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Research Article

Resilience In Compression: Comparative Evaluation Of Elastic Recovery In Two Commercially Available Addition Silicone Impression Materials

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Abstract
This in vitro study evaluates and compares the elastic recovery under compressive strain of two commercially available addition silicone impression materials—Dentsply Aquasil and Ad Sil Acura. Standardized cylindrical specimens (20 mm × 12.5 mm) were prepared per ISO 4823:2007 and subjected to 30% compressive strain using a Universal Testing Machine. Recovery height was measured after 2 minutes, and recovery percentage was calculated. Dentsply Aquasil showed higher elastic recovery (98.5%) than Ad Sil Acura (96.9%), with statistical significance ($p < 0.05$). Results suggest Dentsply Aquasil provides better dimensional stability for clinical use.

Keywords: Elastic recovery, compressive strain, addition silicone, impression material, polyvinyl siloxane

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1. Introduction

Accurate and dimensionally stable impressions are indispensable in fixed and removable prosthodontics. The ability of an impression material to undergo deformation during placement and removal from the mouth, and then return to its original dimensions without permanent distortion, is crucial for the fabrication of precise prostheses. Among the various types of elastomeric materials available, addition silicone impression materials, also referred to as polyvinyl siloxanes (PVS), are most commonly employed due to their superior elastic recovery, excellent dimensional stability, and ease of manipulation. Elastic recovery refers to a material's ability to rebound after being deformed by mechanical forces. In clinical scenarios, impression materials are compressed while seating the tray and undergo further stress during removal from the oral cavity, particularly from areas with deep undercuts. If the material does not recover fully, it can result in dimensional inaccuracies, leading to ill-fitting restorations.[2,4,5,6]

The International Organization for Standardization (ISO) 4823 standard[2] outlines the required performance characteristics of elastomeric impression materials. Specifically, it mandates a minimum elastic recovery of 96.5%. Although many commercial materials claim compliance, variations in formulation—including cross-linking density, filler content, and catalyst type—can significantly influence material performance.

This study aims to perform a comparative evaluation of

elastic recovery under compressive strain for two commercially available PVS materials: Dentsply Aquasil Ultra Heavy Body and Ad Sil Acura Heavy Body. The investigation focuses on in vitro measurement of recovery after standardized deformation, simulating the clinical process of impression making and removal.

2. Materials and Methods

2.1 Materials

Two heavy-body polyvinyl siloxane impression materials were selected:

- Group A: Dentsply Aquasil Ultra Heavy Body (Dentsply Sirona, USA)
- Group B: Ad Sil Acura Heavy Body (Prime Dental Products Pvt. Ltd., India)

2.2 Sample Preparation

Standardized PTFE mold were used to prepare cylindrical specimens of 20 mm in height and 12.5 mm in diameter, following ISO 4823:2007 guidelines. Each impression material was dispensed using its automixing system into the mold
lined with acetate sheets to avoid adhesion. A flat metal plate was used to level the surface and ensure uniform dimensions. After the working time as specified by the manufacturer, the samples were allowed to set fully.[11]
The specimens were then transferred to a 37 ± 1°C water bath and stored for 30 minutes to simulate intraoral temperature conditions prior to testing.

2.3 Compressive Testing Procedure

Each sample was subjected to a uniaxial compressive strain using a calibrated Universal Testing Machine (Instron Model 3345). A 30% compressive strain (corresponding to 6 mm deformation) was applied and held for 2 seconds. After releasing the compressive force, the specimens were left to recover for 2 minutes on a flat surface at room temperature.[1]

2.4 Measurement of Recovery

The recovered height was measured with a digital micrometer accurate to 0.01 mm. The elastic recovery percentage was calculated using the formula:

$$\text{Elastic Recovery (\%)} = ((h_1 - h_2) / (h_1 - h_3)) \times 100$$

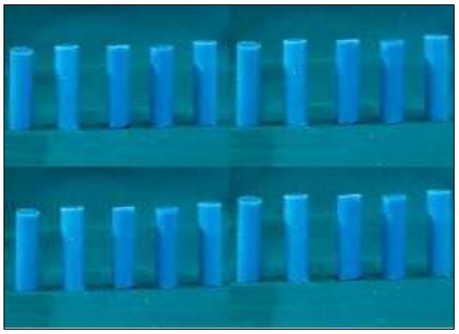
where:

- h_1 = Original height (20 mm)
- h_2 = Height after 2 minutes of recovery
- h_3 = Height under 30% compression (14 mm)

2.5 Statistical Analysis

All measurements were conducted in triplicate for each of the ten specimens per group (n=10). Statistical analysis was performed using SPSS version 26.0. A one-way ANOVA was used to assess differences between groups, followed by Tukey's post hoc test. A p-value < 0.05 was considered statistically significant.

Polytetrafluoroethylene (PTFE) mold



Densply Ultra Aquasil samples

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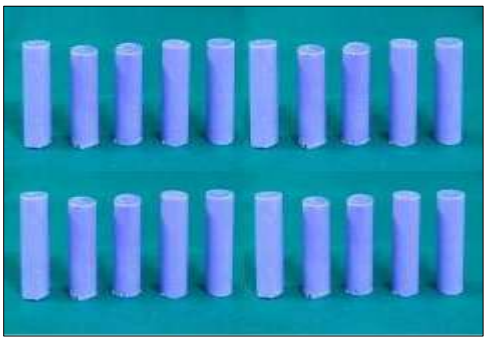


Ad Sil Acura by Prime samples.

