Retentive Properties of Tin-coated Novaloc and Locator Overdenture Abutments

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BACKGROUND

- ✓ Edentulism is a chronic, irreversible condition that substantially impacts patients' well-being and quality of life.
- ✓ The 2-implant mandibular overdenture has been the minimum standard of care for edentulism. However, the 2-implant overdenture's reliance on a reduced number of attachments requires routine reactivation or change in retentive components, which can be inefficient and burdensome.
- ✓ Retention loss due to long-term use represents one of the main drawbacks frequently observed with dental prostheses.
- ✓ Locator attachments containing Nylon are commonly used to attach the implant fixture to the denture.
- ✓ Polyetheretherketone (PEEK), a semi-crystalline polyaromatic thermoplastic polymer has recently been introduced for use in removable prostheses.
- ✓ The Novaloc system matrices utilize PEEK, which is more resistant than traditionally used nylon and contains a traditional titanium nitride (TiN) coating.

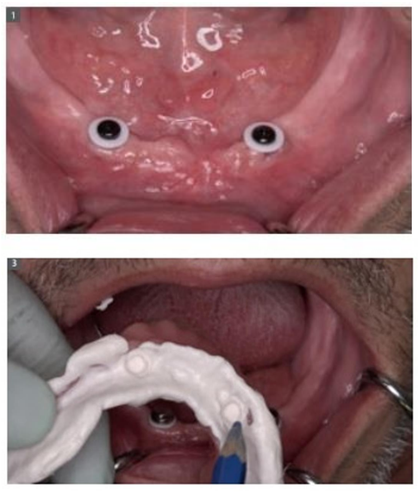

Figure 1: Chair-side 2-implant overdenture retentive system. (Adapted from Straumann Novaloc Retentive System for Hybrid Dentures).

OBJECTIVES

- ✓ To compare the in vitro retentive forces of Novaloc-TiN (PEEK) and Locator (Nylon) attachments for 2-implant overdentures after undergoing compressive cyclic loading and insertion-removal cycling to represent masticatory forces and wear equivalent to 1 week, 1, 3, 6 and 12 months of wear.
- ✓ To understand and compare the physical and mechanical behaviour of these polymers with respect to thermal changes.

METHODS

- ✓ 2 implants with either Novaloc (n=10) or Locator (n=10) overdenture attachments were embedded in parallel 1 cm from the edge of the 3D-printed acrylic resin blocks designed with Meshmixer version 3.5.
- ✓ Mechanical compressive cycling was performed using a Bose ElectroForce Fatigue Testing machine capable of exerting a 66.7-N load per specimen.
- ✓ A 2-mm thick elastomeric membrane was applied between the interface of the blocks to simulate mucosal resiliency.
- ✓ Force was applied at the center of the blocks over 5,000, 25,000, 75,000, 150,000 and 300,000 cycles per specimen, equivalent to 1 week, 1, 3, 6 and 12 months of wear respectively.
- ✓ The retentive force was recorded before and after mechanical compressive cycling to examine the robustness and longevity of the abutment's retentive properties.
- ✓ Retentive force was also recorded at baseline, then after specific insertion-removal cycles (23, 270, 540, & 1080).
- ✓ We also examined the deformation behavior of Novaloc [PEEK] and Locator [Nylon] matrices using a SkyScan 1172 micro-CT scanner to observe deformation before and after cycling.
- ✓ In addition, TGA 5500 and DSC 2500 were used to quantify the weight fraction crystallinity of different inserts before and after cycling.

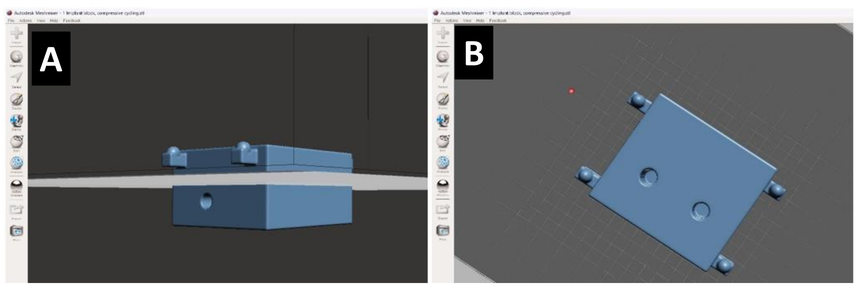

Figure 2: Meshmixer design of 3D-printed acrylic resin blocks housing the 2-implant TiN-coated Novaloc and Locator overdenture attachments. A) side and B) aerial view of overdenture attachment housing.

