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Comparative Adaptation Accuracy of Different Injection Molded Resin Denture Base Materials: A SEM Study

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ABSTRACT

Background: Polymethyl meth acrylate (PMMA) resin has been the most commonly used material for denture bases, despite its popularity, PMMA resin is far from ideal. Polymerization shrinkage and release of thermal stresses are the major disadvantages exhibited by the material. In an attempt to overcome dimensional in accuracies of PMMA resin, new thermoplastic resins and alternative processing techniques have been developed.

Purpose: The purpose of this study was to evaluate and compare the adaption accuracy of two commercially available injection molded resin (Brecrystal and ivoclar).

Materials and Methods: A total of 14 accurate denture bases with the same dimension were fabricated, 7denture bases were made using Ivoclar Injection molding technique and 7 dentures were processed using injection molding technique (Crystal, Bredent, Germany). The adaptation accuracy was examined using Scanning Electron Microscope (SEM). The gap between the resin base and stone cast was measured at canine region and posterior palatal area at five points at 5 points, corresponding to the right and left residual ridge crests, the midline, and the right and left marginal limits of the flanges.

Results: The least total gap score measured was for Bre-Crystal followed by Ivoclar. It has been found that a highly significant correlation was observed for section A, whereas section B showed a significant correlation for Ivoclar denture base material. For Bredent, a statistically significant correlation was found for section B, whereas section A showed an insignificant correlation.

Keywords: Ivoclar denture, Brecrystal denture, Scanning electron microscope, Adaptation accuracy.

INTRODUCTION

Among the polymer materials introduced in prosthetic dentistry, Polymethyl methcrylate (PMMA) is the only proven material for a successful denture base on account of its optimal physical properties and excellent esthetics with relatively low toxicity compared to other plastic denture bases[1-3] . A long established method of denture processing for acrylic resin is a closed flask compression molding system with heat activation in a water bath for resin polymerization. However the polymerization shrinkage of the resin induces distortion of the denture bases due to thermal stress which is virtually unavoidable during the processing of dentures,[4] these added effects result in movement of the prosthetic teeth and increases

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the gap between the denture base and the underlying mucosa which markedly compromise the retention and stability in complete dentures. The distortion during the processing breach the peripheral border seal and increased the volume of internal space beneath the denture base which allowed the ingress of air, saliva, food particles thus compromises retention and stability, eventually resulting in an ill-fitting denture.

Several alternative methods to the conventional compression molding system for denture base Processing have been developed to increase the adaptation of the denture base. Injection molding is one such system introduced to address this issue. A continuous injection molding technique was introduced to eliminate the flash of resin between the halves of the flask and compensated for polymerization shrinkage, [5] by forcing additional resin into the flask during polymerization. Therefore the adaptation, accuracy or dimensional change [6] in the denture bases has become a focus for many studies in removable prosthodontics. It has been suggested that an accurate fitting is a key factor in the physical mechanisms of complete denture retention.

A variety of methods have been used to evaluate the dimensional changes and/or adaption accuracy of a denture base, there is still no gold standard. Microscopic measurements of the posterior border gap[7] and weighing a elastomeric material impressed under a denture base[7,8,9] are one of the most frequently used methods to evaluate the denture adaptation to a master cast due to their simplicity and feasibility. The magnitude of the palatal border gap can express the ability of a border seal, and the weight of an impression material indicates the overall volume of internal space under denture base, which are all important factors in complete denture retention. A reasonable co-relationship between the results of both parameters can be expected for a well-fitted denture base. However, much of previous results regarding the adaptation accuracy of a denture base with variations in the test method are inconsistent [10].

This study compared the adaptation accuracy of a maxillary complete acrylic denture base processed using injection-molding technique by using two commercially available PMMA resins (Brecrystal and Ivoclar). Method of direct measurements of the posterior palatal border gap between the denture and master cast were used to evaluate the adaption accuracy of denture base specimens. A correlation between the data measured using these two different materials was investigated in this study.

MATERIALS AND METHOD

Preparation of denture base samples:

Accurate dentures with the same dimension were fabricated from fourteen master casts(Fig-3). These casts were made from a silicone negative replica (Dupliflex, Proctechno, Spain, batch no. 503- M1Ti). Injection molded dentures of Brecrystal and Ivoclar were polymerized according to each manufacturer instruction.

Brecrystal dentures were cured using thermopress 400 injection molding unit at temperature 260° C and at pressure 5 bar for 26 minutes (Bre-Crystal, pink stippled, Bredent, Germany). After polymerization, the curing flasks were bench cooled to room temperature. Then, they were polished on their casts with a wet rag wheel and pumice. For Ivoclar dentures, Sprues were prepared with modeling wax and were attached to the trial denture is invested in dental stone (Fig- 1). After dewaxing, resin cartridge was introduced into the mold which contains resin in ratio 20gms-30ml. Pneumatic injection mold is used to press material followed by 30 min in boiling water. sprues and small flashes were removed carefully and the denture bases were also polished on their casts with a wet rag wheel and pumice.

