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COMPARISON BETWEEN SINGLE IMPLANT AND TWO IMPLANTS WITH LOCATOR ATTACHMENT RETAINING MANDIBULAR OVERDENTURE (IN VITRO STUDY)

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ABSTRACT

In vitro study was done to compare between single implant and two implants with locator attachment and their effect on the implants and supporting structure. Two mandibular acrylic models were made with placement of one implant at the midline and placement of two implants in the canine region both with locator attachment .Each implant was 3.8 mm in diameter and 12 mm in length. Channels were done in each model mesial and distal to the implants to receive the strain gauge. Each attachment was fitted to its overdenture .The acrylic model was placed on the lower flat metal plate of the testing machine. A loading device (universal-testing machine) was used to apply standardized static load. Loads were applied with magnitude of 100N. A special load applicator was used to apply standardized static load. Loading performed unilaterally in vertical direction at right 1st molar on both model. Comparing the results of single implant and two implants with locator attachment and their effect on the implants showed no significant difference between them (p value>0.05). So it can be concluded that post loading implant survival of single implant overdenture is not significantly different from two implants overdenture with locator attachement.

INTRODUCTION

Edentulism is most often the result of repeated tooth extractions from the combined pathological processes of dental caries, periodontal disease, or a method to reduce the costs associated with dental treatment[1-3].

The rate of edentulism increases at 4% per 10 years in elderly adult and increases to more than 10% per decade after age 70. The average total rate of edentulism around the world is 20% at age 60, although there is wide disparity from the countries. [3]

Sharp residual alveolar ridge crest can be products of preextraction bone destruction, trauma during extractions, or postextraction resorption. Crestal bone irregularities and increasing radiolucency toward the ridge crest suggest this in radiographs showing the ridge in profile. Palpation usually will reveal the sensitivity of the mucoperiosteum over the crest. Because of the sensitivity, sharp ridge

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crests cannot contribute much to the support of a denture.

Surgical reduction is tempting and sometimes indicated, but the reduction in ridge height adversely affects the stability of a denture. The ridges are sometimes be kept for their contribution to stability if they are relieved of direct pressure by using a selective pressure impression technique that gains support for the denture from other areas. (4)

Then, as shrinkage continues, the anterior part of the basal seat for the mandibular denture moves forward. These changes must be noted at the time of the examination for the resultant problems of leverage, occlusion and tooth position for esthetics.(4) The reduction of alveolar ridge size is frequently accompanied by an apparent encroachment of muscle on the crest of the ridge(high muscle attachment) serve to reduce denture bearing area and undermine stability. (4)

Oral implants have revolutionized the practice of dentistry .Many experimental and clinical studies have focused on the mechanisms of tissue integration and the possibilities to secure long term success. The concept of *osseointegration* was developed by BRANEMARK in the middle of the 1960s and led to the predictable long-term success of oral implants. (5)

The highest target in dental profession is the fulfillment of patient wishes. The greatest wish of patient is always the fast, painless replacement of their missing teeth or stabilization of the prosthesis. A fast, stable and esthetic reconstruction of the patient's dento-facial system is the main goal of every dentist.(6)

Many patients cannot afford treatment with two implants or are not willing to accept necessary bone augmentation procedures. Also in some cases, due to severe mandibular atrophy and economic causes especially poor geriatric patients the placement of 2 interforaminal implants is impossible to limit costs, time, and effort, attempts were made to retain mandibular overdentures using only a single midline implant.(7-8) Recently a single implant has been anticipated to be adequate for retention of the mandibular overdenture and suggested as an alternative for older edentulous patients, Cordioli et al were first recommended that the masticatory stress distribution in a single-implant overdenture uses full mucosal support and develops a more favorable stress distribution in the horizontal dimension, which may limit the problems encountered with the standard mandibular overdenture approach. (9)

Different attachment systems have been used to retain mandibular overdenture: Bars with clips, Studs and Magnets are among the most attachments used.(10)A Locator attachment system consists of a matrix and a patrix. The manufacturer refers to female and male components to describe the system. The terms matrix (female) and patrix (male) will be used to describe the system in this study. The matrix is composed of a Locator abutment made of Titanium with a Titanium-nitride coating. It is inserted into an implant and torqued to 25 Newton centimeter (Ncm) force, with a specific torque wrench. The patrix engages the matrix to provide a sufficient retention force to stabilize and retain the overdenture.

Several stress analysis techniques were used in dental researches to help in the assessment of forces transmitted to oral tissues or those induced by occlusion or prosthetic appliances. Among these techniques, electric resistance strain gauge. (11)

MATERIAL AND METHODS

This In-vitro study was conducted on an edentulous clear acrylic mandibular model with single midline implants positioned in the symphasis region and another model with two implants in canine region.

