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THE EFFECT OF SURFACE TREATMENT OF TITANIUM IMPLANT ABUTMENTS ON THE ACCURACY OF DIGITAL SCANNING. AN INVITRO STUDY

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ABSTRACT

Introduction: Conventionally speaking, materials such as irreversible hydrocolloids or elastomers, provided good precision in conventional implant impression procedures. However, impression deformation and plaster cast expansion, affect the final restorative outcome. In the current digital revolution, digital impressions using intraoral scanners have nearly overcome the drastic draw backs of conventional impressions and patient discomfort. Yet still intraoral scanning does posses’ challenges, especially where there are variations in different scanned morphologies, surface roughness and materials, which result in irregular scattering of light, consequently distorting the data collected.

Materials and methods: Using (Exocad Dental CAD) software a custom designed abutment, was designed to simulate a conventional abutment. and sent to a titanium milling machine where three manufactured abutments were produced, only two of the abutments were surface treated (optically sprayed and sand blasted) and all was scanned. Intra oral scanner was used and the scanned data was overlapped on the original digitally designed abutment, and the differences measured in millimeters as root mean square.

Results: Anova test shows statistically significant difference between the three studied group with P. Value of .001*. Post hoc multiple comparison test shows statistically significant difference between studied groups except there was no statistically significant difference between sandblasted and scan spray abutment with P. value of .111.

Conclusion: The application of scanning powder and sand blast roughening on metallic implant abutments, enhances scanning data collection, as to opposed to powder- free scanning of the implant metallic abutments.

KEYWORDS: Implant, Abutment, Scanning, Powder spay

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INTRODUCTION

It is a well-known fact that to achieve successful and accurate implant restorations, precise impressions of the intraoral situations are mandatory.

Conventionally speaking, materials such as irreversible hydrocolloids or elastomers, provided good precision in conventional implant impression procedures. However, impression deformation and plaster cast expansion, affect the final restorative outcome. Furthermore, when using conventional impression methods, the patients usually complain of inevitable gagging and unpleasant taste. [1]

In the current digital revolution, digital impressions using intraoral scanners have nearly overcome the drastic draw backs of conventional impressions and patient discomfort. [2]

Yet still intraoral scanning does posses' challenges, especially where there are variations in different scanned morphologies, surface roughness and materials, which result in irregular scattering of light, consequently distorting the data collected.[3]

In 2017 Li et al, found out that materials with high translucency such as metals, when scanned intraorally, resulted in lower scan precision especially when accompanied with morphological differences.[4]

Later on, in 2019, Bocklet et al, declared that the accuracy of the scanned data is affected by both the type of intraoral scanner and the restorative material.[5]

To overcome the previous drawbacks of inaccuracies it has been recommended to spray an optical spray, titanium dioxide, on the translucent surfaces, which reduces the irregular scattering of light and inaccurate data. Even when powder free intraoral scanners are used, which still possess limitations, a lot of authors recommend the usage of powder spray on certain surfaces to enhance data acquisition.[6,7]

Yet again the introduction of optical powder has its draw backs; when operators apply the powder, the application is from different distances and duration of application, resulting in varying coating thickness, and consequently scan errors. Furthermore, respiratory problems may result from scattered powder particles.[8-10]

The null hypothesis to be questioned in the current invitro study, is that the application of scanning powder, on metallic implant abutments, enhances scanning data collection, as to opposed to powder free scanning and sand blast roughening of the implant abutments.

