A COMPARATIVE STUDY TO EVALUATE THE RETENTION OF CONVENTIONAL AND CAD/CAM FABRICATED BAR ATTACHMENT IMPLANT SUPPORTED ASSEMBLY (IN VITRO STUDY)

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ABSTRACT

INTRODUCTION: The use of implant-supported overdentures is a common approach for treating edentulous mandibles. Retention and stability are provided through attachments; bar attachments being probably the most retentive due to greater mechanical stability and better wear resistance. Micro and macro movement between the retentive surfaces of an attachment during mastication, insertion and removal will lead to wear and decrease of the retentive capacity. Using CAD/CAM technology should produce more precise frameworks with better retention.

OBJECTIVES: was to compare the retention of different Cobalt Chromium bar attachments fabricated by CAD/CAM technology and conventional methods.

MATERIALS AND METHODS: Two bar attachments of different method of fabrication were studied. The bars were divided into two different groups according to whether the bar was fabricated using the conventional method or CAD/CAM technology. The retention provided by each bar was tested using Universal testing machine. The difference in retention was compared between the groups.

RESULTS: Data was collected, tabulated and statistically analyzed using the appropriate test. Group 1 needed 32.91N dislodging force. Group 2 needed 62.8N to separate the clip from the bar

CONCLUSIONS: CAD/CAM fabricated bars showed a significantly higher retentive force in comparison to conventional bars.

KEYWORDS: Bar attachments, Overdentures, CAD/CAM, Cobalt Chromium, Implants

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INTRODUCTION

There are many reasons for edentulism like tooth fracture, trauma, periodontal or periapical disease. Tooth loss can lead to bone resorption and masticatory problems (1). Being edentulous leads to speaking impairment and eating disability that affects the overall quality of life (2). There are various treatment modalities for completely edentulous patients like conventional complete dentures, implant retained overdentures and implant supported full arch fixed complete denture. Treatment with conventional complete dentures usually has many problems including lack of stability, poor retention, soreness, pain and loss of function (3). With the introduction of osseointegrated implants and subsequently the presence of implant-assisted overdentures there now exists a strong replacement for the palliative therapy of conventional complete dentures (4).

Implant overdentures have a greater ability to function than complete dentures; meaning that complete dentures have more functional limitations like difficulty to chew and improper fit (5-7). Patients reported a greater difficulty to chew and bite food when using conventional dentures (8). Most patients with implant overdenture performed functions with greater comfort and could eat a wider range of food items with less difficulty. Also treating edentulous patients with implant overdenture produces a prosthesis that causes less pain, sore spots and uncomfortable eating (9).

Many types of attachment systems have been employed to connect implants to overdentures. Attachments systems have been originally made to increase the retention and stability of tooth supported overdentures. More recently, these attachments are successfully used with implant overdentures. The systems are either independent non-splinted attachments that are connected directly to the implant (magnet, ball, locator, telescopic) or alternatively splint the implants together by using a bar and a bar-clip attachment (10).

Several studies have tested the retention of different types of attachments. Bar attachments proved to provide superior retention and stability (11). Patient satisfaction was also greatest using bar attachments (12). However, bars have proven to have more complications and require a more frequent maintenance period (13). They also exert higher stresses onto the abutments as compared to ball attachments (14).

Bar attachments can either be fabricated in the conventional manner of producing a wax pattern on the master cast, investing and casting (lost wax technique) or it

can be fabricated using Computer aided design/Computer aided manufacturing (CAD/CAM).

Using the lost-wax technique and casting is time-consuming and labor-intensive. It may also produce an attachment of increased misfit and porosity. Therefore, lots of labs and clinicians are resorting to the newer CAD/CAM technology (15). CAD/CAM has been strongly involved in dental practice and is continuing to improve. Using CAD/CAM technology to fabricate inlays, onlays, fixed and even removable prostheses is becoming increasing popular. The presence of the available software and the scanners enables the clinician to either scan the wax/ plastic pattern and mill the bar attachment in the desired material with improved accuracy and thus avoiding the laboratory steps of casting. The clinician also has the ability to scan the patient's oral cavity and create a virtual model on which the design of the bar is made and sent through the internet to the milling machine (16).

