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Evaluation of Conventional Versus Digital Complete Dentures Regarding Denture Retention and Microbial Growth

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ABSTRACT

Aim: This study was conducted to compare between conventional and digital complete dentures as regard prosthesis retention, level of bacteria and/ or yeast present. **Subjects and Methods**: Ten completely edentulous patients every patient was received conventional and digital complete dentures. The patients were allowed to wear each denture, and the test of retention for both dentures was measured. Plaque samples were collected from intaglio surfaces of complete dentures to culture for any colonization of bacteria and/or yeasts. **Results:** When compared conventional and digital complete dentures there were a significant increase in retention in digital denture and a significant increase in microbial growth in conventional denture. **Conclusion:** According this study the retention of digital denture significant higher and digital dentures showed less microbial colonization than conventional dentures..

KEYWORDS

Complete Dentures, Prosthesis Retention, Digital , Bacteria, Yeast

INTRODUCTION

To obtain complete dentures, edentulous patients typically have to make five visits to the dental clinics, involving primary and secondary impressions, jaw relations record, trial of waxed denture, and delivery. These clinical and laboratory procedures are mainly performed manually. Therefore, it is very challenging to ensure the quality for the manually designed and fabricated dentures. Moreover, it is difficult to keep and reuse those physical models generated in the process to generate additional CDs latter when the patients need them [(1)].

The manufacturing of CDs using digital technique has possible to facilitate the manufacture procedures. The possibility to construct CDs by using of the digital method provides both a high usage of laboratory digital technology and therefore effectiveness and high procedures reliability [(2-4).]

The additives manufacturing through 3D printers has become a prime concern because of their ability to mold a variety of materials in

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the field of prosthetic dentistry based on CAD data [5]. Additive manufacturing undertakes the design of the product from a 3D file imported in the Standard Tessellation Language (STL) file, which segments CAD drawings into tiny thin sections and enables layer by layer processing. It can deliver parts without the need for a tool or mold [6].

Combining scanned information on dental structures and the virtual design of final prosthetic reconstructions (CAD) with an ultraviolet (UV) laser beam passed over a photosensitive resin, producing an accurate 3D denture characterized by a complete replica of the external and internal structure[7].

There are some limitations with the digital systems. It was difficult to establish optimal vertical dimension and horizontal relation transfer, and the inability to define the mandibular occlusal plane, and increased laboratory costs compared with conventional methods [8]. Furthermore, some systems do not provide a trial denture, which is considered an important step before the final fabrication of the denture [9].

A digitally fabricated denture has become a rapidly evolving technology, yet little information is available on their clinical or patient-centered outcomes. Therefore, the objective of the current study was to compare the retention and microbial colonization on the surfaces of digital and conventionally fabricated complete dentures.

PATIENTS AND METHODS

Ten completely edentulous patients every patient was received conventional and digital complete dentures. Conventional dentures were fabricated by heat cured acrylic resin, digital dentures fabricated by Talking primary and final impression and jaw relation as a conventional method. Maxillary and mandibular master stone casts were obtained by pouring hard dental stone type III.

On fixed condylar path articulator, casts was mounted with its occlusion block. After that, the waxing up of the trial denture was finalized to create a master waxed-up denture that represented the reference model.

1. Scanning

Fabrication of three-dimensional printed denture base through The 3D-scanned data from both digital scanning was saved in file (STL).

2. Exocad

To producing digital denture using Exocad software producing (STL) file for this denture. This was sent to slicer software. From this reference, CAD digital light processed (DLP) denture was fabricated.

3. 3D-printing denture base

3D printable Resin liquid NextDent (Base, Vertex Dental, Soesterberg, Netherlands), was added to the 3D-printer (E PAX 10X-4K UV LCD 3D Printer USA). Printing was started with a build angle of 45^0, and printing thickness on the z-axis was set at 50 microns. Supports were selected without interrupting the fitting surface of the denture. 3D-printed with a layer thickness of 50μ, and post polymerized using a UV (Ultraviolet) light-polymerization unit for 15 min.

4. Teeth CAD/CAM milling

Fabrication of the denture teeth was approved in CAD/CAM milling machine, the digital denture teeth were fabricated from prepolymerized resin acrylic blocks.(Milling of Acetal teeth template)

5. Bonding teeth to 3D-printed denture base

Bonding milling denture teeth into the socket present in 3D-printed denture base was done by 3D-print resin.

