Digital Radiography: A Survey of Pediatric Dentists

Julie M. Russo, DMD James A. Russo, BS, MS Marcio Guelmann, DDS

ABSTRACT

Purpose: The purpose of this study was to: (1) determine the popularity of digital radiography among members of the American Academy of Pediatric Dentistry (AAPD); and (2) report the most common systems in use.

Methods: An AAPD-approved, voluntary, and anonymous electronic survey was developed and sent to 923 board certified pediatric dentists. Years in practice and in-office x-ray technology (digital or conventional) were inquired about initially. If negative for the use of digital radiography, future consideration for converting to digital radiography was ascertained. For positive responses, more in-depth information was requested. Information on type of system (sensor or phosphor plate), user friendliness, diagnostic ability, patient's comfort, general costs, durability, and parental and overall satisfaction was collected. For most of the questions, a 5-point assessment scale was used. Opportunity for additional comments was provided upon survey completion. Data was analyzed using descriptive statistics.

Results: A 32% (296/923) response rate was obtained. Twenty-six percent of practitioners (78/296) implemented digital radiography in their practices, whereas 71% considered future acquisition. Similar distribution for sensor and phosphor plate users was found. Sensor technology was reported to produce faster images, but was less tolerable by young children due to size and thickness. Phosphor plates were considered more children friendly, less expensive, and less durable. Parental satisfaction was very high with great marketing value. Picture quality was comparable to conventional film. Overall, digital radiography users would recommend it to other pediatric dentists.

Conclusions: Digital radiography is not yet popular among pediatric dentists. Cost reduction and technology advancement may enhance utilization. (J Dent Child 2006;73:132-135)

KEYWORDS: DIGITAL RADIOGRAPHY, SURVEY, PEDIATRIC DENTISTS

Conventional film-based radiography has been routinely used in dentistry for diagnostic purposes for several decades. With the increasing incorporation of technology into the dental office, however, more practitioners are replacing their conventional systems with digital radiography.

Currently, digital radiography can be divided into 2 groups, depending on the sensor used during image capturing: (1) direct digital systems; and (2) indirect digital systems.

Silicon devices, such as charged coupled devices (CCD) or complementary metal oxide semiconductors (CMOS), are considered direct digital units.[1] See Table 1 for list of products and manufacturers. With CCD or CMOS digital xrays, the sensitive crystals contained in the film emulsion are replaced with electronic sensors called pixels, which are capable of detecting and recording the amount of x-ray photons received. Once the sensor is exposed to x-ray energy, the individual pixels record the level of energy. This data is then transferred to a computer, allowing it to be displayed on the screen.[2]

The second sensor available in digital radiography is called photostimulable phosphor plates (PSP) or storage phosphor plates (SPP). See Table 1 for list of products and manufacturers. The PSP system is an indirect digital radiography technique where photostimulable phosphor plates are used to temporarily store the radiographic image, which is then read by a scanning device and digitized for display on the computer screen. With this system, the

Dr. J.M. Russo is resident, and Dr. Guelmann is associate professor and chair, Department of Pediatric Dentistry, University of Florida, Gainesville, Fla; Mr. J.A. Russo is computer engineer, Gainesville, Fla.
Correspond with Dr. Guelmann at mguelmann@dental.ufl.edu

Table 1. Digital System Manufacturer Information		
Product	**Manufacturer**	**Manufacturer Location**
Direct digital system		
Gendex-Visualix	Dentsply Gendex	Des Plaines, Ill
Sidexis	Sirona	Charlotte, NC
Schick CDR	Schick Technologies	Long Island City, NY
Dexis Deluxe	Dexis	Roswell, Ga
Dixi	Planmeca	Roseile, Ill
Vistaray	Durr	Bietigheim-Bissingen, Germany
DynaRay	Dynamic Dental Systems	Gainesville, Ga
Indirect digital system		
DentOptix	Dentsply Gendex	Des Plaines, Ill
Digora OpTime	Soredex	Milwuakee, Wisc
ScanX	Air Techniques	Hicksville, NY
Digident	Orex	Auburodale, Mass

image is not immediately available on the computer due to the processing step involved. The phosphor plates are reusable and must be erased before each use by exposing them to white light.[2]

Currently, there is no research indicating the use of digital radiography systems in pediatric dental practices. Therefore, the purpose of this study was to determine the popularity of digital radiography among pediatric dentists in the United States and to select the most common digital radiography system in use in pediatric practices.