CAD/CAM has proved to have a higher precision and accuracy (17). The reason for the improved accuracy is several folds. The accuracy is partially owed to the fact that it uses less fabrication steps. It has been established that each fabrication step has its own margin of inaccuracy. CAD/CAM fabrication skips impression, cast pouring, investing and alloy casting. The accuracy might be also due to the accuracy of the scanner and the milling machine used when compared the conventional laboratory steps (18).

This study compares the retentive value obtained from CAD/CAM fabricated bars and conventional casted bars. The difference in retention is an indication to the difference in precision.

MATERIALS AND METHODS

In this study two implant retained bar attachments were fabricated. The first group was a conventionally casted Cobalt Chromium (Co.Cr) bar. The other group was CAD/CAM designed and milled bars made from Co.Cr.

For each group a prefabricated plastic female clip was inserted into the fitting surface of the acrylic block. Twelve female clips were assigned to each group. Then the amount of retention was tested for each group separately. Then the data was collected and analyzed with the convenient statistical tests.

Preparation of the models

To prepare the models used for testing. A standard educational model was used (Straumann, Basel, Switzerland.). Closed tray impression copings were fixed onto the implants present in the educational model. A pick up impression was performed and two implant analogues were attached to the impressions copings. The impression was poured using clear acrylic resin to fabricate the model used in testing (Fig.1).

Figure (1): Duplicated model used for testing.

Fabrication of the bar attachments

Group 1 was the conventionally fabricated bar. A ready-made plastic pattern was attached to the abutments over the ridge (Rhein83, Bologna, Italy). This plastic pattern was sprued, invested and casted using Co.Cr (Wironium, BEGO GmbH & Co. KG, Bremen, Germany). (Fig.2)

Group 2 was the CAD/CAM fabricated bar. The model was scanned using a bench scanner (InEos X5, Sirona Dental Systems, GmbH, Bensheim, Germany). On the software, the bar was designed virtually with the exact dimensions as the conventional bar. The design was then milled from a Cobalt Chromium disk (CopraSintec K, Whitepeaks Dental Solutions GmbH & Co. KG, Germany). (Fig.3)

Figure (2): Conventional casted bar attachment.

Figure (3): CAD/CAM fabricated bar attachment.

Testing the retention

After the bar was cemented onto the abutments. The model with the bars was fixed to a Universal testing machine (AGS-X 5KN, Shimadzu, Universal Testing Machine, Japan). A simple tension test was performed on each specimen with a crosshead speed of 50mm/min. The maximum force was recorded for each specimen. This maximum force is the retention provided by each bar. (Fig.4,5)

STATISTICAL ANALYSIS

Data were fed to the computer using IBM SPSS software package version 20.0. Quantitative data were described using mean and standard deviation for normally distributed data while abnormally distributed data were expressed using median, minimum and maximum. For normally

distributed data, comparison between two independent populations was done using independent t-test. Significance test results were quoted as two-tailed probabilities. Significance of the obtained results was judged at the 5% level. A p-value of less than 0.05 was considered statistically significant.

Figure (4): Conventional bar (group1) attached universal testing machine.

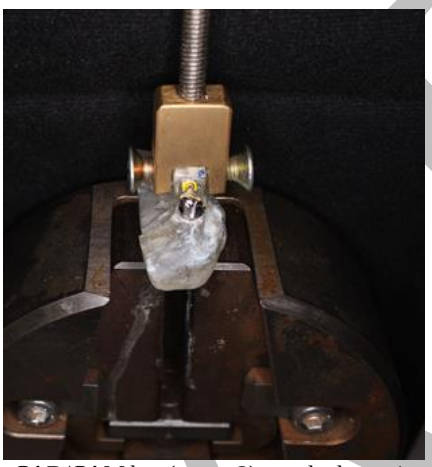

Figure (5): CAD/CAM bar (group 2) attached to universal testing machine.

