Evaluation of Accuracy of Complete-Arch Multiple-Unit Abutment-Level Dental Implant Impressions Using Different Impression and Splinting Materials

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Purpose: *This in vitro study evaluated the accuracy of multiple-unit dental implant casts obtained from splinted or nonsplinted direct impression techniques using various splinting materials by comparing the casts to the reference models. The effect of two different impression materials on the accuracy of the implant casts was also evaluated for abutment-level impressions.* **Materials and Methods:** *A reference model with six internal-connection implant replicas placed in the completely edentulous mandibular arch and connected to multi-base abutments was fabricated from heat-curing acrylic resin. Forty impressions of the reference model were made, 20 each with polyether (PE) and polyvinylsiloxane (PVS) impression materials using the open tray technique. The PE and PVS groups were further subdivided into four subgroups of five each on the bases of splinting type: no splinting, bite registration PE, bite registration addition silicone, or autopolymerizing acrylic resin. The positional accuracy of the implant replica heads was measured on the poured casts using a coordinate measuring machine to assess linear differences in interimplant distances in all three axes. The collected data (linear and three-dimensional [3D] displacement values) were compared with the measurements calculated on the reference resin model and analyzed with nonparametric tests (Kruskal-Wallis and Mann-Whitney).* **Results:** *No significant differences were found between the various splinting groups for both PE and PVS impression materials in terms of linear and 3D distortions. However, small but significant differences were found between the two impression materials (PVS, 91 µm; PE, 103 µm) in terms of 3D discrepancies, irrespective of the splinting technique employed.* **Conclusions:** *Casts obtained from both impression materials exhibited differences from the reference model. The impression material influenced impression inaccuracy more than the splinting material for multiple-unit abutment-level impressions.* Int J Oral Maxillofac Implants 2013;28:xxx–xxx

Key words: *dental implants, dental impression technique, dental models, impression accuracy*

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Passive fit of a screw-retained implant prosthesis is an important determinant of its long-term success.[1–3] Complications such as screw loosening, progressive marginal bone loss, fatigue fractures of the prosthodontic components, and loss of osseointegration may all be attributed, to some extent, to improper fit of the restoration.[4,5]

The precise transfer of intraoral dental implant positions to a working cast is one of the prerequisites for achieving the passive fit of the prosthesis.[6] There are several factors, both laboratory related and clinical, involved in producing accurate working casts for the fabrication of screw-retained fixed implant prosthesis.[7–10] Clinically, a good implant impression is critical in the process of creating an accurate cast.[8,11]

Among the variables that are known to reportedly influence the accuracy of implant impressions, impression material,[8,12,13] splint types and materials (or the absence of a splint),[9,14–20] and direct/indirect impression technique[16,21–23] play major contributory roles. Past literature[6,22,24] has indicated that polyvinylsiloxane (PVS) and polyether (PE) are the recommended impression materials of choice for multiple-unit implant impressions, but no conclusive evidence exists regarding which is more accurate. The majority of the studies[22–27] have shown comparable accuracy, with insignificant differences between PVS and PE, for multiple-implant impressions, while a few papers[8,12] have reported greater accuracy with PVS than with PE, albeit in specific situations when the implants were placed deeply subgingival[8] or were not parallel and had variable connection lengths.[12] On the other hand, PE has also been found to produce better results in terms of implant cast accuracy and abutment-framework interface gaps than PVS.[13]

With regard to the technique for transferring the impression copings to the implant impression, most research shows that the direct, open tray or pick-up method is superior to the indirect, closed tray or transfer technique in that it produces the least distortion, especially for multi-unit implant impressions.[10,16,21,28] With the direct technique, both splinting and nonsplinting of impression copings to improve the accuracy of impressions have been advocated. Recent literature pertaining to completely edentulous situations with four or more implants has demonstrated more accurate impressions with the splinted impression technique than the nonsplinted type.[9,14–16,19–21,29] However, inconsistent results have been seen with respect to the accuracy of splinting vs nonsplinting. Some authors have failed to elicit any differences between splinted and nonsplinted techniques,[22,23,28,30] while others have reported better results with the nonsplinted technique.[17,18] Acrylic resin and dental plaster have traditionally been used to splint impression copings, but the effects of these materials in maintaining the accurate interimplant positions during direct impression transfers and fabrication of precise implant casts is not completely clear.[17–19,30,31] Bite registration silicone and bite registration PE as splinting materials were recently shown to have a positive influence on the accuracy of multi-unit implant impressions because of their rigidity and dimensional stability.[14]

