ABSTRACT

Purpose: The purpose of this in vivo study is to register the forces necessary to displace maxillary complete dentures fabricated by compression molding and injection molding techniques on one and the same patient and to compare the interfacial surface tension and capillarity which are achieved by both techniques.

Material/Methods: Two maxillary complete dentures are made for each patient (total number of patients is 30) using both technologies. The magnitude of dislodging force is measured by a dynamometer.

Results: Mean ± standard deviation for conventional cuvette technique is 17.53N ± 12.11N.

Mean ± standard deviation for injection molding technique is 20.73N ± 13.89N.

Analysis of variance (ANOVA) revealed statistically significant differences in results achieved by conventional cuvette technique and injection molding technology. The results of injection technique were higher than those of compression molding technique (F=123.676, p< 0.001).

Conclusions: Based on the results we suggest a standard for dislodging force of maxillary complete dentures fabricated by conventional cuvette technique- 13N, and by injection molding technology-15.5N. These values would guarantee good interfacial surface tension and capillarity.

The injection molding technique was found to produce better fitting maxillary complete dentures when compared to compression molding technique. This would ensure better retention, less traumatic manifestations after insertion and higher patient’s comfort and satisfaction.

Key words: surface tension, capillarity, dentures, cuvette technique, injection molding

INTRODUCTION:

The retention of a maxillary denture depends on a lot of factors- anatomical, physiological, physical, mechanical and muscular factors. The various physical factors which affect retention are adhesion, cohesion, interfacial surface tension, capillarity or capillary attraction, atmospheric pressure and peripheral seal.

Interfacial surface tension plays a major role in the retention of a maxillary denture. It is in direct proportion to viscosity of the saliva, denture surface area and the velocity of the dislodging force. Good adhesive and cohesive forces aid to enhance interfacial surface tension.

Also it decreases with the increase in the width of the space between the denture base and the mucosa according to Stefan’ law. [1]

Capillarity is improved by closeness of adaptation of denture base to soft tissue, greater surface of the denture-bearing area and thin film of saliva.

When there is close adaptation between the denture and the mucosa, the thin film of saliva tends to flow and increase its surface contact thereby increasing the retention.

So one of the basic purposes of each processing technique of complete dentures is to produce a perfectly fitting denture with minimal fabrication distortions.

Conventional cuvette technique (compression molding, pack and press technique) is widely used for fabrication of acrylic complete dentures. But this technique has some significant disadvantages such as increased vertical dimensions [2], higher porosity, spherical deformation, higher acrylic shrinkage, inaccurate fit of the material to the master cast and larger amount of residual monomer [3].

All these disadvantages could be eliminated by using injection molding system. In 1942 Pryor offered injection processing of poly methyl methacrylate in order to reduce acrylic shrinkage [4]. The injection molding technique has proved its advantages during the years: precise adaptation of acrylics to the master cast, continuous compensation of acrylic shrinkage due to inflowing acrylic material and constant high pressure during the whole polymerization process, better physical properties of dentures, lower porosity and high degree of homogeneity and minimum level of residual monomer. [5, 6, 7] Patients’ comfort is guaranteed by the precise fit of the acrylic dentures as well as minimum level of residual monomer and easy maintenance. [6] An in vitro study confirmed the better denture base adaptation of injection processing technique compared to one achieved by pack and press technique for fabricating dentures. [8]
PURPOSE:
The purpose of this in vivo study is to register the forces necessary to displace maxillary complete dentures fabricated by compression molding and injection molding techniques on one and the same patient and to compare the interfacial surface tension and capillarity which are achieved by both techniques.

MATERIALS AND METHODS:
Using two different technologies – compression molding (pack and press) technique and injection molding technique, a total of 60 maxillary complete acrylic dentures on 30 patients with maxillary edentulism were made. Each patient received two maxillary dentures fabricated by both technologies.

The study group included male (56.67%) and female (43.33%) maxillary edentulous patients, aged 18-64 years (23.33%) and over 64 years (76.67%), with no pathological changes in the denture bearing area and with indications of prosthetic treatment with a complete maxillary acrylic denture.

Every patient signs an informed consent after being informed of the purpose, way of conducting, expected results and the potential risks, related to the research.

