Radiopacity of anterior and posterior restorative composites

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Purpose: The purpose of this study was to evaluate the difference in radiopacity of anterior and posterior composites.
Materials and Methods: Four composites designed for anterior (Litefil II A and Solare A) or posterior restorations (Litefil II P and Solare P) were evaluated. Two self-polymerizing acrylic resins (Unifast III and Provinice) were used as controls. Radiographs of the specimens were taken together with tooth slices and aluminum step wedges. The density of the specimens was determined with a transmission densitometer and was expressed in terms of the equivalent thickness of aluminum per 2.0 mm unit thickness of the specimen (mm Al/2.0 mm specimen).
Results The radiopacity values of composites ranged from 1.5 to 3.7, whereas the two acrylic resins were radiolucent (less than 0.5).
Conclusion: The radiopacity of composite restorative materials varies considerably, and care must be taken in the selection of materials. **(Int Chin J Dent 2008; 8: 49-52.)**
Key Words: aluminum, composite, densitometer, radiopacity.

Introduction

Dental composites are used as restorations, luting agents, base, core foundation, and in many other applications. Radiopacity is one of the prerequisites for dental materials, especially for composite restorations. Advantages of radiopaque over radiolucent materials include easy detection of secondary dental caries as well as observation of the radiographic interface between the materials and tooth structure.

A number of studies have evaluated the radiopacity of dental composites.[1-8] Abou-Tabl et al.[1] used an aluminum step wedge as a radiographic reference for evaluating the radiopacity of dental materials. Most investigators determined the radiopacity of composite on the basis of ISO 4049 standard.[9] According to the ISO 4049 guidelines, the radiopacity of a radiopaque material should be equal to or greater than that of the same thickness of aluminum.

An increasing number of posterior and anterior composite restorative materials have recently been introduced with improved bonding and handling characteristics. However, only limited information is available about the radiographic properties of currently available composites. This study determined the radiopacity values of anterior and posterior composites, and compared these values with those of unfilled acrylic resins.

Materials and Methods

Four restorative composites and two acrylic resins were assessed. Characteristics of the materials are summarized in Table 1. Step wedges made of 99.99% aluminum (2.0-20.0 mm in thickness, Seico Inc., Hiroshima, Japan) and extracted human molars were employed. This project was approved by the Ethical Committee of the Nihon University School of Dentistry (2007-5).

Composite paste was poured into acrylic molds (10.0 mm in diameter and 2.3 mm in height) and light-cured between two glass plates at 25˚C. Monomer liquid and powder of the MMA resins were mixed and self-polymerized according to the manufacturers' instructions, and 2.3-mm-thick specimens were prepared. After 24 hours, the specimens were ground with #600 silicon-carbide paper to obtain a thickness of 2.0 mm. Extracted human molar teeth were sectioned mesiodistally with a rotary cutting machine, wet-polished, and 2.0-mm-thick specimens were prepared.

Table 1. Materials assessed.

Materials	Manufacturer	Lot	Composition	
Direct composite				
Solare A	GC Corp., Tokyo, Japan	0610131	UDMA, SiO_2	
Solare P	GC Corp.	0609152	UDMA, fluoro-alumino silicate, SiO_2	
Litefil II A	Shofu Inc., Kyoto, Japan	100640	UDMA, TEGDMA, alumino silicate, fused silica	
Litefil II P	Shofu Inc.	110658	UDMA, TEGDMA, alumino silicate, fused silica	
Self-polymerizing acrylic resin				
Unifast III	GC Corp.	0605291	Powder:	PMMA
		0605292	Liquid:	MMA
Provinice	Shofu Inc.	060650	Powder:	MMA-EMA copolymer
		100609	Liquid:	MMA

UDMA, Urethane dimethacrylate; TEGDMA, Triethyleneglycol dimethacrylate;
PMMA, Poly(methyl methacrylate); MMA, Methyl methacrylate; EMA, Ethyl methacrylate

Each specimen was placed together with tooth slices and aluminum step wedges on a radiographic film (Ultra-Speed Dental Film DF-50 Occlusal, Eastman Kodak Co., Rochester, NY, USA). Radiographs were taken with a dental X-ray apparatus (DFW-20, Asahi Roentgen Ind., Kyoto, Japan) for 0.6 s at 60 kVp, 15 mA with a target-film distance of 35 cm. The total filtration on the X-ray beam was 2 mm aluminum. The films were processed in an automatic developing machine (Dent-X 9000, AFP Imaging Co., Elmsford, NY, USA) at 27˚C for 6 minutes. The radiographic density of the films was measured with a transmission densitometer (PDA-15, Konika-Minolta Inc., Tokyo, Japan). The radiopacity values of the specimens were expressed in terms of the equivalent thickness of aluminum per 2.0 mm unit thickness of material. For each condition, the mean value and standard deviation of 10 replications were calculated. The radiopacity values of each group were compared by Mann-Whitney U test with the value for statistical significance set at the P=0.01 level (SPSS software, Version 14.0.J for Windows, SPSS Japan Inc., Tokyo, Japan).

