

Brazilian young dental practitioners' use and acceptance of digital radiographic examinations

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ABSTRACT

Purpose: The aim of this study was to investigate the use and acceptance of digital radiographic examinations by Brazilian dental practitioners in daily practice and to evaluate the advances that have occurred over the past 5 years.

Materials and Methods: Dental practitioners enrolled in extension courses at the Piracicaba Dental School, University of Campinas, Brazil, responded to a self-administered questionnaire in the years 2011 and 2015. They were asked about sociodemographic factors and their knowledge and use of digital radiographic examinations. Descriptive analysis was performed, as well as the chi-square and Fisher exact tests, with a significance level of 5% ($\alpha=0.05$).

Results: A total of 181 participants responded to the questionnaire in the years 2011 and 2015. Most of the respondents worked in private practice, had graduated within the last 5 years, and were between 20 and 30 years old. In 2011, 55.6% of respondents reported having ever used digital radiographic examinations, while in 2015 this number increased significantly to 85.4% ($p<.0001$), out of which 71.4% preferred it to conventional images. Moreover, 21.4% of respondents reported having used digital radiographic examinations for more than 3 years. A significant increase in use of intraoral digital radiography ($p=0.0316$) was observed in 2015. In both years, image quality and high cost were indicated, respectively, as the main advantage and disadvantage of digital radiographic examinations.

Conclusion: This study showed that digital radiology has become more common in Brazil over the past 5 years. Most of the Brazilian dental practitioners evaluated in 2015 used digital radiographic examinations. (*Imaging Sci Dent 2016; 46: 239-44*)

KEY WORDS: Radiography, Digital, Dental; Knowledge; Dentists; General Practice, Dental

Introduction

Radiographic digital imaging has been widely used in medicine, but it was only in the 1980s that the first intraoral digital image receptors were developed for use in dentistry.¹ Recently, digital radiography has become the most modern diagnostic imaging modality in dental practice and, in the near future, it is expected to completely replace conventional radiography.

Scientific studies have demonstrated that digital radiographic imaging is a suitable alternative to improve diag-

nostic accuracy, minimizing the radiation-related risks and optimizing the outcomes for both patients and professionals. This has facilitated the acceptance of this imaging modality over film-based radiography by dental practitioners worldwide.²⁻⁶ In many European countries and the United States, the practice of digital radiology is a reality;^{2,4} however, dental practitioners in Brazil experience relatively less accessibility.

The effectiveness of digital dental radiographic systems has been widely reported,⁷⁻¹⁰ but little is known about their acceptance by Brazilian dentists. Thus, taking into account that Brazil is a developing country and has a large number of dentists,¹¹ the aims of this study were to investigate the use and acceptance of digital radiographic examinations by Brazilian dental practitioners in daily practice and to

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evaluate the advances that have occurred over the past 5 years.

Materials and Methods

This study was designed according to guidelines of the local Institutional Research Ethics Committee and was conducted after receiving approval (#039/2011). A total of 273 dental practitioners were enrolled in specialization and refresher courses in any field of dentistry at the Piracicaba Dental School, University of Campinas (UNICAMP), Sao Paulo, Brazil at the time of the study; more specifically, 181 and 92 dental practitioners were enrolled in the years 2011 and 2015, respectively.

A self-administered questionnaire containing 15 questions that had been validated for reproducibility was used to collect the data for the study. Ten specialists in oral and maxillofacial radiology evaluated the questionnaire to verify that the questions were explicit and relevant. Written consent was obtained after verbal and written explanations about the purpose of the study. Initially, a pilot study was conducted with 20% of the total sample to verify the validity and applicability of the proposed methodology. The questionnaire was then distributed to the respondents by the researchers, who remained present to provide additional explanations if needed. The respondents were asked about sociodemographic factors and their knowledge and use of digital radiographic examinations.

The data were tabulated in a Microsoft Office Excel 2013 (Microsoft Corporation, Redmond, WA, USA) spreadsheet. Statistical analyses were performed using BioEstat software version 5.0 (Ayras Company, Pará, Brazil). After descriptive analysis, the chi-square and Fisher exact tests were used to evaluate the associations among variables, with a significance level of 5% ($\alpha = 0.05$).

