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Gender Effect On Wear Characteristics Of CAD/CAM Milled Teeth Versus Pre-Fabricated Artificial Teeth For Complete Denture

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Abstract
Purpose*: This study aimed to assess the gender effect on 2-dimentional wear (2D) (vertical loss) of pre-fabricated and milled artificial denture teeth.*
Materials and Methods*: Thirty-six patients who are completely edentulous were chosen for this research. Two complete dentures were given to each patient. Group I: The complete denture was constructed with pre-fabricated artificial teeth, Group II: The complete denture with digitally fabricated teeth through milling process from Double cross-linked polymethyl methacrylate (PMMA) resin disc. The maxillary and mandibular denture teeth were 3D scanned at the time of insertion (T0), after three months of insertion (T3) and six months (T6) of denture use. Utilizing 3D surface superimposition techniques, the vertical (2D wear) material loss was measured in order to evaluate the tooth wear. Statistical analysis was done using SPSS software. Significant difference was considered if $P \leq 0.05$.*
Results*: wear of the pre-fabricated and milled denture teeth were directly linked with time spent wearing dentures. Pre- fabricated acrylic teeth showed much higher vertical and volumetric wear than milled denture teeth after six months. In this study, the impact of gender on teeth wear was not statistically significant.*
Conclusions*: CAD-CAM milled teeth exceeded pre-fabricated acrylic resin teeth in terms of wear resistance. Regarding wear resistance, the milled denture teeth are acceptable alternatives to the pre-fabricated l denture teeth.*
KEY WORDS*: Wear, Pre-Fabricated denture teeth, CAD-CAM, Gender, Milled teeth.*

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I. Introduction

Teeth wear, which results from attrition, abrasion, and erosion, is regarded as a non-carious loss of tooth substance [(1)]. Wear resistance is a crucial physical quality of artificial teeth used in removable prosthodontics [(2)]. The effects of excessive tooth wear include the loss of posterior tooth support, a decrease in masticatory efficiency, a reduction in the vertical dimension of occlusion, fatigue of the masticatory muscles, modifications to the functional path of masticatory action, improper dental relationships, and temporomandibular dysfunction [(3,4)].

Quantitative approaches based on three-dimensional (3D) dental models have been created to replace the traditional qualitative methodology used to measure tooth wear, such as Eccles, Smith, and Knight's New Tooth Wear Index (NTWI). These are viewed as being more objective and providing a more accurate outcome prediction which is typically expressed as loss in tooth height or volume [(5,6)].

A variety of materials, including acrylic resin, ceramic, CAD/CAM teeth, and resin composite teeth, were employed to create artificial teeth of removable prostheses [(7)]. Because acrylic resin teeth have a low wear resistance, they have been modified by adding filler, copolymer, or poly-methyl methacrylate with the interpenetrating polymer network (IPN), as well as cross-linking agents, various monomers, and these modifications. Additionally enhancing strength and crazing resistance, by cross-linking agents. The weak points of traditional polymethacrylate teeth are eliminated by the double cross-linking process [(8)].

Digital dentures have also been made possible by advances in digital dentistry, in which teeth are milled or printed from resin and bonded to denture base [(9)]. The wear correlations with age, gender, maximum

bite force, and bruxism have been extensively researched by many authors [(1)]. Males exhibit greater masseter muscles and more force of bite than females do, generally [(10-12)].

No prior research has examined the wear differences between male and female complete denture artificial teeth, whether they are manufactured of milled or ready-made acrylic teeth. as a result, Therefore, the objective of the recent study was to compare the wear resistance of pre-fabricated and milled denture teeth in relation to gender. The null hypothesis predicted that there wouldn't be a difference in wear resistance between male and female denture artificial teeth.

II. Materials and Methods

For this investigation, thirty-six complete edentulous individuals, ages 55 to 65, were selected. All patients accepted an informed consent form for their involvement in this study, as per the ethics committee's ruling (No. A11080622) at the faculty of dentistry at Mansoura University. All patients had an edentulous maxilla and mandible, moderate residual ridge height, healthy firm mucosa free of tissue undercuts, a normal maxillofacial relationship "Angle's class I and systemic disease as determined by a physician's medical history and clinical examination, all of which were determined to be true for all patients for at least one year.

Each patient received two prostheses; Group(I): The complete denture with pre-fabricated artificial teeth and Group (II): The complete denture with milled denture teeth. After using each denture for six months and taking two weeks off, the patient received the second type of denture, which used for an additional six months.