In the midline of each denture fabricated by both compression molding and injection molding technique (in the geometric center of the construction) a retention element is temporary fixed, providing a point of application of a force (fig. 1 and fig. 2). This element is fabricated from orthodontic stainless steel wire 0.8 mm and fixed with self-cured acrylic resin. (fig. 3 and fig. 4)

Fig. 1. A maxillary complete acrylic denture fabricated by conventional cuvette technique

Fig. 2. A maxillary complete acrylic denture fabricated by injection molding technique

Fig. 3. A fixed stainless steel wire retention element on a conventional cuvette technique fabricated denture

Fig. 4. A fixed stainless steel wire element on an injection molding technique fabricated denture
The magnitude of the force of every denture is registered by using traction force with direction perpendicular to the occlusal plane. (fig. 5 and fig. 6) The dislodging force which is needed for the separation of every denture form the denture bearing area is measured in N (newton) by a dynamometer (with a scale up to 20 N) (fig. 7) or it is calculated by a formula (1kgf H’ 9.8) when an electronic scale is used (at values above 20 N).

**Fig. 5.** Traction of the denture using a dynamometer – intraoral view

![Image](image1.png)

**Fig. 6.** Traction of the denture using a dynamometer – extraoral view

![Image](image2.png)

**Fig. 7.** Dynamometer with stainless steel wire element used for traction

![Image](image3.png)

The results are documented in writing, dental photography was used as well. After all the measurements were done the fixed retention wire element was removed and the cameo surface of the denture was cleaned and polished.

Statistics was done using SPSS version 16. Descriptive statistics (mean, standard deviation values), analysis of variance (ANOVA) and Shapiro–Wilk test (a test of normality in frequentist statistics) were used. The results were designated as “statistically significant” at p-value < 0.01.

**RESULTS:**

The results are measured or calculated in N (Newton) with accuracy of 0.5 N according to the measurement scale of the dynamometer.

Mean and standard deviation of the force which is necessary to disturb the retention of a maxillary complete denture fabricated by conventional compression molding technique are shown on fig. 8.

**Fig. 8.** Frequency distribution of the result for compression molding technique

![Graph](graph1.png)

The mean value for the conventional cuvette technique is 17.53N with standard deviation of 12.11N.

Mean and standard deviation of the force required to displace upper complete denture fabricated by injection molding technique from the denture bearing area are shown on fig. 9.
The frequency distribution of the result for injection molding technique is presented in Fig. 9.

![Frequency distribution of injection molding technique](image)

The mean value for the injection molding technique is 20.73N with standard deviation of 13.89N.

In all the cases except for one, the values recorded for complete dentures fabricated by compression molding technique were lower than those recorded for dentures fabricated by injection molding technology under constant pressure during the whole polymerization process.

The results in one of the cases were remarkable- 72N for compression molding and 78.5N for injection molding technique. Both results significantly exceed the mean values in both groups.

The results of the comparison of dislodging forces which were registered in maxillary complete acrylic dentures fabricated by both techniques are shown on fig. 11.

![A comparison of dislodging forces](image)

Analysis of variance (ANOVA) revealed statistically significant differences in results achieved by conventional cuvette technique and injection molding technology. The results of injection technique were higher than those of compression molding technique (F=123.676, p<0.001).

DISCUSSION:

In the present in vitro study the factors such as denture surface area and saliva could be eliminated because we explore two dentures which were made on duplicate casts for one and the same patient so these factors remain one and the same for both dentures fabricated by both technologies. So we assume that the interfacial surface tension and capillarity depend predominantly on the width of the space between the denture base and the mucosa. [1]

Perfect adaptation between the tissues and the denture base would suggest smaller space between tissues and impression surface of the denture, greater interfacial surface tension and capillarity, respectively better adhesion and retention of the maxillary complete denture.

By measuring the magnitude of the dislodging force which is necessary to displace the maxillary denture from the denture bearing area we could draw a conclusion about the fitting of the denture to the underlying tissues.

Greater magnitude of this force is an evidence for higher interfacial surface tension and capillarity as well as more accurate fitting of the denture to the denture bearing area. This contributes to reduction of iatrogenic traumatic manifestations, increased retention and stability, higher mechanical strength of the maxillary complete acrylic denture and better patient’s comfort.

Shapiro–Wilk test (a test of normality in frequentist statistics) reveals the mean values for both technologies – compression molding technique- 13.00-16.5N (Shapiro-Wilk=0.589, δ<0.001) and injection molding technique-
Fig. 12. Mean, upper and lower bound for compression molding technique (Shapiro–Wilk test)

![Fig. 12](image_url)

CONCLUSION:
Based on the results of this in vitro study we suggest a standard for dislodging force of maxillary complete dentures fabricated by conventional cuvette technique-13N, and a standard for dislodging force of maxillary complete dentures fabricated by injection molding technology-15.5N. These values would guarantee good interfacial surface tension and capillarity.

The injection molding technique was found to produce better fitting maxillary complete dentures when compared to compression molding technique. This would ensure better retention, less traumatic manifestations after insertion and higher patient’s comfort and satisfaction.

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