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ENDURING MONOMER ELUTION FROM UNALIKEUNADVENTUROUS AND CAD/CAM DENTAL POLYMERS THRU ARTIFICIAL AGING

[1]S.RAM MOHAN REDDY, [2]E. VENKAT REDDY,[3]A. ARUNA JYOTHI, [4]A.RAVEENDRA

[1,2,3]Asst.Professor, Department of Mechancial Engineering, Malla Reddy Engineering College (Autonomous), Maisammaguda(H), Gundlapochampally Village, Secunderabad, Telangana State – 500100

[4]Assoc.Professor, Department of Mechancial Engineering, Malla Reddy Engineering College (Autonomous), Maisammaguda(H), Gundlapochampally Village, Secunderabad, Telangana State - 500100

ABSTRACT

Objectives: Analyze and quantify the residual monomer elution of nine conventional and CAD/CAM (computer-aided design/ computer-aided manufacturing) dental polymers during artificial aging. Materials and methods: A total of 360 square–shaped specimens (14 × 12 × 2 ± 0.05 mm) were fabricated from eight CAD/CAM polymer blanks (n = 40): Avadent Base material, Avadent Teeth material, PMMA Multi blank, PMMA Mono blank, Temp Premium, Telio CAD, Ceramill Temp, Shofu Block HC, and conventional polymer PalaXpress. Specimens were aged in distilled water for 60 days at 37 °C and the evaluation of the residual monomer elution was made through UV spectrophotometry. Statistical analysis was carried out in the SPSS software. One-way ANOVA and Scheffé post hoc test were applied ($\alpha < 0.05$). Results: Aging time significantly changed the elution in all groups, except for PalaXpress. Statistically significant differences of elution were found between the materials. Shofu Block HC presented the highest, whereas PMMA Multi blank A3 and Mono blank A1 presented the lowest elution after the 60th day of aging. Conclusions: CAD/CAM dental polymers as well as the conventional polymer PalaXpress eluted residual monomer within aging time. The differences in elution were material-dependent; still, the maximum elution found is below the specified threshold of ISO standard 20795-1. Clinical relevance With the evolution of CAD/CAM technology, material's manufacturers have invested in the development of polymeric materials with higher resistance and stability to produce indirect restorations using CAD/CAM. It is expected that these materials present lower elution of residual monomer than conventional polymers.

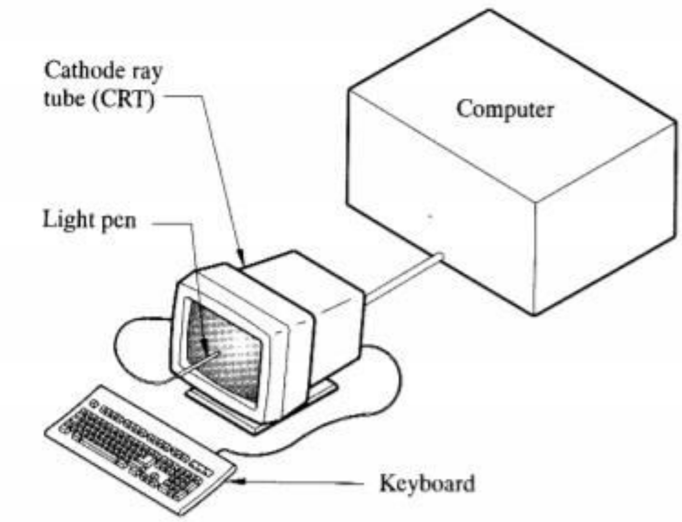
INTRODUCTION

Conventional prosthodontics is an area of dental technology that involves a multitude of time-consuming manual steps. Unsurprisingly, efforts to streamline the time-intensive process and make the procedures more user-friendly have been ongoing for some time now. Digitalizing as many of the procedures as possible is an essential step in achieving this. However, digitalizing the esthetically demanding field of complete prosthetics poses tough challenges to developers. Although elaborately layered, esthetic denture teeth can be produced with appropriate acrylic material, they are difficult to integrate into a digital process. The reason for this is that prefabricated teeth tend to extend beyond the denture base and require shortening. To find a way around this problem, IvoclarVivadent developed a patented process, called "Glue & Mill"1 , to facilitate the integration of highly esthetic teeth into the digital workflow. With this method, the teeth are integrated into the denture base and then reduced (if and as required) by recontouring the basal surface of the denture. Yet, prefabricated denture teeth entail additional problems: for instance, they cannot be customized, involve a complicated cementation process, require the use of a transfer template (normally a dental positioning device) for securing in the correct position and they necessitate a large number of tooth sets of different shapes, shades and sizes to be kept in stock. Against such a backdrop, our task was to develop a material disc that could be processed using digital technology – and in this case milling tools – without diminishing the physical qualities or esthetics of the teeth.

