Influence of Dentine Adhesive with Nanofiller on Postrestorative Sensitivity

Jozo Šutalo
Alena Knežević
Zrinka Tarle

Department of Restorative Dentistry
School of Dental Medicine
University of Zagreb

Summary

Increasing requirements for the longevity of filling and marginal integration has influenced the development of new materials in restorative procedure on enamel and dentine. These requirements have contributed to the development of several generations of composite materials and dentine adhesives. Adhesion of the restorative material on the enamel is succesfully enhanced with the use of enamel adhesives, while bonding to dentine, because of its specific constitution and wetness of its surface, is not always acceptable and longlasting. The latest generation of dentine adhesives shows better bonding values, better sealing of the dentine surface and is simpler to handle than earlier generations of dentine adhesives. The aim of this study was to determine in 453 small medium and deep cavities the clinical existence of postrestorative sensitivity after the application of "Excite" one-bottle enamel-dentine adhesive under a composite resin filling one and three months after the application of the composite filling. After one month 21 teeth showed sensitivity of 1st, 2nd and 3th degree, and after three months only four teeth showed sensitivity of 1st and 2nd degree. This confirmed the fact that "Excite" enamel-dentine adhesive can successfully decrease the presence of postrestorative sensitivity.

Key words: *dentine adhesives, postrestorative sensitivity.*

Acta Stomat Croat
2001; 367-370

ORIGINAL SCIENTIFIC PAPER
Received: Jannuary 23, 2001

Address for correspondence:

Jozo Šutalo
Department of Restorative Dentistry
School of Dental Medicine
Gundulićeva 5, 10000 Zagreb
Croatia

Introduction

Classical restorative materials do not have the ability to adhere to enamel and dentine to provide satisfactory physical and chemical bonding between the cavity walls and restorative material. It is also known that many materials shrink during polymerisation, which leads to leakage between the cavity wall and the filling material. One way of solving the problem of marginal adaptation and microleakage is to use dental adhesives.

Adhesion on enamel is enhanced by micromechanical interlocking of resin bonding interlayer in the demineralized area and around enamel prizm tags, which is enabled by etching with 37% phosphoric acid. Bonding to dentin is enhanced by three different mechanisms: physical absorption (by intermolecular van der Waals forces); by primary chemical connections (ions and covalent) with organic or anorganic dentine substance and by micromehanical interacting of dentine surface (1-3).

Micromechanical interaction of collagen fibers in intertubular dentine is the main mechanism of dentine adhesive bonding. This is enhanced by two mechanisms: penetration of bonding agents into the dentine tubulus where they form resin tags and by forming an interdiffusion "resin-dentine" surface which is known as the "hybrid layer". The hybrid layer is 1 to 5 μm thick and is the connection between dentine tissue and monomer on the molecular level (4). All bonding systems have shown some disadvantages such as: sensitive application procedure, dentine dehydration, shrinkage stress and as its consequent marginal leakage and postrestorative sensitivity.

The filled adhesive systems can penetrate into the interfibrilare spaces of the collagen fibers, increasing the tensile properties of the hybrid layer and enhancing satisfactory bonding. Adhesive systems with nanofiller have higher viscosity and therefore they form a thicker layer (10 - 20 μm) which enhanced adequate properties after curing with blue light which confirms the concept of classical bonding (5).

The aim of this study was to determine the clinical existence of postoperative sensitivity after application of "Excite" one-bottle enamel-dentine adhesive, enriched with nanofiller under composite resin one and three months after application of the filling.

Materials and procedure

In a clinical evaluation of postrestorative sensitivity after application of "Excite" enamel-dentine adhesive with nanofiller 453 cavities of class I, II, III, IV and V were included. All the patients were adults between 18 and 65 years old.

Depending on the cavity location and shape stainless steel for class II cavities or cervical plastic matrices with interdental wedges were used. Rubber dams were used in cases where the dry areas were imposible to enhanced.

All the enamel cavity walls were etched with 37% orthophosphoric acid for 20 - 30 seconds, the dentinal walls were etched for 10 seconds, and the cavities with sclerotic dentine were etched for 15 seconds. After etching they were rinsed with water and gently dried with oil free air. After which enamel-dentine adhesive "Excite" was applied to the cavity walls, and left for 20 seconds and the rest of the adhesive was gently removed with air. All the surfaces were covered with adhesive and polymerised with halogen curing unit "Astralis 7" (Vivadent, Schaan, Liechtenstein) for 20 seconds.

Depending on the cavity types, Tetric Ceram (Vivadent, Schaan, Liechtenstein) and Tetric Flow (Vivadent, Schaan, Liechtenstein) composite materials were used. For all cervical cavities Tetric Flow was applied, and for other cavities Tetric Ceram or combination of Tetric Flow and Tetric Ceram were used. For small and medium sized cavities "bulk technique" was applied and they were polymerized for 40 seconds with "Astralis 7" halogen curing unit. In deep cavities layering technique was always used and each layer was polymerized during 40 seconds using indirect polymerisation technique. All the cavity surfaces were prepared with diamond burs of different size and quality, and the occlusal surfaces were checked with articulation paper and polished with silicon rubbers.

Postrestorative sensitivity to cold and bite were determined after 30 and 90 days, and the degree of sensitivity was graded from 0 to 4.

Degree 0 = without sensitivity
Degree 1 = slight sensitivity
Degree 2 = moderate sensitivity
Degree 3 = moderate sensitivity
Degree 4 = severe sensitivity.

