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ORIGINAL ARTICLE/ARTICOLO ORIGINALE

# Bulk vs wedge shape layering techniques in V class cavities: marginal infiltration evaluation



*Stratificazione a massa unica vs stratificazione obliqua in cavità di V classe: valutazione dell'infiltrazione marginale*

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## KEYWORDS

V class cavities;  
Microleakage;  
Stratification technique;  
Bulk filling;  
Wedge-shape layering.

## Abstract

**Objective:** The aim of this *in vitro* research was to assess if the different stratification techniques could influence the marginal gap in V class restoration.

**Material and methods:** Standard 6 × 4 × 4 mm class V cavities were prepared on the buccal side of 24 extracted sound human premolars. Specimens were randomly divided in two groups: (A) Bulk filling technique; (B) Wedge-shape layering technique. The interfacial sealing ability of the stratification techniques was evaluated by scoring the 7% methylene blue penetration depth through optical microscope observations. The infiltration assessment was performed with a progressive score. Differences in infiltration scores recorded for the tested techniques were evaluated for statistical significance (Mann–Whitney *U* test,  $p < 0.05$ ).

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**PAROLE CHIAVE**

Cavità di V classe;  
Micro-infiltrazione  
marginale;  
Tecniche di  
stratificazione;  
Massa unica;  
Stratificazione obliqua.

**Results:** The A group showed a mean score of  $1.166 \pm 1.114$ , registering the higher score of 3; the B group the mean score was  $0.666 \pm 0.778$ , and a higher score of 2. The two tails Mann–Whitney analysis showed a 0.270 non-significant result.

**Conclusion:** Considering the limitation related to the technique used for the infiltration analysis in small V class cavities, the infiltration score is not influenced by the different stratification techniques.

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**Riassunto**

**Obiettivi:** lo scopo di questa ricerca in vitro è quello di valutare se differenti tecniche di stratificazione possano influenzare il gap marginale in cavità di V classe

**Materiali e metodi:** cavità standard di V classe di 6x4x4 mm sono state preparate sul versante vestibolare di 24 premolari umani integri. I campioni sono stati casualmente divisi in due gruppi: A) tecnica di stratificazione a massa unica; B) tecnica di stratificazione obliqua. La capacità di sigillo, nella zona di interfaccia, delle differenti tecniche di stratificazione è stata valutata, tramite osservazione al microscopio ottico, assegnando un punteggio all'infiltrazione di una soluzione di blu di metilene al 7%. La valutazione dell'infiltrazione è stata effettuata mediante un punteggio progressivo (Osorio et al.) Le differenze nei punteggi di infiltrazione riferiti alle diverse tecniche, sono stati valutati per la significatività statistica (test di Mann-Whitney U,  $p < 0.05$ )

**Risultati:** il gruppo A ha mostrato un punteggio medio di  $1.166 \pm 1.114$ , registrando un punteggio massimo di 3; il gruppo B ha mostrato un punteggio medio di  $0.666 \pm 0.778$ , ed un punteggio massimo di 2. L'analisi a due code di Mann-Whitney ha mostrato un risultato non significativo di 0.270.

**Conclusioni:** considerando le limitazioni correlate alla tecnica di valutazione della microinfiltrazione usata, in piccole cavità di V classe il punteggio di infiltrazione non è influenzato dalle differenti tecniche di stratificazione.

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**Introduction**

An optimal conservative restoration requires a pre-operative choice, regarding techniques and materials to be adopted and considering the interaction between materials and their own limits.<sup>1</sup> The “ideal” material, that should have all the biomechanical characteristics necessary to replace compromised dental tissues, does not exist.

Many aspects should be considered: chemical-physical properties of the material, necessity of anatomical and functional interconnection between restorative material and biological dental structures, aesthetic integration and natural appearance. Especially in cases of difficult adhesion achievement, the choice of a correct treatment plan has particular importance, directly involving the long-term results of the restoration.<sup>2</sup>

The composites polymerization reaction involves a monomer molecules conversion into a polymer network and the formation of shorter covalent bindings. This reaction, influenced by the internal flowability of the material and the polymerization speed, can be considered the main resins limit because of the stress at the interface due to the polymerization shrinkage.<sup>3</sup>

