Chapter One

1.1 Introduction:

Quality Assurance plan include both quality control tests and quality administration procedure. The dental radiographer must be knowledgeable about the quality assurance programme. Quality assurance means the planned and systematic actions that provide adequate confidence that a diagnostic x-ray machine will produce consistently high quality images with minimum exposure of the patients and health care personnel (American Academy of Dental Radiology Quality Assurance Committee, 1983).

The determination of what constitutes high quality will be made by the machine producing the images. Quality assurance actions include both “quality control” techniques and “quality administration” procedures. Quality assurance consist of all the management practices carried out by the dental radiographer to assure that every imaging procedure is necessary and appropriate, the recorded information is clearly visualized and the examination results in the highest image quality and lowest possible radiation exposure, cost and suitable to the patient. A well-designed QA programmed should be comprehensive but inexpensive to operate and maintain for the dental radiographer. The QA programme need surveys and checks that are performed according to a

regular time. A written log of this programme should be kept by staff to ensure that the programme is applied continuously and to reflect its importance among staff. A specific person should be named as leader for the QA programme (Rehab *et al.*, 2007).

Proper practice of dental radiography requires careful attention to the application of the technical steps, and the preventive measure from acquiring infection, or having unnecessary doses of radiation. The dental radiographer must know why dental radiographs are important and why they are a necessary for patient care. The dental radiographer must have both sufficient knowledge and technical skills to perform dental radiographic examinations, beside this the dental radiographer must be able to educate patients about the importance of dental radiographs, and also must be prepared to answer common questions asked by patients about the need for radiographs, x-ray exposure, and the safety of dental x-rays. Infectious diseases have a serious hazard in the dental radiography, and the x-ray technicians at an increased risk for acquiring such diseases. Because of this infection control is very important in dental radiography. Infection control protocols are used to minimize the potential for disease transmission. To protect the technicians and the patients, technicians must understand and use the infection control protocols (Bachman *et al.*, 1990).

The dental radiographer must have a working knowledge of radiographic technique and understanding of the different types of radiographic examinations. Dental radiographic examinations may either be intraoral film (films placed inside the mouth) or extraoral film (films placed outside the mouth). Intraoral examinations are the backbones of dental radiography. Intraoral radiographs can be classified into three categories: periapical projections, bitewing projections and occlusal projections. Periapical radiographs should show all of a tooth, including the surrounding bone. Bitewing radiographs show only the crown of teeth and the adjacent alveolar crest. Occlusal radiographs show an area of teeth and bone larger than periapical films. A full-mouth set of radiographs consist of periapical and bitewing projections. These projections can provide considerable diagnostic information. As with any other radiological investigations the technician must clearly understand the goal of dental radiography and the criteria for evaluating the quality of the images. Dental radiographs should be requested only when can provide information to complement the clinical examination (Bachman *et al.*, 1990).

1.2 **Intraoral radiographic techniques:**

1.2.1 **Criteria of quality:**

Every radiographic examination should produce radiographs of optimal diagnostic quality, having the following features:

i. The radiographs should show the complete area of interest on the image, in case of intraoral radiographs, the full length of the roots and at least 2mm of the periapical bone must be visible.

ii. The radiographs should have the least possible amount of distortion.

iii. The radiographs should have the least optimal density and contrast (Eric Whaites, 2002).

1.2.2 **The Intraoral Radiographic Examinations:**

The intraoral examination is a radiographic inspection of teeth and intraoral adjacent structure. Such intraoral examinations are the foundation of dental radiography. Tow intraoral projection techniques can be applied for periapical radiography: the bisecting-angle technique and the paralleling technique. The paralleling technique is preferred because it provides a less distortion on the image. Types of intraoral radiographic examinations: -

There are three types of radiographic examination that use intraoral film:

1.The periapical examination.

2.The interproximal examination.

3.The occlusal examination.

(i) Periapical Examination:

The periapical examination is used to examine the entire tooth (crown and root) and supporting bone.
The periapical film is used in the periapical examination. The word peri (meaning around) and the word apex (referring to terminal end of a tooth root)
There are two methods for obtaining periapical radiograph:
a. The paralleling technique.

b. The bisecting angle technique.

(a) Paralleling technique:

It is a very important technique, which is used to expose periapical radiographs. The basic principles of this technique can be described as follows:

i. The film placed in the mouth parallel to the long axis of the teeth being radiographed.

ii. The x-ray beam directed perpendicular to the film and long axis of the teeth.
iii. A film holder must be used to keep the film parallel with the long axis of the tooth.
There are five basic rules to follow when using the parallel technique:
1. Film placement
The film must be placed to cover the prescribed area of the teeth to be examined.

2. Film position

The film must be positioned parallel to the long axis of the tooth.

3. Vertical angulation

The x-ray beam must be directed perpendicular to the film and the long axis of the tooth.

4. Horizontal angulation

The x-ray beam must be directed through the contact areas between the teeth.

5. Film exposure

The x-ray beam must be centered on the film to ensure that all areas of film are exposed. After finishing the infection control procedures and the treatment area, the patient should be seated. After seating the patient, the dental radiographer must prepare the patient for the exposure of x-rays by briefly explanation of the radiographic procedures, and the adjustment of the chair so that patient is positioned upright in the chair. Then adjust the headrest to support and position the patient head. The patient head must be positioned so that the upper arch is parallel to the floor, and the midsagittal plane is perpendicular to the floor (Eric Whaites, 2002).

