Hybridization of dental hard tissue. Scanning electrono microscopy

Iulia Saveanu, Ioan Dănilă.
Iaşi, Romania

Summary

The aim of this study was to analyze the ultrastructural aspects of the dental hard tissues-restorative materials interface resulted after the use of the restorative material technique [1]. Material and method: The study included 30 teeth (molars and premolars) extracted for orthodontic or periodontal reasons. Standard first class cavities were prepared which had cylindrical shape, a depth of 2.5 mm and the diameter of approximately *2* mm. The teeth were divided into three groups A, B, C, and were restored according to the manufacturer's indication. The materials used were: Composite Filtek Z-250 and X-flow (3M), Compoglass F, Resin Modiffied Glass Ionomer (RMGI) - Vitremer (3M ESPE), and halogen photoactivation lamp. Results: Adaptation of the restorative composite to the cavities walls showed that its adhesion to enamel margins was very good and counteracts material shrinkage efficiently if small amounts are used: the laminate technique. Conclusion: Practitioners must choose the technique that conserves the restoration as much as possible.

Key words: hybridization, shrinkage, restoration.

Introduction

Continuous improvements of the mechanical and biological characteristics of dental materials allow dental practitioners to extensively apply this preventive technique as soon as possible after teeth eruption. This study proposes to focus the dentist's attention to the importance of strictly following the major material indications according with the clinical situation [2].

Advances in adhesive dental technology have radically changed restorative dentistry. Nevertheless, adhesion to the tooth surface is always in opposition to the polymerization shrinkage of the composite material [3], Although polymerization shrinkage is the cause, shrinkage stress is in fact responsible for quite a few problems; in adhesive restorations encountered in clinical dentistry it can cause separation from the cavity walls or cohesive fractures in one of them.

The aim of this study was to analyze the ultrastructural aspects of dental hard tissues-restorative materials interface resulted after the use of the restorative material technique [4].

Material and method

The study included 30 teeth (molars and premolars) extracted for orthodontic or periodontal reasons. Standard first class cavities were prepared, having cylindrical shape, a depth of 2.5 mm and a diameter of approximately 2 mm. The teeth were divided into three groups A, B, C, and were restored according to the manufacturer's indication. The materials tested were:

1. *Composite Filtek Z-250 (3M ESPE),*
2. *Composite X-flow (3M)* used with *Single Bond adhesive,*
3. *Compomer Compoglass F* used with *Prime&Bond NT adhesive,*
4. Resin Modified Glass Ionomer *Vitremer (3M ESPE),*

Teeth in **group** A were restored with RMGI Vitremer and hybrid composite, in **group B** with flow composite and hybrid composite, and in **group** C with compomer base and hybrid composite.

After restoration the teeth were conserved in bottles with isotonic solution for maximum 48 hours until the samples were prepared for SEM -

the teeth were longitudinally sectioned in 2 halves. The two halves were polished under water-spray, using low speed. The sectioned surface was conditioned with 37% phosphoric acid for 10 sec. Then the teeth were washed with distilled water and dried with air-spray. The samples were kept in their bottle for maximum 24 hours until they were impregnated with $AgNO_3$ and then examined with a SEM, TESLA, BS 340.

Results

Adaptation of the restorative composite to the cavities walls showed that its adhesion to enamel margins is very good and efficiently counteracts material shrinkage if small amounts are used: laminate technique *(Figures 1, 2)*.

Aspects of the material-tooth interface showed that, finally, the filling was a restoration with inconstant adhesion, irrespective of the material or technique, which means no real adhesion is realized.

Between the interface of glass ionomer and dentine substrate *(Figure 3)* we can see material delaminating at the dentine but the hybrid layer is attached to the dentin tissue; we can notice the gap in the dental material because of the condensation technique.

Figure 1. Interface between enamel and composite resin – group A. Optimal marginal adaptation, providing a good sealing and bonding of the restoration

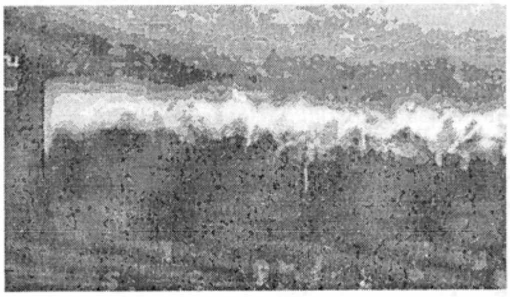

Figure 2. SEM image of the interface between sealant and enamel at the margins of the restoration. The sealant creates the first barrier against bacterial penetration

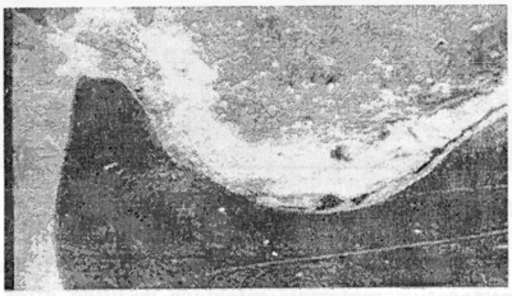

Figure 3. Interface between glass ionomer cements and dentine in group A. We can see a partial delaminating of the glass ionomer from the dentine but the hybrid layer is attached to the dentin tissue.

