Superficial roughness on composite surface, composite enamel and composite dentin junctions after different finishing and polishing procedures. Part I: roughness after treatments with tungsten carbide vs diamond burs

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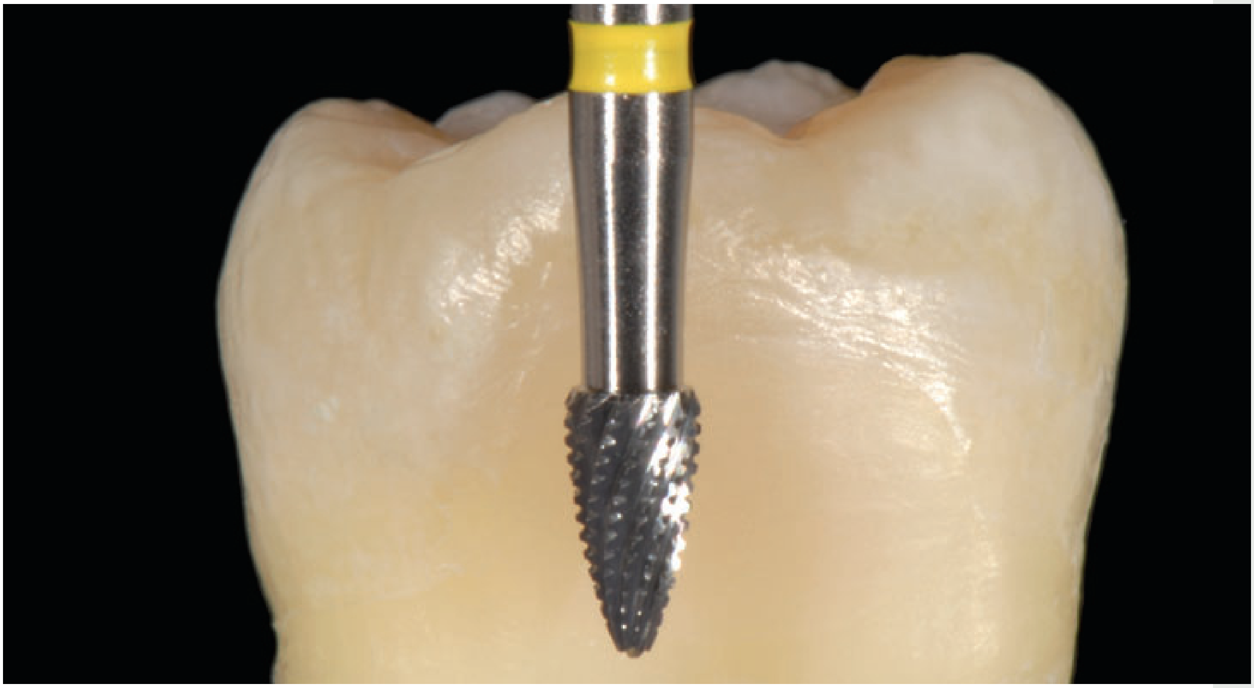

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Abstract

The aim of this study is to investigate different instruments for finishing composite restorations, as well as examining different surfaces and interfaces of the same restoration. The null hypothesis is represented by the fact that there are no significant differences on roughness of composite restorations finishing between tungsten carbide and diamond burs, furthermore the null hypothesis is that there are no significant differences on roughness between finishing on composite surfaces (C), composite-enamel (CE) and composite-dentin (CD) interfaces. The study was performed on 28 teeth, and class V cavities were prepared on the extracted teeth. Restorations were done in Filtek XTE nanofilled composite (3M Espe) in a standardized method, to then be finished. A comparison was made in the phase 1 between tungsten carbide burs (16 blades), diamond burs (46 μm), with a similar shape by the same manufacturer (Komet). Each surface received 5 bur applications. Consequently, an analysis with a profilometer was performed. Phase 2 involved further confrontation of ulterior finishing with ultrafine tungsten carbide burs (30 blades) and with extra and ultrafine diamond burs (25 and 8 μm) (the same shape as previously mentioned). A second analysis was then performed with a profilometer. All measurements were taken on C surfaces, CE and CD interfaces. Statistical analyses were carried out with c2 test (a = 0.05).

Conclusions: The finishing procedures with fine grit or toothing burs gave a better smoothness with tungsten carbide burs compared to diamond burs. While with the ultrafine grit no significant differences were noted between tungsten carbide and diamond burs on the CE and CD interfaces, the diamond bur left less superficial roughness on the C surfaces. With regards to the superficial roughness of the different areas of restoration, it can be concluded that: minor roughness was detected on C surfaces, while the CD interface had the most superficial roughness, regardless of whether the diamond burs or tungsten carbide burs were used. This study shows some statistical differences that could not be clinically perceivable. The clinical relevance could be resumed as follows: the fine tungsten carbide burs provided less roughness compared to a fine diamond bur. There were no differences between the ultrafine tungsten carbide and diamond burs. The less favourable interface to be finished is CD, compared to the CE interface and C surfaces.

(Int J Esthet Dent 2014;9:70–89)

Introduction

The prevention of secondary decay and the esthetic optimization of composite resin material on surfaces are two aspects of practical interest in restorative dentistry. Both can have a close correlation with the clinical phases of finishing and polishing.

