

Merits and Demerits of Radiovisuographic Images on Paper Prints in Institutional Dental Practice: An Observational Study

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Abstract

Background: Digital radiography rules for years, yet not superceded conventional film-based because of hefty investment and inability to manage at offices lacking the software. This necessitates simple, economical and reliable transfer of images for subjective quality assessment on hard copy , with no diagnostic loss of information.

AIM: Analysis of merits and demerits of Radiovisuographic images on paper prints by assessing individual anatomical dental structures and Dental Pathosis /Restorations /RCT for diagnostic accuracy.

Methods: 500 intra oral periapical radiovisuographic images with bisecting angle technique, of Dental Pathosis/Restorations/RCT of maxillary and mandibular incisor and molar regions were taken which was subjected as a print out with an ink-jet printer on A-4 size paper of

image size 8.5 x 6.5 cm. It was subjected for assessing individual structures as per the assessment proforma in Departments (Oral Medicine and Radiology, Conservative & Endodontics and Periodontics). Data were subjected for statistical analysis.

Results: The result showed very good assessment of images in mandibular incisor, good to fair in mandibular molar and maxillary incisor and poor in maxillary molar region. Radicular cyst in maxillary incisor, restoration in maxillary molar, RCT and Ellis fracture in mandibular incisor and restoration and RCT in mandibular molar region showed the best for lesions. Poor visualization of enamel caries were seen in maxillary and mandibular incisor, mandibular incisor and molar region whereas localized periodontitis in maxillary molar region.

Conclusions: Merits of images dominated over demerits. With usage of standardized intraoral technique and superior quality inkjet printer demerits may get upturned towards merits.

Keywords: A4 –Paper, Maxillary Region, Mandibular Region, Printer, Radiovisuographic Images.

Introduction

Sir Wilhelm Conrad Roentgen discovered X-rays which formed the basis of today's radiology. With passing years film sensitivity increased and radiation dose decreased but the basic exposure and developing processes remained unchanged. This necessitated the invention of digital system which offered an instantaneous imaging, with no darkroom and low dose radiation¹

Dawn of the epoch of digital technology in dentistry came in 1987 with the launch of Radiovisuography (RVG) by a French company. However reigning for more than 25 years, conventional film-based radiography has not been substituted wholly because of hefty financial investment and inability to manage a digital format in offices lacking the software.²

Thus the need for simple and reliable transfer of digital images from one office to another increases which makes the hard copies on film, photographic paper and normal paper an effective and alternative solution.³ Most published work has concentrated on the quality of digital radiographs compared to film systems but a handful of authors have investigated the quality of printed digital radiographs.⁴ Moreover it is also essential for the subjective quality assessment of the images on the hard copy so that there is no diagnostic loss of information. Hence the present study is an approach in assessing individual structures in a digital intraoral periapical image on a plain paper and thus summarizing the pros and cons of radiovisuographical images in institutional based dental practice.

Methods

The present study was carried out in Oral Medicine and Radiology section of Saraswati Dental College and Hospital, Lucknow, Uttar Pradesh. With approval from the Institutional Human Ethical Committee. Study included 500 intra oral periapical Radiovisuographic images (RVG) with bisecting angle technique, of Dental Pathosis/Restorations/RCT (root canal treatment) of incisor and molar regions of upper and lower jaw.

Patients diagnosed as pulp and periapical infection, periodontal infections, Restored /RCT treated tooth were covered in the study. Patients in the mixed dentition stage, showing Unco-operative behaviour, having a large intraoral swelling, trismus and pregnancy were excluded from the study. Patients who participated were examined clinically on dental chair with illuminating facility, pair of sterile disposable gloves, mouth masks, Stainless steel kidney tray, mouth mirror, straight probe, tweezers and explorers. For radiographic procedures patients were prepared using lead apron, thyroid collar.

Radiovisuography Set Up comprised of RVG System (Name :- Dr. Suni , CCD Size 2 Sensor), X Ray Machine (70 kVp,8 mA), Computer attached to RVG(Zenith PC), Personal computer attached to printer (Lenovo, Windows 7), Printer (Epson Ink jet printer L 210 series) , Paper (Size : A4).

