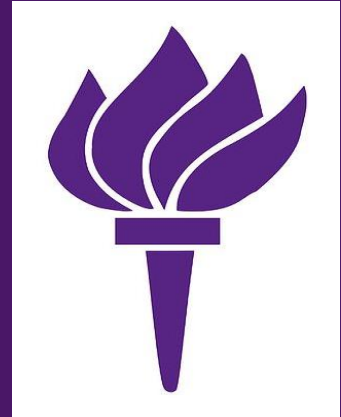




Comparison of Torque Values Between Angulated And Axial Abutment Screws: An In-Vitro Study

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Introduction

Loosening of abutment screws is among the most common technical complications associated with implant-supported restorations, with an incidence rate of approximately 12.7%.¹ In recent years, the use of titanium bases and angled screw channels in hybrid abutment restorations has become increasingly prevalent.² Previous studies have shown that cyclical loading can significantly reduce preload torque values. Lee et al. reported an average of 40% loss of preload torque following 1 million cycles of 300 N·cm at 15 Hz, regardless of screw length. While reverse torque values decreased, no clinically perceptible screw loosening was observed.³ Additionally, Cardoso et al. demonstrated that repeated tightening of abutment screws leads to a permanent reduction in reverse torque values. Even when the screw is replaced, the resistance to loosening remains compromised, suggesting permanent plastic modification of the implant screw threads.⁴

Objectives

- This study aimed to compare the torque values of angulated and axial abutment screws after exposure to simulated functional loading.
- The null hypothesis states that there is no difference in reverse torque values between the two abutment screw types.

Materials/Methods

The methodology was formulated in accordance with ISO 14801:2016 guidelines on dynamic testing of single endosseous dental implants.⁵ The research design was adapted from Cardoso et al.⁴, Mulla et al.⁶, and Swamidass et al.⁷ Twenty implants (Straumann 4.1 × 10 mm Bone Level Tapered Regular CrossFit; Straumann, Basel, Switzerland) were divided into two groups of ten according to abutment type. **Group 1 (control)** received Straumann 5.5 mm Variobase abutments, while **Group 2** received Straumann 5.5 mm Variobase abutments for Angled Crown Solutions. Each abutment was inserted into its corresponding implant fixture and torqued to 35 Ncm following the manufacturer's recommendation (Figure 1). Retorquing at 35 Ncm was performed after 10 minutes to account for settling. Initial torque values (ITV) were then measured with a digital torque gauge (Series TT03; Mark-10, Copiague, NY) (Figure 2A).

Monolithic zirconia maxillary central incisor crowns were fabricated and cemented onto the Variobase using Multilink Implant cement (Ivoclar Vivadent, Liechtenstein) according to manufacturer instructions. Test samples were mounted in a chewing simulator, where a tungsten carbide indenter (r = 3.18 mm) contacted the cingulum at a 30° angle to the loading direction, simulating natural occlusion (EL-3300 Enduratec; Bose, Minnetonka, MN, USA) (Figure 2B). Specimens underwent cyclic loading at 1.5 Hz for 200,000 cycles under a 100 N load, representing two months of functional chewing. Reverse torque values (RTVx) were subsequently measured with the digital torque gauge. The relative change in torque ($\Delta\%RTV = ((RTVx \times 100) / ITV) - 100$) was calculated by comparing removal torque with initial insertion torque. Statistical differences between groups were analyzed using an unpaired t-test with a significance level of $p < 0.05$.

