Palatal Shape And Flexural Strength Of Maxillary Denture Bases

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Abstract

Nearly 90-95 % of denture bases are fabricated using acrylic resins. Acrylic resin in many ways comes close to meeting the requirements of an ideal non-metallic denture base material but still it is not without drawbacks. One of the greatest drawbacks is its relatively low resistance to fracture failure. The basic problem that has been faced with the use of polymethylmethacrylate material is the incidence of midline fracture of maxillary denture bases. A number of predisposing factors have been recognized for the incidence of such factors. This study was undertaken to determine whether the shape of the underlying palate combined with the thickness of denture base would affect the strength of base. For the study, 45 denture bases of heat cure acrylic resin were fabricated on 3 different shapes of the palate and of 3 different thicknesses and then all these samples were tested for fracture toughness under the universal testing machine and the results were analysed.

Keywords: Flexural strength, denture base resins, fracture resistance

Introduction

Resins are one of the commonest and the most acceptable material used in the construction of denture bases since 1935. The popularity of these resins relates to their ability to be formed into complex shapes by the application of heat and pressure. Acrylic resin in many ways comes close to meeting the requirements of an ideal non-metallic denture base material but still it is not without drawbacks. One of the greatest drawbacks is its relatively low resistance to fracture failure.[1] Since years the basic problem that has been faced with the use of this material is the incidence of midline fractures of acrylic resin denture bases. A number of predisposing factors have been recognized for the incidence of such factors. These include unsatisfactory occlusion, poor fit of the prosthesis, deep frenal notches, sharp changes in the contour of the denture bases, incisal notches and finally impact failures. In the absence of all these factors also, fractures are known to occur because of other reasons. Deformation of denture bases occur under masticatory loads and the number of flexions is estimated as close to 500,000 per year. [2]

Over several years, the denture base thus experiences several million flexions during use.[3,2] Maxillary denture bases will thus deform away from the palatal tissues and so fatigue might be a significant factor in fractures. So this incidence of midline fractures needs to be lessened. There are two ways this objective can be achieved. First, an alternative material of great inherent resistance to flexural fatigue can be used and second is to reduce the stress borne by the denture base, which depend on a number of factors such as area and shape of the denture bearing tissues and the thickness and compressibility of the mucosa. The only factors which are under operators control are the thickness of the denture bases or the reinforcement of the denture bases with a suitable material to increase its strength.

Thus it was decided to determine as to whether the shape of the underlying palate combined with the thickness of denture base affects the strength of acrylic resin denture base which is the most commonly used material for the fabrication of the denture bases.

Smith D.C. (1961), 4 did a study on the

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mechanical evaluation of dental polymethylmethacrylate and the effect of water absorption on dentures. He concluded that the most important mechanical property of the denture base so far as the life of the denture is concerned is the resistance to flexural fatigue. He also concluded that crack initiation and development in the acrylic resin is more likely to occur under fatigue conditions. He further said that absorbed water seriously lowers the flexural strength of acrylic resin denture base.

Lambrecht R. James and William L. Kydd (1962) 5 did a study on the functional stresses in the maxillary complete dentures and concluded that if the denture base is more rigid, the frequency of midline fractures will be reduced. They also found out that midline fractures most commonly begin either at the labial notch or in the anterior part of the palate of the denture bases.

Morris C.J. Zafrulla Khan and J. Anthony Von Fraunhofer (1985)2 concluded that the shallow palatal vault bases are inherently weaker and less resistant to fracture than the medium and deep palatal vault bases. Increase in base thickness would increase the fracture resistance of the bases but at the same time a thickness of 3-3.5 mm is not clinically acceptable.

Aims And Objectives

The following were the aims and objectives for undertaking this study

to determine whether the shape of the underlying palate combined with the thickness of denture base would affect the strength of base

to determine the fracture energies of the different thickness of denture bases in three different shapes of palatal vault.

to finally determine the type of thickness of the denture base to be given for each type of palate.

Materials and Method

An in-vitro study was carried out to evaluate the relationship of palatal vault shapes to the flexural strength of maxillary denture bases. Following materials were used in this study.

