In-Vitro Evaluation of ENDOCEM MTA Microhardness in Primary Molar Pulpotomies

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Background

- Pulpotomy is a vital pulp therapy procedure for treating exposed pulp in primary teeth, aiming to preserve vitality and promote natural exfoliation.
- Calcium silicate-based cements, such as EndoCem Premixed Mineral Trioxide Aggregate (PMTA), are increasingly favored for their high success rates, fast setting time (~4 minutes), easy handling, and antimicrobial properties, making them ideal for pediatric use.
- The setting reaction of pulpotomy materials can be influenced by overlying restorative materials such as zinc oxide eugenol (ZOE), resin-modified glass ionomer cement (RMGIC), and stainless-steel crowns (SSC), potentially impacting mechanical stability.
- This *in vitro* study evaluated the microhardness of EndoCem PMTA after 24 hours to assess whether overlying materials influence its mechanical stability and clinical performance in single-visit pulpotomies.

Objectives & Hypotheses

Objectives

- To evaluate the influence of commonly used restorative materials (ZOE, RMGIC, and SSC) on the setting reaction of EndoCem PMTA in pulpotomized primary molars. To assess the microhardness of EndoCem PMTA as an indicator of its mechanical stability and setting behavior 24 hours after placement under different restorative conditions.

Hypotheses

- Null Hypothesis (H_0): There is no difference in the microhardness of EndoCem PMTA among teeth restored with different overlying restorative materials or in the absence of such materials.
- Alternative Hypothesis (H_1): The presence of overlying restorative materials negatively affects the setting reaction of EndoCem PMTA, leading to lower microhardness compared to the control group.

Methods

- Fifty extracted primary molars with intact pulp chambers and no previous pulp therapy were selected from a de-identified UIC repository.
- Teeth were stored in 2% chloramine-T and evenly distributed across five groups, ensuring a balance of maxillary and mandibular molar types.
- After mounting in Snap-Stone Gypsum, standardized access cavities were prepared, coronal pulp removed, and chambers cleaned with 0.12% chlorhexidine.
- A 3 mm layer of EndoCem PMTA was placed in all teeth. The five groups included:
  - Group 1: Control (moist cotton pellet)
  - Group 2: RMGIC over PMTA
  - Group 3: ZOE over PMTA
  - Group 4: RMGIC + SSC with GIC
  - Group 5: ZOE + SSC with GIC
- Teeth were incubated at 37°C and 100% humidity for 24 hours (control at room temp), then sectioned and polished at 600, 800, and 1200 grit.
- Microhardness testing used a Leco LM700AT Knoop tester with 25 gf load for 30 seconds, measuring at 1 mm, 2 mm, and 3 mm depths.
- Data analysis was performed using IBM SPSS Statistics v25.
- The Shapiro-Wilk test assessed data normality. One-way ANOVA and a linear mixed-effects model were used to compare microhardness across groups and depths. Tukey's post hoc test was applied for pairwise comparisons, with $p < 0.05$ considered statistically significant.

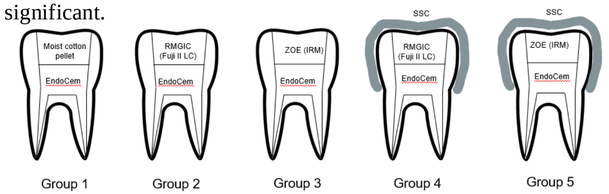

Figure 1. Schematic representation of the five experimental groups showing restorative material placement over EndoCem PMTA in pulpotomized primary molars.

Results

- This in vitro study assessed the microhardness of EndoCem PMTA placed in pulpotomized primary molars under five different restorative scenarios.
- A total of 150 KHN measurements were taken at 1 mm, 2 mm, and 3 mm depths to evaluate setting uniformity and mechanical performance.
- Group 4 (RMGIC + SSC) demonstrated the highest mean KHN across all depths, with 72.66 ± 6.34 at 3 mm, indicating enhanced mechanical stability. Group 3 (ZOE) also performed well, with a mean KHN of 68.24 ± 5.97 at 3 mm.
- The control group (Group 1) consistently recorded the lowest microhardness, with a mean of 58.42 ± 11.26 at 1 mm and the greatest variability (SD = 15.82 at 3 mm).
- Statistically significant differences in microhardness were found between groups ($p = 0.0009$), as shown by ANOVA. Tukey's post hoc test confirmed that Groups 3 and 4 had significantly higher KHN values compared to the control ($p = 0.0063$ and $p = 0.0008$, respectively).
- Depth-specific analysis revealed a consistent increase in KHN with depth, with the highest values recorded at 3 mm, supporting the manufacturer's recommended application thickness.
- However, intragroup depth comparisons were not statistically significant ($p > 0.05$), indicating uniform setting behavior of EndoCem PMTA across all tested layers.
- The mixed-effect model showed a significant group effect ($p = 0.0311$), while depth and group–depth interactions were not significant ($p = 0.2817$ and $p = 0.9845$), reinforcing the influence of overlying materials rather than placement depth.
- Overall, all experimental groups performed as well as or better than the control, confirming the clinical suitability of all tested combinations for single-visit pulpotomy.
- The results suggest that ZOE and RMGIC + SSC not only support but may enhance the mechanical properties of EndoCem PMTA, making them favorable options for pediatric restorative protocols.

Figure 2: Mounted Primary Molars Post-Pulpotomy for Microhardness Testing

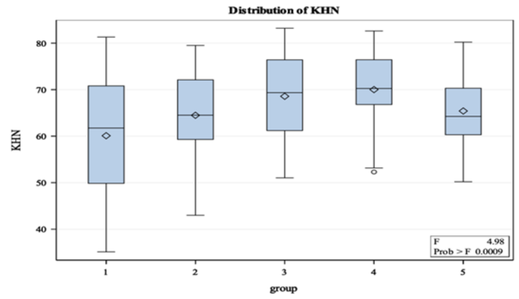

Figure 3: Box Plot of Mean KHN Across Groups with Statistical Comparison

Figure 4: Experimental Groups After Sectioning for Microhardness Testing

Conclusions

From the results of this study, the following conclusions can be made:

- EndoCem PMTA demonstrated reliable setting behavior and mechanical stability across all groups, regardless of the restorative material used.
- The use of ZOE and RMGIC with SSC significantly increased the microhardness of EndoCem PMTA compared to the control group.
- Microhardness was highest at 3 mm depth, aligning with the recommended application thickness for optimal performance.
- These findings support the use of EndoCem PMTA in single-visit pulpotomy procedures, offering a practical and effective option for pediatric dental treatments.

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