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Effect of OT-Bridge System Versus Multiunit Abutment on the Passive Fit and Stresses Induced by CAD/CAM Fabricated All-on-Four Screw-Retained Prostheses (In Vitro Study)

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Abstract

The hazardous effect of stresses induced by lack of passivity in screw-retained prostheses necessitates the selection of a suitable intermediate component between the implant fixture and the prosthetic framework. Thus, this study aims to evaluate passivity and stresses induced by CAD/CAM screw-retained prostheses fabricated using the OT Bridge system compared to the multi-unit abutment anchoring system. Two All-on-4 digital implant models will be fabricated, one for each group. Group 1; nine CAD/CAM frameworks will be fabricated employing the OT Bridge system abutments, while Group 2; nine CAD/CAM frameworks will be fabricated employing the multi-unit abutments. The passive fit will be assessed through microscopic measurement of misfit gaps at one terminal abutment, and micro-strain analysis will be conducted using strain gauges after functional load simulation.

Guidelines

During designing narrow areas of the model may be at risk of fracture during functional load simulation

Materials

- Intraoral scanner (MEDIT I700 intraoral scanner, Seoul, Korea)
- Exocad (Exocad GmbH, Hessen, Germany)
- OT bridge system :Rhein OT bridge catalog: available from; MOD.D3933SP REV.02. Del 11/09/2023
- 3D printer : Microdent 1Pro 3D-printer, Mogassam, and HEX MODEL gray resin, Cairo, Egypt”
- Digital analouges: (Digital analog, Vitronex Elite Implant System, FLOTECNO SRL, Milano, Italy)
- Strain gauge: KFGS-1-120-C1-11 L3M2R, KYOWA,KVALITEST INDUSTRIAL, JAPAN

Abstract

1 The hazardous effect of stresses induced by lack of passivity in screw-retained prostheses necessitates the selection of a suitable intermediate component between the implant fixture and the prosthetic framework. Thus, this study aims to evaluate passivity and stresses induced by CAD/CAM screw-retained prostheses fabricated using the OT Bridge system compared to the multi-unit abutment anchoring system. Two All-on-4 digital implant models will be fabricated, one for each group. Group 1; nine CAD/CAM frameworks will be fabricated employing the OT Bridge system abutments, while Group 2; nine CAD/CAM frameworks will be fabricated employing the multi-unit abutments. The passive fit will be assessed through microscopic measurement of misfit gaps at one terminal abutment, and micro-strain analysis will be conducted using strain gauges after functional load simulation.

2 **Introduction**

The “All-on-4® ” treatmentconcept played a great role in solvingmany problems associated with the placement of implants in anatomically unsuitable ridges. The concept developed by Paulo-Malo is based on using straight and angled multi-unit abutments (MUA) to provide patientswith an immediatelyloaded full-arch restoration with only four implants. This method advocates tilting distal implants to enable; longer implant placement, improved prosthetic support, shorter cantilever arms, increased inter-implant distance, and improved anchorage in bone. [(1,2)] The idea of the OT Bridge fixed prosthetic system (Rhein83, Bologna, Italy) was born from the need to overcomethe disadvantages of angled multi-unit abutments and to greatly simplifyprosthetic procedures.[(3)] This systemis based on the use of the low-profile OT Equator that is foremostused to provide retention for implant-retained overdentures. The morphology of this abutment allows a betterdistribution of the load to the surrounding tissues and it has greater fracture resistance compared to multiunit abutments. [(4)]

The innovation of the OT Bridge systemlies in the use of an “extragrade” titanium abutment and a seeger system that guarantees the connection stability between the abutmentand OT Equator and passivation in the presence of serious disparallelism, the unique design of the “extragrade” abutment can overcome high implant divergence even in extreme casesover 80 degrees. The tolerance between the “extragrade” abutment and the OT Equator has been designed to compensate for minor misalignments that can be produced duringthe