Results

Sociodemographic factors

Ninety-nine (54.6%) of the 181 potential participants responded to the questionnaire in the year 2011 and 82 (89.1%) of the 92 potential participants did so in 2015, resulting in 181 respondents (66.3% of the 273) in the final sample. Some respondents did not answer all the questions. In such cases, only the usable responses for each particular question were used to calculate the percentages.

The age range of the respondents was 22 to 48 years (mean, 27.1 ± 4.9) in 2011, and 21 to 60 years (mean, 28.4 ± 7.2) in 2015, and most respondents were from the

state of Sao Paulo (61.6% and 56.1% in 2011 and 2015, respectively). In both years, the plurality of respondents were enrolled in endodontics courses (22.2% in 2011 and 26.8% in 2015), and the majority worked in private practice and had graduated within the last 5 years (Table 1).

Knowledge and use of digital radiographic examinations

Table 2 summarizes the results about the knowledge and use of digital radiographic examinations by dental practitioners in the years 2011 and 2015. In 2011, most dentists had a computer in their workplace (question 1) and did not digitize conventional (film-based) images (question 4), which was not significantly different from the results obtained in 2015 ($p > 0.05$ for both variables). A significant increase ($p = 0.0138$) in computer use to receive the results of imaging exams (question 3) and, among those who did not have a computer in the workplace, a growing interest in computerizing in the next 5 years (question 2) was observed.

Compared to the year 2011, a significantly greater number of dentists made use of digital radiographic examinations in 2015 ($p < 0.0001$). Moreover, the frequency of dental practitioners who had worked with digital radiographic examinations for more than 3 years increased ($p = 0.0411$).

The preference for digital radiographic examinations increased between the years 2011 and 2015, but not to a statistically significant extent ($p > 0.05$). In the data obtained in 2015, only 9 (12.9%) of the dentists who reported having used digital radiographic examinations preferred the conventional method, and 6 (66.7%) of this latter group reported having used digital radiographic examinations for less than a year (information not presented in Table 2).

A significant increase ($p = 0.0316$) in the use of digital intraoral radiography was observed. The number of dental practitioners using e-mail to receive imaging exams of their patients increased, and the number of those who received printed copies decreased, but this difference was still not significant ($p > 0.05$). The majority of dentists did not use specific software applications to assess digital radiographic examinations. An overall increase occurred in the use of digital tools to assist in the interpretation of the images, such as adjustment of brightness and contrast, zooming, and task-specific enhancement tools.

In the opinion of 121 respondents (96.8% of the 125 who reported ever having used digital radiographic examinations in question 6) from both years, digital radiography provides benefits over conventional radiography (question 13), such as better image quality, ease of storage, and

Table 1. Distribution of the sociodemographic data of respondents in the years 2011 and 2015

Variables	2011		2015		P-value [†]
	n	%	n	%	
Gender					
Male	37	37.4	19	23.2	0.0579
Female	62	62.6	63	76.8	
Age, years					
20-30	82	82.8	62	75.6	0.3108
>30	17	17.2	20	24.4	
Time since graduation (years)					
<5	79	79.8	57	69.5	0.1553
≥5	20	20.2	25	30.5	
Specialty					
Oral and maxillofacial radiology	5	5.1	12	14.6	0.1255
Restorative dentistry	6	6.1	4	4.9	
Endodontics	22	22.2	22	26.8	
Prosthodontics	14	14.1	10	12.2	
Implantology	15	15.2	13	15.9	
Periodontics	10	10.1	11	13.4	
Forensic odontology	16	16.2	4	4.9	
Other*	11	11.1	6	7.3	
What type of practice do you work in?					
Public	7	7.1	7	8.5	0.8557
Private	75	75.8	63	76.8	
Both	17	17.2	12	14.6	

*Others: geriatric dentistry (n = 6 in 2015), oral and maxillofacial surgery (n = 5 in 2011) and orthodontics (n = 6 in 2011). [†]Chi-square (χ^2) test.

easier communication with other professionals. In 2011 and 2015, the cost was considered to be high, which was felt to be the main disadvantage or limitation to the use of digital radiographic examinations.