These are procedures that can be considered secondary to the final prognosis of composite restorations, but can actually have a crucial clinical value. From studies, it has been shown that dentists spend 60 to 75% of their time replacing restorations.[1]

The replacement of old restorations is closely tied to the formation of secondary decay.[2,3] Secondary decay can be considered the primary lesions around restorations;[2] the main areas of localization are the areas where there is a greater stagnation of bacterial biofilm, for example the cervical margins of the restorations.[4] The secondary decay can manifest as deep or superficial lesions in proximity to the restoration.[5] The shrinkage of the polymerization implicit in the composite can produce the formation of interface gaps between tooth and restoration[6] and *in vitro* studies have associated the presence of secondary caries lesions with microfissures.[7]

Restorative materials with different surface characteristics than teeth can cause the formation of a biofilm that increases the capacity of bacteria to colonize in the oral cavity.[8,9] Roughness and hard to clean surfaces contribute to the formation of pigmentation, accumulation of plaque, inflammation of the gums, and secondary cavities.[10-13]

The accumulation of this biofilm on dental structures can cause secondary cavities and the mechanical action of brushing produces a disorganization on this biofilm that can prevent or stop the formation of cavities.[14]

According to some studies, it can be concluded that microleakage and surface roughness do not influence the formation of white spot lesions around composite resin restorations, while others found that the presence of microleakage at the adhesive interface did not significantly affect enamel demineralization, reinforcing the lack of evidence that there is an association between microleakage and caries lesions adjacent to the restoration.[1-3,8] However, microleakage could still be considered an etiologic factor for secondary caries,[7] furthermore the bacterial adhesion on the surface of composite resins has been considered an important parameter in the etiology of caries formation around restorations.[16]

Another important aspect is represented by the esthetic appearance of composite restorations, because this is of great interest to both the dentist and patient. Surface roughness influences resistance to staining[17,18] and the natural gloss of the restoration.[19,20]

An elevated quality in finishing and polishing of restorations appears to be highly important not only for the longevity of the treatment, but also for esthetic reasons. This can be obtained with appropriate procedures.

Many finishing instruments are designed to create smooth surfaces on dental fillings. A great variety is commonly used for finishing and polishing, such as the tungsten carbide burs of different toothing size, diamond burs of different grit size, rubber tips, abrasive discs, polishing strips and pastes.

The first decision for an operator, who must finish resin composite light-curable restorations, is which rotating instruments to use: tungsten carbide or diamond bur. These two types of instruments are different mainly because tungsten carbide is a cutting instrument and has geometrically defined blades, whereas the diamond bur is an abrasive instrument, and has geometrically undefined grains (diamond grains). In literature, some authors consider tungsten carbide burs to be better,[21] while others may consider the diamond bur to be better in obtaining minor superficial roughness,[22] while some authors consider the two methods to be interchangeable.[23-25]

Another question that the clinician should ask himself, is: with what cutting capacity should the restoration be finished? In fact, it should not be taken for granted that there are still significant differences in different cutting capacity (for example fine, extrafine or ultrafine) between the two materials, even for those studies that have considered one instrument to be more valid.

Another important consideration when we speak of finishing is which is the most important surface on a clinical level? In fact, frequently superficial roughness is scientifically investigated with different finishing and polishing of the composite surfaces, which from an esthetic point of view, as well as the adhesion of bacterial biofilm, has validity. However, the restoration-tooth interface is the most important aspect to evaluate microleakage and eventual secondary decay that can stem from it. Therefore, the understanding of the level of roughness of the CE interface and CD interface can have clinical importance. Finally it is already known that with different polishing procedures the result obtained an enamel surface is similar to the unpolished enamel26 and this factor once again underlined the role of the finishing and polishing phases.

The null hypothesis are represented by:

- No significant differences on roughness of composite restorations finishing between tungsten carbide and diamond burs.
- No significant differences on roughness between finishing on C surfaces, CE and CD interfaces.

The objective of this *in vitro* study is the analysis of the different roughness obtained on resin composite restorations in class V cavities with different rotating instrument materials, with different grit and on different interfaces. The analysis that is done can be summarized in three fundamental aspects:

- Comparing fine grit or toothing tungsten carbide and diamond burs
- Comparing ultrafine grit or toothing carbide and diamond burs.
- Superficial roughness with all earlier burs and grit/toothing on C surface, CE interface, and CD interface.

The measurements taken with the profilometer are the central surfaces of the restoration in composite and the composite-enamel interface (crown middle third) and composite-dentin (cervical third under the cementoenamel Junction [CEJ]).

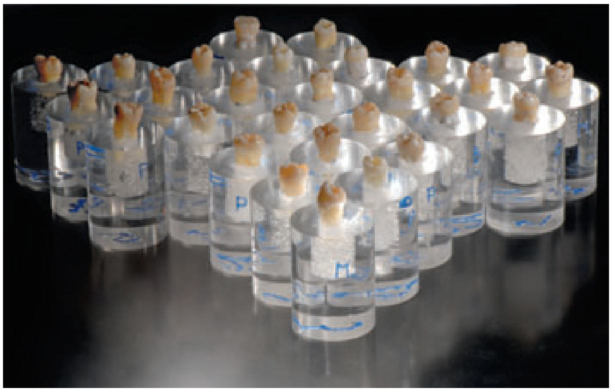


Fig 1 An overview of all specimens prepared for the *in vitro* study.

