SEM ASSESSMENT OF THE NATURE OF THE INTERFACE BETWEEN MOLLOPLAST-B AND DENTURE BASE MATERIALS

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تمتلك مادة السيلكون المرنة معظم الصفات المطلوبة في المواد المبطنة لقواعد الأطقم ولكن الرابطة الموجودة بين هذه المادة ومواد قواعد الأطقم ضعيفة .

كان الغرض من هذا البحث هو تقدير مجهري لتأثير بعض العوامل على السطح الموجود بين المادة المبطنة المرنة وثلاثة من قواعد الأطقم الراتنجية .

وقد استخدمت في هذه الدراسة مادة السليكون حراري النضج (مولو بلاست - ب) وثلاثة من مواد قواعد الأطقم الراتنجية . وقد تم معالجة سطح كل من مواد الأطقم قبل وضع المادة المبطنة عليها كالنحو التالي :

١- تم تغطية بعض الأسطح بمادة «البرايربينما» وتركت الأسطح الأخرى بدون .

٢- خشنت بعض الأسطح وأخرى تركت ناعمة وكذلك وضعت المادة المبطنة على بعض أسطح قواعد الأطقم الغير ناضجة .

هذا بالإضافة إلى تحضير بعض العينات لكل مادة من مواد الأطقم وربطها بالمادة المبطنة ثم حفظها في الماء ومقارنتها بعينات جافة .

وقد دلت نتائج الفحص المجهري الإلكتروني على إختلاف طبيعة الأسطح الموجودة بين المادة المبطنة المرنة ومواد قواعد الأطقم وكذلك لوحظ وجود التصاق مقبول بين المادة المبطنة ومواد قواعد الأطقم غير الناضجة .

بعد حفظ العينات في الماء ظهرت كثير من الفجوات الواسعة مع تغيرات طفيفة في ملمس سطح مادة (المولوبلاست - ب) ويعزي ذلك إلى إمتصاص المادة المبطنة للماء وتورم تركيبها .

Silicone resilient liners possess most of the required properties of denture liners, however they poorly bond to denture bases. It was the purpose of this investigation to microscopically assess the nature of the interface between a denture liner and three acrylic bases as affected by some parameters. A heat-cured silicone liner (Molloplast-B) and three commercially available acrylic denture base materials were used in this study. Each test specimen composed of Molloplast-B that was bonded to both sides of a denture base blank. Prior to packing the liner, the surfaces of each denture base blank were treated. The surface treatment included either application of a primer or roughening. In other test specimens, the liner was packed against "uncured" resin. In addition, the interfaces of "precured" specimens were examined in both wet and dry conditions. SEM examination revealed that the three denture base materials varied in the nature of their interfaces with the denture liner. Satisfactory junction was observe when the liner was packed against "uncured" acrylic bases. After aging in water, the liner/denture base interface displayed numerous wide gaps with slight changes in Molloplast-B surface texture. This could be attributed to water sorption by the liner and subsequent swelling of its structure.

Introduction

Denture lining materials have become an established part of dental prosthetic treatment.

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Among the favorable properties of denture liners are the resiliency which is maintained for a long period of time, and the good adhesion to the denture base materials.[1-3] All favorable properties of a denture liner, in the absence of good adhesion to denture base materials, are considered to be useless.[4-6]

Molloplast-B silicone lining materials possess most of the required properties of a resilient lining material.[7] However, adhesion failure of the Molloplast-B heat-cured silicone liner was reported

in some clinical studies, and has been shown to occur mainly at the periphery of the denture.[7-9]

Several investigators[4,10-12] have microscopically examined the nature of the interface between the resilient liners and the denture base materials. Some parameters are expected to affect the bond between the resilient lining materials and the denture bases. These parameters include aging in water, using a primer with the lining material, and the nature of the denture base material. Lack of detailed information in the dental literature was encountered concerning the effect of these parameters on the nature of the interface between these two materials.

In this study, an attempt was made to microscopically assess the nature of the interface between Molloplast-B and three denture base materials as affected by four parameters; namely the denture base material type, primer coating of denture bases prior to liner packing, and denture base surface nature as well as aging of lined denture bases in water.