Results

The radiopacity values of the 2.0-mm-thick composite specimens are presented in Table 2. A typical radiograph of the specimens taken together with tooth slices and aluminum step wedges is shown in Fig. 1. Statistical analysis results are also summarized in Table 2. The radiopacity values of composites were 1.5 for Solare A, 3.7 for Solare P, 1.8 for Litefil II A, and 2.2 for Litefil II P. The two acrylic resins were radiolucent, and the radiopacity values were less than 0.5. For each composite, the posterior material was more radiopaque than the anterior material ($P<0.001$). The radiopacity values of human enamel and dentin were approximately 4.3 and 2.3 mm Al/2.0 mm specimen, respectively. Radiopacity values of the Litefil II composites were smaller than that of dentin.

Table 2. Radiopacity values of direct composites (mm Al/2 mm specimen)

Material	Median	Mean	SD	Material	Median	Mean	SD	Z-value	P-value
Solare A	1.5	1.5	0.1	Solare P	3.8	3.7	0.2	-3.883	P<0.001
Litefil II A	1.8	1.8	0.1	Litefil II P	2.2	2.2	0.1	-3.914	P<0.001
Z-value=-3.933 P-value <0.001				Z-value=-3.865 P-value <0.001					

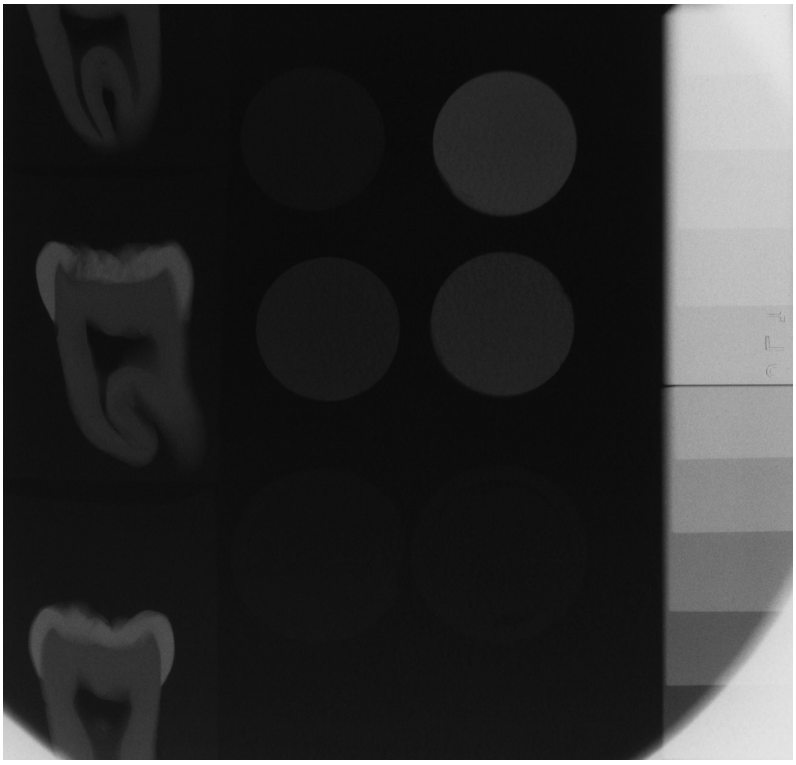

Fig. 1.
A radiograph of Solare A, Solare P (top), Litefil II A, Litefil II P (middle), Unifast III, and Provinice (bottom). Two acrylic resins were radiolucent, and were difficult to detect on the radiograph.

Discussion

Polymeric dental materials can be made radiopaque by incorporation of radiopaque elements into either the filler particles or monomer liquids. Zirconia, silica-zirconia, barium glass, barium sulfate and ytterbium trifluoride are useful for enhancing the radiopacity of dental composites. They are usually added to inorganic fillers before preparation of splintered filler particles. The results of the current study revealed that radiopacity values of the Litefil II composites were not particularly high. This is probably derived from the fact that the amount of radiopaque elements added to the composite was not sufficient. The radiopacity values of the Solare composites also were not high, and the values were smaller than that of enamel. As revealed in the current investigation, the four composite materials showed radiopacity values below that of enamel, and two anterior composites showed radiopacity values below that of dentin. The values may be sufficient to allow detection in some cavity preparations. However, the use of radiolucent materials may lead to an incorrect diagnosis. A radiopacity value equal to or slightly greater than that of enamel is therefore desirable for restorative composites.

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