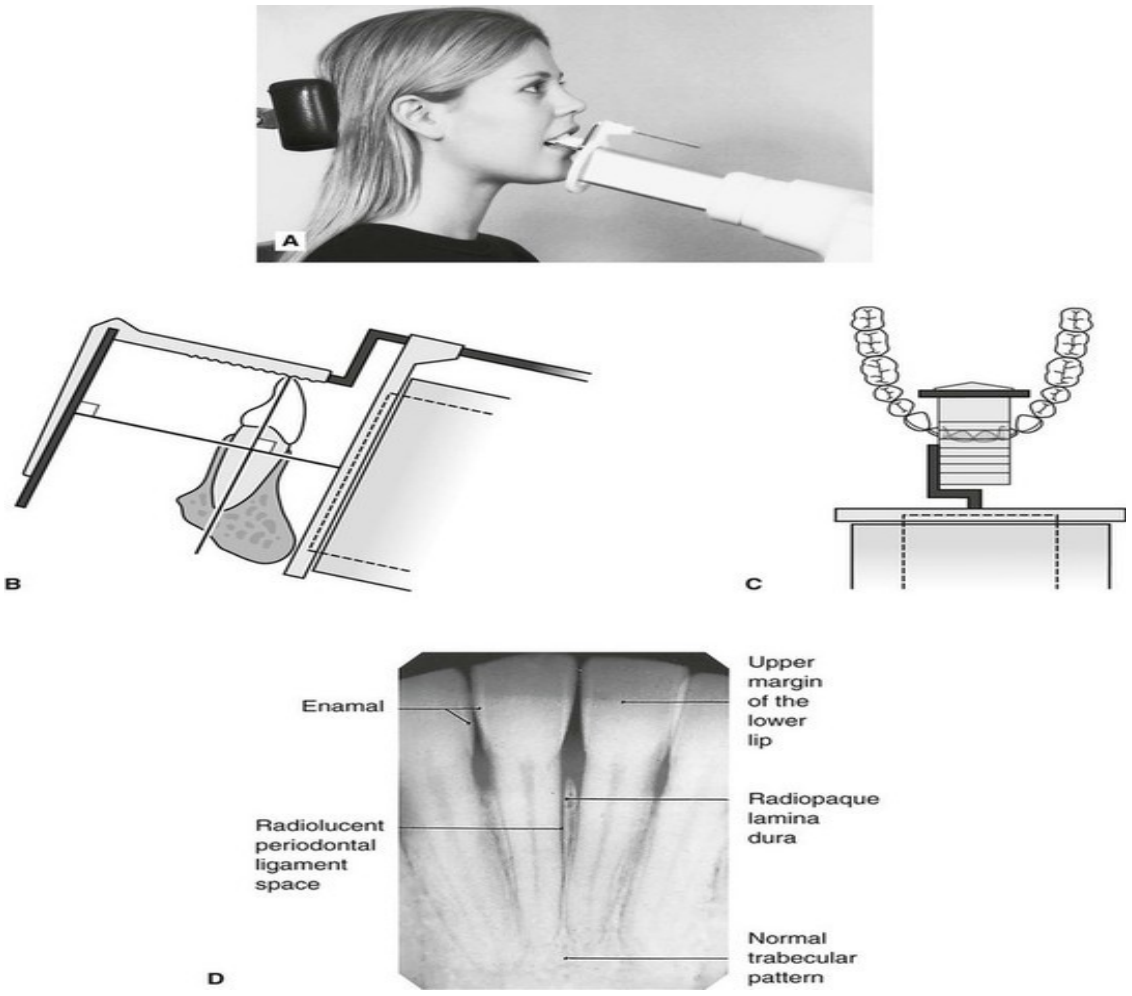

Fig 1.1 shows paralleling technique (Eric Whaites, 2002).

(b) Bisecting technique:

The dental radiographer must be able to do a variety of intraoral radiographic techniques; the paralleling technique is one method for exposing periapical films. Another method is the bisecting technique. Before the dental radiographer can use this technique, an understanding of the basic concepts, including terminology and principles, is necessary. In addition, the dental radiographer must understand patient

preparation, equipment preparation, exposure sequencing, and film placement procedures used in the bisecting technique.

a. Principals of bisecting technique: -

The bisecting technique is based on a simple geometric principal known as the rule of isometry. The rule of isometry states that two triangles are equal angles and share a common side. In dental radiography, this geometric principle is applied to the bisecting technique to form two imaginary equal triangles.

The bisecting technique can be described as follows:

1.The film must be placed along the lingual surface of the tooth, at the point where the film contacts the tooth of the plane of the film and the long axis of the tooth to from an angle.

2.The dental radiographer must visualize a plane that divides in half, or bisects, the angle formed by the film and the long axis of the tooth. This plane is termed the imaginary bisector. The imaginary bisector creates two equal angles and provides a common side for the two imaginary equal triangles. The dental radiographers must then direct the central ray of the x-ray beam perpendicular to the imaginary bisector. When the central ray is directed 90 degrees to the imaginary bisector, two imaginary triangles that result are the right triangles.

b. Film stabilization: -

Film is stabilized either by using film-holding instrument or patient finger to position and stabilize the film.

(i) Film Holders:

A film holder is a device used to position an intraoral film in the mouth and retain the film in position during exposure.