Ivoclar trial denture specimen were prepared using shellac base plate adaptation on the ideal edentulous models. Teeth arrangement is done following principles of teeth arrangement. Finishing and polishing of waxed up dentures is done for smooth dentures. The trial denture was flasked in dental flasks with dental stone. Sprues were prepared with modeling wax and were attached to the trial denture is invested in dental stone (Fig – 2). After dewaxing, resin cartridge was introduced into the mold which contains resin in ratio 20gms-30ml. Pneumatic injection mold is used to press material followed by 30 min in boiling

water. All dentures-cast sets were sectioned transversely in canine region and posterior palatal area 5-mm away from the posterior end of the denture base using vertical cutting machine with diamond disk under water cooling (Fig-4).

Measurement of adaptation accuracy:

The adaptation accuracy of the dentures was examined using scanning Electron Microscope with an accuracy of 0.001mm (Hitachi) Resolution .001mm Magnification 3x (Fig – 5 and Fig- 6). The gap between the denture resin base and stone cast was measured at canine region and posterior palatal area at five points, corresponding to the right and left residual ridge crests, the midline, and the right and left marginal limits of the flanges (deepest vestibule gap). The dimension (V), was determined from the mean of both vestibule gaps (V= (V1+V2)/2), similarly the dimension, C, was determined from the mean of both ridge crest gaps (C= (C1+C2)/2).

Three measurements were made at each location and the mean values were calculated. Arithmetical mean of the reference points were considered as the adaptation value for each denture base material.

Fig 1: wax-up denture for Brecrystal.

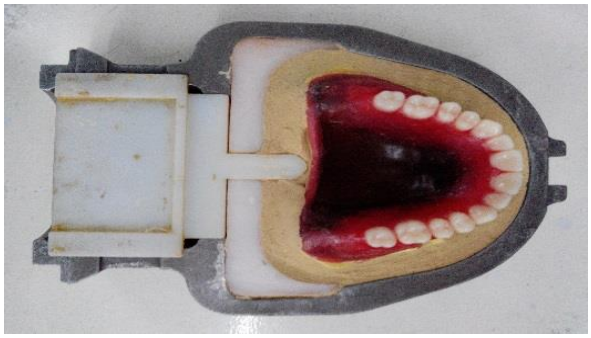

Fig 2: wax-up denture for Ivoclar.

Fig 3: Brecrystal and Ivoclar dentures.

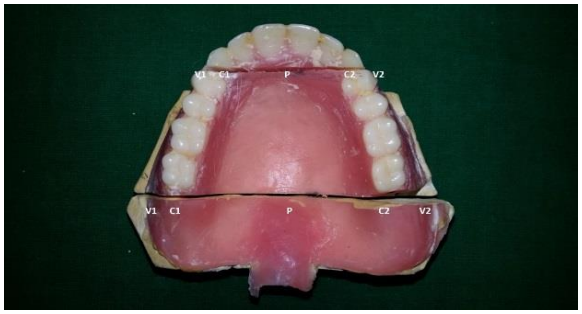

Fig 4: Sectioned denture.

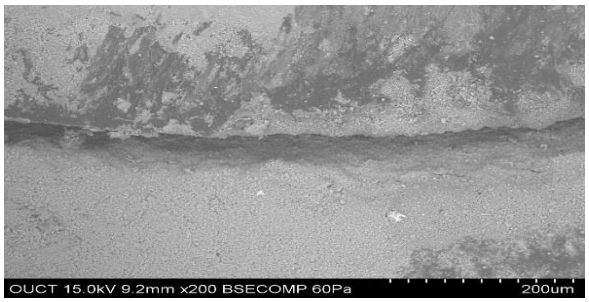

Fig 5: Brecrystal denture SEM image.

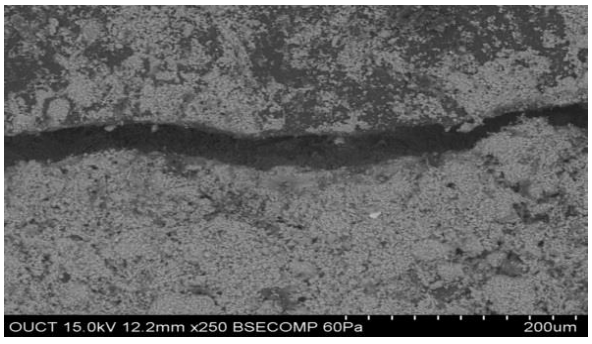

Fig 6: Ivoclar denture SEM image.

Statistical analysis:

All statistical analyses were performed using SPSS software package (Statistical Package for Social Sciences version 20, SPSS Inc, Chicago, IL, USA). Comparisons of data were made by one

sample t-test with a Pearson correlation test at $p<0.05$ level to establish significance of differences.