No significant associations ($p > 0.05$) were found between the use of digital radiographic examinations and the following variables: type of practice (public or private), age (20-30 years or older than 30 years) and time since graduation (less than 5 years or 5 years or more), in both the years 2011 and 2015 (Table 3).

Discussion

For this study, dentists from one of the most important dental schools in Brazil responded to a questionnaire consisting of questions regarding dental practitioners' acceptance and use of digital radiographic examinations in the years 2011 and 2015. These respondents were selected because they were professionals who acquired or requested either conventional or digital imaging techniques in their daily practice. In contrast to developed countries, most dental images in Brazil are obtained in specialized radiology clinics and sent to dental offices.

A pilot study was conducted with a questionnaire to verify the validity and applicability of the proposed method-

ology. According to Shelley et al.,¹² conducting a pilot study reduces measurement error due to the possibility of identifying confusing or misleading questions.

The participants in this study were young, with a mean age between 27 and 28 years. Although the majority of the respondents were from the state of Sao Paulo, as expected, since that is where UNICAMP is located, there were representatives from all 5 geographic regions of the country in this study. Statistical analysis showed no significant associations between age and the use of digital radiographic examinations, which is in agreement with data reported in another study.⁶ In a study conducted in 2010 among with general dental practitioners in Flanders, Belgium, the age of dentists was not evaluated because the researchers did not believe it reflected conditions of practice, since some young dentists work with old equipment and vice-versa.¹³

Dental practitioners who have recently graduated were expected to be more familiar with digital radiographic examinations, considering the recent development of digital technology. However, no statistically significant difference was found between the time since graduation and the use of digital radiographic examinations. Conversely, a study performed in Indiana, USA, observed that participants with less than 10 years of professional practice were

Table 2. Frequency of responses to the questions related to the knowledge and use of digital radiographic examinations among Brazilian dental practitioners in the years 2011 and 2015

Variables	2011		2015		P-value
	n	%	n	%	
1. Do you have a computer at work?					
Yes	91	91.9	73	89	0.6828*
No	8	8.1	9	11	
2. If the previous answer is no, are you interested in computerizing in the next 5 years?					
Yes	5	62.5	7	77.8	0.6199 [†]
No	3	37.5	2	22.2	
3. Do you use a computer to receive imaging exams?					
Yes	34	34.3	44	53.7	0.0138*
No	65	65.7	38	46.3	
4. Do you digitize conventional images?					
Yes	39	39.4	24	29.3	0.2505*
No	60	60.6	58	70.7	
5. If the previous answer is yes, when is it indicated? (More than one option can be selected.)					
Storage	30	76.2	17	70.8	0.3354*
Digital enhancement/manipulation	6	15.4	5	20.8	
Ease of sending to specialists/patients	22	56.4	16	66.7	
Other reason	11	28.2	2	8.3	
6. Have you ever used digital radiography, computed tomography or magnetic resonance imaging in dental practice?					
Yes	55	55.6	70	85.4	<0.0001*
No	44	44.4	12	14.6	
If yes, answer questions 7-15.					
7. What kind of image do you prefer?					
Digital	33	60	50	71.4	0.4058*
Conventional	10	18.2	9	12.9	
I have no preference	12	21.8	11	15.7	
8. How long have you used digital radiographic examinations?					
Less than 1 year	26	47.3	28	40	0.0411*
Between 1 and 3 years	26	47.3	27	38.6	
More than 3 years	3	5.5	15	21.4	
9. What digital examinations have you used? (More than one option can be selected.)					
Intraoral radiography	23	41.8	61	87.1	0.0316*
Computed tomography (cone-beam or fan-beam)	31	56.4	42	60	
Extraoral radiography	28	50.9	31	44.3	
Magnetic resonance imaging	8	14.5	6	8.6	
10. How do you receive digital radiographic examinations? (More than one option can be selected)					
Photographic paper (glossy paper)	24	43.6	26	37.1	0.1742*
Radiographic film (transparent film)	31	56.4	42	60	
Internet/e-mail	14	25.5	37	52.9	
CD	27	49.1	37	52.9	
11. Do you use specific viewing software? If so, which? (More than one option can be selected.)					
Dental Slice	12	21.8	12	17.1	0.2760*
Implant Viewer	5	9.1	7	10	
Other	3	5.5	11	15.7	
No	30	54.5	31	44.3	
12. If you use software, which tools do you use?					
Zoom	20	36.4	22	31.4	0.0636*
Contrast	9	16.4	19	27.1	
Brightness	4	7.3	12	17.1	
Inversion	–	–	9	12.9	
Measurement	11	20	17	24.3	
Other	–	–	3	4.3	
None	24	43.6	16	22.9	
13. Do you think that digital radiographic examinations are more advantageous than conventional radiographic examinations?					
Yes	53	96.4	68	97.1	1.000 [†]
No	2	3.6	2	2.9	

