SHORT COMMUNICATION

Patient discomfort in bitewing examination with film and four digital receptors

PM Jørgensen* and A Wenzel

Oral Radiology, Department of Dentistry, Aarhus University, Denmark

The aim was to compare patient discomfort during bitewing examination using five intra-oral receptors: a conventional film, a storage phosphor plate with a new soft cover, an already manufactured and sold sensor with a wire and two square and two rounded corners, a new version of a previously developed sensor with a wire and four square corners, and a newly developed sensor with a wire and four rounded corners. 60 patients participated in the study. The five receptors [a Kodak paper pack film (Eastman Kodak Company, Rochester, NY), a DIGORA® Optime phosphor plate (Soredex, Tuusula, Finland), and SuniRay (Suni Medical Imaging, Inc., San Jose, CA), DIGORA Toto (Soredex) and Snapshot (Instrumentarium Dental, Tuusula, Finland) complementary metal-oxide-semiconductors] with differences in ergonomic shape were placed in the mouth for a bitewing examination for approximately 10 s. The patients rated their discomfort on a 100 mm visual analogue scale after having had each receptor positioned. There was no significant difference in patient discomfort score between the conventional film and the Snapshot sensor ($p > 0.05$). Both conventional film and Snapshot were significantly less uncomfortable than the other receptors ($p < 0.05$). No significant difference was seen between the storage phosphor plate and the SuniRay sensor ($p > 0.05$). The storage phosphor plate was significantly less uncomfortable than the DIGORA Toto sensor ($p < 0.05$). There was no significant difference in the perception of discomfort between the conventional film and an ergonomically shaped wired sensor with rounded corners.

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Introduction

It has been shown in previous studies that intra-oral radiographic images obtained with a wired sensor contained more errors than those taken with a storage phosphor plate or a film.^{1–5} This was mainly owing to the thicker sensor, which was more uncomfortable for the patient. If the patient had difficulties in tolerating the receptor in his or her mouth, positioning errors may have occurred, leading to a poorer image quality.

Few studies have dealt with patient discomfort during intra-oral radiographic examination. A previous study on discomfort in connection with bite-wing examination showed that two storage phosphor plates [DenOptix QST (Gendex, Hatfield, PA) and

DIGORA® Optime (Soredex, Tuusula, Finland)] were significantly less uncomfortable for the patient than two charge-couple device (CCD) sensors with a wire, of which the latter was a thick sensor (11 mm) with a stiff wire.² A recent study on discomfort in connection with intra-oral radiographic examination of the lower third molar region showed that conventional film was significantly less uncomfortable than five digital intra-oral receptors.³ The thickest sensor with a wire was significantly more uncomfortable than two storage phosphor plates, while the thinnest sensor (SuniRay; Suni Medical Imaging, Inc., San Jose, CA, 3.5 mm thickness) was the least uncomfortable of the sensors.³

All of the receptors evaluated previously had square corners, and today new complementary metal-oxide-semiconductor (CMOS) sensors have been developed, some of which are shaped with round corners and less stiff wires. This should in theory be more comfortable

*Correspondence to: Dr Pernille Mørup Jørgensen, Oral Radiology, Department of Dentistry, Aarhus University, Vennelyst Boulevard 9, 8000 Aarhus, Denmark. Email: pernillemjoergensen@hotmail.com

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for the patient when the sensor is positioned for a bitewing examination. Therefore, it may be expected that if a sensor has a more ergonomic shape, the perception of discomfort for the patient will be lower than that with a larger and less ergonomically shaped sensor.

The purpose of the present study was to compare patient discomfort during bitewing examination using five intra-oral receptors: a conventional film, a storage phosphor plate with a new soft cover, an already manufactured and sold sensor with a wire and two square and two rounded corners, a new version of a previously developed sensor with a wire and four square corners, and a newly developed sensor with a wire and four rounded corners.