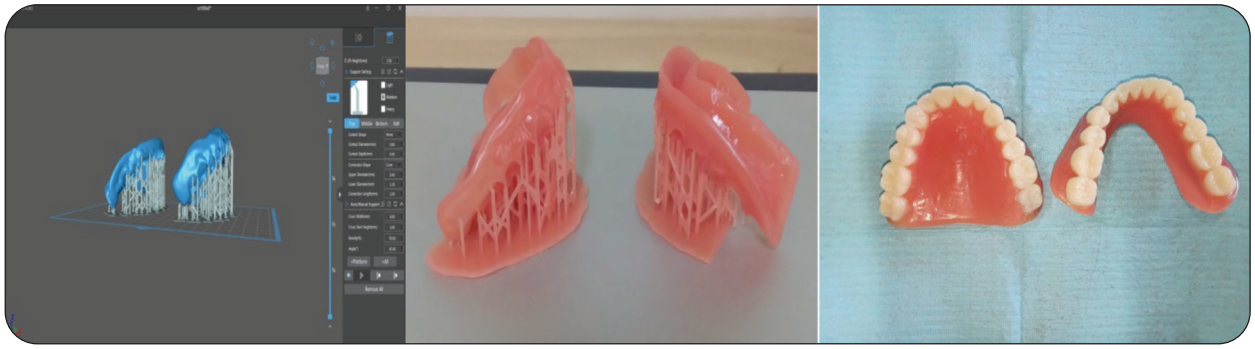

Fig. (1) A. Dentures created using 3D-printing with three different printing directions. B. 3D-printed denture base with bar support. C. Digital complete denture

6. Finishing and polishing

After denture base printed, the supports were removed, and the printed dentures were cleaned in an ultrasonic bath with ethyl alcohol for 10 minutes to remove excess resin. The 3D-printed denture bases were post-polymerized for 40 minutes using an ultraviolet polymerization unit (bre. Lux power Unit 2, Bredent, Germany) as instructed by the manufacturer.

Post-operative evaluation

1. Retention evaluation

Measurement of denture retention:

The retention of maxillary and mandibular denture was tested by measuring the force required to dislodge both dentures from the basal seat using digital forcemeter.

2. Microbial evaluation

Collection of palatal plaque samples;

Swabs were taken from the palatal surface of the upper denture according to a 2cm x 2cm template delimiting the area to be swapped immediately before insertion of denture, three month and six month after wearing the denture.

RESULTS

The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM® SPSS® Statistics Version 20 for Windows

Retention

There was a statistically significant difference between (Conventional) and (Digital) where (p=0.002).

The highest mean value was found in (Digital), while the least mean value was found in (Conventional).

Table (1) *The mean, standard deviation (SD) values of retention of different groups.*

Variables	Retention				
	Upper		Lower		p-value
	Mean	SD	Mean	SD	
Conventional denture	23.50	4.25	17.80	5.27	0.011*
Digital denture	33.50	7.96	27.10	6.19	0.034*
p-value	**0.003***		**0.002***		

Means with different letters in the same column indicates significant difference

**; significant (p<0.05)*

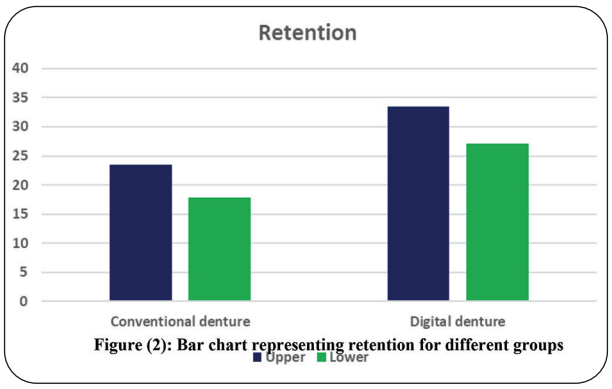

Figure (2): Bar chart representing retention for different groups

Fig. (2) Bar chart representing retention for different groups

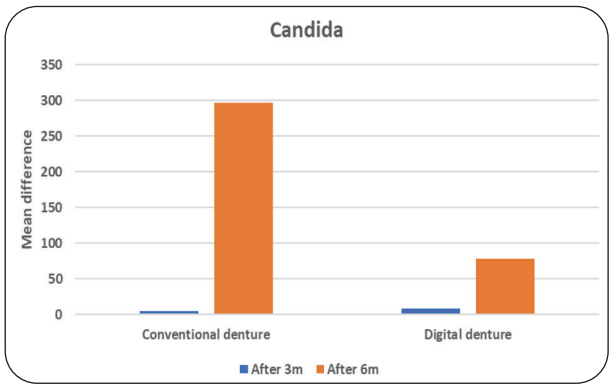

Fig. (3) Bar chart representing candida for different groups

Microbiology:

There was a statistically significant difference between (Conventional denture) and (Digital denture) where (p<0.001).