Fig 2 Specimen ready for the test.

Finishing and polishing protocol

The protocols considered in this study include a sequence of burs (diamond vs tungsten carbide) from fine to ultrafine (analysed in this manuscript: part I) for the finishing phases, then for the polishing phases, a sequence of polishers (from the coarsest to the finest) and a pre-impregnated polishing brush (analysed in part II of this manuscript, to be published in a subsequent issue). All details of manufacturing and codes of burs, number of passages applications on surfaces, number of restorations finished and polished with each single bur are discussed in the materials and methods section.

Materials and methods

Preparation of cavities and composite resin restorations

For this study 28 freshly extracted non-carious human teeth were selected, stored for 15 days in solution saturated with thymol and then in water for the duration of the study. The teeth were mounted on a special positioning device with transparent acrylic resin (Ortho-jet, Lang Dental) embedding the root up to 4.0 mm below the CEJ. All teeth are molars (Figs 1 and 2). Two operators made the cavities, and carried out the restorations and finishing procedures. The specimens were assigned in a random fashion, and each operator then created different cavities. For this study, the 14 buccal cavities will be considered, with respective phases of adhesion, stratification, finishing, and polishing. For each single selected cavity to reduce variability, specimen preparation, as well as finishing and polishing procedures, were carried out by the same operator. All restorations and finishing procedures were carried out with prismatic magnifying loupes systems with 4 x magnification and 300 mm focal distance (Zeiss).

Tooth preparation and restoration

A standardized tooth preparation was applied to all specimens. Class V cavi-

Fig 3 A molar from buccal view before the cavity preparation.

Fig 4 The first phase of cavity preparation with rounded medium grit diamond bur (107 μm).

Fig 5 The second phase of cavity preparation with rounded fine grit diamond bur (46 μm).

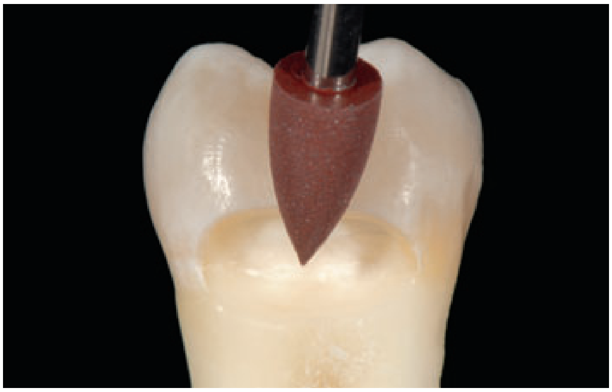


Fig 6 The finishing phase of cavity preparation with rubber polisher.

ties were made on each specimen. The cavity dimensions followed the same parameters and diamond burs mounted on a red ring speed-increasing handpiece, transmission 1:5 with water spray (INTRAcompact 25 LCS, Kavo). The bur used was rounded with a 1.6 mm diameter and drilled down to 107 μm (801 314 016, Komet) (Fig 4) than for the finishing phase of the cavity, a bur with the same shape was used to drill down to 46 μm (8801 314 016, Komet) (Fig 5) the final finishing was done with a polisher (9608 314 030, Komet) (Fig 6). The cavity dimensions are approximately the following: depth 1.6 to 2.0 mm, width 5.0 to 6.0 mm, and 3.0 mm height in the central part and 1.6 mm on the sides. The cervical extension under the CEJ is approximately 1.5 mm to have a composite-dentin margin on which to carry out the procedure (Figs 7 and 8).

Once the cavity preparation was complete, adhesive procedures were carried

Fig 7 A view of final class V cavity prepared for the composite resin restoration.

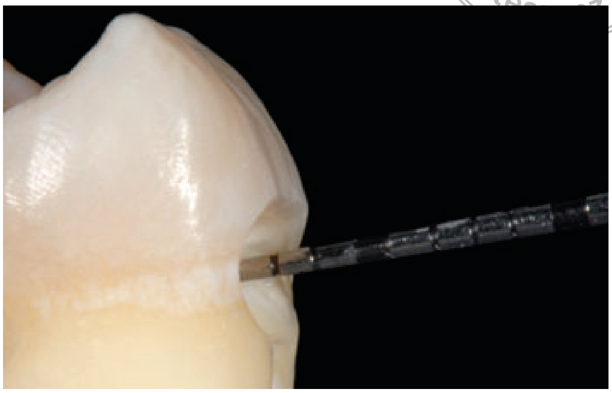


Fig 8 A particular of the cavity before restoration with a probe: all the cavity were codified to standardize the study.

Fig 9 First step of adhesion phases: etching with phosphoric acid at 35%.

Fig 10 After rinsing and drying the etching agent, the area of demineralized enamel is clearly visible. From this image, it is evident that the lower part of the cavity preparation is in dentin.

Fig 11 Before the application of the resin adhesive system, a water solution of chlorhexidine at 0.2% is applied.

Fig 12 The primer (ethanol based) is applied in dentin.

Fig 13 The resin bonding is applied in dentin and enamel.

