
TISSUE CONDITIONERS, PLASTICIZED ACRYLICS AND SILICON ELASTOMERS AS A RESILIENT LINERS USED IN PROSTHODONTICS

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Abstract: There are three categories of resilient liners – tissue conditioners, plasticized acrylics and silicon elastomers. The unique abilities of resilient liner materials to control the distribution of stress over the denture bearing mucosa and to provide a cushioning effect to the cyclic forces of mastication make them suitable for a wide range of applications in the field of prosthetic dentistry. Tissue conditioners are short term resilient liners used as temporary reline materials for immediate dentures and ill-fitting dentures to facilitate tissue healing without interfering with the use of the prosthesis. Plasticized acrylics and silicon elastomers are long term resilient liner materials recommended as preventive measures in patients with low tolerance threshold to load transmitted by the prosthesis. However, the effects of the oral environment on some of the desirable properties of these liner materials limit their durability. Recent researches have been focused on enhancing their serviceable life and hence, clinical efficacy.

Keywords: Tissue conditioners, plasticized acrylics, silicon elastomers, viscoelasticity, micro-gap, micro-leakage

1. INTRODUCTION

Resilient liners are soft and elastic materials that have proved to be an excellent clinical adjunct in the management of patients with chronic denture soreness and have also found a wide range of applications in the field of maxillofacial prosthesis. Their effectiveness in handling such cases has been attributed to their inherent elasticity and viscoelastic property that enables them to control the distribution of stresses over the denture bearing mucosa and they also provide a cushioning effect to the cyclic forces of mastication. It has been very well established through several clinical trials that use of denture with resilient liners in edentulous patients results in greater comfort, markedly improved speech, reduced feelings of pain and soreness under the denture, greater ability to chew, better retention and stability, an increase in psychological comfort and longer denture wearing times. [1, 2, 3] Resilient liners can be short term resilient liners (Tissue conditioners) or long term resilient liners. Tissue conditioners are short term resilient liners used to treat denture soreness. They are used as temporary reline materials for ill-fitting dentures and immediate dentures to facilitate tissue healing without discarding the use of prosthesis and they are also for making functional impressions. This is in contrast with the long term resilient liners which are used to prevent denture soreness and are recommended as a preventive measure in edentulous patients with sharp and atrophied alveolar ridges, patients with thin atrophied mucosa exhibiting low tolerance to load transmitted by the prosthesis, patients who experience pain at nerve ending locations and in cases where denture exhibits poor retention causing recurrent sore spots under the denture. [4]

Based on the composition, Long term resilient liners have been categorized into two groups -- Plasticized acrylics and Silicon elastomers. Both of these are commercially available in auto- as well heat-polymerized form. Long term resilient liners constitute those that should remain serviceable in the oral cavity for at least four weeks; in practice, however their use can extend up to several months and even years. [5]

2. STRUCTURE

Tissue conditioners are auto-polymerized resins available as two components system – powder and liquid systems. The polymer powder generally consists of polyethyl methacrylate (PEM) with molecular weights ranging from 1.79×10^5 to 3.25×10^5 without any initiator and the liquid contains an ester based plasticizer and ethyl alcohol. [6, 7] Tissue conditioners contain no monomers in the liquid and no initiator in the powder. The plasticizers commonly used are large molecular size aromatic esters (except dibutyl sebacate which is an aliphatic ester) such as dibutyl phthalate, benzyl benzoate, butyl benzyl phthalate. [8] There is absence of cross linkages between polymer chains and thus they can best described as non-crosslinked amorphous polymers. The large plasticizer molecule reduces the entanglement of polymer chains, thereby permitting individual chains to slip past one another. This slipping movement permits change in the shape of the soft liner and the set gel provides a cushioning effect for underlying tissue. [9] However the alcohol and the plasticizer leach out quickly and the material hardens within a considerably short time which varies from a few days to a week or two, and gradually loses its cushioning effect. Ideally a tissue conditioner should be replaced with a fresh mix every 2-3 days. [10]

Long term resilient liners are commercially available as plasticized acrylics or silicon elastomers. Both can be either chemically cured (auto-polymerized) or heat cured.