Materials and Methods

Heat-cured silicone denture lining material along with three commercially different acrylic denture base materials were used in this study and are presented in Table 1. All materials investigated were mixed and processed according to manufacturer's instructions.

A total of 40 test specimens were constructed in this study. Each composed of Molloplast-B denture liner that was bonded to both sides of a blank made from each denture material. Trevalon and Lucitone 199 heat-cured denture base materials were each used to fabricate 14 blanks, while 12 blanks were made from Pegasus cold-cured resin. The denture base blanks were fabricated first and then the liner was packed against each of them. These blanks were constructed in moulds produced by investing Perspex blanks (6x6x6 mm) in dental stone* using conventional dental flasking procedure. The surface angles of the Perspex blanks were machined to ensure formation of well defined right angles between each two surfaces. Prior to investing, Perspex blanks were each coated with a thin layer of baseplate wax[5] to facilitate their removal from dental stone during deflasking. Care was exercised during removal of the cured blanks from the dental stone and a hand saw was used in order to avoid creating stresses in the fabricating blanks. The denture base blanks were smoothened using a silicone carbide paper disc (grade 180) in a Kent 3 automatic lapping and polishing unit[f].

Table 1. Resilient liner and denture base materials used.

Products	Batch No.	Type	Manufacturer
Molloplast-B	D-930421 Pr-890301	Heat-cured silicone-rubber	Regneri & Co., Karlsruhe, Germany
Trevalon	P-ND24 L-NH48	Heat-cured acrylic denture base	Dentsply Ltd., DeTrey Div., Weybridge, Surrey, England
Lucitone 99	P-15519322 L-0122102	Heat-cured acrylic denture base	Dentsply International Inc., New York, USA
Pegasus	P-920128 L-683201	Cold-cured acrylic denture base	Davis Schottlander & Davis Ltd., Letchworth, Hertz, England

Test specimens were each fabricated as follows. Two smaller Perspex blanks (6x6x3 mm) were attached and correctly aligned to both sides of each of the "precured" denture base blanks by baseplate wax, and the assembly was then invested. Following removal of the Perspex blanks, the liner was packed, following the manufacturer's instructions, into the created spaces against the denture base blank. Packing of the liner in the stone mold was carried out using a standard packing procedure in order to ensure proper adaptation of the liner against the surface of the denture base blank.

The effect of the primer, provided with the liner, on the denture base/liner interface nature was also studied. Prior to packing of the liner, the surfaces to be bonded were treated as follows. The surfaces of two blanks, per each denture base materials, were coated with the primer, while

* Columbus Dent., Miles Lab. Inc., Missouri,USA.
Dentaurum Modeling Wax, Ptorzheim, Germany.
Engis Ltd., Maidstone, England.

other two blanks were left without primer. For the purpose of examining the effect of the surface nature on denture base material/liner interface, the surfaces to be joined of two blanks per each denture base material, were roughened using a Ruby-nite acrylic stone bur* before packing the liner, while those of other two blanks were left smooth. Additional two "uncured" blanks were produced from the heat-cured denture base resins only. These blanks were constructed in the same manner previously described except that they were not subjected to heat-curing procedure and were allowed to bench-cured overnight. This overnight bench-curing provided blanks in a firm state that resisted distortion upon packing the liner.

Following packing the liner, as a continuation of all test specimens preparation, the flask was closed in a bench press until metal-to-metal contact of the flask halves were obtained. Pressure was maintained on the flask for 25 min and clamps were then placed on the flask. The liner was cured by placing the clamped flask in a water bath[§] at 70°C for 7 hrs, followed by 100°C for 3 hrs, then the flask was bench-cooled to room temperature. The test specimens were each deflasked and any liner flashes were trimmed with scissors and scalpel blades.

In order to investigate the effect of water on the denture base/liner interface nature, two "precured" test specimens per each denture base resin were stored in the eater bath at 37 + TC for 6 months, while other two specimens were stored dry for 48 hrs in polythene bags.

