OPTICAL DENSITY OF DENTAL COMPOSITE MATERIALS IN DIGITAL RADIOGRAPHS

Ingrid Różyło-Kalinowska, Katarzyna Portka, Natalie Namięta, Magdalena Piskórz

Department of Dental and Maxillofacial Radiodiagnostics, Medical University of Lublin

Abstract

Introduction. Blocking a certain amount of an X-ray beam is an important dental composite feature allowing assessing the quality of the filling. Due to that, it is possible to check its integrity to the tooth, reveal an overhanging filling or lack of interproximal points. It is the manufacturer that is responsible for obtaining the right composite density in order to block the exact amount of the X-ray beam by adding some ingredients (e.g. bar, strontium, zinc, yttrium, ytterbium).

Aim. The aim of this paper was to check the degree of optical densities in radiological images of two samples of the same material that were prepared in the laboratory exactly in the same way.

Material and methods. According to PN-EN ISO 4049 principles, two identical samples 1 mm thick and 15 mm wide were made in a shape of a disc within 13 composites manufactured by Arkona. For obtaining radiographs an intraoral X-ray tube Planmeca Intra (with the parameters 70 kV, 8 mA, 0.08 s, distance 36 mm) and a direct radiography system- rvg 5100 Carestream were used for this study. Measurements of optical densities were made using Kodak Dental Imaging Software 6.12.32.0. The optical densities of the materials were compared with a 1 mm and 3 mm metal disc. Four digital radiographs were taken for each material.

Results. All materials examined in the study showed higher optical density than that of 1 mm thick aluminum disc. Only samples of flow materials appeared to have a similar density to the 3 mm disc. A comparison of the density of two identical samples of the same material allowed to make sure, that the X-ray attenuation remains at a similar rate.

Conclusions. The materials described in the paper are easily detected and distinguished in radiographs. Furthermore, they do not appear radiolucent, so they will not be misinterpreted with a caries lesion. Eventually, all the recurrent lesions under those fillings will be easily detectable.

Keywords: radiography, dental restorations, dental materials, dental caries.

Introduction

The Polish word “plomba” frequently used by patients to describe a filling dates back to the 19th century from the French name for lead (Latin Plumbum). In 1802, Luis Laforgue commonly used this material to fill cavities in the posterior teeth, only in anterior teeth he recommended the use of a gold foil. Lead as a dental material, unlike the term itself, is not currently used anymore. Neither patients nor doctors can imagine today's dentistry without composite materials [1]. Those are currently the first-choice materials used for direct restoration of tooth cavities [2]. Composite materials are commonly used both in the aesthetic zone as well as in posterior teeth. The key of a successful treatment with dental composites is the accurate dryness protocol and proper polymerization. Otherwise, the chance of failure is rising, e.g. marginal microleakage, secondary caries, loss of filling and further dissemination of cariogenic bacteria may occur [3]. Particularly, class II cavities (according to Black classification), do require high precision and accuracy in clinical routine. The dentist's challenge is to obtain a perfect adaptation of the material to the tooth and to avoid an overhanging filling. The excess of the material in the interproximal space contributes to food retention, conveying debris and plaque, what inevitably leads to secondary caries and subsequently to periodontal diseases [4]. It is of high importance to detect a microleakage, especially in the case of subgingival fillings of class II, where there is no enamel, and the susceptibility for a secondary caries is really high [5].

The partial inability of X-rays to penetrate the dental fillings is a very important feature that allows a radiological evaluation of the restoration. Due to that, it is possible to check its integrity to the tooth, reveal an overhanging filling or lack of interproximal points. The gradation of material radiopacity seen in radiological images allows to detect secondary caries, which is particularly important in the case of class I and II cavities according to Black [6-9]. The radiopacity of dental materials allows dentists to distinguish the lining, filling, surrounding hard tissues, and allows to reveal of overhanging on and/or exposed edges of the cavity [7].

A perfect dental material, among all its advantages, should have such the above-mentioned feature, as well [10].

It is the manufacturer who is responsible for providing the right composite density in order to attenuate the exact amount of the X-ray beam by adding some ingredients (e.g. bar, strontium, zinc, yttrium, ytterbium). According to the ISO 4049 regulations, if a product is described as a radiopacity in radiographs, its X-ray attenuation should be similar or greater than a layer of aluminum of the same thickness [8].

Aim

The aim of this paper was to check the degree of optical densities in radiological images of two samples of the same material that were prepared in the laboratory exactly in the same way.

Material and methods

Out of thirteen dental composite materials, according to the principles of PN-EN ISO 4049, two identical samples (p1, p2) of 1 mm thick and 15 mm wide were made. Two aluminum discs 1mm (Al-1) and 3 mm (Al-3) were used for the test. Materials used in this study were: blue flow, flow ART OA2, Arkon OA2, Boston OA2, Boston A2, Arkon A2, Flow ART A2, Arkon A3,5, Boston A3,5, Arkon B1, Boston B1, Arkon T. Radiographs were obtained by means of an intraoral X-ray lamp Planmeca Intra

(70 kV, 8 mA, 0,08 s, source-skin distance 36 mm) and a direct digital radiography system – rvg 5100 (Carestream, USA).