After explaining the entire method to the patient and obtaining a written consent(Annexure I) for the same, a thorough detailed examination of patients oral cavity was conducted and the clinical data was collected as per the proforma (Annexure II) and the patient was subjected to radiovisuography. The image obtained was converted to a JPEG format and the printout was taken on A-4 size paper with image size of 8.5 x 6.5 cm with the help of attached printer.

It was further subjected to analysis of the individual structures as per the assessment proforma (Annexure III) in respective three departments Oral Medicine and Radiology, Conservative & Endodontics and Periodontics as these three departments frequently deals with the examination and cure of the Dental Pathosis/Restorations/RCT. Armamentarium and procedure for obtaining radiovisuographic images on paper prints are summarized in Figure 1.

The collected data was then subjected for statistical analysis using *Frequency and Proportion Test and Chi-Square Test*.

Results

Region distribution of 500 study sample showed 110 subjects (22%) seen in maxillary incisor region , 110 subjects (22%) seen in maxillary molar region , 110 subjects (22%) in mandibular incisor region and 170 subjects (34 %) in mandibular molar region.

The age distribution of 500 study sample shows range between 20-29 years in 190(38%) , 30-39 years in 207 (41%), 40-49 years in 85 (17%) and >50 years in 18

(4%). The gender distribution of 500 study sample 248(49.6%) were females and 252 (50.4%) were males. Among the 500 study sample frequency distribution of variety of lesion diagnosed in the subject group, 72(14.4%) is enamel caries , 52(10.4%) is dentinal caries , 70 (14.0%) is apical periodontitis , 96(19.2%) is periapical abscess, 1(0.2%) is radicular cyst, 125(25.0%) is localized periodontitis, 11(2.2%) is ellis fracture, 26(5.2%) is restoration and 47 (9.4%) is RCT.

The assessment of Radiovisuographic images of individual anatomical dental structures on paper prints in the descending order of diagnostic accuracy is shown in Table 1. In maxillary incisor region periodontal space is seen in good category and intraradicular bone in fair category. In Maxillary molar region lamina dura is visualized in good category and periodontal space in fair category.

In Mandibular incisor region lamina dura is observed in good category and periapical area in poor category . In Mandibular molars lamina dura is spotted in good category and crown is seen in fair category . The assessment of Radiovisuographic images of Dental Pathosis/ Restorations/RCT on paper prints in the descending order of diagnostic accuracy is shown in Table 2. In the maxillary incisor region radicular cyst is seen in good category and enamel caries in poor- fair category. In the maxillary molar region restoration is seen in good category and localized periodontitis in poor-fair category. In the mandibular incisor region RCT is seen in good category and enamel caries in poor- fair category. In the mandibular molar region restoration is seen in good- very good category and enamel caries in poor category.

Discussion

Digital imaging utilizes computer technicality and digital receptors for the procurement, visualization, upgrading, storage and transfer of radiographic images. It is a very

attractive alternative to film-based imaging which covers a lot of advantages over conventional film based radiography, but the most commonly cited positive features is radiation dose reduction.⁵ It is been available for more than a decade and since then it has undergone tremendous improvements.⁶

Advent of the digital epoch in dental radiology came in 1987, with the introduction of Radiovisuography (RVG). It is anticipated that 10-20% of dentist use RVG in their dentistry and it has been assessed that the users will progressively increase over the next five to ten years, as dentistry continues to move from conventional based films to digital imaging.⁶

However, unfortunately, this is still not universally reflected in general practice and has not completely taken over conventional film-based radiography because of massive financial investment and inability to manage a digital format in offices lacking the software.² It has been seen that hard copies on film, photographic paper and normal paper can be an effective and alternative replacement for expensive films and digital printouts.

