What's new for the clinician – summaries of recently published papers (July 2024)

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1. THE EFFECTS OF DENTURE CLEANERS ON THE SURFACE, OPTICAL AND MECHANICAL PROPERTIES OF RESINS FOR CONVENTIONAL, MILLED AND 3D-PRINTED DENTURE BASES

Conventional techniques or digital computer-aided design and computer-aided manufacturing (CAD/CAM) by milling or three-dimensional (3D) printing are currently used for denture processing. CAD/CAM-milled discs are pre-polymerised by the manufacturer under heat and pressure, which minimises their porosity and residual monomers; therefore, they exhibit improved mechanical properties and reduced bacterial adhesion. In contrast, resins for denture bases manufactured by 3D printing are polymerised by light, resulting in increased residual monomer concentrations and porosity.[1]Hygiene and the disinfection of removable prostheses is essential to remove biofilm, increase longevity and maintain good oral health.[1] Stomatitis has been reported to be the main cause of superinfection in patients with prostheses, especially infection with *Candida* spp. Poor denture hygiene has not only been associated with problems in the oral cavity but also with a 2.4 times higher risk of severe pneumonia.[1] The ideal hygiene product or system would achieve an optimal level of disinfection of the dentures, be nontoxic and avoid alterations in the physical and mechanical properties, such as colour and dimension. In addition, it should be affordable.[4] Among the mechanical methods for cleaning dentures, brushing is the most used because of its simplicity, effectiveness and low cost.[1]

Chemical methods for denture cleansing include immersing the prosthesis in solutions with solvent, detergent and antibacterial and antifungal actions, which can be used alone or in combination with brushing or ultrasonic devices.[1] These chemical agents are broadly divided into diluted acids, alkaline solution and alkaline peroxide.[1] Alkaline solutions, which include sodium hypochlorite (NaOCl) and diluted acids such as mouthwashes, are effective denture cleaning agents that act on the organic matrix of the biofilm, possess bactericidal and fungicidal action, and remove stains from dentures[1]. Alkaline peroxides comprise oxidising, effervescent, tension-reducing and chelating agents in powder or tablet form, that become hydrogen peroxide solutions on contact with water.[1] Chelates, or chelating agents, remove heavy metals by binding with metal ions to form two or more bonds with their ring-shaped structure and build a stable, water-soluble structure. Common chelating agents include ethylenediamine tetra acetic acid (EDTA), ethylene glycol tetra acetic acid (EGTA) and ethylenediamine.[1] Various effervescent cleaners are available in the market – such as Corega tabs® and Efferdente® in tablet form – are commonly used, which are effective in reducing the adhesion of *Candida albicans* and removing light stains and debris on denture bases.[1]Although CAD/CAM methods have been employed for denture manufacturing since the 1990s, owing to limited scientific evidence they are still considered a relatively new approach. Furthermore, existing evidence on the best chemical protocol for disinfection and biofilm removal in dentures processed using CAD/CAM, 3D-printed dentures in particular, and its effects on their properties, is limited.[1] Bento and colleagues (2024)[1] reported on an in vitro study that sought to evaluate the efficacy of denture cleaners on the adhesion of *Candida albicans* and their effects on the surface, optical and mechanical properties of resins for conventional, milled and 3D-printed denture bases. The null hypothesis postulated that there would be no significant differences between the different types of resins and different types of cleaning agents.

Materials and methods

This was a lab based *in vitro* study. A total of 240 resin samples were made: 120 with a thickness of $10 \times 3.0 \pm 0.03$mm for testing *Candida albicans* adhesion, optical stability, roughness, hydrophilicity and surface free energy, and the remaining samples with dimensions of $15 \times 5.0 \times 3.0 \pm 0.03$mm were used for evaluating *Candida albicans* adhesion, surface microhardness, flexural strength and modulus of elasticity. Based on the denture resin type and manufacturing method, these samples were divided into three groups of 40 each: G1, G2 and G3. Depending on the type of denture cleanser, the samples were further subdivided into five groups: S1, S2, S3, S4 and S5 ($n = 8$).