MATERIALS AND METHODS

Digital abutment design

Using (Exocad Dental CAD) software a custom designed abutment, was designed to simulate a conventional abutment (6.206 mm height 2.298 mm occlusal diameter and 4.015 mm cervical diameter). This abutment design will be used later as a reference for evaluating abutment accuracy. The generated abutment was saved as an STL file (Fig 1) and sent to a titanium milling machine (Arum 450 milling machine), where three manufactured abutments were produced, only two of the abutments were surface treated to be scanned, according to the following protocols. (Fig 2)

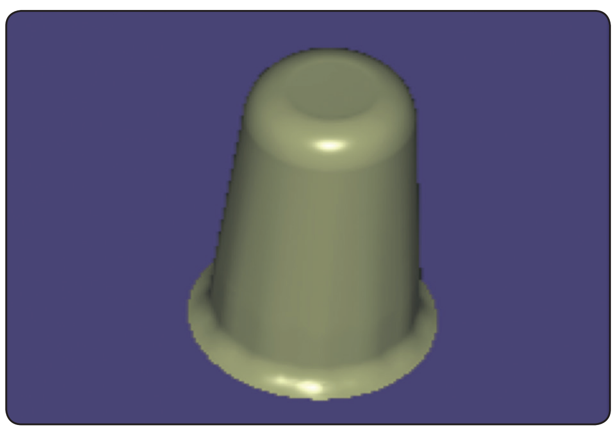

Fig. (1): Computer Designed Custom Abutment.

Surface treatment for scanning:

a) Sand blasting

The first abutment was positioned in the sand blasting unit and blasted for one minute using 110 um grit size (Renfert, sand blasting unit), the abutment was then inspected to check for even surface roughness. (Fig 2)

b) Optical spray

The second abutment was sprayed by an experienced operator using optical spray (Alldent, Germany), the spray distance was constant, and the abutment was checked for even surface coating. (Fig 2)

Abutments scanning:

The three designated milled abutments namely, sand blasted, optical sprayed and unmodified milled abutments, were then scanned using an intraoral scanner (Medit i500, intraoral scanner). The scanning was timed and was done by an experienced operator. The scanning was repeated several times to acquire the best records.

The scanning procedure was repeated ten times for each abutment for proper sample sizing.

Comparing the scan accuracy of abutments

The STL files acquired, from scanning of the three abutments and the STL file of the designed custom abutment were introduced into the (Geomagic Control X; 3D systems) software.

The custom abutment STL file was set as reference for all comparison with the three scanned abutments. Each scanned abutment file was superimposed on the reference file by initial alignment followed by best fit alignment and then 3d comparison was done, deviation labels and RMS (root mean square) were recorded for each comparison. (Fig 3)

Fig. (2): From left to right: machined custom abutment, sand blasted custom abutment, and optical powder sprayed custom abutment.

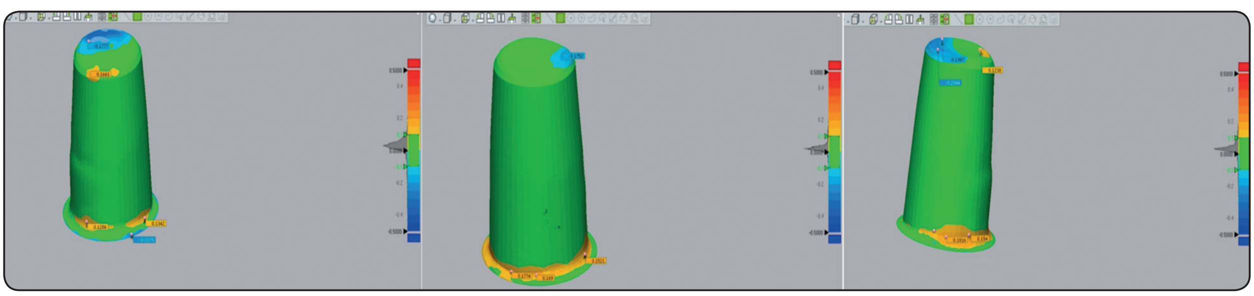

Fig. (3): 3D Comparison and Rms, from left to right : Milled Abutment (0.1228 Mm), Sand Blasted Abutment (0.546 Mm), Optical Sprayed Abutment (0.796 Mm) (Rms)

Statistical methodology

Data were recorded and entered to the IPM SPSS ver. 25 (Statistical Package for Social Science) software.