Table 2. Continued

Variables	2011		2015		P-value
	n	%	n	%	
14. If the previous answer is yes, what are the benefits? (More than one option can be selected.)					
Ease of image storage	41	74.5	52	74.3	0.9111*
Easy communication with other professionals	32	58.2	54	77.1	
Easy communication with patients	21	38.2	33	47.1	
Possibility of using digital tools	27	49.1	40	57.1	
Better image quality	45	81.8	55	78.6	
Help in treatment planning	31	56.4	37	52.9	
Others	1	1.8	2	2.9	
15. In your opinion, what are the disadvantages of using digital radiographic examinations?					
High cost	29	52.7	40	57.1	0.0433*
Need of additional equipment	8	14.5	29	41.4	
Difficulty in interpreting	1	1.8	2	2.9	
No disadvantage	20	36.4	16	22.9	
Other	6	10.9	5	7.1	

*Chi-square (χ^2) test. †Fisher exact test.

Table 3. Relationships of type of practice, age (in years) and time since graduation (years) with the use of digital radiographic examinations in the years 2011 and 2015

Year/Use of digital radiographic examinations	Type of practice				P-value	Age, years				P-value	Time since graduation, years				P-value
	Public		Private			20-30		>30			<5		≥5		
	n	%	n	%		n	%	n	%		n	%	n	%	
2011															
Yes	4	57.1	40	53.3	1.000†	47	56.6	8	47.1	0.6492*	38	55.1	17	56.7	
No	3	42.9	35	46.7		36	43.4	9	52.9		31	44.9	13	43.3	
Total	7	100	75	100		83	100	17	100		69	100	30	100	0.9415*
2015															
Yes	6	85.7	55	87.3	0.9595†	52	83.9	18	90	0.7209†	47	82.5	23	92	
No	1	14.3	8	12.7		10	16.1	2	10		10	17.5	2	8	
Total	7	100	63	100		62	100	20	100		57	100	25	100	0.3284†

*Chi-square (χ^2) test. †Fisher exact test.

proportionately the smallest group using digital radiographic examinations.⁴

Despite the large number of computerized dental offices, only 34.3% of dentists reported using a computer to receive imaging exams in 2011, but this number increased considerably to 53.7% in 2015. Importantly, most of the respondents reported a great interest in computerizing their offices in the future. This makes it evident that only a minority will probably not have access to digital radiographic examinations in the near future, which favors the transition process. According to a study conducted by Wenzel and Møystad,⁵ dental practitioners who made use of digital radiography had more computers in their offices, and a quarter of those who did not use digital radiographic examinations did not have computers in their work environment. Brian and Williamson⁴ showed that 36.7% of

non-users of digital radiographic examinations planned to make it part of their clinical routine within 5 years, which is similar to the results of this study. In a study conducted by Dölekoğlu et al.,⁶ 67% of respondents reported using of digital radiographic examinations.

Film-digitized radiography was mostly used for archiving and/or sharing with other professionals. This confirms a growing trend in digital image use and also confirms the advantages cited by Wenzel and Møystad¹⁴ in relation to the ease of communication between practitioners and patients, as well as data archiving and retrieval.

