with a black marker (PILOT) in order to guarantee that the ferrule remained stable at the same place, the table was taken to the

Table 1. List of material.

Material	Manufacturer	Batch	Expiration date	Further details
Osseointegrated implants	Conexão Sistemas de Próteses Ltda.	114835	7/12/2014	Titanium cortical screw Master Actives Grip 3.75 x 13
	SIN - Sistema de Implante	I00814	10/2014	Tryon Sup. Tra. Imp. Screw 3.75 x 13
	Signo Vinces Equipamentos Odontológicos Ltda.	13579	-	Inttegra System Implant 3.75 x 13
Prosthetic component	Conexão Sistemas de Próteses Ltda.	122438	4/10/2015	Micro-Unit abutment 1.0 mm Ext. Hex. 3.75/4.0
	SIN - Sistema de Implante	J090028298	9/2015	Min. Abut Ext. Hex. 04.1 x 1 mm
	Signo Vinces Equipamentos Odontológicos Ltda.	16456	10/2015	Conical mini abut. 4.1 mm 1.0-mm high RP

base of the articulator. The position where the device would be statically fixed was then set. To this end, with the articulator table, the right position for all components was initially determined, so as to allow implant placement at the central area of the ferrule (Fig 2).

The arm of the articulator was then fixed, and the position of the table was marked with a black marker at the base. The table was removed and double-sided tape (3M - Adere) was placed at the articulator's base in order to set the position of the table (Fig 3).

The table was once again placed over the base, this time being at a fixed position as previously set by the double-sided tape. Its position was then checked, making sure that the implant placement site would be the one previously set.

To standardize the depth in which implants would be inserted into the acrylic resin, one implant was installed in an open

RP stainless steel 4.1-mm molding post (Signo Vinces Equipamentos Odontológicos Ltda. - batch 16988 - exp.: 11/2015), a component that was later used for placing all implants. The molding component screw was totally fixed at the articulator's shaft tweezers. The internal 20 x 20 ferrule was replaced by a new one, with no acrylic resin inside. Measurements were made in a way that the implants would have been placed 9 mm inside the acrylic resin and 4 mm outside of it.

In order to render the position of the depth of the articulator's shaft fixed and unique, a clamp (INCA - RSF $\frac{3}{8}$ x $\frac{1}{2}$ " - 10 x 13 mm) was placed at the part of the shaft that is above the articulator's arm. With the shaft positioned as previously established, the clamp was tightened, thereby standardizing, by means of a stop, the position in which the shaft was set during implant placement (Fig 4).



Figure 1. Articulator table with white adhesive, wooden device and tip with acrylic resin and mark.



Figure 2. Table properly positioned to determine implant placement site.



Figure 3. Double-sided tape at the base of the articulator.



Figure 4. Clamp fixed at the articulator's shaft.

Thus, the interchangeable articulator began to function in a static manner, in which the only move allowed was the shaft's, however, with a unique and previously set position for implant placement.

IMPLANT PLACEMENT INTO ACRYLIC RESIN

Initially, and before placing each implant into the acrylic resin, a brush (ROMA - 302 - 1/2") was used, and the 20 x 20 internal ferrules were isolated with solid Vaseline (Rioquímica - Indústria Farmacêutica), so as to prevent the acrylic resin from sticking to it.

After the ferrule was properly isolated, it was positioned at the articulator's table. The acrylic resin was prepared using monomer

and polymer proportions as specified by the manufacturer. In a rubber Dappen dish, the acrylic resin was mixed with the aid of a #24 stainless steel spatula. Subsequently, the resin was dispensed into the internal 20 x 20 ferrule and an implant, which was properly installed and fixed at the molding component by means of tweezers and at the articulator shaft, was placed at the desired and previously set position, thereby allowing the implant to be placed into the acrylic resin (Fig 5).

