An investigation of the optical density of composite resin using digital radiography

Avaliação da densidade óptica de resinas compostas por meio de radiografia digital

Wilton Mitsunari TAKESHITA, MDS
Luis Roque de Araujo dos SANTOS, MDS
Post-graduation students – Oral Biopathology Program – Dental Radiology – Dental School of Dentistry of São José dos Campos – UNESP, São Paulo – Brazil

Julio Cezar de Melo CASTILHO, DDS
Professor – Department of Surgery, Periodontology and Radiology **–** Dental School of Dentistry of São José dos Campos – UNESP, São Paulo – Brazil

Edmundo MEDICI FILHO
Luiz Cesar de MORAES
Chair Professor – Department of Surgery, Periodontology and Radiology –
Dental School of Dentistry of São José dos Campos – UNESP, São Paulo – Brazil

Eduardo Kazuo SANNOMIYA, DDS
Professor – Department of Orthodontics of Metodista - UMESP, São Paulo – Brazil

Abstract

The aim of this study was to verify the radiopacity of four microhibridas composed resin: Filmagic – Vigodent, Herculite – Kerr, TPH – Dentsply, W3D – Wilcos in the color A3 and compares them with the dental enamel using direct digital radiography system. Acrylic Plates of 20mm for 30mm had been used, in the thickness 1mm, 2mm and 3mm, contend four cavities which had been filled with resins composed, it was used three human teeth in the same thickness, 36 samples was confected. The specimens were stored at 37 ± 1ºC and immersed in distillate water. The specimens and the human tooth had been radiographed with the Dentsply – Gendex 765DC® from a distance of 40cm and to capture the images, a charge-coupled-device system for digital radiography (Visualix® Dentsply-Gendex) and a software DIGORA® for Windows®. The results submitted to statistical analysis (Tukey´s test a variance analyze ANOVA) showed that there was statistical difference among the optical density of the dental enamel and composite resins, being that the composite resin TPH presented 220,76 (1mm), 239,32 (2mm) e 244,09 (3mm), followed by Herculite 192,87 (1mm), 211,67 (2mm) e 225,16 (3mm); W3D 179,90 (1mm), 205,07 (2mm) e 220,95 (3mm) e Fill Magic 174,59 (1mm), 190,90 (2mm) e 212,01 (3mm) e enamel 113,66 (1mm), 119,97 (2mm) e 143,13 (3mm). The composite resins in the thicknesses studied had presented optical density values higher than enamel so they had been satisfied to be used in dental restorations.

Uniterms

Composite resins, density; radiographic image enchancement

Introduction

The use of composed resins consists a considerable advance in the techniques of dental restoration, it was used acid in 1955 to modify the dental surface and to become it more receptive the adhesion. These materials must have good biocompatibility, adaptation to the edges of the socket, good adhesion to dentine and enamel, resistance to the consuming and the degradation, easy manipulati-

on and the optical density of the material must be higher than the dental structures, so that it is more easy to determine the presence or absence of relapsing caries and adequate cervical adaptation and the proximal contour of the restoration [21,22,23,24]. Of this form the American Dental Association[4] (1989) included the evaluation of the radiopacity as necessary requirement for the restoring materials.

The digital radiography became a reality in the dentistry in 1987, with the system RadioVisiography (Trophy Radiologie, Vincennes, France)[19]. After that several systems appeared, being basically two concepts to get the images: the first one is used a sensor called CCD (charge-couple device), and the other system presents a storage phosphor, like a radiographic film, needing this form, a scanner appropriate for the supply the image [6,15,19].

The purpose of this study is to verify the optical density the composite resins and to compare them in relation the dental structures.

Materials and method

In this research were used six composite resins in the color A3: Fillmagic (Vigodent, Rio de Janeiro, Brazil), Herculite (Kerr, California, United States of America), TPH (Dentsply, Rio de Janeiro, Brazil), W3D (Vita, Zahnfabrik, Germany) and three human teeth higid extracted for periodontal or orthodontic reasons, consumed in the thickness 1mm, 2mm and 3mm.