impression and the pouring of the cast model. [5] Another important aspect is relatedto seeger's retentive force. The tightness of the “extragrade” abutmenton the equator is not linked so much to the presenceof the connecting screw but to the mechanical retention given by the Seeger. The clinician will be able to use the abutmentsin "blind mode" without any connection screw, entrusting theconnection only to the seeger. Thus, it is possible to realize a fixed full-arch prosthesis by avoiding unaesthetic holes for the connection screws. [6]
Passive fit of implant frameworks is crucial for achieving long-term success of osseointegration and preventing future complications. [7-9] To assess framework fit, there are two in vitro approaches: modeling and dimensional measurement techniques. The modeling techniques (photoelastic analysis, strain gauge analysis &finite element analysis) are useful to assess the effect of the inaccuracy of fit of the prosthesis on the implant-bone complex. The dimensional measurements (stereomicroscopes, optical microscopes & micro-CT) are done mainly to measure the gap between the prosthesis and the implant as an indicator for framework misfit. [10] Strain gauge analysis is a technique for measuring micro-strains. It is based on the principle that certain materials change their electrical resistivity when subjected to a force. [11] They are efficient in quantifying strain, which could give a direct indication of the stress exerted within the structures. [12] Microscopes of differing magnifying powers can be used in vitro to directly measure the misfit gap. [10]Microscopy has been used to evaluate the fit of partial or complete arch implant-supported fixed prostheses connected to external connection implants or multiunit abutments [13-15,16,17,18])

The fixed OT Bridge prosthesis is reported to have numerous advantages versus multiunit abutments, however, to the best of our knowledge, no studies of comparison for misfit-induced stresses between MUA and OT-Bridge are today present in literature. Thus, the present study will be conducted in an attempt to investigate one of the advertised benefits of the new OT bridge system by assessing and comparing the passive fit of screw-retained CAD/CAM frameworks fabricated employing the modern OT Bridge system versus the traditional use of MUA as intermediate abutments in all-on-4 full arch rehabilitations.

3 **Sample Grouping:**

This study will comprise two equal groups based on the type of intermediate abutments employed for the fabrication of the

screw-retained all-on-four implant frameworks, as follows:
Group I: nine CAD/CAM frameworks will be fabricated on the first model utilizing the new OT Bridge system.
Group II: nine CAD/CAM frameworks will be fabricated on the second model utilizing the multiunit abutment system.

4 **Laboratory Steps:**

A.

CAD/CAM fabrication of Digital Implant Models (DIMs):

Two digital implant models with soft tissue crests will be fabricated for installation of four digital implant analogs; two straight equidistant analogs anteriorly and two 30-degree angled analogs posteriorly. During designing, the model creator software will be used to create the slots for the strain gauges buccal and lingual to each implant and parallel to their long axes. The CAM files will be sent to a three-dimensional printer. Two models will be printed, one for each group. The digital implant analogs will be inserted into the models after their manufacturing. Four OT equator abutments will be installed to the first model, and four multiunit abutments will be installed to the second model.

B.

Capturing geometry:

For each model, the corresponding scan abutments will be installed. Using the laser scanning technique each model will be projected & scanned with an intraoral scanner.

C.

Digital designing of frameworks:

For each model, the design of the corresponding frameworks will be virtually accomplished based on the computed position of the implants and using the virtual abutments in the digital library available for each of the two systems (Extragrade abutments and MUA retentive abutments), creating STL files for CAM production.

D.

CAM production of implant frameworks:

Eighteen Chrome-cobalt frameworks for a hybrid prosthesis design will be fabricated using a 5–axis milling machine to allow milling of the connection features and the screw channels.

5 **Methods of Evaluation:**

A.

Frameworks passive fit:

The passivity of fit will
be evaluated by direct measurement of the vertical gap at one terminus of each framework under the stereomicroscope; one side of the framework will be screwed to its respective abutment in the working model using a screwdriver and torque wrench under torque specified by manufacturer, then retightened after 10 minutes to avoid preload screw loosening and discrepancies will be observed at the other unscrewed side. For each specimen, two stereomicrographs at the buccal and distal surfaces of the unscrewed side will be captured by a digital camera. Images will be then transferred to the computer software system for analysis and measurement of the gaps between the margins of the framework and corresponding abutments. [19]

B.

Micro-strains induced around the implants:

For micro-strain
analysis, strain gauges will be positioned & bonded in their places in each model. After functional simulation and load application the micro-strains induced around each implant will be assessed. [20]

6 **Data analysis:**

The data will first be
recorded manually and then transferred into digital form. The obtained data will be recorded,
tabulated, and statistically analyzed using the appropriate statistical tests.

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