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In vitro stress analysis study of different prosthetic options using single posterior implant for management of mandibular unilateral distal extension saddle

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Abstract

Aim: The aim of this study is to compare in vitro, micro-strain induced by different prosthetic options using single posterior implant in lower unilateral distal extension saddle (Kennedy class II).
Materials and methods: For this study, three prosthetic designs were made I, II, and III on epoxy resin model representing mandibular unilateral distal extension edentulous area with the second premolar as the main abutment and implant was placed at the site of the second molar. For group (I), The design principle was (RPI clasp on the second premolar abutment, lingual bar major connector, double Aker clasp on the first and second molar on the other side and (ball & socket) attachment on the implant). For group (II) the design principle was ((RPI clasp on the second premolar abutment and (ball & socket) attachment on the implant)). For group (III) implant tooth connected fixed partial denture was fabricated using the 2nd premolar as mesial abutment and the implant as distal abutment. A self-protected linear strain gauge was used for this study to measure the micro-strain induced on the buccal and lingual sides of the implant and 2nd premolar abutment.
Results: SPSS software program was used in the statistical analysis of the results. The results revealed that Maximum stresses induced at tooth and implant abutments were in case of group (II) design and distribution of micro-strain between the implant and tooth abutment in case of group (III) design was better than distribution in cases of the two other groups.
Conclusion: The conclusions are as follows: (1) maximum strain induced at tooth and implant abutments were in case of side plate design; (2) distribution of micro-strain between the implant and tooth abutment in case of fixed restoration was better than distribution in case of the other two groups.

Keywords: Implant; Stress analysis; Partial over denture

1. Introduction

Posterior free end edentulous areas are more prevalent among population. Absence of posterior abutments to support and retain partial dentures

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affects the prognosis of prostheses. A problem of support, retention and stability is usually associated with distal extension removable partial dentures (RPDs) [1,2].

One of the most challenging situations requiring treatment with RPD is cases classified as Kennedy class II. Being unilateral and free end with abutments only on one side of the edentulous area create a long lever arm resulting in an unstable removable prosthesis [3].

The restoration of distal extension RPD requires planning following biomechanical design principles. Obtaining adequate support, retention and stability from both the ridge and abutments should be designed without eliciting any harm to the supporting structure [2].

The use of posterior implants has been suggested for stabilization of the distal extension bases in the vertical direction and to carry the retentive elements for partial overdentures [4]. Placement of posterior implants if anatomically possible, converts the edentulous defect from a distal extension Kennedy Class I or II situation to a more biomechanically favorable Kennedy Class III category [5].

The placement of endosseous osseointegrated implants under a removable prosthesis was proved to provide bone preservation, prosthetic retention, stability, and a degree of occlusal support resulting in improved function, facial esthetics and comfort [6].

Tooth-implant connection by means of prosthetics remains a controversial issue due to the disparate results obtained in the various studies that have been conducted around the world. The differences in the union between an osseointegrated implant and natural tooth's union to the alveolar bone lead to difference in response to the different masticatory forces, both natural and pathological. A number of published studies and articles have dealt with this issue in very different ways: bibliographic reviews [7], in vitro studies [8], in vitro biomechanical studies [9], and clinical case studies [10].

A strain gauge is a device used to measure the strain of the object. The most common type of strain gauge consists of an insulating flexible backing that supports a metallic foil pattern. The gauge is attached to the object by a suitable adhesive. As the object is deformed, the foil is deformed, causing its electrical resistance to change [11].

Latest studies published with strain-gauge analysis show the use of this method to examine the biomechanical aspects of over denture with different attachment system, to measure the force transmission onto implants supporting overdentures and to assess the deformation of abutments of different heights in mandibular cantilevered implant-supported complete prosthesis [12–15].

So the aim of this in vitro study is to evaluate strain induced by different prosthetic options using single posterior implant in lower unilateral distal extension saddle (Kennedy class II).

2. Materials and methods

In this in vitro study, strain gauge technology was used to compare the stresses induced by different prosthetic options using single posterior implant for restoring lower unilateral mandibular distal extension saddle (Kennedy class II).

2.1. Fabrication of the mandibular epoxy model

Commercially available rubber maxillary and mandibular models with acrylic teeth were used.[1] This model contained anatomically shaped teeth with roots which can be inserted and removed from the model. The 1st and 2nd molars were removed from the rubber model unilaterally and their root sockets were blocked with wax.[2]

An impression for this modified cast was made using silicon rubber base[3] impression material. The remaining teeth were removed from the rubber model and their roots were wrapped with 0.3 mm thickness tin foil material to simulate the dimensions of the periodontal ligaments and then inserted in their positions in the impression. Epoxy resin[4] material was poured into the silicon impression. After complete polymerization, the epoxy model was removed from the silicon rubber impression. The tin foils surrounding the roots of the teeth were removed. The acrylic sockets and the roots of the teeth were painted with rubber base adhesive[5] and allowed to dry. Light body silicon rubber impression material was injected in the sockets of the teeth then the teeth were repositioned in their places inside the model.

[1] Nissin dental products incKyoto Japan.
[2] Cavex Set Up Regular modeling Wax, Holland BV. Haarlem, The Netherlands.
[3] Speedex, coltene A.G., Alsatten, Switzerland.
[4] Kemapoxy 150 JM, CBM International.
[5] Zetaplus adhesive, Zhermack, Italy.