Many published studies have examined the effects of various factors on the accuracy of implant impressions at the implant level.[8,14,15,19–21,32] However, data on implant impression accuracy at the abutment level are scarce,[6] especially for complete-arch impressions.[7,16,25] Therefore, the aim of this in vitro study was to evaluate and compare the three-dimensional accuracy of casts obtained using nonsplinted and splinted impression techniques and to determine the effect of impression material (PE and PVS) on the accuracy of multi-unit implant impression transfers at the abutment level. Two null hypotheses were tested:

1. There would be no difference in the accuracy of the casts in terms of linear (in all dimensions, ie, *x*-, *y*-, and *z*-axes) and three-dimensional (3D) discrepancies between PVS and PE impression materials.
2. There would be no significant differences in the accuracy of the casts in terms of linear (in all dimensions *x*-, *y*-, and *z*-axes) and 3D discrepancies between the nonsplinted and splinted groups for both impression materials.

MATERIALS AND METHODS

Study Design

The study compared two different impression materials: PE (Impregum Penta Soft, 3M ESPE) and PVS (Aquasil Ultra Monophase, Dentsply Caulk). Groups using these two impression materials were further subdivided into four subgroups: (*1*) nonsplinted (control); (*2*) splinted with bite registration PE (Ramitec, 3M ESPE); (*3*) splinted with bite registration addition silicone (GC Exabite II NDS, GC Corp); (*4*) splinted with autopolymerizing acrylic resin (Pattern Resin, GC Corp). All impressions were done with the direct impression technique.

For each splinting subgroup, five sample impressions of the reference cast were made, thus comprising 20 impressions for each impression material. Standardized working casts were made from each impression. Measurements of the interimplant distances on the individual working casts in three dimensions were obtained and the differences calculated in relation to the reference model. The distortion values for different impression materials and splinting subgroups were then compared using statistical analysis.

Fabrication of the Reference Model

A reference model with six bone-level implant analogs (RC, 4.1 × 10 mm, Straumann), four in the interforaminal area and two in the molar regions, was fabricated with heat-curing denture base acrylic resin (DPI Heat Cure). Multibase abutments (RC, straight, 4.5 mm, gingiva height 1 mm, Straumann) were connected to the implant analogs and torqued at 30 Ncm. The reference model resembled a mandibular screw-retained implant-supported fixed complete denture situation (Fig 1).

Custom Tray Construction

Five stops (one anterior and two posterior bilaterally) were made in the land area of the reference model to ensure repeatable and accurate positioning of the

Fig 1 Reference cast with implants and multi-base abutments in place.

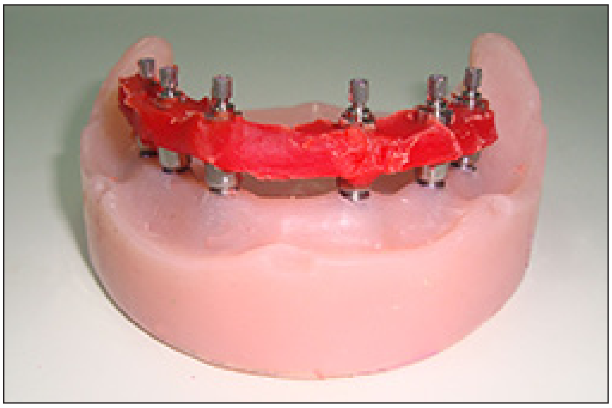


Fig 2a Impression copings splinted with acrylic resin (Duralay).

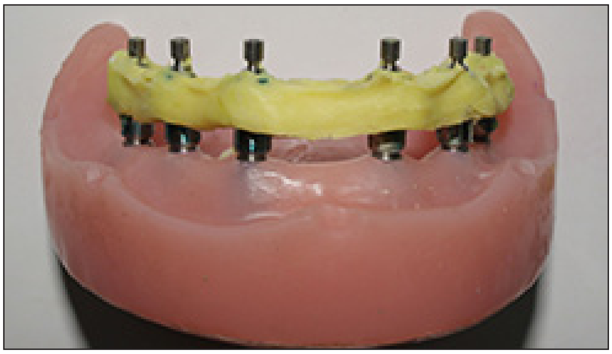


Fig 2b Impression copings splinted with bite registration polyether (Ramitec).