To obtain the desirable image quality on the hard copies few studies in medical imaging have been done to assess the quality of printer used or the most efficient output medium for the digital image. Kirkhorn et al. carried out a study to evaluate the quality of digital medical images (digital chest radiographs from a computed radiography system) printed on paper with an ink jet printer. Different versions of paper prints and viewing conditions were compared to find the optimum alternative.⁷ Lyttkens K et al. conducted a study on the image quality of ink-jet printed paper copies (matt coated paper) and as laser recorded film of digital chest radiographs (chest phantom with simulated tumors in the mediastinum and right lung, derived from a computed radiography system).⁸ Combs et al. conducted a study using CT images using an ink-jet

gray-scale paper printer and several types of medium (matte paper, glossy paper, transparency film) to illustrate main financial advantage of paper over film which lies in the cost of consumables.⁹ Geoffrey I et al. conducted a study using a high – resolution laser printer for printing six computed tomographic (CT) scans and six radiation therapy simulator radiographs on plain paper¹⁰ whereas Bley T et al. conducted a study using CT scans film copies and paper prints using high quality printers for evaluation of image quality of paper prints.¹¹

Similar few studies have been done in the field of dentistry using various printers and papers to obtain the desired image quality, but the main objective was to compare the various printers and papers on very small number of images.

To best of our knowledge no study has been done till date on the overall assessment of the digital paper image. Keeping this in mind, we conducted a study to assess the image quality of radiovisuographic image on A- 4 size paper in order to establish diagnostic accuracy of anatomical dental structure and Dental Pathosis/Restorations/ RCT.

The study included 500 Intraoral periapical digital radiograph out of 500 subjects (49.6% females and 50.4% males) of Dental Pathosis/Restorations/ RCT. In our study, age of the subjects ranged between 20-29 years (38%), 30-39 years (41%), 40-49 years (17%) and >50 years (4%) The region wise sample distribution of 500 study subjects was 110 subjects (22%) in maxillary incisor region, 110 subjects (22%) in maxillary molar region, 110 subjects (22%) in mandibular incisor region and 170 subjects (34%) in mandibular molar region. Similar study done by Gijbels et al. obtained images from 15 subjects (8 female and 7 male) which ranged between 26-32 years.¹²

In our study Radiovisuographical images were obtained using RVG System (Dr. Suni, Size 2 CCD Sensor), Intra oral X - Ray Machine(exposure parameters 70 kVp, 8 mA). Similar other studies were done by Schulze et al. in which images were obtained using Intra oral x-ray machine attached to RVG system (Sirona Dental System).³ Gerrard obtained image using orthopantomogram,⁴ Benediktsdóttir I. S obtained image using 2 digital panoramic systems (Digora and Orthophos Plus) ¹³ whereas Gijbels et al. obtained image using orthopantomogram (Cranex).¹²

In our study the sample included 500 intra oral periapical digital radiograph of maxillary and mandibular (incisors and molars) region of Dental Pathosis/ Restorations/RCT. An intra oral periapical digital radiograph gives a highly detailed image of the anatomical dental structures and lesions. Similar study were done by Schulze et al. on only 3 typical intraoral radiographs,³ Gerrard on 5 digital panoramic radiographs,⁴ Benediktsdóttir I. S on 164 digital panoramic radiographs ¹³ and Gijbels et.al. on 15 digital panoramic radiographs.¹²

In our study Radiovisuographical paper images were obtained using EPSON Ink jet printer L 210 series. Similarly study done by Schulze et al. using 3 ink jet and 2 thermo-sublimation printers,³ Gerrard using Fuji DryPix 5000 printer, Hewlett-Packard LaserJet 2300 printer, Epson Stylus C45printer and Epson Stylus Photo R2400 printer.⁴ Benediktsdóttir I.S used Kodak 1200 ink-jet printer ¹³ whereas Gijbels et al. used Drystar 2000 printer to print the digital image.¹²

In the present study Radiovisuographical images were obtained on 75gm/m² A-4 size white paper of size image 8.5cm x 6.5 cm. Similar study done by Schulze et al used glossy paper as an output medium.³ Gerrard in his study used radiographic film, Hewlett-Packard 80 gsm A-4 office paper and Epson 250 gsm A-4 photographic

paper.⁴ Benediktsdóttir I. S used monitor display, glossy paper and transparent film ¹³ whereas Gijbels et al. in his study used transparent , glossy, satin and regular paper.¹²