(ii) Finger - Holding Method:

Also known as digital method, this is used as alternative to the film-holder device in bisecting technique. The finger or the thumb is used to stabilize the periapical film. The finger or thumb is always placed at the opposite side of the film. The thumb of the patient is used position the maxillary films, and the index of the patient is used to stabilize the mandibular films. The left hand of the patient is used for exposure on the right side of the mouth, and right hand of the patient is used for exposure on the left side of the mouth. In spite of finger-holding method is popular method, it remains least desirable method for exposing films using bisecting technique. The disadvantage of finger-holding method can be summarized as follows:

1. The hand of the patient is in the path of the primary beam, resulting in unnecessary radiation exposure.

2. The patient may need excessive force to stabilize the film, causing the film to bend and result in image distortion.

3. The film may slip from its position, resulting in inadequate exposure of the area of interest.

4. Incorrect alignment of PID causes a partial image or cone-cut.

Film with bisecting technique size 2 intraoral film is used, size 2 film is placed in a vertical direction in the anterior regions, and placed in a horizontal direction in the posterior regions.

c. PID Angulations: -

In the bisecting technique, the angulation of the PID is important. Angulation is varied by moving the PID in either a horizontal or vertical direction: -

(i) Horizontal Angulation:

It refers to the positioning of the tube head and direction of the central ray in horizontal plane. It is the same for different types of technique. When using correct horizontal angulation, the central ray is directed perpendicular to the curvature of the arch and through the contact areas of the teeth. Incorrect horizontal angulation results in overlapped contact areas.

(ii) Vertical Angulations:

It refers to positioning of tube head in a vertical or up and down plane. Vertical angulation measures in degrees and

registered on the out side the tube head. When using correct vertical angulation, the radiographic image is the same length as the tooth. When using incorrect vertical angulation, it will result in a radiographic image is not the same length as the tooth; instead, the image appears longer or shorter. And they are not diagnostic. Foreshortened images result from excessive (too steep) vertical angulation or if the central ray is directed perpendicular to the plane of the film rather than perpendicular to the imaginary bisector. Elongated images result from insufficient (too flat) vertical angulation, or if the central ray is directed perpendicular to the long axis of the tooth rather than perpendicular to the imaginary bisector. There are five basic rules to be followed in the bisecting technique:

1.Film placing:

The film must be positioned to cover interested area of teeth to be examined.

2.Film positioning:

The film must be placed against the lingual surface of the tooth. The occlusal end of the film must be 2 mm beyond the incisal surfaces. The apical end must rest against the palatal or alveolar tissues. The patient should be instructed to press the film gently against the cervical portion (where the crown meats the root) of the tooth.

3.Vertical angulation:

The central ray must be directed perpendicular to the imaginary bisector that divides the angle between the film and the long axis of the tooth.

4.Horizontal angulation:

The central ray of the x-ray beam is directed through the contact areas between the teeth.

5.Film exposure:

Center the x-ray beam on the film to ensure that all areas of the film are exposed. Failure to center the x-ray beam results in a partial image on the film or cone-cut. Before exposing periapical films using bisecting technique there are three steps should be done; patient preparation, equipment preparation, and film placement methods.

After the completion of infection control procedures, the patient should be seated, then briefly explain the procedure to the patient. After that position the patient upright in the chair, and then adjust the headset to support the patient’s head. Place lead apron with thyroid collar over the patient. Finally remove all objects from patient’s mouth. Eyeglasses must also be removed. Following patient preparation, the dental radiographer set the exposure factors (kilovoltage, milliamperage, and time), (Eric Whaites, 2002).

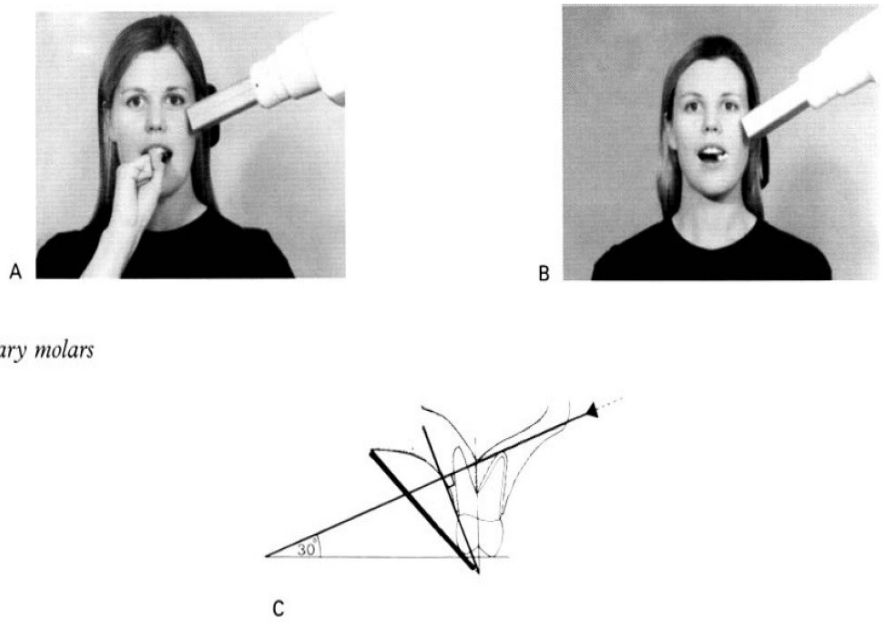

Fig 1.2 Bisecting technique (Eric Whaites, 2002).

patient positioning with the patient A supporting the film packet and B using the Rinn Greene Stabe bite block. C Diagram of the relative positions of film, tooth and X-ray beam

(ii) Interproximal Examination:

The interproximal examination is used to examine the crowns of both the maxillary (upper) and mandibular (lower) teeth on single film. This examination is useful in examining adjacent tooth surfaces and Cristal bone.

a. Film:

the bite-wing film has “wing” or tab attached to the film; the patient “bites” on the “wing” to stabilize the film-hence the term bite-wing.