Chemical structure

Proven DCL material was employed to develop the monochromatic SR Vivodent CAD discs. DCL is short for "double cross-linked" and refers to the high chemical resistance provided by the high degree of polymeric cross-linking. The form and size of the highly cross-linked organic fillers have been tailored for optimum gloss retention and polishing properties. In addition, the fillers are designed to feature a significantly reduced susceptibility to wear. Thus, the DCL polymer formed a reliable basis to develop a material that was able to meet the stringent requirements placed on a material in permanent use. Some cunning was necessary to design a monochromatic material that could be used to provide esthetic tooth replacements. For this purpose, the existing relationships between pigment-based shading, scattering effect of the translucent fillers and the opacity of the resin matrix were examined in detail.

The findings were used to create an optimally balanced variant, for which a patent application was filed 2 . This formulation makes it possible to mill denture teeth and entire tooth segments that feature a translucent incisal area and yet demonstrate the required chroma emanating from the depth of the tooth. The fillers used in the material provide special gravel-like contours, which distinguishes them from the spherical fillers typically used in dental materials. The uneven shape prevents the filler grains from becoming dislodged if the softer matrix material surrounding them is eroded.



Early CADD hardware

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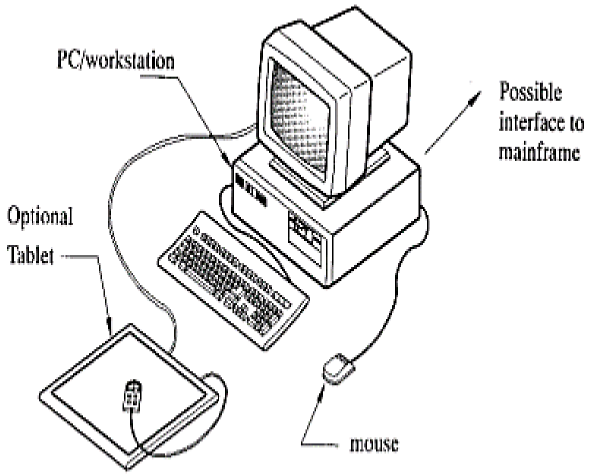

Typical modern CADD hardware

Materials testing

To date, no specific test methods have been defined for testing material discs designed for milling prosthetic teeth. In the light of this fact, the current standard for artificial teeth materials (ISO 22112:2017) served as a guide to test the material in ways that are commensurate with its field of application. In essence, the following material-specific tests, among others, were deemed relevant:

- Bonding to denture base polymer
- Resistance to blanching, distortion and crazing
- Colour stability
- Dimensional stability

For these tests, we first milled teeth, in the appropriate geometry, from the discs and then we tested them in the same way as we would have tested prefabricated denture teeth. The values typically obtained with prefabricated teeth were employed as reference values. In addition, we devised methods to test entire tooth segments. To assess the static benefit of bridged tooth segments, bonded tooth segments and bonded individual teeth were tested under identical conditions. These investigations were extended to test the IvoBase CAD Bond bonding system in conjunction with specified denture geometries (see page 16 onwards).

The mean static loads (N) registered were: A – 2904.13 (159.33); B – 2716.55 (307.14); C – 2539.96 (153.17); D – 2263.17 (167.96). Statistically significant differences were found between all groups ($p < 0.05$). The differences in survival after fatigue between groups was statistically significant, except between Groups A and C ($p = 0.86213$). The mode of fracture was always catastrophic (split) in Group A (without fibers) while in Groups B and C the crack was mainly partially deviated, and in Group D it was mostly totally deviated, with few differences between fractures occurred under static or dynamic loads. In all deviated fractures, the fractographic analysis confirmed the stress-breaking effect of the FRCs layer

The manufacturing process has been fundamentally changed by the introduction of the 20-mm material disc. When conventional teeth are manufactured, the resin material is built up in very fine layers, resulting in correspondingly low-volume final moulds that are then polymerized (prefabricated teeth often have a volume of less than 1 ml). By contrast, when discs are manufactured, a bulk-polymerization process is involved with different exigencies: a smooth and homogeneous polymerization and cross-linking process is required to obtain a good material quality and avoid possible material defects, such as porosities or inhomogeneities. While porosities are

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normally detected in the course of in-process checks, different test methods are required to assess the homogeneity of the material. The chipping test has been especially developed for this purpose and has proven to be one of the most useful methods. In the process, teeth are milled from discs in various configurations and loaded until they break. The fracture pattern and the load-to-fracture value provide a good picture of the quality of the polymerization and the level of homogeneity within the material. They also indicate if the material is too brittle.

