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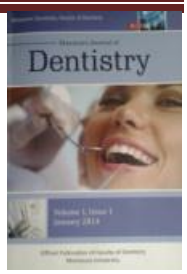
# Stress applied on implant assisting mandibular complete overdenture - in vitro comparison of Casted Metal bar and InFibra Ribbon bar attachments

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***Abstract:***

Mandibular implant assisted overdenture is an especially attractive treatment because of its relative simplicity, minimal invasiveness and economy. Splinting of implants by bar, prevent micromovement and hence improve ossointegration in addition to improvement of overdenture retention.

***Purpose:*** The purpose of this in-vitro study was to evaluate and compare stress applied on implant assisting mandibular complete overdenture by using two types of bar attachment: a) prefabricated instant adjusting bar b) infibra ribbon bar.

**Materials and Methods:** This in vitro study was carried out on a six standard educational edentulous mandibular models. According to the type of bar attachment used, models were classified into two main groups as follow: group I had instant adjusting bar attachment and group II had infibra ribbon bar attachment, they connected to installed implants at canine region. The models were covered by polyvinyl siloxane impression material to simulate the oral mucosa covering the ridge. Acrylic resin complete mandibular overdentures were constructed. Strain gauges were bonded at labial, lingual, mesial, and distal surfaces of each implant abutment. LLOYD Digital loading device was used to apply vertical load of 50 N on the overdentures at right first molar. The stresses were measured. Data was collected and statistically analysis.

**Results:** This study revealed that the highest stress was observed at the labial surface and the lowest at the distal surface of loaded and unloaded side of implant abutment, implant abutment surfaces that assisted mandibular complete overdenture with bar attachment was subjected to a more stresses applied on loading side compared to unloading side, and implant abutment surfaces subjected to a more stresses when it connected to instant adjusting bar joint attachment compered to infibra ribbon bar attachment mandibular complete overdenture.

**Conclusions:** Variation in sintering time from1.6h to 3.0h did not affect structure and fracture toughness of Y-TZP zirconia. Thermocycling of zirconia sintered at normal sintering time has no apparent detrimental effect on their properties.

## *Introduction*

Many elderly patients exhibit a highly reduced dentition with regard to number of teeth lost due to periodontal disease or caries. In these cases fabrication of fixed prostheses becomes impossible.(1)

Rehabilitation of a partially edentulous patient can be established using a wide range of prosthetic treatment options. Depending upon the clinical need and demand, restoration of the lost structure can be achieved by using simple conventional removable partial denture, overdenture, or dental implants.(2)

The two implant assisted mandibular overdenture is the least costly implant option; it offers a significant increase in retention and stability over a complete denture and demonstrates a considerable improvement in quality of life. For these reasons two implant assisted overdenture is considered the standard of care for edentulous mandibles.(3)

Despite widespread acceptance of this treatment, some controversies still exist with regard to the design of the overdenture and selection of appropriate attachment system.(4)

Bar attachment has the advantage of splinting implants together and act to inhibit displacing forces in both vertical and oblique directions.(5)

The implant supported milled bar overdenture is a therapeutic option requiring its correct diagnosis and adequate therapeutic planning from start. When it is well planned, it offers excellent long run rates of success in the maxilla and mandible.(6)

Fiber reinforced is proven technology today which is being in almost every fields, dentistry is no exception in accepting this technology.(7) The use of reinforced composite ribbon has become a day to day practice in clinical dental practice which has made life easier for the dentist at the same time helping him provide quality care to the patient.(8)

The polyethylene fiber bar (InFibra Ribbon bar) was made by using polyethylene fiber and universal resin cement. This bar was easily fabricated, good manipulation and not need laboratory work.(9)

Stress analysis of dental structures has been a topic of interest in recent years with an objective of determining stresses in the dental structures and improvement of the mechanical strength of these structures.(10)

In vitro studies have been used even widely than in vivo studies; due to absence of the periodontal tissues and bone

consistency vary from patient to another. Thus, comparative studies should be more accurate and practical, if they were laboratory performed.(11)
Therefore the purpose of this in vitro study was to compare the stress applied on implant assisting mandibular complete overdenture regarding casted metal bar and inFibra ribbon bar attachment.