There are four sizes of bite-wing film (0,1,2, and 3):

i. Size 0: It is used to examine the posterior teeth of the children with primary dentitions.

ii. Size 1: It is used to examine the posterior teeth of the children with mixed dentitions.

iii. Size 2: It is used to examine the posterior teeth in adults.

iv. Size 3: It is used only for bite-wings.

b. PID Angulations:

In the bite-wing technique, the angulation of the PID is very important. Angulation may be varied by moving the PID in either a horizontal or vertical direction.

(i) Horizontal Angulation

The central ray is directed perpendicular to the curvature of the arch and through contact areas of the teeth. Incorrect horizontal angulation results in overlapped (unopened) contact areas.

(ii) Vertical Angulation

A +10 degree (downward) vertical angulation is used for bite-wing radiograph. The +10 degree vertical angulation is used to compensate for the slight bend of the upper portion of the film and the slight tilt of maxillary teeth.

c. Bite-wing technique:

The bite-wing technique is used in interproximal examination.

The basic principles can be described as follows:

(i) The film is placed in the mouth parallel to the crown of both upper and lower teeth.

(ii) The film is stabilized by the patient bites on the bite-wing tab (Is a heavy paperboard tab used to stabilize the film during the exposure).

The central ray of the x-ray beam is directed through the contact areas of teeth, using +10 degree vertical angulation.

(iii) Occlusal Examination:

The occlusal examination is used to examine large areas of the maxilla (upper jaw) or mandible (lower jaw) on one film. The occlusal radiograph is preferred when the placement of the periapical films is too difficult for the patient or when the area of interest is larger than a periapical film.

a. Film type: The occlusal film is used in the occlusal examination (size 4).

b. Technique: The occlusal technique is used in the occlusal examination. The basic principles of occlusal technique can be described as follows: -

i. The film is positioned with white side facing the arch that is being exposed.

ii. The film is placed in the mouth between the occlusal surfaces of the maxillary and mandibular teeth.

iii. The film is stabilized by the patient bites on the surface of the film (Eric Whaites, 2002).

1.3 Objectives of the study:

1.3.1 General objective:

The main objective of this study to evaluate the quality control in dental x-ray department in Al Neelain university clinic.

1.3.2 Specific objective:

1.To assess the quality control system at Al Neelain clinic and suggest corrective actions.

2.To evaluate radiation exposure at the dental department under study in order to reduce cross-contamination between

patients as well as between patients and health care providers.

3.To find out if there is unnecessary exposure to the radiation of the patients and the staff, and accordingly adjust the machine in such a way as to obtain consistent high quality images and propose recommendations that can be applied in different dental department.

1.4 problem of the study:

Radiation is a major risk in diagnostic medical imaging and therapy. The problem is caused by incorrect use of radiography equipment and from unnecessary radiation exposure to patients.

1.5 Importance of the study:

The study may hopefully add information which is useful in solving the problem of the department in question and other similar departments. The study may provide solutions and recommendations that will serve to avoid such problems.

1.6 Outline of the study:

The study was outlined into five chapters as follows:

Chapter one showed the general introduction in addition to Intraoral radiographic techniques and objective, problem, importance of the study, and thesis out line and the outcome of the study.

Chapter two covered the study literature review including theoretical background and previous study.

Materials and methods of experiments were presented in chapter three.

Chapter four presented the study results.

Chapter five discussed the finding of the study, and gave conclusion to the results of the experiments, discussion, recommendations and references.

1.7 The outcome of the study:

The outcomes of this study included giving a solution to the problems which affect the application of the quality control programme in the dental x-ray department in Al Neelain clinic.

Chapter Two

Literature review

2.1 Theoretical background:

2.1.1 Quality Control:

Quality control uses a plan of action to ensure radiographs of consistently high quality and high protection from radiation and infection. This plan includes several routine assessments of images, and protective measures. The assessment includes the image quality; this is affected by the performance of the x-ray machine, manual processing procedure, viewing condition, system of infection control and radiation protection. Optimization of these conditions results in the most accurate diagnostic images and lowest possible Exposure for dental patient and dental radiographer. The dental x-ray department in Al Neelain clinic has an important role in teaching student technologist, and dentistry student. The study aims to assess the quality control system in this department, and suggests a corrective action when necessary, in order to solve the problems which may lead to error in the application of quality control. The study will be carried out through the data collection, questionnaires, and assessment of radiation protection in this department. In previous studies a comparison done between different types of dental radiographic techniques to choose the best techniques, and the researcher said that the bisecting technique is the best in visualizing the entire tooth and its

supporting structures (Rehab *et al.*, 2007). Another study said the orthopan tomography is the best in demonstrating the surrounding bone of the teeth (Fekry *et al.*, 2004).

The purpose of this chapter is to introduce the dental radiographer to quality control tests that are used to monitor dental x-ray equipment, and film processing (Bachman *et al.*, 1990).

2.1.2 Quality Administration Procedure

Quality administration refers to the management of the quality assurance plan in dental office. The basic elements of a quality administration programme include the following:

(i) Description of the plan.

(ii) Assignment of duties.

(iii) A monitoring schedule.

(iv) A maintenance schedule.

(v) A record-keeping log.

(vi) A plan for evaluation and revision.

(vii) In-service training.

A written description of the quality assurance plan used dental radiography should be on file and made available to all staff members. The staff members must understand the standards of quality as well as the purpose of maintaining quality control of radiographic procedures. A written

monitoring schedule detailing all quality control tests and the frequency of testing for all dental-ray equipment should be posted in the department. A record-keeping log of all quality tests, including the specific test performed, the data performed, and the test results, should be carefully maintained and kept on a file in the department (Bachman *et al.*, 1990).