The samples had been confectioned using acrylic plates (10mm by 30mm) in the thickness 1mm; 2mm e 3mm contend four cavities (5mm), which had been filled with composite resins. The composite resins were inserted in the orifices by means of Thompson spatula #6 and accomodated to prevent the formation of bubbles. The acrylic plates will be interposed by two glass blades to promote homogeneity of the material, according to Martins et al.[18] (2002). It was used the Gnatus Optilight 600 (420mW/cm_) to light curing the samples applying the active tip of the device directly on the samples, involving the surface of the composite resin, for a time of 40s. The composite resin obeys an alphabetical orderly sequence, in accordance with the first letter of the commercial mark (**F**illmagic® → **H**erculite® → **T**PH® → **W**3d®) from the marking made in the acrylic plate. Three acrylic plates had been produced for each thickness, totalizing, of this form nine acrylic plates, as it had four differents composet resins 36 samples was confectioned.

The samples had been stored in pipes of assay and dived in the distilled water 37 ± 1ºC, for 24 hours, with purpose to simulate the buccal environment, according to Vicentini et al.[25] (1996).

After the lighting curing, the acrylic plates and the human teeth had been exposed with a Dentsply–Gendex 765DC® (Milan, Italy) dental x-ray generator at 65 kVp and 7mA, from a distance of 40 cm and exposures 0,02s. To capture the images, we use a system of direct digital x-ray (Visualix® Dentsply-Gendex, Italy), equipped with the sensor charge-couple device – CCD. It was realized for each acrylic plate three radiographys, totalizing 27 radiographys and to analyze the optical density we used a software DIGORA® for Windows®, an area of 400 pixel^2. Three differents areas had been analyzed in each sample, totalizing for each acrylic plate 12 measurements, adding three measurement of the enamel, we have 15 measurements in each one of the 27 radiographs, so in the total we measured 405 times to verify the optical density.

Results

The mean of the optical density values was submitted to statistical analysis; ANOVA (2-way) and Tukey´s test ($p < 0,05$) and allowed to conclude that all resins presented the lowest optical density values with 1mm of thickness, followed by 2mm and 3mm ($p = 0,001$). All the optical density values was higher than the enamel.

For thickness of 1mm and 2mm was found statistical significance, the TPH was different from the others while the W3D and Herculite had not statistical significance and finally the Fill Magic presenting the lowest value of the optical density, however not different from the W3D.

For thickness 3mm was found statistical significance, the TPH was different from the others while the W3D, Herculite and Fill Magic had not statistical significance, however the Fill Magic presented the lower values of optical density.

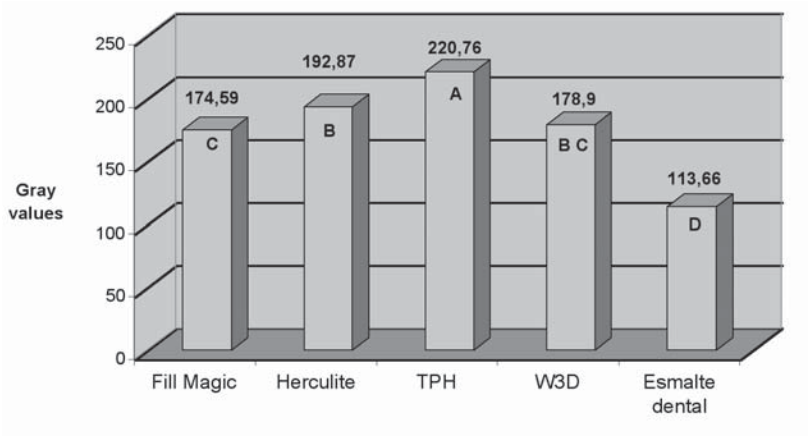

FIGURE 1 - Average values of the optical density of the composite resins in the thickness of 1mm. Average followed of same letter has no statistical signifcance to the level of 5% of significance.

