Four implant supported mandibular overdenture with resilient telescopic attachment and different mucosal thickness (in vitro study)

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Abstract:

Purpose: To comparethe effect of mucosal thickness on stress distribution around implant supported mandibular overdenture with resilient telescopic attachament.

Keywords. Implant supported overdenture. Telescopic attachment .microstrain

Materials and methods:

This in vitro study was done on a three standard educational edentulous mandibular model. According to the mucosal thickness divided into three groups. For each group four implants, two implants placed in the canine region and two implants placed in the premolar region. Tapered telescopic attachment with occlusal convergence of 0.03 mm was attached to each implant fixture. For each group three different mucosal thickness were used which are (one, two, three mm) layer of poly ethylene vacuumed sheat were placed on the models to acts as spacer and replaced with polyvinyl siloxane impression

material to simulate the resilient edentulous ridge mucosa. An experimental acrylic resin denture was conventionally fabricated on the model. Four strain gauges were attached to each implant to measure the strain on the implants .By using universal testing machine unilateral load applied to the occlusal surface of the right first molar region.

Results: The results of this study showed greatest strain with 1 mm mucosal thickness at different sites measurement (lingual= 63.12) in loading side and with 2 mm mucosal thickness (Lingual= 9.37) in non loading side and the greated strain with 3 mm mucosal thickness at different sites measurement (mesial= 5,62) in loading side. The stress was lowest with 3 mm mucosal thickness in the mesial and distal sides. For all sites for loading side was associated with greater strain then non loading side for 1, 2.3 mm.

Conclusion:

The stresses around dental implants obviously reduced with increased mucosal thickness.

Introduction:

It was agreed that the implant overdenture is an especially attractive treatment because of its relative simplicity, minimal invasiveness and economy (1). It minimized risks on patients and tissues and becomes a true alternative to fixed prosthesis

(2).Attachments used in conjunction with implants were found to enhance the retention, the stability and support of overdentures together with the implants, thus extending their longevity (3).

Many types of attachments have been used to augment the retention and stability of an implant overdentur. Among the different types used , stud, bar and magnetic attachments are the most commonly used. Furthermore, other attachment systems are used as the telescopic retainers (4, 5).

All attachments are either rigid or resilient. Rigid attachments restrict rotational movement and provide only a limited path of off angle insertion, while resilient attachments allow varying amounts of rotation and angulation correction. In situations where implants are even minimally nonparallel, a resilient attachment will consistently show less friction, wear, and breakage. Considering that patients frequently bite appliances into place, this resiliency also prevents premature wear and breakage (6).

Telescopic overdenture (double crown system as attachment for overdenture) is a treatment concept that has been widely and successfully used to support dentures since telescopic crowns introduced in the 1970s (7).They avoid the disadvantages of screw retained superstructures such as difficult access to the screw, access hole on the occlusal surface or esthetically unfavorable positions. They also allow easy access for oral hygiene procedures, relative independence of the individual attachment which often allows for sufficient support of the denture even after single abutments have failed as well as good handling of the overdenture (8).The comparatively high retention, horizontal stabilization, supports and rigid connection to the abutments obtained by telescopic overdenture leads to good mastication and phonetics (9).

