EGYPTIAN DENTAL JOURNAL
www.eda-egypt.org
VOL. 68, 579:587, JANUARY, 2022
PRINT ISSN 0070-9484 • ONLINE ISSN 2090-2360
FIXED PROSTHODONTICS AND DENTAL MATERIALS
Submit Date : 22-08-2021 • Accept Date : 07-10-2021 • Available online: 30-01-2022 • DOI : 10.21608/edj.2021.90416.1764

BITING FORCE OF PATIENTS REHABILITATED WITH PRECISION ATTACHMENTS UNILATERAL REMOVABLE PARTIAL DENTURE

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ABSTRACT

Statement of the problem: Analyzing occlusal force help understanding the efficiency of prosthesis. **Purpose:** This study was designed to analyze the postrehabilitation occlusal function of subjects treated with Precision Attachments Unilateral Removable Partial Denture PURPD, utilizing bite force sensor (the Tscan system).

Materials and Methods: Ten patients who have unilateral missing teeth (Kennedy class II) who received PURPD prostheses to reconstruct occlusal function were analyzed. The Tscan III system was used to measure maximum occlusal force between PURPD side and the dentate side.

Results: Subjects with precision attachment unilateral partial dentures demonstrated decreased significant occlusal force.

Conclusion: Precision Attachment Unilateral Removable Partial Denture PURPD prosthesis induced less occlusal force compared to dentate side.

Clinical Implications: PURPD can be used in treatment of unilateral missing teeth when bridgework and/or implant supported prosthesis are contraindicated. This prosthesis provides the patients with function and esthetics without the need for cross-arch extension. It showed less occlusal force when compared with the dentate side of the patients. PURPD seems to be an efficient prosthetic therapy in the treatment of many challenging situations.

KEYWORDS: Precision attachment unilateral partial denture, T-Scan, occlusal analysis.

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INTRODUCTION

Restoring large number of missing teeth is carried out through Removable Partial Denture RPD therapy. RPDs can restore function and esthetics with acceptable results. Conventional RPD design is usually bilateral and utilizes a major connector that extends cross arch to connect both sides of the edentulous ridges. Sometimes these extensive appliances are intolerable for the patients. For these patients, bridgework may not be a viable option and it is not always possible to provide implant-retained restorations for anatomic and economic reasons.

Restoring unilateral; missing teeth was always a challenge to Prosthodontists. Precision attachment partial dentures provide solution for these problematic situations and provide patients with esthetic and functional replacement of partial missing teeth and oral structures. Precision retained partial dentures are mostly indicated in long edentulous spans, distal extension bases and non-parallel abutments [1, 2].

In Precision Attachments Unilateral Removable Partial Denture PURPD, the rigid precision attachment (OT CAP Unilateral Attachment (Rhein83 Inc. Bologna, Italy) is composed of two cast preformed plastic patterns. The first is the matrix (male part), which composed of two spheres that is cast to the wax pattern of the prepared abutments. The second part is the patrix (female part), which is cast to the RPD framework. These attachments eliminate the need for damaging clasp arm [3].

These precision attachments are designed to increase shear force strength, prevents rotation of female cap and increased lateral stability. It also eliminates the need for extending the RPD design to the other side of the ridge.

Further from improving esthetics and retention of removable partial dentures, the recent developments of precision attachment has made designing of precision attachment removable partial dentures more versatile. Proper selection of precision attachment is very important in the prognosis and management of challenging situations. Their applications avoid unnecessary surgery and cutting sound teeth.

However, precision attachments are not without disadvantages. Most of the attachments are very small and come with many parts to assemble. Construction of such attachment requires skillful dental technicians who need special training. In addition, wear and tear of attachment rings may need replacement over time [4].

The conventional non-digital occlusal indicators commonly used by dentists for occlusal adjustments are articulation papers, shimstock foils, impression waxes and patient's subjective "feel" feedback. The reliability of these static materials is questionable as none of these methods used in clinical practice have the ability to detect the force of contact, sequence of closure or applied occlusal load when the patient bites on strips of articulation paper or shimstock foils. Studies show these markings do not quantify the occlusal force and time or assess the contact sequence, and that the ink substrate left on the teeth is not an accurate indicator with which to judge a tooth contacts relative occlusal force levels [5].