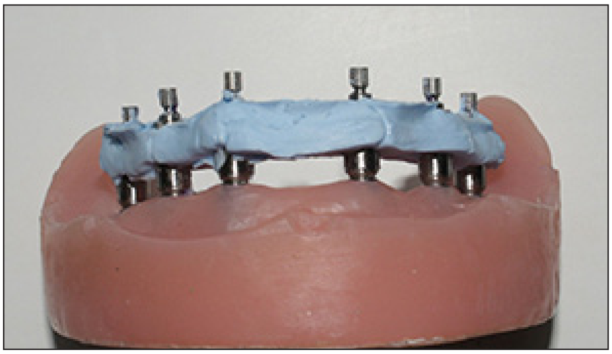


Fig 2c Impression copings splinted with bite registration addition silicone (Exabite).

custom impression trays. Two layers of modelling wax were adapted onto the model, and an impression was made using putty-consistency PVS (Optosil, Bayer Dental). The impression was poured with improved dental stone to obtain a spaced primary cast. Eight custom trays (four per impression group) measuring 2 mm in thickness and with six windows corresponding to the sites of the implants were made using light-curing resin (Kemdent) on the spaced primary cast. The trays were perforated to aid in mechanical retention of the impression material and left undisturbed for 24 hours prior to impression making to ensure dimensional stability. The custom tray samples were further divided into four subgroups, one for each splinting technique group. The same tray was used for all five impressions involving a nonsplinting or splinting technique with a specific impression material. After each use, the tray was cleaned and the recommended adhesive reapplied prior to making the next impression.

Impression Procedure

Impression copings (RC Impression Post Open Tray, abutment level, Straumann) were hand-tightened to the implant abutments on the reference model using a long screwdriver (SCS L, 27 mm long, Straumann). A silicone putty index was prepared to act as a scaffold and to standardize the shape and amount of splinting material used for each impression. For the nonsplinting subgroups, the impression copings and the trays were coated with the recommended adhesives (Dentsply Caulk, 3M ESPE) and left to dry for 15 minutes before impression making. For the acrylic resin splinting subgroups, after application of the recommended adhesives, resin (Pattern Resin, GC Corp) was mixed, packed into the silicone putty index, and polymerized for 15 minutes before sectioning between each pair of implants. Twenty-four hours later, the sectioned parts were rejoined at the gaps with the freshly mixed pattern resin material by the brush bead method (Fig 2a) and allowed to set again prior to the impressions. For the two remaining subgroups, recommended adhesives were used to paint the copings. The bite registration PE (Ramitec, 3M ESPE) and silicone (GC Exabite II NDS, GC Corp) were then mixed and dispensed using their respective delivery systems onto the impression copings and allowed to set. Impressions were then made in a similar manner as the other subgroups (Figs 2b and 2c). Eight sets of impression copings, comprising six copings per set, were employed for impression making. Each set of copings was specifically assigned to a splint or nonsplint test group to facilitate five impressions.

Fig 3 Evaluation of casts using a CMM.

All the impressions were made by the same operator, and the number of impressions per session was restricted to two or three to prevent operator fatigue. Impressions of different groups were planned for each session in no particular order, but generally, for the purpose of standardization, it was ensured that no specific impression material or impression material/nonsplint/splint combination was consecutively repeated in a session. The impression materials were mixed and dispensed by automix machines for PE and PVS (Pentamix-2, 3M ESPE, and Renfert Duomix, Dentsply Caulk, respectively). The material was injected around the exposed surfaces of the impression copings using a syringe, and the custom tray filled with the impression material was seated on the reference model to record the impression. Finger pressure was applied to ensure complete seating of the trays in a standardized manner. The impression was allowed to set according to the manufacturers' recommended setting times. After this period, the copings were unscrewed and the impressions removed and washed with distilled water. The impressions were left undisturbed for 2 to 3 hours before pouring with stone.

Each impression was poured with type IV dental stone (Elite Rock Thixotropic, Zhermack). The stone was mixed according to the manufacturer's instructions by hand for 15 seconds to incorporate the water, followed by vacuum mixing (Whip-Mix) for 30 seconds. The mixed stone was vibrated into the impression, and casts were allowed to set for 1 hour before the copings were unscrewed and the impressions separated. All the casts were stored at room temperature for at least 48 hours before any evaluation was performed.

