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Effect of Abutments Design on Wear of Locator Attachments in Implant Retained Mandibular Overdenture.

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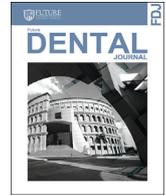
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Effect of Abutments Design on Wear of Locator Attachments in Implant Retained Mandibular Overdenture

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ABSTRACT

Objectives: The aim of this study is to compare the effect of abutments design on wear behavior of Locator attachments in implant-retained mandibular overdenture. **Materials and Methods:** Two epoxy models representing an edentulous mandible were used, two implants were placed in each model. Twenty-four locator attachments were used (twelve in each study group). Cycles of Insertion and removal were performed using a universal testing machine resembling 3 years of clinical use, then each abutment was scanned by scanning electron microscope (SEM) before and after insertion and removal cycles. Data were compared qualitatively using a specialized computer software. **Results:** There was a statistically significant difference in wear between the two studied locator groups $P=0000^*$. Locator F-TX showed $29 \pm 1.704\%$ of surface change. PEEKLOC. Locator showed $21 \pm 2.090\%$ of surface change. **Conclusions:** PEEKLoc. abutment design showed more wear resistance than the recently introduced Locator F-TX.

1. INTRODUCTION

The use of dental implants to retain and support the edentulous mandible for stabilizing complete dentures is a known successful documented treatment option.¹⁻³ The McGill consensus⁴ stated early that two implants mandibular overdenture should always be the first-choice standard of care for edentulous mandibular patients. There are several privileges recorded for this line of treatment. The superior chewing efficiency with better biting force and obvious patient satisfaction. Also, less bone resorption of the posterior residual mandibular ridge was reported by almost 1 mm within five years of use compared to conventional dentures^{5,6}

The solitary stud attachments are more broadly used and acceptable. Their simplicity, lower cost, ease of maintenance and adjustment requirements, reasonable space requests, and simpler oral hygiene measurements had made them the most commonly used type of attachment mechanism for implant overdentures.^{7,8} The Locator attachment (Zest Dental Solutions, Escondido, California, USA) was introduced in 2001 to overcome the limitations of the widely used ball attachments as larger inter arch space obligations and restricted application in non-parallel implants.⁹

The loss of retention is the most common and repeated reported prosthetic complication combined with a non-splinted overdenture attachment which leads to patients' dissatisfaction. One of the main criteria of success of an

implant-retained overdenture depends on the retentive force of the attachment system.¹⁰ Retentive force, unfortunately, diminishes due to repeated insertion and removal of the denture during function.¹¹ This action leads to abutment wear and clip deformation. The introduction of high-performance polymer attachments, as well as innovative abutment designs and geometries in conjunction with different wear-resistant coatings, were introduced to overcome the loss of retention complication.¹²

Recently, Locator F-Tx was introduced as an alternative treatment option for a fixed retrievable prosthesis in full arch cases. The proposed attachment could be easily placed and removed by the dentist with superior aesthetics, few clinical steps, and adequate patient satisfaction.¹³ The retentive component of locator F-TX is mainly composed of polyether ether ketone (PEEK) balls, with different retention values a low Blue retention ball (5 lbs of retention) a medium Tan retention ball (10 lbs), and a high Green retention ball (20 lbs).¹⁴

Lately, Humana dental implants and accessories^{*} has been introduced (PEEK Loc locator) to overcome the high frequency of nylon cap replacement in patients who are treated with implant retained overdenture. They claim that the use of PEEK caps offers higher retention and long-lasting performance when compared to conventionally used nylon caps.

* (Humana dental implants and accessories, Frankfurt, Germany)

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The present study aims to evaluate the degree of abutment wear of two different designs of locator attachment systems after simulated insertion and removal cycles. The null hypothesis is there is no difference in Locator abutment wear with a different design.

2. MATERIALS AND METHODS

Model preparation

Two identical epoxy models (Ramsis ®, Egypt) for a completely edentulous mandible with adequate ridge width and height were used. A Special tray was fabricated and a silicon secondary impression (Zhermack Oranwash L (140ML)) was made for the epoxy models. The impression was poured into a hard stone and the rest of the denture construction procedure was carried out according to standard protocols and both dentures were finished and polished.¹⁵

The constructed dentures were verified on both epoxy models assuring them to be properly seated. Alternative finger pressure was applied on both sides to ensure the absence of rocking and lack of resistance during the insertion and removal of the dentures.

