

# Experimental Study on the Improvement of the Use of Diacrylic Composite Resins in Restorative Dentistry by Compensatory Techniques

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*The materials as well as the procedures successfully used in modern restorative dentistry are based on scientific selection criteria which can predict outstanding results both in terms of physiological aspects and durability of the workmanship. The rationale of using certain materials and the success or failure to use certain techniques have contributed in time to the evolution of restorative dentistry. The optimal way of combining the material with its application and finishing technique implies an exhaustive approach to the subject that still requires the specialists' research and concern for their improvement and development. Among the restorative materials, those that meet the patients' aesthetic exigencies are the composite resins. In spite of all the advantages resulting from their intrinsic characteristics, it should be noted though that composite resins still have inconveniences related in the first place to the polymerization contraction/shrinkage, which causes a gap between the obturation and the dental tissue further resulting in the generation of marginal micro-infiltrations with all the related drawbacks. Knowing the behavior of the material and understanding its use in various manners can help the practitioner in its efforts to minimize undesirable effects, which is generally possible by applying compensatory clinical techniques. The aim of the experimental research is to evaluate the marginal micro-infiltrations from the class II cavity restorations with composite diacrylic resins according to the different techniques of restoration (stratification technique, flow technique and pre-photopolymerized insert technique) and the establishment of the optimal restorative technique to minimize side effects.*

**Keywords:** composite diacrylic resin, polymerization shrinkage, class 2 cavity, restoration techniques, obturation, marginal microinfiltration

The last step in the treatment of simple caries is to restore coronary morphology using a heterogeneous material, a micro denture called obturation [1-3]. Stopping the evolution of the carious process is accomplished by the exertion of all the altered tissues, resulting in a solution of continuity at dental tissues level. Dental composites and their adhesive systems or techniques allow for maximum preservation of the dental rigid structures, on the one hand providing their strength and, on the other hand, providing minimal pulp inflammation during restoration [4-8]. They are materials of a good quality / price ratio and outstanding physiognomic aesthetics. The composite diacrylic resins (DRCs) used by practitioners in many clinical situations of the restorative dentistry lead to successful results only by appropriately assimilating the techniques of manipulating these materials and by observing the restoration work technology [9-13].

Of utmost importance are the quality of the polymerization process and the bonding contraction, two elements which are still unresolved issues in the treatment of dental injuries with the DRC. In this context, the main objective of the present research is the evaluation of marginal microinfiltrations in composite resin restorations, depending on the different restoration techniques [14-17] for 2nd class cavities. The optimal method of restoration and the techniques that can be learned and applied by practitioners in order to optimize the clinical behavior of the photopolymerizable composite diacrylic resins used in direct restorations will be highlighted.

## Experimental part

For the experimental research, a number of specific dental materials were used and investigations were carried out with specialized equipment and tools. Molars and maxillary and mandibular premolars; extra hard gypsum; diamond mills (spherical, cylindrical, converse) for finishing; diamond disk; applicators; interdental wedges; metal matrices; matrix support; 36% phosphoric acid (Zmack etch); Adhesive (Gluma); fluid composite (3M ESPE); composite; Methylene Blue. Appliance for investigation of restorations: optical endodontic microscope (Zumax/fig.1) and digital camera (Nikon D3001).

The study was conducted on 30 molars and maxillary and mandibular premolars collected over a period of 3 months from private dentists [17]. After extraction the teeth were cleaned and kept in physiological saline. They were then inserted into gypsum blocks with the root portion and, to restore the situation in the oral cavity, the point of contact



Fig.1. Optical endodontic microscope (Cabinet of dentistry with private practice)

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Fig 2. Group I teeth after preparation

between them was achieved. On the 30 molars and maxillary and mandibular premolars, class II cavities were prepared using spherical, cylindrical and reverse diamond-shaped mills. The teeth were divided into 3 groups:

I. 10 teeth obturated by prepolymerized composite insert technique;

II. 10 teeth obturated by fluid composite flow technique;

III. 10 teeth obturated by stratification or oblique incrementing (OIT) technique using viscous composite.

Next, the teeth were restored using different techniques on the three groups of teeth. Regardless of the filling/obturation technique, for all three groups of teeth the procedure was as follows: the cavity was conditioned with 36% orthophosphoric acid for 20 s; the cavity was washed for 15 s and then dried by air jet from the dental unit; the adhesive was applied and photopolymerized for 20 s;

For the group I of teeth, a first layer of fluid composite was applied to the gingival wall, a pre-photopolymerized insert was inserted, then the cavity was obturated by the stratification technique (fig.3, fig.4).