The total number of small cavities was 145, medium sized cavities 156 and 152 deep cavities. The total number of small, medium and deep cavities according to classes is shown in Table 1.

The total number of cavities filled with "Excite" enamel-dentine adhesive and Tetric Flow composite material was 203, and the total number of cavities filled with "Excite" enamel-dentin adhesive and Tetric Ceram composite material was 138. The total number of cavities filled with "Excite" enamel-dentine adhesive, Tetric Flow and Tetric Ceram composite material was 112 (Table 2).

Results

The results obtained were statistically analysed using ANOV-a and are shown in tables and graphs.

The total number of sensitive teeth depending on the degree of sensitivity after one month is shown in Figure 1. After one month postrestorative sensitivity was not found in any small cavities. It was found in 4 medium size cavities and 17 deep cavities (Figure 2). The degree of postrestorative sensitivity depending on cavity class is shown in Figure 3. Postrestorative sensitivity was found mostly in class II cavities.

After three months postrestoratove sensitivity was again tested and was found in 4 deep cavities (two cavities of class II, one cavity of class I and one cavity of class V) (Figure 4). After three months no postrestorative sensitivity was found in small and medium size cavities.

Figure 5 shows postrestorative sensitivity after one and three months depending on the filling material.

Figure 6 shows a decrease of postrestorative sensitivity after three months in relation to postrestorative sensitivity after one month.

Discussion

During the last three years five generations of dentine adhesives have been present on the market. Common characteristics of the first three generations are low adhesion, high degree of marginal leakage and hidrofobicity. Newer generations of dentine adhesives are hydrophylic and ensure higher bond strength to enamel and dentine.

The bond strength to dentine, with smear layer is not higher than 10 MPa, and if the smear layer is removed it is approximately 20 MPa. The highest bond strength is in the case of etched dentine and is 32 MPa. The higher bond strength of dentine adhesive with dentine is enhanced by forming a hybrid layer in the intertubular dentine (5-7). All composite resins show polymerization contraction which causes shrinkage stress resulting in adhesive or cohesive fractures. Marginal leakage and postrestorative sensitivity occur as a consequence of these fractures. It is therefore necessary to avoid or decrease polymerization shrinkage. For compensation of polymerization contraction dentine adhesive should ensure bond strength at least of 17 to 20 MPa (8, 9).

"Excite" enamel-dentine adhesive has crosslinked connected small and large chains of monomers such as HEMA, glycerin-dymethacrilate and BiS-GMA, which penetrate into the dentine tubulus and build up retentional resin tags after polymerisation and the rest of the adhesive forms a hard polymer layer. Small hydrophylic molecules of monomers make the dentine wet, while hydrophobic components make the composite wet. Monomer and filler particles of 12 nm are dissolved in a relatively low concentration of aethanol. Aethanol has shown the best properties as a solvent for hydrophobic and hydrophylic monomers (10). So far clinical experience has shown lower postrestorative sensitivity using an adhesive which contains aethanol as a solvent (9). The latest research has shown lower sensitvity after application of this kind of dentine adhesive which is due to the low concentration of this solvent (11).

As can be seen from Figures 2 and 3, postrestorative sensitivity was of a different degree after one month in medium and deep cavities and was most frequent in class II cavities.

After three months postrestorative sensitivity decreased and persisted in only two deep cavities of class II, one cavity of class I and one cavity of class V. Decrease in postoperative sensitivity is possibly due to the very high bond strength of "Excite" enamel-dentine adhesive to hard tooth tissue (which is 34 MPa) and to configuration factor and cavity shape. It is known that closed cavities (class I), because of the unsuitable configuration of factor "C", are unsuitable for restorations with classical composite materials. In such "closed" cavities "sandwich technique" is recommended, which involves the use of flowable composite resins or glass-ionomer cements in the first thin layer which forms the so called "elastic cavity wall" to enable compensation of polymerization contraction stress and longevity of the restoration.

Class V cavities, if they are not "closed", have the most suitable configuration factor "C" of about 1.10 (12). The longevity of the filling depends on tension and teeth flexion. Due to the poor amount of enamel and exposed dentine the bond strength is lower. If composite materials with a higher modulus of elasticity are used in class V cavities, fallout from the cavity will be more frequent. Because of the

correlation between modulus of elasticity and contraction stress, use of flowable composites with low modulus of elasticity for class V fillings is recommended.

Although postrestorative sensitivity was more often present in cavities filled with Tetric Ceram composite material after application of "Excite" enamel-dentine adhesive, statistical analyses have shown that there was no important difference in decrease of postrestorative sensitivity for different filling materials. However, after three months there was a significant difference ($p < 0.01$) in decrease of sensitivity for all filling materials and types of cavities (Figures 5, 6).

According to these results, flowable composite materials could be recommended under classical composite materials in medium and deep cavities with a high C factor.

Conclusion

As the most frequent consequence of composite restoration postrestorative sensitivity could compromise all the restorative procedure. Using enamel--dentine adhesive "Excite", which contains aethanol as a solvent and filler particle of 12 nm, which gives adequate viscosity for sufficient penetration in dentine tubuli, it is possible to avoid and even decrease sensitivity. Bond strength to enamel-dentine surface enables compensation of polymerization contraction stress which significantly decreases postrestorative sensitivity of the tooth. "Excite" enamel-dentine adhesive could be recommended as a material which can prevent the transfer of impulses to odontoblastic processes in dentine tubuli, which are opened during the cavity preparation and which can contribute to maintenance of dentine permeability.