Comparative Study Evaluating the Effect of Two Different Border Molding Materials on Retention of Maxillary Complete Denture

A thesis
Submitted to the Faculty of Oral and Dental Medicine,
Cairo University

In

Partial Fulfillment for the Requirements
Of Master Degree in Removable Prosthodontics

Submitted by
Reem Abdel-Halim Mohamed Abdel-Halim
B.D.S. 2005
Faculty of Oral and Dental Medicine
Cairo University

2012
Supervisors

Prof. Dr. Mahmoud Mukhtar El Far

Professor of Removable Prosthodontics
Department of Removable Prosthodontics
Faculty of Oral and Dental Medicine
Cairo University

Dr. Azza Farahat Metwally

Lecturer of Removable Prosthodontics
Department of Removable Prosthodontics
Faculty of Oral and Dental Medicine
Cairo University
ACKNOWLEDGMENT

Foremost, I thank ALLAH the most graceful and the most merciful for all his blessings and for being able to complete this work.

It gives me a great pleasure to express my deepest gratitude and cordial feeling to Prof. Dr. Mahmoud El Far Professor of Removable Prosthodontics, Removable Prosthodontics Department, Faculty of Oral and Dental Medicine - Cairo University. I am greatly indebted to him for suggesting this work and for his valuable guidance, continuous encouragement and discussion, It has been a great honor to proceed this work under his supervision.

I am also so grateful to Dr. Azza Farahat Metwally, Lecturer of Removable Prosthodontics, Department of Removable Prosthodontics, Faculty of Oral and Dental Medicine - Cairo University. I shall not forget her sincere guidance, valuable help, I would like to thank her also for her beneficial flexible guidance during this work and the concern she paid to the subject of this thesis.

I would like to thank my colleagues and all the staff members of the Prosthodontic department, Faculty of Oral and Dental Medicine, Cairo university, who continuously encouraged me throughout this study.
Dedication

To every member in my warm small family; without their love and support I could have not achieved this work.

To my parents who are a precious gift from Allah, and to whom I am grateful with every good thing happens in my life and with their prayers I am here today.

To my beautiful sisters Rehab, Radwa, Rafaa, Salma and to my lovely brother Ramy, who are always the source of care and joy for me.

To my fiancé Mohamed who stands beside me in every step with generous support and patience.
# List of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acknowledgement</td>
<td>III</td>
</tr>
<tr>
<td>Didication</td>
<td>III</td>
</tr>
<tr>
<td>Table of Contents</td>
<td>III</td>
</tr>
<tr>
<td>List of tables</td>
<td>V</td>
</tr>
<tr>
<td>List of figures</td>
<td>VI</td>
</tr>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Review of Literature</td>
<td>3</td>
</tr>
<tr>
<td>- Retention of complete denture</td>
<td>3</td>
</tr>
<tr>
<td>- Factors affecting complete denture retention</td>
<td>3</td>
</tr>
<tr>
<td>- Methods Enhancing The Retention Of Complete Dentures</td>
<td>17</td>
</tr>
<tr>
<td>- Evaluation of Complete Denture Retention</td>
<td>19</td>
</tr>
<tr>
<td>- Border Seal</td>
<td>22</td>
</tr>
<tr>
<td>- Border Molding</td>
<td>24</td>
</tr>
<tr>
<td>- Requirements of Border Molding Materials</td>
<td>24</td>
</tr>
<tr>
<td>- The materials used for Border Molding</td>
<td>25</td>
</tr>
<tr>
<td>- Techniques used for border molding</td>
<td>30</td>
</tr>
<tr>
<td>- Relation between complete denture retention and border molding materials</td>
<td>32</td>
</tr>
<tr>
<td>Aim of the study</td>
<td>34</td>
</tr>
<tr>
<td>Materials and Methods</td>
<td>35</td>
</tr>
<tr>
<td>Results</td>
<td>56</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Discussion</td>
<td></td>
</tr>
<tr>
<td>➢ Discussion of methodology</td>
<td>65</td>
</tr>
<tr>
<td>➢ Discussion of results</td>
<td>73</td>
</tr>
<tr>
<td>Summary</td>
<td>76</td>
</tr>
<tr>
<td>Conclusions</td>
<td>77</td>
</tr>
<tr>
<td>Bibliography</td>
<td>78</td>
</tr>
<tr>
<td>Arabic Summary</td>
<td></td>
</tr>
</tbody>
</table>
Introduction

Complete denture prosthesis involves the replacement of the lost natural teeth and associated structures. One of the goals to be achieved is to construct a denture that is retentive and stable in place. As irretentive denture disturbs all other goals as speech, mastication and in turn affects patient’s psychology.