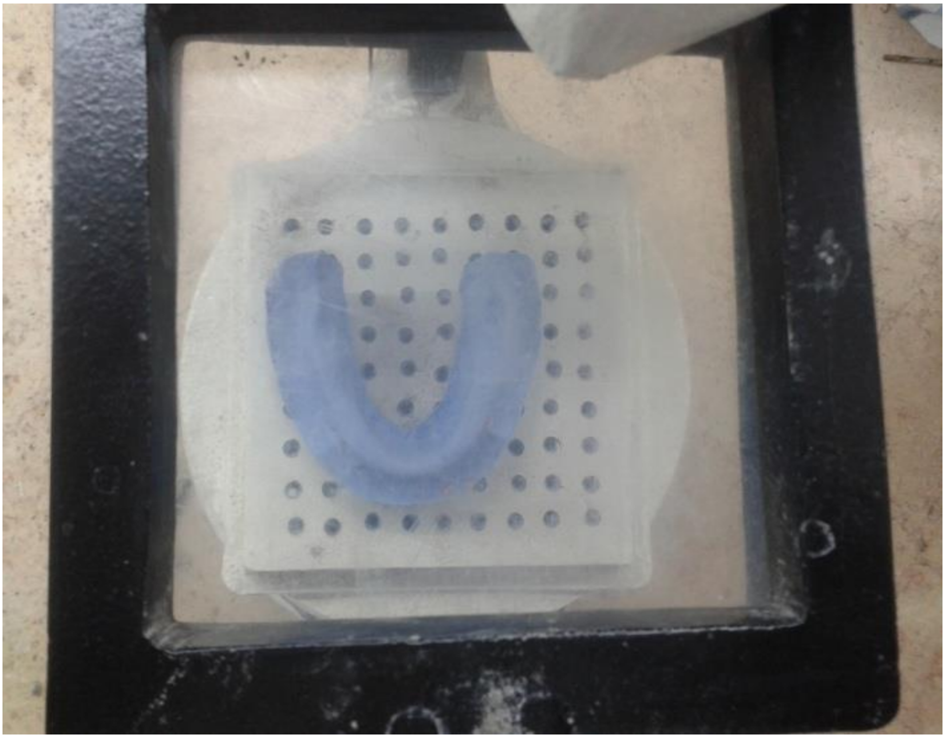
The mucosal thickness may affect the denture base displacement during denture function; therefore, the mucosal thickness probably influences the stress distribution. Some previous in vitro studies have indicated the effects of differences in the retentive system for supported implant with spuriously softtissue(10, 11).

Therefore, the purpose of this in vitro study was to compare the effect of different mucosal thickness on stress distribution around implant retained mandibularoverdenture with different distribution of telescopic attachment.

Materials and methods:

Three standard educational edentulous mandibular model (Dentium dentist for dentist company) were used in this study. According to the mucosal thickess, the models were classified into three major equal groups: group I, four implants (3.6 mm in the diameter, 14.0 mm in the length; Dentium company) were placed two bilaterally in the canine region vertical to the residual ridge and two were placed in the premolar region vertical to the residual ridge, with 1 mm mucosal thickness (fig. 1). Group II, four implants were placed, two in the canine region, and two in the premolar region with 2 mm mucosal thickness. Group III Four implant, two placed in the canine region and two placed in the premolar region. the mucosal thickness, Simulation to the mucosa covering the residual ridge for all groups. 1, 2, 3 mm layer of poly ethylene vacuumed sheat (fig.2,3), was placed on the models which acts as spacer, and replaced by polyvinyl siloxane impression material (Speedex, Coltene/Whaledent Inc. Cuyahoga Falls, OH, USA), the impression material was mixed during flasking and placed in the upper part of plaster index then closed with pressure until setting and the flask opened trimming for excess border to produce model with 1, 2, 3 mm thickness respectively as (1 mm for I, 2 mm for II, and 3 mm for III) polyvinyl siloxane impression material to simulate the resilient edentulous ridge mucosa.

(Fig 1) four implants inserted in the model, two in the canine region and two in the premolar region.



(fig.2) the mandibular cast seated in vaccum machine.