In our study both maxillary and mandibular incisor and molar region was involved and after taking out the print the images were assessed for individual anatomical dental structures which included crown, root, periodontal space, lamina dura, periapical area and intraradicular bone also Dental Pathosis/Restorations/RCT . Similar study was done by Schulze et al. using periodontal ligament space, interproximal caries, apical lesions and marginal bone level.³ Gerrard analysed for lower and anterior border of maxillary sinus, periodontal bone level of upper and lower jaw, periapical structures of upper jaw, trabecular bone of upper and lower jaw, mandibular canal and mental foramen.⁴ Benediktsdóttir I. S analysed for assessment of position and morphology of mandibular third molars¹³ whereas Gijbels et al. analysed for caries, periaipical pathology, periodontal marginal bone loss, visibility of mandibular canals, condyles and anterior nasal spine.¹²

In our study after taking out the prints the image was assessed with the help of an assessment form (*ANNEXURE III*) using 4 point scale which were categorized as poor, fair, good and very good. Similar study on paper print assessment was done by Schulze et al. using a questionnaire comprising of 11 major questions which were further subdivided. Out of the questionnaire, 4 major questions were subdivided into 14 single questions that was assessed on a 3 point confidence scale(pathology definitely present, uncertain and not present) which was designed for evaluation of accuracy of interproximal caries, apical translucency, length of root canal filling. Another 4 major questions were subdivided into 14 single questions that was assessed on 3 point scale (diagnostically acceptable, uncertain and diagnostically unacceptable) for ranking of image quality.³ Gerrard used

the visual grading system used by Molander et al. which were categorized as much worse, worse, equal, better and much better.⁴ Benediktsdóttir I. S analysed by comparing the prints to the monitor display which was considered as gold standard method and then an additional comparisons were done by the findings present at the time of the operation for the actual position and morphology of third molars.¹³ Gijbels et al. analysed on a 5 point scale, ranging from certainly impossible to evaluate to certainly possible to evaluate.¹²

In the present study the collected images were then distributed nearly equally in three respective departments. 168 images were sent in the Department of Oral Medicine and Radiology, 167 images in the Department of Conservative and Endodontics and 166 images in the Department of Periodontics which were then interpreted by trained dentists and recorded in the assessment form. Similar study in dentistry was done by Schulze et al. in which a total of 16 observers (11 from 3 different university dental schools, 5 from different private offices) participated. These observers were 12 general dental practitioners, 3 oral surgeons and 1 medical radiologist who had working experience ranging between 1 and 20 years.³ Gerrard used nine experienced dentists of oral surgery department who were working in the hospital.⁴ Benediktsdóttir I. S used oral surgeons¹³ whereas Gijbels et al. used two oral radiologists, two final year students and one periodontologist.¹²

In our study the Radiovisuographic images on paper prints were used for assessing the diagnostic accuracy of individual anatomical dental structures of Dental Pathosis /Restorations/ RCT. Similar study were done by Schulze et al. to compare dental radiographs printed on glossy paper from calibrated low-cost printers with monitor display.³ Gerrard in his study investigated for the loss of diagnostic information of printed radiographs compared to

the on-screen digital image.⁴ Benediktsdóttir I. S study was to compare the accuracy of 3 modalities of digital panoramic radiographs—monitor-displayed images and printed copies on glossy paper and on blue transparent film¹³ whereas Gijbels et al. made a comparison between the subjective image quality of panoramic radiographs printed with direct thermal technology, as shown on a computer monitor and those printed with an inkjet printer using regular mat paper, glossy paper, satin paper and transparencies.¹²

The present study was conducted to assess the individual anatomical dental structures and Dental Pathosis/Restorations/RCT in Radiovisuographic images on paper prints for diagnostic accuracy which helped in summarizing the merits and demerits of Radiovisuographic images on paper prints.

Conclusion

To our knowledge literature search revealed no such study till date on the assessment of the digital image obtained using a printer and paper and also taking into consideration the cost/benefit ratio in an institutional based dental practice. Further studies are recommended on a larger sample with more variety of lesions to assess for diagnostic accuracy and for a strong base for future research.

Our study is a definitive trial in revolutionizing the digital era. *“Research is to see what everybody else has seen and to think what nobody else has thought”* Albert Szent-Gyorgyi

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Ethical approval: Ethical issues of this study have been approved by Institutional Human Ethical Committee.