METHODS

After obtaining approval from both the American Academy of Pediatric Dentistry (AAPD) and the Review Board of the University of Florida, Gainesville, an electronic survey regarding the use of digital radiography in pediatric dentistry was sent to 923 board certified AAPD members. An invitation cover letter explaining the study, with a link for online completion of the survey, was e-mailed to each subject. Participation was voluntary and confidential. An e-mail reminding survey completion was sent a month after the original message. The survey consisted of 19 multiple choice questions, which included the number of years the subject had been in practice, type of practice (solo, group, etc), and the x-ray technology in use (conventional or digital). In case of a negative response for the use of digital technology, future purchase consideration of digital radiography was asked. If "no" was selected, a few questions explaining that decision were to be completed.

For those who implemented digital radiography in their practices, more in-depth information was requested, such as the type of system in use, user friendliness, ease of preparation/placement, patients' comfort, ease of processing, diagnostic ability, total cost, cost for monthly maintenance, number of exposures, amount of damage, causes of damage to sensor or phosphor plate, patient/parent satisfaction, and overall satisfaction. For the majority of questions, a 5-point assessment scale was used: (1) being very satisfied/very easy to use; (2) satisfied/easy; (3) neutral; (4) unsatisfied/difficult; and (5) very unsatisfied/very difficult. At the end of the survey, space was left for any comments participants wanted to add regarding the use of digital radiography in pediatric dentistry. After completion of the study, percentage analyses were used to report the data collected.

Table 2. Reasons for Nonutilization of Digital Radiography	
Cost	36%
Need more information	23%
Close to retirement	20%
Associateship	11%
University practice	7%
Training involved	3%

RESULTS

Of the 923 e-mailed surveys, 296 responses were obtained (32%). Seventy-four percent of subjects were strictly using conventional film, 13% were only using digital, and 13% were using both film and digital. Overall, 26% of practitioners have incorporated digital radiography into their practices in some way. Utilization of digital radiography based on years of experience is displayed in Figure 1. For the types of practices that have incorporated digital radiography, group practices are the most prevalent (27%), followed by solo practitioners (24%). For pediatric dentists using film, 71% said that they would consider buying digital radiography units in the future. Reasons for nonutilization are explained in Table 2.

For digital radiography users, very similar utilization was found for CCD/CMOS sensors (51%) and for those using PSP systems (49%). In addition, 46% of digital radiography users had also incorporated digital panoramic machines in their practices.

Overall, most subjects using CCD/CMOS sensors were "satisfied" or "very satisfied" (82%) with their equipment and 52% of parents/patients were "very satisfied." Also, 46% of CCD/CMOS users rated user friendliness as being "very easy." Ease of preparation, placement, and comfort to the child was rated as "easy/comfortable" by 33% of the practitioners, whereas 20% rated it as "difficult." Quickness of image display was rated as being "very fast" (52%). Forty-six percent of practitioners rated CCD/CMOS sensors as being equal to film (39% rated it better, 16% worse).

The majority of subjects said that CCD/CMOS units are "expensive" (61%) or "very expensive" (21%), and the cost per month on average is approximately $100 to $200. Most

sensors were able to survive well over 200 image captures (59%), however, 66% of sensors had to be replaced at some point due to them being defective (22%), the wire being damaged (22%), or from patient biting (16%). Seventy-five percent of the subjects using CCD/CMOS sensors would purchase their machine again, and 81% would recommend it to other pediatric dentists.

For subjects using PSP, 77% were "satisfied" or "very satisfied" with their machine and parents/patients were "very satisfied" (58%). Also, the majority of PSP users rated user friendliness as being easy. Ease of preparation, placement, and comfort to the child was rated as "easy/comfortable" by 58% of the practitioners. Ease of image processing and quickness of display was rated as being "easy/quick" (49%). Forty-two percent of practitioners rated PSP systems as being "better than film" (33% rated it equal, 26% worse). The majority of subjects said that PSP units are expensive (63%), and the cost per month on average is approximately $100 to $200. Most PSP plates were able to capture 100 to 150 images (31%), however, more than 50% of phosphor plates have to be replaced yearly due to damage (patient biting, damage to the sensor wire.). Eighty-six percent of the subjects using PSP units would purchase their machine again, and 91% would recommend it to other pediatric dentists.

DISCUSSION

Digital imaging was first introduced in France in 1984, and was introduced into the dental literature in the United States in 1989.[3] It is estimated that 10% to 20% of dental practitioners are currently using digital imaging, and it is anticipated that these percentages will steadily increase.[4] Seventy-four percent of the board certified pediatric dentists who participated in the study were currently using conventional film, whereas 26% had incorporated digital radiography into their practices in some way. Since this survey was distributed electronically, however, the subjects who responded may be more inclined to use modern technology compared to those who did not respond to the e-mail. There were no significant differences in the number of years in practice or the practice type and percentage of digital radiography use (Figure 1).