All test specimens were examined, following a method used by Sinobad et al,[4] using EBT EXA1 scanning electron microscope* Each test specimen was first mounted onto aluminum stub with a connective carbon cement[†] (Leit-C), then sputter coated in gold using Emscope SC500 Sputter Coater Unit[†]. Each specimen interface was scanned entirely at x300 magnification and selected areas were photographed and scanning electron micrographs were produced.

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[†]Neubauer Chemikalien, Germany.

Results

SEM photomicrographs [Fig. la-c] of test specimens at the interface between the liner and various brands of denture base materials revealed, in general, a satisfactory junction with the formation of some gaps of different widths and number.

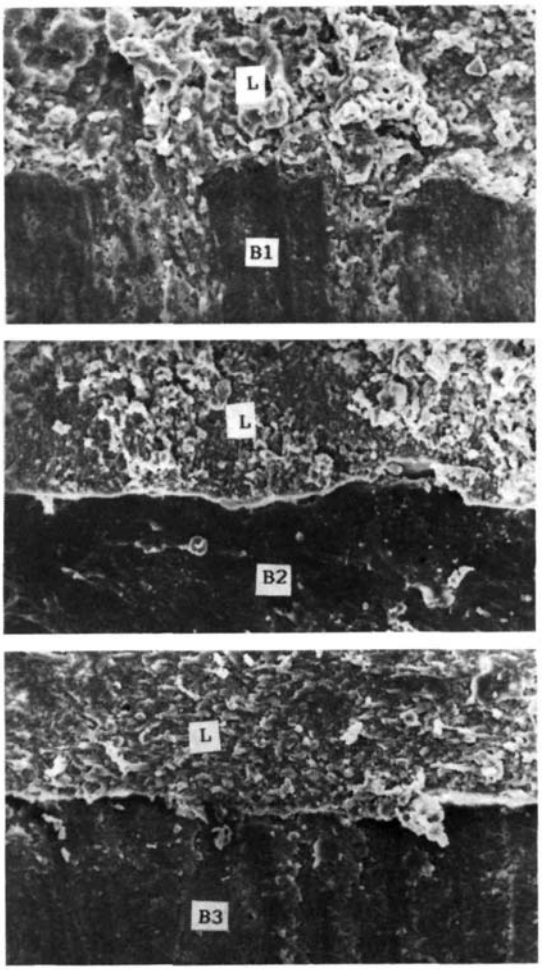

Figure 1a-c. Scanning electron micrographs (x300) at the interface showing: **(a)** small gaps between the liner (L) and Trevalon (B1); **(b)** gaps of considerable width between the liner (L) and Lucitone 199 (B2); **(c)** wide gaps between the liner (L) and Pegasus (B3).

Emscope Lab. Ltd., Ashford, Kent, England.

The interface between Trevalon acrylic resin and Mollo-plast-B showed a few and very narrow gaps [Fig. la], while in Molloplast-B/Lucitone 199 interface, slightly wide gaps were observed [Fig. lb]. In case of the liner/Pegasus interface [Fig. lc], there were more and wider gaps present compared to those of the other two interfaces.

In test specimens with primer coating, SEM photomicrograph [Fig. 2a] displayed a defined interface with some gaps. These gaps were less in number and narrower than those present at interfaces of specimens without primer [Fig. 2b].

The SEM examination of test specimens prepared with different denture base surface nature revealed that Molloplast-B penetrated to some extent into the roughened denture base surface with the formation of some gaps at the interface [Fig. 3a]. In specimens with smooth denture base surface, a definite demarcation line with wide gaps was observed [Fig. 3b]. However, in Fig.3c, fewer and narrower gaps were visible at the interface of Molloplast-B packed against "uncured" denture base blanks.