Construction of acrylic model and experimental overdenture:

Edentulous male patient was selected to obtain duplicate of the lower arch for this study from those attending to out-patient clinic, prosthodontic department, Ain Shams University, The patient exhibited severally resorbed ridge. A final impression was made using conventional method, that is, zinc oxide eugenol wash impression materials* after border molding with green stick compound** in open mouth position, mandibular master cast was obtained after pouring the final impressions with type III dental stone ***. An impression of stone cast was made using silicone impression material. (fig.1)**** Autopolymerized clear acrylic resin***** with enough amounts was poured into the silicone rubber impression using a mechanical vibrator and a vacuum former machine to avoid porosity .After the acrylic resin had been set, the clear acrylic model was removed from the cast former and finishing and polishing was done. (fig.2)

Fig. (1) Silicone rubber impression

Two identical experimental overdentures were produced by using duplicating flask technique and autopolymerizing acrylic resin******

In this study dental milling machine******* was used to make drill hole in midline of symphseal region and canine region of mandible to locate implants in the mandiblar model corresponding to implant fixture dimensions. (3.8 mm in diameter and 12 mm in length) and locater attachment (3.5 diameter and gingival height2.0 mm).# (fig.3)

Fig. (2) Acrylic resin model

Fig. (3) Implant placement

* DPI Impression Paste, the Bombay Burmah Trading Corporation, Mumbai.
** Impression compound type I made in Argentina.
***Stone Plaster, Neelkanth Minechem, Rajasthan, India.
****Speedexcolton A. G, Alsatten, Switzerland
*****Castavaria, Vertex-Dental B.V. The Netherlands
******DPI cold cure acrylic denture base material.
*******Degussa AG, Frankfurt, Germany
Dentium Superline – Dentium Inc., Samsung-dong, Gangnam-gu, Seoul, Korea

Self-cure acrylic resin was mixed and applied to fix implants in its place on edentulous clear acrylic model. * (fig.4)

The female metal housings were fitted over the locator and the overdenture was seated, areas to be relieved in the fitting surface of the overdenture, opposite to the metallic housing were marked. Relief was made and the overdenture was reseated and tried in place by using pressure indicating paste to clarify the amount of relief. A mix of self cure acrylic resin** was used to pick up the metal housings.(fig.5)

Fig. (4) Model with locator attachment

Additional linking gingival mask silicone material*** with nearly viscoelasticity of the oral mucosa was injected from double mix cartridge over reduced residual ridge in the clear acrylic model. A stone index for the acrylic model was constructed covering the denture bearing area, labial, buccal and lingual vestibules and tongue space of the mode l. Approximately 2.0mm thickness was reduced from the acrylic model. This was controlled by a round bur of 2mm depth for pitting the edentulous area, followed by uniform reduction to the denture bearing area and the limiting borders. The reduced edentulous area was painted by rubber adhesive****. Then stone index was repositioned in its previous position after its painting with a separating medium to produce an even thickness of the gingival mask, until setting of gingival mask material (Fig. 6)

For installation of the strain gauges, the wires of the strain gauges were oriented vertically in their grooves and fixed in a position using an adhesive recommended by the manufacturer***** Then the

Fig. (5) Metal housing in the fitting surface of the denture

*Repairsin clear, GC Corporation
** Acrostone dental factory Egypt
*** Multisil-Mask Soft bredent. Senden .Germany
**** Zetaplusa dhesive, Zhermack., Italy

vertical base was prepared (1 cm width -2cmheight) by using clear autopolymaizing resin then fixed it to the base of clear acrylic model . (fig.7)

The strain gauges used in this study were supplied with fully encapsulated grid and attached wires. Four strain gauges (KFG-1-120-C1-11L1M2R, with gauge factor 2.08+/-1.0%, gauge length 1 mm, gauge resistance 120.4+/-0.4 ohm, adoptable thermal expansion 11.7 PPM/^{0}C, and temperature coefficient of gauge factor +0.008/^{0}C) were installed at the mesial and distal aspects of implants.