## *Materials and methods*

This in vitro study was carried out on six standard educational edentulous mandibular models.
According to the type of bar attachment used, models were classified into two main groups as follow:-
Group I: This group had instant adjusting bar attachment connected to installed implants at canine region.
Group II: This group had inFibra ribbon bar attachment connected to installed implants at canine region.
The models were covered by polyvinyl siloxane impression material (Speedex; Coltene/ Whaledent, Altstatten, Switzerland) to simulate the oral mucosa covering the ridge.
Two implants fixture (Dyna Dental Engineering bv, 4600 AB Bergen op Zoom, Netherlands) of mean size 13 mm in length and 3.6 mm in diameter were installed in the residual ridge of the model in the canine region. They were set similar to the distance between two natural canines.
The prefabricated instant adjusting bar (Dyna Dental Engineering bv, 4600 AB Bergen op Zoom, Netherlands) was installed to the implants, which consists of bar joints, bar extension abutments, round shaped bar, universal fixation screws, and bar riders.
InFibra ribbon bar was constructed through the following steps: the polyethylene fiber (InFibra Ribbon System) (InFibra reinforcement, bioloren, Italy) of 4 mm width was cut in adequate length using hot scalpel then folded, 2 mm width, not oval to leave 1 mm space between the bar and the ridge. Universal resin cement (Universal Resin Cement, biolren, sarona, Italy) was luted to the first abutment then the fiber was bounded to the abutment for its buccal aspect, one side of implant surface, by the universal resin cement. The fiber was polymerized by light cure device. The fiber cross the ridge to reach the second abutment at the lingual aspect, implant of opposite side, and luted with universal resin cement then cured. The fiber crosses again the ridge to reach the first abutment at start point to form figure eight. It was luted with resin cement and cured to bond again with the first abutment. The resin cement was applied between the fibers that crossed the ridge and around it to construct final shape of the bar. Resin cement was also luted around the abutment, but not covers the top of the abutment. The assembly was cured. Excess resin was removed by using of low-speed finishing bar, the constructed bar was finished and polished with 1 mm space from the gingiva as cleansing surface.
Acrylic resin complete mandibular overdentures were constructed. Strain gauges were bonded at labial, lingual, mesial, and distal surfaces of each implant abutment. LLOYD Digital loading device was used to apply vertical load of 50 N on the overdentures at right first molar. The stresses were measured. Data was collected and statistically analyzed.

*Fig. (1): InFibra Ribbon bar 1mm above the gingiva*

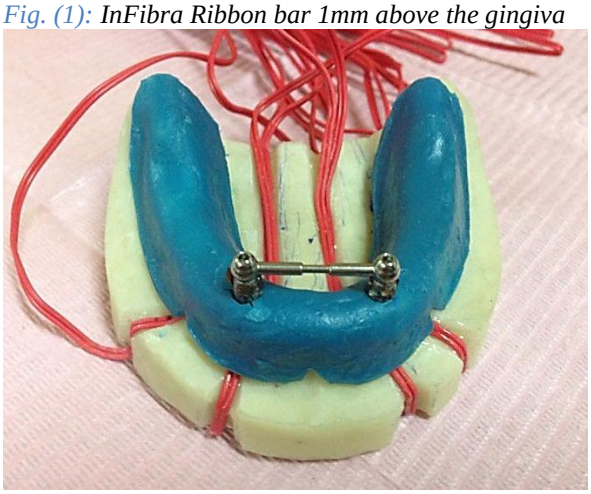

*Fig. (2): Instant Adjusting bar installed on the model with four strain gauges applied to each implant surfaces*

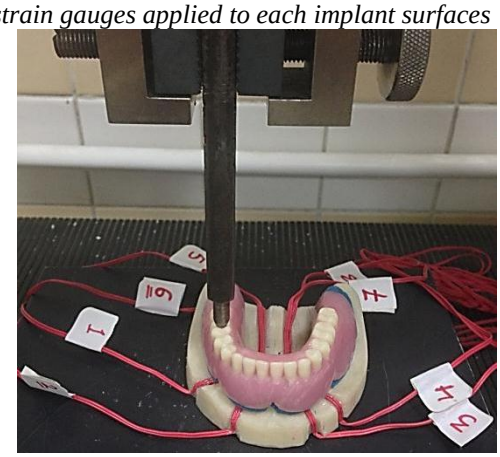

*Fig. (3): Unilateral load on the right first molar region*

## *Discussion*

Strain gauge stress analysis technique used in this study offers potential of improving the design of overdenture bar attachment. The design and evaluation of bar attachment

can be performed in vitro rather than by clinical trial. However, like all techniques it has own limitation.

Bar-and-clip attachments have been advocated for splinting the implants and connecting the prosthesis to them.(12,13)

The inFibra Ribbon System is a tooth colored splinting product fabricated from highly crystallized white and polyethylene longitudinal fibers. These fibers have been selected to provide mechanical characteristics that are ideal for specific dental use.(14)

This study was conducted to evaluate the nature of stresses applied to the implant overdenture abutments for improving the understanding of biomechanics of bar overdenture attachment supplied with different material form include Instant Adjusting bar joint and InFibra Ribbon bar.