The samples for the conventional group (G1) were prepared using metal moulds cut to the appropriate dimensions, which were placed in plastic muffles positioned between glass plates on a special type IV plaster. The conventional medium-pink method (Classic) resin was handled according to the manufacturer's instructions, inserted into the moulds, kept under a load of 14.71 kN for 2min in a hydraulic press, and bench-cured for 30min. The samples were polymerised in a boiling water bath (100°C) for 60min. After polymerisation, the edge irregularities and excess resin were removed using a Maxicut drill.

The samples fabricated using the milled (G2) and 3D printed (G3) method were first designed in CAD software in accordance with the specified dimensions. Standard CAD mosaic language files were sent to the CAM software of the milling machine and 3D printer. Blocks of medium-pink were milled in a 5-axis milling machine to obtain the milled samples, and a medium-pink liquid resin was used in a stereolithographic printer with digital light processing technology to obtain the 3D printed samples.

All samples were subjected to a standardised finish and polishing using sanding discs of different roughness (grit), coupled to an automatic polishing machine under constant water irrigation at 300rpm for 30sec on each face. All samples were randomised and placed in 24 plates with 2ml wells, packed with surgical grade and sterilised using ethylene oxide gas (Oximed®) according to the ISO9001:2015 standard protocols for microbiological tests.

An isolated *Candida albicans* ATCC#90,028 strain was placed on Sabouraud dextrose agar (SDA) plates for 24hr in an oven at 37°C. The colonies formed on the plate were transferred to a test tube with brain heart infusion (BHI) broth and kept in an oven at 37°C for 24hr. A positive control of the strain was performed, recording a growth of 2.23×10^6 CFU/ml (Colony Forming Unit). The samples, after sterilisation, were immersed in sterile human saliva for 2hr in an oven at 37°C with 5% CO_2 to form an acquired film.

The colonies formed in the tube with BHI were transferred to a petri dish with SDA using an inoculation loop and kept in an oven at 37°C with 5% CO_2 for 24hr. Subsequently, the colonies formed on the plate were transferred to yeast malt broth until cloudy, and the absorbance was measured using a spectrophotometer at a wavelength of 625nm until reaching an optical density compatible with the oral biofilm (absorbance at 350 ABS). Next, 2ml of broth was distributed in each well for each sample, which was kept in an oven at 37°C with 5% CO_2 for 48hr. The samples were then washed with sterilised distilled water and immersed in 2ml of denture cleansers according to randomisation (Corega Tabs, Efferdent, 1.0% NaOCl or Listerine cool mint) for 20min in a standard electric shaker.

The samples were then transferred to test tubes with 5ml of 0.9% NaCl for vortex processing for 1min and ultrasonicated for 6min to segregate the biofilm from the sample. Six serial dilutions were made 1:9 µL (10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, 10^{-5} and 10^{-6}). For each sample, a plate with SDA divided into six quadrants was prepared, and three drops of 25 µL were placed in each quadrant, depending on its dilution. The plates were incubated in an oven at 37°C with 5% CO_2 for 24hr. After this period, counting was performed using a digital colony counter, choosing the quadrant with 3-30 colonies per drop. The average number of *Candida albicans* colonies (10 CFU/ml) was calculated by averaging three drops of each sample and multiplying by the dilution exponents.

The optical stabilities of the samples were evaluated using a spectrophotometer and measured using the CIE L*a*b* colour scale. With the data collected before and after contamination with *Candida albicans*, the chromatic difference was calculated using the CIEDE 2000 system (ΔE00). The higher the ΔE^{00} value, the greater the colour change of the material, resulting in lower optical stability.

Surface roughness was analysed by contact profilometry using an SJ-401 surface roughness profilometer featuring a diamond with a diameter of 2mm. Three measurements were performed on each sample by a single operator and the average of these measurements was defined as the roughness value Ra (µm).

