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RESEARCH ARTICLE

AMOUNT OF BONE LOSS AND DIGITAL OCCLUSAL ANALYSIS OF DIFFERENT ATTACHMENT DESIGNS IN BILATERAL DISTAL EXTENSION PARTIAL DENTURE CASES

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Abstract

Background: OT unilateral extra-coronal attachment considered as one of the best choices for distal extension partially edentulous cases.

Aim: Comparing OT unilateral extra-coronal attachment with modified OT unilateral extra-coronal attachment RPDs with bracing arm regarding amount of bone loss and occlusal load (using T-scan system).

Methods: Ten patients have missing bilateral mandibular molars teeth were treated according to split-mouth design using protocol A (OT unilateral extra-coronal attachment) and protocol B (modified OT unilateral extra-coronal attachment with a bracing arm). Amount of bone loss was evaluated radiographically at time of denture insertion, 3 months, 6 months, 9 months, 12 months and 18 months after denture delivery to measure the bone height changes. Also, occlusal load was evaluated using T-scanner (Digital occlusal analysis).

Results: Regarding bone loss: Protocol B was significantly lower than protocol A after 6 and 12 months, while in occlusal load analysis Protocol B was insignificantly lower than protocol A.

Conclusion: Less vertical bone height resorption and less occlusal forces in bracing side (OT unilateral extra-coronal attachment RPDs with a bracing arm) when compared with the non-bracing side.

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Introduction:-

The best treatment choice of patients with missing teeth (partially edentulous cases) is removable partial denture therapy (RPD) which is acceptable and economical modality treatment. Removable partial dentures (RPD) have an important role in the health of periodontium. Preservation of the remaining tissues is considered the main objective of removable prosthodontics treatment. ⁽¹⁾

Distal extension partially edentulous cases considered as challenging situation. The use of dental implants considered as better choice than fixed partial dentures (FPDs), provided that prerequisites are fulfilled from the biomechanical point of view, in cases with remaining teeth are unable to withstand masticatory loadings ^(1,2,3).

Association between a fixed partial denture (FPD) and removable partial denture (RPD) by means of attachments becomes a successful substitute to a conventional clasp retained RPD. Especially when the use of dental implants and/or conventional FPDs is limited or not indicated, due to inadequate amount of bone and financial reasons, the retention combination of fixed partial denture (FPDs) and removable partial dentures (RPDs) is achieved through

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clasps, adhesive, intra- or extra-coronal attachments, telescopes, root caps, and/or prefabricated interradicular retainers^(4,8).

Various types of extra-coronal attachments are commonly used in combinations of FPDs and RPDs to achieve retention and stability. Attachment retained RPD considered as successful approach that can facilitate both esthetic and a functional replacement of missing teeth and oral structures. Extra-coronal attachments were also successfully used in unilateral distal extension base cases since they provide good esthetics, retention, and favorable distribution of stresses to the abutment teeth. They are also well tolerated by the patient and they are easy to maintain and clean.^(5,6,7)

The extra-coronal OT attachment is attachment with vertical insertion that provide resiliency and retention of different degrees according to the color-coded nylon caps as yellow Caps provide extra soft retention, while pink caps provide soft retention and white caps provide standard retention. The male part is a metal sphere casted with abutment crown and attached to it through a parallel (vertical), the female part is a nylon cap seated firmly in a metal housing incorporated within the partial denture framework. The OT strategy attachment can be used in combined prosthesis, frames. The OT strategy is recommended in cases of unilateral edentulous or bilateral edentulous cases with the added advantage of personalized control of stability and resilience. However, the reduced dimensions of these attachments permit them to be applied in very small areas making them perfect for many cases in removable prostheses.^(9,10)

Several investigators reported that the main disadvantage of removable partial dentures is the risk of local damage to the remaining teeth and their supporting tissues; this occurs mainly as a result of increased plaque accumulation, caries, periodontal disease, resorption of residual ridge supporting the partial denture and improper distribution of occlusal forces.^(11,12,15)