Kolmogorov-Smirnov test of normality revealed normally distribution of the variables, so data were described using mean, standard deviation and 95% CI of the mean.

Comparisons were carried out between more than two independents normally distributed variables using one-way Analysis of Variance (ANOVA) test. Followed by Post-hoc multiple comparisons test.

RESULTS

Anova test shows statistically significant difference between the three studied group with P. Value of .001*

Post hoc multiple comparison test shows statistically significant difference between studied groups except there was no statistically significant difference between sandblasted and scan spray abutment with P. value of .111 (Table 1 and 2) (Fig 5)

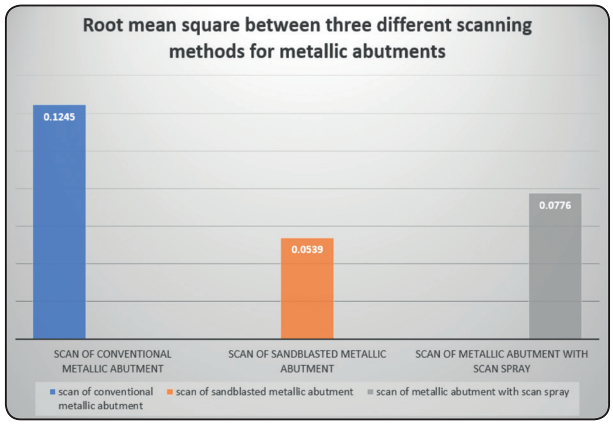

Fig. (5): Mean root mean square between three different scanning methods for metallic abutment.

TABLE (1): One Way ANOVA Test Comparisons Between the Three Different Scan Methods For Metallic Abutment

Different scan methods	scan of conventional metallic abutment	scan of sandblasted metallic abutment	scan of metallic abutment with scan spray	P. value
Mean ± SD	.1245±.0122	.0539±.0088	.0776±.0111	.001*

: Statistically significant ($p<0.05$)** ***NS: Statistically not significant ($p\geq0.05$)

TABLE (2): Percentage of Retention Loss In (Newton) Between the Two Studied Groups at Different Time of Measurement Primary Retention Vs One, Two and Three Years of Use.

Different scan methods		P. value
scan of conventional metallic abutment	scan of sandblasted metallic abutment	.001*
scan of conventional metallic abutment	scan of metallic abutment with scan spray	.005*
scan of sandblasted metallic abutment	scan of metallic abutment with scan spray	.111 N.S.

: Statistically significant ($p<0.05$)** ***NS: Statistically not significant ($p>0.05$)

DISCUSSION

Digital impressions simplify the implant impression procedures by reducing accumulated errors that are inevitable in conventional impression techniques. However, no single technique is perfect even digital impression present drawbacks.[11-14]

The intraoral surfaces whether natural teeth, restorations or implant abutments, possess different surface characteristics that simply reflect light differently. This disparity in light reflection results in errors in data collection by the intraoral scanners.

To eliminate the reflection the application of 13-85μm of optical spray, is highly recommended on reflective surfaces.[15-21]

In the current study the unmodified milled abutment when compared to the virtually designed custom abutment has shown 0.1228 mm root mean square difference, which is statistically significant, proving that the increased reflective surface has shown great deviation from the designed abutment.

Meanwhile the abutments sprayed with optical spray have shown,0.0796 mm and the sand blasted abutments have shown 0.0546 mm root mean square difference, from the virtually designed custom abutment. Which proves also that by reducing the reflective areas on the metallic abutment surface by optical spraying or sand blasting, reduces discrepancies and therefore increasing accuracy.

Sand blasted abutments have shown less deviation from the virtual custom designed abutment, than optical sprayed abutments, however, the evidence was not statistically significant, this may be attributed to the fact that sand blasting provided more nonreflective surfaces than powder spraying.

CONCLUSION

The application of scanning powder and sand blast roughening on metallic implant abutments, enhances scanning data collection, as to opposed to powder- free scanning of the implant metallic abutments.

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