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Research Article

Effect of recent severe Abutments Angulation on Implant Loaded at lower first premolar on the Fracture Resistance

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Abstract

Background: The angulation of the abutment can affect the success of the dental implant because it controls the forces applied on the screw. **Objectives:** The goal of this research had been to assess the impact of abutment angulation on an implant loaded at the posterior mandible on the resultant stresses & and fracture resistance. **Methods: To** study the fracture resistance, the following method will be used. Fifteen casts representing missed lower first molar will be constructed & and divided into 3 groups (5 samples each) according to the type of abutments used: 1. The model consists of a Dental implant (4x 10 mm), internal hexagon straight abutment and crown height of ten ml., 2. Dental implant (4x 10 mm), internal hexagon,15-degree angled abutment and a crown height of ten mm., 3. Dental implant (4x 10 mm), internal hexagon,30-degree angled abutment and a crown height of ten mm. The three groups will be subjected to fracture resistance tests. The data will be collected, tabulated and statistically analyzed. **Results**: 15 angled abutments showed the best fracture resistance (Fracture resistance test) in comparison to straight and 30 angled abutments. **Conclusion**: Angulation 15 abutment increases fracture resistance of the overlaying CAM-milled zirconia single crowns than straight abutment.

Keywords: Crown height, Dental Biomechanics, Internal hexagon

Introduction

Modern dental implants are made of biocompatible titanium and are surgically inserted into the jawbone to replace missing teeth by supporting a prosthetic tooth crown. Although implants have great long-term retention rates (approximately 95% after 5 years), failures are far more common in regions with poor bone quality and density, leading to defective patient outcomes. The majority of failures are caused by subpar clinical skill and a lack of awareness of the potentially harmful stress factors that can occur during implant installation and function [(1)]. A dental implant's main purpose is to serve as an abutment for a prosthetic appliance that mimics the root and crown of a natural tooth [(2,3)]. Therefore, any success criteria must include the primary support of a functional prosthesis. Additionally, the mechanical performance, Osseo-integration of the bone implant complex with low loading stresses on the bone-implant interface, & patient satisfaction with the aesthetic appearance of the implant restoration have been among the most crucial clinical criteria for prosthetic success [4,5,6]. The purpose of the current investigation was to ascertain if single-unit dental implants with angled abutments may reduce stress on the surrounding bone.

Materials and Methods

Methods

I- Sample grouping

- Fifteen casts representing missed lower first molar constructed & divided into 3 groups (5 samples each) according to the type of abutments used:

1- Dental implant (4x 10 mm), internal hexagon, straight abutment and crown height of 10 mm.

2- Dental implant (4x 10 mm), internal hexagon,15-degree angled abutment & crown height of ten mm.

3- Dental implant (4x 10 mm), internal hexagon, 30-degree angled abutment & crown height of ten mm.

II- Model Construction:

A- Cast model preparation

2 material (acrostone), polymer and monomer were mixed till dough stage then inserted into the socket.

B- Implant insertion

The implant was loaded in the center of the acrylic resin in the socket with a ratchet until it was submerged 1 mm beneath the acrylic material's surface, before the acrostone's complete setting.

C- placement of implant Abutment

After the complete setting of the acrostone, the straight and angled abutments were placed into the 15 cast by screwing it into the implant body.

D- putty index:

A suitable metal tray size 2 was chosen and then loaded with additional silicone rubber impression material (heavy body).

After the impression material had fully set, the tray was withdrawn, loaded with a mild wash impression, and re-placed onto the mold until it had done so. The tray was then removed, the abutment was unscrewed, and the implant analogue was then inserted. Alginate was used to create an upper jaw impression using a tray size 2 and hard stone type 3.

III- Restoration construction

A- Core construction

Using Cercon's CAD/CAM-based technologies, Cercon Brain, Cercon Eye, a laser scannervand a milling machine, zirconium core thicknesses of 0.8 mm were created.

B- Crowns Construction

Using the Cercon technique, 15 crowns were machined altogether. Using a premade putty key, diagnostic wax-ups of the crowns had been completed. The putty key was filled with molten wax, which vented out the other end. By using the putty key for each restoration, variables were decreased, and a precise replica of the wax pattern was created with full anatomical contour [7.8].

IV- Samples testing

The samples were subsequently put under compressive loading in a universal testing device (Shimadzu Autograph AG-50kNE, Shimadzu Co., Ltd., Japan) with a crosshead speed of one mm/minute. A steel rod with a four mm diameter had been positioned along the lower molar crown's midline fissure to apply compression force. A categorization created for the inquiry [9–11] was used to record the force (N) needed to cause the crown to fracture as well as the manner of failure.

V- Statistical Analysis Tests

Each group's means and standard deviations were computed and compared. The data on fracture resistance were analyzed using one-way analyses of variance (ANOVA) with accompanying post hoc Tukey pair group comparison tests[12–14] ($p>0.05$).

Results

- Fracture resistance of the tested groups the fracture resistance of the three tested groups is presented in table (1) and fig. (1). Group B (15-degree angulated abutment) showed the highest fracture resistance 1242.41 N followed by group A (straight abutment) 1046.87. Finally, group C (30-degree angulated abutment) recorded the least fracture resistance 996.00N.

