Research Article

Submitted: Jun 14, 2022
Accepted: July 27, 2022
Published: Aug 3, 2022

Determination and Classification of Intraoral Photostimulable Phosphor Plate Artifacts in Dental Radiology

Dr. Abhinaya Luitel,[1] Dr. Harleen Bali,[2] Dr. Rinky Nyachhyon,[3] Dr. Kripa Gurung,[4] Dr. Rajmee Shrestha,[5] Dr. Aasma Rijal,[6] Dr. Roshani Subedi[7]

[1,2,4-7]Department of Oral Medicine and Radiology, Kathmandu University School of Medical Sciences, Dhulikhel Hospital, Kavrepalanchok, Nepal

[3]Department of Oral Medicine and Radiology, People's Dental College and Hospital, Kathmandu, Nepal

Correspondence :

Dr. Abhinaya Luitel. Email: abhinayaluitel@gmail.com

ABSTRACT

Introduction: Digital imaging is recently used in dentistry as substitute for conventional film-based radiography. It has many advantages and new possibilities for recording and interpreting radiographic data.

Objective: The objective of this study was to identify different types of intraoral photostimulable phosphor plate image artifacts and classify them as operator error artifacts, scanner artifacts, and plate artifacts with their frequency of occurrence.

Materials and Method: A retrospective chart review was conducted between 25th April, 2022 to 31st May 2022 at Department of Oral Medicine and Radiology after the ethical approval. Complete enumeration method was used to include all the intraoral images taken by size two photostimulable phosphor plates between January 2020 to January 2022 in the archives of dental radiology. The artifacts were identified and classified into operator error artifacts, scanner artifacts, and plate artifacts. The data were entered in Microsoft Excel sheet and transferred to SPSS v.20 for analysis and descriptive statistics was performed.

Result: Of 11,700 radiographs evaluated, 10,146 (86.76%) had artifacts. There were total of 14,682 (63.35%) photostimulable phosphor plate related artifacts, 6,845 (29.53%) operator related artifacts and 1,639 (7.07%) scanner related artifacts. There were nine (0.03%) artifacts which remained unidentified.

Conclusion: The most common artifact identified was photostimulable phosphor plate related artifact including partial stripping and scratches. Following this was ambient light induced artifacts under operator related artifacts. The least common artifacts were scanner related artifacts under which roller artifact was common.

Keywords: Artifacts; digital dental radiography; photostimulable phosphor plate.

INTRODUCTION

Conventional and digital radiography are main streams of dental radiology.[1] Digital radiography allows image manipulation thus enhancing the image quality without the need to retake the image.[2] It permits easy archiving of images and their electronic transfer between different specialties in dentistry.[3]

Citation

Luitel A, Bali H, Nyachhyon R, Gurung K, Shrestha R, Rijal A, Subedi R. Determination and classification of intraoral photostimulable phosphor plate artifacts in dental radiology: A retrospective chart review. J Nepal Dent Assoc. 2022 Jan-Jun;22(34):20-4.

Photostimulable phosphor (PSP) plates are selected by dental practitioners due to its easy intraoral placement with minimal discomfort.[1,3] These plates are available in different sizes similar to conventional film and hence, vulnerable to bending and scratching during handling resulting in artifacts.[1,2]

Digital dental radiology produces new types of image pitfall that remains a problem for clinicians especially where it is a new avenue.[4,5] To the best of authors' knowledge and literature search there are no study pertaining to intraoral PSP image artifact from Nepal. Recognising these artifacts and defining the cause will guide towards the possible solution. This will also indirectly check on the quality control and assurance of PSP imaging system. Thus, the objective of this study was to identify different types of intraoral PSP image artifacts from the dental radiology archives and classify them as operator error artifacts, scanner artifacts and PSP plate artifacts[1,3] with their frequency of occurrence.