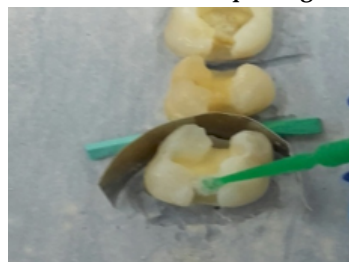


Fig.3. Application of the adhesive (Group I of teeth)



Fig.4. Applying the fluid composite and the metal matrix (Group I of teeth)

For group II a layer of 1 mm of fluid composite was applied directly to the gingival wall of the cavity, after which the cavity was obturated by the stratification technique (fig. 5, fig. 6). For group III, the first layer of composite was applied directly to the gingival wall, in oblique position and photopolymerized for 40 seconds; The other layers were introduced by the same technique, i.e. the oblique incremental technique (OIT). After filling the cavities, the teeth were immersed into 1% methylene blue for 24 h, then cut in sections of 1mm using a diamond disk mounted to a vestibulo-orally right piece (fig.7).

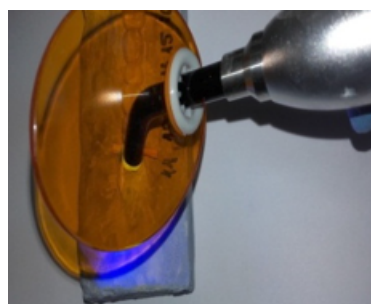


Fig. 5. Fotopolymerisation of the adhesive (Group II of teeth)

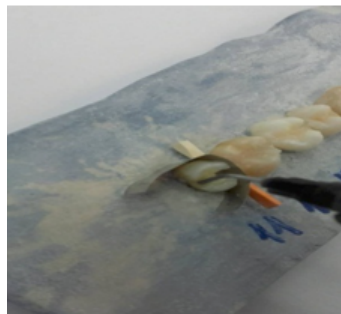


Fig.6. Applying the fluid composite (Group II of teeth)



Fig.7. Vestibulo-Oral Sections

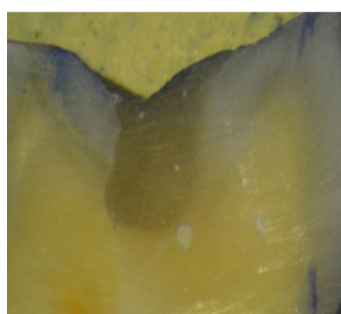


Fig.8. Mesial Section (group I of teeth)

Sections were analyzed by Zamax endodontic optical microscope at 50X magnification (fig. 1). The images were taken with Nikon D 3001 digital camera attached to the endodontic optical microscope (fig.7-fig.16) [17].

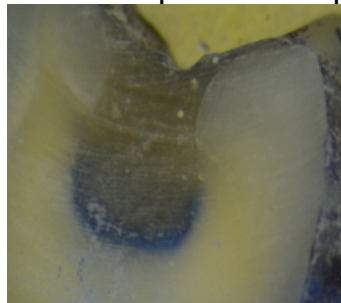


Fig. 9. Central Section (group I of teeth)



Fig. 10. Distal Section (group I of teeth)

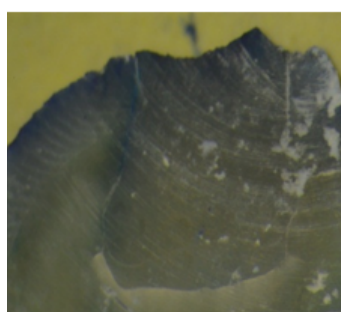


Fig. 11. Mesial Section (group II of teeth)

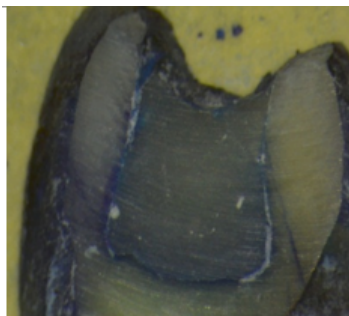


Fig.12. Central Section  
(group II of teeth)

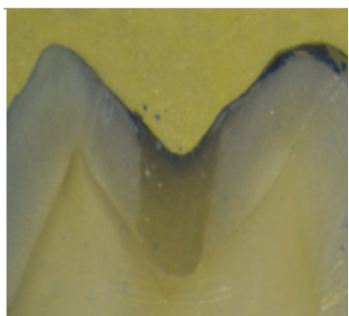


Fig. 13. Distal Section(group II  
of teeth)