Analyzing occlusal forces using T-Scan System is considered as one of the most recent digital methods using a pressure-mapping sensor intraorally. The system consists of several components; include a sensor and support, the system unit, a handle assembly, computer software and a printer. The sensor is the key component. The T-Scan allows the quantification of occlusal contact data by registering parameters such as bite length as well as the timing and force of tooth contact, and stores the data on a hard drive which can be played incrementally for data analysis in a time-based video.^(13,14)

Aim:

This study was conducted to evaluate two different designs of extra-coronal attachment in removable partial dentures regarding preservation of supporting structure health and occlusal forces distribution.

Methodology:-

Ten partially edentulous patients, in an age ranged 30-45 years old, were selected from the Out Patient Clinic, Prosthodontic Department, Faculty of Dental Medicine, Misr University for Science and Technology, All patients had Kennedy class I partially edentulous mandibular arch with the second premolar being free end abutment that shows sufficient occluso-gingival height of its clinical crown.

The opposing dentition was intact arch with no noticeable over eruption or tilting or restored with acceptable fixed restoration, Edentulous ridge covered by healthy firm mucoperiosteum, without abnormal bony irregularity or severe lingual undercuts, The abutment teeth had apparently good periodontal condition with no signs of mobility or inflammation with firm and healthy marginal gingiva, All patients had skeletal Angle's class I maxillo-mandibular relationship, Adequate inter-arch space and no temporo-mandibular joint disorders. All selected patients were non-smokers. All patients were apparently in good general health, and free from systemic or debilitating diseases that might affect the bone health. Very old or uncooperative patients were excluded from the study. Only patients who can be easily motivated to achieve and maintain good oral hygiene were selected.

A complete past and present medical history were recorded in the patient's chart. Special attention should be paid, the systemic diseases that might affect the bone reaction e.g.: uncontrolled diabetes mellitus, hyperparathyroidism and anemia, the mucous membrane of the cheeks, lips, ridges, and tongue was inspected to be free from any signs of inflammation. The soft tissue covering the ridges was inspected by firm pressure using the index fingertip. The abutments mobility was tested by subjecting the tooth to bucco-lingual movements between the handles of two

mirrors. Amount of attached gingiva around abutment teeth and degree of gingival recession were also inspected; all the selected cases had a zone of attached gingiva of at least 2mm.

A preoperative panoramic radiograph was made for each patient to detect any pathologic condition, and to determine crown: root ratio, the status of the periodontal ligament space and the amount of bony support around the abutments, also the quality of the residual ridge at the distal extension area.

Maxillary and mandibular alginate impressions were made for all the patients in a suitable stock tray and poured into dental stone to obtain the diagnostic casts. Diagnostic jaw relation was recorded using inter-occlusal wax record method. The casts were then mounted. The mounted case was examined for occlusion, inter- occlusal distance and condition of the remaining teeth regarding degree of super-eruption, intrusion, tilting and attrition.

The proposed abutments (first and second premolars) were prepared on the stone cast and waxed up. The attachment patrx was then joined to the wax pattern and aligned as to be parallel to the underlying ridge and above it by 1mm. The nylon cap was snapped onto the patrx, then a complete diagnostic set-up of the crowns & the attachment system was carried-out to verify the occluso-gingival height of the abutments and inter- arch space to accommodate attachment and superstructure without interfering with normal occlusion.

Ten patients have missing bilateral mandibular molars teeth were treated according to split-mouth design using protocol A (OT unilateral extracoronar attachment) and protocol B (modified OT unilateral extracoronar attachment with a bracing arm).

Preprosthetic procedures were performed for each patient:

All necessary periodontal procedures through supra and sub-gingival scaling and root planning were carried-out, followed by polishing of the remaining teeth, All conservative procedures were performed for all patients as the following: Simple carious teeth were restored with proper filling ,Root canal treatment was carried-out if needed, Any missing teeth were restored by a fixed- bridge. And finally, the Patients were instructed to follow a strict oral hygiene regimen.