MATERIALS AND METHOD

A retrospective chart review was conducted between 25th April, 2022 to 31st May 2022 at Department of Oral Medicine and Radiology after the ethical approval from Institutional Review Committee (Ref. 21/22, dated April 24, 2022), Kathmandu University School Medical Sciences. Complete enumeration method was used to include all the intraoral images taken by size two PSP plates between January 2020 to January 2022 in the archives of dental radiology. Radiographs were taken by CE 0297 PSP plate and Carestream (CS 2100) intraoral periapical radiograph machine using bisecting angle technique. Images were produced by digital imaging technique with constant exposure parameters (Kvp: 60, mA: 7, sec: 0.32). A total of 11,700 images were viewed using image viewer software (Vistasoft 2.0.1). The investigator, AL (Oral Medicine and Radiology specialist) viewed the images in a same room, same computer screen, under ambient light. The artifacts were identified and classified into operator error artifacts, scanning error artifacts and PSP plate error artifacts. In case of any confusion regarding artifacts, consensus was reached by discussing with another maxillofacial radiologist. Predesigned proforma in word document was used for data collection. The data were entered in Microsoft Excel sheet and transferred to IBM SPSS Statistics for Windows, version 20 (IBM Corp., Armonk, N.Y., USA) for analysis and descriptive statistics was performed.

RESULT

Of total 11,700 radiographs, 10,146 (86.76%) had artifacts. All the radiographs having artifact had more than one artifact present. There were a total of 14,682 (63.35%) PSP plate related artifacts, 6845(29.53%) operator related artifacts, 1,639 (7.07%) scanner related artifacts and nine (0.03%) unidentified artifacts (Table 1).

Table 1: Classification and occurrence of artifacts in photostimulable phosphor plate images

Type of artifacts			n (%)	Total N (%)
PSP plate artifacts	Partial stripping		7,548 (51.40)	14,682 (63.35)
	Scratches		7,134 (48.59)	
Scanner artifacts	Roller artifact		1,636 (99.81)	1,639 (7.07)
	Eraser unit artifact		3 (0.18)	
Operator artifacts	Ambient light artifacts	Noise	2,657 (38.81)	6,845 (29.53)
		Irregular densities	833 (12.16)	
	Conecut		2,698 (39.41)	
	Film bend		459 (6.70)	
	Foreign body		152 (2.22)	
	Reverse film		46 (0.67)	
Unidentified artifacts			9 (0.03)	9 (0.03)
Total			23,175 (100)	

DISCUSSION

Digital intraoral imaging systems have gradually replaced film-based imaging in recent years, as this technology has many advantages over conventional imaging. Two types of receptors are used for digital intraoral radiography: solid-state sensors which are used with a wire and PSP plates that are cordless.[4] Solid state sensors have been used for more than two decades, while systems that use PSP plates have only recently been used in clinical practice.[6] The PSP plates are more comfortable to the patient because they are cordless, more flexible, and thin, which resembles standard films.[4,6] However, despite their superiority, PSP plates are more susceptible to bending and scratches, require more time for scanning, and subsequently develop more image artifacts, which consequently affects image quality.[6]

In the present study, 10,146 (86.76%) of the radiographs had artifacts. This figure is high as compared to other studies where the PSP plate radiographic artifacts ranged from 6-40%.[2,4,5] These intraoral radiographic artifacts were further categorised into three main categories: operator, PSP plate, and scanner related artifacts. The most common type of artifacts identified in this study was PSP plate related artifacts which was 14, 682 (63.35%) (Figure 1). Under this, an artifact due to partial stripping of plate was seen in7,548 (51.40%) while scratches were seen in 7,134 (48.59%) and they occurred together. The other similar studies had PSP plate artifacts between 9.30%-19.30%.[1-5] Partial stripping artifacts are seen as irregular radiopaque shadows on radiographic image due to partial stripping of protective coating of photostimulating luminescence layer of the plate.[7] This partial stripping can be due to, improper handling of PSP plate, PSP scanner mismatch, and friction between roller of the scanner and PSP plates.[8] Use of compatible plate-scanner systems, professional manipulation of PSP plates and routine evaluation of PSP plates can help to avoid these artifacts.[7-9] However, because of propensity to scratch associated with deterioration of image quality, a study revealed that 95% of the PSP plates used for 10 weeks and more becomes undiagnostic and needs replacement.[7]

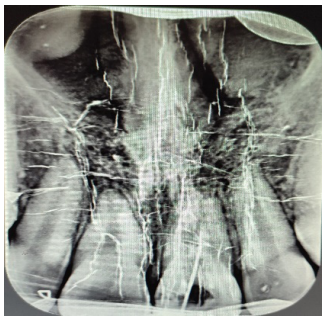

Figure 1: White arrow shows partial stripping artifact while black arrow shows scratch artifacts.