Measurement Protocol

All 40 casts were measured and analyzed for 3D accuracy using a coordinate measuring machine (CMM) (Mistral, DEA, Brown & Sharpe) linked to a computer. The accuracy of the CMM according to the manufacturer was 0.005 mm (5µm). Three measurements were recorded for every interimplant distance in the *x*-, *y*-, and *z*-axes for each cast, and then the mean values were calculated. The same operator performed all the measurements. Intraoperator reliability assessment for interimplant distances in *x*-, *y*-, and *z*-axes showed high intraclass correlation coefficients of > 0.75 for all axes, indicating high intraoperator reliability.

The implant abutments were denoted sequentially 1 through 6 (from left to right). The centroid of each implant abutment was then located using a CMM probe with a diameter of 2 mm (DEA Brown & Sharpe, TP 2 by 20 mm) by touching four points on the circumference of the outer circle of the implant abutments (Fig 3). PC Demis CMM software (PC-DEMIS v. 4.2 MR1 release, Hexagon Metrology) was used for geometric transformation and data processing. The centroid of abutment 1 was considered as the reference point (point zero) for all measurements in the *x*-, *y*-, and *z*-axes, where the *y*-axis passes through the centers of the implant abutments 1 and 6. The plane formed by the upper surface of implant abutment 1 was to represent the point zero on the *z*-axis. The distances between the centroids of implant abutment 1 and 2 (D1x, D1y), 1 and 3 (D2x, D2y), 1 and 4 (D3x, D3y), 1 and 5 (D4x, D4y), and 1 and 6 (D5x) were measured in the *x*- and *y*-axes, respectively (Figs 4a and 4b). The planes formed by the platforms of the implant abutments were then measured by touching four different points on the upper flat surface of each implant abutment with the CMM probe. The readings were fed into a computer to calculate an automatic average value for each abutment platform plane using the PC Demis software. The vertical distances between the planes formed by implant abutments 1 and 2, 1 and 3, 1 and 4, 1 and 5, and 1 and 6 were then measured to determine the interimplant distances in the *z*-axis (D1z, D2z, D3z, D4z, D5z) (Fig 4c).

A total of 14 interimplant distances were measured for the reference model and for each of the 40 casts. The mean average values obtained from the casts were compared with the standard values acquired from the reference model and the differences were calculated. The linear differences in different axes were used to calculate 3D differences (Δr) by applying the formula $\Delta r^2 = x^2 + y^2 + z^2$, where *x*, *y*, and *z* represent the differences in the respective axes.[9,32] A spreadsheet (Excel 2007, Microsoft) was customized and employed to accomplish this task.

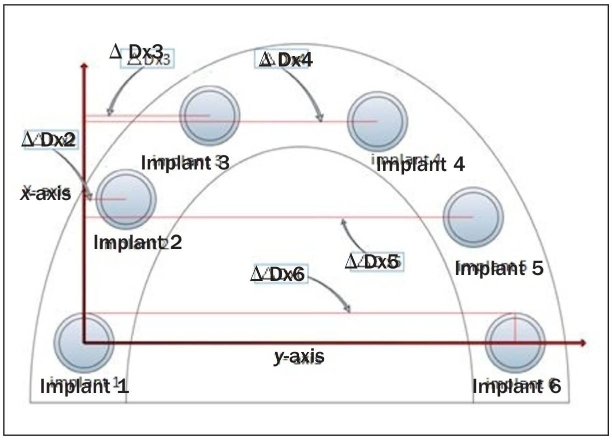


Fig 4a Schematic representation of interimplant distances in the *x*-axis.

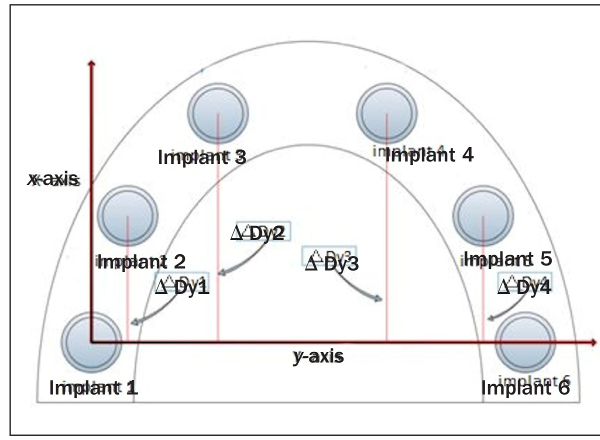


Fig 4b Schematic representation of interimplant distances in the *y*-axis.