The most important challenge in adhesive dentistry is lowering the polymerization shrinkage. The research, during the last 15 years, has been focused on creating high performance adhesive systems and low-shrinking material. However most of the composites on the market show a volume

shrinkage values in the range of 2–3% and this determines stress at the interface tooth/restoration that could induce gap and marginal micro-leakage formation.<sup>2–4</sup>

The penetration of acids, enzymes, ions, bacteria and their products within the margins of the restoration could be responsible of marginal discoloration, post-operative sensitivity, secondary caries and pulp damage and are all linked to the micro-leakage.<sup>5–7</sup> The micro-gap dimension is observed between 5 and 20  $\mu\text{m}$  and, being one of the most important factors in the long-term evaluation of the restoration, is the most predictive parameter for its survival.<sup>3</sup>

The inter-relation between resinous materials, adhesive systems and cavity walls have to be considered when planning the therapeutic strategy in order to reach the best performance.<sup>8,9</sup> To choose the proper type of resin, an evaluation regarding its composition should be done considering the ratio between the organic and the inorganic fraction.<sup>10</sup> An increased filler percentage should determine a lower shrinkage, but reduces the sliding ability of the composite, causing a plastic deformation reduction at the free surface level during the reaction of polymerization.<sup>11–13</sup> Composite resins high in inorganic volume could not achieve a proper dissipation of the shrinkage stress while wear resistance is increased.<sup>14–16</sup>

The nano-filled resins are characterized by low shrinkage due to the presence of pre-polymerized particles of micro-filled composite (nano-cluster), reinserted within the matrix.<sup>16</sup> To lower the polymerization shrinkage stress, many

techniques could be performed such as layering and incremental curing, even if these techniques cannot eliminate the stress completely.<sup>17</sup> Scientific evidences have underlined that the composite stratification techniques lower the contraction stress during the composite polymerization.<sup>17–19</sup>

Different stratification techniques are used, such as:

- Bulk filling technique
- Gingival-occlusal layering, used for small cavities
- Wedge-shape layering, used to prevent the cavities wall deformation.

The aim of this *in vitro* study was to determine if different stratification techniques could affect the marginal gap in small V class restorations.

## Materials and methods

### Sample preparation

In the present study 24 caries-free premolar teeth, extracted for periodontal reasons were used. After the extraction, samples were cleaned and stored for a period that was less than 3 months in physiologic solution at room temperature. On the buccal surface of the samples class V cavities with dimensions of  $6 \times 4 \times 4$  mm were performed. Variations of  $\pm 1$  mm were considered acceptable. The 4 mm depth was chosen to assure that the cavities could be filled and cured *in toto*. Cavities gingival margins are placed about 1.5 mm occlusally from the cement-enamel junction (Fig. 1).

The cavity preparation was carried out by a single operator by using a disposable pear shape diamond bur (012

Summit Dentsply ADD manufacturer's details) with a high-speed hand-piece under water cooling. Cavity margins were refined with an Arkansas bur using low-speed hand-piece under water cooling (Shofu Dura – White-Stone Fg 025, ADD manufacturer's details).

### Restorative protocol

All the samples were subjected to the same restorative protocol as follows:

35% phosphoric acid was applied to the enamel margins for 15", and then rinsed with air/water spray for 15", then, Scotch Bond XT (3M-ESPE, St. Paul, MN, USA) was applied on enamel and dentin following manufacturer's instructions.

The composite used in this study to restore the class V cavities, (Filtek Supreme 3M-ESPE St. Paul, MN, USA) is based on aromatic and aliphatic traditional dimethacrylates.

The 24 teeth were randomly divided into two groups in relation to the different stratification technique used:

- Group A: 12 samples restored using bulk filling technique.
- Group B: 12 samples wedge-shape layering technique.

The polymerization of the adhesives and composites was carried on with LED lamp (LED Anthos T, ADD manufacturer's details).

### Experimental procedure

After 1 week of water storage at 37 °C, the teeth were submitted to a thermo-cycling (500 cycles of 20", 5–55 °C). Subsequently the root apices of the samples were sealed with epoxy resin and the outer surface was isolated with varnish. The restoration had a margin of about 1 mm around not isolated area.

After being stored in a dry environment for 24 h, teeth were immersed in the methylene blue 7% solution at room temperature for 3 days. Then the samples were rinsed and sectioned longitudinally at the middle of the restoration (Fig. 2).