2.1.3 Quality control tests:

Are specific test that are used to maintain and monitor dental x-ray equipment. “Quality control techniques” are those techniques used in the monitoring (or testing) and maintenance of the components of an x-ray system. The quality control techniques thus are concerned directly with the equipment. To avoid excess exposure of patient and personnel to x-radiation, the dental radiographer must have clear understanding of the quality control procedure used to test specific equipment, supplies, and film processing in the dental office (Quality assurance for dental facilities *et al.*, 1990).

2.1.4 Equipment:

Quality control test are necessary to monitor dental x-ray machine, dental x-ray film screens, and cassettes, and viewing equipment. To consistently produce diagnostic high quality radiographs, dental x-ray equipment must be functioning properly (Quality assurance for dental facilities *et al.*, 1990).

2.1.5 Dental x-ray machine:

The dental x-ray machine must be inspected and monitored periodically, and must also be calibrated at regular interval. Calibration of dental x-ray equipment must be performed by qualified technician to ensure consistent x-ray machine performance and production of diagnostic radiographs. There are many annual tests recommended for dental x-ray machines. These tests are designed to identify minor malfunctions, including machine output variation, tube head drift, timing errors, inaccurate kilo voltage and mill amperage reading. Most of the tests require some basic testing material, film and test logs to record the results (Quality assurance for dental facilities *et al.*, 1990).

2.1.6 X-ray machine test:

Generally, x-ray machines are quite stable and rarely need to be tested; the following parameters should be measured:

1. X-ray output. A radiation dosimeter is used to measure the intensity of radiation output, usually is measured in milliroentgens.

2. Beam alignment. The field diameter for dental intraoral x-ray machine should be no greater than 3 inches.

3. Beam energy. The kVp or half-value layer (HVL) of the beam should be measured to ensure that the beam has sufficient energy to produce good quality radiograph without excessive soft tissue dosage.

4. Timer. The timer should be accurate. The test can be done by using a spinning top with notch on the edge.

5. mA the linearity of the mA control should be done with a dosimeter or with stepwedge.

6. Focal spot size. The focal spot size may become enlarged with excessive heat generated within the x-ray machine (Quality assurance for dental facilities *et al.*, 1990).

2.1.7 Dental x-ray film:

The dental X-ray film must be properly stored, protected and used before its expiration date. For quality control purposes, each box of film should be tested for freshness as it is opened. The following fresh film test is recommended to check newly opened box of film:

1. Prepare film. Unwrap one unexposed film from newly opened box.

2. Process film. Use fresh chemicals to process the unexposed film.

The result of fresh film can be interpreted as follows:

a. Fresh film, if processed film appears clear with as height blue tint, the film is fresh and has been properly stored and protected.

b. Fogged film, film that has expired, has been improperly stored, or has been exposed to radiation appears fogged. If

the film is fogged it must not be used (Quality assurance for dental facilities *et al.*, 1990).

2.1.8 Screens and Cassettes:

Extraoral intensifying screen used within the cassettes holder should be examined periodically for dirt and scratches. Screen should be cleaned monthly commercially available cleaners recommended by the screen manufacture. After cleaning, antistatic solution should be applied to the screen. Screens that appear visibly scratched should be replaced. Cassettes holder should be examined for worn closures, light leaks, and wrapping, which may result in fogged and blurred radiographs; these cassettes must be repaired or replaced. Cassettes also must be checked for adequate screen-film contact (Council dental material *et al.*, 1989).

The following film screen contact test is recommended:

1. Insert one film between screens in the cassette holder.
2. Place wire mesh test object on the top of the loaded cassette.
3. Position the position indicating device (PID) using a 40-inch target-film distance while directing the central ray perpendicular to the cassette.
4. Expose the film using 10 mA, 70 KVp.

5. Process the exposed film.

6. View the film on a viewbox in a dimly lit room at a distance of 6 feet.

The result of the film-screen contact test can be interpreted as follows:

a. Adequate contact:

If the wire of mesh image seen on the film exhibits a uniform density, good film-screen contact has taken place. Proceed with cassette and screen use.

b. Inadequate contact:

If the wire of mesh image seen on the film exhibits varying densities, poor film-screen contact has taken place. Areas of poor film-screen contact appear darker than good contact areas.

2.1.9 Viewing equipment:

The viewbox is a light source that is used to view dental radiographs. A working viewbox is necessary equipment for the interpretation of the dental radiographs. The viewbox conation fluorescent light bulbs that emit light through an opaque plastic or plexiglass front. The viewbox should emit a uniform light when it is functioning properly. A photographic light meter can be used to determine proper viewing

brightness (Quality assurance for dental facilities *et al.*, 1990).

The viewing box should be periodically examined for dirt and discoloration of the plexiglass surface. The surface of the viewbox should be wiped clean daily. Permanently discolored plexiglass surfaces must be replaced. Any blackened fluorescent light bulbs must also be replaced (American Academy of Dental Radiology Quality Assurance Committee, 1983).

2.1.10 Film processing: -

film processing is on the most critical areas in quality control and requires daily monitoring, processing problem have the potential to result in a large number of non-diagnostic radiographs. Quality control tests must be performed routinely to determine whether or not the conditions for film processing are acceptable (Quality assurance for dental facilities *et al.*, 1990).

2.1.11 Darkroom lighting: -

The darkroom must be checked for light tightness and proper safe lighting every 6 months. The following light leak test is recommended for the dark room:

1. prepare dark room, close the dark room door and turn off all lights, including the safelights.
2. Examine darkroom, once your eyes are accustomed to the darkness, observe the areas around the door, the seams of

the walls and ceiling, the vent areas, and keyhole for light leaks.

The results of the light leak test can be interpreted as follows:

No Light leaks: If the darkroom is light- tight, no visible light is seen. Proceed with film processing.

