



Jul 23, 2024

🌐 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)

DOI

<https://dx.doi.org/10.17504/protocols.io.14egn6e4zl5d/v1>

Abdelrahman Hazem¹, Shaimaa Lotfy Mohamed², Sara Ibrahim Soliman Mohamed³

¹Faculty of dentistry Ain shams university- Egypt;

²Professor of Prosthodontics Faculty of Dentistry - Ain Shams University;

³Lecturer of Oral and Maxillofacial prosthodontics, Faculty of Dentistry, Ain-shams University.



abdelrahman hazem

dental

Create & collaborate more with a free account

Edit and publish protocols, collaborate in communities, share insights through comments, and track progress with run records.

Create free account

OPEN  ACCESS



DOI: <https://dx.doi.org/10.17504/protocols.io.14egn6e4zl5d/v1>

Protocol Citation: Abdelrahman Hazem, Shaimaa Lotfy Mohamed, Sara Ibrahim Soliman Mohamed 2024. 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). **protocols.io** <https://dx.doi.org/10.17504/protocols.io.14egn6e4zl5d/v1>



License: This is an open access protocol distributed under the terms of the **[Creative Commons Attribution License](#)**, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited

Protocol status: Working

We use this protocol and it's working

Created: July 23, 2024

Last Modified: July 23, 2024

Protocol Integer ID: 103899

Keywords: CAD/CAM, Screw-Retained Prosthesis, Passive Fit, Stress Distribution, OT Bridge System, Multi-Unit Abutment., digital implant model, prosthetic framework, retained prosthesis, strain gauges after functional load simulation, bridge system versus multiunit abutment, using strain gauge, cam screw, implant fixture, four screw, ot bridge system, hazardous effect of stress, abutment, cad, terminal abutment, functional load simulation

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®" treatment concept played a great role in solving many 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 patients with an immediately loaded 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 overcome the disadvantages of angled multi-unit abutments and to greatly simplify prosthetic procedures. ⁽³⁾ This system is based on the use of the low-profile OT Equator that is foremost used to provide retention for implant-retained overdentures. The morphology of this abutment allows a better distribution of the load to the surrounding tissues and it has greater fracture resistance compared to multi-unit abutments. ⁽⁴⁾ The innovation of the OT Bridge system lies in the use of an "extragrade" titanium abutment and a seeger system that guarantees the connection stability between the abutment and 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 cases over 80 degrees. The tolerance between the "extragrade" abutment and the OT Equator has been designed to compensate for minor misalignments that can be produced

during the impression and the pouring of the cast model.⁽⁵⁾ Another important aspect is related to seeger's retentive force. The tightness of the "extragrade" abutment on the equator is not linked so much to the presence of the connecting screw but to the mechanical retention given by the Seeger. The clinician will be able to use the abutments in "blind mode" without any connection screw, entrusting the connection 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 (Extragate 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.

