

Review article



## VISCO-ELASTIC PROPERTIES OF SOFT RELINING MATERIALS – REVIEW

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### SUMMARY

Despite the achievements of modern dentistry in fields of implantology and CAD-CAM technologies, the challenges associated with edentulous patients' treatment are still remaining. Difficulties are getting even greater, when it is a matter of highly atrophied alveolar ridges, covered with very thin mucosa, people suffering from xerostomia, exostosis, very well developed torus palatinus or tuberae maxillae.

Problems of the patients with removable dentures usually are poor adhesion and stability, pain, wounds, difficult adaptation with the new dentures, etc. At this moment there are only two possibilities to help these people. The first one is the use of implants; the second one is to use soft relining materials. There are some obstacles that reduce the use of implants in all patients, because of medical, anatomical, psychological and financial concerns. While in the second option the contraindications are quite less.

**Keywords:** soft relining materials, implantology, “two-layer” denture,

### Introduction

Although soft relining materials have lots of advantages, they have a lot of disadvantages as well, that make many clinicians refuse using them very often. These are the poor bonding with the denture base, the quick hardening and discoloration of the material, specific odour, etc. Despite all this, the Dental Estimates Board of Statistics for England and Wales, states that just for one year period in the dental laboratories 24000 “two-layer” dentures were made and another 11000 “old dentures” were relined using soft relining materials. The relined dentures, made in a direct method in the dental surgeries are not included in this statistics.

British Standard Glossary of Dental Terms, 1983 [1] defines the soft relining materials as resilient and elastic materials forming the whole or part of the prosthetic surface. They usually play a cushioning role, between the hard denture basis and the underlying soft tissue and thus reducing the masticating forces and preventing the po-

tential stress concentration over one single point and reducing to some extent the overall pressure. In this way, the trauma over the underlying mucosa is reduced as well as the velocity of resorption of the alveolar ridge [2].

### Indications for use:

Indications for the use of soft relining materials are the following conditions in the mouth [3, 4]:

- thin and dry mucosa
- highly resorbed and sharp alveolar ridges
- exostosis
- uneven and (or) nonsymmetrical atrophy of the

alveolar ridge

- relining of immediate denture
- chronic inflammation of the soft tissue
- allergic reactions towards acrylic resin
- undercuts of the alveolar ridge
- chronic xerostomia
- for obturators and post-resectional dentures [5, 6, 7].

Voronov et al. [8] suggest the following classification of the soft relining materials, according to their chemical composition:

- ▼ rubber materials
- ▼ acrylic materials
- ▼ polyvinylchloride materials
- ▼ polyurethane materials
- ▼ fluoroelastomeric materials

Depending on the way of polymerization, the soft relining materials can be divided into several groups:

- cold-curing
- hot-curing
- light-curing
- materials, using high-frequency energy

The cold-curing materials polymerise directly in the patient's mouth. The rest of the materials polymerise in the dental laboratory under the influence of physical factors and very strict technological protocol.

### Visco-elastic properties of soft relining materials

Awareness of the visco-elastic properties of the materials gives the practitioners an opportunity to predict to a certain extent their behaviour in clinical conditions [9].

Taguchi et al. [10] investigate the influence of visco-elastic properties of soft relining materials towards the pressure of the underlying anatomic structures. Methods of investigating this pressure can be divided into three major groups. The first one measures the pressure directly in the patient's mouth. The second one uses the finite elements analysis. In the third group, indirect measurements of simulation models are made. The direct measurements held under the conditions of the oral cavity have serious disadvantages, because of the difficulties connected with the installation of the sensors. It is also almost impossible to evaluate the influence of the thickness and the viscoelasticity of the mucosa. On the other hand, each element of the finite elements analysis acquires the viscoelastic coefficients of the mucosa and the alveolar bone. When using simulation models, most of the disadvantages of the first two groups have been eliminated, and the results are with the very high level of authenticity. According to the investigators, the acrylic relining materials demonstrate viscoelastic behaviour and have the possibility to reallocate the occlusal forces, applied to them. On the other hand, the elastic relining materials show utterly elastic behaviour. They can preserve their shape, despite the applied pressure upon them [11]. That is why it is very important to understand the viscoelastic behaviour of each material, to choose the best one, according to the clinical situation. Upon static loading tissue conditioners behave like viscous fluids, while under dynamic loading, they are getting stiffer.

