ANNOTATIONS

Dimensional Stability of Elastomers for Maxillofacial Applications

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Determination of the amount of permanent deformation for maxillofacial elastomers is essential in evaluating the potential for permanent dimensional change as a result of stress on the peripheries of maxillofacial appliances. The permanent deformation and volume change of various maxillofacial elastomers under conditions of accelerated aging were investigated with the use of a Weather-Ometer (Model 25 WR, Atlas Electric Devices, Inc.). Four categories of elastomers evaluated in this study were: 1. RTV Silicones – (a) Silastic 382, (b) 399, and (c) 44210. 2. Heat Vulcanized Silicone – Silastic 44515, Dow Corning Corporation, Midland, MI 48640. 3. Polyvinyl chloride – Prototype III, Sartomer Industries, Inc., Essington, PA 19020, and 4. Polyurethane – Epithane, Daro Products, Inc., Box 224, Butler, WI 33007.

Samples were prepared for testing by following the manufacturers' instructions and, when possible, under vacuum to eliminate porosity. Five samples of each material were evaluated before and after 900 hours of aging in the weathering chamber. During the aging process, a 2500 watt Xenon light source was left on continuously, and distilled water was sprayed on the samples for 18 of every 102 minutes. The humidity of the chamber was maintained at 90% RH, and the temperature was 43 C or a black panel temperature of 63 C.

The new values of permanent deformation were determined by elongating a tensile sample to the point of rupture, measuring the increase in length after 24 hours of recovery and representing this value as percentage of the original length. This method was employed after evaluating the results obtained in an earlier study (*J Dent Res*, Spec Iss B:B150, 1977) which gave values of maximum percent elongation of 227±13 for silicone 382, 221±24 for silicone 399, 445±27 for silicone 44210, 441±32 for silicone 44515, 422±51 for polyurethane, and 215±22 for polyvinyl chloride. In the present study, each elastomer was taken to the ultimate elongation and then allowed to recover with no stress – a technique relevant to the mode of failure around the thin edges of a prosthesis under service conditions. Although the test was more challenging to those materials having higher ultimate elongation, it was necessary in order to investigate the potential of permanent deformation for each material.

The volume measurement of each sample before and after accelerated aging was determined by buoyancy technique in distilled water. The results listed in the Table are normalized values.

The results for permanent deformation and volume change obtained are summarized in the Table. The means and standard deviations were calculated for each material at each time interval, and were then compared before and after aging by Tukey's multiple comparison test at a 95% level of confidence. The Tukey intervals are given in the footnotes of the Table.

No statistical differences in permanent deformation were found for all silicone elastomers before and after 900 hours of aging. Prior to aging, permanent deformations were low for all silicones. The values ranged from 0.22% to 0.26%. These results were interesting, since the test method used was most severe for silicones 44210 and 44515 with maximum percent elongations of 445 and 441, respectively. Polyvinyl chloride with a permanent deformation at 13.80% was the largest, and this value changed slightly after accelerated aging. The permanent deformation increased from 13.80% to 14.24% after 900 hours. The polyurethane had good elastic recovery, and suffered a permanent deformation of only 0.36%. However, this material demonstrated severe degradation when exposed to conditions of accelerated aging, and the weathering was stopped after 600 hours. This elastomer became sticky and soft; and the measurements for permanent deformation could not be made at that time interval.

Accelerated aging did cause volume changes in all materials, but the change could not be measured for the polyurethane due to physical deterioration. The material that exhibited the largest volume change was the polyvinyl chloride with an overall reduction of 5.62% in volume after 900 hours of aging. Among the silicone elastomers, the largest change was observed for Silastic 399 with a total decrease of 2.14% in volume; whereas Silastic 44210 demonstrated excellent stability with a volume decrease of only 0.34% after 900 hours of aging. Volume changes observed on aging were statistically significant for all silicone materials; however, these values are probably insignificant in actual clinical applications.

The results presented here complement the results of the earlier study. Silicones, in general, under conditions of accelerated aging were more stable than other elastomers. These additional results should provide useful information for clinicians when selecting elastomers for maxillofacial applications.

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TABLE 1
DIMENSIONAL STABILITY OF MAXILLOFACIAL MATERIALS

Elastomer	0		900	
	Permanent Deformation %	Volume %	Permanent Deformation %	Volume %
Silastic 382	0.22 ± 0.08	100.00	0.20 ± 0.11	99.40 ± 0.06
Silastic 399	0.26 ± 0.08	100.00	0.24 ± 0.11	97.86 ± 0.04
Silastic 44210	0.24 ± 0.08	100.00	0.24 ± 0.10	99.66 ± 0.06
Silastic 44515	0.26 ± 0.05	100.00	0.22 ± 0.08	99.46 ± 0.06
Polyvinyl Chloride	13.80 ± 0.86	100.00	14.24 ± 0.62	94.38 ± 0.07
Polyurethane	0.36 ± 0.08	100.00	Disintegrated	

Underline indicates no statistical difference in means with respect to time at 95% level of confidence.
Tukey Intervals for times: for Permanent Deformation = 0.26, for Volume = 0.05.

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