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ANNEXURE - I

INFORMED CONSENT

SARASWATI DENTAL COLLEGE AND HOSPITAL, LUCKNOW

Department of Oral Medicine and Radiology

I , _____ the undersigned, hereby give my consent for the performing Radiovisuography on me for the study of “MERITS AND DEMERITS OF RADIOVISUOGRAPHIC IMAGES ON PAPER PRINTS IN INSTITUTIONAL DENTAL PRACTICE: AN OBSERVATIONAL STUDY” being conducted by Dr. Prachi Anand, Department Of Oral Medicine And Radiology, Saraswati Dental College And Hospital, Lucknow. I will be undergoing for one / two radiographic exposures. The procedures will take nearly 15 min.

I hereby voluntarily, unconditionally give my consent without any fear or pressure in mentally sound and conscious state to participate in this study.

Witness / Representative:

Patient Signature:

Date

Place

ANNEXURE – II

Case History Proforma for Dissertation Titled

**“Merits and Demerits Of Radiovisuographic Images On Paper Prints In Institutional Dental Practice: An
Observational Study”**

S.N:-

Date:-

Name:-

Age:-

Gender:-

Address:-

Occupation:-

Chief Complaint:-

Medical History:-

Clinical Examination:-

Provisional Diagnosis:-

RVG In Relation To:-

Final Diagnosis :

ANNEXURE - III

FEED BACK FORM

Purpose Of Rvg Taken For:-

Diagnosis: (Yes/ No)

Treatment Plan: (Yes / No)

Area Wise Analysis :

		Poor	Fair	Good	Very Good
Crown	Enamel				
	Dentin				
	Pulp				
Root	Dentin				
	Pulp				
	Root Canal				
Periodontal Space	Lateral				
	Apical				
Lamina Dura	Lateral				
	Apical				
Interdental /Crest Bone Loss					
Intra- Radicular Bone					
Periapical Area					
If Lesion Present	Periphery				
	Shape				
	Internal Structure				

Overall Performance Of The Radiograph In Showing The Details :

Poor	Fair	Good	Very Good

Comments:

Figure 1: Armamentarium and Procedure for Obtaining Radiovisuographic Images on Paper Prints.

