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ORIGINAL RESEARCH

Compare the denture base strain of resin denture base reinforced with glass e-fibre and metal mesh with conventional resin denture base in two implant supported over denture

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Abstract
Introduction: The classical treatment plan for the edentulous patient is the complete removable maxillary and mandibular denture. However, in recent years, the two-implant mandibular over denture has been proposed as anal ternative to more complex over denture designs. The incidence of mechanical complications including denture base deformation and fracture of denture has been reported in long-term clinical studies. The Purpose of this study was to evaluate and compare the influence of glass fibre and metal mesh reinforcement on denture base strain on two implant supported overdenture. **Materials and Method:** Eighteen experimental overdenture bases were fabricated for the evaluation of strain on their B&D positions(on top of the ball attachment) during load application. For strain measurements, total 4strain gauge, two strain gauge(2measuring directions, 0 and 90degrees) each were cemented at the crest and of B and D position. A universal testing device at a crosshead speed of 0.5 mm/min was used for strain measurements. **Conclusion**: E-glass fiber reinforcement placed over the residual ridge and implant attachment reduced denture base strains and deformation of two implant-supported overdentures by almost 50%. Metal mesh reinforcement placed over the residual ridge and implant attachment increases the base strain and deformation
Key words:denture base, glass e-fibre, metal mesh

Introduction

The classical treatment plan for the edentulous patient is the complete removable maxillary and mandibular denture. However, in recent years, the two-implant mandibular overdenture has been proposed as an alternative to more complex overdenture designs [1,2]. It is also considered a more feasible option for geriatric patients, who are less likely to adhere to complex implant interventions, because of its diminished functional demands and because of the favourable local bone condition in the symphyseal region, which ensures satisfactory primary implant stability. However theincidence of mechanical complications including denture base deformation and fracture of denture has been reported in long-term clinical studies.[3]

The fracture of mandibular overdenture occurs as a result of fatigue failure by masticatory forces. The fracture starts as crack initiated between denture teeth followed by propagation to areas of the greatest strain within the denture base[4]. Deformation/fracture in overdenture occurs during functional loading, especially in the thinner areas such as midline and over the fulcrum abutments or implant attachments. These risks of prosthesis failure can be minimized by identifying stress distribution, stress magnitude, and selective reinforcement in areas of high stress concentration.[5]A traditional method of preventing the fracture of dentures is to reinforce them with wire and plates made of Co-Cr alloy or stainless steel. Recently, glass, polyaromatic polyamide (amide), or ultrahigh molecular weight polyethylene fibers have been advocated to prevent denture fracture. These fibres are reported to provide straight forward aesthetics and the chemical bond between the fibres and polymer matrix is good enough which allows the transmission of load from weak polymer matrix to stronger fibre component.[6]

The Purpose of this study was to evaluate and compare the influence of glass fibre and metal mesh reinforcement on denture base strain on two implant supported overdenture.

Materials and Methods

In this two dental implants were attached on mandibular edentulous stone cast in the B and D areas of the cast. Ball stud attachments have embedded in the denture base resin, and a ball abutment was threaded to the implant fixture. Eighteen experimental overdenture bases were fabricated for the evaluation of strain on their B&D positions (on top of the ball attachment) during load application. Three test groups were fabricated as follows.

1. **Group1:** HP (n=6) fabricated from heat-polymerized acrylic resin without reinforcement
2. **Group2:** HPF (n=6) fabricated from heat-polymerized acrylic resin with E-glass fibre reinforcement running over the residual ridge
3. **Group3:** HPM (n=6) fabricated from heat-polymerized acrylic resin with metal mesh covering the residual ridge and the ball matrix.

Adequate adhesion of the fibers to the polymer matrix is a crucial factor for the strength of the fiber-reinforced structure. Silane coupling agent has been used successfully in improving the adhesion between polymers and glass fibers. PMMA-preimpregnated glass fibers allow interfacial adhesion in order to transfer stresses from the weak polymer matrix to the stronger fibers. The preimpregnated fibers need further impregnation with a thin mixture of the polymer used in the final construction.

For strain measurements, total 4 strain gauge, two strain gauge(2 measuring directions, 0 and 90 degrees) each were cemented at the crest and at the lingual of B and D position on the polished surface of each overdenture above the ball attachment, connected to the sensor interfaces and controlled by a personal computer. Strain values were recorded from each channel separately. A universal testing device at a crosshead speed of 0.5 mm/min was used to apply a 100-N vertical occlusal load bilaterally through a metal bar (5×5×100 mm) positioned on the occlusal surface running across the 2 sides in the first molar areas. The strain of each experimental denture were recorded for 120 seconds, with an intervening interval of 5 minutes for recovery. The measurements were repeated 5 times for each denture, and the mean strain values for both channels Ch1 Ch2 Ch3 & Ch4 were recorded and submitted for statistical analysis.

