THE EFFORT OF VARIOUS MIXING METHODS ON DYNAMIC VISCOELASTICITY OF A TEMPORARY SOFT LINING MATERIAL; COE-COMFORT

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Statement of Problem. Temporary soft relining materials are used in a diverse clinical situations such as tissue conditioner, relining material, functional impression by varying its viscoelasticity. However, reproduction of consistent viscoelasticity has been not possible.

Materials and methods. Considering setting mechanism of this material, this study has measured the effect of varying amount of void in dynamic viscoelasticity of soft relining material, with three different mixing methods. In each methods 10 specimens were made and subjected to dynamic viscoelastic test which were measured at specific times over period of 72 hours.

Results. The analysis of the result shown that there was no statistically significant differences between different mixing methods.

Conclusion. Different mixing methods had no effect over control of viscoelasticity of soft lining material. Further research is recommended for under similar oral environmental condition.

Key Words

Key word: Soft tissue liner, Coe-Comfort, Viscoelasticity

Temporary soft lining materials are multipurpose product used in diverse clinical situations; relining poorly fitted dentures, temporary lining for tissue managements, diagnostic treatment, polished surface contouring, intraoral maxillofacial prosthesis and functional impressions.[1,2] To satisfy these clinical demands it is necessary to produce a lining material with various yet manufacturable and reproduceable consistency. Allowing maintenance of material compliancy for continual flow over the fitting surface and to transfer masticatory forces evenly but resilient enough to maintain the occluso-vertical dimension and resist flowing out of the denture.[3-5]

The mechanism of setting of tissue conditioner

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is not fully understood. It is a physical process where liquid; plasticiser and alcohol, infiltrating into polymer powder to form a viscoelastic material through gelation.[6] Clinicians rely on their experiences to mix tissue conditioner to produce right consistency and flow rate to use in each case. Through absorption of water and dissolve of plasticiser in intraoral condition, the tissue conditioner lose its compliancy over period of time. This lack of comprehensive understanding of the gelation mechanism restricts an accurate management of material for each clinical situations. Many efforts have been made to control and preserve the viscoelasticity by altering plasticiser8, alcohol quantities[12] and changing powder to liquid ratio.[11] All these investigations have yet to produce an ideal tissue conditioner or ways in which methodical manipulation of the material could be deduced.[7-9]

According to Braden10 the increase in size of droplet in tissue conditioner which resulted from the osmotic infiltration of water to the impurities of the material, may affect physical properties. The variation of void size have been observed when Visco-gel was vacuum treated by Nimmo et. al.[11] and produced a smooth surface. Since the setting mechanism of the tissue conditioner depends on a physical process, structural differences in the set material may have influence in its properties, particularly viscoelasticity. However, there have been no experiments on the effects of voids on viscoelasticity of the tissue conditioner have been performed. In this study it was hypothesised that varying the mixing method which produce different quantities of voids may have influence on the viscoelasticity of a tissue conditioner. Coe-comfort(Coe Lab., IL, USA) Which has been used in this experiment for its high frequent usage in a clinical environment. This hypothetical consistency in viscoelasticity will enable reproduction of tissue conditioner mixture at varied viscoelasticity permitting at a standardized consistency of the material rather than depending on the expertise when mixing the material. Three mixing methods were employed; manual, machine and vaccume mixed Coe-comfort were subjected to dynamic viscoelastic test at a given time intervals. Malstrom[12] also have shown that the changes in viscoelasticity is a time dependant behaviour, therefore viscoelasticity have been measured over period of 72 hours.

METHODS AND MATERIAL

An acrylic based temporary soft liner Coe-Comfort (Coe Lab., IL, USA) used consists of polymethylmethacrylate, ethyl alcohol, dibutyl phthalate, and zinc oxide undecylenate. For each specimen 5cc of liquid and 6g of powder were measured using micropipet (PIPETMAN, Gilson Co., France) and an electronic scale (OHAUS/SD-2020, USA). These were then mixed for 12 seconds by manually, with machine or vaccume mixer. The manual mixing was the control group. An Impression material mixer, MIGMA mixer (MIKRONA, Swiss) was used and vaccume mix was carried out in a bell jar under 170 mmHg negative pressure created with custom made vacuum pump. Immediately after mixing, the mixture was poured into a plastic cap and a specimen size of 22㎜ in diameter with 3㎜ height soft lining discs were produced. Altogether 30 specimens were made, 10 for each mixing methods.

