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Evaluation of Microleakage of Hesperidin incorporated dentin adhesive- an invitro study

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ABSTRACT

Background: Resin-dentin bonds are less durable than resin-enamel bonds, because of the heterogeneity of the structure and composition of dentin. The failure of resin-dentin bonding will result in microleakage, staining, recurrent caries, and postoperative sensitivity. Hesperidin as a natural collagen cross linker inhibits collagen degradation by MMP inhibition and also facilitates remineralization. Thus it can prevent microleakage and also further demineralization by improving dentin bond stability.

Materials And Methods: In total etch dentin adhesive, 2% hesperidin was added. Dye penetration testing with a stereomicroscope was used in class V cavities to analyse microleakage. The scoring method applied was comparable to that of Munro, Hilton, and Hermesch (2003). Independent sample t test was used for statistical analysis using statistical software version 23.

Results: For the test groups, microleakage values generally occurred at the junction of the restored dentin and enamel, whereas for the control groups, they mostly occurred at the junction of the restored dentin and axial wall. The difference was statistically significant in favour of the test group with less microleakage when compared to the control group, according to statistical analysis using the student t test (p value: 0.04).

Conclusion: Within the limitations, Hesperidin incorporated total etch dentin adhesive can be used effectively to reduce microleakage in total-etch adhesive restorations.

Clinical Significance: Microleakage at the adhesive interface can cause a number of issues, including secondary caries, post-operative sensitivity, and restorative failure. The durability and success rate of adhesive restorations can be increased by lowering microleakage with the use of hesperidin. For long-term therapeutic outcomes and patient satisfaction, this is especially crucial.

Keywords: *Hesperidin, Collagen-crosslinker, Total etch dentin adhesive, Micro-organisms, Quality of life*

INTRODUCTION

Dental compounds called dentin adhesives are used to bond restorative materials to the tooth structure, such as composite resin. The term "microleakage" describes the tiny cracks or openings that may appear where the adhesive meets the tooth structure[1]. These openings may allow oral fluids, germs, and other substances to enter, which may result in post-operative sensitivity, secondary caries, or restorative failure[2]. In restorative dentistry, microleakage is a major concern since it can result in a number of consequences, including secondary caries, postoperative sensitivity, and restoration failure[3]. In order to improve bonding agents' ability to seal, researchers have looked at the introduction of bioactive chemicals. Several factors can influence microleakage in dentin adhesive systems: The manner in which the adhesive is applied can have an impact on the strength of the bond and the occurrence of microleakage[4]. For effective adhesive penetration and to get rid of the smear layer, the dentin surface must be properly etched, rinsed, and dried. Incomplete resin infiltration brought on by inadequate or poor adhesive application might promote microleakage[5]. To achieve a micromechanical bond, total etch adhesives simultaneously erode enamel and dentin. However, moisture can hinder the penetration of the adhesive and degrade the strength of the bond. During the bonding process, insufficient moisture control can lead to increased microleakage at the adhesive interface[6]. To get the best bond strength and reduced microleakage, total etch adhesives require careful application and accurate application technique. Inadequate rinsing of the etchant or uneven application of the adhesive can result in insufficient infiltration of the adhesive resin into the etched surface. This insufficient infiltration may leave small holes and cause more microleakage.Total etch adhesive systems may deteriorate over time as a result of factors like mechanical stress, hydrolysis, and enzymatic degradation[7]. The binding strength may become less strong as the adhesive ages, and microleakage may appear or get worse[8]. The integrity of the restoration may be jeopardised by this long-term deterioration, which may also result in secondary caries or restoration failure. As a potential strategy to reduce microleakage, flavonoids have been added to total etch adhesive systems. The antioxidant and anti-inflammatory effects of flavonoids, which include substances like hesperidin, have been recognised as having various advantages in adhesive dentistry[9]. Citrus fruit flavonoid Hesperidin(HPN) has demonstrated remarkable anti-inflammatory and antioxidant capabilities that may improve the effectiveness of bonding agents.According to studies, hesperidin interacts with collagen fibres to help stabilise and cross-link them[10]. Dentin contains a significant amount of collagen, and when collagen ages, gaps and microgaps can occur at the adhesive interface, which can cause microleakage. Hesperidin assists in preserving the integrity of the dentin substrate and lowering the risk of microleakage by stabilising the collagen matrix. Hesperidin and other flavonoids, according to certain research, may be able to enter dentinal tubules and create a sealing layer there. At the dentin-adhesive interaction, this tubule-sealing effect can lessen fluid flow, stop bacterial penetration, and minimise microleakage[11]. Hesperidin can be added to dental adhesive systems to strengthen the connection, lower the chance of microleakage, and increase the overall effectiveness of adhesive restorations. In order to shed light on its potential as a useful addition for minimising microleakage, the goal of this study is to examine the effect of Hesperidin incorporation on the microleakage of bonding agents. Our team has extensive knowledge and research experience that has translate into high quality publications[12–21,22–26]