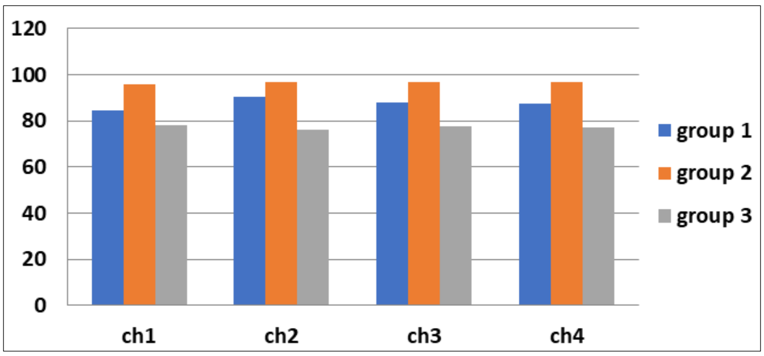
Results

The type of acrylic resin had no statistically significant effect on mean strain values among groups (P=0) while the reinforcement significantly affected them (Pwhile the reinforcement significantly affected them. The interaction between reinforcement and acrylic resin type was not statistically significant (P=0). For all tested groups, strain values recorded by Ch1 &3were tensile in nature, while those recorded by Ch2 & 4were compressive. A statistically significant difference was found in the mean strain values of Ch1 Ch2 Ch3 and Ch4 among the tested groups.

Table 1:Shows the mean strain values of the tested groups

	Ch1	Ch2	Ch3	Ch4	P value
Group 1	84.53±4.20	90.30±2.38	88.11±2.71	87.53±1.7	0.02
Group 2	96.0±1.33	96.91±1.36	96.75±1.42	96.63±1.22	0.01
Group 3	77.90±0.58	76.03±1.15	77.42±0.57	76.87±0.95	0.01
P value	0.00	0.00	0.00	0.00	

Mean values of tested groups for strain where*p*<.05 significant where



Graph 1: Shows the mean strain values of the tested groups

Discussion

The series of studies were performed to investigate the effect of fiber and metal mesh reinforcement on the mechanical properties and strains of implant overdentures. The mechanical studies aimed to determine glass fiber layers for efficient overdenture reinforcement, as well as to investigate the behaviour of metal mesh reinforced overdentures under static and dynamic loading conditions.

Excessive denture base deformation can lead to denture base fracture complications. In addition, this deformation can transmit compressive stress to the bone causing residual ridge resorption, recurrent ulcer formation, and/or implant overloading[7,5]. Excessive forces transmitted to the implant through the denture base during functional loading can cause a variety of complications such as attachment fracture and implant dislodgement or failure [5]. Approximately 30% to 40% of the overall implant-supported overdenture loads were found to be supported by implants [8]. Therefore, overdenture base reinforcement might be necessary not only to minimize denture base deformation but also to protect the supporting structures (implants and residual bone) from excessive harmful stress [5].

The type of strain developed within the implant overdenture base and its location can differ according to the attachment type and resiliency [9,5], attachment height[10] , and the number of supporting implants [11]. Attachment resiliency can minimize implant loading [11,12]. However, it can affect denture base deformation and longevity too, which is important for long-term stability [11].

The hypothesis of studywas accepted since the number and position of fiber layers demonstrated a significant effect on the flexural strength of locator retained overdenture and confirmed that the fiber positioning significantly affected locator-retained overdenture strength. Moreover, it showed that cyclic loading had a significant effect on flexural strength. Those findings were in agreement with previous studies which reported that applying glass fiber reinforcement can improve the mechanical properties of acrylic resin denture bases [13]. The fracture load values increased significantly when E-glass mesh fiber reinforcement was added above the abutments of a simulated implant-supported overdenture [14]. In the same study, the effect of using glass fiber as a reinforcement material for soft liner-retained overdentures on these mechanical properties was evaluated.

Using fibers did not make a significant improvement on the flexural properties of locator-retained overdenture. This could be due to the low volume fraction of glass fibers in the high stress-bearing area of the specimen [6]. Another reason might be the insufficient bonding of the fibers or polymer matrix to the coupling agent [4].

The fibers selected for this study were silane-treated and preimpregnated with polymethyl methacrylate, which enabled them to be properly bonded with the resin matrix and provide strong adhesion with it for proper load transfer.

Conclusion

Based on the findings of this *in vitro* study, the following conclusions were drawn.

1. E-glass fiber reinforcement placed over the residual ridge and implant attachment reduced denture base strains and deformation of two implant-supported overdentures by almost 50%.
2. Metal mesh reinforcement placed over the residual ridge and implant attachment increases the base strain and deformation

The findings of the studies demonstrated that glass fibers are suitable for reinforcing implant overdentures and can reduce the incidence of fracture complications. The necessity of proper positioning of fiber reinforcement in enhancing the strainproperties ofwas emphasized in these investigations.

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