Protocol references

1. Taruna, M., Chittaranjan, B., Sudheer, N., Tella, S. and Abusaad, M.D., 2014. Prosthodontic perspective to all-on-4® concept for dental implants. *Journal of clinical and diagnostic research: JCDR*, 8(10), p.ZE16.
2. Estafanous, E.W., Osswald, M., Oates, T.W., Ellingsen, J.E., Huynh-Ba, G. and Chvartszaid, D., 2014. " All-on-four": where are we now?. *The International Journal of Oral & Maxillofacial Implants*, 29(2), pp.285-288.
3. Tallarico, M., Scrascia, R., Annucci, M., Meloni, S.M., Lumbau, A.I., Koshovari, A., Xhanari, E. and Martinolli, M., 2020. Errors in implant positioning due to lack of planning: a clinical case report of new prosthetic materials and solutions. *Materials*, 13(8), p.1883.
4. Scrascia, R., Martinolli, M., Venezia, P., Casucci, A., Ortensi, L. and Tallarico, M., 2018. Feasibility of low profile attachments to improve quality of life on patients with implant-retained mandibular overdenture: 1-year preliminary results of a multicenter prospective case series study. *Oral Health Dental Manag*, 17(5).
5. Marco, M., Giuliano, B. and Luca, O., 2016. Oral rehabilitation with implant-supported overdenture and a new protocol for bar passivation. *Glob J Oral Sci*, 2, pp.10-9.
6. Santonocito, D., Nicita, F. and Risitano, G., 2021. A parametric study on a dental implant geometry influence on bone remodelling through a numerical algorithm. *Prosthesis*, 3(2), pp.157-172.
7. Helldén, L.B. and Dérand, T., 1998. Description and evaluation of a simplified method to achieve passive fit between cast titanium frameworks and implants. *International Journal of Oral & Maxillofacial Implants*, 13(2).
8. Skalak, R., 1983. Biomechanical considerations in osseointegrated prostheses. *The Journal of prosthetic dentistry*, 49(6), pp.843-848.
9. Rangert, B.O. and Jemt, T., 1989. Forces and moments on Brånemark implants. *International Journal of Oral & Maxillofacial Implants*, 4(3).
10. Thielke, S., Serrano, J.G. and Lepe, X., 1998. A method for true coordinate three-dimensional measurement of casts using a measuring microscope. *The Journal of prosthetic dentistry*, 80(4), pp.506-510.
11. Clelland, N.L., Gilat, A., McGlumphy, E.A. and Brantley, W.A., 1993. A photoelastic and strain gauge analysis of angled abutments for an implant system. *International Journal of Oral & Maxillofacial Implants*, 8(5).

- 12.** Smedberg, J.I., Nilner, K., Rangert, B., Svensson, S.A. and Glantz, P.O., 1996. On the influence of superstructure connection on implant preload: a methodological and clinical study. *Clinical oral implants research*, 7(1), pp.55-63.
- 13.** da Cunha Fontoura, D., de Magalhães Barros, V., de Magalhães, C.S., Vaz, R.R. and Moreira, A.N., 2018. Evaluation of Vertical Misfit of CAD/CAM Implant-Supported Titanium and Zirconia Frameworks. *International Journal of Oral & Maxillofacial Implants*, 33(5).
- 14.** Katsoulis, J., Mericske-Stern, R., Rotkina, L., Zbären, C., Enkling, N. and Blatz, M.B., 2014. Precision of fit of implant-supported screw-retained 10-unit computer-aided-designed and computer-aided-manufactured frameworks made from zirconium dioxide and titanium: an in vitro study. *Clinical oral implants research*, 25(2), pp.165-174.
- 15.** de França, D.G.B., Morais, M.H.S., das Neves, F.D. and Barbosa, G.A., 2015. Influence of CAD/CAM on the fit accuracy of implant-supported zirconia and cobalt-chromium fixed dental prostheses. *The Journal of prosthetic dentistry*, 113(1), pp.22-28.
- 16.** Abduo, J. and Lyons, K., 2012. Effect of vertical misfit on strain within screw-retained implant titanium and zirconia frameworks. *Journal of prosthodontic research*, 56(2), pp.102-109.
- 17.** Massignan Berejuk, H., Hideo Shimizu, R., Aparecida de Mattias Sartori, I., Valgas, L. and Tiossi, R., 2014. Vertical microgap and passivity of fit of three-unit implant-supported frameworks fabricated using different techniques. *International Journal of Oral & Maxillofacial Implants*, 29(5).
- 18.** Kiroleoglou, I., Pissiotis, A. and Konstantinos, M., 2018. Accuracy of fit of implant-supported bars fabricated on definitive casts made by different dental stones. *Journal of clinical and experimental dentistry*, 10(3), p.e252.
- 19.** Shetty, R., Singh, I., Sumayli, H.A., Jafer, M.A., Feroz, S.A., Bhandi, S., Raj, A.T., Patil, S. and Ferrari, M., 2021. Effect of prosthetic framework material, cantilever length and opposing arch on peri-implant strain in an all-on-four implant prostheses. *Nigerian Journal of Clinical Practice*, 24(6), pp.866-873.
- 20.** Rutkunas, V., Dirse, J., Kules, D. and Simonaitis, T., 2023. Misfit simulation on implant prostheses with different combinations of engaging and nonengaging titanium bases. Part 1: Stereomicroscopic assessment of the active and passive fit. *The Journal of Prosthetic Dentistry*, 129(4), pp.589-596.