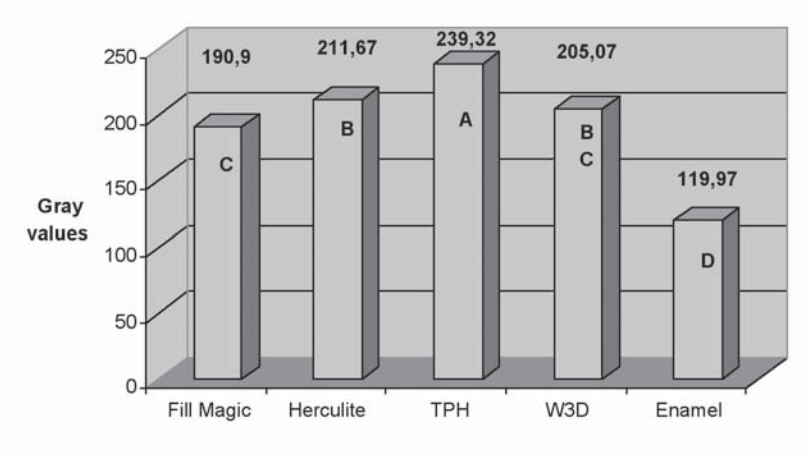

FIGURE 2 - Average values of the optical density of the composite resins in the thickness of 1mm. Average followed of same letter has no statistical signifcance to the level of 5% of significance.

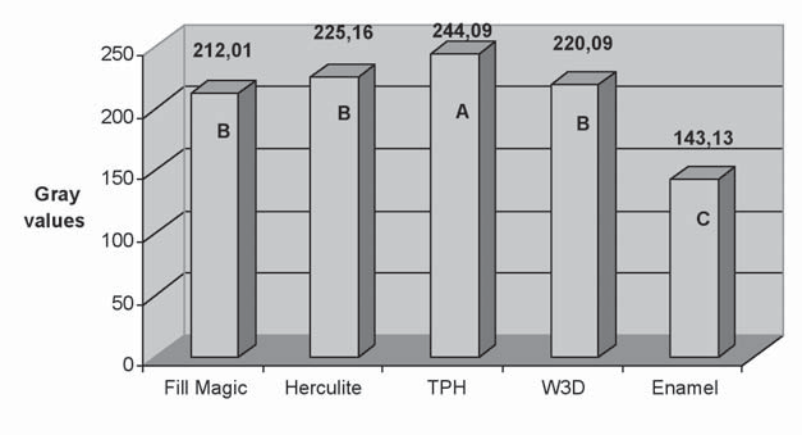

FIGURE 3 - Average values of the optical density of the composite resins in the thickness of 1mm. Average followed of same letter has no statistical signifcance to the level of 5% of significance.

Discussion

The composite resins have the original property to be radiolucents, making it difficult of this form to detect caries and radiolucent lesions injuries, evaluation of the form of the restoration (excess or lack of restoring material), and the imperfections in the restoration[8].

The manufacturers of composite restorative resins incorporated elements with a high atomic number to the inorganic load component of material[2-4,9,16,20]. The incorporated components can be quartz, colloidal silica, glass of fluorsilicato of aluminum, being that the barium is an widely used element to increase the radiodensity of composite resins, therefore present a higher radiopacity than other used elements for this intention as, strontium, zirconium or zinco[25].

Of this form, the optical density of composite restorative materials have been studied by Cook[9] (1981); Costa & Chevitarese[10] (1998) e Loguercio et al.[17] (2001) by means of aluminum stepwedge and a densitometer, where the density of the obtained radiographs were measured with a densitometer using a 1mm aperture and the radiodensity levels determined for enamel and dentin [10, 11,23]. The methodology of this work used a software to determine the optical density of the radiographs provided a maximum number of 256 gray levels from zero through 255[14]. According to Farman et al.[12] (1996) the contrast detection of digital systems, compared to Ektaspeed Plus intraoral radiographic film appears to be clinically acceptable.

The comment of the results gotten in this research allowed us to evaluate that the composed resins showed optical density values statistical significance among itself and higher than the enamel, in the thicknesses of 1mm, 2mm or 3mm, according to Loguercio et al.[17] (2001) that evaluated the radiographic density and found significant differences between composite resins and the enamel, like our research, the highest value of radiopacities found by this autors it was observed in the composite resin TPH.