An appropriate variation was observed on the more stress applied on the implant surfaces for Instant Adjusting bar group and InFibra Ribbon bar group. The highest stress was observed at the labial side and the lowest at the distal side. This result may be explained that under loading the overdenture and the bar deflected in vertical and horizontal direction. Vertical direction at central area causing stress applied at the labial side of implant. While horizontal deflection of bar, in anterioposterior direction, causing great stress applied on distal side of implant. Under loading residual ridge distal to the implant abutment will support the prosthesis. Therefore, the stress applied on the distal side of the implant will be minimized.

For instant adjusting bar and InFibra Ribbon bar, the loading side significantly exhibits more stress applied in all implant surfaces, includes labial, lingual and mesial surfaces except distal surface compered to non-loading side. The significant result of this study may explained that unilateral loading on overdenture may cause great stress applied on the implant abutment situated at the loading side than non-loading side, this in agreement with Dong et al (15) who stated that during application of unilateral load, higher stresses were observed around abutments in the loaded side than those in unloaded side. This might be due to the denture base contact the top of the copping at the loaded side after load application which became a fulcrum of concentrated stresses.

Moreover, the non-significant result may be due to close approximation or equalization of the amount of stress applied distally on loading and non-loading sides. This explanation was reinforced by the result obtained in this research as value of more stress was closely approximated on loaded and unloaded implant abutment connected with InFibra Ribbon bar attachment regarding implant surfaces.

The result of this study revealed that, the more stress value recorded in all implant surfaces of loading and non-loading side except mesial surface of unloaded sides implant, was significantly more in the Instant Adjusting bar joint attachment compared to that recorded with InFibra Ribbon bar attachment. The same result was observed when comparing the more stress value of mesial surface of unloaded implant side although the more stress value was not significantly differs. This result may be explained that, regardless the nature of stress overdenture implant abutment of InFibra Ribbon bar attachment was suggested to least stress compared to Instant Adjusting bar joint attachment with multiple short sleeves. The former was better from reduction of stresses than the latter. This may be due to variability of load application on the bar, central and peripheral loading with InFibra Ribbon bar and central loading with Instant Adjusting bar joint with multiple short sleeves. Although the situation of application of load was the same in both bar attachment system, rigidity of Instant Adjusting bar may transmitted higher stresses applied on the abutment implant. Dolder (16) stated that when the denture is under loading, the sleeve is in contact with bar joint. Abdel-khalik (17) reported that bar joint attachment deflects in horizontal and vertical directions when the structure is under loading. The greater deflection of the bar joint attachment at its central area. This cause an extreme amount of stress at peripheral side of the bar connecting the implant abutments. There in-turn induce stresses on abutment leading to its vertical depression and rotation. In other words under loading, overdenture abutment of bar joint attachment may behave a crane in its supporting bone.

Alternatively, converted with InFibra Ribbon bar attachment may be explained that under loading the super structure reduce of more stress value that sighted to implant abutment, the InFibra Ribbon bar attachment may deflect in a lesser degree compered to Instant Adjusting bar joint due to its resiliency, support principle of InFibra Ribbon bar that utilized its entire length and soft liner representing female housing of the bar. By this mean most of stress applied on the bar will be damped, consequently the peripheral end of the bar subjected to stress of an exaggerated manner, that in-turn reduce the stress transmitted to abutment implant surface located in loading and non-loading side.

The most widely known feature of polyethylene fiber is their elasticity, which is similar to dentin and composite resins. Due to favorable elasticity, stress distribution during clinical function is uniform.(18)

Resiliency of soft liners reduces the load applied over the overdenture abutments and in turn reduces alveolar bone changes.(19,20,21,22) Liners also used to distribute masticatory forces more evenly to the implants and edentulous ridge.(23)

It was observed that overdenture with bar-clip attachment transmit a higher stresses to all surfaces of the implant abutments compared with those with bar soft-liner attachment. This may be due to the ability of the-soft liner material to act as cushion and it allow the complete overdenture movement around the bar which may decrease the resulted stresses.(24)

Given the interesting finding of the stress analysis, displacement of the overdenture bar joint and InFibra Ribbon bar attachment is recommended for further investigations.

## *Conclusion*

1- InFibra Ribbon bar is the attachment of choice for assisting the mandibular complete overdenture because it reduce the induce stresses applied on the implant abutment.

2- Prefabricated Instant Adjusting bar joint isn't advocated as attachment for mandibular complete overdenture because of inducing high stresses on implant abutment.

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