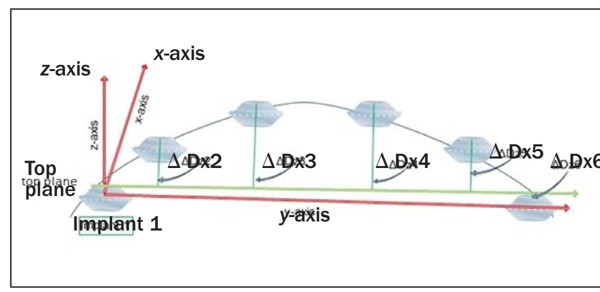


Fig 4c Schematic representation of interimplant distances in the *z*-axis.

Statistical Analysis

The relative values of the linear and 3D discrepancies were used to analyze the overall accuracy of the sample casts in comparison to the reference model. All values of distortion were considered as 'positive' for analysis, because deviations in either direction are equally unacceptable.[9,32] Because assumptions of normality were not met, nonparametric tests were used to analyze and compare the data statistically. The Mann-Whitney test was used to analyze the effect of impression materials and the Kruskal-Wallis test was used to compare the different splinting groups at a significance level of .05 (SPSS v. 17, SPSS Inc).

RESULTS

The medians and interquartile ranges of the differences in interimplant distances in the *x*-, *y*-, and *z*-axes and 3D displacements (Δr) are shown in Tables 1 to 5.

Statistically, between the different nonsplinting and splinting subgroups, no significant differences were found in all three axes (Tables 1 to 3, Figs 5 to 7) and in 3D (Table 4) (Fig 8) for both PE and PVS impression materials ($P > .05$). Evaluating the effect of the impression materials without considering splinting techniques as a factor, significant differences were found between PVS and PE in the *x*-axis ($P = .042$) and the *z*-axis ($P = .019$) (Fig 9) and in 3D ($P = .036$), with PVS being the more accurate material (Table 5). In the *y*-axis, PE was better than PVS; however, the differences between the impression materials were statistically insignificant ($P > .05$) (Fig 9). The two impression materials groups with similar splint/nonsplint materials (PVS/nonsplint vs PE/nonsplint, PVS/Duralay vs PE/Duralay, PVS/addition silicone vs PE/addition silicone, PVS/Ramitec vs PE/Ramitec) showed no significant differences between any of the combinations, except for the Ramitec splint group ($P < .05$) in the *y*- and *z*-axes (Tables 2 and 3). PE/Ramitec was found to be more accurate than the PVS/Ramitec combination in the *y*-axis, and the converse was true in the *z*-axis. However, no significant differences were found in the *x*-axis (Fig 5) (Table 1) or in 3D (Fig 8) (Table 4).

In the *x*-axis, the largest change in interimplant distances was observed with PE splinted with Ramitec (Dx = 51 μm) and the smallest discrepancy was seen for PVS splinted with Exabite (Dx = 26 μm) (Table 1) (Fig 5). In the *y*-axis, PVS splinted with Ramitec (Dy = 33 μm) elicited the greatest discrepancy, and the nonsplinted PE showed the least displacement (Dy = 11 μm) (Table 2) (Fig 6). In the *z*-axis, the maximum and minimum changes were recorded with PE and Duralay splint (Dz = 103 μm) and PVS impression/Ramitec splint (Dz =

Table 1 Median Linear Differences in Interimplant Distances (μm) in the *x*-axis

	Impression material	
Splint test group	PE	PVS
Control (nonsplint)	30 (41)	27 (40)
Ramitec (PE)	51 (29)	48 (61)
Exabite (addition silicone)	50 (50)	26 (63)
Duralay (acrylic resin)	50 (45)	39 (32)

Medians and interquartile ranges shown.

Table 2 Median Linear Differences in Interimplant Distances (μm) in the *y*-axis

	Impression material	
Splint test group	PE	PVS
Control (nonsplint)	11 (27)	22 (34)
Ramitec (PE)	18 (32)*	33 (40)*
Exabite (addition silicone)	17 (35)	15 (31)
Duralay (acrylic resin)	19 (29)	25 (35)

*Statistically significant difference between groups ($P < .05$).
Medians and interquartile ranges shown.

Table 3 Median Linear Differences in Interimplant Distances (μm) in the *z*-axis

	Impression material	
Splint test group	PE	PVS
Control (nonsplint)	89 (43)	53 (64)
Ramitec (PE)	70 (109)*	31 (99)*
Exabite (addition silicone)	56 (137)	60 (74)
Duralay (acrylic resin)	103 (131)	62 (91)

*Statistically significant difference between groups ($P < .05$).
Medians and interquartile ranges shown.