Hydrophilicity and surface free energy were analysed using a Drop Shape Analysis System DSA100E automatic dispenser digital goniometer. To determine the surface free energy (mJ/m^2), additional measurements of the contact angle were performed using a 20 µL drop of diiodomethane. The surface microhardness was evaluated using a microhardness tester (HMV-2T; Shimadzu Corp.) equipped with a Knoop diamond, according to the standard guidelines. Three measurements were taken and the average of three measurements was defined as the Knoop microhardness value (KNH, Kgf/mm^2) of the sample.

The flexural strength and modulus of elasticity were tested using a 3-point bending test on a universal testing machine, in accordance with the ISO 20795-1 guidelines: (2013) for denture base polymers.

Results

In this study, all denture cleansers significantly reduced the quantity of *Candida albicans*, with Listerine and 1% NaOCl reducing 100% of the microorganisms in both sample formats. Furthermore, chromatic changes and surface roughness values were considerably higher for 1% NaOCl. In contrast, 1% NaOCl presented higher free surface free energy values and greater hydrophilicity than the other cleaners, mainly in 3D-printed resin, which is favourable for reducing the adhesion of *Candida albicans*. However, NaOCl acts directly on the organic matrix of the resin, resulting in the dissolution of the polymeric structure of the denture, modifying its structural characteristics, which can lead to the weakening of the resin. This is proven by the low flexural strength and modulus of elasticity of the 3D-printed resin with 1% NaOCl.

Multiple pair comparisons showed that the resins manufactured using CAD/CAM showed significantly less colour change than the conventional resin for all denture cleansers ($P<0.05$). Compared to water, 1% hypochlorite solution showed the highest colour change values, with a significant increase in all resins ($P<0.05$).

Surface roughness values were significantly higher in 3D-printed resin than in other resins for all cleansers ($P<0.05$), with the exception of 1% hypochlorite, which did not show a significant difference with conventional resin ($P=0.104$). Compared to water, 1% hypochlorite solution presented the highest roughness values, with a significant increase in all resins ($P<0.05$) .
The 1% hypochlorite showed the highest surface free energy values, a significant increase compared with those of other cleansers in the 3D-printed resin ($P<0.05$). Additionally, the denture cleansers did not significantly alter the contact angles of the conventional and milled resins. Multiple pair comparisons (Tukey's test) showed that the surface microhardness was significantly lower for 3D-printed resin for all cleansers ($P<0.05$), with the exception of 1% hypochlorite ($P=0.088$). Compared to water, all cleansers demonstrated significantly reduced surface microhardness ($P<0.05$); with the lowest values for Corega and Efferdent cleansers, with no difference between them ($P>0.05$). Listerine outperformed all the cleansers and was the most effective in reducing *Candida albicans* without altering the properties of conventional and CAD/CAM denture resins. Notably, the samples were immersed in denture cleansers only for 20min.

Conclusions

Listerine demonstrated superior efficacy in reducing *Candida albicans* with minimal effect on denture properties, whereas 1% NaOCl had a significant negative impact on the properties. The mechanical properties were significantly lower in 3D-printed resin than in other resins for all denture cleansers.

Implications for practice

The ease of use of CAD/CAM technology and milling or 3D printing dentures must be tempered against the impact denture cleansers have on the properties of these dentures.

REFERENCE

1. Bento VA, Sayeg JM, Rosa CD, Lopes LF, Marques MC, Pellizzer EP. Efficacy of denture cleansers on Candida albicans adhesion and their effects on the properties of conventional, milled CAD/CAM, and 3D-printed denture bases. Clinical Oral Investigations. 2024 Jul;28(7):1-1

2. PERFORMANCE OF CHATGPT IN CLASSIFYING PERIODONTITIS ACCORDING TO THE 2018 CLASSIFICATION OF PERIODONTAL DISEASES

A new classification for periodontal and peri-implant diseases and conditions was introduced in 2018 and remains in use today. Various diagnostic tools have been developed to aid clinicians in the decision-making process based on the 2018 periodontal classification.[1]