RESULTS

The Mean values and standard deviations for the maximum posterior border gap (P), crest gap (C) and vestibule gap (V) for different materials are shown in table 2, represents the adaptation accuracy of the two examined dentures.

The statistical correlation between both the sections for the two denture base materials. One-sample t-test was applied to correlate the values of both the sections of individual materials. It has been found that a highly significant correlation was observed for section A, whereas Section B showed a significant correlation for Ivoclar denture base material. For Bredent, a statistically significant correlation was found for Section B, whereas Section A showed an insignificant correlation. Pearson correlation statistical analysis was done to found correlation between the two denture base materials. A positive linear relationship was observed for Bredent, whereas Ivoclar showed a statistically insignificant correlation.

Table 1: Comparison between Ivoclar and Breden.

Material Group	Section A (canine region)			Section B (PPS region)			Total section gap		Total gap score
	V	C	P	V'	C'	P'	A	B	
Ivoclar	47.06±1.29	47.73±1.85	48.25 ± 4.09	35.73 ± 1.67	31.50±3.09	21.41 ± 3.28	47.68±0.59	29.55±7.36	38.62±12.82
Bredent	35.59±1.58	13.67±0.41	34.29 ± 3.05	20.91 ± 1.99	19.47±0.71	27.34 ± 2.33	27.85±12.29	22.57±4.19	25.21±3.73

V=vestibule, C=crest, P=palate, A=section at canine, B=section at PPS

DISCUSSION

It is widely accepted that the successful function of a complete denture is dependent upon its accuracy of fit [11]. Dimensional inaccuracies, because of polymerization shrinkage, have been demonstrated to cause clinical instability of the resulting denture base against the denture bearing tissues [12]. This may in turn lead to pain during function as a result of uneven loading of the denture base. Denture base adaptation depends upon a number of factors, both clinical and laboratory in nature, as well as the dimensional accuracy of the material from which it is constructed [13].

In order to allow accurate comparison of injection molded and conventional pressure packed acrylic denture bases, a re-useable "master" mould was produced. Similar methodology has been used previously [14]. A number of studies have reported that dimensional changes do not occur evenly over the entire denture base [14,15,16,20]. Gap formation between the denture base and cast are generally attributed to polymerization shrinkage of the resin material and a tendency of cooling shrinkage toward the central area of the denture base, as well as to subsequent distortion caused by confinement of the surface topography of the alveolar ridge [17]. Therefore, different gap formation was generally observed between the central portion of the posterior border, the crest of the ridge and buccal vestibule area.

Injection molding has been demonstrated in a number of studies to produce better denture base adaptation than the conventional denture processing technique [15,18]. This study investigated overall base plate adaptation accuracy denture bases produced by conventional pressure packing or injection molding techniques.

The dimensional accuracy of the injection-molded PMMA was better than the conventional PMMA, and these results are in agreement with [14]. Comparative studies have demonstrated that modern injection molding techniques result in fewer dimensional inaccuracies than conventional processing techniques [19,20]. This is based on the

principle that throughout the carefully controlled polymerization procedure, PMMA resin is continuously injected at pressure to compensate for polymerization shrinkage.

The gap pattern demonstrated in the current study confirmed that the dimensional changes of the commercial acrylic resins may be dependent on many factors, such as base thickness [21], different locations of the base [22] and palatal geometry [23], which promote critical effects in the magnitude and localization of the distortion, mainly occurring in the posterior palatal region. Therefore, the distortion pattern of the base obtained in this study agrees with those of previous investigations [24] also showing the complexity of the gap formation which involves diverse and different factors.

The gap formation occurring during the complete denture procedure has been recognized by several authors [25] and still continues to be the major disadvantage of the process. In this study, the smaller gap values for the Bre-Crystal system packing method compared with the conventional method, independently of the other factors, indicates that the dimensional change occurred in the denture base was influenced by the resin packing method [26]. It is debatable whether the differences observed between conventional pressure packed and injection molded PMMA samples would actually be clinically significant. As the denture bearing mucosa is compressible and the palatal seal is largely dependent on the prepared post dam [27], dimensional changes may be of little clinical relevance to the success or failure of the material as a denture base. However, a relatively higher fit of the denture base may be helpful in reducing the initial adaptation period of the denture wearer.

CONCLUSION

Within limitation of this study it could be concluded that:

- Changes of the acrylic resins depend on many factors, such as different locations of the base and palatal geometry.
- The smaller gap values for the Bre-Crystal injection molding technique compared with the Ivoclar injection molding technique independently of the other factors indicates that the dimensional change which occurred in the denture base was influenced by the Processing method.
- Brecrystal Injection molded PMMA resin is superior in terms of dimensional accuracy compared to Ivoclar Injection molded PMMA resin.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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