For the evaluation of infiltration depth, an optical microscope (OPMI PRO ERGO S7B ZEISS) with 12.5 $\times$  magnification was used.<sup>20,21</sup>

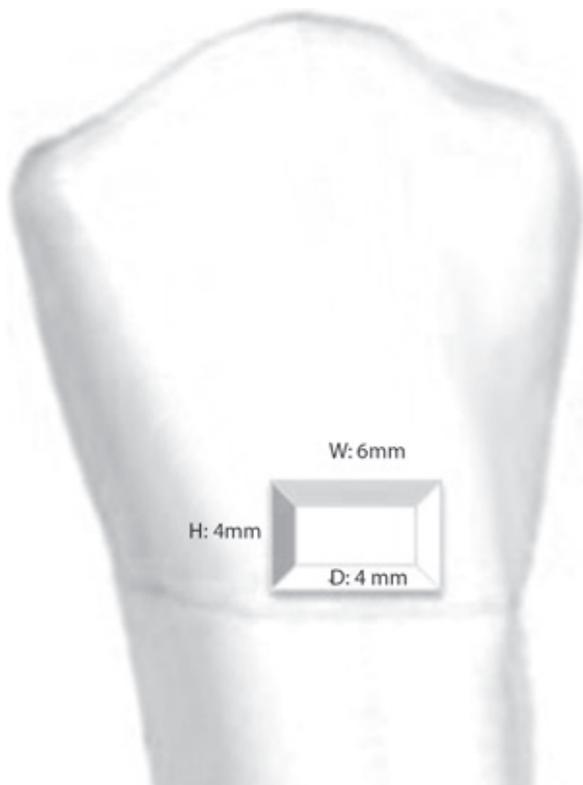
### Sample analysis

The marginal infiltration score was assessed using the system proposed by Osorio et al.,<sup>22</sup> that, evaluating, under magnification the dye penetration in the cavity walls, assign to each sample a score as follows:

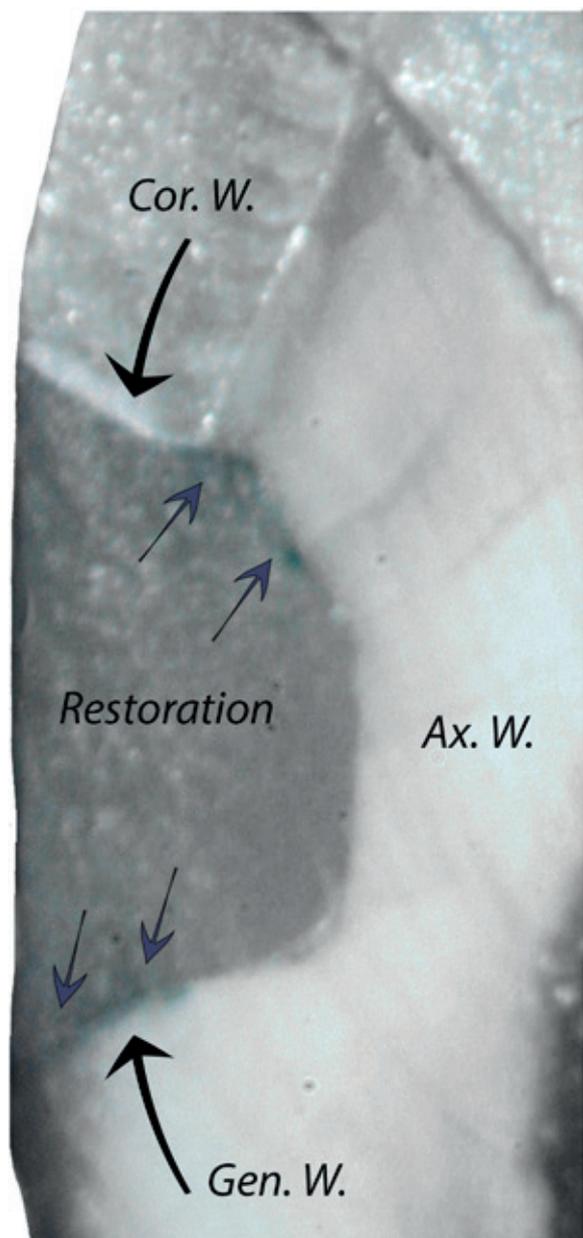
- 0: No infiltration
- 1: Infiltration does not cross the centre of the interested wall cavity
- 2: Infiltration crosses the centre of the interested wall cavity
- 3: Axial infiltration
- 4: Axial infiltration reaches surrounding dentinal tubules.