The highest mean value was found in (Conventional denture), while the least mean value was found in (Digital denture).

Table (2) *The mean, standard deviation (SD) values of candida of different groups.*

Variables	Candida				
	Conventional denture		Digital denture		p-value
	Mean	SD	Mean	SD	
After 3m	5.20	0.84	8.20	1.64	0.007*
After 6m	296.60	46.31	78.20	7.53	<0.001*
p-value	**<0.001***		**<0.001***		

Means with different small letters in the same column indicates significant difference; Means with different capital letters in the same row indicates significant difference

**; significant (p<0.05) ns; non-significant (p>0.05)*

DISCUSSION

The 3D scanner captures data from a patient's unique dental anatomy converting it to a digital 3D CAD file. This file is an editable/printable file, using photosensitive liquid resins, repeatedly layered on a support structure, and polymerized by functional additive manufacturing technologies through an ultraviolet or visible light source. [10]

The result of retention under maximum load There was a statistically significant difference between (Conventional denture) and (Digital denture) where (p<0.001). The highest mean value was found in (Digital denture), while the least mean value was found in (Conventional denture). This results in digital denture due to decrease residual monomer level and thus, low polymerization shrinkage, making it more hydrophobic and more dimensionally stable than conventionally cured resins and clinically smooth surface [10].

Digital dentures are assumed to have more favorable material properties than conventionally fabricated dentures, among them a lower methacrylate monomer release. Digital Dentures had significantly lower mean volume and weight than conventional dentures. Baltic Denture System had a significantly smaller surface area. None of the Digital dentures released significantly less monomer than the conventional. [11]

In this study two different types of denture base materials were used the first was constructed from conventional acrylic PMMA and the second was made from 3D-printed resin. At the time of delivery, the patients were instructed not to wear their dentures at night to give chance for oral tissue to recover. This is important for the integrity of the oral tissue, and decrease the accumulation of plaque that might increase the risk of developing denture stomatitis. Patients were also instructed to clean their denture after each meal under tap water with no other mechanical or chemical means that might affect plaque accumulation and microbial flora. (12)

The results of the current study revealed that, there was a gradual increase in the microbial count during the time of using both the conventional acrylic resin denture and digital dentures. This gradual increase may be due to that, the mouth dealt with them as a foreign body thus reacting by increasing the total micro-organisms. Although, the increase of colonization of microorganisms during the follow up period might also be due to surface roughness of the materials, as aging process promotes roughness of the denture base surface. (13)

CONCLUSION

Digital technology showed promising potential for high retention and minimizing the adherence of micro-organism to the denture base surface for long time, meaning that the digital method can meet the clinically acceptable precision for design and development of CDs as a trial for restoring edentulous jaws.

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تقييم الأطقم التقليدية مقابل الأطقم الرقمية الكاملة باعتبار قوة الاحتفاظ بالطقم ونمو الميكروبات

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الملخص :

الهدف: هذه الدراسة للمقارنة بين الأطقم التقليدية مقابل الأطقم الرقمية الكاملة باعتبار قوة الاحتفاظ بالطقم . وإجراء تقييم ميكروبيولوجى لمستوى البكتيريا الموجودة على بعض أسطح الأطقم الكاملة .

المواد والاساليب: تم اختيار عشرة مرضى بدون اسنان وذلك لعمل طقمين كاملين (تقليدى ورقمى) لكل مريض وتقييم قوة الاحتفاظ لكل طقم وذلك عند تسليمه للمريض بواسطة جهاز قياس قوة الاحتفاظ الرقمى . تم أخذ ثلاث مسحات من طقمى الأسنان لكل مريض . تم الحصول على المسحات من سقف حلق المريض ومن سطح الأطقم العلوية الملاصقة لأنسجة الحلق.

النتائج: أظهرت النتائج أن الأطقم الرقمية الكاملة تمتلك قوة احتفاظ أكبر من الموجودة فى الأطقم التقليدية. كما أظهرت الدراسة الميكروبيولوجية ان عدد الكانديدا الملتصقة والبكتيريا المتجمعة أعلى في القيمة المتوسطة فى الأطقم التقليدية عنها فى الأطقم الرقمية.

الخلاصة: من هذه الدراسة خلصنا إلى أن متوسط قوة الاحتفاظ فى الأطقم الرقمية أعلى وأيضاً اقل في الالتصاق الميكروبي من الأطقم التقليدية

الكلمات المفتاحية : طقم كامل ، ثبات التركيبه ، بكتريا ، فطر،رقمى.