Fig 14 The bonding agent is gently dried and cured for 30 s.

out in order to complete the composite restoration by etching with phosphoric acid 35% (Ultratech, Ultradent) for 30 s in enamel and 20 s in dentin (Figs 9 and 10). The cavity was rinsed for 60 seconds with a constant spray of water and air, and a chlorexidine galenic digluconate solution at 0.2% was applied on the dentin for 20 s[27] (Fig 11), the liquid was then aspirated slightly without drying the dentinal substratum, in order to avoid the collapse of the collagen fibers. The adhesive system that was used is an etch and rinse in 3 steps (Optibond FL, Kerr), the alcohol-based primer was applied for 60 s (Fig 12) and after drying, a resinous bond was applied on the enamel and dentin (Fig 13), for 30 s and polymerized for 30 s with a halogen light (Optilux 501, Kerr) with a power of 800 mW/cm^2 (Fig 14).

A thin layer of flowable composite (less than 0.5 mm) shade A3 (Tetric Flow, Ivoclar Vivadent) (Fig 15) was then applied at the bottom of the cavity and cured.

Fig 15 A thin layer of flowable composite is applied on the floor cavity.

All cycles of polymerization of composite were carried out in the same fashion: a first ramping cycle for 20 s (10 s from 100 to 400 mW/cm^2 and the last 10 s at 800 mW/cm^2), and a second cycle for 30 s at 800 mW/cm^2.

Finally, two layers of microhybrid nanofilled composite resin were applied, the first to simulate dentin with a thickness of approximately 1 mm A3 Body Filtek Supreme XTE (3M Espe) (Fig 16) and then polymerized as indicated. The second and more superficial layer of composite was applied, with a thickness of approximately 0.5 to 1 mm A3 Enamel Filtek Supreme XTE (3M Espe) (Fig 17). The composites were selected from the same batch number.

Fig 16 The dentin composite resin is layered, leaving a superficial space for enamel composite.

Fig 17 The enamel composite resin is applied to complete the layering phases.

Fig 18 Rebonding phase: the margins of the restoration are sealed with a specific low viscosity resin.

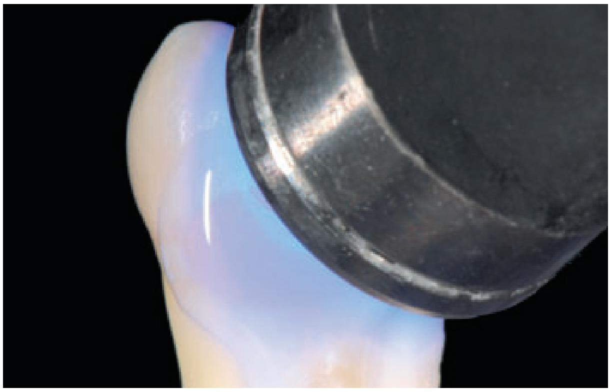


Fig 19 The last polymerization is done with a translucent air-block agent.

To complete the restoration, a sealer was applied to the margins of the composite, to seal any small gaps (Optiguard, Kerr) (Fig 18) that was polymerized for 30 s at 800 mW/cm^2, and to completely convert the superficial composite, a gel air-block was used on the restoration, which was cured for an additional 30 s at 800 mW/cm^2 (Deox, Ultradent) (Fig 19).

Once the procedures for the repair were complete, the specimens were ready for finishing. The specimens to be treated with the tungsten carbide and diamond burs were treated by the same operator who carried out the different phases of the restoration.

Finishing procedures

The finishing procedures relative to this article are divided in 2 different phases: phase 1, fine grit or toothing (Table 1), phase 2, ultrafine grit or toothing (Table 1), both phases 1 and 2 will be distinguished between specimens treat-

Table 1 Details and codes of the rotary intruments used in the finishing phases

Type of Burs	Manufacturer	Order#	Particle size/ number of blades
Phase 1 carbide fine	Komet, Lemgo	H390Q 314 018	16 blades
Phase 1 diamond fine	Komet, Lemgo	8390 314 016	46 micron
Phase 2 carbide ultrafine	Komet, Lemgo	H390 UF 314 018	30 blades
Phase 2 diamond extra/ ultrafine	Komet, Lemgo	390EF 314 016/390UF 314 016	25/8 micron

ed with diamond burs and tungsten carbide burs. Both type of burs were used applying light pressure in a single direction that had been previously traced on the specimen surface. After three specimen applications, the bur was replaced with a new one.

Phases 1 and 2 of finishing were carried out on 14 specimens (7 for each operator) that were assigned randomly at the time of the cavity preparation. The specimens to be treated with tungsten carbide or diamond burs were also randomly assigned. Both were treated using only burs with a friction grip attachment mounted on a red ring hand piece (INTRAcompact 25 LCS, KaVo). The speed is between 80,000 and 100,000 rpm. The burs were applied five times to each surface, with the carbide burs following the rotation of the blades and the handpiece.

Phase 1 was carried out (according to the parameters described above) using a conical rounded tip diamond bur fine grit (46 μm) (8390 314 016, Komet) on seven specimens (Figs 20 to 22) and a tungsten carbide fine toothing bur (16 blades) with a comparable form to that of the diamond – conical rounded tip with special cross cut (H390Q 314 018, Komet) on the other seven specimens (Figs 23 to 25).