After aging in water at 37 + 1°C for 6 months, the specimens [Fig. 4a,b) had wider and more gaps at their interfaces compared to those found when specimens were stored dry for 48 hours. It was also noted [Fig. 4b] that slight changes in the

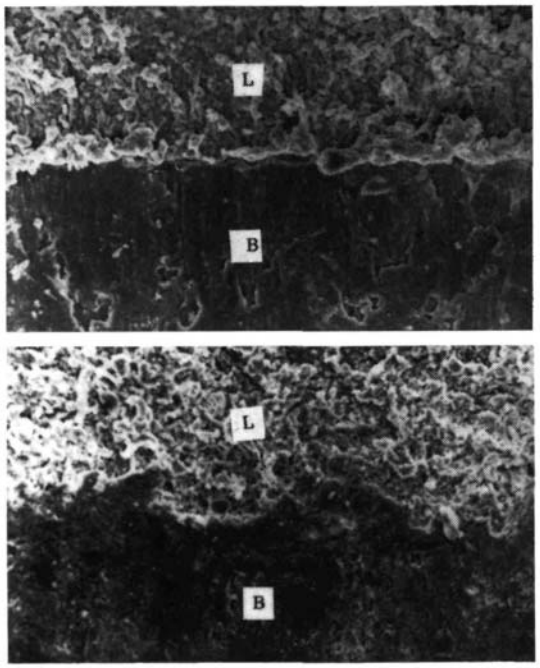

Figure 2a-b. Scanning electron micrographs (x300) at the interface showing: **(a)** narrow and few gaps between the liner (L) and the denture base material (B) with primer coating; **(b)** a gapped junction between the liner (L) and the denture base material (B) without primer coating.

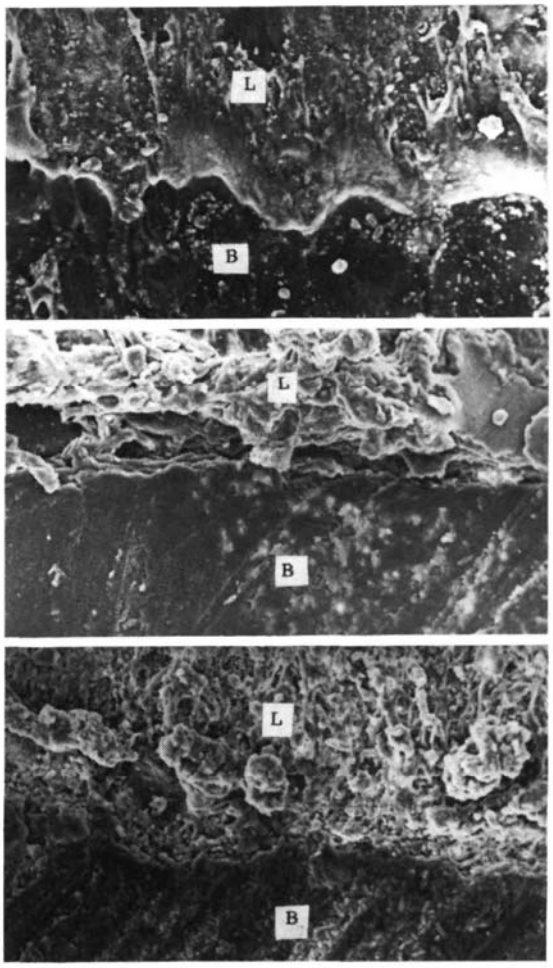

Figure 3a-c. Scanning electron micrographs (x300) at the interface showing: **(a)** some penetration of the liner (L) into the roughened acrylic denture base material(B; **(b)** gaps between the liner (L) and the smooth acrylic denture base material (B); **(c)** very few gaps between the liner (L) and the denture base "uncured " material (B).

