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Comparative Evaluation of Bonding Efficiency between Denture Lining Material and Denture Base Resin after Various Surface Treatments and Storage in Artificial Saliva an In Vitro Study

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Abstract

Background: Debonding of soft liners from denture base is one of the major problems noticed with relined dentures. Various surface treatments are advocated in literature to overcome this issue. Most of these methods have shown damaging effects on the mechanical properties of resin while improving the adhesive properties. Hence, this study aims to compare and evaluate the use oxygen plasma and lasers to improve the adhesion between the soft liners and resin.

Method: A total of 36 resin blocks with 10x 65 x 3.5mm dimension were prepared. The blocks were divided into 3 groups each with n= 12 and bonded to silicone based soft liner. Group A- Control group with no treatment, Group B- Oxygen Plasma treated, Group C- laser treated. Each group was further subdivided with n=6. Subgroup A – checking for Peel off strength without artificial ageing and Subgroup B – checking for peel off strength after artificial aging in artificial saliva for 30days. The samples were tested for Peel off strength under universal testing machine at a cross head speed of 15mm/min.

Conclusion: Within the limitations of the study, it can be concluded that both Oxygen-Plasma treatment and Carbon dioxide laser treatment are effective in improving the adhesion of the silicone based soft liner (DETAX,Mollosil) to the acrylic resin (DPI, heat cure). The Peel strength values obtained after Oxygen-plasma treatment were more than that of laser treated samples, both without and after immersion in artificial saliva.

Keywords: soft liners, silicone soft liners, polymethyl methacrylate, peel off strength, carbon dioxide laser, oxygen plasma treatment.

Introduction

Resilient denture lining materials are viscoelastic materials that are designed to act as a cushion between the hard denture base and soft tissues in order to reduce the masticatory forces transmitted by prosthesis to the underlying tissues. The viscoelastic properties of these materials are important for their cushioning effect, which allows even pressure distribution.[1] Soft liners are mainly used for patients who cannot tolerate hard acrylic bases and it helps in distributing the pressure uniformly over the supporting tissues.[1,2] The successful construction of a denture using two different materials relies partly on a satisfactory bond between the materials.

One of the serious problems encountered is the debonding of soft liners from the denture base that plaques their longevity.[1,3,4,5] Several surface treatments like mechanical roughing e.g sandblasting, chemicals, mechano-chemical have been investigated to modify the acrylic resin surface before applying soft liners to increase the bond strength between liners and denture base surface.[4,5,6] But none of the surface treatments have proven to be beneficial to improve the adhesion without damaging the properties of denture base resins. [4,6,7,9]

Recent literature advocated the use of plasma and lasers to improve the adhesion between soft liners and acrylic resin but with limited research.[8,10] Therefore, this study compared and evaluated laser and plasma oxygen surface treatment modalities to improve the bond strength.

The type of bond test used was the peel off strength. It is considered to mimic intra oral conditions closely as there is even distribution of force over the bonding area.[11]

The Soft liner's function in an aqueous environment of the oral cavity i.e ageing in saliva has not been documented in literature after laser and oxygen plasma treatment. It is therefore important to know the peel off strength of these surface treated resin samples bonded to soft liners and immersed in artificial saliva. Hence, in this study all samples were stored in artificial saliva and tested for peel off strength after 30 days. Further, there is no literature to suggest the behaviour of soft liners after artificial aging in saliva.

Aim of the Study

To compare and evaluate the bonding efficiency between denture lining material and denture base resin after various surface treatments.

To compare and evaluate the bonding efficiency between denture lining material and denture base resin after storage in artificial saliva for 30 days.