Subjective interpretation of the applied occlusal load based upon the surface appearance characteristics of these traditional occlusal indicators has no capacity to quantify relative occlusal force levels required to render objective occlusal adjustments [5].

There are several methods available to evaluate occlusal forces clinically; however, most of these methods lack evidence-based support to verify quantitative data assessment. The commonly used quantitative occlusal approaches include a computer-aided video system, a photo-occlusion method, and the T-scan system [6]. The T-scan system composed of a 0.1-mm-thick sensor made with a flexible material that can prevent errors of mandibular deviation caused by excessively thick or hard sensors when occluding. The parameters obtained from the T-scan III system, including introduction time, occlusal center, determine of occlusal center, and percentage of occlusal force distribution, can provide a

reference for analyzing instant occlusal conditions. These parameters can also form a time track distribution of the points of maximum occlusion and occlusal force through contact of the teeth with the sensor. This information is beneficial for quantitative research in occlusal equilibrium. The T-scan III system sensor is composed of two high tear and strain resistance polyester films as substrate. Its inner layer is composed of 1500 sensor point,

T-scan III system can bear occlusal force and change form during occlusal movement. The sensor is approximately 60 μm thick, which does not prevent the subjects when performing different types of occlusal excursions. The sensor can read local electronic resistance due to occlusal forces. The system measures the changes in current loops. After collecting the data, corresponding software can conduct quantitative analysis of the changes in occlusal contact points, force overtime, and then compute a distribution of the occlusal forces. Accuracy and repeatability of T-Scan III system has improved over the previous systems. The system can analyze the percentage of force distribution of one tooth, the anterior and posterior occlusal forces, and the left and right occlusal forces. Regarding occlusal center, the system can record the track of occlusal center from the initial contact position to the final position [7]. This study aimed to evaluate occlusal forces in patients using PURPD.

MATERIALS AND METHOD

Ten male patients (age range from 48 to 65 years with mean age 53.8) who have unilateral missing teeth (Kennedy Class II) were selected from the prosthetic clinic, Future University in Egypt. The patients received Precision Attachments Unilateral Removable Partial Denture PURPD.

They all possessed Kennedy class II edentulous ridges, with premolars or canines as last standing abutments. The opposing arch was either fully dentate or restored with fixed restorations. One patient received two PURPD in the same side (left), one in the maxilla and one in the mandible. Another patient received two PURPD in the same arch (right and left). All patients had good oral hygiene, enough abutment height and sufficient inter-arch space in the edentulous areas. Exclusion criteria included patients with gingival or periodontal disease, diabetic patients, smokers, and patients with signs of occlusal trauma. Each patient received on the edentulous side, two splinted fixed porcelain-fused to metal restorations with a unilateral extra-coronal attachment (Rhein83 Inc. Bologna, Italy), and a unilateral partial denture, not crossing to the other intact side.

Fabrication of the framework

The Unilateral cast attachment from Rhein83 is specifically intended for unilateral, bilateral or implant bar applications without additional support from milled bracing arms. OT Unilateral design features a two-in-one combination of 1.8 mm horizontal and vertical spheres utilizing OT Cap and OT Strategy micro size female caps. The male section of the attachment is engineered with a vertical strut which extends through the base of the attachment giving lateral stability and distal support to the prosthesis. The Uni-Box female component is a one-piece cast housing that covers the entire male section, adding superior strength to the acrylic. Male and female components are invested and cast in a single ring, saving time and material costs.