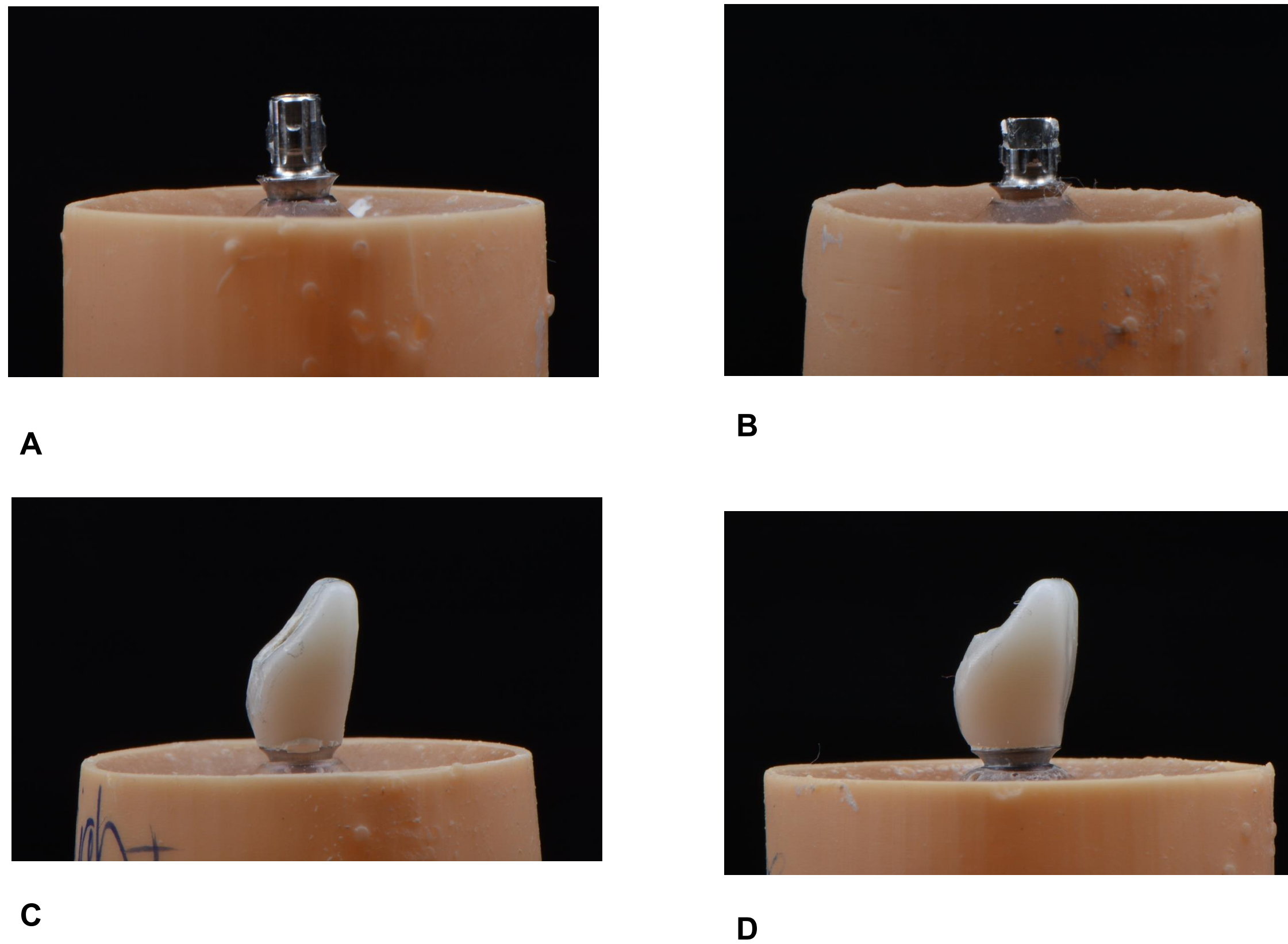


Figure 1: **A:** Straumann 5.5mm Variobase abutments (control group). **B:** Straumann 5.5 mm Variobase for Angled Crown Solutions abutment (Group 2). **C:** Monolithic zirconia maxillary central incisor crowns for control group. **D:** Monolithic zirconia maxillary central incisor crowns for group 2