The specimens were then analyzed in an anonymous fashion (the operator at the profilometer did not know which burs were used on which specimens) in the center at Komet in Lemgo, using the roughness profilometer (Perthometer S8P 4.51, Mahr Perthen). The roughness of the surface was analyzed by choosing between three different substrates: composite at the center of the restoration (C), composite-enamel (CE) interface and composite-dentin (CD) interface (Fig 26). The results that are obtained are supplied according to different parameters highest peak (Rmax), mean roughness depth (Rz), average roughness (Ra), and the difference between the highest peak and the lowest valley (Rt), all measured in yoctometers (ym). It is decided to use the Rz data that represents the average height difference between the five highest peaks and the five deepest valleys. This is a

Fig 20 The appearance of the roughness surface of a class V composite restoration before the first phase of finishing with tungsten carbide burs.

Fig 21 First phase of carbide finishing: a tungsten carbide fine toothing bur (16 blades), with conical rounded cross cut tip, was applied using light pressure in a single direction for five times.

Fig 22 The appearance of the roughness surface of a class V composite restoration after the first phase of finishing with a fine toothing tungsten carbide bur.

Fig 23 The appearance of the roughness surface of a class V composite restoration before the first phase of finishing with diamond burs.

Fig 24 First phase of diamond finishing: a fine grit diamond bur (46 µm) was applied using light pressure in a single direction for 5 times.

Fig 25 The appearance of the roughness surface of a class V composite restoration after the first phase of finishing with a fine grit diamond bur, the lines leaved from the bur are easily detectable.

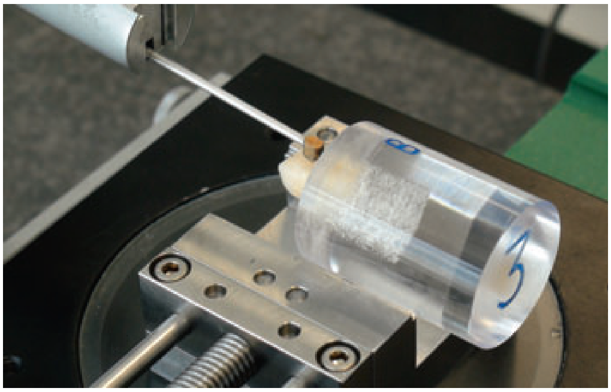


Fig 26 The profilometer in action after the first finishing phase.

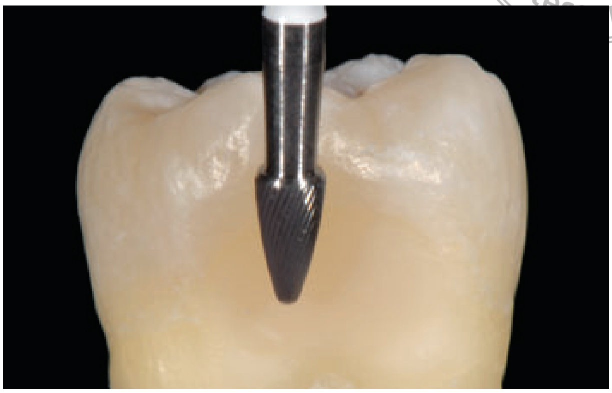


Fig 27 Second phase of carbide finishing: a tungsten carbide ultrafine toothing bur (30 blades) was applied using light pressure in a single direction for 5 times.

Fig 28 The appearance of the roughness surface of a class V composite restoration after the second phase of finishing with an ultrafine toothing tungsten carbide bur.

Fig 29 Second phase, step 1, diamond finishing: an extrafine grit diamond bur (25 μm) was applied five times using light pressure in a single direction.

method suggested for short surfaces. After the survey of surface roughness, the other phase of finishing began.

The second phase was carried out following the same principles with burs with a form comparable to those used in phase 1, using seven specimens already treated with the diamond bur, and finished with extrafine grit (25 μm)(390EF 314 016, Komet) and ultrafine grit (8 μm) (390UF 314 016, Komet) diamond burs with applied five times using light pressure in a single direction (Figs 29 to 32).

The seven specimens already treated with tungsten carbide burs were finished with ultrafine toothing carbide burs (30 blades) (H390 UF 314 018, Komet) and also applied five times using light pressure in a single direction (Figs 27 and 28). The speed was still between 80,000 and 100,000 rpm.

The specimens were then analyzed again with the roughness profilometer using the same criteria as phase 1 (Fig 33).

Fig 30 The appearance of the roughness surface of a class V composite restoration after the second phase, step 1, of finishing with an extrafine grit diamond bur.

Fig 31 Second phase, step 2, diamond finishing: an ultrafine grit diamond bur (8 μm) was applied five times using light pressure in a single direction.

Fig 32 The appearance of the roughness surface of a class V composite restoration after the second phase, step 2, of finishing with an ultrafine grit diamond bur.

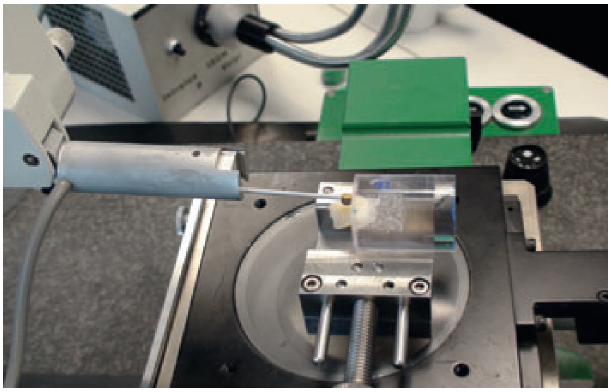


Fig 33 The profilometer in action after the second finishing phase.