Table 1

1. Jeltrate (alginate impression material) Dentsply India Pvt. Ltd. New Delhi
2. Dental stone (Dentsply India Pvt. Ltd. New Delhi)
3. Acrylin H-fibre reinforced heat cure acrylic (Asian Acrylates, Mumbai)
4. Modelling wax no.-2 (Hindustan Dental Products, Hyderabad)
5. Dental plaster (Prevest denpro Ltd. Jammu)
6. Separating medium (Deepti Dental Products, Ratnagiri)
7. Distilled water (Savita Chemical Industries, Belgaum)

Table 2

Equipment used

1. Three plaster master casts representing shallow, medium and deep palatal vault shapes.
2. Three custom made perforated acrylic special trays for making impressions.
3. Rubber bowl and plastic spatula
4. Borosil water measure (in ml)
5. Vacuum mixer (Multi Vac Degussa, Germany)
6. Clamp and flasks
7. Electronic preset digital curing machine
8. Wax knife
9. Carver
10. Acrylic trimmers and polishing burs
11. Pre-heating oven Dial caliper
12. 5 mm diameter rod
13. Universal testing machine

Methodology

Three edentulous maxillary casts representing different palatal vault shapes, i.e., shallow, medium and deep were selected from clinical laboratory. Each cast was duplicated 15 times with irreversible hydrocolloid material (alginate) by using custom made acrylic perforated trays. (Figure 1). Five casts of each palatal form were waxed with a single thickness of base plate wax, five with double thickness and remaining five with three thickness thus making a total of 15 patterns for each type of palatal form and similarly a total of 45 patterns were prepared for three different types of palatal vault shapes. (Figure 2). These patterns were invested, dewaxed and processed to denture bases with fibre reinforced heat cure acrylic following the conventional technique. (Figure 3). Short curing cycle involving 74 °C for 2 hours and then increasing the temperature to 100 °C for 1 hour more was used. After finishing and polishing the samples, they were stored in distilled water for 2 days at 37°C in a preheating oven. (Figure 3). The thickness of each of the 45 acrylic resin bases were then measured in midline, first premolar, second premolar and anterior region and recorded and mean thickness was calculated for all the specimens. Mean was calculated as some discrepancy in the thickness was expected to take place during waxing, processing and final finishing and polishing procedures.

Samples were tested in a universal testing machine with a 5 mm diameter rod. (Figure 4). The non tissue side of the bases were placed on the plate of the universal testing machine and were loaded in compression at 5mm/min by a 5 mm diameter flat ended rod mounted in the upper jaw of the machine. As the specimen was subjected to load, the dial gauge needle also moved and the reading at the time of fracture of the specimen was noted. This reading was multiplied by 0.01 and deflection at fracture was obtained in millimeters. Like, if reading was (n) then deflection at fracture = n x 0.01 mm

To convert it into cms, it was divided by 10 i.e., (n x 0.01) cm 10

The final fracture energy was calculated as half the product of fracture load and deflection at fracture. i.e., (load x deflection) kg/cm2 2 The readings so obtained have been summarized in the table and were statistically analyzed and compared.

Results

The shallow palatal vault bases are inherently weaker and less resistant to fracture than the medium and deep palatal vault bases in all the three thicknesses. Increase in the denture base thickness from 1.5-3.5 mm increases the fracture resistance, (Figure 6) but a thickness of more than 2-2.5 mm might not be clinically acceptable. Also the increase in base thickness increases the strength of the denture base but the increase in the strength is probably not enough to justify a greater mass of material in the mouth. Ideal thickness for any denture base is 2mm, but as the shallow palatal vault bases exhibit low strength at this thickness, special considerations may be used.

Discussion

Nearly 90-95 % of denture bases are fabricated using acrylic resins. Over the years, the basic problem that has been faced with the use of polymethylmethacrylate material is the incidence of midline fracture of maxillary denture bases. The results of this study indicate that with all the three types of palates, there is an increase in the fracture load on increase in the base thickness. Thus the fracture load for a triple thickness base was almost 4 times that of single thickness base and almost twice that of double thickness base. When the fracture energies were compared, there were highly statistical significant differences between the fracture energies of single and double, double and triple and triple and single thickness bases in the same vault. (i.e. $p < 0.001$). Thus, the fracture energy of the triple thickness bases was found to be highest. It was also concluded that the incisal notch was the prime contributing factor in midline fractures and that it is the base of the notch were fracture originates. Also with an increase in the base thickness there is an increase in the strength but this is probably not enough to justify a greater mass of material in the mouth. It has also been proved that thickening of the palate beyond the normal value of 2-2.5 mm will only increase strain and thus will not help to reduce the risk of fracture. At this point, two practical solutions to the problems of fracture in the weaker shallow palatal vault bases are the use of metal bases and the perfection of occlusion where discrepancies exist. Finally from all these comparisons it was concluded that the shape of the palatal vault and the base thickness significantly affect the fracture resistance of denture bases.

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