Effect of blocking ring used during picking up the female housings of ball attachments used for retaining 4-implants mandibular complete overdenture:In vitro stress analysis study

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Abstract:

Purpose: This stress analysis in vitro study was used to evaluate the effect of blocking ring spacer used during picking up the female housing of ball attachment used for retaining mandibular 4- implants assisted complete overdenture.

Materials and Methods: Epoxy resin model representing a completely edentulous mandibular ridge was used. The model received four implants inserted at canine and first molar area bilaterally. The residual ridge and the retromlar regions for epoxy resin model was covered by resilient soft liner to simulate the oral mucosa. The study groups were classified according to using of blocking ring spacerinto two groups: **Group I**: the female housing of ball attachment was picked up with using of blocking ring spacer**. Group II**: the female housing of ball attachment was picked up without using of blocking ring spacer. Four linear strain gauges were inserted in to the epoxy resin at 2mm mesial, distal, buccal and lingual to each implant in order to monitor the strain around the implants on loading and non-loading sides during unilateral and bilateral load application.

The results: when compared the stresses during unilateral loading in the loading side between groups, for anterior implants, group II recorded significant higher stresses than group I. For posterior implants, group II recorded significant higher stresses than group I. when compared the stresses between implant positions: For both group there was no significant difference between implant positions.

Conclusions: Regarding stress analysis, using of blocking ring spacer is recommended during pick up procedure of female housings of ball attachments used for retaining 4-implants mandibular complete overdenture to minimize the peri-implant stresses.

Key words: Implant overdenture, Ball attachment, Blocking ring spacer, strain gauge.

Introduction

The most common treatment indicated for edentulous patients is the conventional complete denture. Some drawbacks with conventional complete dentures, were been observed such as lack of retention, support and stability. The implant overdenture has become the first choice for the rehabilitation of patients with edentulism because of its clinical effectiveness in improving masticatory performance and patient satisfaction, and also provide stability, retention, masticatory function and patient satisfaction. (1)

The number of implants required to provide an adequate mandibular implant overdenture treatment outcome remains debatable. It was pointed out that the value of fewer implants as a cost saving approach has a merit for many patients. However, the use of 4- implants is recommended in certain cases to produce greater overdenture stability and preserving the supporting peri-implant bone. (2)

However, the design of the attachment must provide an optimum stress distribution around the implant to cope with the stress transmitted to the bone, within physiological levels. Ball attachments are among the simplest of all attachments and widely used because the ball attachment are less costly, less technique sensitive, and easier to clean than bars and less wear or fracture of the component than that of gold alloy bars. (3)

It was also reported that the use of the ball attachment may be advantageous for implant-supported overdentures with regard to optimizing stress and minimizing denture movement. (4) The female housings of the ball attachment were picked up in presence of blocking ring spacer using self-cured acrylic resin. This allowed for functional fitting of the denture and permitted better load distribution between the mucosa and the implants, also placing the blocking ring around the Ball Abutment providing primary soft tissue support and a resilient situation. (5)

Materials and Methods

This in vitro study was carried out on readymade epoxy resin* model coverd by auto polymerizing silicone soft linear material representing completely edentouls mandibular ridge

I. Construction of experimental overdentures: Two experimental overdentures was used for group I and group II.

II.Fabrication of Guide template:

Clear acrylic guide template was fabricated to be used as a guide for implant placement

III. Implant installation:

Four implants were secured in the prepared holes of the epoxy resin model using the placement tools of the implants to simulate osseointegrating. The platform of the implants was adjusted at level with the crest of the ridge

IV-pickup of ball attachments:-

The groups were classified according to using of blocking ring**,** into two groups:

Group I: the female housing of ball attachment was picked up with using of blocking ring**.**

Group II: the female housing of ball attachment was picked up without using of blocking ring**.**

V-Strainmeasurements:

1. Strain gauge installation:

Four strain gauges* were used and installed vertically in to prepared respective site 2mm mesial, distal, buccal and lingual to each implants.

2. Strain measurement:

Each model was put on the compression grip of the universal testing machine and secured in position with the occlusal plane of the overdenture in a horizontal position.

stress around the implants unilaterally and bilaterally.

The universal testing machine was connected to a personal computer through computer aided software to allow for the accurate control of both the amount of the applied load and the duration. The machine was used in this the study to apply compressive loads to measure the resulting

Fig1: Bilateral (central) loading using a metal bar.

Results:

When compared the stresses during unilateral loading in the loading side between groups, for anterior implants, group II recorded significant higher stresses than group I. For posterior implants, group II recorded significant higher stresses than group I. when compared the stresses between implant positions: For both group there was no significant difference between implant positions.For both groups and implant positions, the stresses around the implants of loading side were found to be significantly higher than stresses around the implants of non-loading side.