Statistical analysis

Descriptive statistics were used to present the sample (mean ± SD); data were expressed in yoctometers. Evaluation of the finishing phases was performed using the c2 test. Data analysis was performed using the software STATA (StataCorp 2007, Stata Statistical Software: Release 10. College Station). An a error of 0.05 was accepted as a statistically significant difference.

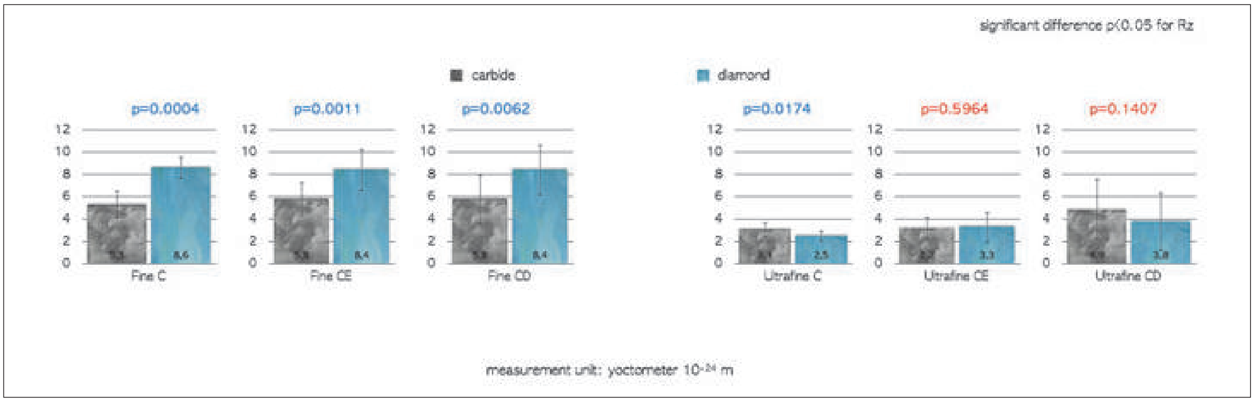
Results

Rotary instruments: fine tungsten carbide vs fine diamond burs

Considering the surface of the nanofilled composite (C) it was discovered that the fine toothing tungsten carbide bur (H390Q 314 018, Komet) left an inferior roughness that can be considered statistically significant ($P < 0.05$) compared to the fine grit diamond bur (8390 314 016, Komet).

Table 2 Mean roughness depth (rz) using fine and ultrafine tungsten carbide and diamond burs on different substrates

	C	CE	CD	C	CE	CD
	Fine/SD	Fine/SD	Fine/SD	Ultrafine/SD	Ultrafine/SD	Ultrafine/SD
c	5.3/1.2	5.8/1.5	5.8/2.2	3.1/0.7	3.2/1	4.9/2.7
d	8.6/1	8.4/1.9	8.4/2.3	2.5/0.5	3.3/1.4	3.8/2.6



Considering the same rotary instruments, the results on the CE and CD interfaces, the fine tungsten carbide bur confirmed an inferior roughness, which was statistically significant compared to the fine grit diamond bur (Table 2).

Rotary instruments: ultrafine tungsten carbide vs ultrafine diamond burs

Considering the surface of the nanofilled composite, it was discovered that the ultrafine toothing tungsten carbide bur (H390 UF 314 018, Komet) left a superior roughness that can be considered statistically significant ($P < 0.05$) compared to the diamond burs (390EF 314 016 / 390UF 314 016, Komet) used in the extrafine and ultrafine grit sequences.

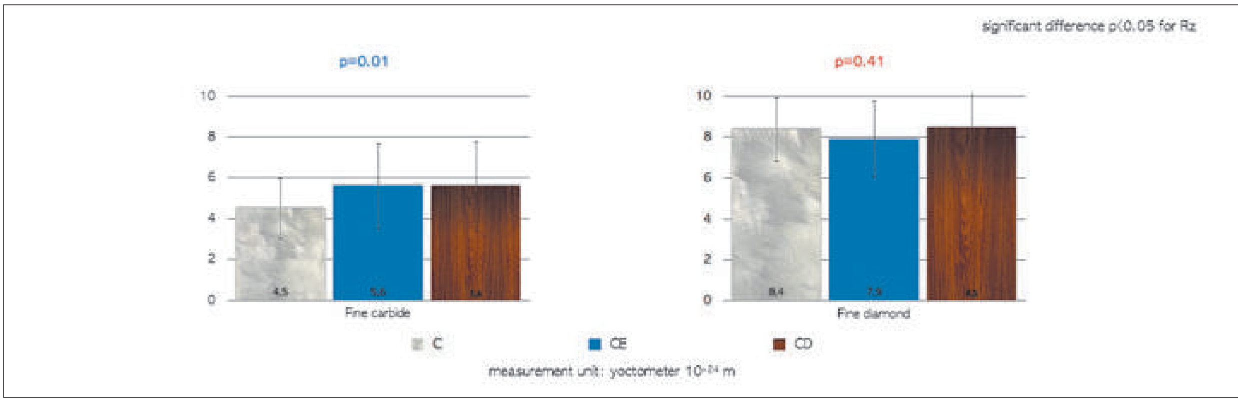
Considering the same rotary instruments, the results on the CE and CD interface, the ultrafine tungsten carbide bur did not show any differences on roughness that were statistically significant, compared to the extrafine and ultrafine grit diamond burs (Table 2).