All implants were placed following that same method. Initially, the six Signo Vinces Equipamentos Odontológicos Ltda. implants were placed, followed by implants manufactured by SIN - Sistema de Implante, and finally, the six implants manufactured by Conexão Sistemas de Próteses Ltda. were placed.



Figure 5. Implant being placed into the resin.



Figure 6. Conexão implant specimen.

The specimens were obtained after removing the implants that had been properly placed into the internal 20 x 20 acrylic resin ferrule (Fig 6).

SPECIMEN PREPARATION

Specimens were marked on the edges of the acrylic cube obtained after implant placement. One of the edges randomly received a V mark, while the edge placed at its right side received an M mark, the edge positioned at its left side received a D mark, and the edge positioned at its opposite side received an L mark. The edge placed at the opposite side of the implant and which functioned as a base for the specimen received a mark correspondent to the implant manufacturer and its placement sequence (i.e.: the second implant by Conexão Sistemas de Próteses Ltda. was marked as IC2).

The prosthetic components were also separated according to their manufacturers and numbered from one to six, thereby totaling six implant units from each manufacturer. As they were removed from their packaging, all components were distributed in a plastic organizing box (Mecânica e Estamparia São Bernardo Ltda. - Ref.: 119) of which divisions were tagged according to the manufacturer and the order they had been opened (i.e.: the third prosthetic component by Signo Vínces Equipamentos Odontológicos Ltda. brand to be unpacked was marked as CSV3).

GROUP FORMATION FOR ANALYSIS

With a view to assessing all possible combinations between implants and components, three control groups were determined. They comprised implants and components fabricated by the same manufacturer. Each one of the three control groups was assessed,

even when the implants by a given manufacturer were combined with prosthetic components by the other two manufacturers involved in the study.

Groups were divided as shown in Table 2.

Each implant and prosthetic component was numbered from 1 to 6 according to the number of the sample. Thus, implant samples numbered as 1 would only be tested with prosthetic components numbered as 1, the ones numbered as 2 would only be tested with components numbered as 2, and so on.

METHOD FOR PROSTHETIC COMPONENTS PLACEMENT OVER IMPLANTS

Since each component was installed on three implants, one of each brand, and since each implant received three components, one of each brand, the development of a method for those installations was rendered

Table 2. Groups distribution.

Group	Combination
1	ISV x CSV
1.1	ISV x CSIN
1.2	ISV x CCON
2	ISIN x CSIN
2.1	ISIN x CSV
2.2	ISIN x CCON
3	ICON x CCON
3.1	ICON x CSV
3.2	ICON x CSIN

necessary, so as to prevent the tightening of a second or third component from having potential influences over the analysis. Thus, two implants of each brand received two prosthetic components of each brand in their first tightening; two implants of each brand received two prosthetic components of each brand in their second tightening; and two implants of each brand received two components of each brand in their third tightening. This procedure standardized to all groups a factor that could initially have been a variable among them.

With no alterations to the groups of analysis, and by setting a sequence for the assembly of the prosthetic components over implants as prescribed in the aforementioned method, all prosthetic components received the same torque which was measured by a digital torque gauge (Lutron, model TQ 8800). The torque established and prescribed by the manufacturers was 20 N/cm².

DETERMINING MICROSCOPE AND ANALYSIS POINTS

Measurements of unfitting between implants and prosthetic components were obtained by a TM-505 microscope (Mitutoyo, Japan). Measurement sites were obtained on both sides of the implant platform and the component. Thus, two readings were obtained on each side, with a total of eight readings per implant.

DETERMINING STATISTIC ANALYSIS FOR THE DATA

One-way analysis of variance (ANOVA) was used to determine unfitting differences between components and implants of the same brand and when combined with other brands.

RESULTS

Results are presented in Figures 7, 8 and 9 and Tables 3 and 4.

Figure 7. Comparative statistical result between three prosthetic components (SV, SIN and CON) installed over SV implant. There was no statistic difference between groups (P = 0.1470).