Although all the tested materials had showed radiopacity values significant differences of the enamel. The requisite radiopacity is uncertain in the minds of some investigators, the others believe that they should be at least as radiopaque as enamel. Curtis et al.[11] (1990), believes that restorative materials that have a high radiodensity, like mettalic restorations (silver amalgam) may interfere with the detection of recurrent dental caries and cervical adaptation in class II. There is a phenomenon that occurs because exists optical illusions, described for Berry[5] (1983) called cervical burnout ima-

ges in the film emulsion and mach band effects in the retinal receptors. They are optical illusions that may appear in the dentin along the proximal dentine-enamel, or in dentinal peaks bounded by occlusal and proximal enamel, and their perception is modified by film and object density.

In relation to the results of the average values of optical density in the different thicknesses studied by our research, the values followed a linear trend, so the more thick more radiopaque. The TPH composite resin in the thickness of 3mm presented the highest value of optical density and enamel in the thickness of 1mm presented the lowest optical density value, like works of Graziottin et al.[14] (2001) e Silveira et al.[22] (2000) that analyzed the thicknesses of 1mm, 2mm, 3mm and 4mm.

The composite resin TPH presented the highest optical density values because their components inorganic have chemical elements with high atomic number, conferring more radiodensity, while the Fill Magic in all the thicknesses studied presented the lowest optical density.

While the research of Akerboom et al.[1] (1993); Bouschlicher et al.[7] (1999); Curtis et al.[11] (1990); Tamburús[23] (1990) e Willems et al.[26] (1991) verified the radiopacity of the composite resins by a stepwedge; Graziottin et al.[14] (2001); Fenyo-Pereira[13] (1998) e Silveira et al.[22] (2000), used digital radiographs system to verify optical density of composite resin. We used this resource because it is convenient. Soon, we believe that it will be the method of election not only for verification of optical density, but also as part of diagnosis.

Conclusion

From the results presented in this research, we concluded that:

- The optical density values of the composites resins studied increased as thickness increased.
- In the thicknesses of 1mm, 2mm and 2mm the composite resin TPH presented the highest optical density values followed by Herculite, W3D and Fill Magic.
- All the composite resins studied had presented optical density values higher than enamel, of this form had been presented satisfactory for the clinical use.

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Resumo

O objetivo desse estudo é verificar a radiopacidade de quatro marcas de resinas compostas microhíbridas: Filmagic – Vigodent, Herculite – Kerr, TPH – Dentsply, W3D – Wilcos na cor A3 e compará-las com o esmalte por meio de radiografia digital direta. Utilizaram-se placas de acrílico de 20mm por 30mm, nas espessuras 1mm, 2mm e 3mm contendo quatro orifícios os quais foram preenchidos com as resinas composta e fotopolimerizadas, como parâmetro utilizamos três dentes humanos desgastados nas mesmas espessuras. Confeccionaram-se 36 corpos de prova mantidos em tubos de ensaio com água destilada a 37 ± 1ºC e juntamente com o dente humano, foram radiografados com o aparelho Dentsply – Gendex 765DC® a uma distância de 40cm e para capturar as imagens, um sistema de radiografia digital direta Visualix® Dentsply-Gendex, com o sensor CCD, para tratamento das imagens utilizou-se o software DIGORA® for Windows®. Os resultados submetidos à análise estatística (teste de Tukey ao nível de 5% de significância a análise de variância ANOVA) mostraram diferenças estatisticamente significantes entre os valores médios de densidade do esmalte e resinas compostas, a resina composta TPH apresentou valores médios de densidade óptica de 220,76 (1mm), 239,32 (2mm) e 244,09 (3mm), seguida pela Herculite 192,87 (1mm), 211,67 (2mm) e 225,16 (3mm); W3D 179,90 (1mm), 205,07 (2mm) e 220,95 (3mm) e Fill Magic 174,59 (1mm), 190,90 (2mm) e 212,01 (3mm) e esmalte 113,66 (1mm), 119,97 (2mm) e 143,13 (3mm). Conclui-se: as resinas compostas nas espessuras estudadas obtiveram valores de densidade óptica superiores a do esmalte, portanto satisfatórias para o uso clínico.

Unitermos

Resinas compostas; densidade; intensificação de imagem radiográfica

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Julio Cezar de Melo Castilho
Departamento de Cirurgia, Periodontia e Radiologia
FOSJC – UNESP.
Av. Francisco José Longo, 777
12245-000 – São José dos Campos – SP
castilho@fosjc.unesp.br
luisroquearaujo@hotmail.com