Materials and Methodology

1. Preparation of the acrylic resin blocks

Four customised dies were fabricated with 10x 65 x 3.5mm dimension (Figure 1). Polymethyl methacrylate denture resin (DPI heat cure, Dental Products of India Ltd, Mumbai) was then mixed, packed and processed according to manufacturer's instructions. (n=36) Dimensions of samples was checked with a digital scale to standardize and match with the metal dies. (Figure 2,3)

2.Sample distribution

A total of 36 Polymethyl methacrylate rectangular resin samples were fabricated and randomly divided into 3 groups. (Figure 2)

Group A – (n=12) Control group with no surface treatment.

Group B – (n=12) Oxygen Plasma surface treated group.

Group C – (n=12) Laser surface treated group.

All groups were further divided into 2 sub- groups:

Sub Group A - Tested for peel off strength without artificial aging. (n=6)

Sub Group B - Tested for peel off strength after immersion in saliva for 30 days. (n=6)

3. Oxygen-plasma surface treated group

The plasma treatment system used in the study was Electron Cyclotron Resonance (ECR) plasma. First, the specimens were positioned in the substrate holder and the system was evacuated using a rotary vacuum pump until it reached a pressure of 0.013 mbar. A 2.45 Ghz microwave was then introduced into the plasma chamber through a quartz window, and magnetic field of 875 gauss was created. Oxygen gas was then introduced into the reactor to displace residual gases.This process was repeated three times to ensure complete removal of impurities. Finally, pressure was stabilized at 19 mbar by appropriate opening of the inlet valve. Plasma treatment was carried out for 20 minutes for all the sample. (Figure 4)

4. Laser surface treated group

Carbon dioxide laser was used for the purpose of this study. The bonding surfaces of all 12 samples were thoroughly cleaned to remove all debris and were positioned to the laser tip. Pulse mode with settings of 3 Hz, 10 W and long pulse duration for 20 seconds was applied. (Figure 5)

5. Packing of soft liners to the surface treated acrylic samples

All the acrylic blanks were cleaned with distilled water and an adhesive tape was applied to define the area over which the silicone elastomer was to be bonded to the acrylic substrate.The tape covered an area of 10mm × 25 mm leaving an uncovered area of 10 mm× 40 mm where the silicone had to be bonded to the acrylic substrate. The uncovered area of acrylic blank was cleaned with distilled water and then left to air dry.

Silicone based soft Liner material (DETAX, Mollosil) was mixed in equal proportions as supplied in cartridges and the mix was directly placed onto the rectangular acrylic resin samples and left to polymerise for 10minutes (n=36).

All the specimens were prepared to a uniform size with smooth surfaces by placing polyester film over them. (Figure 6)

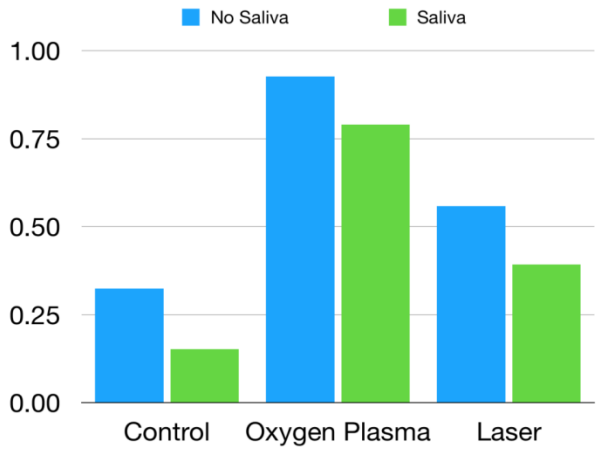
6. Immersion in artificial saliva

Half of the samples in each group (n=6) were immersed in artificial saliva (Wet mouth, ICPA HEALTH LTD) in closed glass containers. All the specimens were kept for 30 days and tested for their peel off strength. (Figure 7)