Figure 4. Interface between flow composite and dentin, group B

In *Figure 4* we can observe that though the flow composite material is firmly attached to the dentin, a space is present between flow composite and dentin. We can see the delaminating of the material to the substrate. The high polymerization shrinkage of the flow composite material can confirm this fact.

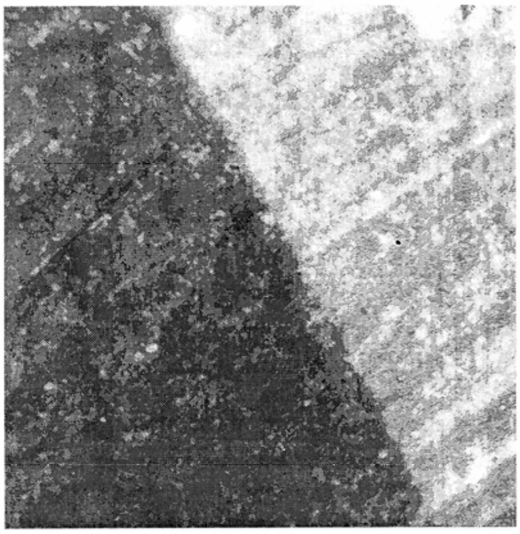

Figure 5. Interface between composite with high viscosity and flow composite resin in group B

In we can observe a perfect intrication at the interface between high viscosity composite and flow composite resin in group B.

Discussion

The aspects at the material-dentin interface show that irrespective of the type of material used, the restoration has inconstant adhesion.

Our studies put in evidence the adhesive failure zone irrespective of the technique employed; it is possible that factors due to the technique of section sampling might also play a role.

However, although the adhesion was selective, in the zones where this was not realized, a hybrid layer was remaining and a failure zone appeared between adhesive systems and material or in the restorative material structure.

Thus, through polymerization shrinkage, total adhesion is transformed in selective adhesion (adhesion at the marginal cavities). So, two barriers are created, which operate against microleakage. The first barrier is established at the margin of the enamel and the second barrier is established at the base by flow or adhesive systems of the composite, which will oppose to bacterial microorganisms penetration in the dentin structure. In conclusion, the results show that the selective adhesion technique appears anyhow and this might be due to the flow capacity of the composite or compomer. Selective bonding might improve sealing and marginal adaptation of large restorations with a high configuration factor and those restored with an incremental technique. In addition, a distinctive advantage of the selective bonding is that it creates two independent penetration barriers within the restorative system. The first barrier is the margin of the restoration. In the event this barrier fails, a second barrier against penetration – formed by the adhesive liner – is located inside the cavity.

Conclusion

The practitioners must choose the technique that conserves the restoration as much as possible.

The restoration success is determined by the biological principles followed by the practitioner.

References

1. Saveanu I., Danila I., Iovan G., Hanganu C., Ichim I., Barlean L., Parus M., Mihailovici L. Adeziunea biomaterialelor la structurile dure dentare – consideratii clinice si de laborator. *Supliment al Revistei de Medicina Stomato-logica,* Febr. 2002, Ed. Apollonia: 254-261.

2. Abate P.F., Betacchini S.M., Polack M.A., Macchi R.L. Adhesion of a compomer to dental structures. *Quintesence* int., 1997; **28**: 509-512.

3. Romanu M., Bratu D., Lakatos S., Florița Z. Polimerizarea in Stomatologie (Polymerization in Dentistry). Ed. Brumar, Timișoara, 2000: 192-210.

4. Nakabayashi et al.: *Hybridization of dental hard tissue,* 1999; 15-68.

Correspondence to: Dr. Iulia Saveanu, Assist. Prof., Department of Preventive Dentistry, Faculty of Dental Medicine, "Gr. T. Popa" University of Medicine and Pharmacy, Universitatii Street, no. 16, Iasi, Romania. E-mail: dsaveanu@krafteurope.com