Then the clear acrylic model was placed on the lower flat metal plate of testing machine. A loading device* (universal testing machine) was used to apply standardized static vertical and oblique loads with a magnitude of 100 N at the right first molar tooth on the occlusal surface of each experimental overdentures. A special load applicator (rod shaped with pointed tip) was used to apply unilateral load in vertical directions for each experimental overdenture on the right central fosse of first molar and the load was perpendicular to occlusal surface. Micro strain were recorded of each strain gauges with enough time elapsed between each testing. Once the load was completely applied, the microstrain readings were transferred to microstrain units from two channel strain meter. (fig.8)

Fig .(6) Mucosal stimulation

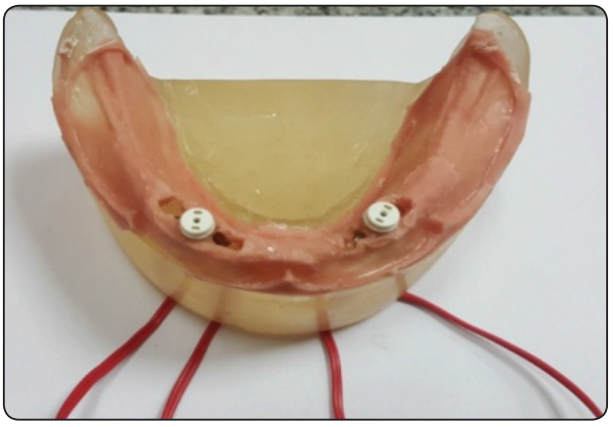

Fig. (7) Strain gauge orientation

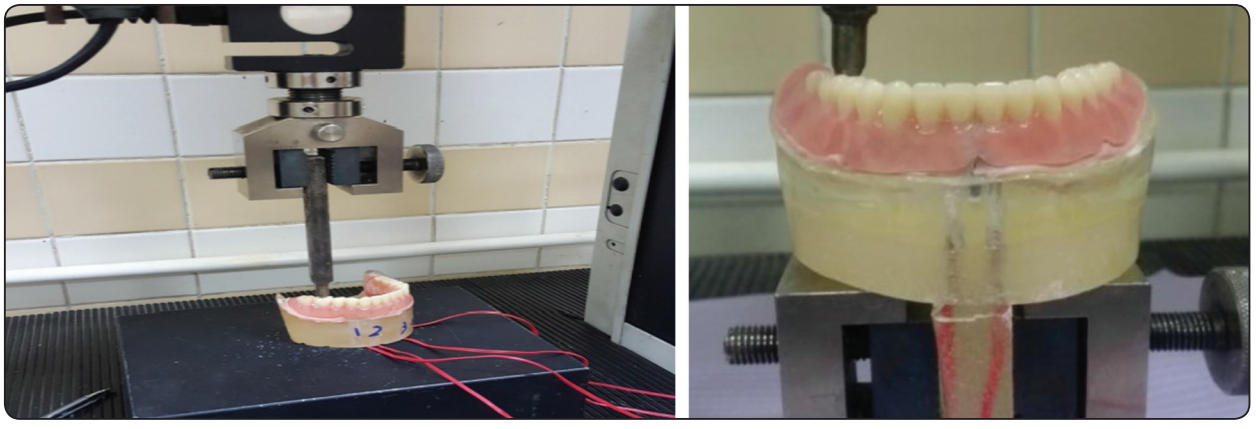

Fig. (8) Unilateral loading

* Lloyd LR 5K, Hampshire,UK

Statistical analysis

Numerical data were explored for normality by checking the data distribution, calculating the mean and median values, evaluating histograms and normality curves and using Kolmogorov-Smirnov and Shapiro-Wilk tests. Data were presented by mean, standard error. Paired t-test was used for comparison between groups and the significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM® SPSS® Statistics Version 20 for Windows.

RESULTS

All the data was collected and tabulated. Statistical analysis was performed by Microsoft Office 2010 (Excel). Paired t-test was used to compare between the two dentures.

Comparison between microstrains recorded during vertical unilateral load

Effect of Unilateral load on the unloaded side :

Mean of unilateral micro strain on the unloaded side:

Table (1) Shows the mean values of recorded microstrains at the left side of the single midline implant and left implant of the two implants model with locater when vertical posterior loads was applied. The mean value of the recorded microstrains. at the left side of single midline implant was 23.75± 6.41and it was found that the mean value of micro strain on the two implants model for the left implant was 28±2.016

Effect of Unilateral load on the loaded side :

Mean of unilateral micro strain on the loaded side:

Table (2) Shows the mean values of recorded microstrains at the right side of the single midline implant and right implant of the two implants model with locater when vertical posterior loads was applied. The mean value of the recorded microstrains at right side of single midline implant was 155 ± 18.5 for vertical loading and it was found that the micro strain on the two implants model for the right implant was 110 ± 2.264

TABLE (1)VV

Unloaded side		Mean	Std. Error	95% Confidence Interval		P value
				Lower Bound	Upper Bound	
Single implant	Left side	23.750	±6.4	19.400	27.100	>0.05
Two implants	Left implant	28.000	±2.016	23.352	32.648	

TABLE (2)

Loaded side		Mean	Std. Error	95% Confidence Interval		P value
				Lower Bound	Upper Bound	
Single implant	Right side	155.000	±18.5	153.350	156.650	>0.05
Two implants	Right implant	110.000	±2.264	104.780	115.220	

® IBM Corporation, NY, USA.
® SPSS, Inc., an IBM Company.