ChatGPT is an implementation of the Generative Pre-trained Transformer 3 (GPT-3.5) language model developed by OpenAI, which is freely available to the public.[1] GPT-3.5 is a highly expansive neural network-based natural language processing (NLP) model, currently one of the largest in existence. With training on 175 billion parameters, its primary purpose is to generate text that closely resembles human language. Acting as a versatile chatbot, GPT-3.5 is capable of performing diverse NLP tasks such as language translation, summarisation and answering questions. Furthermore, it can offer alternative differential diagnostic support. Clinicians can obtain a list of potential diagnoses and advice on subsequent management choices by providing the model with case details.[1] Better differential diagnostic assistance systems may be created by considering the strengths and weaknesses of such models. To explore this possibility, Tastan Eroglu and colleagues (2024)[1] reported on a study that sought to evaluate the ability of ChatGPT to determine the stage, grade and extent of periodontitis according to the 2018 classification when provided with rich case descriptions, understanding the capabilities and limitations of this tool.

Methodology

This research was based on an analysis of the baseline digital records and subsequent stage, extent and grade characterisations of 200 untreated patients diagnosed with periodontitis. All cases were evaluated by four examiners to obtain gold standardised diagnoses. The information used to determine the stage, grade and extent of periodontitis was input directly to ChatGPT, followed by the query, “What is the stage, grade and extent of periodontitis?” The chatbot’s replies were then compared with the standardised diagnoses.

Two hundred and fifty-eight periodontitis cases were selected from the archive of patients of the Periodontology Department at a university in Turkey. Patients with acute periodontal lesions, gingival diseases, dental implants and periodontitis as a manifestation of systemic diseases were excluded (n = 43). The four experts, who were responsible for providing the standardised reference diagnoses (RDs), reviewed and discussed the cases collaboratively, reaching a consensus through open discussion. Cases in which consensus could not be reached and those with inappropriate clinical, photographic and radiographic records were excluded from the study (n = 15). As a result, the experts provided consistent diagnoses for the remaining cases (n = 200), which were considered RDs for the respective cases.

Each case description included a comprehensive summary of the patient’s medical and dental history, intraoral photographs, a panoramic radiograph, a complete set of periapical radiographs and periodontal charting that encompassed various clinical measures related to periodontal health. The measures were plaque scores, probing depth, bleeding on probing, clinical attachment loss (CAL), furcation involvement (FI) and tooth mobility. The dental records of each patient included information regarding various aspects of their oral health, such as gingival bleeding, tooth mobility, dentin hypersensitivity, halitosis, family history of periodontitis, utilisation of interdental oral hygiene devices, usage of mouthwashes, presence of para-functional habits, chewing dysfunction, tooth migration, prior orthodontic treatment, previous periodontal treatment and previous prosthetic treatment. Moreover, the last dental examination and professional oral hygiene procedure (≤ 1 year, > 1 year or > 3 year) and the number of teeth loss due to periodontitis (0, ≤ 4 or ≥ 5) were reported. Each patient’s medical history contained details on pertinent medical issues, including glycaemic management and cigarette use. The entire documentation was compiled into a presentation file. This presentation file was evaluated together by four experts.

All radiographs were reviewed by the experts and re-evaluated until consensus was reached. For cases with radiographs available from five years prior, bone loss over the past five years was measured in millimetres. When previous radiographs were not available, the percentage of radiographic bone loss (RBL) was calculated. The four experts assessed the case phenotype in addition to RBL to determine indirect evidence of progression. This evaluation was classified into three categories: heavy biofilm deposits with low levels of destruction, where significant biofilm accumulation is present but associated tissue destruction is minimal; destruction commensurate with biofilm deposits, where the extent of tissue destruction is proportionate to the amount of biofilm present; and destruction that exceeds expectations given biofilm deposits, where observed tissue destruction surpasses what would be anticipated based on biofilm accumulation alone.

The performance of ChatGPT in staging, grading and determining the extent of periodontitis was evaluated using case descriptions. Since ChatGPT is a language model and cannot use images, the patients’ radiographs were evaluated by the experts. The extent and rate of bone loss were measured and converted to numerical data that ChatGPT could use. Standardised texts containing the information used to determine the stage, grade and extent of periodontitis for each case were created.