The lab procedures start with position and connect OT Unilateral attachment using the OT Cap paralleling mandrel after accurate consideration of occlusal plane. Placing Uni-Box cast over vertical spheres that were attached to the wax-up crowns, the positioning ring assures stability. The cast connector is joined to the Uni-Box with resin to reinforce the structure. The positioning ring is then removed from OT Cap sphere and both structures are sprue. OT Unilateral and Uni-Box are invested in one-step in to the casting ring. Cast crowns and super-structure are carefully sandblast the casting to avoid erosion of spheres and bar's surfaces. Black processing caps are inserted. Cast crowns and

super-structure are tried-in the patient mouth. The wax-up of the saddle resin plate was made to adhere as much as possible to gingival tissue in order to deliver good stability. Completed prosthesis is made in a conventional manner. The steps of partial denture construction were continued, including metal try-in, jaw relations and final insertion, with final retentive caps and inserted into the frame. The cast crowns with the OT Cap sphere were cemented to the prepared abutments. Fig.1-4

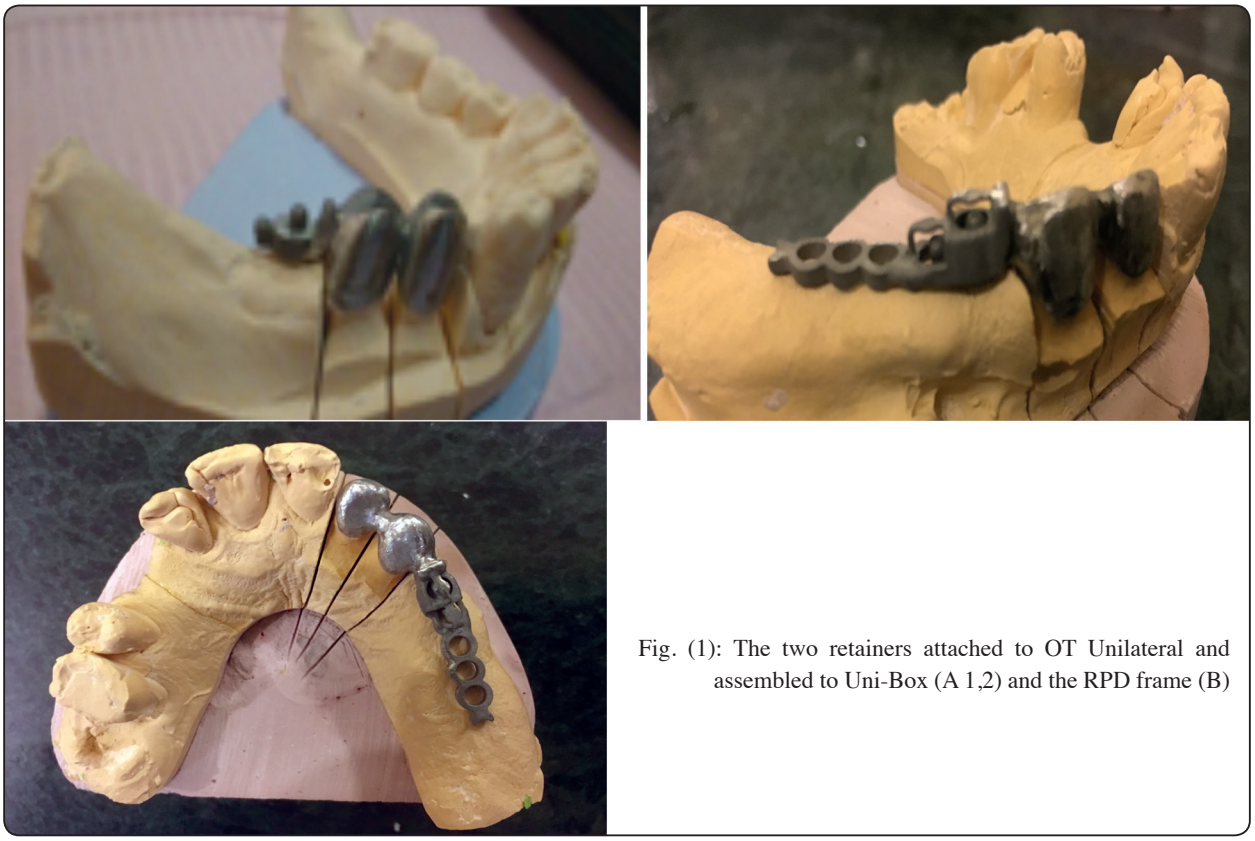

Fig. (1): The two retainers attached to OT Unilateral and assembled to Uni-Box (A 1,2) and the RPD frame (B)