Measurements of optical densities were obtained using Kodak Dental Imaging Software 6.12.32.0. Four radiographs were taken for each dental material, by placing two identical samples next to two aluminum discs respectively 1 mm thick (Figure 1) and 3 mm thick (Figure 2) and separately, one composite disc between two wedges (1 mm, 3 mm) for two samples (Figures 3 and 4). All materials were put directly on the detector. The densities of composites were compared with those of metal discs.

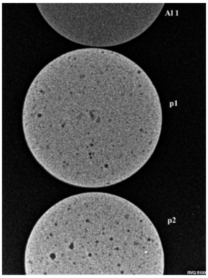

Figure 1. Two identical samples of flow A2 (p1, p2) placed next to the aluminium disc 1 mm thick (Al1)

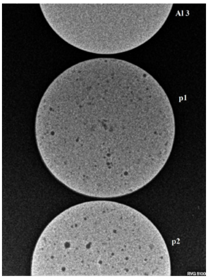

Figure 2. Two identical samples of flow A2 (p1, p2) placed next to the aluminium disc 3 mm thick (Al3)

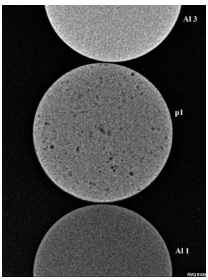

Figure 3. First sample of flow A2 (p1) placed with wedges (Al1, Al3)

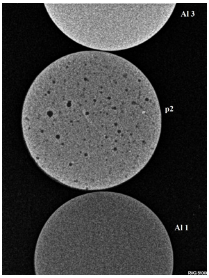

Figure 4. Second sample of flow A2 (p2) placed with wedges (Al1, Al3)

Results

The results of optical densities are presented in the Table 1. In the first series of tests, two discs of the same material were compared with a wedge with a thickness of 1 mm. In that part of study, all materials have demonstrated higher density than aluminum of the same thickness.

Table 1. The results of optical density of composite samples

	FLOW blue	FLOW OA2	Arkon OA2	Boston 0A2	Boston A2	Arkon A2	FLOW A2	Arkon A3.5	Boston A3.5	Arkon B1	Boston B1	Arkon T	Boston T
1 rtg													
Al1	56	75	25	24	33	34	64	31	30	21	27	27	31
p2	117	128	160	144	163	157	110	163	153	140	159	157	164
p1	131	137	167	173	156	160	138	155	164	163	170	146	168
2 rtg													
Al3	89	143	66	79	78	63	125	78	78	74	69	58	73
p2	120	105	157	158	161	139	107	159	162	157	162	159	163
p1	133	143	167	165	157	173	149	159	163	158	152	167	165
3 rtg													
Al1	77	127	58	38	41	42	77	38	39	58	39	38	34
p1	132	128	165	160	161	160	109	164	162	158	166	161	162
Al3	138	141	59	75	81	81	150	78	79	58	77	77	71
4 rtg													
Al1	82	77	32	40	40	50	79	38	40	62	40	32	36
p2	125	105	159	162	162	155	108	166	162	161	164	159	163
Al3	142	153	64	75	75	84	150	78	77	63	68	63	75

The evaluation of two equal composite materials densities demonstrated similar radiopacity compared to that of a 3 mm thick aluminum disc. For flow ART OA2 samples, the measurement of densities were the following: p1- 143, p2-105, Al-143, while flow ART A2 p1-149, p2-107, Al-125. Two discs of the same material showed no significant deviations in measurements, except for flow like materials.

The density measured in X-rays with a sample of material placed between aluminum discs showed that the material has higher radiopacity in every case, except for three flow like materials. In the case of two different samples of the same material, the densities were in the range between measurements obtained for aluminum with a thickness of 1 mm and 3 mm.

Discussion

In today's dentistry a radiopaque dental material should become a golden standard. It is estimated, that annually there are over 500 million fillings made. Furthermore, over half of them are composite fillings [11]. The most commonly used composite materials, depending on the type of filler used, are divided into micro- and nano-hybrid. The amount of the nonorganic part within dental composites varies between 42 and 85%. This affects the features and indications for the use of a given material [12]. Composite flow like materials were first introduced in 1996. Due to the smaller amount of the filler, their consistency is fluid, what makes them easily introduced into the cavity, and their adaptation to the internal walls of the cavity is very good [6].

Along with the new laboratory solutions, the use of composite materials has expanded, e.g. teeth splinting, sealing, temporary filling (including milk teeth), marking root canals, remodeling the occlusal plane and cementing of fiber posts. Regardless of the materials used, it is preferred to use dental composites that are easily detected in radiographs (as they appear radiopaque), since evaluation of a radiographic image supplements the clinical examination. Dental materials that have lower density than dentine may be a source of a diagnostic mistake. The quickest radiological add-on is a digital radiographic system – either indirect or direct one. The measurement, including optical densities, is simpler than when working with analogue images [13].

Conclusions

All materials described in the paper were easily detectable in an X-ray image and distinguishable from aluminum discs. In accordance with ISO 4049 standards, it allows to differentiate those composites from the hard tissues of the tooth. The above-mentioned materials are not radiolucent, thus they will not be misinterpreted with a caries lesion. Eventually, any possible pathology occurring in the surrounding, either underneath or next to a dental composite, can be noticed.

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Corresponding author
Magdalena Piskórz
Department of Dental and Maxillofacial Radiodiagnostics,
Medical University of Lublin
Karmelicka St. 7, 20-081 Lublin
e-mail: mkrzyzanowska86@gmail.com