This evaluation was carried out separately by two different operators. In case of disagreement, the highest score was assigned for statistical analysis.<sup>22,23</sup>

The numerical data are expressed as mean and standard deviations (SD) and median. Statistical analyses were performed using SPSS 17.0 for Window package. The non-parametric Mann Whitney test was used in order to compare



**Figure 1** Cavity scheme (Width  $\times$  Height  $\times$  Dept). V class,  $6 \times 4 \times 4$  buccal cavity.



**Figure 2** Specimen sample: The arrows indicate the blue colorant solution infiltration

Ce.W. = cervical wall, A.W. = axial wall, Co.W. = coronal wall.

groups A and B and  $p < 0.05$  was considered to be statistically significant.

## Results

The statistical analysis shows for the 12 samples of the V class restored using the bulk filling technique a mean score of 1.166 with a SD of  $\pm 1.114$ , a median value of 1 and an higher score of 3.

For the 12 samples of V class cavities restored using the wedge-shape layering technique, the mean score is 0.666 with a SD of  $\pm 0.778$ , a median value of 0.5 and the higher score of 2.

The Mann–Whitney test showed a non-significant difference between the groups ( $p = 0.270$ ).

## Discussion

A consequence of polymerization reaction of composite materials is a volumetric shrinkage of 2–3%.<sup>2,4,24</sup> This contraction is transferred to the dental tissues manifesting as a stress that could cause deformation, gap between resin and cavity walls, micro-crack formation, infiltration of intraoral fluids and a consequent post-operative sensitivity.<sup>25</sup>

The layering technique in direct restorations is widely recognized as an important factor to determine a better marginal adaptation and to reduce the stresses generated by the polymerization shrinkage.<sup>17</sup> Different layering techniques have been proposed for direct restoration of class V cavities,<sup>26–28</sup> however the most effective restorative technique to reduce stress is still unknown.

The bulk stratification let operator realize a one-time restoration, useful when treating complex clinical case or when a shortening of the operating time is needed, especially considering that the adhesion characteristics could minimize its disadvantages.<sup>29–31</sup>

Several authors suggest the use of an incremental layering technique rather than a bulk filling technique, in order to reduce polymerization stress. This procedure should ensure minimal infiltration, especially when the restoration margin lies near or beyond CEJ.<sup>24,32,33</sup>

From the statistical analysis of the infiltration scores obtained in the present study, it is evident how the values of the bulk technique are double in score compared to the layering technique's one, but showing a lack of statistical significance. This aspect could be linked to the high standard deviation registered that could be related to limitation of the investigation protocol used to assess the leakage.

However, this data could be related to the V class cavities dimension. In such a small cavity the polymerization stresses and the composite contraction are greatly thwarted by a  $24.2 \pm 3.4$  MPa bonding strength on dentine and  $26.5 \pm 4.9$  on enamel that overcome this mechanical issue (shear bond strength and physicochemical).<sup>34</sup>

These results agree with other studies that have shown that in small class V cavities a direct restoration with bulk technique does not cause a significant increase in the amount of microleakage.<sup>35</sup> Sensi et al.<sup>36</sup> did not observed significant differences in the treatment of V classes using occlusal layering or bulk technique.

Moreover, the results have shown that, regardless of the techniques used, the bond between the dentine and the resin was able to withstand the stress generated by the polymerization shrinkage leading to low level of micro-leakage even in difficult cases.<sup>4,23,37</sup>

The self-etch adhesive approach, was chosen, thanks to less operative steps resulting in a lower incidence of possible technical mistakes.<sup>22,23,38</sup> However, the literature underlined how an enamel insufficient adhesion potential may lead to an insufficient quality of the marginal restoration causing marginal infiltration and inflammatory reaction.<sup>23,27,32,39</sup> To overcome this minus, a selective enamel pre-etching should be performed and, as evident in an *in vitro* study, the bonding force became greatly increased.<sup>23</sup>

## Conclusion

In small V class cavities, the marginal infiltration score analysis, carried out by the system proposed by Osorio, used to evaluate the restorative techniques, bulk or wedge-shape, shows that these two did not statistically influence the marginal infiltration score and the presence of detectable marginal gap. This results may be linked to the infiltration analysis technique used that obtain a high standard deviation values and so a lack of statistical significance.

## Conflict of interest

The authors deny any conflict of interest.

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