The second most common type of artifacts seen in this study was operator related artifacts which was 6,845 (29.53%). Further sub classifying these artifacts, 3,490 (50.97%) were ambient light induced artifacts in the form of noise, 2,657 (38.81%) and irregular densities, 833 (12.16%). Following this was cone cut, 2,698 (39.41%), film bend artifact, 459 (6.70%), foreign body artifact, 152 (2.22%) and reverse film artifact, 46 (0.67%). Contrary to this study, operator related artifacts were most common, 70.40%-86.20% in other similar studies conducted in different geographic regions.[1-5] Noise and non-uniform image densities are seen as grainy image with variable densities for same structural areas.[10] This occurs due to too much ambient light intensity and exposure associated overlapped or unsheathed PSP plate and delayed scanning.[10,11] Preventing the contact and contamination of unsheathed PSP plate and scanning them immediately after exposure helps overcome these artifacts.[10,11] Although the manufacturer recommends an ambient light intensity of up to 1000 lux, a semi-dark room is recommended for scanning and plate scanning delays should not be more than 10 minutes.[9-11] Cone cut appears as an arc shaped partial whitening or opacity leading to partial image due to misalignment of PSP plate with position indicating device (PID).[1-3] To avoid this, proper alignment of PSP plates with PID must be ensured so that entire plate gets exposed.[3] Film bend artifact produces slight line on the bent area, distortion of image and density difference on either side of the bent area.[2-4] Film bend at times is intentionally done for patients' comfort while sometimes it happens unintentionally inside patient's mouth. It can be avoided by careful placement of PSP plates inside mouth and use of local anaesthetics when needed

Figure 2: Black arrow showing reverse film artifact.

Figure 3: Black arrow shows roller artifact while white arrow shows eraser unit artifact.

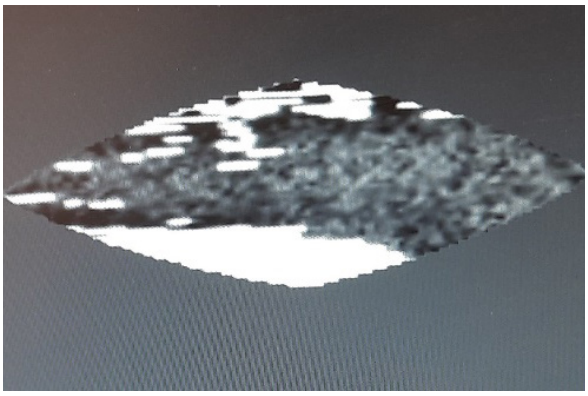

Figure 4: Unidentified, laser unit error like artifact.

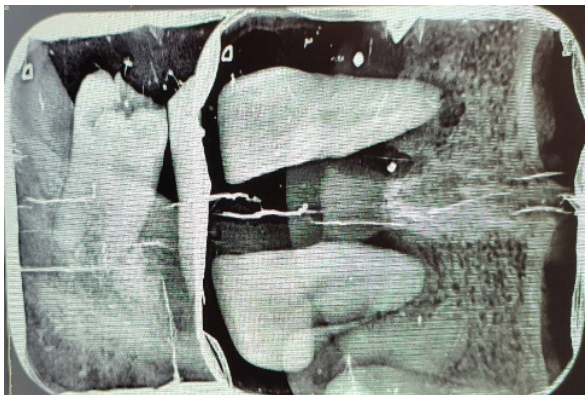

Figure 5: Unidentified, double image like artifact.

to reduce patient's discomfort. Foreign body artifacts are most common in PSP plate images of maxillary anteriors.[3] Most common are nose pins appearing as radiodense structures interfering with area of interest. Removal of these nose pins before the radiographic procedure will avoid this artifact. Reverse film artifact is seen as well-defined round radiopacity in the radiographic image when the PSP plate is kept reversed and the metal disk is exposed (Figure 2).[3-5] Thoughtful orientation and placement of the PSP plate inside the oral cavity helps avoid this artifact.