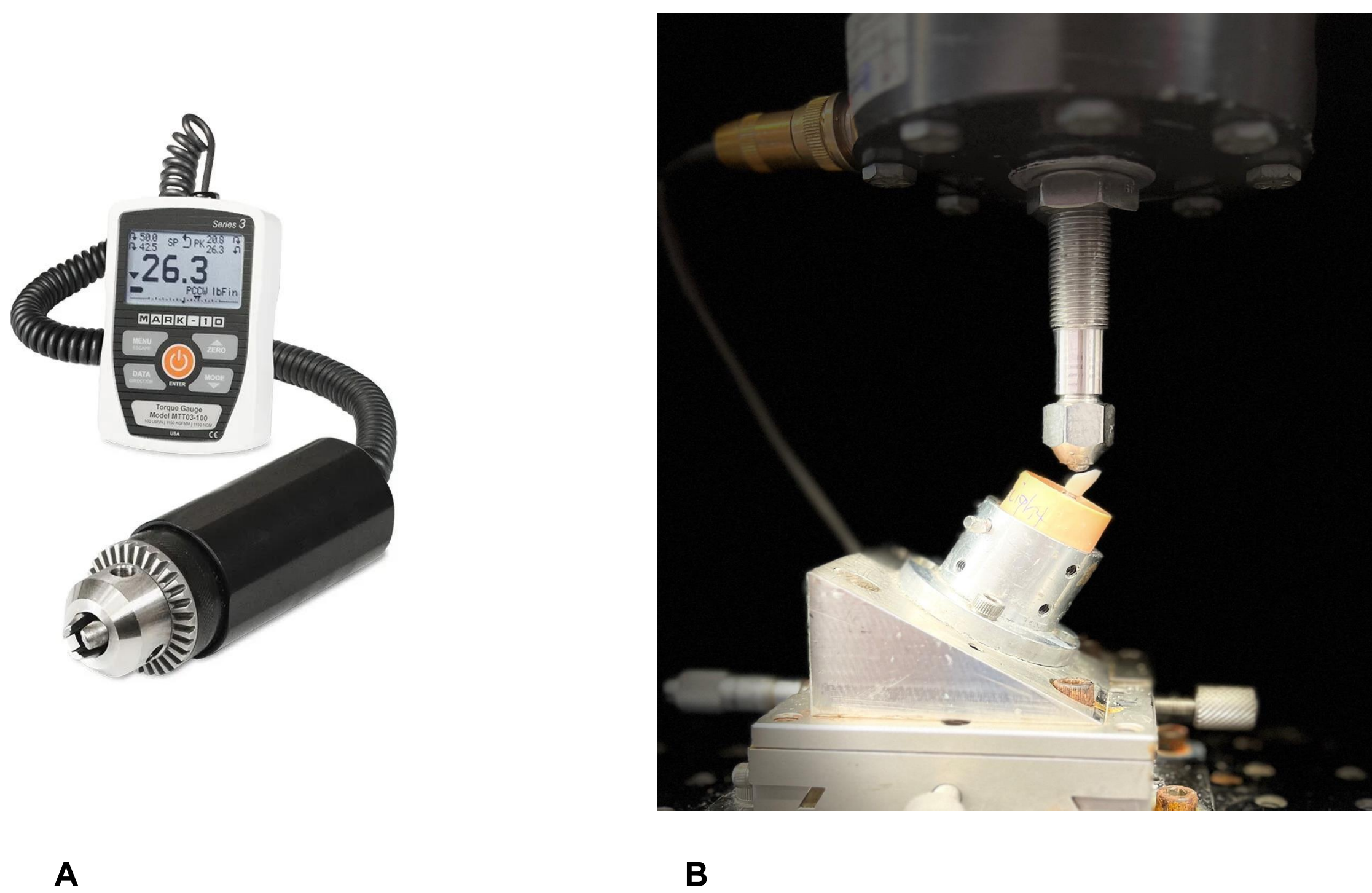
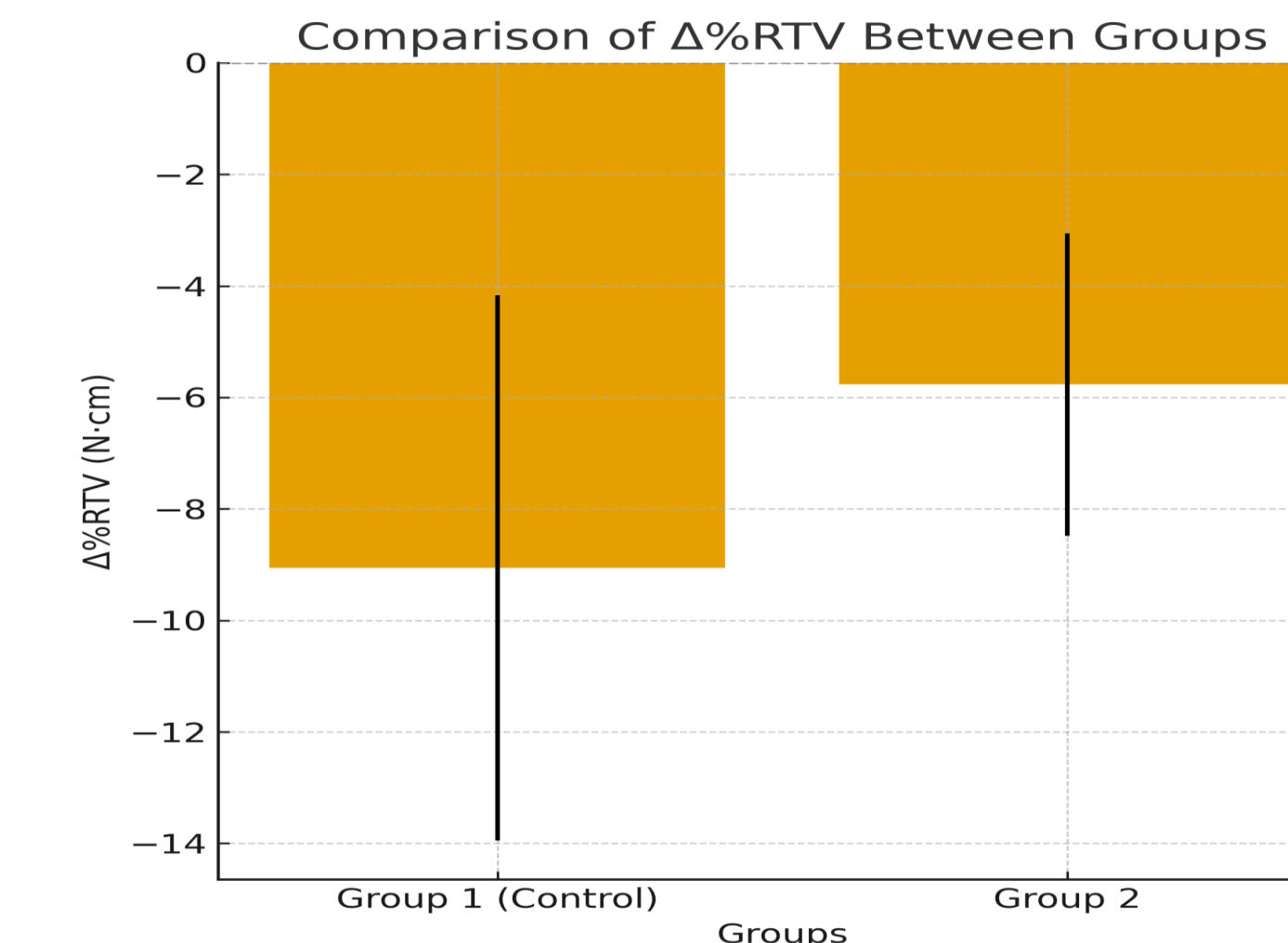