Preparation of the abutment teeth:

Primary impressions were made using alginate impression material in a suitable stock tray and poured in dental stone to obtain the primary casts on which individual trays were constructed on a 2mm spacer. The lower first and second premolars on each side were prepared with a deep chamfer finishing line extend sub-gingivally (0.5-1mm) with sufficient occlusal (2-2.5mm) and circumferential reduction (1-1.5mm) to receive two full porcelain veneered crowns. Gingival margin of the prepared abutments was retracted by retraction cord before impression making. Finally, putty impression was made. The light body rubber base impression material was mixed and applied over the putty impression and then reinserted in patient's mouth until setting, The prepared abutments were protected by readymade temporary crowns which were cemented using temporary cement .The impression was then washed, inspection and poured in extra-hard dental stone. The obtained cast was sawed to obtain separate removable dies for the prepared abutments (first and second premolar). The dies were indicated by ditching and the wax patterns of both crowns were built-up. The dies were replaced on the cast which was placed on the table of the milling machine.

Prosthesis design:

The OT Unilateral attachment Kit consists of five components: OT unilateral castable bar attachment, 2 Positioning ring (maintain the space for the nylon cap during construction of the partial denture metal framework - assures stability for the female cap), 2 retentive (nylon) caps with 12 month duration time in the mouth that fit onto their spheres respectively and located in metal housing at the fitting surface of the denture, reinforcing retentive extension (castable saddle) to provide rigidity for the partial denture framework, and castable Uni-box which was casted into metal along with the partial denture framework to house the nylon caps.

All patients received two attachments first one followed protocol A (OT unilateral extra-coronar attachment) and another one for other side followed protocol B (modified OT unilateral extra-coronar attachment with a bracing arm)as presented in figure (1)



Figure (1):- A: Intraoral view of attachment assembly inside patient's mouth.
B: Extra oral view of attachment assembly.

Patient instructions: All patients were recalled 24 hours after delivery and one week later, to eliminate any patient's complaints that might arise during the initial period of prosthesis adaptation. At time of denture insertion, patients were motivated to follow proper oral and denture hygiene program.

Patient Evaluation:

All patients were evaluated clinically and radiographically. This was done at time of denture insertion, six months, and twelve months after denture delivery.

Bone loss:

Patients were evaluated measure the bone height changes. Dürr Dental computerized system was used. It consists of intraoral image plates which is flexible and thin for simple positioning, Conventional holder systems, Cable-free system, Broad exposure range, wide grey scale range. The Image Plate and Film Holder System Set Color instrument sets together with a long cone (rectangular or round type) constitute the implementation of the Right angle- / Paralleling Technique in x-ray diagnosis. Thus, allowing that the x-ray beam is directed perpendicular to the recording image plate which has been positioned parallel to the long axis of the tooth. Individually constructed radiographic acrylic templates were used for making standardized and reproducible serial digital images for the abutment. The template was designed to receive the Dürr Dental periapical film holder in a position just lingual and parallel to their long axes using the long cone parallel technique.

Digital occlusal analysis:

The method considered for the digital occlusal analysis is T-scanner (Tekscan system) which is a computerized system. The system is composed of a computer with a specific board and software capable of converting information recorded by the sensor to visual and numerical information on tooth contact. For T-scan system to function properly, computer system must meet or exceed specified system requirements.

The T-scan USB handle does not require an additional interface card or parallel box in order to be connected to computer. When inserted into computer, the computer's operating system will automatically detect and configure the hardware for use. The T-Scan sensor was an ultra-thin (.004", 0.1 mm), flexible printed circuit that detected the patient's occlusal parameters as presented in figure (2).