Heat cured silicon elastomers are supplied as a single paste system consisting of polydimethyl siloxane with terminal vinyl group through which cross linking occurs and benzoyl peroxide as initiator. Chemically cured silicon elastomers are supplied in the form of a two-paste cartridge - a base paste and a liquid catalyst. The base paste contains polymethyl-hydrosiloxane, as well as divinyl polysiloxane. The catalyst paste contains divinyl polysiloxane and a platinum salt. When the two pastes get mixed together, they undergo addition polymerization to yield the elastomer.

3. CHARACTERISTICS AND CLINICAL IMPLICATIONS

The desirable effects of resilient liner materials results from their ability to evenly distribute and absorb the functional forces during mastication by dint of their viscoelastic behaviour. In cases of unfavourable foundation areas (sharp/uneven/irregular alveolar ridge anatomy), the denture fails to fit and sit firmly on the foundation. Under masticatory load application, such dentures moves and tilts upon the foundation and thus beneath the denture, the area of support become small. Consequently, the pressure exceeds several folds greater than the average pain threshold of the alveolar mucosa and the patient complains of soreness and discomfort. Elastic deformation of the lining material beneath the denture base under masticatory load increases the contact surface beneath the denture resulting in more even pressure distribution and pain reduction. [11]

Viscoelasticity is the property of a material by virtue of which it exhibits both elastic and viscous behaviour i.e. to say, the application of stress causes elastic deformation in it if stress is quickly removed but it causes a plastic deformation if it is sustained for a prolonged period. Several tests have been employed to investigate the viscoelastic properties of the liner materials. However, it is to be understood that in clinical situations, the denture liners are exposed to both a rapidly applied forces caused by mastication or swallowing and to a more long term force caused by functional pressure or changes in the oral supporting tissues. [12] Also given the fact that the elastic recovery time for liner materials differ (for e.g. the elastic recovery time for silicone liner materials and acrylic soft liner materials are 1-2 sec and 30 secs respectively); for a test to be considered of clinical relevance it becomes necessary to measure the viscoelastic properties over a wide range of frequencies in order to allow correct predictions of viscoelastic behaviour under these clinical situations. [12] The dynamic mechanical test using viscoelastometer based on the principle of a non-resonance forced vibration fulfil this criteria. In the dynamic mechanical test, three rheological parameters are generally used for evaluation of the dynamic viscoelasticity of materials- (i) storage modulus (E') which describes elasticity of materials (ii) loss modulus (E'') describes viscosity (iii) loss tangent ($\tan \delta$) is the ratio of the loss modulus and the storage modulus (E''/E'). [11,13]

Murata et al. found that acrylic lining materials which exhibit higher values of loss tangent (δ) and storage modulus. [14]

E' provide greater improvement in masticatory function compared to silicon liners which exhibit lower values of loss tangent (δ) and higher value of storage modulus (E'). Tissue conditioners which have higher loss tangent values but lower storage modulus provide lesser improvement compared to acrylic or silicon liners.

An inherent limitation of silicone resilient liners is their inability to form durable bond with the denture base material. Polymethyl methacrylate (PMMA) denture base resin and silicon based lining materials have different molecular structures and cannot be chemically bonded and thus, the bonding between them relies completely on the use of an interfacial adhesive. [15] Failure of adhesion of these liners to the denture base lead to the existence of a micro-gap at resin base- soft liner interface. Such micro-gap may serve as a potential source for micro-leakage culminating in the debonding of liner from denture base. [16] To overcome this problem, the use of a suitable solvent based primer is recommended. Sarac et al. in their study concluded that the surface treatment of the denture base resin with methyl methacrylate monomer prior to adhesive application causes swelling of the denture base surface resulting in better penetration of the adhesive into the denture base and hence more effectively reduced micro leakage compared to the use of the adhesive alone. [17]

Microbial colonization of the denture lining material poses a significant challenge. The conditions prevailing in the oral cavity under the denture base i.e. high humidity, warm temperature, inaccessibility to self-cleansing action of action promote the growth of micro-organisms. Micro-organisms initially adhere to surface of the liner material and later they also invade into the structure of the materials. The latter phenomenon in particular reduces the effectiveness of conventional denture cleansers to restrict their growth. All this may predispose the patient to infection and denture induced stomatitis. Studies have shown that rougher surface of the resilient liners favors the adhesion of micro-organisms and allow fungal growth. [18, 19, 20] Kang et al. reported that acrylic based soft liners exhibited greater Candida adhesion compared to silicon liners and attributed this result to the base components and the hydrophilicity of the materials. [21] Also heat cured silicon liners exhibited significantly less yeast adhesion than

RTV silicon linings. [22] The chemical composition of the room temperature polymerized resilient liners and the difference in surface energies or higher hydrophilicity could be the reasons for this condition. Bulard et al. in his study on the colonization of *C. Albicans* and penetration of long term resilient liners noted a high degree of colonization in the region of resin denture base – silicon soft liner interface which may be attributed to the existence of micro-gap in this region due absence of durable and ineffective bond between the denture base and the silicon soft liner. [23,24] This could be a potential cause for the de-bonding of silicon soft liners in the oral cavity.