Goiato et al., (2008) stated that Patient’s requirements of complete denture are to restore the normal contour, function, esthetics and speech. Most of these goals are accomplished through achieving retention.

Retention is directly proportional to the adaptation of the base to the supporting oral tissues, border seal and to a lesser degree to the surface tension at the periphery.

Appropriate peripheral extension and accurate recording of tissue details in the final impression are responsible for success of a complete denture. The denture borders of a final impression should simulate the finished & polished denture base.

Winkler, (2009) declared that effective border seal is attained through border molding; one can’t depend on the secondary wash to achieve a positive retentive response.

Various techniques and impression materials have been tried for successful shaping of the borders of a denture according to the morphological and functional conditions of an edentulous mouth. The original material used for border molding was modeling compound it
records the borders accurately but later on more simple materials and techniques were introduced.

Rubber base impression material was recommended for border molding and final wash impression, for its simplicity, ease of manipulation, decreased discomfort to the patient, short chair time and accurate reproduction of undercut areas.

However, it has not been determined yet which type of border molding materials is better for maxillary complete denture retention.
Retention of complete denture

Retention had been defined as the quality inherent in the dental prosthesis acting to resist the force of displacement along the path of placement or it is the resistance of a denture to dislodgement. Academy of Prosthodontics, (2005).

Emel, (2002) concluded that most complains of complete dentures are those related to appearance, pain, difficulties during eating, stability and retention. The causes of dissatisfaction with complete dentures are complex. They include not only the quality of the dentures and the oral conditions, but also patients’ related factors such as their attitude towards the dentures, as well as the interpersonal relationship between the patient and prosthodontist.

Factors affecting complete denture retention:

The recognition, understanding, and incorporation of certain mechanical, biological and physical factors are necessary to ensure optimal complete denture retention. Those factors are the determinants that promote the properties of retention in the finished prosthesis through their influence on the relationship between the tissue surface of the denture and the mucosal surface of the edentulous ridge. Kroll, (1983).

Jeganathan and Payne, (1993) stated that retention is dependent on a complex interplay of factors including the surface area of contact between the denture and the supporting tissue, the
adaptation of the denture base, surface tension factors, peripheral seal, and neuromuscular control.

These factors varied within and between patients and cannot be quantified. Clinically, base tissue contact, base extension, and the border seal were the factors that may be influenced by the clinician. Jeganathan and Payne, (1993)

Retention is obtained primarily through the effect of soft tissue impaction against the denture base at the junction between the mobile mucosa and attached mucoperiosteum. The posterior palatal seal plays an important role in complete denture retention by pressure contact against the palate. Tyson, (1985).

Ahmed, (2011) mentioned that the phenomenon of residual ridge reduction following loss of the natural teeth has an influence on success of complete denture therapy. He added that anatomic, physiologic and mechanical factors associated with the retention of complete dentures are important for achieving optimal therapeutic results.

Generally, the factors influencing the retention of complete denture are classified into;

I- Physical factors
II- Physiological factors
III- Mechanical factors
IV- Anatomical factors
V- Surgical factors
VI- Psychological factors
I-Physical factors

Darvell and Clark, (2000) mentioned that the denture retention is a dynamic issue dependent on the control of the flow of interposed fluid and thus its viscosity and film thickness.

The role of physical factors in denture retention:

Jacobson and Krol, (1983) summed-up the role of physical factors together in a very simple, yet comprehensive way. They claimed that surface tension created at the meniscus of the denture border maintains a pressure gradient between the atmospheric pressure and the reduced pressure within the fluid film that occurs during dislodging forces. To be effective air must be excluded from the issue, and the fluid film must be as thin as possible. Intimate tissue contact is the biologic factor that promotes those conditions by eliminating air entrapment.

Jacobson and Krol, (1983) added that the border seal maintains the relationship between surface tension and atmospheric pressure by preventing the ingress of air once the denture is seated. Border seal also maintains the thin fluid film at the denture border, allowing a meniscus to develop in response to displacing forces.

They added that, adhesion and cohesion are secondary forces that act within the fluid film, forming and maintaining the surface tension of the peripheral meniscus.

(i) Adhesion and Cohesion:

Adhesion is defined as the property of remaining in close proximity, as that proximity resulting from the physical attraction of
molecules to a substance or molecular attraction existing between the surfaces of bodies in contact according to Academy of Prosthodontics, (2005).

However, Cohesion is defined as the force where molecules of matter adhere to one another or it is the molecular attraction by which the particles of a body are united together throughout their mass or it is the attraction of aggregation. Academy of Prosthodontics, (2005).