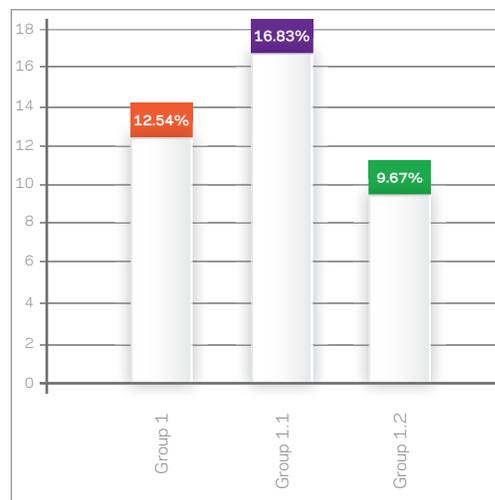
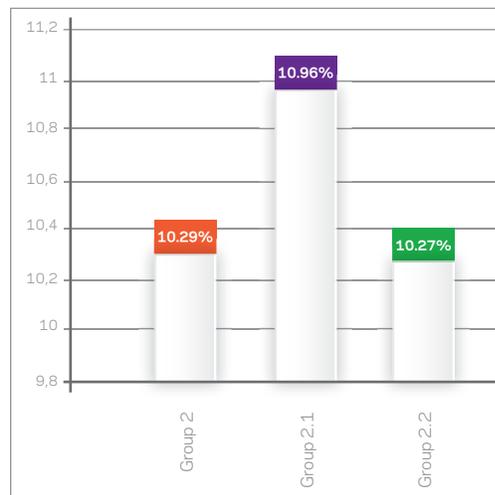


Figure 8. Comparative statistical result between three prosthetic components (SV, SIN and CON) installed over SIN implant. There was no statistic difference between groups (P = 0.1470).



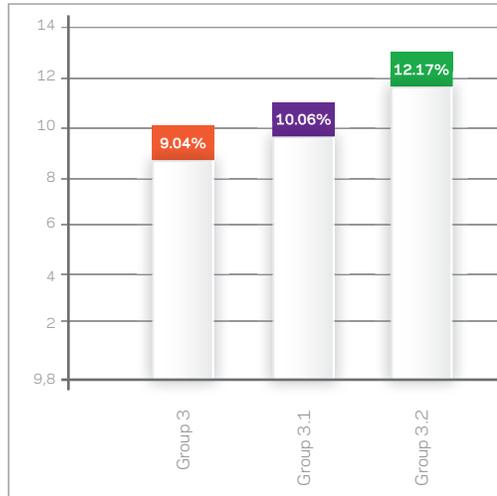


Figure 9. Comparative statistical result between three prosthetic components (SV, SIN and CON) installed over CON implant. There was no statistic difference between groups ($p = 0.1470$).

Table 3. One-way analysis of variance used for comparison between groups.

	Group								
	1	1.1	1.2	2	2.1	2.2	3	3.1	3.2
Sample 1 mean	17.00	11.12	12.62	12.00	12.75	10.00	8.87	11.27	10.62
Sample 2 mean	16.87	11.50	9.62	11.12	14.37	10.25	9.75	10.50	9.62
Sample 3 mean	7.62	18.50	6.75	9.00	11.00	14.50	6.50	10.75	11.37
Sample 4 mean	13.87	40.12	6.75	9.75	8.12	11.87	8.37	10.50	11.75
Sample 5 mean	9.12	10.25	11.12	9.00	10.75	7.50	11.25	9.00	14.50
Sample 6 mean	10.75	9.50	11.12	10.87	8.75	7.50	9.50	8.25	15.12
Group mean	12.54	16.83	9.67	10.29	10.96	10.27	9.04	10.06	12.17
Standard deviation	3.99	11.86	2.45	1.23	2.36	2.68	1.58	1.18	2.18

Table 4. Average values expressed in micrometers for the vertical unfitting between implants and prosthetic components.