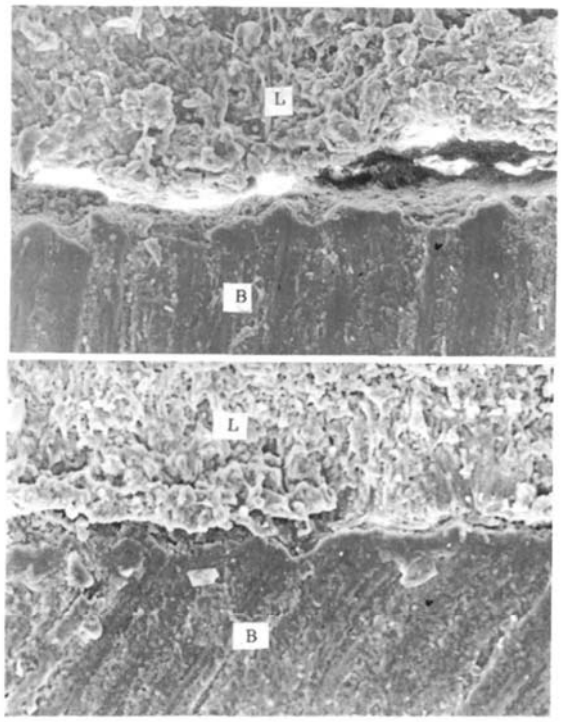

Figure 4a-b. Scanning electron micrographs (x300) at the interface showing: **(a)** wide gaps, in a wet specimen, between the liner (L) and the denture base material (B) along with a slight swelling in the liner (L); **(b)** a definite demarcation line and narrow spaces, in a dry specimen, between the liner (L) and the denture base material (B).

surface texture of Molloplast-B had occurred following immersion in water.

Discussion

Scanning electron microscopic examination of the interface can reveal some information concerning the effect of various parameters on the bond between resilient liners and denture base materials. This information includes the appearance of either a distinct or a diffuse boundary at the interface. The latter indicates that chemical bonding between the two materials takes place.

In this study, it has been demonstrated that the interface between the Molloplast-B and denture base materials depends on some parameters including the type of denture base materials, the nature of their surfaces, the use of primer with the liner and aging in water for a period of time. It was found from the SEM examination that the interface between Molloplast-B and the three tested denture base materials varied in nature. Knowing that the acrylic denture base materials have basically the same chemical structure, the observed differences could be attributed to the presence of various additives in the powder or the liquid components of each denture base material. It may also be possible that variation in wetting behavior among the denture base resins could have contributed to such interfacial variations.

In specimens produced using the primer, the presence of fewer and smaller gaps at the interface suggests that the application of Molloplast-B adhesive primer does improve the bonding between the liner and the denture base materials. This finding is consistent with that reported by other researchers.[13]

When the liner was packed against rough denture base surfaces, scanning electron photomicrographs showed that the liner has penetrated into the irregular denture base surfaces. This penetration suggests a micro-chemical attachment which may improve the bond between the two materials. This observation is confirmed by the finding of another researcher[10] who showed the sandblasted denture base surfaces to provide a means for mechanical locking of a soft material into the hard resin. However, the findings of some other researchers[12] were found to disagree with those of the present investigation, where their SEM results showed wide gaps at the interface between Molloplast-B and sandblasted acrylic resins. When the liner was packed against smooth denture base surfaces, the presence of relatively wide gaps at the interface indicates that the denture base surface smoothing yielded the weakest bond. This finding agrees with that of another investigator[10] who demonstrated that the silicone rubber resilient lin-

ing material displays a very definite line of demarcation at the interface when processed against a highly polished acrylic surface. The most satisfactory interface in this investigation appeared to be between the liner when packed against "uncured" acrylic resin where the interface displayed an intimate contact with hardly visible gaps. This finding is in agreement with that of other investigators.[11,12]

The interface between the liner and the denture base material was demonstrated to be affected by aging in water. Water appeared to have a direct deteriorating effect on both the liner and its adhesion to the denture base materials. This effect could be attributed to water sorption by the liner which could lead to its swelling and building up of stresses at the liner/denture resin interface. The results of this study agree with those of other investigators[12] who showed that aging the specimens in water for six months had a weakening effect on the inter facial bond.

Conclusions

Based on the findings of this study, the following conclusions can be drawn:

1. The three investigated denture base materials cover a wide range of variations in the bonding characteristics to Molloplast-B liner.
2. The use of the primer improves the bond between the lining and denture base materials.
3. Packing the liner against "uncured" acrylic denture base produces a satisfactory bond between the two joined materials compared to that formed with rough or smooth denture base surfaces.
4. Exposure of the liner to water appears to have a deteriorating effect on the liner/denture base material interface.

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