DISCCUSSION

This in- vitro study was conducted to evaluate and compare the generated stress patterns around single midline implant and two implants with locator attachement retaining mandibular complete overdenture. The strain gauge technology was used in this study; this technology was used as it is sensitive, stable, accurate and reproducible on the selected sites and can be applied nearly in every situation where strains are to be evaluated.[12-13] Duplicate of a patients edentulous lower ridge, rather than mandibular model used for educational purpose, was used for this study to simulate the real clinical situation and to relate the results of this study to the clinical situation.[14] A lower model was used in this study because of the mandibular conventional complete denture is more problematic than of the maxillary conventional denture due to several factors such as thin mucosal coverage of the edentulous ridge, a reduced support area, the mobility of the floor of the mouth and the movement of the mandible and the tongue which is associated with problem in denture stability and support and retention. [15]

The treatment of completely edentulous mandible with a new concept emerging, which is a single central mandibular implant retains the mandibular overdenture. It was suggested that single-implant–supported overdentures may be appropriate for the treatment of edentulism in geriatric patient groups. For standardization as much as possible and for more reliable result two clear acrylic model were used in this study upon which a denture was constructed then identical cold cure pink acrylic replicas has been made for this denture to ensure the use of same size, shape and set up of teeth to achieve exact anatomical and mechanical considerations for the test.

The model used for this study was fabricated to simulate as much as possible the natural condition. The surface of the denture bearing area was replaced by 2-mm thick layer of a gingival mask material, which served as artificial mucosa. It was reported that the modulus of elasticity of gingival mask materials to be in the same range with that of the oral mucosa. [16] An adhesive was used between the gingival mask layer and the underlying clear acrylic model, in order to provide stable non movable surface. [17]

The first molar was chosen for loading in the posterior region because maximum occlusal forces are often exerted in this area where there is maximum contraction of all elevator muscles. [18]

Loading was done with 100 N as a moderate average level of biting force with implant retained overdenture .[19] Unilateral posterior loading were performed, to simulate the clinical situation as much of the chewing forces are carried unilaterally. Micro-strains were recorded at each site of the strain gauge with enough time (fifteen minutes) was given between each force applications to allow complete rebound of the resilient structures before application of the next load.

A recent meta-analysis was performed to compare the survival of single implant vs.two implant overdentures in the edentulous mandible and concluded that post loading implant survival of single implant overdenture is not significantly different from two implants overdenture. [20]

Many studies compared single midline implant retained ovedenture with two implant retained overdenture the results showed no significant difference between them. [21-26]

Other study from a biomechanical point of view, during mastication, the occlusal forces on the posterior teeth of the single implant retained mandiblar overdenture cases the denture is free to move in all directions and effective stress concentration around the crestal bone may be reduced when compared to two implants retained mandible overdenture . [27]

Maeda et al, study using strain gauges, observed that single-implant overdentures have similar

biomechanical effects as two-implants overdentures in terms of lateral forces to the abutment and denture base movements under molar functional loads. [28] Other study as **Liu et al**. used finite element analysis (FEA) under vertical load on the anterior region, concluded that. the single - implant overdenture tends to rotate over the implant from side to side; however, no significant increase in strain was observed in the peri-implant region. [29]

This study reinforces the concept that a single-implant overdenture has similar biomechanical features to the conventional denture, with primary mucosal support and with the additional advantage of implant retention. In addition to increase masticatory efficiency of single midline implant retained mandibular overdenture than conventional CD. [27]

Although a single implant is generally less retentive than the two-implants overdenture, patient satisfaction in clinical studies is greatly improved by increasing retention using a single implant,with the additional advantages of lower costs and simpler clinical procedures.[27-30]

The implant success, prosthetic outcome and patient satisfaction are comparable whether one or two-implants are used for support of mandibular overdentures. In addition to possible cost savings with a single implant overdenture. [31-32]

In this study using single midline implant to retain mandibular overdenture was proved to have the same satisfaction and comfort, several studies were observed in comparison between using single implant and two implants, low cost, same satisfaction and retention but not result there is not significantly different in the post loading implant survival ratio.[33-36]

On the other hand the locator attachment system has the lowest profile in comparison with the other stud and bar attachments and it permit up to 40° of divergance between two implants. The advantages of locator attachment are related to its design which allow space of 0.2 mm for vertical reseliancy and 8° hinging in any direction thus allowing the attachment to move in both the vertical plane and hinging axis through out this locator can favorably distribute forces along the long axis of the implant.[37].

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