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Original Research Article

# Evaluation of microleakage in Class V restorations using ketac™ N100 and equia forte™: A comparative in vitro study

**Ruchi Singla[1]*, Amandeep Singh Uppal[1]**

[1]Dept. of conservative Dentistry and endodontic, Dr Harvansh Singh Judge Institute of Dental Sciences & Hospital, Panjab University, Chandigarh, India.

## Abstract

**Objective:** This study evaluates and compares the marginal sealing ability of two advanced glass ionomer-based restorative materials—Ketac™ N100 and Equia Forte™—in Class V cavities.

**Materials and Methods:** Thirty extracted, non-carious human premolars were prepared with standardized Class V cavities on buccal and lingual surfaces. Group 1 (n=15) was restored with Ketac™ N100, while Group 2 (n=15) received Equia Forte™ restorations. Following thermocycling (200 cycles between 5°C and 55°C), specimens were subjected to methylene blue dye penetration testing. Dye infiltration was analyzed under 50 x stereomicroscope, and microleakage scores were recorded and statistically evaluated using the Wilcoxon signed-rank test.

**Results:** Equia Forte™ demonstrated significantly reduced microleakage at both occlusal and gingival margins compared to Ketac™ N100 ($P < 0.05$). Both materials showed higher leakage at the gingival margins.

**Conclusion:** Equia Forte™ offered better sealing performance in Class V restorations, suggesting a more effective barrier against microleakage in challenging cervical areas.

**Keywords:** Class V cavities, Ketac™ N100, Equia Forte™, Microleakage, Restorative materials, Glass ionomer

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## 1. Introduction

Class V lesions, typically located at the cervical third of the tooth near the cementoenamel junction (CEJ), present a unique restorative challenge due to the anatomical and histological complexity of this region. The CEJ marks the transition between enamel and cementum, and restorations in this area often involve bonding to both substrates—each with distinct surface characteristics and bonding affinities. Enamel, being highly mineralized, offers a more predictable bonding surface, whereas dentin and cementum are more organic, hydrated, and less receptive to adhesion, increasing the risk of marginal leakage and restoration failure.[1,2]

Microleakage, defined as the passage of bacteria, fluids, molecules, or ions between the cavity wall and the restorative material, remains a critical concern in Class V restorations.[3,14] It can lead to postoperative sensitivity, marginal discoloration, secondary caries, and eventual pulpal inflammation.[4,5] The cervical location of these lesions further complicates isolation and moisture control, both of which are essential for optimal bonding and sealing.[2]

To address these challenges, advancements in glass ionomer technology have led to the development of materials with enhanced physical and chemical properties. Ketac™ N100, introduced by 3M ESPE, is the first nano-filled, resin-modified glass ionomer (RMGI) restorative. It incorporates bonded nanofillers to improve polishability, wear resistance, and fluoride release while maintaining the benefits of conventional GICs such as chemical adhesion and biocompatibility. However, its resin component introduces polymerization shrinkage, which may compromise marginal integrity, particularly at the gingival margin.[6]

*Corresponding author: Ruchi Singla
Email: dr.ruchisingla@gmail.com

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In contrast, Equia Forte™ represents a newer class of glass hybrid restorative systems, combining highly reactive glass particles with a high-molecular-weight polyacrylic acid matrix and a nano-filled resin coating (Equia Forte Coat).[7] This system is designed to enhance flexural strength, wear resistance, and marginal sealing while maintaining fluoride release and moisture tolerance.[8]

Despite these advancements, comparative data on the microleakage performance of Ketac™ N100 and Equia Forte™ in standardized Class V cavities remains limited. Therefore, this in vitro study aims to evaluate and compare the microleakage of Ketac™ N100 and Equia Forte™ in Class V restorations using a dye penetration model.

## 2. Materials and Methods

Thirty non-carious human premolars freshly extracted for orthodontic and periodontic reasons were included in the study. A uniform cavity depth of 1.5 mm was established using a cylindrical diamond bur in an air- and water-cooled high-speed handpiece (NSK PANA AIR, Nakanishi Inc., Tochigi-ken, Japan). The occlusal margins of the cavities were positioned within enamel, while the gingival margins extended into dentin. To ensure uniformity, cavity dimensions were controlled using a pre-fabricated metal strip template (2 × 2 mm), and burs were pre-marked at 1.5 mm to guide depth. Each bur was limited to four cavity preparations to maintain cutting efficiency. The cavosurface margins at both occlusal and gingival ends were designed to be sharp and non-beveled. specimens were randomly divided into two groups of 15 teeth each, yielding 30 restorations per material groups.

Group 1: teeth restored with Ketac™ N100 (3M ESPE)
Group 2: teeth restored with Equia Forte™ (GC Corporation)

Teeth were restored following manufacturer's instructions. Following 24 hours of storage in distilled water at 37°C, the restored specimens underwent 200 thermocycles between water baths maintained at 5°C and 55°C, with each immersion lasting 1 minute and a transfer interval of 10 seconds between baths.