The specimens were stored in a distilled water bath at the room temperature 20°C after setting and after each dynamic viscoelasticity measurements the specimens were immediately replaced to the water bath. Distilled water was changed daily during the period of experiment.

Each specimen was placed under dynamic load and changes in the thickness of the material were recorded at given time intervals; 2hr, 12hr, 24hr, 48hr, and 72hr, after mixing. An automatic compressive load applicator (FM Korea Co., Seoul, Korea) comprised of a horizontal arm attached to a motor that created a sinusoidal application of load on each specimen through vertical arm. Through lifting of the vertical arm with motor supported the weight of the horizontal arm, leaving no weight on the specimen but on removal of the support, the weight of the horizontal arm was applied on the specimen. The sinusoidal loading was applied at 2Hz for 1minute. The linear variable displacement transducer, LVDT (GT2500, RDP Electronics Ltd., Wolverhampton, UK) attached to the vertical arm recorded the changing thickness of specimen during the testing period and stored in a specifically written program, SYHAD911. The sampling frequency was set to 3times per second. The LVDT, AD converter and conditioning module were calibrated prior to the experiment for their accuracy.

In the viscoelastic behaviour of Coe-comfort, a cumulative deformation was predicted after initial 30 seconds of dynamic loading when simple linear regression analysis was examined. Initial 30 seconds of the testing periods were examined by two-way AVONA and the Bonferroni test using SPSS Ver 11 software (SPSS Inc., Chicago, IL, USA)

RESULTS

The viscoelasticity changes of each Coe-Comfort specimen were deduced from deformation thickness of the material under dynamic loading per unit time over given time intervals. Consequently the aging effect was also measured. In each specimen linear regression analysis of the maximum deformation points recorded at the first 30 seconds was used and accumulated deformation was predicted. The linear regression from each specimen and storage time was plotted on a table in different mixing groups and the mean values and deviation values were then demonstrated. The later 30 seconds of the dynamic loading have shown little changes on deformity and these part of the experiment was discarded from analysis. (Fig. 1)

The table revealed a continual reduction in the thickness of the specimens during the storage time regardless of the difference in their mixing methods. (Fig. 2 & 3)

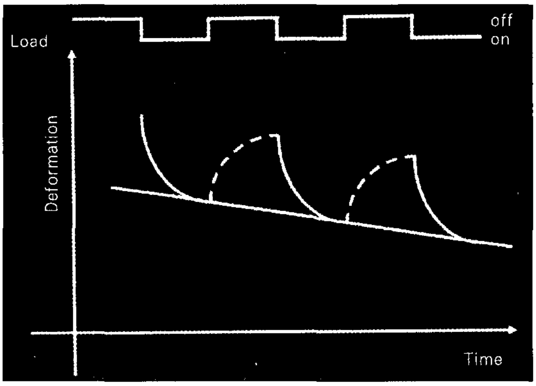

Fig. 1. Deformation versus time graph used for simple linear regression analysis(straight line) under the dynamic load.

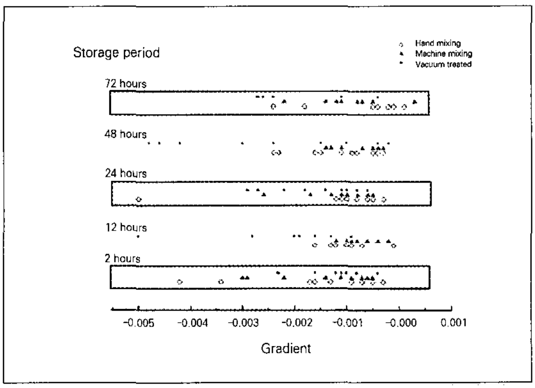

Fig. 2. Scattering plot representing the gradient valuefrom linear regression analysis grouped from mixing method and storage time.

