International Journal of Applied Dental Sciences 2018; 4(4): 367-370

ISSN Print: 2394-7489
ISSN Online: 2394-7497
IJADS 2018; 4(4): 367-370

www.oraljournal.com
Received: 21-08-2018
Accepted: 25-09-2018

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Comparison of flexural strength of two commercially available heat polymerized PMMA

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Abstract
Aim: Present study aims to compare the flexural strength of 2 commercially available, heat-polymerized acrylic denture base materials (DPI and Trevlon).
Materials and Methods: Fifteen specimens of ISO specified dimensions are prepared for both the experimental groups 30 dental stone molds were prepared using brass metal dies of ISO specified dimensions. All samples were tested for flexural strength according to ISO specification 1657 with the use of a three point loading apparatus in the universal testing machine at a crosshead speed of 5 mm/min.
Results and Discussion: The mean flexural strength of conventional heat polymerized acrylic resin DPI Group - A was found to be 76.52 $\pm$ 5.423125 MPa The mean flexural strength of unreinforced conventional heat polymerized acrylic resin Trevalon Group - D was found to be 109.56$\pm$ 7.558231MPa There was a significant difference between the flexural strength of the two commercially available PMMA.
Conclusion: Within the limitations of this in vitro study the following conclusions can be drawn: 1.There exists a marked difference between flexural strength properties of the two commercially available PMMA. 2. There is a need to make informed evidence based choices in selection of denture base materials in clinical practice.

Keywords: PMMA, flexural strength, heat polymerized, denture base, resin

Introduction
One of the most widely used materials in prosthetic dentistry is polymethyl methacrylate. Since it was introduced to dentistry in 1937 by Dr. Walter Wright, [1] it has been successfully used for denture bases, artificial teeth, and impression trays. However, the primary problem is its poor strength characteristics, including low impact strength and low fatigue resistance. Polymethyl methacrylate is the most commonly used denture base resin due to its various desirable properties. However, there is inherent disadvantage of low flexural strength which leads to fatigue fractures in dentures. This not only increases the expenditure of the patient but also causes great inconvenience. Various modalities have been tried to overcome this problem with varying degrees of success. It is desirable have a denture base material with high fatigue and impact resistance. Present study aims to compare the flexural strength of 2 commercially available, heat-polymerized acrylic denture base materials (DPI and Trevlon). Although the impact strength increases by the addition of plasticizing ingredients, other properties such as elastic modulus, fatigue, and transverse strength are reduced. According to a survey conducted by U. R. Darbar [2] *et al* in 1994 fracture of PMMA denture base is a common clinical problem. Literature is replete with considerations of resin denture bases fracture being an unresolved predicament. A significant saving in expenditure would result if a cost effective material with enhanced fatigue and impact resistance was readily available [3]. The most popular material at present for the fabrication of dentures, which has high impact strength, is rubber modified acrylic polymer whose handling characteristics are more or less identical to conventional PMMA [4]. This study compared the flexural strengths of two commercially available conventional PMMA resins.

Materials and Methods
Materials used in the study
1. Heat polymerized denture base material,-polymer and monomer DPI-heat Cure (pink),

Mumbai. Batch no. Polymer-762, monomer-766.

2. Heat polymerized denture base material,-polymer and monomer. Trevalon. Dentsply India Pvt. Ltd. Gurgaon, (pink). Batch No. Polymer- T051228, monomer- UL 050203 (Figure 1).

Preparation of specimen

Fifteen specimens of ISO specified dimensions (64 X 10X 2.5 mm^3) are prepared for both the experimental groups (Table 1) 30 dental stone molds were prepared using brass metal dies of ISO specified dimensions. Each die (Figure 2) was coated with a thin layer of petroleum jelly before being invested in dental stone for ease of removal. After the final set of the dental stone, the flask was opened, and the die was gently removed from the investing material. The master die had a threaded hole in the center to facilitate easy removal from the stone mold. The prepared molds then were immersed in hot water to remove any trace of impurities and to facilitate the application of separating medium. Two coats of separating media were applied with a brush while the flasks were still warm. The mold cavities obtained were used for the preparation of acrylic resin test specimens. The test specimens were made with conventional heat-polymerized acrylic resin - polymer and monomer DPI-heat Cure (pink), Mumbai. Batch no. Polymer-762, monomer-766 and Heat polymerized denture base material,-polymer and monomer. Trevalon. Dentsply India Pvt. Ltd. Gurgaon, (pink). Batch No. Polymer-T051228, monomer- UL 050203.

A mixture of monomer and polymer in the ratio of 1:2.4 by weight was allowed to reach dough stage, then kneaded and placed in the mold. Trial closure was performed with a hydropress. The flask was clamped, and low pressure was maintained for 30 minutes to allow proper penetration of monomer into the polymer, even flow of the material, and outward flow of excess material. The flask was immersed in water in an acrylizer (Kavo, GmbH, D7970, West Germany) at room temperature. The temperature was gradually raised to 73 °C and maintained for two hours followed by a gradual increase to 100 °C and maintained for one hour. After completion of the polymerization cycle, the flask was allowed to cool in the water bath to room temperature before deflasking. The acrylic specimens then were retrieved, finished, and polished.