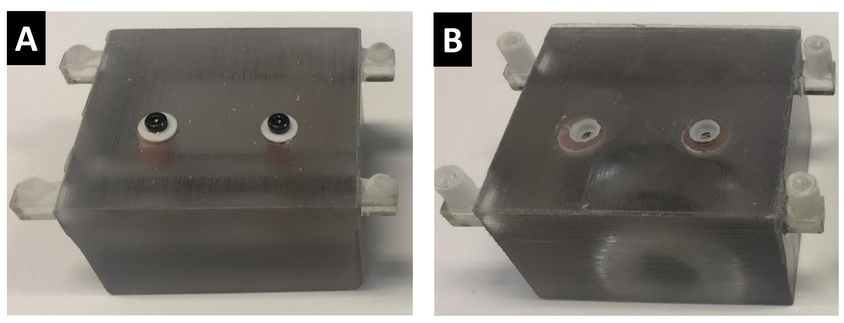

Figure 3: 3D-printed resin block housing the overdenture attachments. A) patrix and B) matrix.

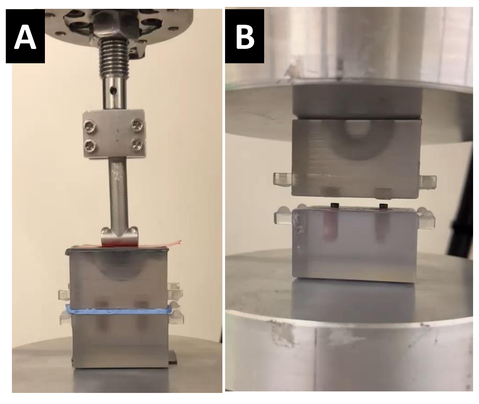

Figure 4: Bose ElectroForce Fatigue Testing machine. The blocks housing 2 implants were mounted between the device's jigs and underwent A) compressive and B) insertion-removal cycling to represent mastication and insertion-removal by the user, respectively.

RESULTS

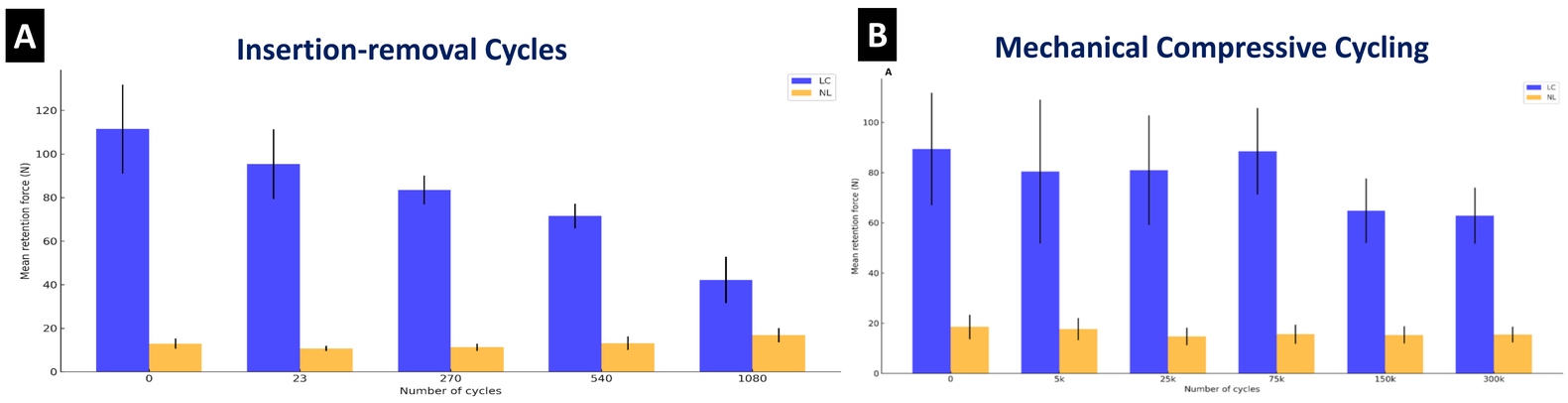

Figure 5: A) Average retentive force recorded at baseline, and after specific insertion-removal cycles (23, 270, 540, & 1080), where a significant decline in retention was observed for Locator after insertion-removal cycling ($p<0.05$), while Novaloc retention remained stable. **B)** Average retentive force following mechanical compressive cycling equivalent to 1 week, 1, 3, 6 and 12 months of wear. Notably, Locator attachments displayed a fluctuating retentive force throughout the 300,000-cycle duration, while the Novaloc system displayed stable retention throughout the cycling duration.

