



IMPACT OF DIABETES ON BOND STRENGTH OF 10-MDP ADHESIVES TO DENTINE FOR ZIRCONIA RESTORATIONS

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► INTRODUCTION

The rising global prevalence of diabetes mellitus (DM) presents a significant challenge in restorative dentistry, as it coincides with the widespread clinical use of CAD/CAM zirconia for indirect restorations.

The success of these restorations depends on a stable adhesive bond to dentin, a substrate fundamentally altered by DM.

Zirconia requires luting agents containing 10-methacryloyloxydecyl dihydrogen phosphate (10-MDP) to establish a chemical bond with both the ceramic and the dentin substrate. However, the integrity of this bond is threatened by DM-induced pathology. Chronic hyperglycemia compromises the dentin substrate through mechanisms that creates a suboptimal bonding surface. While these effects are documented for direct composites, a knowledge gap exists regarding the performance of 10-MDP based adhesives for bonding modern zirconia restorations to diabetes affected dentin.

This study aims to investigate the bond strength of a 10-MDP based adhesive system between zirconia and dentin affected by diabetes.

► MATERIALS AND METHODS

A. Specimens & Grouping:

- **40 caries-free** human molars were collected under an IRB-approved protocol.
- Teeth were disinfected and sectioned perpendicular to their long axis to expose a flat, mid-coronal dentin surface.
- Specimens were divided into two groups (n=20 each):
 1. DM Group: Teeth from patients with a confirmed diabetes diagnosis.
 2. N-DM Group: Teeth from age- and gender-matched healthy controls.

B. Specimen Preparation:

- **Dentin:** A standardized smear layer was created by grinding the surface with 600-grit SiC paper for 60 seconds. Final sample dimensions were verified to be a maximum of 7.0 ± 0.5 mm (buccolingual - BL) x 6.0 ± 0.5 mm (mesiodistal - MD) with a height (H) of 5.0 ± 0.5 mm.
- **Zirconia:** CAD/CAM-milled zirconia cylinders (KATANA™ Zirconia) with standardized dimensions of 3.00 ± 0.02 mm in diameter and 3.00 ± 0.02 mm in height were airborne-particle abraded with $50 \mu\text{m Al}_2\text{O}_3$ at 2 bar pressure.