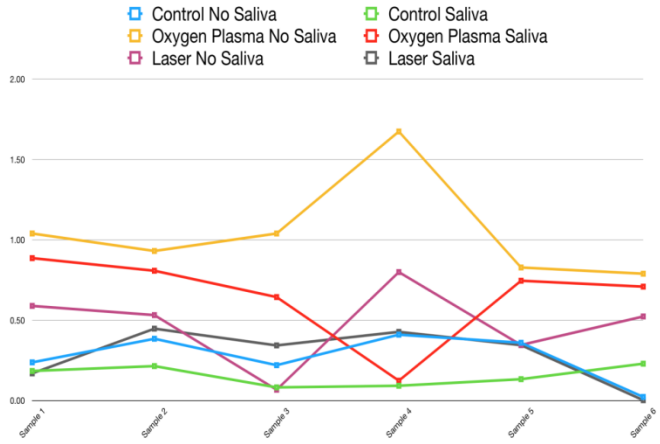
7. Checking for peel off strength using Universal testing machine

All the groups were subjected to an 180° peel strength test on universal testing machine. In each specimen, the silicone strip was bonded to acrylic denture base at one end (10 mm × 40mm) and left free at the other (10 mm × 25mm).The free end of the strip was turned back at 180° so that the hard acrylic base was clamped in the lower clamp and the soft free silicone strip was gripped in the upper clamp.Cross head speed was maintained at 15mm. (Figure 8)

Results



Graph 1



Graph 2

Means (After Removing Outliers)

	No Saliva	Saliva	Percentage Difference
Control	0.32	0.15	53.09
Oxygen Plasma	0.93	0.79	14.69
Laser	0.56	0.39	29.66

Table 1

The highest mean peel off strength was noted with oxygen plasma surface treated group followed by laser treated and the least for the control group without any surface treatment. The mean peel off strength was decreased after artificial aging but was not statistically significant for the oxygen plasma surface treated group.

Discussion

A resilient denture liner is a rational option adopted to protect the ridges. In the field of Prosthodontics, they hold a huge importance because of their extensive areas of applications.[2,6]

To improve the bonding between soft liner and denture base resins several methods have been proposed in literature. They may be categorized into mechanical, chemical and chemo-mechanical.[1,4,5]

Plasma-surface modification (PSM) as an effective processing technique and is gaining popularity in the biomedical field. With PMS it is possible to change the chemical and biomechanic properties of polymeric surfaces without adverse effects on their physical characteristics since the surface treatment is confined to only a few nanometres below the surface.

Through the oxygen plasma treatment, oxygen containing groups of C-O and C=O are effectively introduced onto the polymer surface due to the highly reactive property of oxygen plasma. The presence of oxygen containing groups improves the surface hydrophilicity of the plasma treated specimens which enables the penetration of the soft liner into the irregularities on the acrylic resin surface.8 Consequently, the latter phenomenon is contributed to an increase in bond strength between the denture base resin and soft liner.[8,14]

Lasers were regarded as a complex technology with limited uses in clinical dentistry, but there is a growing awareness of the usefulness of lasers in the armamentarium of the modern dental practice, where they can be used as an adjunct or alternative to traditional approaches. The impact of high energy pulse from laser causes instant vapourisation of water with a maximum volumetric expansion. This expansion causes the surrounding material to ablate thereby increasing the surface area.[10] Therefore, soft lining materials penetrate into the irregularities or pits produced by the laser increasing the strength of the bond.

When laser groups and oxygen plasma groups were compared, the mean peel off strength with oxygen plasma surface treatment was higher as compared to the laser treatment. Also, artificial aging by immersion in saliva for 30 days contributed to lower mean peel off strength for both groups. However, the oxygen plasma treated group did not have statistically significant difference before and after aging.

In clinical use, the soft lining materials are constantly bathed in saliva, and when out of the mouth, they are usually immersed in water for storage or solutions of denture cleansers for cleansing purpose. [13]

In these situations, water or saliva can be absorbed into the lining material and plasticizers or other soluble components can be leached out.

Both processes are likely to affect the physical properties of soft lining material, which in turn has a direct effect on the performance of the soft liner in the mouth.