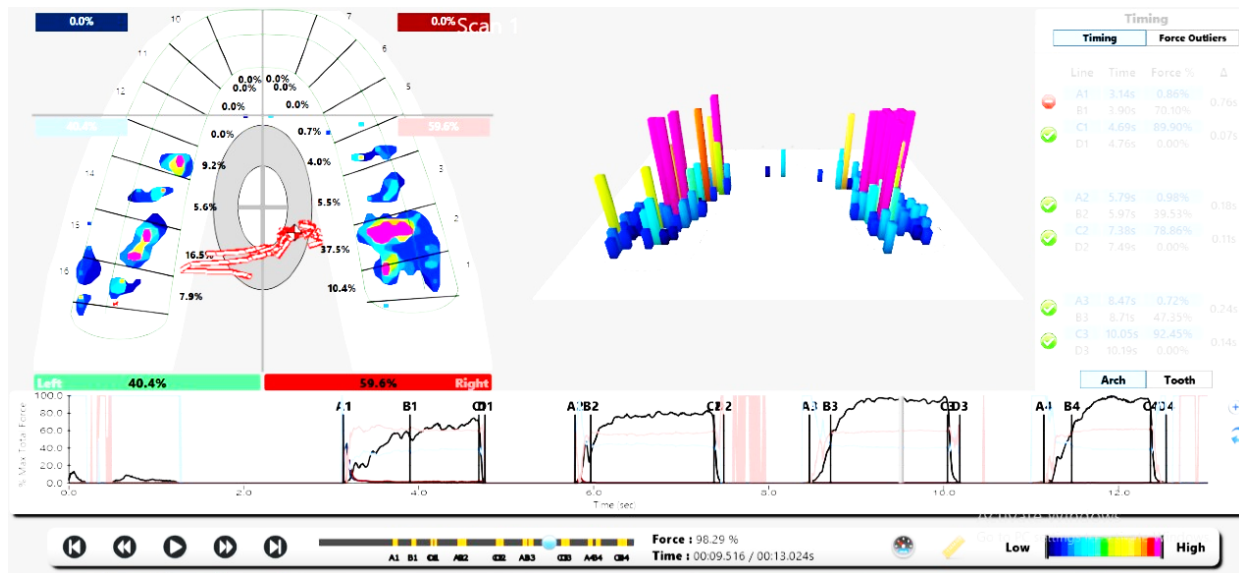


Figure (2):- Occlusal analysis records (Tekscan records).

Results:-

Amount of bone loss in non-bracing side was 0.6 ± 0.17 , 1.51 ± 0.31 and 1.74 ± 0.43 after 1,6 and 12 months respectively, while in bracing side it was 0.48 ± 0.19 , 0.61 ± 0.22 and 0.85 ± 0.31 after 1,6 and 12 months respectively. Comparison was performed between both side by using Independent t-test which revealed significant difference ($P < 0.05$) after 6 and 12 months. On the other hand , comparison between amount of bone loss within each group after 1, 6 and 12 months was performed using repetitive One Way ANOVA which revealed significant difference in means with different superscript letters as $P < 0.05$ (after 1 mon/6 months in non-bracing side, 1 mon/12 months in non-bracing side, 1mon/12 months in bracing side), as presented in table (1) and figure (2).

T-scan analysis of occlusal load forces revealed 28%, 19% and 18% in anterior segment, in left posterior segment (Bracing side) it was 23%, 24% and 25%, while in right posterior segment (Non-bracing side) it was 24.2%, 56% and 56.9% after 1 month, 6 months and 12 months respectively as presented in table (2) and figure (3). Comparison between different segments in different follow up periods was Performed using Chi square which revealed insignificant difference ($P < 0.05$). Moreover, comparison was performed between different follow up periods using Chi square which revealed insignificant difference ($P < 0.5$) at all segments as presented in table (2)

Table (1):- Mean and standard deviation of bone loss in both groups after 3months, 9 months and 18 months:

	Protocol A (Non bracing side) M ± SD	Protocol B (Bracing side) M ± SD	P value
1 months	$0.61^a \pm 0.17$	$0.48^a \pm 0.19$	0.12
6 months	$1.51^b \pm 0.31$	$0.61^{ab} \pm 0.22$	0.001*
12 months	$1.74^b \pm 0.43$	$0.85^b \pm 0.31$	0.001*
P value	0.001*	0.013*	

M; mean SD; standard deviation *significantly different means.
Means with the same superscript letters are insignificantly different.
Means with the different superscript letters are significantly different.