After thermocycling, the root apex of each specimen was sealed using sticky wax. To prevent dye infiltration elsewhere, all tooth surfaces—except for a 1 mm border surrounding the restorations—were coated with two layers of nail varnish. The specimens were then immersed in a 0.2% methylene blue solution for 24 hours. Following immersion, the teeth were thoroughly rinsed using running water and air-dried to facilitate dye stabilization. Each specimen was then longitudinally sectioned in the buccolingual plane through the midpoint of the restoration using a slow-speed diamond disc. The cut surfaces were examined under a stereomicroscope at 50× magnification to assess dye penetration at both occlusal and gingival margins. Microleakage at the tooth–restoration interface was scored for each margin using the following criteria:[9]

1. Score 0: No dye penetration
2. Score 1: Dye penetration less than half the occlusal or gingival wall.
3. Score 2: Dye penetration up to the full length of the wall.
4. Score 3: Dye penetration extending beyond the wall into the axial surface.

The Wilcoxon signed-rank test was applied for data analysis, and a P-value below 0.05 denoted statistical significance.

## 3. Results

**Table 1** presents the mean microleakage scores recorded at the occlusal and gingival margins for both groups. In Group 1 (Ketac™ N100), the mean score at the occlusal margin was 1.2 ± 0.8, while the gingival margin exhibited higher microleakage with a mean score of 2.1 ± 0.9. In Group 2 (Equia Forte™), the mean microleakage scores were lower at both margins—0.6 ± 0.5 at the occlusal and 1.4 ± 0.7 at the gingival margin.

Statistical analysis using the Wilcoxon signed-rank test indicated that the differences were significant ($P < 0.05$) in all paired comparisons. Specifically, microleakage at the gingival margin was significantly higher than at the occlusal margin within both groups, and Equia Forte™ consistently outperformed Ketac™ N100 at both sites (**Table 2**).

**Table 1:** Mean microleakage scores

| Group | Occlusal Margin (Mean ± SD) | Gingival Margin (Mean ± SD) |
|---|---|---|
| Ketac™ N100 | 1.2 ± 0.8 | 2.1 ± 0.9 |
| Equia Forte™ | 0.6 ± 0.5 | 1.4 ± 0.7 |

**Table 2:** Statistical analysis of group 1 and 2 by Wilcoxon signed-rank test

| Groups | P-Value | Significance |
|---|---|---|
| 1 (Occlusal) and 2 (Occlusal) | < 0.05 | Significant |
| 1 (Gingival) and 2 (Gingival) | < 0.05 | Significant |
| 1 (Occlusal) and 1 (Gingival) | < 0.05 | Significant |
| 2 (Occlusal) and 2 (Gingival) | < 0.05 | Significant |

## 4. Discussion

When group 1 and group 2 were compared, statistically significant difference was found. This study showed that Equia Forte™ performed better than Ketac™ N100. The success of Equia Forte™ in this study can be attributed to its innovative formulation. It incorporates highly reactive glass fillers and a reinforced polyalkenoate matrix, which contribute to a denser material with improved marginal adaptation. Most importantly, it includes a nano-filled resin coating that protects the restoration during its initial setting and maturation phases—critical for preventing early

microleakage and enhancing durability.[7,8] This aligns with the study of Gurgan et al.10, who demonstrated that Equia Forte™ maintained its seal well in clinical conditions over several years.

Ketac™ N100, while more esthetic and smoother to handle due to its nano-filled resin-modified glass ionomer base, may be more prone to shrinkage-related stress. Its resin component—though advantageous for polishability and strength—introduces polymerization contraction, which can compromise marginal integrity, especially where enamel is absent.[6,11]

When group 1 and group 2 occlusal and gingival level was compared, statistically significant difference was found. Both materials showed higher microleakage at gingival margins than at occlusal ones. These results are in accordance with many studies that have observed cervical margins, particularly on the dentin side, are difficult to seal consistently.[12,13,15]

The gingival margin often lies entirely in dentin or cementum, which presents a more complex bonding environment due to its high water content, tubular structure, and organic composition. Bonding to enamel is more predictable and durable.[13]

While this in vitro study provides valuable insights into the comparative marginal sealing of Ketac™ N100 and Equia Forte, Long-term in vivo studies are essential to confirm the clinical relevance and durability of these materials under functional stress.

## 5. Conclusion

1. Equia Forte™ exhibited better sealing ability and less microleakage than Ketac™ N100 in Class V restorations.
2. Gingival margins remain particularly vulnerable, suggesting a need for materials with improved dentin-bonding performance.

## 6. Source of Funding

None.

## 7. Conflict of Interest

None.

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