Light leaks: If present, light leaks are seen around the door, through the seams of the walls or ceiling, or through a vent or keyhole.

Light leaks must be corrected with weather stripping or black tape before proceeding with film processing.

Only after the light – tightness of the darkroom has been established can the safe lighting be checked.

The following safe lighting test, often referred to as the coin test is recommended:

(i) Prepare darkroom. Turn off all the lights in the darkroom including the safelight (American Academy of Dental Radiology Quality Assurance Committee, 1983).

(ii) Prepare film. Unwrap one unexposed film. Place on a flat surface at least 4 feet from the safelight. Place a coin on top of the film.

(iii) Turn on the safelight. Allow the film and coin to be exposed to the safelight for 3 to 4 minutes.

(iv) Remove the coin and process the film.

The result of the safe lighting test can be interpreted as follows:

If on visible image is seen on the processed radiograph, the safe lighting is correct. If the image of the coin and a fogged background appear on the processed radiograph, the safelight is not safe to use with that type of film, to avoid safe lighting problem, the dental radiograph must use the film manufacturers recommended safelight filers and bulb wattages. In addition, the film must be unwrapped at last 4 feet away from the safelight. A coin test is used for safe lighting. Coin placed on unexposed film under safelight. Developed film showing outline of coin indicating that safelight intensity is too great and is not safe. Safelight problems must be corrected before proceeding with film processing (American Academy of Dental Radiology Quality Assurance Committee, 1983).

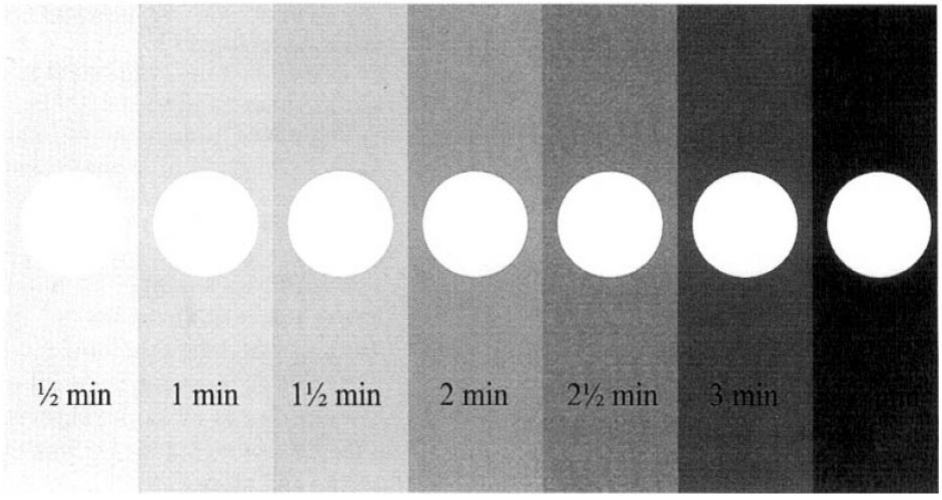

Fig 2.1: A simulated coin test result.

The film with seven coins on it, has been gradually uncovered every 30 seconds. The coin-covered part of the film remains white while the surrounding film is blackened or fogged. The longer the film is exposed to the safelight the darker it becomes (American Academy of Dental Radiology Quality Assurance Committee, 1983).

2.1.12 Processing equipment:

Processing equipment must be maintained and monitored on a daily basis. The thermometer and timer must be checked for accuracy with manual processing techniques. The processing time and temperature recommendations of the film manufacturer must be followed. If automatic processing equipment is used, the water circulation system must be checked, and the solution levels, replenishment system, and temperatures must all be monitored. The manufacturers procedure and maintenance direction must be carefully followed. Each day, two test film should be processed in the automatic processor. Test films are recommended:

(i) Prepare films. Unwrap two unexposed films, expose one to light.

(ii) Process both films in the automatic processor.

The results of the automatic processor test films can be interpreted as follows:

a. Functioning processor: -

If the unexposed film appears clear and dry and if the film exposed to light appears black and dry, the automatic processor is functioning properly. Proceed with processing.

b. Non-functioning processor: -

If the unexposed film does not appear clear and dry and if the exposed film does not completely appear black and dry, then the processing solution and temperature must be checked. Correction must be made before proceeding with processing (American Academy of Dental Radiology Quality Assurance Committee, 1983).

2.1.13 Processing solution:

The most important component of the film processing quality control is the monitoring of the processing solution. The processing solution must be replenished daily and changed every 3 to 4 weeks as recommended by manufacturer. As alternative using the calendar to determine the freshness of solutions, quality control tests can be used to monitor the strength of the developer and fixer solutions. Processing solution must be evaluated each day before any patient film

are processed (American Academy of Dental Radiology Quality Assurance Committee, 1983).

2.1.14 Developer strength:

When the developer solution loses strength, the time-temperature recommendations of the manufacturer are no longer accurate. An easy way to check the strength of the developer solution is to compare film densities to a standard. One of the following tests can be used:

(i) Reference radiograph.

(ii) Stepwedge radiograph.

(iii) Normalizing device.

(a) Reference radiograph: -

A reference radiograph is one that processed under ideal conditions and then used to compare the film densities of radiograph that are processed daily. The following steps can be taken to create reference radiograph:

(i) Prepare film. Use fresh film to make a reference radiograph.

(ii) Expose the film using the correct exposure factors.

(iii) Process the film using fresh chemicals at recommended time and temperature.

View he references radiograph and the daily radiographs side by side on a viewbox. Compare the densities on the

reference radiograph with the densities on the daily radiographs.