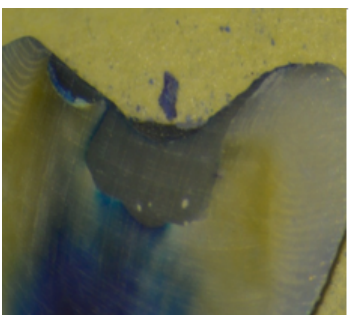


Fig. 14. Mesial Section (group  
III of teeth)

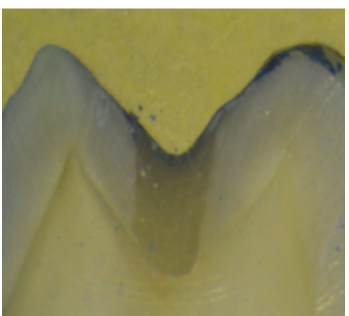


Fig.15. Central Section (group  
III of teeth)

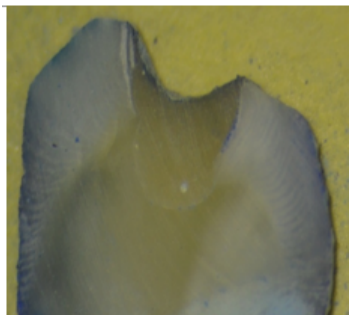


Fig.16. Distal Section(group III  
of teeth)

The extent of infiltration at the level of each section (medial, central, distal) was analyzed in the gingival, vestibular and oral walls, and the data obtained was processed using Microsoft Excel program.

## Results and discussions

After researches, the restoration quality was evaluated infiltrations in vestibular (V), oral (O), and gingival (G) walls were compared, analyzing the three sections (medial, central, distal) of the obturated teeth by the three restoration techniques. The experimental results are

presented graphically (fig.17, fig.18, fig.19) [17]. We further carried out a comparative study of the quality of the restorations through the three experimental techniques used, comparing the infiltration of the oral, vestibular and gingival walls.

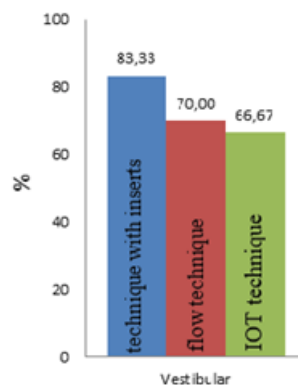


Fig.17. The degree of infiltration  
of the *Vestibular* wall for the  
three restorative techniques

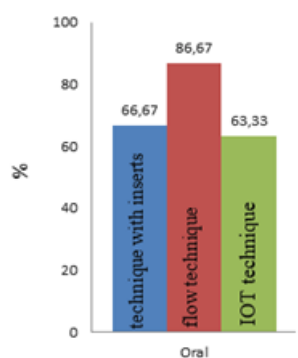


Fig.18. The degree of infiltration  
of the *Oral* wall for the three  
restorative techniques

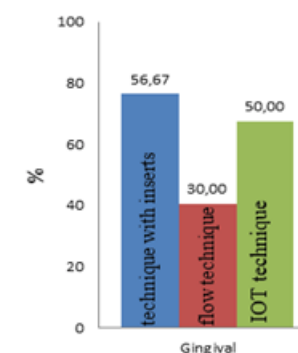


Fig. 19. The degree of  
infiltration of the *Gingival*  
wall for the three restorative

As seen in the technique with pre-photopolymerized inserts, the highest infiltration level (83.33%) occurs in the vestibular wall, followed by the oral wall (66.67%) and then the gingival (56.67%).

For *flow technique*, the highest infiltration rate occurs in the oral wall (86.67%), followed by the vestibular wall (70%) and then the gingival one (30%). In the IOT technique the maximum infiltration rate is reported in the vestibular wall (66.67%), followed by the oral wall (63.33%), while the lowest degree of infiltration is found in the gingival wall (50%).

We note that for the *vestibular wall* the highest degree of infiltration is to be found with pre-photo-polymerized insert technique (83.33%), followed by flow technique (70%) and IOT technique (67%).

For the gingival wall, the highest infiltration rate is also reported for pre-photo-polymerized insert technique (56.67%), followed by IOT (50%) and then flow technique (30%).