In complete denture situation, cohesion implies the interaction between the salivary molecules within the salivary layer or film. Adhesion implies the interaction between saliva and the mucosa and the interaction between the denture base material (acrylic resin) and the saliva. In other words, the saliva acts as the "adhesive" between the substrates of mucosa and denture base, where adhesion is achieved through ionic force between salivary glycoprotein, surface of acrylic resin and the mucous membrane.

Cohesion is an influential factor in denture retention as it maintains the integrity of the saliva film between the denture and mucosal surface. Its effectiveness is inversely proportional to the thickness of the saliva film and directly proportional to base adaptation. Meaning that its effectiveness increases as the thickness of the film decreases and hence the denture that fits closest to the tissues will have the best cohesion. Zarb et al., (2004).

Murray and Darvell, (1993) suggested that adhesion is the greatest physical principle involved in complete denture retention. Its effectiveness is correlated to the viscosity of the saliva in an inverse ratio,
the thicker and more viscous the saliva, the less the adhesion and vice versa.

(ii) Surface tension and capillary attraction:

Surface tension is a property of liquids in which the exposed surface tends to contract to the smallest possible area, as in the spherical formation of drops. This is a phenomenon attributed to the attractive forces, or cohesion, between the molecules of the liquid. (Academy of Prosthodontics, 2005).

Capillary attraction is that quality or state which causes elevation or depression of the surface of a liquid that is in contact with the solid walls of a vessel. (Academy of Prosthodontics, 2005).

Darvell and Clark, (2000) considered the surface tension as one of the important factors in complete denture retention. They explained that one of the consequences of the surface tension of liquids is the tendency to minimize the area of the free surface, generating a curved surface. The negative pressure exerts a force tending to draw the contacting surfaces towards each other. This is the force that retains wet surfaces together against a straight pull.

Zarb et al., (2004) stated that interfacial surface tension is dependent on the ability of the fluid to “wet” the rigid surrounding material. If the surrounding material has low surface tension, as oral mucosa does, fluid will maximize its contact with the material, thereby wetting it readily and spreading-out in a thin film.

They added that when the adaptation of the denture base to the mucosa is sufficiently close, the resulting space is filled with a thin film
of saliva which act like a capillary tube and help to retain the denture. This force like the other physical factors is directly proportional to the area of the basal seat covered by the denture base.

(iii) Viscosity of saliva:

Darvell and Clark, (2000) consider the viscosity of saliva as one of the important factors in complete denture retention.

According to Basker et al., (1992) the retentive force is generated from the resistance of the saliva to flow, which is directly proportional to its viscosity. They also related it to the dimension of the path through which it flows. The narrower the path, the greater the viscosity of saliva, the more effective will be the retention.

Niedermier and Kramer, (1992) observed that patients with viscous saliva of limited quantity or patients using denture adhesives could produce a thin film of saliva giving good initial retention. During function, this film of saliva would increase in thickness as the denture was displaced. The total volume of saliva required to keep the film intact would increase beyond the volume of saliva available.

They added that that pattern of good initial retention with subsequent deterioration has been noted with denture adhesives and occurs clinically with some patients who have scanty, viscous saliva.

(iv) Atmospheric pressure:

Atmospheric pressure is the pressing force of the atmosphere. It is the physical factor of hydrostatic pressure due to the weight of the atmosphere on the earth's surface. It is normally equalized on all surfaces,

Colon et al., (1982) explained that well and properly extended denture borders will form a sealed compartment. The forces produced in this sealed environment are less than the pressure of the surrounding medium. The difference between these two pressures known as atmospheric pressure provides retentive form.

Atmospheric pressure is one of the important physical factors in retention of complete denture. Retention derived from adhesion and cohesion can resist only dislodging forces acting perpendicular to the denture and fail to resist dislodgement of denture by horizontal forces and lateral torques. These dislodgements can be resisted by the retention of the denture provided by the partial vacuum created by the denture border seal. Such a seal will prevent the entrance of air under the denture during the process of speech, deglutition, or mastication of food and such a seal will create a partial vacuum that will operate only when tipping thrusts tend to dislodge the denture. Rajesh, (2010).

(v) **Peripheral seal and denture borders:**

Basker and Davenport, (2002) indicated that the denture border should be shaped so that the channel between it and the sulcus tissues is as small as possible for optimum retention.

Soratur, (2006) concluded for better retention of complete denture: the denture base must cover the largest area possible, the denture periphery must extend on the compressible tissues and must form a seal and the tissue surface of the denture must lie in continuous and intimate contact with mucosa.
II-Physiological (Biological) factors

(i) Neuromuscular control:

Neuromuscular control refers to the functional forces exerted by the musculature of the patient that can affect the retention. It is of vital importance for a successful denture, since the forces generated during mastication are sufficient to destabilize dentures with optimum retention. Winkler, (2009).