Comparison of daily radiographs with the reference radiograph can be interpreted as follows:

a. Matched densities: If the densities on the reference radiograph match the densities on the daily radiographs, the developer solution strength is adequate. Proceed with processing.

b. Unmatched densities: If the densities on the daily radiographs appear lighter than those seen on the reference radiographs, the developer solution either weak or cold. If the densities seen on the daily radiographs appear darker than those seen on the reference radiograph, the developer solution is either too concentrated or too warm.

Weakened or concentrated developer solution must be replaced. If the developer solution is too cold or too warm, the temperature must be adjusted.

(b) stepwedge radiograph:

A stepwadge is advice constructed of layered aluminum steps. When a stepwedge is placed on the top of a film and then exposed to x-rays, the different steps absorb varying amounts of x-rays. When processed, different film densities are seen on the dental radiograph as result of the stepwedge.

The following steps can be taken to create stepwedge radiographs.

(i) Prepare the film: Use a total of 20 fresh films to create a supply of films for daily testing. Place an aluminum stepwedge on top of one film.

(ii) Expose the film: Repeat with remaining films using the same stepwedge and exposure factors.

(iii) Using fresh chemicals: Process only one of the exposed films. This processed radiograph will exhibit different densities as the result of stepwedge and is known as standard stepwedge radiograph.

(iv) Storage of the films: Store of the remaining 19 exposed films in a cool, dry area protected from radiation.

(v) Films processing: Each day, after the chemicals have been replenished, process one of the exposed stepwedge films.

(vi) Viewing the radiographs: View the standard radiograph and the daily radiograph side by side on a viewbox. Compare the densities seen on the daily radiograph with the densities seen on the standard radiograph. Comparison of the daily stepwedge radiograph with the standard stepwedge radiograph can be interpreted as follows:

a. Matched densities:

Use the middle density seen on the standard stepwedge radiograph for comparison. If the density seen on the standard radiograph matches the density seen on the daily radiograph, the developer solution strength is adequate. Proceed with processing.

b. Unmatched densities:

If the density on the daily radiograph differs from that on the standard radiograph by more than two steps on the stepwedge, the developer solution is depleted. The developer solution must be changed before proceeding with processing (American Academy of Dental Radiology Quality Assurance Committee, 1983).

2.1.15 Fixer strength:

The fixer removes the unexposed silver halide crystals on the film that result in “clear” areas on the film, when the fixer becomes weak, the film takes a longer time to clear, and when the fixer is at full strength, a film takes 2 minutes, to clear without agitation (American Academy of Dental Radiology Quality Assurance Committee, 1983).

2.1.16 Manual and automatic film processing:

Quality control of manual and automatic film processing is important because deficiencies in this process are the most common cause of faulty radiographs. Several steps, followed carefully, greatly increase the probability of producing radiographs of consistently high quality. Replenish solution daily at the beginning of the workday, check the level of the

processing solutions and replenish if necessary. The developer should be replenished with fresh developer or preferably with developer replenished. The fixer should be replenished with fixer. At the beginning of the workday, check the temperature of the processing solutions. The solutions must reach the optimal temperature before use 68 F (20 ^{O}C) for manual processing and 82 F (28 ^{O}C) for heated automatic processors. Regular clearing for processing equipment is necessary for optimal operation. The replacement frequency of processing solutions depends on the rate of use of the solutions and on the size of the tanks (Council dental material *et al.*, 1989).

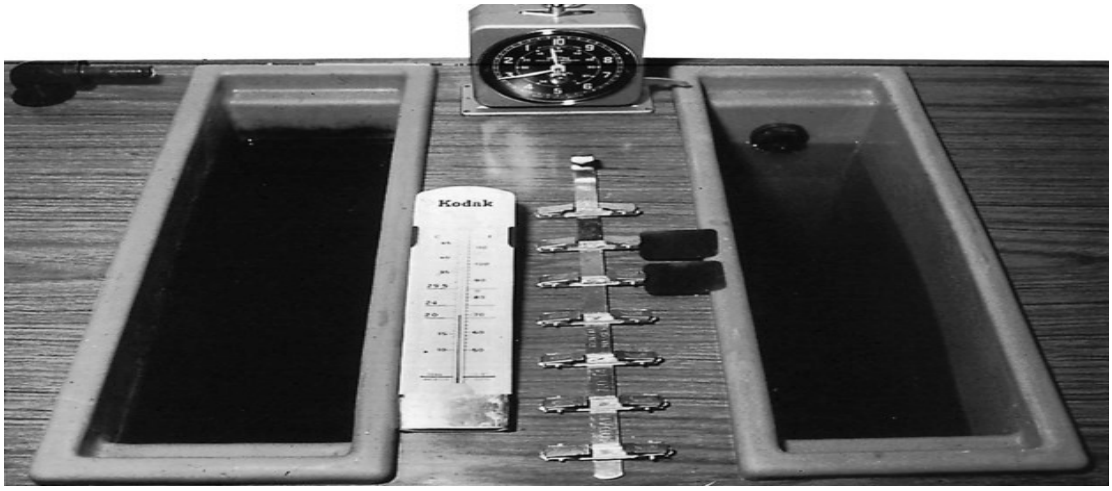

Fig 2.2: the basic requirements for manual processing including three solution tanks, thermometer, timer and film (Council dental material *et al.*, 1989).

2.1.17 Reject analysis:

To achieve high standard level of images quality, there should be continuous assessment for the rejected films so as

to reduce the number of the retakes radiographs. Every x-ray department must have a reject-analysis system. The system must determine what information required, how the data can be collected, and how correct problems arise in the department using the collected data (Bachman et al., 1990).