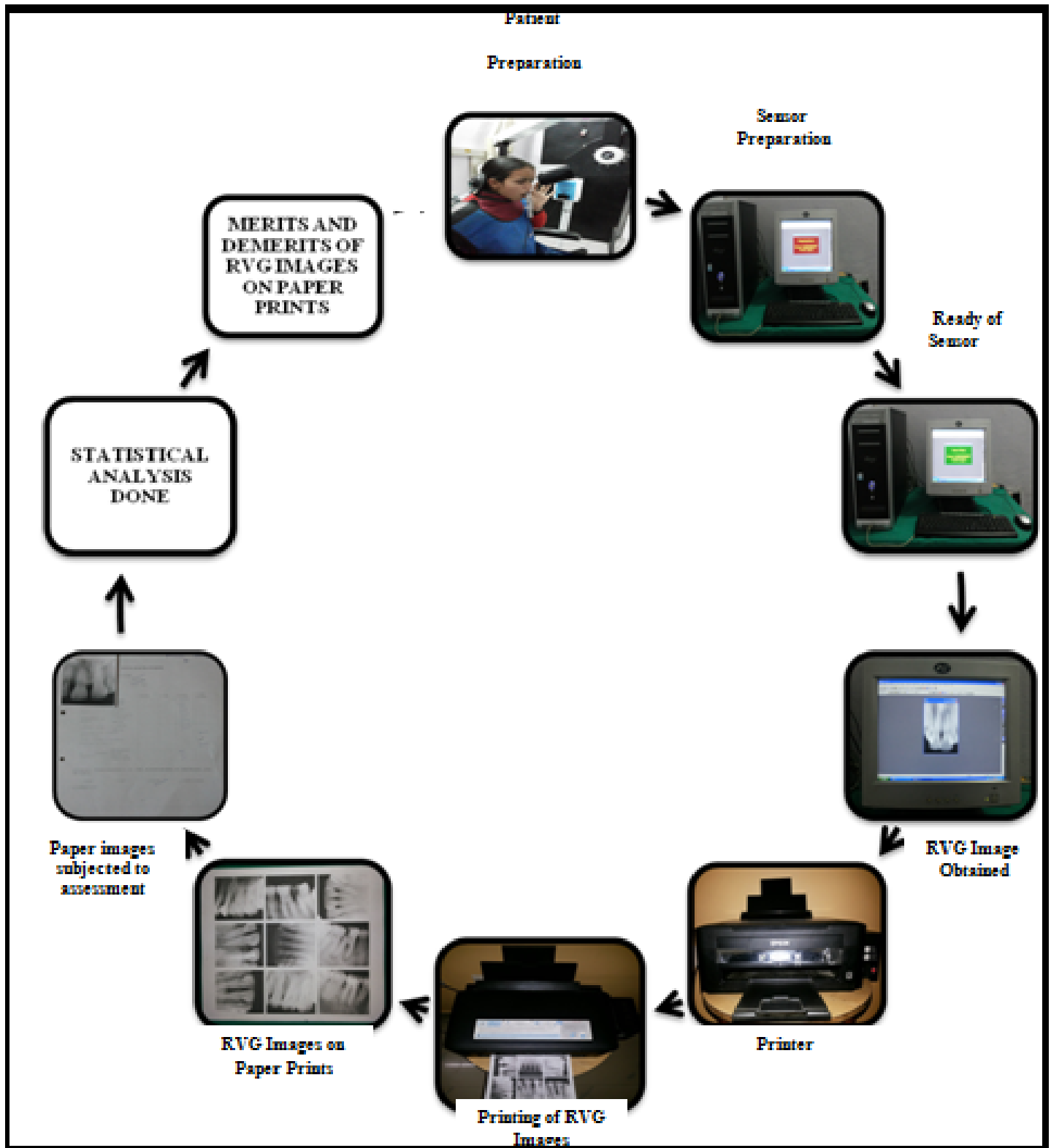


Table 1: Showing the assessment of Radiovisuographic images of individual anatomical dental structures on paper prints in the descending order of diagnostic accuracy

Region	Anatomical Dental Structures	Assessment
Maxillary Incisors	Periodontal space	Good
	Lamina dura	Good
	Root	Good
	Crown	Good
	Periapical area	Fair
	Intraradicular bone	Fair
Maxillary Molars	Lamina dura	Good
	Crown	Fair
	Root	Fair
	Periapical area	Fair
	Intraradicular bone	Fair
	Periodontal space	Fair
Mandibular Incisors	Lamina dura	Good
	Periodontal space	Good
	Root	Good
	Crown	Good
	Intraradicular bone	Good
	Periapical area	Poor
Mandibular Molars	Lamina dura	Good
	Periodontal space	Good
	Periapical area	Good
	Intraradicular bone	Good
	Root	Fair
	Crown	Fair

Table 2: Showing the assessment of Radiovisuographic images of Dental Pathosis/ Restorations/RCT on paper prints in the descending order of diagnostic accuracy

Region	Diagnosis	Assessment
Maxillary Incisors	Radicular Cyst	Good
	Restoration	Good
	RCT	Fair-Good
	Apical Periodontitis	Fair-Good
	Dentinal Caries	Fair-Good
	Ellis Fracture	Fair-Good
	Localized Periodontitis	Fair-Good
	Periapical Abscess	Fair-Good
	Enamel Caries	Poor-Fair
Maxillary Molars	Restoration	Good
	RCT	Fair-Good
	Apical Periodontitis	Poor-Good
	Periapical Abscess	Fair
	Dentinal Caries	Fair
	Localized Periodontitis	Poor-Fair
Mandibular Incisors	RCT	Good
	Ellis Fracture	Good
	Localized Periodontitis	Fair-Good
	Periapical Abscess	Fair-Good
	Apical Periodontitis	Fair
	Dentinal Caries	Fair
	Enamel Caries	Poor-Fair
Mandibular Molars	Restoration	Good- Very Good
	RCT	Fair - Good
	Localized Periodontitis	Fair -Good

	Apical Periodontitis	Fair - Good
	Dentinal Caries	Fair - Good
	Periapical Abscess	Fair –Good
	Enamel Caries	Poor