Implant placement and grouping

The models were placed on a dental surveyor adjusted at zero tilt to insure complete implant parallelism. Then, tripodding was carried on both models and each tripod point was marked using a permanent marker pen. The two implants with regular platforms, 3.8mm in diameter and 10.5mm in length were inserted at a distance of 22mm (11m from the midline at each side). Sequential drilling was made and the drill holes were irrigated with tap water to remove any epoxy debris. Epoxy resin was mixed and loaded in a plastic syringe, and then the drilling holes were half-filled with the epoxy resin mix. Then, implants were inserted and tightened in their position using a torque wrench adjusted to 30Ncm. After a complete set of resin, the implants were loaded with locator abutments (each model has a different locator design) and tightened by a torque wrench at 15 Ncm as recommended by the manufacturer.

Grouping:

Group I: Locator F-TX (Zest Dental Solutions, Escondido, California, USA)

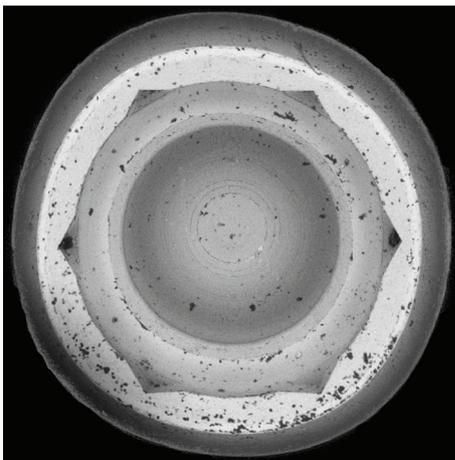


Figure (1) — Electron microscope scanning of Locator F-TX at T0

Group II: PEEKLoc. (Humana dental implants and accessories, Frankfurt, Germany)

Different PEEK retentive elements were placed on each corresponding locator abutments design and the attachments pickup procedure was carried out according to standard protocols.¹⁶

To ensure standardization, the denture geometric center was determined by measuring an equal distance from both anterior and posterior teeth and a hook was placed from which dentures were pulled during the cycles of insertions and removals.

Wear assessment:

Initially, brand new unused PEEK retentive inserts were scanned by scanning electron microscope (SEM). as seen in Figure 1,4 Then, models of both study groups were mounted on the universal testing machine. After that, 3000 cycles of insertion and removal were performed for each model and resembling 3 years of use.

Secondly, retentive elements of each group were scanned again by SEM as seen in Figures 2,5 and the scanned image was compared to the reference image scan at (T0).

Qualitative wear assessment was performed by evaluation of surface morphology of retentive elements and detecting of the surface changes at different time intervals during the wear process. the number of surface changes was measured by pixels subtraction from the superimposed photos by ImageDiff™ software (ImageDiff™,2015, USA). as seen in Figures 3,6.

Statistical methodology

Data were entered into a computer software (Statistical Package for Social Science) program for statistical analysis (ver 25). The variables were found to be normally distributed using the Kolmogorov-Smirnov test of normality, so the parametric statistics were adopted. Data were described using mean, and standard deviation. Comparisons were carried out between two studied independent normally distributed variables using an independent sample t-test. Based on previous studies that evaluated wear of overdenture resilient attachments, the minimum required sample size was found to be 8 inserts per group (number of groups=2) to detect an effect size (two tails) of 1.508 in the wear degree of PEEK.¹⁷ The sample size was calculated using GPower version 3.1.9.2.

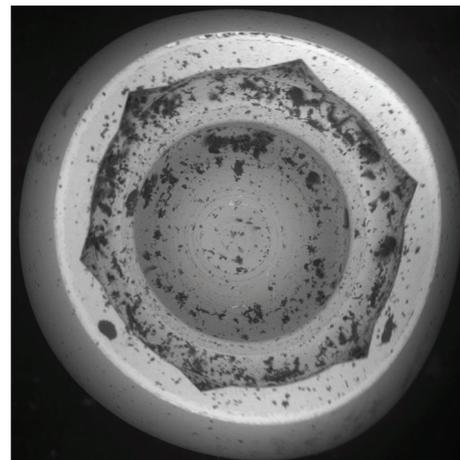


Figure (2) — Electron microscope scanning of Locator F-TX at T3 resembling 3 years of simulated insertion and removal cycles.