Table 4 Median 3D Differences in Interimplant Distances (μm)

	Impression material	
Splint test group	PE	PVS
Control (nonsplint)	106 (49)	84 (84)
Ramitec (PE)	88 (99)	95 (82)
Exabite (addition silicone)	122 (106)	85 (71)
Duralay (acrylic resin)	118 (121)	93 (69)

Medians and interquartile ranges shown.

Table 5 Median Linear and 3D Differences Between PE and PVS

	Impression material	
Dimension	PE	PVS
x-axis	48 (47)*	37 (44)*
y-axis	20 (28)	28 (31)
z-axis	77 (79)*	55 (88)
3D	103 (85)	90 (75)*

*Statistically significant difference between groups ($P < .05$).
Medians and interquartile ranges shown.

31μm), respectively (Table 3) (Fig 7). With regard to 3D changes, the largest interimplant discrepancy calculated was found for the PE impression material splinted with Exabite (122 μm) and the smallest was found for nonsplinted PVS impressions (84 μm) (Table 4) (Fig 8).

DISCUSSION

On the basis of the current results, the first null hypothesis was rejected, as the casts obtained from PVS impression material were found to be significantly more accurate than PE in terms of linear (*x*- and *z*-axes) and 3D discrepancies, compared to the reference model. However, in the *y*-axis, the linear discrepancies between the two impression materials did not differ significantly. The second null hypothesis was accepted, because the linear and 3D discrepancies between the nonsplinting and the various splinting groups were comparable and differences insignificant for both PVS and PE. With regard to intraexaminer reliability, the values obtained pointed to acceptable reliability and consistency of the measurement method.

In the current study, the linear and 3D discrepancies between the master cast and the experimental models ranged from 11 to 103 μm (Tables 1 to 3) and 84 to 122 μm (Table 4), respectively. These distortion values were well within the range (0.6 to 136 μm) reported by the majority of studies that evaluated the accuracy of complete edentulous arch implant impressions.[6,9,14,18,19,21,27] Data recorded in all three axes in the current study showed that certain materials accurately reproduced interimplant relationships in one or more axes, but not in all three axes. The consolidated 3D differences between materials were found to be significant, indicating that the collective error might contribute to fit (or misfit) of the prosthesis. The numeric differences, however, were slight (PE 103 μm versus PVS 90 μm) (Table 5), and the clinical significance, if any, of this 13-μm difference is unknown.

The 3D discrepancy values of various nonsplint/splint test groups in this investigation were generally higher and in a small range (84 to 122 μm) (Table 4) compared to the 'machining tolerance' values of 22 to 100 μm described by Ma et al[33] and 31.9 μm by Phillips et al.[18] The 3D deviations were also larger than the acceptable implant-level clinical 3D misfit range of 59

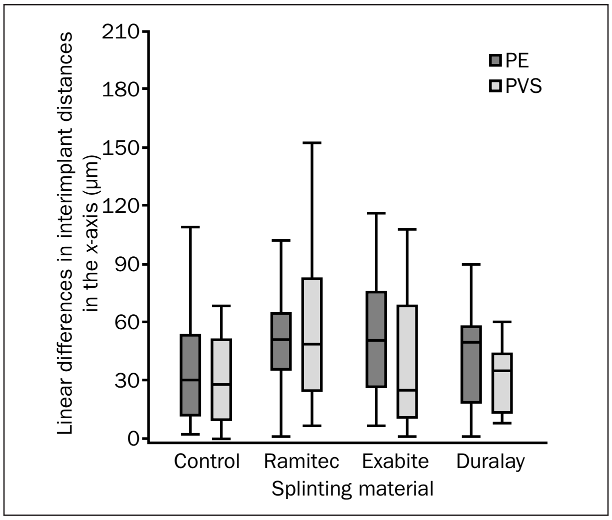


Fig 5 Differences in interimplant distances in the *x*-axis for the four splinting test groups and two impression materials.

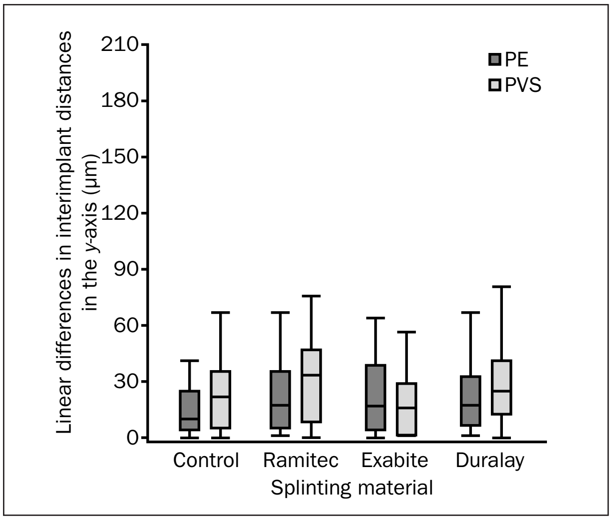


Fig 6 Differences in interimplant distances in the *y*-axis for the four splinting test groups and two impression materials.