Scanner related artifacts seen this study were just 1639 (7.07%) (Figure 3). Among these, 1636 (99.81%) were roller artifacts while, three (0.18%) was eraser unit artifact. This was synchronous to findings from other similar studies which reported 9.3%-10.3% of scanner related artifacts.[1-5] Roller artifacts appear as gray straight or zigzag lines of various radiopacities extending in fast or slow scan directions.[2,12] It appears due to dirt on rollers or accumulation of dust or dirt on the light guide or reflector.[12] Cleaning of transport mechanism or light guide unit by service personnel helps reduce this error.[2,12] Eraser unit artifacts appear as ghost images of previous exposure due to defective light emitting diode (LED) causing inadequate erasing.[2-4,12] If there are repeated artifacts the eraser unit leads to be changed.[3,4]

In this study, nine (0.03%) of the artifacts remained unidentified (Figure 4 and 5). One (11.11%) resembled laser unit error artifact while rest eight (88.88%) of them were showing double images of two different regions with distinct two PSP plates outline. It appeared like two of the PSP plates were scanned together rather than an eraser unit artifact.

The main limitation of this study was that image quality might have been altered due to image manipulation. Evaluation of radiograph retake log due to artifacts was not possible due to retrospective nature of the study.

CONCLUSION

Within the scope of this study, the most common artifact identified was PSP plate related artifact including partial stripping and scratches. Following this was ambient light induced artifacts under operator related artifacts. The least common artifacts were scanner related artifacts within which roller artifact was common. Proper physical handling of PSP plates and their timely replacement when suspected to be damaged and quality control for digital radiography unit ensures optimal system functionality and image quality. It should be carried out at regular time intervals (daily, weekly, monthly and yearly). Training radiology technicians at regular intervals and updating them about the digital sensor system will help avoid operator related artifacts.

Conflict of interest: None.

REFERENCES

1. Elkhateeb SM, Aloyouny AY, Omer MMS, Mansour SM. Analysis of photostimulable phosphor image plate artifacts and their prevalence. World J Clin Cases. 2022;10(2):437-47. [PubMed | Full Text | DOI]
2. Deniz Y, Kaya S. Determination and classification of intraoral photostimulable phosphor plate artifacts and error. Imaging Sci Dent. 2019;49(3):219-28. [PubMed | Full Text | DOI]
3. Caliskan A, Sumar AP. Definition, classification and retrospective analysis of photostimulable phosphor image artifacts and errors in intraoral dental radiography. Dentomaxillofac Radiol. 2017;46(3). [PubMed | Full Text | DOI]
4. Gulashi A, Secgin CK. Assessment of intraoral image artifacts related to photostimulable phosphor plates in a dentomaxillofacial radiology department. Niger J Clin Pract. 2016;19(2):248-53. [PubMed | Full Text | DOI]
5. Chiu HL, Lin SH, Chen CH, Wang WC, Chen JY, Chen YK, et al. Analysis of photostimulable phosphor plate image artifacts in an oral and maxillofacial radiology department. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2008;106(5):749-56. [PubMed | Full Text | DOI]
6. Stelt PF. Better imaging: The advantages of digital radiography. J Am Dent Assoc. 2008;139 Suppl:7S13S. [PubMed | Full Text | DOI]
7. Bedard A, Davis TD, Angelopoulos C. Storage phosphor plates: How durable are they as a digital dental radiographic system? J Contemp Dent Pract. 2004;5(2):57-69. [PubMed | Full Text]
8. Kalathingal SM, Shrout MK, Comer C, Brady C. Rating the extent of surface scratches on photostimulable storage phosphor plates in a dental school environment. Dentomaxillofac Radiol. 2010;39(3):179-83. [PubMed | Full Text | DOI]
9. Roberts MW, Mol A. Clinical techniques to reduce sensor plate damage in PSP digital radiography. J Dent Child. 2004;71(2):169-70. [PubMed | Full Text]
10. Ramamurthy R, Canning CF, Scheetz JP, Farman AG. Impact of ambient lighting intensity and duration on the signal-to-noise ratio of images from photostimulable phosphor plates processed using DenOptix and ScanX systems. Dentomaxillofac Radiol. 2004;33(5):307-11. [PubMed | Full Text | DOI]
11. Akdeniz BG, Gr¨ondahl HG, Kose T. Effect of delayed scanning of storage phosphor plates. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2005;99(5):603-7. [PubMed | Full Text | DOI]
12. Oestmann JW, Prokop M, Schaefer CM, Galanski M. Hardware and software artifacts in storage phosphor radiography. Radiographics. 1991;11(5):795-805. [PubMed | Full Text | DOI]