Figure 2: **A:** Series TT03 Torque Gauge; Mark-10, Copiague, NY. **B:** Test samples mounted in a chewing simulator by sliding a tungsten carbide indenter (r = 3.18 mm) on the cingulum, simulating aspects of natural occlusion (EL-3300 Enduratec, Bose, Minnetonka, MN, USA) at a 30° angle from the loading direction

Results

The mean percent change in torque ($\Delta\%RTV$) was greater in Group 1, which received Straumann 5.5 mm Variobase abutments (-9.06 ± 4.89 N·cm), compared to Group 2, which received Straumann 5.5 mm Variobase abutments for Angled Crown Solutions (-5.77 ± 2.71 N·cm). Although Group 2 demonstrated a smaller mean reduction in reverse torque, the difference between groups was not statistically significant ($p = 0.094$)



Discussion

Previous studies have shown that preload loss occurs under cyclic loading regardless of screw length or abutment design.^{3,4} Our findings are consistent with Mulla et al.⁶ and Swamidass et al.⁷, who reported no significant differences in reverse torque between straight and angled screw channel systems. This indicates that angulated screw channels provide restorative flexibility without increasing the risk of screw loosening.² Since angled screw channels are increasingly used in the anterior region, these results support their application to correct implant angulations in esthetic areas without compromising screw stability. Within the limitations of this in vitro study, both designs experienced torque loss after loading, but the difference was not statistically significant.

Conclusion

Angulated and axial abutment screws yielded statistically homogenous torque loosening values after being subjected to simulated chewing.

Acknowledgments

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