Surfaces: composite vs composite-enamel junction vs composite-dentin junction

Considering the surface to be finished as the principle variable, it was discovered that with fine tungsten carbide burs there were not statistically significant dif-

Table 3 Mean roughness depth (Rz) on different interfaces using fine tungsten carbide and diamond burs

	Fine c/SD	Fine d/SD
C	4.5/1.5	8.4/1.6
CE	5.6/2.1	7.9/1.9
CD	5.6/2.2	8.5/2.4



ferences between CE and CD interfaces, while the C surface showed inferior roughness.

With fine diamond burs, there were not statistically significant differences on roughness between C, CE and CD (Table 3).

Considering the different surfaces, with ultrafine tungsten carbide and diamond burs, it was discovered that the CD interface had the highest roughness, CE had the intermediate and C had the inferior roughness (Table 4).

Discussion

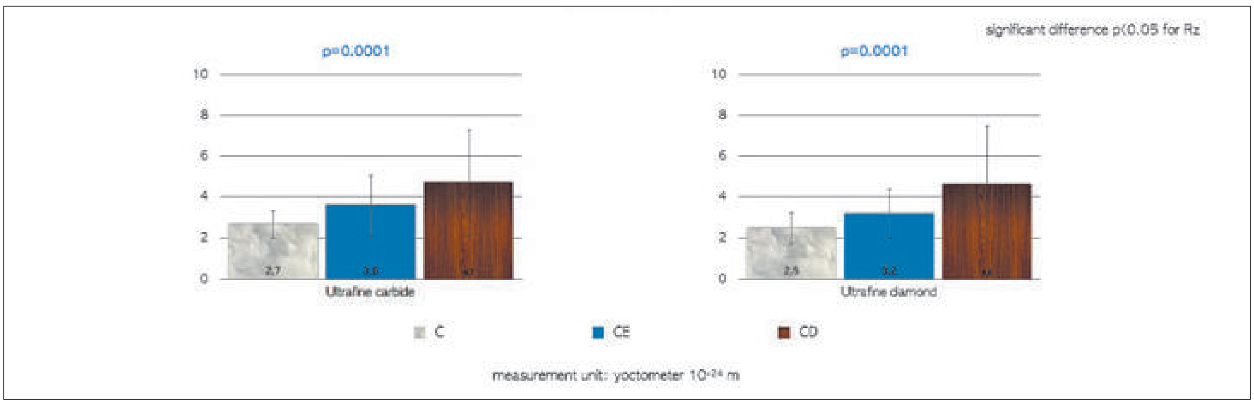
The material used for this study is Filtek Supreme XTE (3M Espe), which is a nanofilled material that makes use of nanotechnology (capable of grouping clustering nanometric particles) also known as nanoclusters, and are also defined as nanoparticles. These types of materials give excellent results with regards to surface roughness.[28]

In vitro scientific studies have shown that various nanofilled materials give an excellent surface quality,[29,30] have low wear[31] and increased wear resistance.[32,33]

The nanofilled materials also possess excellent mechanical properties,[34] a rela-

Table 4 Mean roughness depth (RZ) on different interfaces using ultrafine tungsten carbide and diamond burs

	Ultrafine c/SD	Ultrafine d/SD
C	2.7/0.7	2.5/0.8
CE	3.6/1.5	3.2/1.2
CD	4.7/2.6	4.6/2.9



tively low shrinkage and high strength.[35] Some observations found that even the finest grade diamond finishing bur caused extensive damage to surface areas of enamel, and on composite. It was concluded that composites finished with diamond burs appeared rough and uneven, which was particularly evident with the hybrids because of the mixture of large and small particles.[36]

The choice of different rotary instruments to obtain smoother surfaces, has been investigated in the past, with excellent polishing results in favor of the tungsten carbide burs.[21] On the contrary, other authors have noticed that the carbide tips did not perform at the same level, causing damage to the peripheral margins of the restoration.[22] It can be assumed that the cause is a non-homogeneous performance of the blades of this type of bur.

The unfavorable roughness achieved with the diamond bur has been underlined in the past, but it was considered that the carbide burs left ridges that were more difficult to eliminate later on with the final polishing. Some authors concluded that although the diamond burs gave rougher surfaces, and were not optimal, overall the gouges were not as deep as with the carbide burs and could therefore be more easily polished to a smooth surface.[37]

In past studies driven with scanning electron microscopy, it was observed that diamond burs had a tendency to tear filler particles and leave irregularities on the composite surface.[38] On the contrary, another showed that the hardness of microfill complexes and their weak bond to the organic matrix do not permit the flutes of a carbide bur to cut cleanly.[39]

In this study, the comparison was not made between tungsten carbide and diamond burs with the same colorimetric code (red ring). The reason for this stems from the fact that the carbide burs that were used have a yellow code (with fine grit according to the manufacturer) there is an addition of horizontal notches (blue ring), whose function is to subdivide shavings in many microshavings. According to the manufacturer, removal should be greater on material of hard consistency with respect to the same bur without notches. When magnified, small scrapes can be noticed due to the action of the notches, which can be a drawback with respect to the advantage of greater removal and lesser bur kneading with respect to the version without notches. However, as it has been noticed from data from this study, the grade of finishing is advantageous if compared to the fine grit diamond bur (red ring, 46 µm). Afterwards, the tungsten carbide fine toothing bur with 16 blades with yellow-blue ring was used (like the normal yellow ring that has 16/20 blades) and not the bur with a red ring that generally has 8 to 12 blades. The comparison was done with a fine grit diamond bur (red ring, 46 μm) and for the second phase of the finishing it was decided to use two steps for the diamond (extrafine yellow ring, and ultrafine white ring). For the cutting characteristic of the tungsten carbide bur (yellow-blue ring), it was decided to avoid the step with the extrafine bur in the second phase of finishing (also indicated by the manufacturer) and to proceed with the ultrafine multiblade white ring (30 blades).