For each patient, conventional complete dentures were constructed. In a suitable stock tray, making primary impression (Alginate Cavex, Holland, normal set impression material) and secondary impression using zinc oxide eugenol-free impression material (Cavex Outline, Cavex Co., Holland) for maxillary and mandibular arch and jaw relation transfer to semi-adjustable articulator (Whipmix, Semi- adjustable Articulator), selecting (YAMAHACHI DENTAL MFG.,CO. Aichi Japan) pre-fabricated teeth for conventional denture, It were arranged for bilateral balanced occlusion, try in the waxed denture by each patient, then denture was flasked, finished, and polished in conventional manner. The denture was flasked, accomplished, and polished in the usual ways.

Maxillary and mandibular complete dentures and master casts were lightly sprayed with an anti-glare spray (YETI DENTAL digital line Digi-scan Spray Art.-Nr. 581-0300, Germany) then scanned using a 3D scanner, desk scanner (Auto Scan-DS-EX, lab-scanner, Germany). Exo-cad Dental IDB 2.4 plovdiv7290 [version 2.4 Engine build 7290]'s CAD-CAM complete denture software was used to import the output data (STL files). When creating the complete dentures with milled teeth, the designing software utilized to identify the peripheral limits and detect anatomical landmarks on the virtual model. using the software's step-by-step instructions to assess the casts. The artificial teeth are practically shaped to match the alveolar ridges. Teeth setting was selected from the Exo-cad library, to properly fit the teeth in conventional denture in shape and size. Adaptation of the denture base with2 mm thickness to the teeth according to the manufacturing technique which is milling technique, (Figure. 1).

The newly designed denture was superimposed by STL file of the constructed conventional denture, comparing the polished surface, tooth alignment, and tooth form.

White polymethyl methacrylate blanks (white PMMA block, XTCERA, China of 98 mm diameter and 16mm in length has been utilized to mill denture teeth with milling machine with five-axis (MODELA MDX-50, DGSHAPE, Japan) then finished and polished. The CAD CAM teeth and a heat-cured acrylic resin denture base (Acrostone, acrylic resin, heat cured Egypt) were bonded together with a self-curing bonder. The denture was finished and polished. Denture insertion and follow up for any post insertion complaint, (Figure.2).

Evaluation of denture teeth wear (2D wear analysis)

The maxillary and mandibular dentures were lightly sprayed with antiglare spray (YETI DENTAL digital line Digi-scan Spray Art.-Nr. 581-0300, Germany), then scanned using 3d desktop scanner (AutoScan-DS-EX,3d shinning scanner, Germany) outputting STL files, three time, (T0) before insertion as reference data, and the measured data was three months after insertion (T3) and six months later (T6). The resulting data was imported to software for surface matching (Geomagic Control X, X by 3D Systems Inc., Rock Hill, South Carolina, United States.), to trim the STL files and remove the extra point to retain the important points then evaluating the wear of the occlusal surface.by superimposition of the STL files. (T0) was superimposed with (T3) and with (T6), then (T3) superimposed with (T6).

Alignment between the reference and the measured data was done automatically using the initial alignment then the best fit alignment. Using, 2D compare option to evaluate the vertical occlusal wear of the measured data at two planes of cross-section, one at first premolar and the other at first molar. the cross section is seen constantly passing via the cusp point. These steps were repeated for the conventional teeth and the milled teeth

Statistical analysis

The Statistical Package of Social Science (SPSS) application for Windows (Standard version 26) was used to analyze the data. The Shapiro test was used to determine the data's initial normalcy. The two groups were compared using an independent t test, whereas the paired groups were compared using a paired t test. Continuous variables were provided as mean SD (standard deviation). The 5% level (p-value) is the set level of significance for the aforementioned statistical tests. If the p-value was less than 0.05, the results were deemed significant. The significance of the findings increases with decreasing p-value.

III. Results

The descriptive statistics of 2D wear in group I and II in male and female during various observation intervals [initial 3 months following denture insertion (T0-T3), second 3 months following denture insertion (T3-T6), and initial 6 months following insertion (T0-T6)].

(Table 1) presents comparison between males and females regarding 2D wear among conventional group. According to the results, Significant variation existed between each pair of time intervals in the same gender and between males and females. AT T0-T3, the 2D wear in males (0.146±0.08) is higher than female (0.066± 0.02).

T -test showed that this difference was statically significant. The 2D wear in male at T0-T6 (0.184± 0.12) considerably outperformed all males observation times and higher than (T0-T6) of female (0.072± 0.02) ($P<0.05$). wear was significant decreased between the two intervals (T0-T3 to T3-T6), (Figure.5). When comparison of 2D wear in male and female between different intervals among milled group.