Table 1: Comparison between stresses around implants of loading side and non-loading side during unilateral loading in each group

		Loading side		Non- Loading side		P value
		X	SD	X	SD	
Group I (with rings)	Anterior implants	137.02	207.96	43.88	27.31	.023*
	Posterior implants	62.78	39.00	10.66	7.23	.002*
Group II (without rings)	Anterior implants	291.60	435.61	58.73	22.02	.001*
	Posterior implants	90.45	23.22	24.97	18.72	.003*

*p is significant at 5%

Discussion

The results of this study showing a recorded stresses around all studied implants. This result concurred with ***Borchers et al***. [6] who stated that an implant supported overdenture is subjected to various types of axial and nonaxial stresses, including the masticatory forces. The resultant of these forces is transmitted through the superstructure and the attachments to the implants and may lead to concentration of stresses in the different parts around implants. Also, this result is in agreement with ***Akca et al,***[7]who explained that the implant bone interface is rigid and transmits all loads directly to the adjacent bone. This condition produces a high level of stresses which can be counterproductive for long term survival of the implants.

Although the recorded means of stresses during bilateral loading around implants of group I were less than those in group II, this result was found to be statistically insignificant. This less stresses in group I may be due to the presence of blocking ring spacer that allow better functional fitting of the denture base during pickup of female housing and permitted better load distribution. this explanation is in agreement with ***Amal and Iman*** [8]who stated that placing of blocking ring around ball attachment during pickup of female housing allow for functional fitting of the denture and permit better load distribution between mucosa and implants providing primary soft tissue support and resilient situation. ***Menicucci et al.***[9]concluded that with using of spacer, the overdenture with ball attachment demonstrated the lowest and more symmetrically distributed stress to the implant abutments.

Also during bilateral loading when compared between stresses around anterior and posterior implants in each group, insignificant difference was noted. This may be due to strategic distribution of the four implants in addition to the low profile and vertical resiliency of ball attachments, which provide excellent settlement of the denture base during bilateral loading without fulcrum formation and stress concentration. This result is in agreement with ***Takeshita et al.***[10]who noted that the excellent design of ball attachment and implant strategic position allow good distribution of load and least stresses to be transferred to bone around implants. Moreover, when ball attachment system is resilient; the stress in the bone around implants is subsequently lessened and thus reduces the maximum stress level.

On the other hand during unilateral loading, the loading side showed significant higher stress around anterior and posterior implants in group II (without blocking ring) than group I (with blocking ring). . While insignificant difference between anterior and posterior implants in each group was recorded . This may be due to the absence of vertical space between metal housings and implants that result in restricted movement of the denture and more stresses transmitted around implants.

This result in agreement with ***,Takeshita et al .***[10] who noted that low profile attachment having a direct contact with their keepers without intervening space, may be responsible for transmission of the stress to the implants.

Also, this outcome was in parallel with ***Omran et al.***[11]who explained that when the ball and socket contact each other without intervening space it does not permit vertical movement of the prostheses due to absence of vertical resiliency and result in more stress around implants.

Finally, during unilateral loading the non-loading side recorded significant higher stresses around the anterior and posterior implants in group II than in group I, while the anterior implants recorded higher stresses than the posterior implants in each group.

The recorded significant higher stresses in groupII than group I may be due to the absence of blocking ring spacer which result in decreasing the share of residual ridge and increase of the stresses on all implants in the same manner as during bilateral loading.

The significantly higher stresses around anterior implants than the posterior implants in non-loading side may be due to the effect of horizontal stresses (non- axial forces) resulting from the lifting of the prosthesis in the non-loading side. In parallel to the present study ***M. Shishesaz et al. .***[12]noted that, the Deformation of the overdenture and lifting of non-working side exerts a bending moment to the attachment systems and creates additional stresses in metal parts of ball attachment. Also ***Amer et al.***[14] noticed that, the highest maximal stresses were around the most anterior implant.

In addition to the result of this study, during unilateral loading , the stresses around implants of loading side were found to be significantly higher than stresses around the implants of non-loading side in each group. This result may be due to the largest force concentration in the areas around implants closed to the application of load .This in agreement with the finite element study of ***Daas et al***[15] that showed that implant close to the point of application of load on the prosthesis suffer greater mechanical stress .

Conclusions

Regarding stress analysis, using of blocking ring spacer is recommended during pick up procedure of female housings of ball attachments used for retaining 4-implants mandibular complete overdenture to minimize the peri-implant stresses.

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