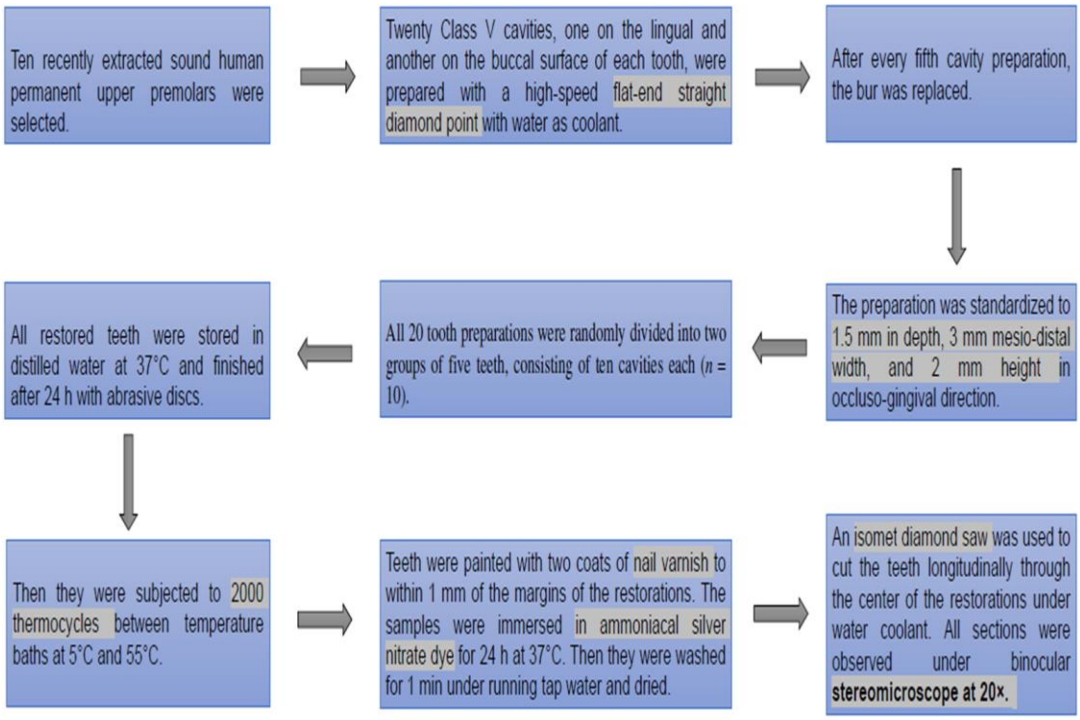
MATERIALS AND METHODS

Preparation of Test solution

In Total-etch dentin adhesive , 2% of hesperidin (HPN) was incorporated (2 mg of HPN powder in 98 mg of bonding agent). In this study, the total etch adhesive used was Adper single bond 2 (3m ESPE). Pure form of HPN powder from Sigma-Aldrich with more than 90% purity was used for this preparation. Hesperidin was solubilized using dimethyl sulphoxide, a small amount of which was utilised as a solvent. Adper Single Bond 2, an over-the-counter total etch dentin adhesive (3 M ESPE), served as the parent substance. For getting 2% concentration, 20 mg of hesperidin (Sigma-Aldrich) powder was directly dissolved in 0.025 ml of pure dimethyl sulfoxide. The final concentration of 2% hesperidin in the total etch adhesive used was obtained by incorporating the Hesperidin/Dimethyl sulfoxide into Adper single bond 2 at the right ratio (20 mg of HPN(0.0025ml DMSO) in 1 ml of bonding agent).

Control group
Flavonoid(HPN)free adhesive

Test group
Flavonoid(HPN) incorporated adhesive (20mg HPN+0.025ml DMSO+ 1ml of Adper single bond 2)



FLOWCHART 1: Procedural Methodology

Scoring system used was similar to that used by Munro, Hilton, and Hermesch(2003).

Score 0 – No evidence of microleakage
Score 1 – Dye penetration up to half of cavity depth [enamel restoration junction]
Score 2 – Microleakage more than half of the depth of cavity wall [dentin restoration junction]
Score 3 – Dye leakage involves axial wall**.**