There was insignificant difference between each 2-time intervals and the highest wear was reported at T0-T6 ($p=0.090$). and no significant difference between T0-T3 and T3-T6, (Table 2), (Figure.6).

IV. Discussion

The purpose of this study was to determine the degree of wear in both male and female CAD/CAM milled teeth and pre-fabricated artificial teeth.

The desktop scanner has been used in this study [13,14]. The Geomagic Control X program was utilized, and the denture teeth's scans were superimposed using best-fit techniques., allowing digital measurements to be recorded. These measurements are easier to use, more understandable for 3D inspection in any manufacturing workflow, and accurate in comparison to traditional physical measurements [15].

Similar to this, the research conducted by Stober et al. (2014) revealed that premolar and molar occlusal contact regions had the maximum vertical loss[13] **.**

In general, PMMA teeth without filler particles showed more wear than PMMA teeth treated with fillers [16].

According to the study of Kim et al., [17], double cross linked (DCL) conventional teeth seem to have similar wear resistance to milled teeth. According to the wear resistance, milled denture teeth (DCL-CAM and NC-CAM) are good replacements to traditional denture teeth, according to the relative wear observed in this study.

Although there was no statistically significant difference in the current study, generally, Men experience much greater attrition rates than women, according to a number of earlier research [10,11].

However, despite the fact that the mean tooth wear of male subjects (2.3 ±1.5 mm3) was higher than that of female subjects (1.9 ± 1.2 mm3), there was no statistically significant difference in the study by Park et al, [1].

Men tend to wear more than women, according to studies by Stober et al [18]. This is in line with the findings of Ohlmann et al. [19], who also looked at occlusal wear in a group of patients wearing partial and complete dentures.

No study, however, demonstrated a statistically significant effect of gender on occlusal wear in the group of patients wearing just complete dentures [19,20]. According to Heintze et al., men often experience more wear [21]. One possibility is that the edentulous subjects did not exhibit the gender effect on bite force. On the other hand, males displayed noticeably more biting force in dentate patients. Additionally, it has been demonstrated that complete denture users have a lower biting force than partial denture wearers [22].

The teeth were digitally scanned in three dimensions before and after wear to evaluate wear. The veritable (2D) loss of the worn tooth structure was then calculated by superimposing and subtracting the two 3D models. Numerous writers have suggested this approach due to its accuracy in clinical and laboratory research [23-25].

V. CONCLUSIONS

The following conclusions can be given with the limits of this study:
There was no difference in tooth wear between males and females when comparing CAD/CAM milled teeth to pre-fabricated acrylic resin teeth with higher wear resistance in CAD/CAM milled teeth.

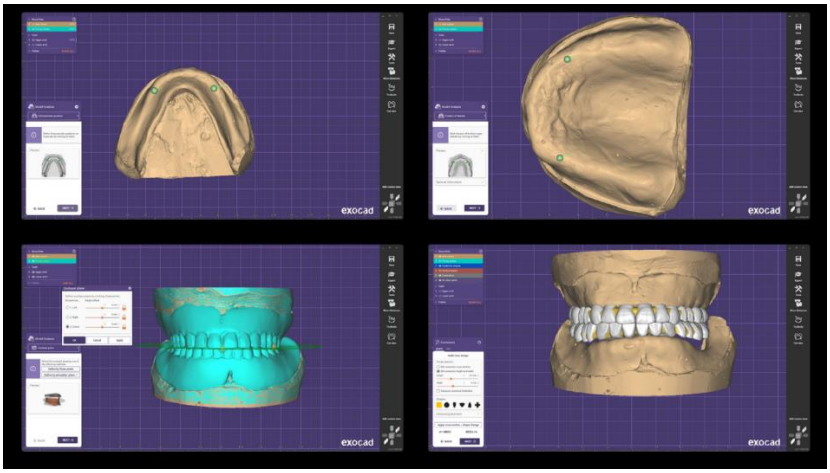

Fig.1: Scanned master casts and conventional complete denture were imported to EXO CAD and selection of the milled teeth.