Conclusion

Within the limitations of the study, it can be concluded :`

Both Oxygen-Plasma treatment and Carbon dioxide laser treatment are effective in improving the peel off strength of the silicone based soft liner (DETAX, Mollosil) and acrylic resin (DPI, heat cure).

Peel strength values obtained after Oxygen-plasma treatment were more than that of laser treated samples both without and after immersion in artificial saliva.

Considering the clinical feasibility and cost effectiveness, laser treatment is more appropriate for the purpose of increasing adhesive strength between denture base resin and soft liners.

Figure 1: Four Customised Metal Dies

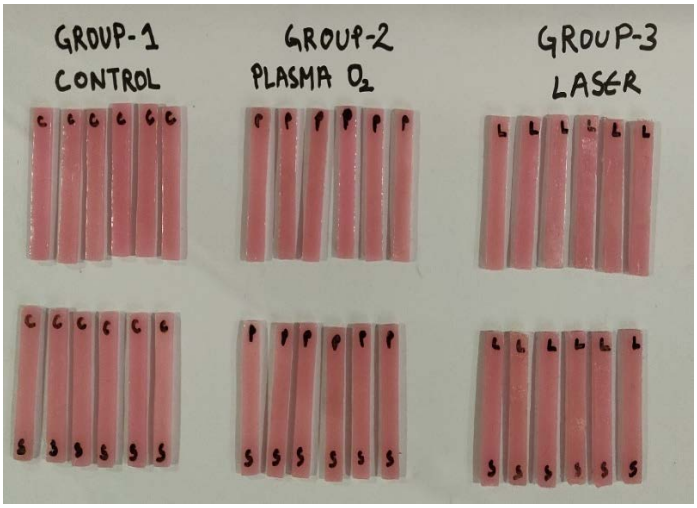


Figure 2: Thirty-Six Acrylic Resin Blocks

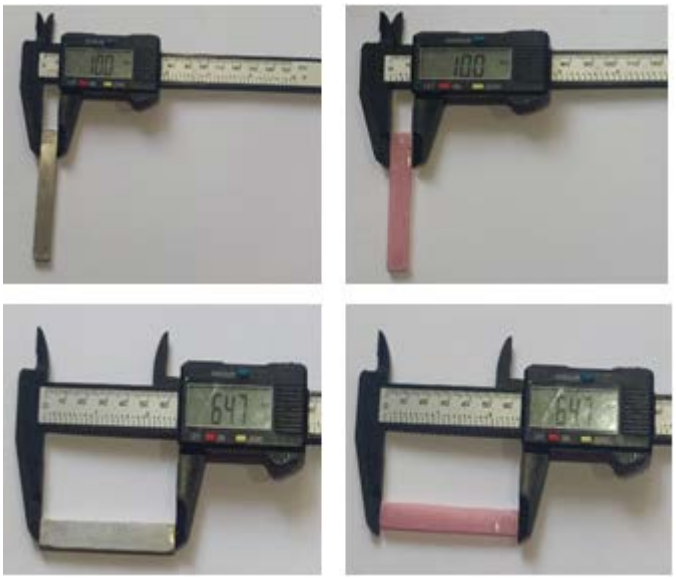


Figure 3: Standardisation of Samples

Figure 4:Oxygen Plasma Treatment

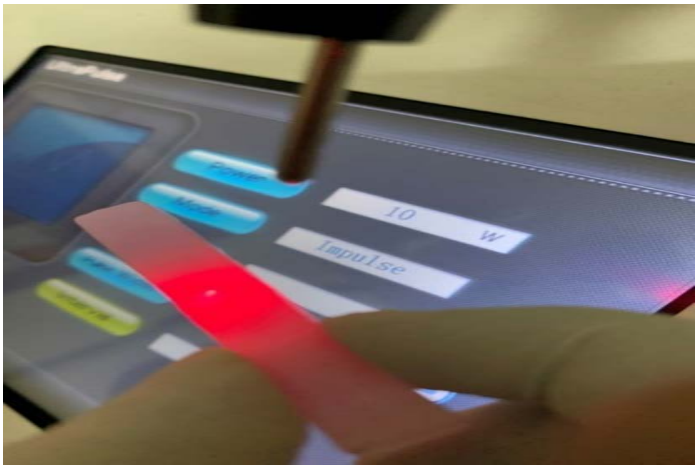


Figure 5 : CO2 Laser Surface Treatment

Figure 6: Packing of Soft Liner on surface treated acrylic resin samples

Figure 7: Storage in artificial saliva

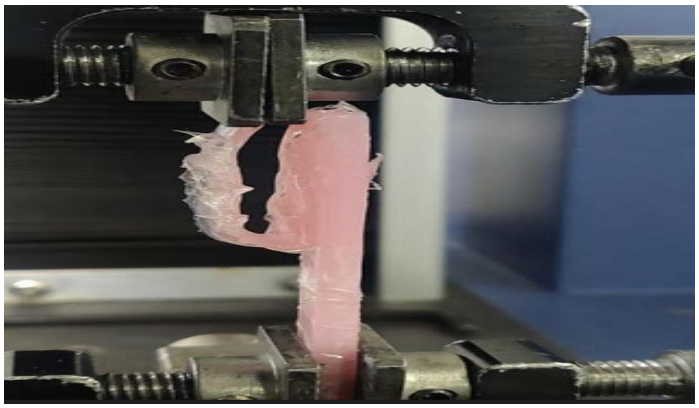


Figure 8: Testing under UTM for peel off strength

References

1. Akin, H. et al. 2011. Effect of different surface treatments on tensile bond strength of silicone-based soft denture liner. Lasers. Med. Sci., 26:783–788.
2. Kawano, F. Et al 1991. The influence of soft lining materials on pressure distribution. J. Prosthet. Dent., 65:567-575. Kawano, F. Et al 1992.
3. Comparison of bond strength of six soft denture liners to denture base resin. J. Prosthet. Dent., 68(2): 368–371. Kulkarni, R.K. and Parkhedkar, R. 2011.