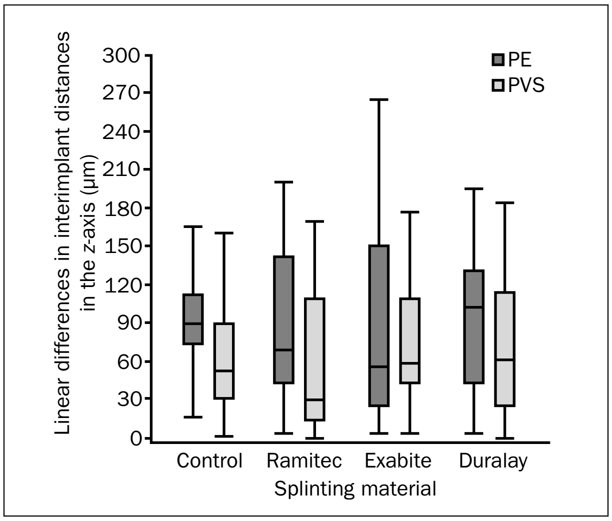


Fig 7 Differences in interimplant distances in the *z*-axis for the four splinting test groups and two impression materials.

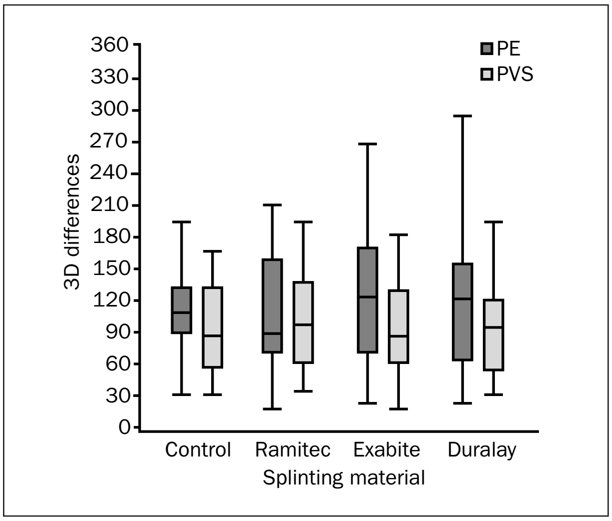
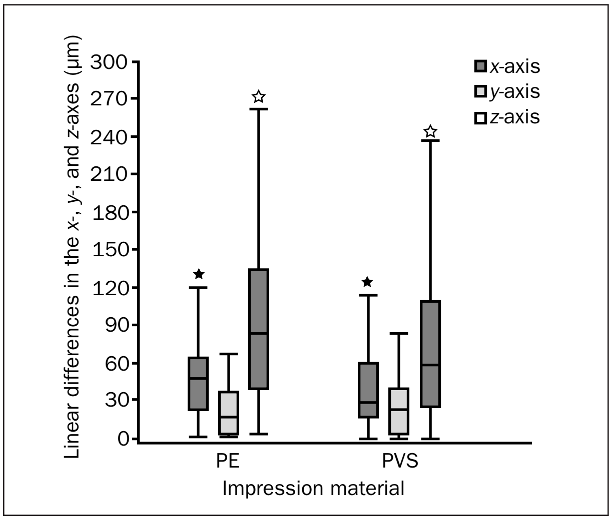


Fig 8 Three-dimensional differences in the interimplant distances for the four splinting test groups and the two impression materials.

