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Correlation between Shore-A-Hardness of Impression Materials and Removal-Forces - A Questionable Assumption

Objectives

There are recommendations to use impression materials with low stiffness, respectively, a soft Shore-A hardness for impressions of periodontal damaged teeth (Fig. 1, 2). [1] These "soft"-materials should prevent further damage of the periodontium when the impression is removed from the teeth as well as cast breakage during separation from impression.
It is assumed that the necessary force for removal of an impression is dominated by the force of deformation to remove the impression from the undercut region. [2]
There is no data on the removal forces of modern impression materials. Does Shore-A hardness correlate to the forces necessary to remove or to separate?

Material and Methods

Two polyether and 12 polyvinyl siloxane materials were investigated. Impressions were made of a polyurethane resin model (Fig. 3) with full dentition (KaVo UK T 16). Ready-made metal stock trays were used.
The model was mounted in a Zwick test machine. The stock tray was always filled up to the edge with impression material and was fixed vertically in the test machine. The tray was then placed in the same position as the model by the machine (Fig. 4). After the impression material was set, the test machine removed the impression from the model at a speed of 400 mm/min. At the same time Shore-A hardness was measured. Each material was tested 7 times. Two hours after removal the tray was boxed with a collar and poured with a type IV dental stone.
With the aid of a centering device every cast impression was placed in the test machine. After 24h, the test machine separated the impression from the cast. Shore-A hardness was measured again.
The correlation between the removal/separation forces and the Shore-A hardness-values was calculated. One-way ANOVA following a-posteriori tests was conducted.


Fig.1


Fig.2


Fig.3


Fig.4

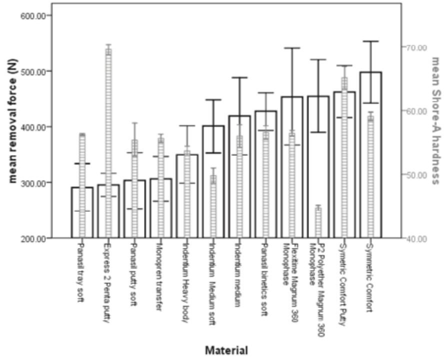

Fig.5 Mean removal forces (broad bars) and mean Shore-A hardness (narrow bars)

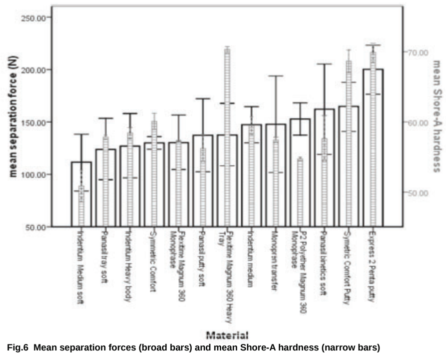

Fig.6 Mean separation forces (broad bars) and mean Shore-A hardness (narrow bars)

Results

Forces for the removal from the model differed significantly between different materials ($p<0.001$). For materials that were the easiest to remove, forces were 46% less than forces for the material that was hardest to remove. There was no correlation between the removal forces from the model and the Shore-A hardness ($r=0.121$, $p=0.254$; Fig. 5). Measured values for Impregum couldn't be determined using this particular test set-up. After a strain of more than 1500N, the holding device broke out of the model.
Forces for the separation from the cast differed significantly between the different materials ($p<0.001$). For the material that was the easiest to separate, forces were 40% less than forces for the material that was hardest to separate. There was a marginal correlation between separation forces from the cast and the Shore-A hardness ($r=0.53$, $p<0.001$; Fig. 6).
Experiments with impression materials showed that stiffness and Shore-A hardness correlated. [3] Therefore, it seems plausible that Shore-A hardness correlates with forces at removal and separation. Evidence for this correlation was found for Polyether Impregum and Impregum soft. [4] Our investigation showed that the correlation between Shore-A hardness and the force needed for removal in respect to separation is at best marginal. Aside from elasticity, there are static and dynamic friction forces. Forces to overcome cohesive, adhesive power, and low-pressure are summed up at removal. These theoretical considerations result in practical recommendations, e.g. placing an impression in soap solution prior to separation or loosening an impression by leveraging and edging. [5]

Conclusion

Shore-A hardness of an elastomeric impression material does not correlate with removal forces nor with separation forces. Whether these results can be transferred to a clinical situation should be investigated.

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