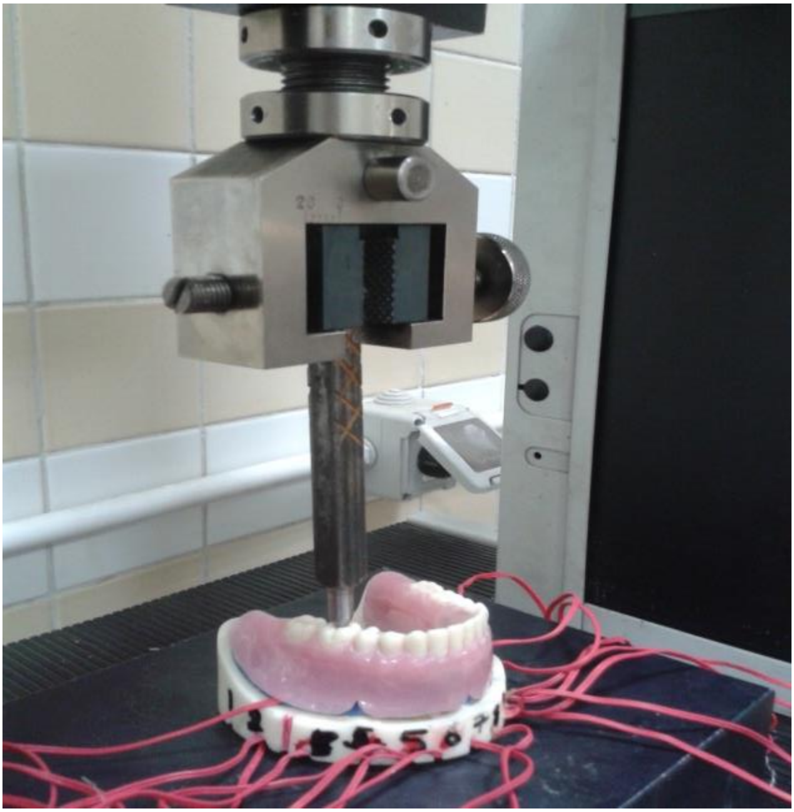
(fig. 3) one mm thickness of vaccumed polyethylene sheet.

The internal hex abutment of gingival height for group I =1 mm, for group II = 1.5 mm and for group III = 2.5 mm. The abutments were prepared as primary copings to allow vertical play (resiliency) as follow: The occlusal surface was reduced for 0.3 mm, the occlusal third of the axial walls was reduced for 0.03 mm. The secondary coping were provided by manufacture as readymade plastic coping that fit the dimensions of the abutments. These copings were provided with two vertical slots to retain the acrylic resin denture base.

For telescopic overdenture construction:Holes were done related to number of telescopic attachment on the fitting surface of the mandibular denture. The mandibular denture was fitted again on the model, then autopolymerized acrylic resin was mixed and applied on the polished surface of the mandibular denture and closed all the holes around the telescopic attachment. After setting, finishing and polishing was done.

Four strain gauges (KFR 05 120 C 11; Kyowa Electronic Instruments, Japan) were attached to the mesiodistal and buccolingual sides of the neck part of each implant to measure the strain on the implants .By using universal testing machine unilateral load applied to the occlusal surface of the right first molar region to major the stress around each implant.

Load of 50 N was applied to the occlusal surface of the right first molar region(fig.4). This study used a one point concentrated load on the molar part that was considered to receive the load with the largest force during function, to simulate a moderate level of biting force on an implant retained overdenture.



(fig. 4) unilateral load on the right first molar region.

Results: Tables 1, 2, 3, 4 shows:

Table (1) show comparison of record microstrain values between different mucosal thickness for both groups at loading side.

There was statistically significance different between different thickness for both groups (P < or = 0.00, 0.001, 0.00).

Table (2) show comparison of record microstrain values between different mucosal thickness for both groups at non loading side.

There was statistically significance different between different thickness for both groups (P< or = 0.00, 0.00, 0.00).

Table (3) show comparison of record microstrain values between loading and non loading sides for both groups.

There was statistically significance different between loading and non loading sides for both groups for 1 mm (P< or = .00, .00,. 00, .00), for 2 mm (P< or = .00, .00, .049, .00) and for 3 mm (P< or = .017, .00, .00, .00).

Discusion:

A n implant stabilized overdenture is a treatment possibility that improves function and comfort for edentulous patients and eliminates many of the problems that edentulous patients experience with conventional dentures (12). In spite of the attractiveness of overdenture treatment, there are controversial opinions about design and indications for different attachment system for overdenture. As denture saddles tend to function like a fulcrum, implants may, depending on the attachments, receive a considerable bending moment transferred from the implant into the bone (13).

The long term clinical use of resilient of telescopic attachment has been described .The implant abutment was used as the inner telescope due to the internal hex of the abutment prevents rotation (14, 15, 16). The conical telescopic attachment retention comes from friction between the inner and outer coping surface. Such retention depends on the number of copings, the taper angle of the inner crown and the dimensions of the surfaces contact (17, 18, 19, 20, 21).