Fig 9 Differences in the interimplant distances in the *x*-, *y*-, and *z*-axes for PVS and PE. Black = statistically significant difference between impression material groups in the *x*-axis; white stars = statistically significant difference between impression material groups in the *y*-axis.



to 72 µm proposed by Papaspyridakos et al[9] for one-piece fixed complete prostheses anchored by external-connection implants. However, it can be argued that the margin of error at the implant level is much smaller than that at the abutment level for a complete-arch prosthesis directly screwed onto the implants, as higher preload forces could be expected because of the greater screwdriver torque recommended in such cases.[34]

In the present study, no significant differences were found between the splint and nonsplint groups, which is in agreement with another recent study with similar methodology.[14] However, in the other investigation,[14] splinting with PE (Ramitec) demonstrated the best results, followed by acrylic splint, nonsplint, and addition silicone splint, albeit with statistically insignificant differences. In another recently published study[20] examining the accuracy of complete-arch impressions, the acrylic resin splinted technique was found to be better than the nonsplinted type. The findings of this study also contradict those of some other studies[15,16,19] with regard to the effect of splinting on accuracy. Implant number, impression level (abutment level vs implant level), implant system design, operator error, and variable dental stone expansion may be some of the probable factors responsible for disagreement between the studies. On the other hand, the outcome of the current study was consistent with the results of a few recently published articles showing no differences between direct splinting and nonsplinting impression techniques for complete-arch situations.[22,23,28]

Bite registration addition silicone and PE generally performed well as splinting materials and produced accuracy comparable to that provided by nonsplinted and acrylic resin splinted impression techniques. More studies (in vitro and clinical) are needed to ascertain the use of these materials to splint complete-arch impressions by modifying other factors affecting impression and implant cast accuracy.

The differences in the *x*-axis noted in the current study are in a similar range reported by previous studies[9,14,18,19] for both splinted and nonsplinted impressions. The deviations observed in the *y*-axis were the smallest recorded in this study for all the sample casts. The opposite was true for deviations in the *z*-axis (critical vertical distortions that caused gaps at the abutment-framework interface), which were relatively large compared to the values in the other two axes (*x*- and *y*-) for all nonsplinting/splinting groups and impression materials. The reasons for such decreased distortion values in the *y*-axis and the increased distortion values in the *z*-axis must be explored further. Similar findings were reported for distortions in the *y*-axis for splinted complete-arch impressions by Papapyridakos et al[9] and for horizontal distortions (*y*-axis) by Lee et al.[8] The vertical distortion values (*z*-axis deviations) found in this study differed from the range of values (5 to 40 µm) reported by other recent studies.[8,9] The need to evaluate the rotational displacement of implants in the *z*-axis in terms of the angle of rotation was not felt in the present study, as the impressions were made at the abutment level with multi-base abutments.

In this study, PVS was found to be more accurate than PE, similar to a few other investigations.[8,12] However, this finding was inconsistent with several other studies, which found no statistically significant differences between the two.[22–27] Studies evaluating the PVS and PE impression materials for complete-arch implant impressions with different splinting materials are scarce; hence, a reasonable comparison between the present study and other investigations could not be made. The reasons for the disagreement between the present study and other papers could possibly be attributed to the fact that bite registration silicone and PE were used as test splint groups in this study, which could have influenced the final outcome.

In the current study, a "relative" distortion analysis was performed by measuring the interimplant distances in linear and 3D dimensions in reference to implant-abutment replica 1, as the magnitude of error in the complete-arch screw-retained fixed implant prosthesis is related to the positions of the implants relative to one another.[14] One of the limitations of this paper was that the evaluation of accuracy of implant casts was done using a reference model with ideally placed parallel implants. The results might have been different if some of the implants had been angulated, as shown by earlier studies investigating the effect of implant angulation on impression accuracy.[6,12] Another limitation was the resting of the sectioned acrylic resin splint for 24 hours prior to rejoining and subsequent impression making. Although this step is not clinically relevant, the purpose was to put adequate measures in place to minimize shrinkage of the autopolymerizing acrylic resin. Pattern acrylic resins have been shown to undergo volumetric shrinkage of 7.9% in the first 24 hours, and 80% of that shrinkage apparently occurs in the first 17 minutes, after mixing, at room temperature.[35] Additionally, the acrylic resin splint group was considered as a positive control in this study, with bite registration addition silicone and PE as the test groups. Nevertheless, the results might have been different if the acrylic resin splint had been sectioned and rejoined within a short time, prior to the impressions.

CONCLUSIONS

Within the limitations of this in vitro study, the following conclusions were drawn.

Casts obtained from polyvinylsiloxane impression material were found to be more accurate than those obtained with polyether impression material ($P < .05$), although the actual magnitude of difference (13-µm difference in three-dimensional misfit) was minor.

No significant differences ($P > .05$) were found in terms of cast inaccuracy between the different splinting groups for both tested impression materials.

The linear and three-dimensional differences measured in this study were within the range observed in previous studies (0.6 to 136 µm).

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