Table (2):- Percentages of occlusal load in anterior segment left posterior segment (Bracing group) and right posterior segment (non-bracing group):

	1 months	6 months	12 months	P value

Anterior segment	28%	19%	18%	> 0.05
Right posterior segment (Protocol A: non-bracing)	24.2%	56%	56.9%	> 0.05
Left posterior segment (Protocol B: Bracing)	23%	24%	25%	> 0.05
Total occlusal load	75.2%	99%	99.9%	> 0.05
P value	> 0.05	> 0.05	> 0.05	

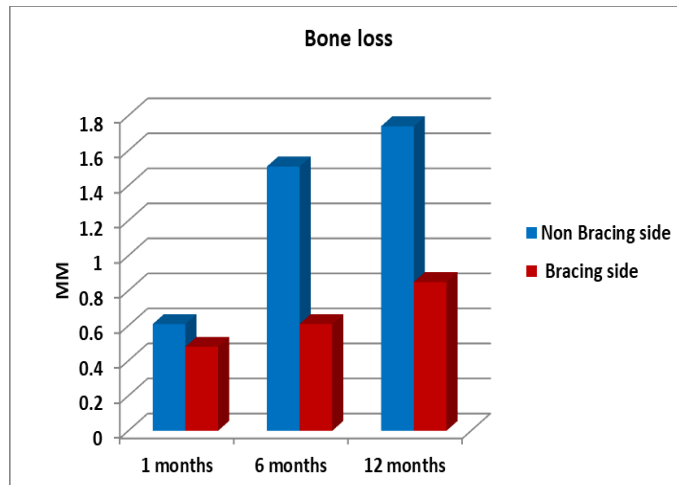


Figure 1: Bone loss after 1., 6 and 12 months and 12 months

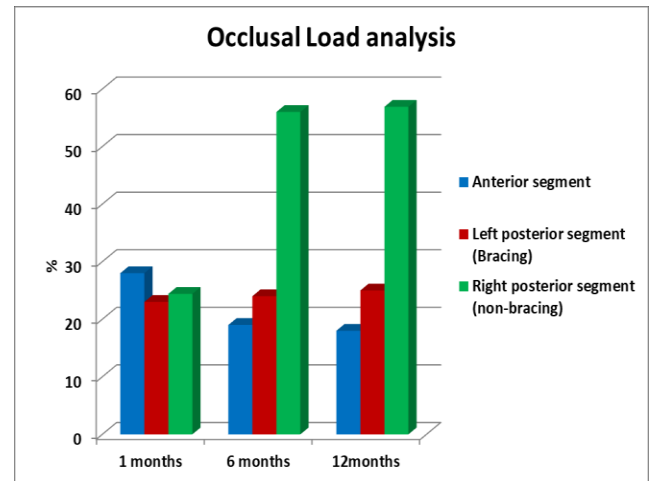


Figure 2: Occlusal load analysis after 1, 6 and 12 months

Discussion:-

This study was carried out on ten partially edentulous patients with age ranged from 30-45 years. This to avoid the effect of changes in the female hormonal conditions on the oral mucosa and bone. It was reported that estrogen withdrawal in post-menopausal women is associated with progressive decrease in the alveolar crest height and alveolar bone density^(12,13,14). Patients selected in this study had bilateral mandibular distal extension edentulous area (Kennedy class I) with the second premolar was the last standing abutment. This category represents the most frequently partially edentulous cases.

In this study split-mouth research design was used. It was concluded that split-mouth clinical trials may provide an efficient research tool for research work, provided that proper selection criteria are utilized. Split mouth designs guard against variables^(19,20). Randomized control trials provide strong hierarchy in evidence base research split mouth design eliminate many errors encountered in vivo study. The difference in bone quality and quantity, occlusal loads, preferable side chewing, soft tissue and oral hygiene measures are applicable to both sides of the mouth.