The variety of drawings that are utilized in engineering are too numerous to illustrate individually here. A few examples from engineering disciplines will demonstrate the versatility of modern CAD systems.

- Aerospace: Layout drawings, part drawings, subassemblies, assemblies
- Chemical: Process schematics, process plant layout drawings
- Civil, Construction: Structural detail drawings, site plan drawings, construction drawings, road - use plans
- Electrical, Computer: Circuit board design, very large system integration (VLSI) design
- Industrial and Manufacturing: Manufacturing plant layout drawings, subassemblies, assemblies
- Mechanical : part drawing, subassemblies, assemblies

The advantages of using CADD systems are listed as follow:

- constant quality drawing the quality of lines, dimensions, symbols, notes, etc., are independent of the individual skill of the draughtsman;
- creation of database, which is the collection of useful information that may be retrieved by draughtsmen and accessed by other processors;
- creation of library of commonly used electrical, hydraulic, welding, etc., symbols standard components such as nuts, bolts, screws, bearings, etc., projection symbols, parts of drawings, etc., can be stored in the memory and recalled when needed and additionally they can be positioned anywhere on the screen and redrawn to any scale and angle of inclination.
- use of layers the drawings may be drawn on any one of a number of available layers, which may be considered as a stack of transparent sheets and any separate sheet can be selected for drawing construction lines, grids, dimensions, notes, hatching, etc., but to make up together a complete drawing when required.
- saving on repetition repetitive work on similar features or drawings and the resulting tiredness and boredom is replaced by automatic redrawing, hence attention and interest are maintained with the consequent marked increase in speed and productivity;
- greater accuracy due to computer mathematical accuracy, a high

level of dimensional control is obtained with reduction in the number of mistakes resulting in accurate material and cost estimates;

- multicolour drawings visualisation of drawings relates directly to the projection used, pictorial projections are easier to understand than orthographic projection and the different colours obtainable by computers enhance the understanding even further;
- editing functions the powerful editing functions of correcting mistakes, deleting and inserting new features, copying, moving, translating and rotating features, scaling, etc., is only made possible with the use of computers.

CADD Software Structure:

The database for a CADD package contains data defining the two- or three-dimensional geometry of the drawing or design. It can be viewed as a mathematical model which is a precise geometrically accurate representation of the component or assembly. The input to this is the addition to and modification of the model by the designer or draughtsman and includes the addition of geometric and detail entities such as lines, curves, points, notes or dimensions and modification to correct errors and enhance productivity. These additions and modifications should immediately be seen on the graphical display, which is the main interactive output medium of the software and therefore needs to be very effective. In the case of draughting one needs to be able to add a drawn feature with as much or greater ease than one would be able to do on a drawing board.

Forty two human freshly extracted molars were cut to expose middle dentin and then polished with #600 grit silicon carbide for 60 s to create a standardized smear layer. Afterwards, specimens were randomly assigned into 3 groups according to the cavity preparation method (n = 11): G1 (control – high speed conventional preparation); G2 (200mJ/20 Hz/50s) and G3 (200mJ/20 Hz/300s). The laser wavelength (2.94m) was set with cooling spray at 4A/6W. Thereafter, self-etch universal adhesive (3 M/ESPE) was applied to a flat occlusal dentin surface according to manufacturer's instructions and a resin composite (Filtek Z350 3M/ESPE) block (5mm-high) was built in order to produce the specimens. After 24 h storage in distilled water at 37 ◦C, the composite/dentin sticks were prepared (1mm2) and TBS test was performed. In addition, nine dentin discs per group were prepared to perform the analysis of the behavior of collagen fibrils by second harmonic generation (SGH) (at 380 nm excitation) and hybrid layer formation/resin tags extension using confocal laser (at 800 nm excitation). In both analyses, fluorochrome Rhodamine B was added to the adhesive

METHODOLOGY

Computer aided drawing

Designers generally use drawings to represent the object which they are designing, and to communicate the design to others. Of course they will also use other forms of representation

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1. Symbolic and mathematical models, and perhaps three-dimensional physical models
2. but the drawing is arguably the most flexible and convenient of the forms of representation available. Drawings are useful above all, obviously, for representing the geometrical form of the designed object, and for representing its appearance. Hence the importance in computer-aided design (CAD) of the production of visual images by computer, that is computer graphics.