Clinically it was observed that in real life, prosthodontists recognize the ability of certain patients to wear their dentures and function without complain despite the fact that they may be extremely ill-fitting, unstable or even broken. Jacobson and Krol, (1983). Hence neuromuscular control is a complementary factor to the previously mentioned physical factors.

Grasso et al., (1994) reported that if the denture flanges and borders followed the anatomy of the arches and harmonized with the surrounding muscles both retention and stability of the prosthesis will be enhanced. The polished surface of the denture should be properly shaped to enhance retention provided by muscular control.

According to Grasso et al., (1994) and Zarb et al., (2004) the buccal flanges of the maxillary denture should slope up and out from the occlusal surfaces of the teeth and the buccal flanges of the mandibular denture slope down and out from the occlusal plane, the contraction of buccinators will tend to seat both dentures on their basal seats. Lingual surface of lingual flanges should slope toward the center of the mouth so
the tongue can be seated against it and hence achieving a perfect border seal.

The base of the tongue is guided on top of the lingual flange by the distolingual end of the flange which turns laterally towards the ramus. This part of the denture also helps to ensure border seal at the end of the mandibular denture. Grasso et al., (1994) and Zarb et al., (2004).

Zarb et al., (2004) explained that the oral and facial musculature can supply supplementary retentive forces, provided that the teeth are positioned in the neutral zone between the cheeks and tongue, and the polished surface of the dentures are properly shaped.

(ii) Neutral zone:

Neutral zone is the potential space between the lips and cheeks on one side and the tongue on the other; that area or position where the forces between the tongue and cheeks or lips are equal (Academy of Prosthodontics, 2005).

Natural or artificial teeth are subjected to equal and opposite forces in this zone from the surrounding musculature (Wee et al., 2000). Consequently, retention and stability become more dependent on the correct positioning of the teeth (Khalil, 2009).

Violation of the neutral zone may cause denture movement during speech, chewing or swallowing (Massad, 2004).

(iii) Saliva:

Denture retention is considered by some investigators to be a function of saliva surface tension, its viscosity, the thickness of saliva
film, the contact surface and the saliva denture contact angle. Kikuchi et al., (1999).

Turner et al., (2008) studied the effect of hyposalivation and xerostomia on the complete denture and they reported the importance of saliva in denture retention. They added that the condition of dry mouth with its treatment have a passive effect on denture use, patient satisfaction and adaptive problems.

(iv) Tongue:

De Franco and Ortman, (1988) reported that the tongue size and muscular coordination were considered important factors affect retention of mandibular dentures. They are essential in controlling the denture during normal physiologic activities such as speech, mastication and deglutition.

Wright, (2004) claimed that the tongue position is one of the important factors that affect the retention of the lower denture. Patients, who have a normal tongue position, are considered to have a set of conditions that are conductive to the retention of the mandibular denture. On the other hand, those having a retracted tongue position are lacking the ability to develop or to maintain retention without some degree of training.

Zmudzki et al., (2008) studied the influence of tongue activity on lower denture retention under biting forces. They concluded that; the role played by the tongue in denture retention lies on the ability to locate the denture by means of tactile sensation. They added that tongue plays a role in supporting the forces counteracting denture dislodgement, and also the
tongue surface of denture's flanges is shaped and contoured so that it is harmonized with the possible maximum pressing force of the tongue.

Lee et al., (2009) studied the improved denture retention in patients with retracted tongues. They concluded that in all morphological classes, when participants held their tongues in the ideal resting position, the average mandibular denture retention increased by 57.73%.

(v) Mucosa:

Compagnoni et al. (2003) studied complete denture movement related to mucosa displacement in edentulous patients. They found the mucosa that covers the residual ridges of edentulous patients may undergo some distortion under physiological load leads to its displaceability and this distortion allows some movement of the denture. This movement can result in acceleration of residual ridge resorption and loss of retention and stability.

They added that the thickness of the mucosa should be considered when recording impressions. Mobile tissues are dealt with either by surgical reduction in the thickness of these tissues or by using special impression techniques which distribute the load in a particular manner.

III-Mechanical factors

(i) Engagement of undercuts:

Engaging naturally-existing undercuts (e.g. lingual pouch in mandibular arch, areas behind maxillary tuberosities or anterior tissue undercuts in maxillary arch) enhance the retention of complete denture mechanically. Ohkubo and Hosoi, (1999).