A very important variable, other than which type of bur to use (carbide or diamond), is with which cutting capacity of the rotating instrument the finishing is done, also because usually the clinician, according to which grade of surface finishing and modification he would like to make, begins with more aggressive instruments to then move on to finer blades or grit. The results of this study show how fine toothing carbide burs finish the restoration surfaces better in composite than fine grit diamond burs. The study also shows that with ultrafine grit, smoother surfaces are achieved, but that there are not significant differences between carbide and diamond burs.

Another question is with regards to the speed of rotation of the burs during finishing procedures. In the past, it has been observed that carbide burs used at high speed on hybrid composites created a smooth surface,[40] but it is also true that for better control of the rotating instrument, it is advisable to reduce rotation speed. In fact, on natural enamel it has been observed that the diamond bur used at a high speed produced a very rough enamel surface.[26]

The importance of a good finishing on interface restorations is considered by some to be fundamental to prevent secondary decay.[7,16]

Not all studies agree on the correlation between roughness on the interface restoration tooth and the presence of secondary decay.

Regardless, it is common sense to reestablish a smooth surface after a restoration in composite, first and foremost to impede the adhesion of bacteria on the composite and to avoid microinfiltration at the margins of the repair and to obtain a suitable appearance. Some analysis found, at both the enamel and the dentin margins, no statistically significant differences in microleakage across bur types. Further results show that dentin margins leaked significantly more than enamel margins for all bur types.[41]

Based on these observations, even this study indicates that the surface roughness is worse on the CD interface than on the CE interface and therefore the composite surface. This fact is of great importance because it emphasizes how factors that can be considered relevant by the clinician with regards to surface roughness are secondary with regards to the type of tissue on which the restoration terminates.

Conclusions

Within the limitations of this study, the following conclusions can be drawn for clinical purposes, relative to direct restorations in composite:

- Comparing the fine grit and toothing burs, the tungsten carbide had a better capacity of finishing compared to the diamond bur, thereby obtaining surfaces with less surface roughness, both on C surfaces and on the CE and CD interfaces.
- Comparing the ultrafine grit and toothing burs, the diamond bur had a better capacity of finishing than the tungsten carbide bur only on C surfaces, while significant differences were not noted on the CE and CD interfaces.
- Comparing the three surfaces: C, CE, and CD, it was noted that with fine grit diamond burs there were no significant variations, while with fine toothing carbide burs, differences were noted between C compared to CE and CD, which gave equal results. With both the carbide and diamond ultrafine grit burs, there were analogous differences that were statistically significant: C was the smoother surface, followed by the CE interface and finally higher superficial roughness was noted on the CD interface.
- The clinical perception, which does not have scientific validity, notes that with prismatic magnifying 4X, there was a greater roughness on the surfaces finished with the fine grit diamond bur.

Clinical relevance

Considering the measurement units to analyze the roughness with the profilometer and the yoctometer, this study shows some statistical differences that could not be clinically perceivable.

- The null hypothesis that considered that there were no significant differences on the roughness of composite resin restorations finishing between tungsten carbide and diamonds burs can be rejected with regards to the fine burs, because the tungsten carbide burs (Fig 22) showed better finishing compared to the diamond burs (Fig 25).
- Considering the ultrafine burs, the null hypothesis can be accepted that concluded there wouldn't be any clin-

ical differences between the tungsten carbide (Fig 28) and diamond burs (Figs 32).

- The null hypothesis that considered that there would be no significant differences on roughness between finishing on C surface, CE and CD interfaces can be rejected, because from a clinical point of view the CD interface is the most difficult to finish compared to C and CE. Furthermore, the CD interface is usually a critical point for hygiene procedures and for potential secondary caries, and the clinician should pay close attention during the finishing of this area.

Acknowledgements

Many thanks to all those who participated and contributed to the realization of this study. Komet, who in addition to supplying the rotating instruments for the finishing and polishing stages, carried out all the analyses with the profilometer. Thanks to Dr Dario Consonni for the statistical analysis. Thanks to 3M-Espe, Kerr, Ultradent and Ivoclar Vivident for supplying the material to carry out the restorations. Thanks to Drs Raffaele Acunzo, Andrea Camurati, Samuele Chiapparoli, Francesca Manfrini, Roberto Rossi, Giovanni Sammarco, and Ilaria Venuti for their help in locating extracted teeth. Thanks to Mrs Francesca Vasile, Ms Daniela Enriquez and Mr Renato Alcidi, for contributing in various ways to the realization of the samples. Thanks to Dr Domenico Massironi for his advice and teachings. Thanks to Ms Marina Conti and Mr Mauro Ferraris for their support.

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