In the years 2011 and 2015, 55.6% and 85.4% of the respondents, respectively, reported making use of some form of digital imaging, with intraoral radiography and computed tomography being the most cited forms. In a study conducted in Norway in the beginning of the year 2000, only

14% of the respondents reported using digital radiography,⁵ while in Indiana, USA, this number reached 19.7% in 2007⁴ and, in Turkey, 67% in 2011.⁶ This sequence of studies done between 2001 and 2011 confirms the important growing trend of acceptance of digital radiology.

In 2015, 71.4% of the respondents indicated that they preferred digital images. Out of those who preferred conventional images, 66.7% had been using digital radiographic examinations for less than a year, which may reflect their lack of knowledge of the benefits of digital radiographic examinations. This suggests that continuing education in dentomaxillofacial radiology is essential, since greater acceptance is expected from those who are more aware of the advantages of digital over conventional radiology.

Most of the respondents in the present study recognized the advantages of digital radiographic examinations, such as image quality, ease of storage, and easier communication between professionals. Image quality and ease of storage were also among the most frequently cited advantages in other studies.^{5,6} In the study of Brian and Williamson,⁴ the most-cited benefits were saving time (87%) and the elimination of processing-related problems (77%). Additionally, Dölekoğlu et al.⁶ found radiation dose reduction (79%) to be a major reason for using digital radiographic examinations. The present study also revealed that the main limitations to the use of the digital technology were related to its high cost, which is in agreement with the findings of previous studies.^{2,4-6,15}

In conclusion, most of the Brazilian dental practitioners who participated in this study made use of digital radiographic examinations. Moreover, the use of digital radiology has increased in Brazil over the past 5 years.

References

1. Brennan J. An introduction to digital radiography in dentistry. *J Orthod* 2002; 29: 66-9.
2. Berkhout WE, Sanderink GC, Van der Stelt PF. A comparison of digital and film radiography in Dutch dental practices assessed by questionnaire. *Dentomaxillofac Radiol* 2002; 31: 93-9.
3. Wenzel A. A review of dentists' use of digital radiography and caries diagnosis with digital systems. *Dentomaxillofac Radiol* 2006; 35: 307-14.
4. Brian JN, Williamson GF. Digital radiography in dentistry: a survey of Indiana dentists. *Dentomaxillofac Radiol* 2007; 36: 18-23.
5. Wenzel A, Møystad A. Decision criteria and characteristics of Norwegian general dental practitioners selecting digital radiography. *Dentomaxillofac Radiol* 2001; 30: 197-202.
6. Dölekoğlu S, Fişekçioğlu E, İlgüy M, İlgüy D. The usage of digital radiography and cone beam computed tomography among Turkish dentists. *Dentomaxillofac Radiol* 2011; 40: 379-84.
7. Wenzel A, Grondahl HG. Direct digital radiography in the dental office. *Int Dent J* 1995; 45: 27-34.
8. Wenzel A. Digital radiography and caries diagnosis. *Dentomaxillofac Radiol* 1998; 27: 3-11.
9. Wenzel A. Matters to consider when implementing direct digital radiography in the dental office. *Int J Comput Dent* 1999; 2: 269-90.
10. van der Stelt PF. Filmless imaging: the uses of digital radiography in dental practice. *J Am Dent Assoc* 2005; 136: 1379-87.
11. Saliba NA, Moimaz SA, Garbin CA, Diniz DG. Dentistry in Brazil: its history and current trends. *J Dent Educ* 2009; 73: 225-31.
12. Shelley AM, Brunton P, Horner K. Questionnaire surveys of dentists on radiology. *Dentomaxillofac Radiol* 2012; 41: 267-75.
13. Aps JK. Flemish general dental practitioners' knowledge of dental radiology. *Dentomaxillofac Radiol* 2010; 39: 113-8.
14. Wenzel A, Møystad A. Work flow with digital intraoral radiography: a systematic review. *Acta Odontol Scand* 2010; 68: 106-14.
15. Davies C, Grange S, Trevor MM. Radiation protection practices and related continuing professional education in dental radiography: a survey of practitioners in the North-east of England. *Radiography* 2005; 11: 255-61.