The selected patients were free from any systemic diseases that may affect the results of the study as indicated by medical questionnaire fulfilled by the patient. Also, very old patients were excluded as there is a great relation between alveolar bone loss and advanced age, as well as, between alveolar bone loss and various endocrine and metabolic diseases, e.g. Diabetes and hyperparathyroidism. Also, neuromuscular control greatly affected by age.^(10,17)

Patients with abnormal ridge relation, abnormal habits and TMJ disorders were excluded, to avoid the abnormal masticatory forces that may lead to excessive ridge resorption and inaccurate occlusal load analysis.⁽¹⁰⁾

To eliminate any possible local factor that might affect the results of this study, patients with jaw relation other than Angle class I, temporomandibular joint disorders, and parafunctional habits as clenching, bruxism or deep overbite were not included in this study. Occlusal status of the remaining dentition as dental abrasion, attrition and wear

facets were used as diagnostic aid for presence of parafunctional habits. ⁽¹¹⁾One of the most important factors that influence the degree of forces transmitted to the lower arch is the opposing arch type, the opposing arch was either dentulous or partially edentulous that was restored with a fixed restoration, to regulate the amount of occlusal forces transmitted to the lower arch. In treatment of posterior mandibular edentulous area, extrusion of the opposing teeth and tilting of teeth was 99 corrected, to establish a reasonable occlusal plane and develop harmonious occlusion both in centric and eccentric jaw positions. This is also important to control lateral stresses transmitted to the remaining teeth. This was guided by the mounted diagnostic casts. ⁽¹¹⁾With the introduction of unilateral attachment, it was possible to restore distal extension areas without the need of cross arch extension **Sravanthi**⁽¹⁵⁾ stated that the support of RPD and its connection with fixed prosthesis creates cross arch stability through masticatory activity and permits function similar to that of fixed prosthesis. Use of stress attachment system minimizes the metal display which improves esthetics. Optimal positioning of the attachment should be in harmony with the path of insertion of the planned prosthesis for a successful clinical outcome. Moreover, Extra coronal castable attachments have elastic retention, due to it is elasticity the flexure and construct a resilient and shock absorbing prosthesis can be controlled^(16,19)

Computerized image Plate and Film Holder System provided standardized reproducible images without any geometric variation, as it allowed for a fixed target to film distance. Moreover, there is no magnification of the image with this system. ^(18,19) The computerized system avoided the drawbacks of the conventional radiographic techniques. Also offered the advantage of instant image display and lower radiation dose. It is considered an accurate and reliable method for evaluating bone density changes if compared to other methods ^(24, 25). Radiographic evaluation showed that the bracing side causes less bone resorption than non-bracing side. This could be attributed to the effect of bracing arm in sharing some of loads transmitted to the supporting structures. This is with the agreement with the previous studies which stated that the crown ledge or shoulder provides effective stabilization and reciprocation also acts as an auxiliary indirect retainer. Regarding T-scan occlusal load analysis revealed higher percentages of load in non-bracing side which may be attributed to bracing effect of bracing arm in bracing side. ^(20, 22, 24) To avoid the quick loss of the performances of the OT unilateral, replacement of the retentive caps once a year is suggested by the manufacture to avoid loss of retention which allows the lateral movement of the prosthesis and exerts extra forces on the abutments ^(10,21,23).

Conclusion:-

Regarding bone loss: Protocol B (modified unilateral OT attachment retained distal extension partial dentures with a bracing arm) showed less bone resorption than protocol A (unilateral OT attachment retained distal extension partial dentures).

Regarding digital occlusal load analysis (T scan) Protocol B (modified unilateral OT attachment retained distal extension partial dentures with a bracing arm) showed less occlusal forces than protocol A (unilateral OT attachment retained distal extension partial dentures).revealed lesser occlusal forces in bracing side than non-bracing side.

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