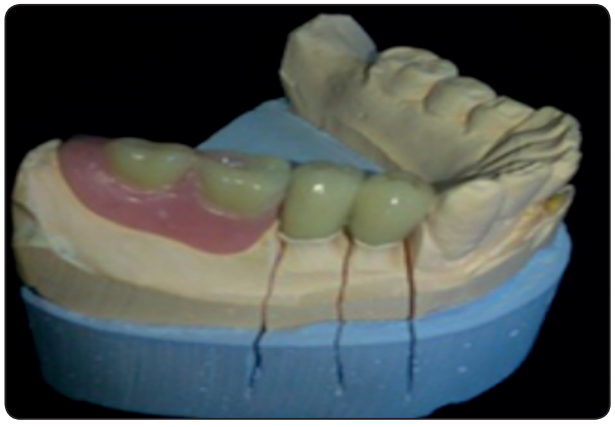

Fig. (2) Top view of the two retainers attached to OT Unilateral and assembled to Uni-Box and the RPD frame

Fig. (3): The final prosthesis in the patient mouth.

Occlusal analysis:

Occlusal analysis was recorded, using the T-scan system (TekScan, Inc., Boston, MA, USA), which consists of a sensor, and scanning handle (hand piece) that conveys the information collected to the computer, with its software. Each patient was seated in the same position during scanning and data collection. Prior to data collection, the patients were taught to position their mandible from rest position to Maximum Intercuspation (MI). After several trials and training, the sensor was placed close to the maxillary occlusal plane, and the patients were instructed to close in MI, and then open in resting position, this procedure was repeated 3 times and the results were recorded. All patients were tested when wearing the unilateral partial denture and compared to the intact side, Figures (4, 5).

The recorded data included contact locations and relative occlusive forces. The IP model of the T-scan III system was selected to estimate asymmetrical locations of the occlusal centers, and the asymmetries of occlusal force Figure (5). The color-coding indicates the forces, as the warmer the color, the taller the column, the greater the force.

Collected data were tabulated and statistically analyzed to evaluate biting force using T-Scan system between natural teeth and PURPD in addition to their relation to patient's age. The results of this study are presented in Tables (I, II) and Figures (6).