Source of variation	Degrees of freedom	Sum of square standard deviation	Mean square standard deviation	Fisher's f-test
Treatment	8	26.6 and -05	33.0 and -06	1.6155
Error	45	92.8 and -05	21.0 and -06	

DISCUSSION

Faced with the great success of rehabilitation by means of dental implants, as shown by Lekholm, Adell and Brånemark,¹ implant therapy has been increasingly included in treatment planning with a view to solving the issue of tooth loss.

According to Binon et al,⁴ lack of satisfactory adaptation between dental implants and prosthetic components may mostly lead to loosening and breakage of the screw, bacterial plaque retention, adverse response of soft tissues and loss of osseointegration, which compromise rehabilitation treatment success. Those harms caused by vertical unfitting have also been reported in previous reports and cited by several other authors.⁵⁻¹⁰

There is no doubt that in order to attain good prosthetic component adaptation over implants, correct torque application is paramount.¹¹⁻¹⁴ Based on those findings, a digital torque gauge was used for the present study when measuring placement and torque of all prosthetic components tested.

Another extremely important fact necessary to achieve a consensus among studies¹⁵⁻¹⁸ refers to the use of machined components, since machined components have proved to achieve better adaptation in comparison to molten components. Moreover, machined components minimize potential biological and mechanical implications.¹⁵⁻¹⁸ Thus, the aforementioned findings justify the use of machined prosthetic components in the present study.

In 1991, Jemt¹⁹ reported that unfitting values of 100 μm were acceptable. However, another study reports that unfitting greater than 20 μm causes potential harm.²⁰

Satisfactory adaptation of prosthetic components over external hexagon implants

has been observed in several studies which, after assessing 13 different systems, obtained averages lower than 5 μm .²¹ Another research found satisfactory adaptation between implants and prosthetic components.²²

Due to an increasing number of new implant system manufacturers arising in the market, and with virtually all of them manufacturing implants and external hexagon components with measurements that are said to be compatible with the Brånemark system, the use of implants and prosthetic components of different brands has become possible without statistically significant alterations in vertical adaptation. Likewise, the present study found no statistically significant alterations, since only one group had samples with a significant unfitting mean value, which was not enough to rise the group's average to the point that it became statistically different from the others. This sample's unfitting was mostly related to an isolated flaw than to the fact that its implants and prosthetic components are not of the same brand.

The results yielded by the present study disagree with Binon et al⁴ who assessed potentially compatible brands and found that not all components can be considered compatible. Another study concluded that systems might be considered compatible, provided that the fit between them is possible. Nevertheless, this study reported that alterations, although more frequent when an exchange is made, might also be seen within the same system.²³

When testing three different brands of Brazilian prosthetic components placed over Nobel Biocare MK3 implants, Binon et al⁴ found that the best fitting was observed for prosthetic components of the same brand. However, all components were

tested with the same implant, so the implant platform received torque from several components. This might have affected adaptation results, since potential deformities occurring on the implant platform due to torque received by means of previously installed components was not evaluated. Still, none of the components tested had a torque higher than 20 μm ,²⁴ which would be the acceptance standard set by Binon.²⁰ The aforementioned potential interference to the result, to which the study conducted by Silva²⁴ was subjected, was eliminated from this research due to the number of samples and the method established for the installation of components over implants.

Thus, similarly to Dellow⁶ who assessed four potentially interchangeable

systems, this study did not find any differences among the vertical unfitting averages when exchanging implants and components, thereby considering all systems tested compatible.

CONCLUSIONS

Prosthetic components and external hexagon implants manufactured by Signo Vinces Equipamentos Odontológicos Ltda., SIN - Sistema de Implante Ltda., and Conexão Sistemas de Próteses Ltda. were considered compatible in this study.

The prosthetic components and external hexagon implants assessed can be exchanged with no significant loss of vertical adaptation, which does not incur in any harm.

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