Table I. Levene's test of equality of error variances to examine the assumption of Two-way ANOVA analysis

F	df1	df2	Sig.
2.068	8	36	0.066

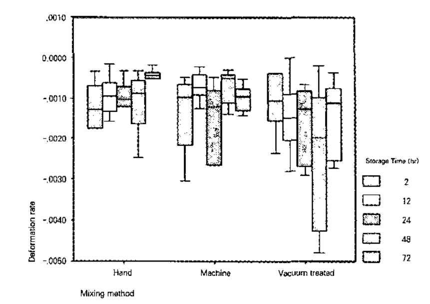

Fig. 3. Box-Whisker Plots of deformation rate(㎜/sec): The mean value and deviation of each mixing group.

Table II. The results of a two-way analysis of variance for analysizing two factors: mixing methods(MIXING) and storage period(TIME)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected model	7.947E-06	8	9.933E-07	2.083	0.064
MIXING	3.383E-06	2	1.692E-07	0.355	0.704
TIME	3.365E-06	2	1.683E-06	3.528	0.040
MIXING×TIME	4.243E-06	4	1.061E-06	2.224	0.086
ERROR	1.717E-05	36	4.770E-07		

ANOVA test performed on the mixing groups and storage times have shown no statistically significant differences were noted($p>0.05$). (Table I & II)

DISCUSSION

In the clinical usage of the temporary soft lining material, the difficulties rise from the lack of control and standardization of viscoelasticity for its diverse clinical situations in which these materials are used. Reduction of the viscoelasticity of the material with aging have been researched extensively. Limited improvements from substitution or addition of materials, changes in powder and liquid ratio, temperature have been made but total elimination of control of viscoelasticity with aging have yet to be developed.[8,13,14]

The consistent reproduction of same viscoelasticity of the material at each varied clinical use also have been failed. The lack of in-depth understanding of the material setting mechanism have restrained manufacturers from giving specific methods and quantities of mixing but left the resulting consistency and viscoelasticity of the material on the hands of clinicians experience and preference.

The temporary soft lining material in subjected to continual compressive pressure as well as short intense masticatory pressure. The material should sustain its viscoelasticity property during these wide variety of pressure in whichever reasons it is used clinically. Therefore it is only justified to subject the testing specimens under dynamic pressure rather than static viscoelastic tests such as puncture strength test, creep test or stress relaxation test.[4]

Unlike hypothesized, the result of viscoelasticity between the three different mixing methods have resulted with no statistically significant differences at each storage time. Although as expected, from leaching out of alcohol and plasticizer from the mixture, with aging, all these methods have reduced in the viscoelasticity. The result was somewhat unexpected as the effect of varied physical characteristics have not made any effect on the physical property.

The microstructure of each specimens have not been determined to prove the difference in volume of voids in each mixing group. The differences have been only presumed from previous studies by Nimmo[13]. Also suitability of vacuum mixing have been questioned by Casey[15], that only certain soft lining material have long enough working time for vacuum mixing. Therefore, it would have been helpful to under go further quantitative investigation on the voids in each mixing method specimens.

Both Kazanji[16] and Branden[10] have mentioned that the different solubility of soft lining materials in saliva or artificial saliva to distilled water. Some soft lining material have shown to have increased solubility and resulting reduced compliance. Aloul[13] have shown increased leaching of plasticizer in artificial saliva than in ethanol, water or air. The testing specimens were same material, Coe-Comfort but the storing environment may have influenced on viscoelasticity. Considering the leaching effect of the material, one had expected more significant reduction on compliance with aging from increased surface area from increased volume of void within the mixture.

Within the limitation of this study it has been shown that the different mixing methods with possible variation on void have made no difference to physical property of Coe-comfort. The authors think this should be taken as primary pirate study and further investigation should follow to see the effects of mixing methods of Coe-comfort and other temporary soft lining materials in both vitro and vivo condition.

CONCLUSION

This study have shown only limited view on the mixing methods on the viscoelasticity of Coe-comfort. If any conclusion could be made from this study, it can be said that mixing methods have had no effects on the vicsoelasticity of Coe-Comfort, but future research is strongly recommended with much reduced variabilities of testing conditions.

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