In the process of design, technical drawings are used. Drawings explain the design and also establish the link between design and manufacture. During the stage of design and detailing depend on the designers' skill and experience. Changes in previous designs take a long time because the drawings have to be produced again.

Computer-aided drawing is a technique where engineering drawings are produced with the assistance of a computer and, as with manual drawing, is only the graphical means of representing a design. Computeraided design, however, is a technique where the attributes of the computer and those of the designer are blended together into a problem-solving team. When the term CAD is used to mean computer-aided design it normally refers to a graphical system where components and assemblies can be modelled in three dimensions. The term design, however, also covers those functions attributed to the areas of modelling and analysis. The acronym CADD is more commonly used nowadays and stands for computer-aided draughting and design; a CADD package is one which is able to provide all draughting facilities and some or all of those required for the design process.

Two-dimensional (2D) computer drawing is the representation of an object in the single-view format which shows two of the three object dimensions or the mutiview format where each view reveals two dimensions. In both cases, the database includes just two values for each represented coordinate of the object. It can also be a pictorial representation if the database contains X, Y coordinates only.

Three-dimensional (3D) computer drawing is the coordinate format. Three dimensional computer aided drawing allows the production of geometric models of a component or product for spatial and visual analysis.

CONCLUSION

According to the results presented and taking in consideration of the limitations of this study, it can be concluded that:

1. Similarly to conventional PMMA, CAD/CAM polymers release residual MMA and other monomers through the elution process within aging.
2. Differences in elution were material-dependent in this study.
3. The quantities of residual MMA eluted from all the materials are under the established limits for dental polymers in the ISO 20795-1.

REFERENCES

1. Pfeiffer P, Rosenbauer EU (2004) Residual methyl methacrylate monomer, water sorption, and

water solubility of hypoallergenic denture base materials. J Prosthet Dent 92:72–78

2. Kedjarune U, Charoenwolaruck N, Koontongkaew S (1999) Release of methyl methacrylate from heat-cured and autopolymerized resins: cytotoxicity testing related to residual monomer. Aust Dent J 44:25–30
3. Ivkovic N, Bozovic D, Ristic S, Mirjanic V, Jankovic O (2013) The residual monomer in dental acrylic resin and its adverse effects. Contemp Mater 4:84–91
4. Rao MRN, Reddy NS, Ramasay C, Banj RF (2016) Spectrophotometric analysis of residual monomer in acrylic resin samples processed with two different polymerization methods. Indian J Dent Sci 8:35–37
5. Stafford GD, Brooks SC (1985) The loss of residual monomer from acrylic orthodontic resins. Dent Mater 1:135–138
6. Goiato MC, Freitas E, Santos D, Medeiros R, Sonego M (2015) Acrylic resin cytotoxicity for denture base – literature review. Adv Clin Exp Med 24:679–686
7. Saravi ME, Vojdani M, Bahrani F (2012) Evaluation of cellular toxicity of three denture base acrylic resins. J Dent (Tehran) 9:180–188
8. Jorge JH, Giampaolo ET, Machado AL, Vergani CE (2003) Cytotoxicity of denture base acrylic resins: a literature review. J Prosthet Dent 90:190–193
9. Lung CYK, Darvell BW (2005) Minimization of the inevitable residual monomer in denture base acrylic. Dent Mater 21:1119–1128
10. Bettencourt AF, Neves CB, Almeida MS, Pinheiro LM, Oliveira SA, Lopes LP et al (2010) Biodegradation of acrylic based resins: a review. Dent Mater 26:e171–e180
11. Urban VM, Cass QB, Oliveira RV, Giampaolo ET, Machado AL (2006) Development and application of methods for determination of residual monomer in dental acrylic resins using high performance liquid chromatography. Biomed Chromatogr 20:369–376
12. Giunta JL, Grauer I, Zablotsky M (1979) Allergic contact stomatitis caused by acrylic resin. J Prosthet Dent 42:188–190
13. McCabe JF, Basker RM (1976) Tissue sensitivity to acrylic resin. A method of measuring the residual monomer content and its clinical application. Br Dent J 140:347–350
14. Harrison A, Huggett R (1992) Effect of the curing cycle on residual monomer levels of acrylic resin denture base polymers. J Dent 20:370–374
15. Nisar S, Moeen F, Khan YH (2015) Effect of varying powder liquid ratios and curing conditions on the residual monomer concentration of heat cure acrylic resin. Pakistan Oral Dent J 35:713–718