Modification of the abutment was made by creating an occlusal space (0.3mm) as well as (0.03mm) from the occlusal third of axial walls to create vertical play for the resiliency of the telescopic attachment (19).

Unilateral loading of the overdenture was used to simulate the clinical situation as much of the chewing activities are carried out unilaterally. A force increasing from 0 to 50 N was applied by means of an electronic force donor. (17, 25). In this in vitro study, the tests were performed under 50 N loads because these loads were within the average range of occlusal force observed in denture wearers with poor masticatory performance (26, 27).

The results of this study showed that at distal, mesial, buccal and lingual sites of loading side, greatest strain recorded with 1mm thickness, lowest with 3mm thickness. With exception of buccal sites, all sites at non loading side recorded greater strain with

2mm thickness and lowest strain with 3mm thickness, this may be due to as the mucosal thickness is increasing, the elastic modulus decreased so does the stress, these findings are in agreement with the results of the study doned by Tanino et al., (23)since the 3 mm mucosa (resilient) models lower stress values were observed when compared to the 1 mm mucosa (hard) models. Hence, as elastic modulus decreased (high resiliency) so did the stress (23).

Also song et al. evaluated the relieving effect of different mucosa thickness beneath mandibular complete denture using a three dimensional FEA. It was observed that as mucosa thickness increased so did the relieving energy leading to lower bone tissue deformation. Therefore, thicker mucosa is beneficial to reduce bone loss (24).

For all sites (mesial, distal, buccal and lingual), group I showed with greater strain than group II, III at loading site for 1 and 2mm thickness. At non loading side, group III had greater strain than group for (mesial, distal and lingual), and group II had greater strain than group I, III for (buccal side).

Conclusion:

The stresses around dental implants obviously reduced with increased mucosal thickness.

Table (1) comparison of recorded microstrain values between both groups at loading side:

	1mm thickness	**2mm thickness**	**3mm thickness**
Distal	36.8±1.25	5.6±1.25	1.25±1.44
Mesial	44.3±1.25	1.87±1.25	5.62±1.25
Buccal	24.73 ±1.25	1.5±00	1.19±1.37
Lingual	63.12 ±1.25	7.75±2.5	5.3±1.19
ANOVA (p)	.00	.001	.00
LSD	7.5	3.7	4.1

X: mean; SD: standard deviation; LSD; least significant difference.

Table (2) comparison of recorded microstrain values between different mucosal thickness and both groups at non loading side:

	1mm thickness	**2mm thickness**	**3mm thickness**
Distal	26.25 ±2.5	46.25 ±2.5	1.87 ±1.25
Mesial	2.5±2.8	46.25 ±2.5	1.87 ±1.25
Buccal	25.6±1.25	10.62 ±18.7	41.25±2.5
Lingual	18.12 ±1.25	9.37±1.25	5±00
ANOVA (p)	.00	.00	.00
LSD	8.12	35.6	3.12

X: mean; SD: standard deviation; LSD; least significant difference.

Table (3) comparison of recorded microstrain values between loading and non loading sides for both group.

	1mm thickness(group I)	**2mm thickness (group II)**	**3mm thickness (group III)**

	Distal (**X±SD**)		
Loading side	36.8±1.25	5.6±1.25	1.25±1.44
Non loading side	26.25 ±2.5	46.25 ±2.5	1.07
t test (**p**)	.00	.00	.017
	Mesial (**X±SD**)		
Loading side	44.3±1.25	1.87±1.25	5.62±1.25
Non loading side	2.5±2.8	46.25 ±2.5	1.87 ±1.25
t test (**p**)	.00	.00	.00
	Buccal (**X±SD**)		
Loading side	26.73 ±1.25	7.5±00	1.19±1.37
Non loading side	25.6±1.25	10.62 ±18.7	41.25±2.5
t test (**p**)	.00	.049	.00
	Lingual (**X±SD**)		
Loading side	63.12 ±1.25	3.75±2.5	5.3±1.19
Non loading side	18.12 ±1.25	9.37±1.25	5±00
t test (**p**)	.00	.00	.00

X; mean, SD; standard deviation

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