Materials and methods

60 patients (26 male and 34 female) participated in the study. The mean age was 40.6 years (range, 22–74 years). All patients had at least two premolars and one molar, or one premolar and two molars in each side, making it possible to position the receptors accurately for a bitewing exposure.

The patients were informed about the purpose of the study and asked to participate without being told anything specific about the digital receptors or film. The receptors were placed in the mouth of the patient for a bitewing examination. The X-ray tube was positioned correctly and the receptor remained in position in the mouth for approximately 10 s. However, no radiation exposure was performed. The five receptors were numbered and the first patient started with Receptor 1, proceeding to Receptor 2 and so forth. The second patient started with Receptor 2 and the same sequence was followed. The operator shifted between starting in the right or the left side of the patient's mouth and the second receptor was placed in the other side, shifting sides continually until all five receptors had been positioned. The whole session lasted less than 10 min.

The receptors are shown in Figure 1 and their characteristics are given in Table 1. The three CMOS sensors, SuniRay, DIGORA Toto (Soredex) and Snapshot, were covered with a Sirona Hygienic Protection bag (Sirona, Bensheim, Germany). The DIGORA Optime storage phosphor plate was covered with a DIGORA Optime Opti Coverbag, size two (Soredex). The film was paper pack. To hold and position the film and the phosphor plate, a Kwik-Bite film holder (Kerr, Bioggio, Switzerland) was used; for the sensors, a Troll-Byte sensor holder (TrollDental, Trollhättan, Sweden) was used (Figure 2). Examples of the phosphor plate and a sensor in position for a bitewing examination are presented in Figure 3.

During the session the patient recorded on a visual analogue scale (VAS) his or her perception of discomfort after having had the receptor positioned in

a

b

Figure 1 (a) Thickness of the complementary metal-oxide-semiconductor sensors, from left: SuniRay (Suni Medical Imaging, Inc., San Jose, CA), DIGORA® Toto (Soredex, Tuusula, Finland) and Snapshot (Instrumentarium Dental, Tuusula, Finland). (b) Shape of the five receptors. Upper row from left: film and phosphor plate; lower row from left: SuniRay, DIGORA Toto and Snapshot

their mouth for 10 s. 0 mm reflected absolutely no discomfort and 100 mm reflected maximum discomfort. After the clinical part of the study was accomplished, the patients' VAS scores were measured to the nearest full millimetre. The data were transferred to SPSS version 13.0 (IBM Corporation, Armonk, NY) and comparison of the VAS scores from the different receptors was performed with paired *t*-tests.

Results

The VAS scores for the five receptors are shown in Table 2. There was a large difference between individual patients' perception of discomfort: the scores ranged from 0 mm to more than 90 mm on the scale. There was no significant difference in

Table 1 Receptors used in the present study

Receptor	Film	PSP plate	Sensor	Sensor	Sensor
Name	Insight	DIGORA® Optime	SuniRay	DIGORA Toto	Snapshot
Manufacturer	Eastman Kodak Company, Rochester, NY	Soredex, Tuusula, Finland	Suni Medical Imaging Inc., San Jose, CA	Soredex	Instrumentarium Dental, Tuusula, Finland
Receptor type	Paper pack	PSP	CMOS	CMOS	CMOS
Size, mm	45 × 33	45 × 37	43 × 31	43 × 31	42 × 30
Field of view, mm	30 × 40	31 × 41	26.1 × 35.2	26 × 36	26 × 36
Thickness, mm	1.4	1.4	5.9	6.8	5.0
Thickness at cord attachment, mm	–	–	11	9	8
Weight, g	2	2	17	17	15
Weight with converter attachment, g	–	–	68	47	44
Length of sensor to converter attachment, mm	–	–	835	445	444
Number of rounded corners	4	4	0	2	4
Resolution, pixels	–	874 × 1164	793 × 1067	1358 × 1916	1368 × 1896
Resolution, ppi	–	726	769	1337	1337
Bit depth	–	8	8	8	8

CMOS, complementary metal–oxide–semiconductor; PSP, photostimulable phosphor.

patient discomfort score between the conventional film and the Snapshot sensor ($p > 0.05$). Both conventional film and Snapshot were significantly less uncomfortable than the other receptors ($p < 0.05$). No significant difference was seen between the storage phosphor plate and the SuniRay sensor ($p > 0.05$). The storage phosphor plate was significantly less uncomfortable than the DIGORA Toto sensor ($p < 0.05$).