- ✓ Locator abutments showed a significant decrease in retentive force following insertion-removal cycling.
- ✓ Mechanical compressive cycling and insertion-removal of the 2-implant overdenture yielded a greater net retentive force for the Locator attachments relative to the TiN-coated Novaloc system, displaying fluctuating retentive force throughout the cycling duration.
- ✓ No significant differences were observed between the retention forces at baseline and following 300,000 cycles with the Novaloc attachment, indicating consistent retentive properties throughout the cycling duration.

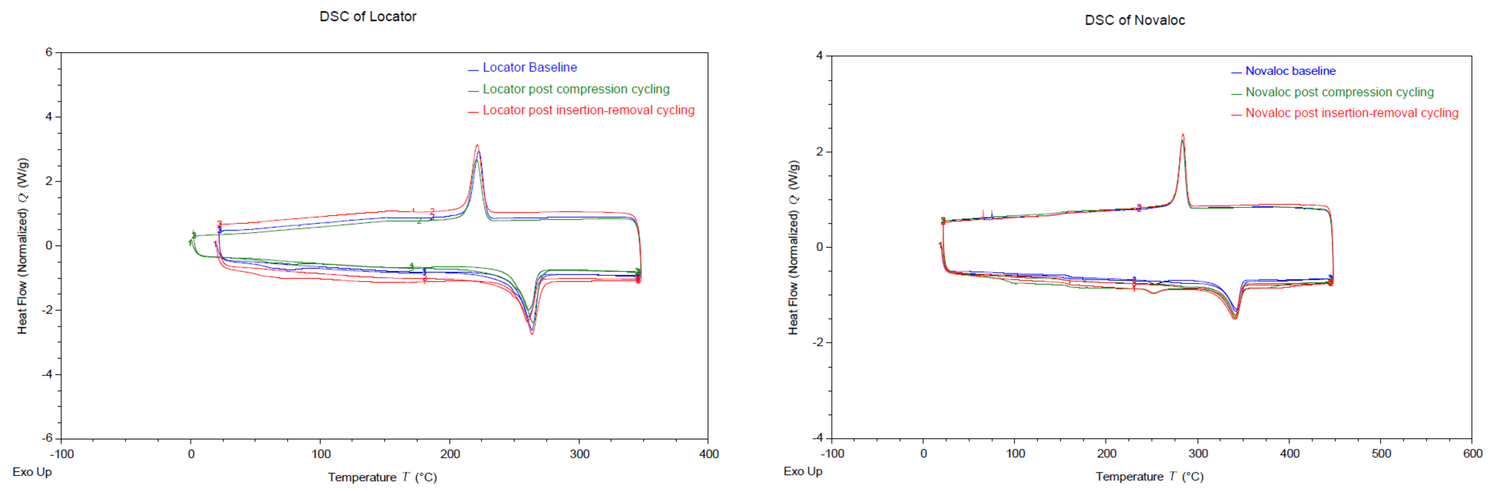

Figure 6. Differential Scanning Calorimetry (DSC) of Novaloc and Locator attachments. PEEK attachments (Novaloc) show higher glass transition temperature and melting point relative to Nylon (Locator).