According to the Tukey test, the implant angulations considerably (p 0.05) decreased the overlaying CAM-milled zirconia single crowns' ability to withstand breakage. The samples built on the 15 angled abutments had the best fracture resistance, however, it was not statistically different from the outcomes observed for the straight abutments. In contrast, the fracture resistance of crowns bonded to the 20 angled abutments was the lowest of all the groups evaluated.

Table (1): The mean fracture strength N (SD) of groups A to C.

Abutment Angulation	Mean Fracture Resistance	Standard Deviation
Group A (0 angulation)	1046.87 N	724.83
Group B (15ngulation)	1242.41 N	652.71
Group C (30 angulation)	994.00 N	99.08

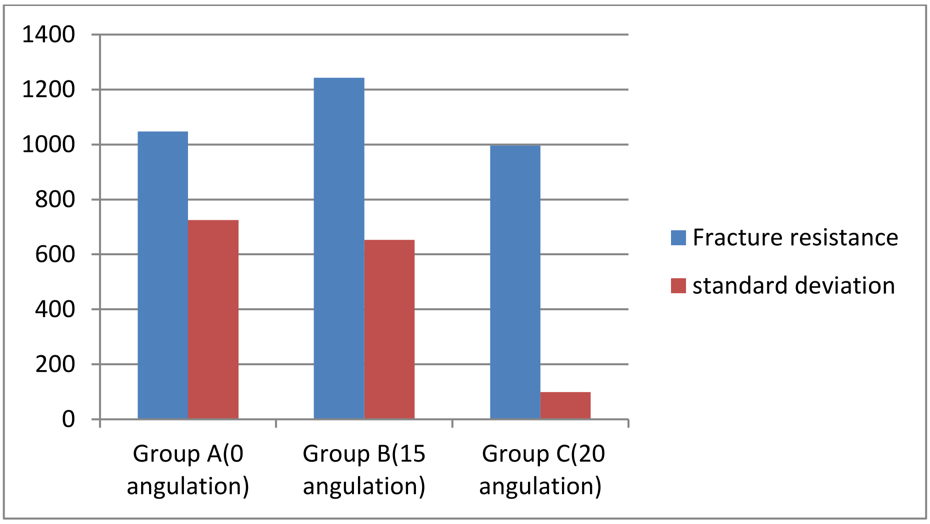

Fig (1) comparison between fracture resistance N & standard deviation of the tested groups

II- Mode of failure

Tables (2, 3, 4) recorded the mode of failure of the 3 tested groups according to the classification of the mode of failure.

Table (2): The description of the mode of failure of group A (0 angulation)

Sample	Mode of failure	Core status
1-	v	Not intact
2-	I	Intact
3-	I	Intact
4-	I-II	Intact
5-	I-II	Intact

Table (3): The description of the mode of failure of group B (15 angulation)

Sample	Mode of failure	Core status
1-	IV	Intact
2-	III	Intact
3-	III	Intact
4-	IV	Intact
5-	V	Intact

Table (4): The description of mode of failure of group C (30 angulation)

Sample	Mode of failure	Core status
1-	IV	Intact
2-	III	Intact
3-	III	Intact
4-	IV	Intact
5-	IV	Intact

Discussion

This study examined the in vitro fracture resistance of various abutment implant angles.

Many abutment angulations, including 0, 15, 20, 25, 30, 35, and 50 angulations, were tried in vitro in the past (3). The majority of these investigations suggested that angulations greater than 30 have a negative impact on the overlaying prosthesis and the osseointegrated implant body (4). Abutment angulations have changed from 20 to zero, which is beneficial for extending the life of the overlaying prosthesis and lowering stress on the implant body and prosthesis. (7-9)

This study was an experiment to see which abutment angulation is better for the durability of overlaying zirconia crowns in the lower first molar area, despite the results of **J. Carvello et al.,** (15).

The advantage of using biomechanical models, like the one examined in this work, is that they can give information on the clinical situation.(11.13)

Because of its excellent strength criteria, the Ankylos plus system (ANKYLOS-adent Gmbh Mannheim/Germany) was used in this study. According to the current findings, a 30-implant abutment angulation considerably (p 0.05) decreased the fracture resistance of the abutting CerconCAM-milled zirconia single crowns. This can be attributable to variations in the stress produced beneath the cusp points. The findings revealed that after applying pressure to the crowns, 14 of 15 cores remained undamaged. Almost half of all crown failures occurred through the midline, with the core remaining intact in all but one case while the other half of the crown was dislodged or lost.

The current model system must be carefully taken into account for the general conclusion. This model was initially used for static testing of a dental material. Second, despite best efforts, it proved challenging to standardize the occlusal surface of the underlying Cercon crown due to variations in implant abutment angulation. Further investigation is required to determine the impact of the cusp angle on the scatter of compressive failure loads recorded by the model.

Conclusions

1- Angulation 15^0 abutment increases fracture resistance of the overlaying CAM-milled zirconia single crowns than straight abutment.

2- Increasing the abutment angulation may lead to a deeper fracture of the restoration.

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