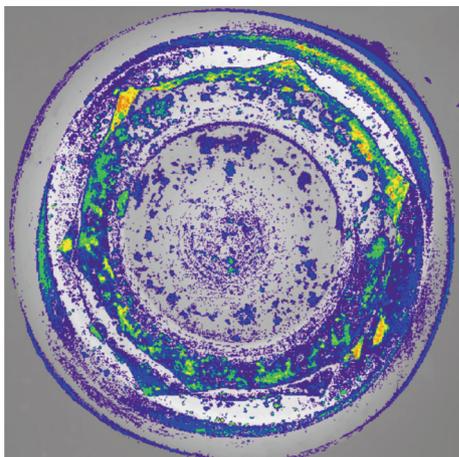


Figure (3) — Pixels comparison between T0 and T3 of Locator F-TX.

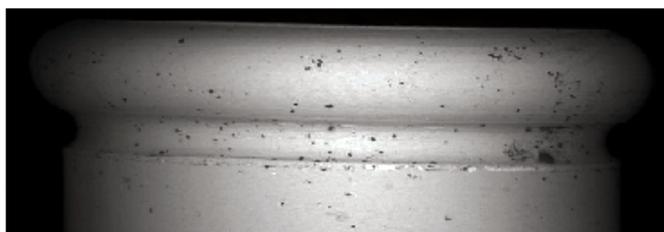


Figure (4) — Electron microscope scanning of PEEK Loc. at T0

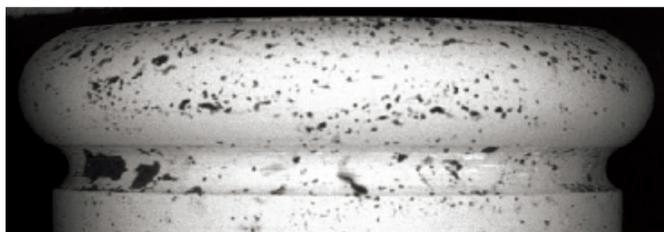


Figure (5) — Electron microscope scanning of PEEK Loc. at T3 resembling 3 years of simulated insertion and removal cycles.

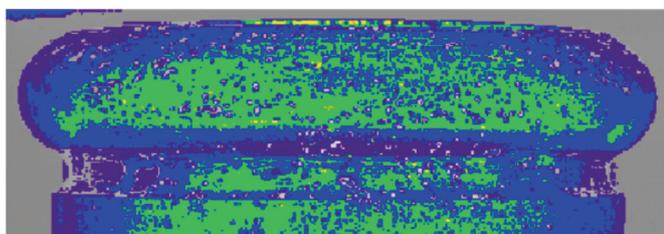


Figure (6) — Pixels comparison between T0 and T3 of PEEK Loc.

3. RESULTS

Table (1):

Independent sample t-test comparing percentage of change in surface between the two Locators groups

	PEEK Loc. (M±SD)	Locator F-TX (M±SD)	P-value
Percentage of wear % By change in pixels	21±2.090 %	29±1.704 %	0000*

PEEK Loc. group showed less percentage of surface wear compared to the Locator F-TX group.

*: Statistically significant ($p < 0.05$)

NS: Statistically not significant ($p \geq 0.05$)

Table (2):

Percentage of retention loss in (Newton) between the two studied groups at different time of measurement Primary retention vs one, two and three years of use.

	peek clip p value	nylon clip p value
T0-T1	0.000*	1.000 NS
T0-T2	0.000*	0.002*
T0-T3	0.000*	0.195 NS
T1-T2	1.000 NS	0.420 NS
T1-T3	0.000*	0.006*
T2-T3	0.001*	0.000*