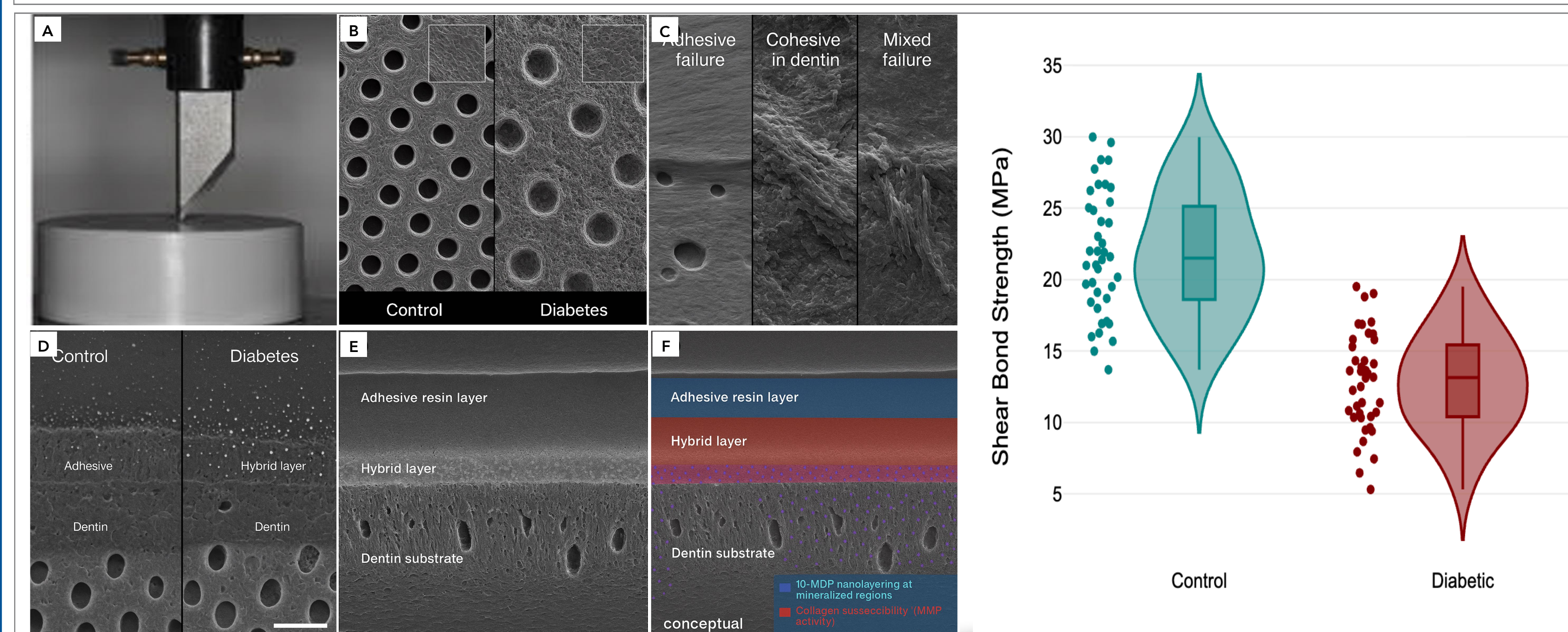
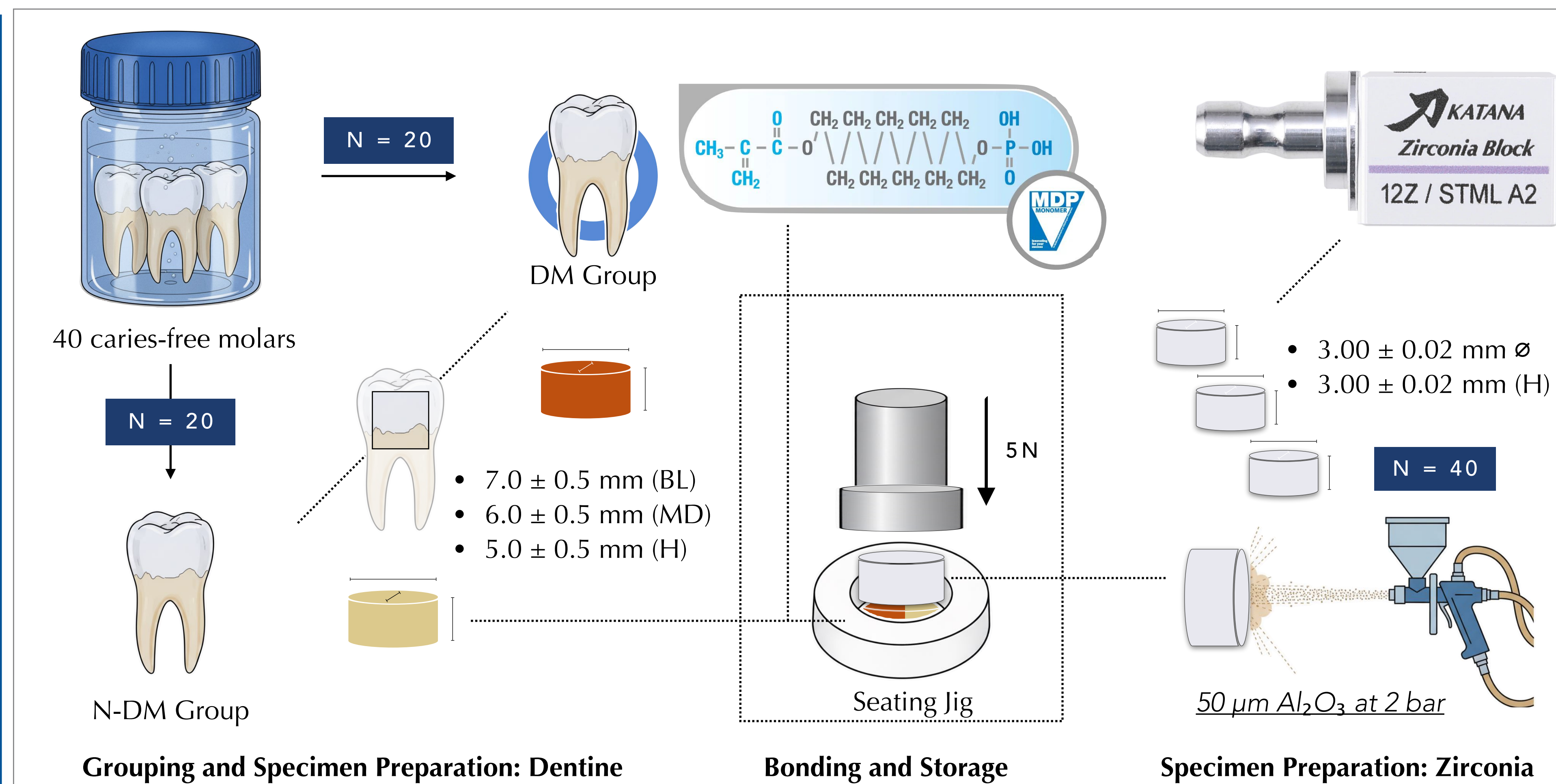