For the *oral wall* the highest infiltration rate is reported for the flow technique (87.67%), followed by the technique with inserts (66.67%) and the last place is for the IOT technique (63.33%)

## Conclusions

The in vitro experimental study on obturation techniques for the use of composite diacrylic resins has led to the following conclusions:

- marginal microinfiltrations are present in a lower or higher percentage in all 3 techniques used;

- since the composite diacrylic resins undergo dimensional variations during the polymerization process, it is very important to use the appropriate technique in order to obtain a good adaptation of the material to the cavity and a suitable marginal seal

- consideration of the factors involving the material and operative technique such as the volume of the composite resin introduced into the cavity and the association of the composite resin with other materials whose properties are more suitable for application to the cervical area;

- a thin layer of fluid composite (0.5-1 mm) features higher marginal quality; the use of fluid composite liners can reduce the value of micro-infiltrations in the composite restorations, which is explained by the high percentage of organic matrix of the fluid composite which increases the stress of contraction;

- the fluid composite applied to the cervical wall causes better marginal closure (superior sealing and low infiltration) compared to other techniques, plus the advantage of partially absorbing the mechanical shocks resulting from the masticatory process.

The results of the study show that the stratification technique remains a viable technique, the oblique layers having the advantage of small thickness and a reduced shrinkage volume.

## References

1. EARAR, K., CERGHIZAN, D., SANDU, A.V., MATEI, M.N., LEATA, R., SANDU, I.G., BEJINARIU, C., COMAN, M., Mat. Plast., **52**, no. 4, 2015, p. 487-493.
2. GRAHAM, J., MOUNT, W.R. Conservarea si restaurarea structurii dentare, Ed. ALL Educational, Bucuresti, 2006; 55-68, 121 – 154.

3. SCUTARIU, M.M., MATEI, M.N., MACOVEI G., LEATA, R., CHISCOP, I., ILIE, M., SURDU, A., Mat. Plast., **52**, no. 3, 2015, p.402-407.
4. ANDREIA A. CAVALHO et al., Marginal microleakage of class II composite resin restorations due to restorative techniques, Rev. odonto. cinc., vol. 25, no. 2, 2010, p.165-169.
- 5.\*\*\* <http://www.dentalnews.ro/restaurari-directe-cu-rasini-evolutie-aplicatii-si-tehnici>.
6. MENSUDAR, R., et al., Use of innovative megafillers for improving the marginal adaption of composite restoration, Indian Journal of Multidisciplinary, vol. 1, no. 4, 2011, p.186-189.
7. GARBEROGLIO, R., COLI, P., BRANNSTROM, M., Contraction gaps in class II restorations with seff-cured and light-cured resin composites, Am J. Dent, vol. 8, no. 4, 1995, p.267-271.
8. PFEIFER CS, FERRACANE JL, SAKAGUCHI RL, BRAGA RR., Factors affecting photopolymerization stress in dental composites, J Dent Res., vol. 87, no. 11, 2008, p.1043-1047.
9. KREVERLAAN GJ., FEILZER AJ., Polymerization shrinkage au contraction stress of dental resin composites, Dent. Mater., vol. 21, no. 11, 2005, p.1151.
10. DONLY K.J., WILD T.W. et al., An in vitro investigations of the effect of glass inserts on the effective composite resin polymerization shrinkage, J. Dent. Res., vol. 68, no. 8, 1998, p.1234-1237.
11. GHIORGHE, C. A., IOVAN, G., ANDRIAN, S., NICA, I., TOPOLICEANU, C., PANCU, G., Studies on Adhesion of Composite Resins and Glass-Ionomer Cements in Open-Sandwich Technique, Rev.Chim. (Bucharest), **68**, no. 8, 2017, p. 1890
12. MARECI, D., EARAR, K., ZETU, I., BOLAT, G., CRIMU, C., ISTRATE, B., MUNTEANU, C., MATEI M.N., Mat. Plast., **52**, no. 2, 2015, p. 150-153.
13. BICA C., MARTHA K., BICA D., ESIANU D., MATEI M.N., Mat. Plast., **54**, no. 4, 2017, p. 777-780.
14. MANOLE, M., BERECE, C., FLOREA, C. A., BURDE, A. V., SINESCU, V., Rev.Chim.(Bucharest), **68**, no. 8, 2017, p. 1919
15. REIS A.F., et al., The effect of filling techniques and a low viscosity composite liner on bond strength to class cavities, Journal of dentistry, vol. 31, no. 4, 2003; p. 59-66.
16. VERSLUIS A., et al. Does an incremental filing techniques reduce polymerization shrinkage stress, Journal of dental research, vol. 75, no. 3, 1996, p. 871-878.
17. DOCAN A., Studii si cercetari privind realizarea optima a obturatiilor definitive pe cavitati de clasa a II-a utilizand diferite tehnici restaurative, lucrare de licenta, UDJ Galati , 2016.

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