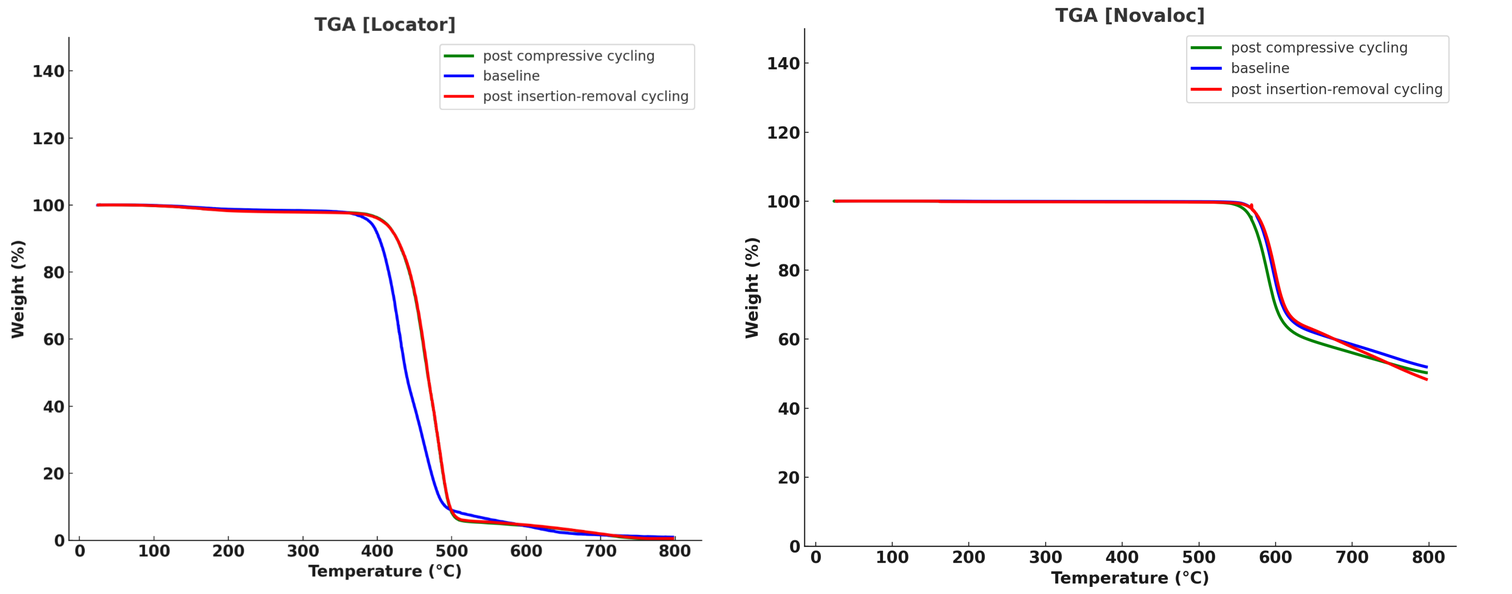

Figure 7. Thermogravimetric Analysis (TGA) of Novaloc and Locator attachments. Locator attachments show faster thermal degradation relative to Novaloc. Novaloc was more thermodynamically stable.

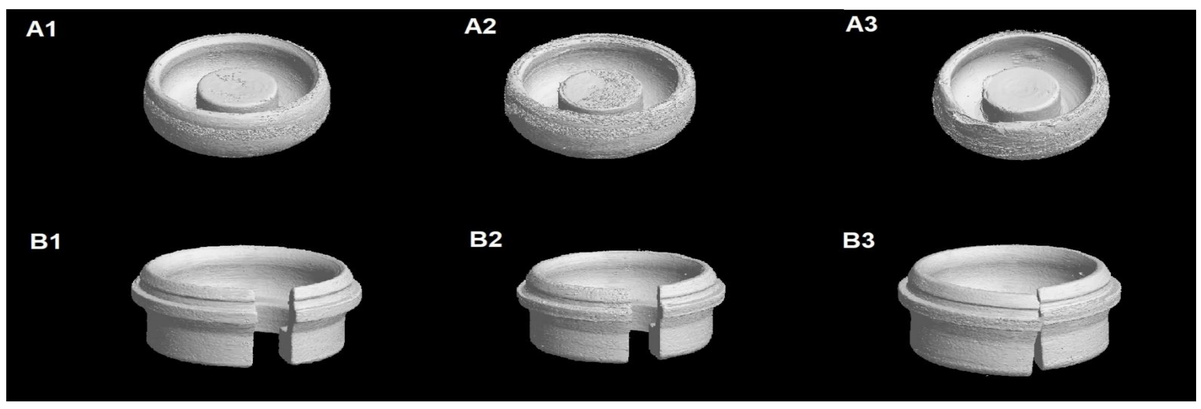

Figure 8. Micro-CT of Locator (A), and Novaloc (B) attachments at baseline (1), and post-compression (2) and insertion-removal (3). Evidence of increased surface degradation and slight dimensional changes of the Locator attachment's interior surface can be observed post-cycling (A2,A3).

CONCLUSIONS & IMPACT

- ✓ The Novaloc system offers superior retentive force durability following mechanical compressive and insertion-removal cycling, indicating preserved retentive force longevity relative to the Locator overdenture attachments system despite lower overall retentive force.
- ✓ Novaloc attachments exhibit superior thermal stability relative to Locator.
- ✓ Our results elucidate the consistently stable retentive properties of the Novaloc system, lending to lower upkeep burden and maintenance costs, which offers various advantages for the intended population.

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