For the purposes of this study, a ChatGPT account was created in September 2023. The current ChatGPT version was used. To minimise the impact of prior responses, a new chat window was used for each case. A standardised text was created for every case in the ChatGPT query. It was then asked, “What is the stage, grade and extent of periodontitis?” The responses were recorded for later analysis.

The primary outcome was the level of agreement between the reference diagnoses (RDs) and the results obtained from ChatGPT. The secondary outcome was the effectiveness of each variable input to ChatGPT in determining the periodontitis stage and grade.

Results

The 200 cases analysed in this study comprised the full periodontitis spectrum. According to the analysis conducted by ChatGPT, out of a total of 200 instances, 78 cases (39%) were classified as stage I, 44 cases (22%) were classified as stage II, 74 cases (37%) were classified as stage III, and 4 cases (2%) were classified as stage IV. In relation to the grading system, 91 cases (46%) were classified as grade A, 85 cases (43%) were classified as grade B and 24 cases (12%) were classified as grade C. A total of 136 cases (68%) were classified as localised, while the remaining 64 cases (32%) were categorised as generalised.

ChatGPT correctly determined the stage in 59.5% of the cases, the grade in 50.5% of the cases and the extent of periodontitis in 84.0% of the cases. The levels of agreement between the RDs and ChatGPT’s responses in terms of stage, grade and extent of periodontitis were determined. Moderate agreement was observed in terms of periodontitis stage (kappa of >0.4 to <0.6). Fair agreement was seen in terms of grade (kappa of >0.2 to <0.4). Regarding the extent, there was a substantial agreement (kappa of >0.6 to <0.8). ChatGPT used confident language consistently, even when incorrect (100%, 200 of 200).

The multiple correspondence analysis showed high variance (64.08%) between ChatGPT’s stage, RD’s stage and the variables affecting the periodontitis stage (CAL, PD and RBL). There was observed correspondence among RD’s stage I, ChatGPT’s stage I, 1-2mm CAL, PD of up to 4mm and RBL below 15. A strong correspondence was seen among RD’s stage II, ChatGPT’s stage II, CAL of 3-4mm, PD of up to 5mm, and RBL between 15 and 30%. ChatGPT’s stage IV, the number of teeth loss is five and above, ChatGPT’s stage III, RD’s Stage III, 5mm and above CAL, 6mm and above PD, RBL greater than 30% values were very close to each other. Additionally, they were located close to the point of origin. The variables and ChatGPT’s stages III-IV exhibited a lack of clear distinction.

In the context of multiple correspondence analysis, the proportion of variation accounted for by the variables ChatGPT’s grade, RD’s grade, RBL/age, smoking and diabetes status, and the phenotype of destruction was found to be relatively low, namely 42.71%. It was observed that ChatGPT’s grade B corresponds to DCB and $10>$cigarettes a day. There was correspondence among ChatGPT’s Stage C, RD’s Stage C, RBL/Age ratio of >1, $10\leq$cigarettes a day and DEB but no correspondence was observed between ChatGPT’s Grade A-B and RD’s Grade A-B.

Conclusions

ChatGPT was better at diagnosing the extent and distribution of periodontitis impacted by a single component than the stage and grade influenced by numerous components and modifying variables. ChatGPT’s periodontitis classification performance was reasonable, but future improvements are expected. Further research is required to fully comprehend its capabilities and limitations and to identify optimal approaches to their integration into clinical practice.

Implications for practice

AI technology is advancing rapidly and will certainly be useful as an adjunct for clinical diagnosis. However, the final responsibility still lies with the clinician in determining diagnosis and treatment decisions.

REFERENCE

1. Tastan Eroglu Z, Babayigit O, Ozkan Sen D, Ucan Yarkac F. Performance of ChatGPT in classifying periodontitis according to the 2018 classification of periodontal diseases. Clinical Oral Investigations. 2024 Jun 29;28(7):407

CPD questionnaire on page 346

The Continuing Professional Development (CPD) section provides for twenty general questions and five ethics questions. The section provides members with a valuable source of CPD points whilst also achieving the objective of CPD, to assure continuing education. The importance of continuing professional development should not be underestimated, it is a career-long obligation for practicing professionals.