Fig. (4): The T-Scan in the patient mouth

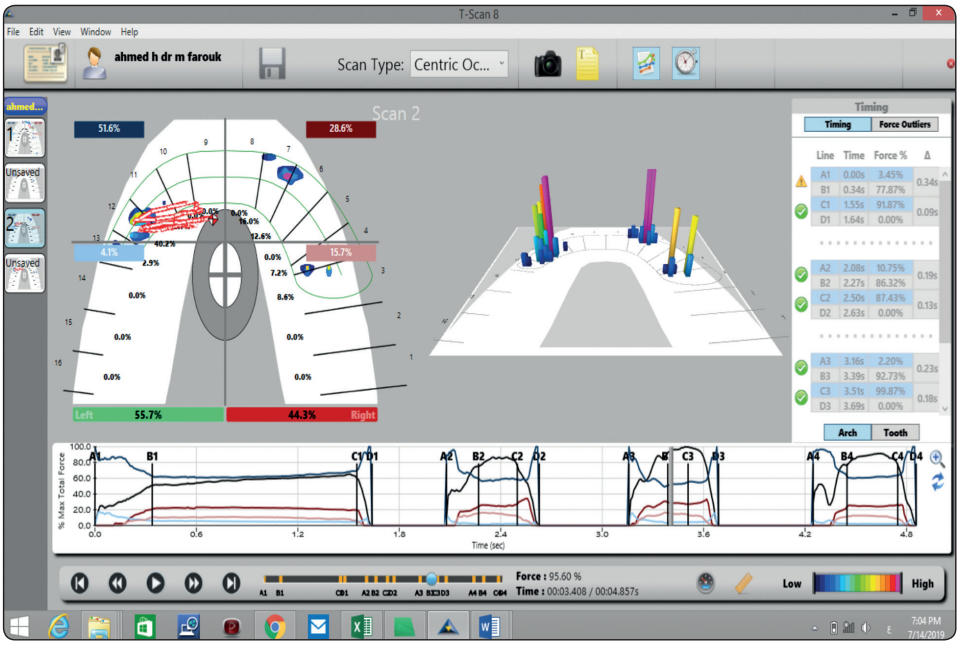

Fig. (5): T-Scan multi-bite screen capture showing 2D, 3D graph and zoom graph window.

Microsoft Excel ® 2016 and Statistical Package analyzed data for Social Science (SPSS) ® Ver. 22. A probability value of (P≤0.05) was considered statistically significant.

TABLE (I): Comparison of biting forces of PURPD and Dentate occlusion:

	PURPD Occlusion		Dentate Occlusion		P-value
	M	**S.D**	**M**	**S.D**	
Biting Force (T-Scan)	41.7 %	8.37	58.2%	8.36	**0.00****

M; Mean, SD; Standard Deviation, P; Probability Level
*****significant different***

TABLE (II): Correlation of biting forces of PURPD and Dentate occlusion ro age:

Age		Dentate Occlusion (T-Scan)		r	P-value
M	**S.D**	**M**	**S.D**		
53.8	5.007	58.28	8.36	**-0.188***	**0.603****

M; Mean, SD; Standard Deviation, r; Pearson`s Correlation Coefficient, P; Probability Level

****Weak Negative Correlation***

*****insignificant different***

Age		PURPD Occlusion (T-Scan)		r	P-value
M	S.D	M	S.D		
53.8	5.007	41.72	8.37	**0.188***	**0.603****

M; Mean, SD; Standard Deviation, r; Pearson`s Correlation Coefficient, P; Probability Level

****Weak Positive Correlation***

*****insignificant different***

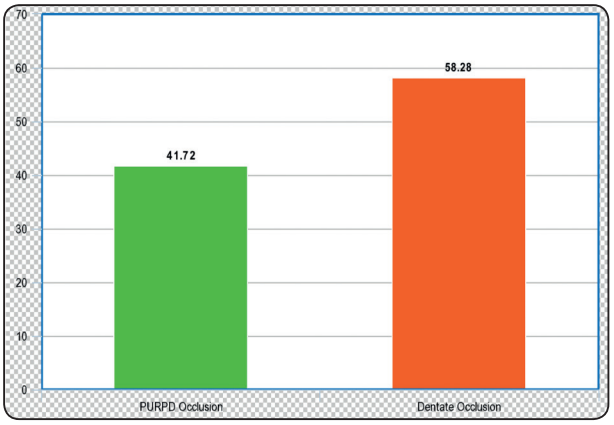

Fig. (6): Bar Chart revealing Comparison between PURPD and Dentate Occlusion regarding Biting Forces

RESULTS

The T-Scan III desktop screen illustrates the distribution of forces between left and right sides. Force in Figure (6).

By performing t-test between PURPD occlusion and dentate occlusion, it showed significant difference between both types of occlusion as P-value ≤ 0.05, listed in table (I).

Pearson's correlation test was performed to reveal the relation of both PURPD and dentate biting force occlusion to the age of the patients. There was insignificant negative week relation between PURPD biting force and age, while there was insignificant positive week relation between Dentate biting force and age, as listed in table (II).

The numerical values recorded in this study showed the pattern of occlusal forces distribution with this type of prosthesis. The results of this study showed also, that PURPD induced less force when compared with the dentate side of the same patient. Whenever the PURPD was opposed by natural teeth showed less force than natural versus natural.

DISCUSSION

Precision attachment unilateral partial dentures have many advantages where fixed restorations and/or implant prosthesis are contraindicated. It enhances cosmetic appearance, maintain periodontal health, increase longevity of abutment teeth and allow for patient comfort. It also, eliminates the need to cross arch extension of the prosthesis that has a major influence on patient acceptance. Precision attachment partial dentures allow compensation of any future changes that may occur in the mouth [8].