In the moist environment of the oral cavity, the resilient liners exhibit water sorption, the degree of which depends upon the hydrophilicity of the matrix and the presence of leachable plasticizers or other soluble substances. [5] This phenomenon may manifest as alteration in mechanical properties of the liners (e.g. loss of viscoelastic behaviour), change in dimensions, microbial growth, discoloration, etc.

Silicone elastomers are hydrophobic by virtue and they do not contain leachable plasticizers, so water sorption is significantly lower which accounts for their greater dimensional stability, better retention of elastic properties, more color stability and hence prolonged durability. However, a potential drawback of the hydrophobicity of silicon-based liners could be absence of good affinity to the supporting tissues.

4. RESEARCH TRENDS

Mante et al. in their study found that the application of surface sealants can prevent an increase in the hardness value of the acrylic-based liner materials in service for extended periods and hence can contribute to their durability. [25] Microbial colonization of the resilient liner material still remains an unresolved issue and has also been postulated to be a potential cause of de-bonding of silicon liners from the denture base. Incorporation of anti-fungal agents such as nystatin have been proposed but they are effective only for short periods. [26] Similar issues arise with incorporation of nano-silver particles into liner materials. Silver ions released into the environment decreased overtime which could reduce their anti-microbial properties. [27] Also nano-silver particles may cause alteration of mechanical properties and discoloration of the liner material. [28] The use of white ceramic micro- or nanofillers with antimicrobial properties appears to be a more appropriate solution to this solution but more research works are warranted in this regard. [5]

Hayakawa et al. in their study compared some of the clinically relevant properties of Clearfit LC with four commercial products – two plasticized acrylics (Supersoft, Soften) and two silicones (Molloplast B, Sofreliner). [29] They found that the polyisoprene-based material exhibit low water sorption and solubility, moderate softness, high staining resistance and satisfactory shear bond strengths to the denture base resins. It also provide clinicians sufficient working time due to light curing properties and thus can serve as attractive alternative as a lining material. The desirable properties of polyphosphazene-based liner materials include excellent shock absorption, durability due to lack of plasticizers, resistance to fungal growth, low water sorption hence more dimensional stability, color stability, decreased porosity hence low staining and presence of odor. [30,31] Also, it is radiopaque and can be identified if any parts or pieces gets accidentally ingested or inhaled by the patient. This becomes of particular significance in dealing with patients with neuro-muscular disabilities and patients of maxilla-facial prosthetic rehabilitation.

5. CONCLUSION

Resilient liners find a wide range of applications in the field of prosthetic dentistry due to their inherent viscoelastic property which enable them to cushion and evenly distribute the masticatory load beneath the denture. They are used to treat mucosal soreness resulting from ill-fitting prosthesis (tissue conditioners) and their use is also recommended as a preventive measure in patients who are likely to develop mucosal soreness with the regular use of the prosthesis. However, the effects of the oral environment on their some of their desirable properties limit their clinical efficacy.

Microbial colonization of the denture liners continues to be an unresolved issue with the use of the soft liners. The growth and penetration of microbial biota particularly in the region of denture base-soft liner interface has been ascertained as a significant factor contributing to the de-bonding of silicon liner from the denture base. Attempts have been made to incorporate anti-fungal agents like nystatin, nano-silver particles into the liner materials but their effects have been found to be short lasting.

Viscoelasticity of a liner material defines its ability to impart a cushioning effect to the masticatory load, its elastic behaviour determine its ability to increase the contact area beneath the denture base by elastic deformation under masticatory load and thus providing a more even pressure distribution. Acrylic based resilient liners which exhibit greater viscoelastic behaviour have been found superior to silicon based resilient liners (which are found to exhibit more of elastic behaviour) in terms of providing greater degree of stress relief and increased patient comfort but they lag behind silicon materials in terms of durability.

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