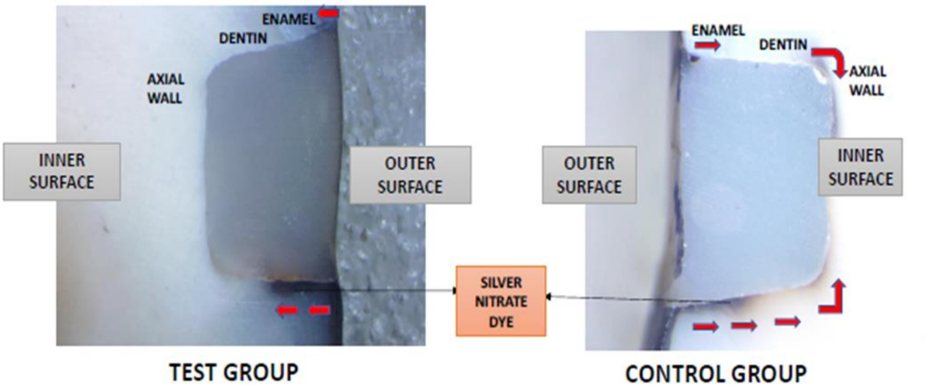


FIGURE 1: Stereomicroscope Tooth sections

DISCUSSION

Hesperidin can be added to bonding agents to strengthen their ability to prevent and lessen microleakage[27,28]. A more stable and long-lasting bond interface can be achieved by using hesperidin's antioxidant characteristics to reduce the bonding agent's deterioration. Oral fluids, germs, and debris can enter the mouth through gaps or marginal discrepancies between dental restorations and tooth structure, causing microleakage. The antioxidant capabilities of Hesperidin may aid in maintaining marginal integrity by preventing the deterioration of the adhesive contact[29]. By reducing the possibility of microleakage, this can assist maintain a tight seal between the restoration and the tooth structure. The integrity of the bond may be compromised by inflammation at the repair margins, which would promote microleakage. The anti-inflammatory qualities of hesperidin might aid in lowering inflammation in the surrounding tissues, which might subsequently help lessen microleakage[10]. Hesperidin may contribute to the integrity of the bonding interface by suppressing pro-inflammatory cytokines and regulating the inflammatory response[30]. To prevent microleakage, the bonding interface must be stable over the long term[31]. The capacity of hesperidin to lessen oxidative stress and inflammation may help to maintain the bond's long-term stability throughout time, lowering the chance of microleakage[32]. While the addition of hesperidin has the potential to reduce microleakage, it is important to take into account other variables that may affect a bonding agent's capacity to seal[33]. Since it can dissolve a variety of compounds, including resins and polymers frequently found in dental adhesives, Dimethyl Sulphoxide(DMSO) is renowned for its exceptional solvency capabilities. It is frequently employed as a vehicle or carrier for additional active substances or research chemicals[34]. DMSO may have an impact on the viscosity, film thickness, and polymerization parameters of dental adhesives. By changing the strength and endurance of the adhesive bond, these characteristics may indirectly affect microleakage[35,36]. However, the formulation and content of the adhesive system being utilised may affect how DMSO specifically affects microleakage. Microleakage can be impacted by a variety of factors, including the adhesive system that is utilised, surface preparation methods, and bonding process modifications. In order to evaluate the unique contribution of hesperidin incorporation, these aspects should be carefully controlled. The effect of hesperidin incorporation on microleakage requires further study to be fully assessed. Some of the issues discussed in this study include determining the optimal hesperidin concentration, evaluating the bond's long-term stability, and compared hesperidin-incorporated bonding agents with conventional systems. In order to guarantee the bonding agent's overall effectiveness and safety, investigations should also look into how hesperidin incorporation affects other bonding agent characteristics including binding strength and biocompatibility. It has been demonstrated that hesperidin interacts with collagen fibres and encourages cross-linking, which can improve the collagen matrix's mechanical stability and characteristics. The dentin structure is strengthened and given greater resilience to deterioration over time because of collagen cross-linking. Hesperidin may encourage collagen cross-linking at the adhesive interface by being added to adhesive solutions, improving bond strength and longevity. This can lead to increased bond strength and decreased microleakage, which are essential for the durability and accomplishment of adhesive restorations. In this present study Microleakage values for test groups were mostly at enamel restoration & some at dentin restoration junction and for control groups were mostly at dentin restoration junction & some involving axial wall. Statistical analysis with student t test shows that the difference was statistically significant that favor towards the test group with decreased microleakage compared to the control group (p value-0.04). The antioxidant and collagen cross-linking capabilities of hesperidin are thought to have a role in its potential to reduce microleakage in total etch dentin adhesives. It can scavenge and neutralise free radicals because of the many phenolic hydroxyl groups that are present in its structure. Free radicals are extremely reactive chemicals that can damage the dentin and adhesive contact through oxidative stress and free radical damage. Hesperidin can reduce the production of free radicals and decrease the oxidative breakdown of adhesive components by acting as an antioxidant. This aids in protecting the adhesive interface's integrity and reducing microleakage brought on by oxidative stress. The primary structural protein in dentin is collagen, and cross-linking is the process by which collagen molecules create covalent bonds with one another to boost its mechanical strength and stability. Collagen's amino acid residues and the hydroxyl groups in hesperidin can form hydrogen bonds, which helps to create cross-links.The antioxidant activity of hesperidin can also help to sustain collagen stability by shielding it from oxidative damage, maintaining its structure, and halting collagen degradation. The collagen matrix in dentin is strengthened by the cross-linking process, increasing its durability and lowering microleakage. Further invivo findings are essential to validate these results.

CONCLUSION

Within the limitations, Hesperidin incorporated total etch dentin adhesive can be used effectively to reduce microleakage in Total-etch adhesive restorations.

Clinical Significance

Microleakage at the adhesive interface can cause a number of issues, including secondary caries, post-operative sensitivity, and restorative failure. The durability and success rate of adhesive restorations can be increased by lowering microleakage with the use of hesperidin. For long-term therapeutic outcomes and patient satisfaction, this is especially crucial.

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