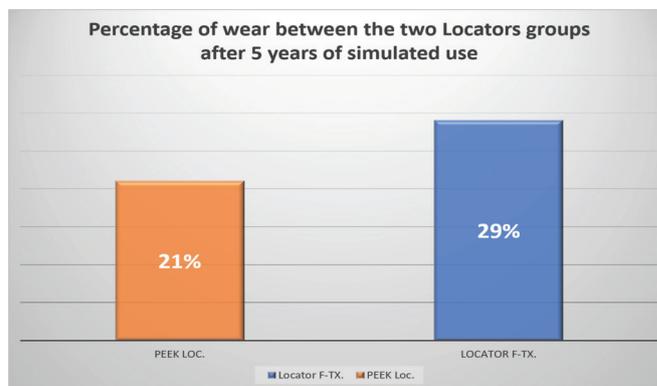


Figure (7) — Percentage of change in surface between the two Locators groups

4. DISCUSSION

The Locator F-TX attachment used in this study was tried as part of a removable prosthesis as it was reported by P. O. that the Locator F-Tx attachment system was a viable option for immediately loaded implant-supported prostheses, he also stated that it is an aesthetic solution, with no complications, and no fractures of the provisional or final restorations.¹⁴

Amato and Polara also reported that there is a similarity in steps used to fabricate a fixed, full-arch prosthesis with the Locator F-Tx Attachment system and implant overdenture supported by a traditional Locator Attachment.¹⁸

The manufacturing company proposes a special instrument for retrievability of the designed prosthesis and is qualified as a fixed, retrievable prosthesis because the retention force of the peek ball in the F-Tx system is high with an increased number of implants. The attachments can be picked up via a chairside procedure (similar to the Locator Attachment System).¹⁹

Abdelaziz et al reported that Locator F-TX offers high retention values ranging from 28 to 33 Newton which may be responsible for wear and surface alterations.^{14,20}

Locator f-Tx attachment has a round design which enables the system to be used with tilted implants .spherical abutment geometry allows the attachment to pivot in any direction up to 20° eliminating the need for angled abutments and aligning them to fit within the aesthetic outline of the prosthesis.²¹ The retentive (PEEK) balls of the Locator require replacement due to loss of retention; however, the changing process is simple.²²

It was reported by Behrens BA that a Scanning electron microscope was used for wear analysis and it is a successful wear measuring tool as it detects both the surface and dimensional changes.²³

The number of insertion and removal cycles was determined as it was reported by the literature that approximately 1,000 to 1,500 insertion and removal cycles (3 or 4 removals a day) represent the clinical use of one year.²⁴

It was reported that no parallel implant results in additional wear of the attachment and affects the longevity of the attachment system.²⁴ For this reason, The use of the dental surveyor for determining the implant position in the model is very important as Implant placement for non-splinted IOD attachments is recommended to be parallel to the direction of overdenture insertion and perpendicular to the occlusion plane.

ImageDiff software was used to standardize the method for comparing the surface change in the locator attachment as this software offers a color guide to enable the interpretation of results, as white areas indicate areas of similarity between reference and sample photos, purple, blue, green areas indicate the area of dissimilarity between reference and sample photos. these different colors representing different degrees of dissimilarities between the two compared photos. This method of comparison prevents the bias in comparing electron microscope data by the operator as all the results are digitalized by the software.

The most frequent complication encountered with the LOCATOR attachment was the loss of retention over time. Attachment wear is affected by the number and angulation of implants supporting the prosthesis. Therefore, a modification in the attachment design and the attachment surface treatment may help decrease the maintenance needs and further enhance its clinical performance.^{25,26}

The locator F-tx has shown a surface change of 29% compared to 21% in the PEEKLoc. Locator due to the fact that locator F-tx offers higher retention values which will affect the rate of surface wear as was reported by Rutkunas, V et al that the attachments insert providing relatively greater retention seem to have greater resistance to vertical forces during removal of the denture, leading to more wear and deformation of the attachments.²⁷

The accepted explanation for the Locator surface changes could be a thinning of the Locators' coating with the volumetric decrease due to continuous friction between the retentive insert and the metal abutment This is logical since the Locator retention mechanism depends mainly on the compressive forces between the retention inserts and the metal ring²⁸

5. CONCLUSIONS

Locator F-TX has more surface changes compared to PEEKLoc. after stimulated use due to its high retention values which make it unsuitable as a removable overdenture attachment.

6. RECOMMENDATIONS

It is recommended to test the two Locator attachments with different designs in vivo environments including artificial saliva and denture cleansing solutions.

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