Fig. 2: a) Complete denture with pre-fabricated teeth, b) complete denture with milled teeth

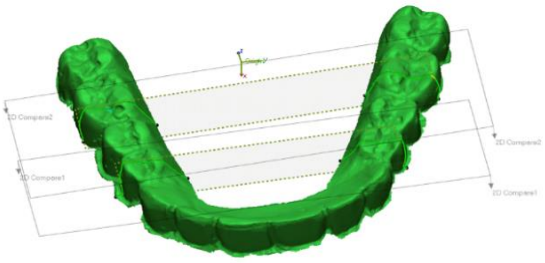

Fig. 3: 2D compare of (T0) STL file with (T3) STL file of complete denture with pre-fabricated teeth

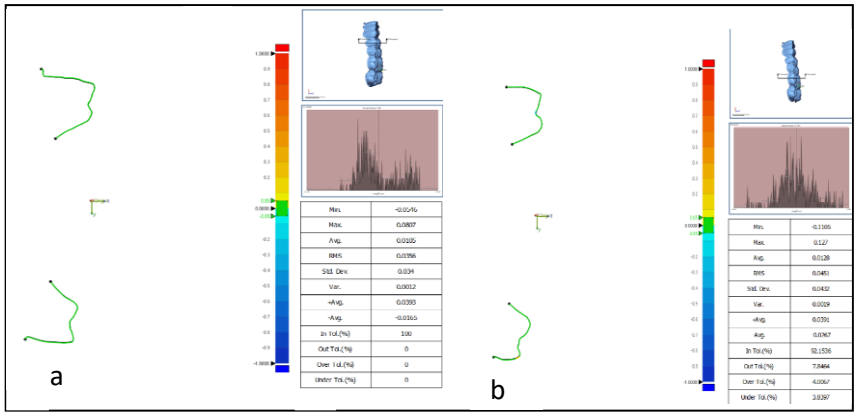

FIG. 4: a)2D compare at first premolar, b) 2D compare at first molar

Table.1: Comparison between males and females regarding 2D wear among conventional group

2D wear	Conventional group		Independent t- test	P value
	Males	Females		
T0-3	0.146±0.08	0.066± 0.02	t=3.15	**0.005***
T0-6	0.184± 0.12	0.072± 0.02	t=3.09	**0.005***
T3-6	0.037± 0.02	0.019± 0.004	t=2.60	**0.016***

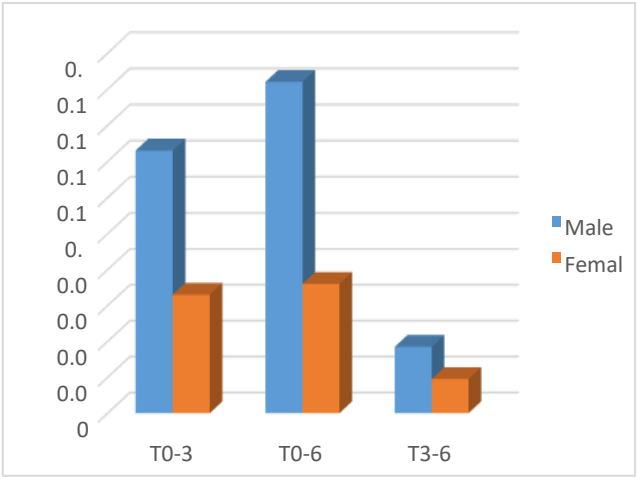

Fig. 5: 2D wear among males and females in conventional group

Table.2: Comparison between males and females regarding 2D wear among Milled group

2D wear	Milled group		Independent t- test	P value
	Males	Females		
T0-3	0.074± 0.05	0.043±0.01	t=1.36	0.204
T0-6	0.08±0.05	0.048±0.01	t=1.87	0.090
T3-6	0.021±0.008	0.015±0.002	t=1.04	0.324

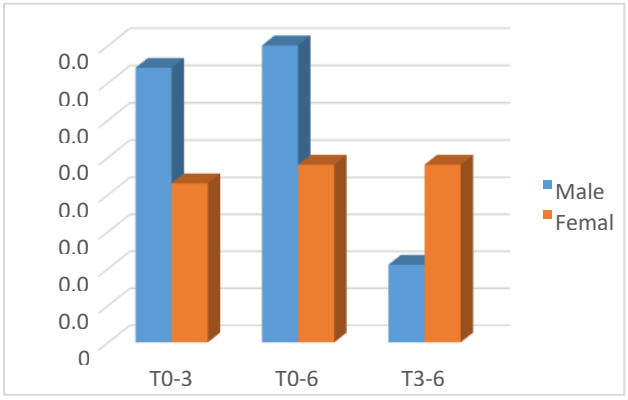

Fig. 6: 2D wear among males and females in Milled group

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