Many studies showed that PURPD kept their retention over some years and allowed better distribution of stresses [9, 10].

A precision attachment partial denture will not dislodge during normal function. The reason the partial denture does not dislodge out is that it has two surveyed paths of insertion so that the path of insertion is different from the path of pull of the muscles and the action of the tongue and gravity. Although the partial cannot be dislodged during function, it still can move slightly in a vertical direction to allow release the forces instead of transmitting these forces to the abutment teeth. The result is physiologic stimulation of the abutment teeth and the edentulous ridges. Clinical studies has shown that this physiologic stimulation results in increased longevity of the abutment teeth, even when a few teeth are required to carry the load of an entire arch. This stimulation of the edentulous ridge also prevents the bone resorption that typically reduces tissue support for the partial denture. The tissue under a well-fitting precision attachment partial is typically healthy and firm. The wear of attachments that are used in this manner, even after many years of function showed that the prosthesis may require relining or alteration of the occlusion to compensate for changes, it is rarely necessary to adjust or replace the male attachments on the partial. The partial is never kept in a glass of water overnight. It could be worn 24 hours a day to prevent collapse of the musculature and the occlusion and only removed for hygiene. The patients who received PURPD were accepting this type of prosthesis even after many years of usage and indicated that it enhanced their comfort and satisfaction [8, 11, 12].

Success of distal extension prosthesis depends on stress control on the abutment. This is could be achieved by conventional prosthetic procedures that include distribution of load by impression technique, broad coverage and stable denture base, rigid design, physiologic shimming, splinting of abutments and proper selection of attachments [13]. This was manifested in the results of this study as it showed that PURPD side induced less force compared to the fully dentate side.

With the improvement in the T-Scan system and proven reliability, it was possible to use it as clinical diagnostic device to analyze occlusal force. Over the past 25 years, T-Scan has emerged as a diagnostic tool that is capable of determination of correct occlusal pattern and led to high quality treatment results. The whole system has been improved and revised. These revisions included hardware, sensor and software to come up to the latest version of T-Scan III system. This new version is far improved over the earliest T-Scan I system. T-Scan quantifies the amount of relative occlusal force, which enables researches to predictably identify and to analyze the occlusal force pattern of the subjects instead of absolute numerical values of e occlusal force[14,15]. It was proved that the T-scan III system can be used as a measurement tool in clinical research. However, the occlusal force was affected by various factors such as age[16], sex [17], and facial structure [18]. Therefore, an objective reference cannot be achieved by analyzing the function of prosthetic rehabilitation through measuring the occlusal force. Sierpinska et al. in her studies[19, 20] explore the relationship of occlusal time and masticatory function, and report that when the upper and lower occluding posterior teeth were decreased, the duration of every chewing cycle was less and the subjects needed to increase total chewing time to compensate and maintain their occlusal function. PURPD showed minimal

bone resorption [22-, 23]. Studies showed also, that the preferred side of chewing has little influence in the induced forces [24].

Few limitations of the T-Scan were reported. These limitations includes thickness of the sensor (0.1 mm) which still relatively thicker as compared to other occlusal indicators. In addition, the sensor may be damaged when forces are concentrated over a small area such as, sharp tooth cusp. This may lead to incorrect recording of the occlusal contacts and/or artifacts in the produced images. The T-Scan system is able to duplicate occlusal interferences only exceeding 0.6 mm. However, these variances are small. The T-Scan is considered a valuable method for clinical evaluation and understanding of occlusal difficulties [25,-27].

CONCLUSION

The precision attachment unilateral removable partial denture PURPD has shown over many years that it is a viable solution for patients who have unilaterally missing teeth and are contra indicated for bridge work and / or implant therapy. It provided patients with functions and esthetic without the need for cross arch extension of the prosthesis. Using T-Scan III, it was possible to detect occlusal forces induced by PURPD. The results showed that PURPD induced less force that may contribute to the longevity of this type of prosthesis.

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