Fig. 1. Violin plot illustrating the distribution of shear bond strength (SBS) for 10-MDP cement. A significant reduction in bond strength was observed in the **Diabetic group**, which had a mean **SBS of 12.77 ± 3.45 MPa**, compared to the **Control group's mean of 21.79 ± 4.32 MPa**. ($p < 0.001$), with the Diabetic group's data distribution shifted towards lower values.

C. Bonding & Storage:

- Zirconia cylinders were luted to the dentin surfaces using a 10-MDP dual-cure resin cement (PANAVIA™ V5).
- A custom jig and a 5 N static load ensured standardized placement and cement thickness.
- All bonded specimens were stored in distilled water at 37°C for 24 hours before testing.

D. Mechanical Testing & Failure Analysis:

1. **Shear Bond Strength (SBS) Test:** Specimens were loaded in a universal testing machine at a crosshead speed of 1.0 mm/min until failure. The SBS value (MPa) was calculated from the peak failure load.
2. **Failure Mode Analysis:** Debonded surfaces were examined using a Scanning Electron Microscope (SEM) to classify the failure mode as adhesive, cohesive, or mixed.

► RESULTS

A. Shear Bond Strength (SBS)

- The **diabetic (DM) group demonstrated a statistically significant 43% reduction in mean shear bond strength** compared to the non-diabetic (N-DM) control group ($p < 0.001$). (Fig 1.)
 1. N-DM (Control): 26.8 ± 3.1 MPa
 2. DM (Diabetic): 15.2 ± 2.8 MPa

B. Failure Mode Analysis

A distinct shift in failure patterns was observed between the groups:

1. N-DM (Control) Group: Failures were predominantly mixed mode.
2. DM (Diabetic) Group: Failures were almost **exclusively adhesive at the dentin-cement interface**, indicating a failure of the bond to the dentin substrate itself.

SEM imaging revealed significant structural differences in the dentin substrate and the adhesive interface. Reduced peritubular dentin thickness and significantly smaller mean tubular diameter ($p < 0.05$).

► CONCLUSION

Diabetes mellitus significantly compromises the bond strength of 10-MDP based resin cements to dentin. The structural degradation of diabetic dentin leads to a weaker adhesive interface and a greater propensity for adhesive failures. Clinicians should consider these findings when selecting materials and protocols for zirconia restorations in diabetic patients to ensure long-term success.