RESULTS

The mean force was calculated and compared between the groups. The mean force needed to dislodge the clip for group 1 (Conventional bars) was 32.91N with the minimum value being 29.06N and the maximum value was 38.75N. The mean dislodging force for group 2 (CAD/CAM bars) was 62.68N with the maximum value of 71.41N and a minimum 55.16N. Table (1) Fig (6)

Table (1): Comparison between dislodging force group 1 and group 2.

Simple tension (Newtons)	Group 1 (n=12	Group 2 (n=12)
Range (min-max) Mean S.D.	29.06-38.75 32.91 3.31	55.16-71.41 62.68 6.66
P1		0.001*

p: p value for comparing between the two groups
*: Statistically significant at $p \leq 0.05$
Group 1: Conventional Co.Cr bar
Group 2: CAD/CAM Co.Cr bar

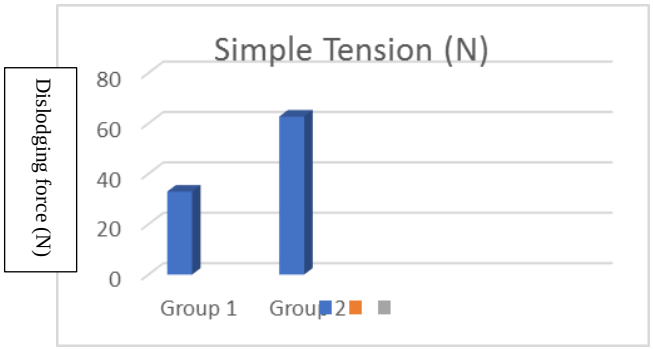

Figure (6): Comparison between dislodging force group 1 and group 2.

DISCUSSION

The use of removable dentures is still a major section in dentistry and is an important reality for many edentulous patients (19). The conventional treatment of completely edentulous patients is complete dentures. However, this conventional treatment proved to have many problems and is displeasing for the patients in many occasions. Problems with complete dentures range from instability and poor retention to difficulty to masticate and grind food (20). The use of implant overdentures has significantly improved denture retention, stability and support which lead to an increase in occlusal force and chewing efficiency. The retention and stability of an overdenture has been found directly related to the type of attachments used. Studies showed that bar attachments provide superior stability in comparison to other attachments (21). Which type of attachment provides the best retention is still under controversy. However, Van Kampen (22) found that bar attachments showed the highest retentive values in comparison to ball and magnets. Cune et al (23) tested patient satisfaction of eighteen totally edentulous patients treated with implant overdentures. This study concluded better patient satisfaction with ball and bar attachments.

Retention is an important and significant determinant of patient satisfaction with the removable prosthesis (24). Studies have shown that the more retentive the overdenture, the more the patient is able to use it more efficiently in terms of mastication and speaking. It also generates a better self-esteem and self-confidence (25-27).

A universal testing machine was used in this study with a cross head speed of 50mm/min to imitate the speed of dislodgment of the denture clinically (28,29). Using CAD/CAM technology for fabrication produces frameworks and bars of superior precision than conventional casting techniques (30). Several studies reported with the advancement of dental materials and CAD/CAM software, the precision of bars is progressively improved (31, 32). Seven Rinke (33) presented a case report of CAD/CAM milled framework and abutments. He reported a very high precision framework that it fits intimately over the abutment with no need for cement for retention.

In this study there was a significant difference in the retentive forces between the Co.Cr CAD/CAM fabricated bar versus that fabricated conventionally. The CAD/CAM bar showed 29.77N higher force than the conventional bar. This significant difference can be attributed to the higher precision of the CAD/CAM bar. This higher precision allowed the female clip to fit more intimately onto the bar

and therefore needed a higher pull force to be separated. This claim is consistent with the experiment published by Sven Rinke et al (33) that claimed precision of CAD/CAM fabricated framework is very accurate and precise that it fits intimately onto its corresponding abutment with very high precision (25-27).

CONCLUSION

Retention provided by CAD/CAM fabricated bars was almost double conventional casted bars. This increase in force is due to better precision of the milled bars over casting. This increased retention will prove beneficial for the overdenture patients.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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