Discussion

This study was performed without actually exposing for a bitewing image. This was chosen after ethical considerations to avoid many identical patient exposures. We tested

five different receptors, but in most cases it would have been diagnostically justifiable to make only two bitewing images (one for each side). Thus, it was not possible to assess the quality of the bitewing image and decide if any image should have been retaken. However, care was taken to ensure that the receptor was positioned correctly and the patient bit correctly onto the holder without moving the receptor in the mouth for the 10 s period. We therefore believe that the test provided a realistic simulation of the clinical situation.

After the patients had tried each of the receptors, his or her perception of discomfort was noted on a VAS. The VAS is an established scoring scale for measurements of subjective phenomena such as pain, unpleasantness, nausea and anxiety.⁶ VAS measures have been demonstrated to be reliable⁷ and generalizable,⁸ with higher accuracy than other tested subjective scales.⁶ The variation in VAS ratings is a characteristic of individual subjects;⁹ therefore, VAS measures are most useful when comparisons are relative within the individual; that is, when the patient is his own control, e.g. when scoring unpleasantness during dental treatment with and without the use of a distraction method in the same session^{10,11} or when scoring post-operative discomfort after periapical surgery over a time period.¹² The patients in our study showed a large variation in how well they tolerated the receptors. Some patients recorded a high level of discomfort for all five receptors and some recorded very low discomfort for all five. This is another argument for choosing the design of five receptors positioned in each patient.

We found that the VAS scores in general were relatively low compared with previous studies that have used VAS scores for patient (dis)comfort during intra-oral radiographic examinations with different

Figure 2 Receptor holders and covers. (a) Kwik-Bite (Kerr, Bioggio, Switzerland) and (b) Troll-Byte (TrollDental, Trollhättan, Sweden) holders, (c) DIGORA® Optime Opti Coverbag (Soredex, Tuusula, Finland) and (d) Sirona Hygienic Protection bag (Sirona, Bensheim, Germany)

a

b

Figure 3 Examples of receptors placed for a bitewing examination. (a) Storage phosphor plate; (b) Snapshot sensor (Instrumentarium Dental, Tuusula, Finland)

types of receptors. One study examined discomfort during bitewing examination and found that the DIGORA Optime phosphor plate resulted in a mean score of 32 mm while CCD sensors obtained scores between 23 mm and 55 mm.² The patients' feeling of discomfort was thus much higher in that study than in ours. We covered the plate with a bag with softer edges than those of a previous version, which might

explain the improved comfort of the phosphor plate. Moreover, the film and sensor holders used in the present study are new and different from those used in previous studies. Another study examined discomfort during examination of lower third molars with five receptors and found that film was the least uncomfortable (mean VAS, 29 mm), while both the phosphor plates and the sensors obtained high discomfort scores (VAS range, 44–61 mm).³ The new version of the Suni sensor, SuniRay, which was used in the present study, was thicker than the previous version of this sensor brand. This may account for the fact that the SuniRay sensor was not the most comfortable sensor in our study, as was reported in the previous study.³ A third study assessed patient comfort (*i.e.* scores should be interpreted reversed to discomfort) during a full-mouth examination using conventional film, a storage phosphor plate and two sensors.¹³ With the use of a film holder, the film obtained a low mean comfort score of 40 mm, while the digital receptors ranged between 80 mm and 90 mm on the VAS.¹³ The digital receptors were, however, used without a holder and positioned in the mouth supported by the patient's finger, which makes comparison with the present results difficult.