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Testing the flexural strength

The sizes of the specimens were measured and differences in dimensions were eliminated by grinding the specimens to the predetermined dimensions.(Figure 5) All the samples were stored in distilled water at room temperature for 50 +/- 2 hours before the testing procedure. All samples were tested for flexural strength according to ISO specification 1657 (65 X 10X 2.5 mm^3) with the use of a three point loading apparatus in the universal testing machine (H50KN Hounsfield Tensometer, Surrey, UK) (Figure 3) at a crosshead speed of 5 mm/min. A load was applied by a centrally located rod until fracture occurred. (Figure 4). The flexural strength was calculated using the following formula.

$$FS = \frac{3}{2} \times \frac{pl}{bd^2}$$

Where FS is flexural strength, p is the peak load applied, l is the span length, b is the sample width, and d is the sample thickness.

Statistical analysis

After data collection, mean values and the Standard Deviations of the flexural strength, for each group were analyzed. The statistical computations were made with statistical software (SPSS version 12.0 for Windows; SPSS Inc, Chicago, Ill).

Results and Discussion

Johnson and Matthews [5] (1949) stated that on an average a denture flexes about 500,000 times a year. They noted that polymethylmethacrylate resin had a tendency to fracture at midline due to flexural fatigue failure. Matthews E, Wain EA [6] (1956) measured the stresses in denture bases during function. They concluded that the stresses are confined to the palatal aspect of dentures and area lingual to the incisors. They found that the incisal notch was the prime factor in midline fracture and most fractures originated from the base of this notch. Smith DC [7] (1957) stated that fractures of the dentures excepting some accidental causes such as impact were due to flexural fatigue. He discussed the then recent developments in non-metallic denture base materials. He also discussed different alternatives to polymethylmethacrylate. Grant WFD [8] (1960) studied the fracture of acrylic and modified co- polymer vinyl dentures. He concluded that out of 695 acrylic dentures constructed in a period of five years, 14.4% or 100 dentures fractured. Out of this in 8.6% or 59 denture fractures were due to denture base failure. Smith [9] (1962) found midline fractures to be a common problem in maxillary complete dentures and stated that such fractures were caused by flexural fatigue phenomena. He discussed the status of acrylic resin as a denture base material. He also discussed recent development in acrylic resins and alternatives to polymethylmethacrylate. He compared the mechanical properties including flexural strength and stiffness of polymethylmethacrylate, high impact polymethylmethacrylate, nylons, epoxy resins, high impact polystyrene, high density polythene, polyacetal, polycarbonate and chlorinated polyether. He found that nylons do not fracture under test conditions and are too flexible while polymethylmethacrylate has highest strength.

Lambrecht JR, William LK [10] (1962) analyzed the functional stress in maxillary complete denture bases. They found that midline fractures often originated at the labial or anterior part of the palatal aspect of the dentures. The mean flexural strength of conventional heat polymerized acrylic resin DPI Group - A was found to be 76.52 $\pm$ 5.423125 MPa (Table 1) which compared with previous study by Arundati R and Patil NP [11] (52.36$\pm$ 2.5). However, the curing cycle used in that study was different (73 C for 90 mins and 100 C for 30 mins)

The mean flexural strength of unreinforced conventional heat polymerized acrylic resin Trevalon Group - D was found to be 109.56± 7.558231MPa which was in agreement with previous study by Gutteridge DL [12] (1992) 92.7± 8. There was a significant difference between the flexural strength of the two commercially available PMMA.

Fig 1: Materials Used in the Study

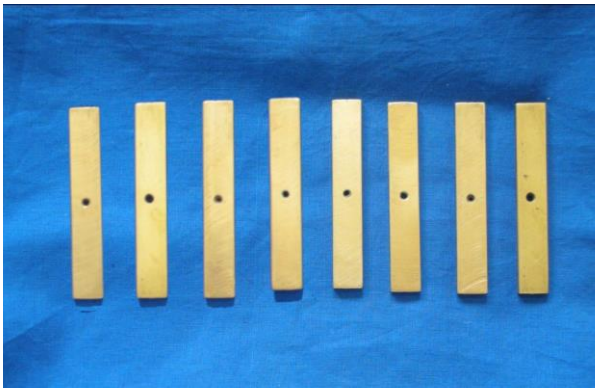

Fig 2: Metal Dies

Fig 3: Universal Testing Machine

Fig 4: Specimen Loaded in Three Point Apparatus

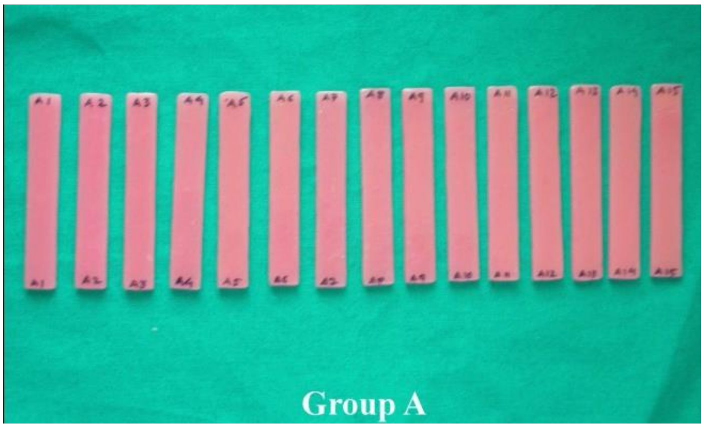

Fig 5: Test Specimens (GROUP A)

Table 1: Descriptive ANOVA

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1 Group A	15	76.52	5.423	1.400	73.52	79.52	70	86
2 Group B	15	109.56	7.558	1.952	105.37	113.75	98	124

Conclusion

Within the limitations of this in vitro study the following conclusions can be drawn: 1. There exists a marked difference between flexural strength properties of the two commercially available PMMA. 2. There is a need to make informed evidence based choices in selection of denture base materials in clinical practice.

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