Adding of inorganic fillers decreases the immediate elastic recovery of the liner, and it is getting closer to that of the mucosa. The quantity of the inorganic fillers, as well as the number of the crosslinks, are connected with the modulus of elasticity and viscosity. The softer the material is, the less the quantity of the filler is. This fact has a major impact on the physical properties (for example greater water absorption). In vitro investigations concerning the viscoelastic properties of the materials should be held for at least 60 days [12]. The scientific efforts of lots of researches are towards inventing materials with brand new characteristics. Aziz et al. [13] are comparing the mechanical properties of several experimental elastomeric materials with silica reinforcing fillers. The conclusions of the authors are that the modified materials have better mechanical properties: tensile bond strength, percent of elongation, Shore hardness, etc. Adding such fillers can also decrease the water penetration, depending on the degree of adhesion towards the monomer. To investigate the fillers' surface, modern techniques are used, including gas chromatographic analysis. Decreasing water absorption, leads to increasing of the clinical permanence of the materials.

Kasuga et al. [14] consider that materials containing fluorine monomers have more reliable and long-last-

ing viscoelastic properties. Kanie et al. [15, 16] investigate the effect of adding methacrylic monomers towards experimental light curing soft relining materials, based on urethane (meth)acrylic oligomers. They draw a conclusion that adding an extra amount of methacrylate causes a reduction of the viscosity of the experimental materials, without having an influence on their mechanical properties.

Acrylic materials can be more easily dissolved in fluids in comparison with the silicone ones. That is why they suffer greater changes in the colour and Shore hardness. The explanation of this phenomenon is the establishment of a balance between the elastic and osmotic forces. The acrylic materials undergo two parallel processes, when kept in water: leaching of plasticisers and water absorption. The balance between these two processes reflects the volumetric stability and tensile bond strength between the soft relining materials and the denture basis. The fluids have almost no adverse effect on the silicone materials. Being hydrophobic with no plasticisers, they demonstrate no water absorption. According to ADA specification 12, the water absorption should not exceed 0.08 mg/cm<sup>2</sup> and solubility-0.04mg/cm<sup>2</sup> per week. Higher levels of absorption and solubility are connected with changes in colour, odour, the growth of pathogenic microorganisms, swelling and shrinkage of the relining material, as a result hardening and biodegradation occur. That's way these two processes can serve as a landmark of the reliability of the materials. The ideal soft relining material must have very low values of absorption and solubility. Differences in the behaviour of these materials show that results achieved in the conditions of artificial saliva are more reliable, compared with those achieved in distilled water [17].

Volumetric stability and weight changes are of primary importance for obtaining precise functional impressions, which is the other form of clinical application of tissue conditioners. This can be done by investigating the changes in solubility and absorption. The percentage of solubility of all materials investigated by Murata et al. [18], (with only one exception) is higher, compared with the percentage of absorption. As a result, all investigated materials demonstrate polymerization shrinkage. This is associated with the micro-leakage of plasticisers into the oral cavity. The results show that the optimal time for taking precise functional impression is within 24 hours after insertion into the patient's mouth. During that time these materials possess optimal visco-elastic properties. After the 24-th hour, as a result of the plasticiser leakage, tissue conditioners are getting harder, and their efficiency decreases. This fact compromises to some extent this group of materials and reduces their clinical application in time. The enormous quantity of crosslink's of the silicone soft relining materials decreases the ability of

micropores' formation and thus preventing water penetration. Silicone molecules are hydrophobic besides this, which is yet another reason for the lower degree of water absorption. That is why silicone materials are considered to be more stable in time.

Chladek et al. [19, 20] investigate the sorption, solubility, bond strength, changes in hardness and antifungal activity of a new experimental, incorporated with silver nanoparticles material. The authors report of a parallel between the decrease in hardness and the increased concentration of silver nanoparticles (over 80 ppm). As a negative characteristic of the material, the scientists point out the prolonged time of elastification, which could be

a potential clinical problem, as far as direct methods of relining are concerned. These results are in coincidence with the results obtained from Mancuzo et al. [21].

## CONCLUSION

During the first days of adaptation, the pain and the wounds make most of the patients refuse wear their dentures. It is not necessary for the old people to start learning new and very complicated habits while using expensive and complex devices. The "two-layer" dentures are a reasonable alternative and a powerful tool, with the help of which, the problems associated with the removable dentures can be overcome.

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