Sensors, such as CCD or CMOS, are considered direct digital units. Fifty-one percent of pediatric dentists who use digital radiography are using systems with a sensor (CCD/CMOS). Some advantages of direct digital radiography over film include instant image production, radiation reduction, elimination of processing chemicals, and image enhancement capabilities. Also, direct digital radiography can be used as educational tools for both patients and parents.[5] Most subjects said they were satisfied with their direct digital units, and 75% would purchase them again. Disadvantages include decreased resolution, higher costs, and unknown sensor lifetime. Sixty-six percent of subjects said they had to replace sensors, which can each cost a few thousand dollars. The main reasons for replacement are defective sensors and damage to the sensor wire due to patient biting. The life of

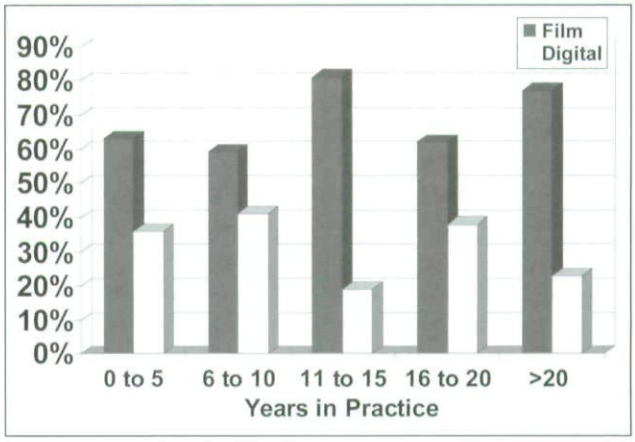

Figure 1. Utilization of digital radiography based on years in practice.

a sensor, however, is much longer then that for phosphor plates, well exceeding over 200 exposures. The major disadvantage of direct digital radiography is the rigidity and thickness of the sensors, which can be quite uncomfortable for patients, especially children.[5]

Phosphor plate systems (PSP) are considered indirect digital units. Forty-nine percent of pediatric dentists who use digital radiography are using systems with phosphor plates (PSP). A major advantage of the PSP system is the ease and comfort of placement in patient's mouths, especially children. The phosphor plates are just as flexible, if not more flexible, than conventional film. Other advantages include radiation reduction, image enhancement capabilities, lower costs compared to direct digital, and patient education. Most subjects said that they were satisfied with their indirect digital units, and 86% would purchase one again. One disadvantage, however, is the time required (approximately 20 seconds for newer units) for the phosphor plates to be scanned before they appear on the computer screen. Nevertheless, this time is still greatly reduced compared to film.[6] Also, plates have an average life of 100 to 150 exposures and can be easily damaged by bite marks or bends, which can create permanent artifacts on subsequent images taken with the same plate. Numerous plates will be needed for a busy practice. The cost per phosphor plates, however, ranges from about $20 for a size 2 film, so the cost for replacement is much less than that of a sensor.

Overall, for those subjects currently using film, 71% would consider buying digital radiography systems in the future. For the subjects who were not satisfied with their digital radiography unit, only 33% would consider going back to film. This shows that digital radiography is possibly the wave of the future. At this time, the authors are unable to conclude which type of digital unit is most popular for use in pediatric dentistry. Both CCD/CMOS and PSP systems have high satisfaction rates. Nonetheless, for those pediatric dentists using CCD/CMOS sensors, 81% would recommend them to other pediatric dentists, whereas 91% of PSP users would recommend their digital units to their colleagues.

CONCLUSIONS

Digital radiography is not yet popular among pediatric dentists. Among the ones using it, no special preference for one system or the other was noted. Nevertheless, digital radiography seems to be promising and should improve over time as cost reduction and technology advancement are enhanced.

REFERENCES

1. 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;31:93-99.
2. Parks ET, Williamson GF. Digital radiography: An overview. J Contemp Dent Pract 2002;3:23-39.
3. Mouyen M, Benz C, Sonnabend E, Lodter JP. Presentations and physical evaluation of radiovisiography. Oral Surg Oral Med Oral Pathol 1989;68:238-242.
4. Van der Stelt, PF. Research utilizing dental electronic record. Joint symposium of the IADR, AADR, and ADEA. San Diego, Calif. March 6, 2002.
5. Paurazas SB, Geist JR, Pink FE, Hoen, MM, Steiman, HR. Comparison of diagnostic accuracy of digital imaging using CCD and CMOS-APS sensors with E-speed film, in the detection of periapical bony lesions. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2000;89:356-362.
6. Brennan J. An introduction to digital radiography in dentistry. J Orthod 2002;29:66-69.