4. The effect of denture base surface pretreatments on bond strengths of two long term resilient liners. J. Adv. Prosthodont., 3:16-9. Makila, E. 1976.
5. Soft lining to relieve soreness beneath dentures. J. Oral. Rehabil., 3:145-150. Murata, H. et al 2002.
6. Dynamic viscoelasticity of soft liners and masticatory function. J. Dent. Res., 81(2):123-128. Mustafa, M.M. and Ruytera, I.E. 2007.
7. Evaluation of bond strength of soft relining materials to denture base polymersDent. Mater., 23(11):1373-81. Nishigawa, G. et al 2003.
8. Plasma treatment increased shear bond strength between heat cured acrylic resin and selfcuring acrylic resin. J. Oral. Rehabil., 30:1081–1084. Sarac, D. et al 2006.
9. The evaluation of microleakage and bond strength of a silicone-based resilient liner following denture base surface pretreatment. J. Prosthet. Dent., 95:143-51
10. The current status of laser applications in dentistry. Australian Dental Journal, 48(3):146-155. Wright, P.S. 1976.
11. Sanchez-Aliaga A, Pellissari CV, Arrais CA, Michel MD, Neppelenbroek KH, Urban VM. Peel bond strength of soft lining materials with antifungal to a denture base acrylic resin. Dental materials journal. 2016 Mar 25;35(2):194-203.

12. Soft lining materials: Their status and prospects. J. Dent., 4:247-256
13. Wright, P.S. 1984. The success and failure of denture softlining materials in clinical use. J. Dent., 12: 319–327. Zhang, H. et al. 2010.
14. Effect of oxygen plasma treatment on the bonding of a soft liner to an acrylic resin denture material. Dent. Mater., 29(4):398-402.