Testing of samples on Universal testing machine

Results of elastic recovery under compressive strain

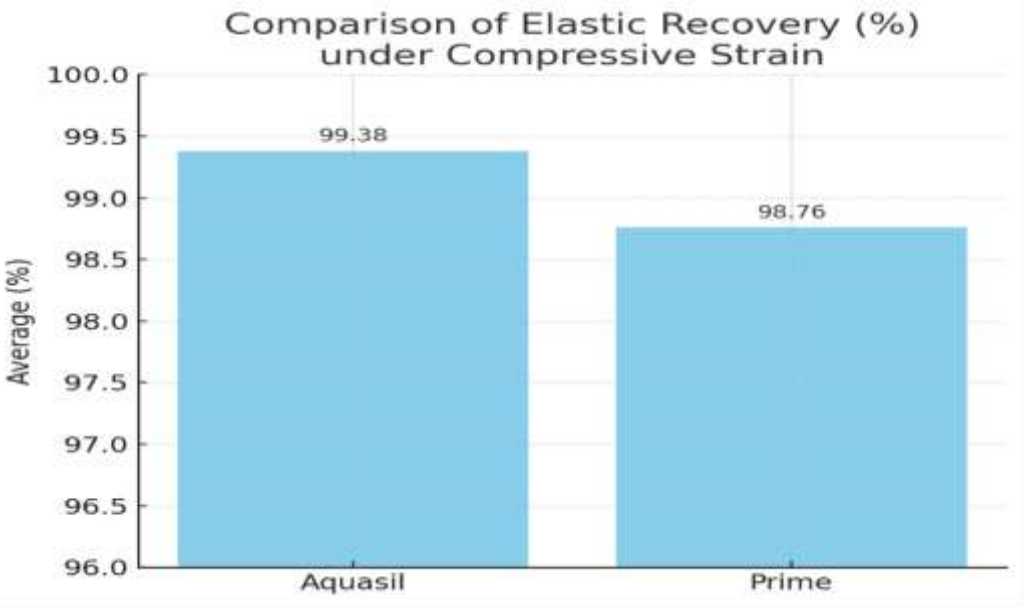
3. Results

A total of 20 specimens (10 per group) were tested for elastic recovery under 30% compressive strain. All specimens met the minimum ISO 4823 requirement of 96.5% elastic recovery.

The mean elastic recovery for Dentsply Aquasil was 98.5% ± 0.41, whereas Ad Sil Acura showed a mean recovery of 96.9% ± 0.57. The difference in recovery between the two groups was statistically significant ($p < 0.05$), indicating superior elastic rebound in Dentsply Aquasil.

Table 1 summarizes the descriptive statistics of the recovery percentages:

Material	Mean recovery %	Standard deviation	Range
Dentsply Aquasil	98.5	0.41	97.9 ~ 99.1
Ad Sil Acura	96.9	0.57	96.2~98.0



The analysis of variance (ANOVA) confirmed a significant difference in the recovery means ($F = 15.72$, $p < 0.001$). Tukey's post hoc test revealed that Dentsply Aquasil had significantly higher recovery than Ad Sil Acura ($p < 0.05$).

These findings highlight that although both materials comply with ISO standards, Dentsply Aquasil provides a more consistent and higher elastic recovery profile, which is critical for maintaining impression accuracy.

4. Discussion

The results of this study showed that both Dentsply Aquasil and Ad Sil Acura fulfilled the ISO 4823 criteria for elastic recovery under compressive strain, confirming their suitability for clinical use. However, Dentsply Aquasil demonstrated a significantly higher mean recovery percentage than Ad Sil Acura.

Elastic recovery is influenced by the material's internal structure, especially the degree of cross-linking and filler distribution. The superior performance of Dentsply Aquasil may be attributed to its higher filler loading and optimized polymer matrix. These features improve shape memory, reduce permanent deformation, and enable better rebound following mechanical loading.

Previous studies have consistently ranked PVS materials at the top for elastic recovery compared to other elastomeric families such as polyether or condensation silicones. The findings of this study are consistent with literature by Lawson et al. (2008) and

Lu et al. (2004), both reporting high elastic recovery values for high-quality PVS formulations.

Although Ad Sil Acura is a cost-effective alternative and demonstrated acceptable performance, its slightly lower recovery may be critical in impressions requiring exceptional dimensional fidelity, such as those for implant-supported prostheses or long-span bridges.

The limitation of this study includes its in vitro nature. In vivo conditions involve additional variables such as moisture, patient movement, and tray selection. Future research should involve clinical evaluations and include tensile recovery and tear resistance for comprehensive assessment.

5. Conclusion

- Both Dentsply Aquasil and Ad Sil Acura demonstrated acceptable elastic recovery, exceeding the ISO 4823 minimum requirement of 96.5%.
- Dentsply Aquasil exhibited statistically superior recovery, suggesting it is more reliable for high-accuracy impressions.
- Material formulation, particularly polymer network structure and filler content, significantly affects elastic performance.
- Clinicians should consider elastic recovery during material selection for critical prosthetic procedures.
- Further studies under clinical conditions are recommended to validate these in vitro findings.

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