The low VAS scores for discomfort found in our study may be the result of manufacturers' increasing focus on the benefits of smaller and more ergonomically shaped sensors. The Snapshot sensor, which was the most ergonomically shaped sensor in this study with four rounded corners, was scored as almost as comfortable as the conventional film. As shown in Table 1, the Snapshot sensor was smaller in physical length, width and thickness than the other sensors. These improvements, however, did not compromise the field of view, which was approximately the same for all sensors.

Conclusion

It has previously been shown that wired sensors were more uncomfortable to patients during a bitewing examination than a conventional film or a storage phosphor plate. In the present study, there was no significant difference in the perception of discomfort between the conventional film and an ergonomically shaped wired sensor.

Table 2 VAS score: mean, median, minimum and maximum for each receptor

Receptor	Mean (standard deviation), mm	Median, mm	Minimum, mm	Maximum, mm
Film	17 (2.1)	11	0	66
Snapshot (Instrumentarium Dental, Tuusula, Finland)	18 (2.4)	10	0	74
DIGORA® Optime (Soredex, Tuusula, Finland)	25 (3.2)	17	0	82
SuniRay (Suni Medical Imaging Inc., San Jose, CA)	28 (3.1)	23	0	90
DIGORA Toto (Soredex)	34 (3.6)	29	0	93

References

1. Wenzel A, Møystad A. Work flow with digital intraoral radiography: A systematic review. *Acta Odontol Scand* 2010; **68**: 106–114.
2. Bahrami G, Hagstrøm C, Wenzel A. Bitewing examination with four digital receptors. *Dentomaxillofac Radiol* 2003; **32**: 317–321.
3. Matzen LH, Christensen J, Wenzel A. Patient discomfort and retakes in periapical examination of mandibular third molars using digital receptors and film. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2009; **107**: 566–572.
4. Hellén-Halme K, Johansson PM, Håkansson J, Petersson A. Image quality of digital and film radiographs sent to the Dental Insurance Office in Sweden for treatment approval. *Swed Dent J* 2004; **28**: 77–84.
5. Sommers TM, Mauriello SM, Ludlow JB, Platin E, Tyndall DA. Pre-clinical performance comparing intraoral film and CCD systems. *Dent Hyg* 2002; **76**: 26–33.
6. Lara-Muñoz C, De Leon SP, Feinstein AR, Puente A, Wells CK. Comparison of three rating scales for measuring subjective phenomena in clinical research. I. Use of experimentally controlled auditory stimuli. *Arch Med Res* 2004; **35**: 43–48.
7. Price DD, McGrath PA, Raffi A, Buckingham B. The validation of visual analogue scales as ratio scales measures for chronic and experimental pain. *Pain* 1983; **17**: 45–46.
8. Price DD, Harkins SW. The combined use of visual analogue scales and experimental pain in providing standardized assessment of clinical pain. *Clin J Pain* 1987; **3**: 3–11.
9. Quiton RL, Greenspan JD. Across and within session variability of ratings of painful contact heat stimuli. *Pain* 2008; **137**: 245–256.
10. Bentsen B, Svensson P, Wenzel A. Evaluation of effect of 3D video glasses on perceived pain and unpleasantness induced by restorative dental treatment. *Eur J Pain* 2001; **5**: 373–378.
11. Ram D, Shapira J, Holan G, Magora F, Cohen S, Davidovich E. Audiovisual video eyeglass distraction during dental treatment in children. *Quintessence Int* 2010; **41**: 673–679.
12. Christiansen R, Kirkevang LL, Hørsted-Bindslev P, Wenzel A. Patient discomfort following periapical surgery. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2008; **105**: 245–250.
13. Goncalves A, Wiezel VG, Goncalves M, Hebling J, Sannomiya EK. Patient comfort in periapical examination using digital receptors. *Dentomaxillofac Radiol* 2009; **38**: 484–488.