2.1.18 Infection control:

The dental radiographer and patients are at increased risk of acquiring tuberculosis, herpes viruses, upper respiratory tract infections, and (AIDS). Under universal precautions, all human blood and saliva are treated as if known to be infectious for human immunodeficiency virus (HIV) and hepatitis B virus. The goal is to block the transmission of infectious agents between patients and dental radiographer or other patients. Although radiographic procedures are not invasive, saliva is a potentially infectious medium because of its frequent contamination with blood. One set of procedure is used for all patients, regardless their presumed status. In radiographic practice the prevention of cross- contamination is achieved by using surface disinfectants on all surfaces and by using barriers to isolate equipment from direct contact. Most instruments that accumulate on working surface must be sterilized before being used for other patients. Although barriers greatly help in infection control, they do not replace the need for surface cleaning and disinfection (Bachman et al., 1990).

2.1.19 Infection control procedures:

The infection-control sequence for dental radiography is as follows:

1. Prepackage x-ray film and sterilize film-holding instrument.

2. Disinfect and cover the PID, x-ray tube and support, working surfaces, chair, and apron.

3. Expose radiographs.

4. Process contaminated x-ray films.

5. Remove all barriers and wipe all working surfaces and apron with disinfectant.

Any surface that may be contaminated should be surface disinfected. This includes the x-ray machine control panel, tube head, and beam alignment device, dental chair and head – rest, surfaces on which film is placed (Wolfgang, 1993).

2.1.20 Infection control barriers

(i) Protective clothing:

Dental radiographer must wear protective clothing (lab coat) to prevent skin exposure when contact with blood or other body fluids are anticipated. Protective clothing must be changed daily or more frequently if it is visibly soiled.

(ii) Gloves:

Dental radiographer must wear medical latex or vinyl gloves to prevent skin contact with blood, saliva, or mucus

membranes. The dental radiographer must wear new gloves for each patient. Gloves must also be worn when touching contaminated surfaces. No sterile gloves are used for examinations and nonsurgical procedures.

(iii) Masks and protective eyewear:

Surgical masks and protective eyewear must be used when spatter and aerosolized sprays of blood and saliva are likely. When a mask is used, the mask must be changed between patients (Glass, 1994).

2.1.21 Infection control procedures used prior to exposure

The following surfaces must be covered or disinfected:

(i) X-ray machine: The tube head, PID, control panel, and exposure button must all be covered or disinfected.

(ii) Dental chair: The headrest, and chair adjustment control must be covered or disinfected.

(iii) Work area: The area where the x-ray films are placed during exposure must be covered or disinfected.

(iv) Lead apron: If contaminated, must be wiped with a disinfectant between patients.

(v) Film: Dental x-ray films should be kept in a disposable container (Wolfgang, 1993).

2.1.22 Preparation of the dental radiographer:

Prior to x-ray exposure of the patient, hands must be washed with soap or an antimicrobial solution in the presence of the patient. Immediately following handwashing, gloves must be placed. Contaminations are created during radiographic exposures, the use of surgical mask and protective eyewear is optional (Glass, 1994).

2.1.23 Infection control procedure used during exposure:

The dental radiographer should take especial care to touch only covered surfaces. Infection control procedures during exposure can be described as follows:

(i) Drying of exposed films: After each film has been placed in the patient mouth, exposed, and removed, it must be dried with a paper towel to remove excess saliva.

(ii) Collection of exposed films: After film drying, each film must be collected in container so as to be transported to the darkroom and must not be touched by gloved hands. To prevent film fog caused by scatter radiation, the container should be placed away from the controlled area (Glass, 1994).

2.1.24 Infection control procedure used following exposure:

Following film exposures, all contaminated instruments must be discarded, and any uncovered areas must be disinfected. After that the gloves must be removed and discarded and the hands must be washed. After the exposure of x-ray films,

there are specific infection controls guidelines must be followed during transport of the films to the darkroom, during film handling, and during film processing.

(i) Film transport: Exposed films must be placed in a container which should not be touched by gloved hands.

(ii) Darkroom: Cotton and gloves are necessary for film handling during processing and must be available in the darkroom (Glass, 1994).

2.1.25 Radiation protection:

Many of early pioneers in dental radiography suffered from adverse effects of ionizing radiations. The role of the dental radiographer is to achieve a high protection to the patient before, during, and after exposure to x-rays (International Commission on Radiation Protection, 1990).

2.1.26 Patient protection:

With the use of proper patient protection techniques, the amount of radiation received by the patient can be minimized. The first important step in reducing the amount of x-radiation a dental patient receives is the proper prescribing, of dental radiographs. There should be professional judgment to make decisions about the number, type, and frequency of dental radiographs (Alcox, 1978).

2.1.27 Proper equipment:

The dental x-ray tube head should be equipped with appropriate aluminum filters, lead collimator, and position-

indicating device. During exposure a thyroid collar, lead apron, fast film, and film-holding devices are used to limit the amount radiation received by the patient. Also the dental radiographer should select the proper exposure factor and technique, to limit the amount of radiation exposure and to ensure the diagnostic quality of films. After exposure films must be handled and processed properly to produce diagnostic radiographs and to limit patient exposure to radiation (Bean and Devore, 1969).

2.1.28 Operator protection

The dental radiographer must use proper protection measures to avoid exposure to primary radiation, leakage radiation, and scatter radiation. The dental radiographer should never expose to the primary beam and limit x-ray exposure is to maintain an adequate distance during exposure. The dental radiographer must stand at least 6 feet away from the x-ray tube head during x-ray exposure. when this distance is not possible, a protective barrier must be used (Bean and Devore, 1969).

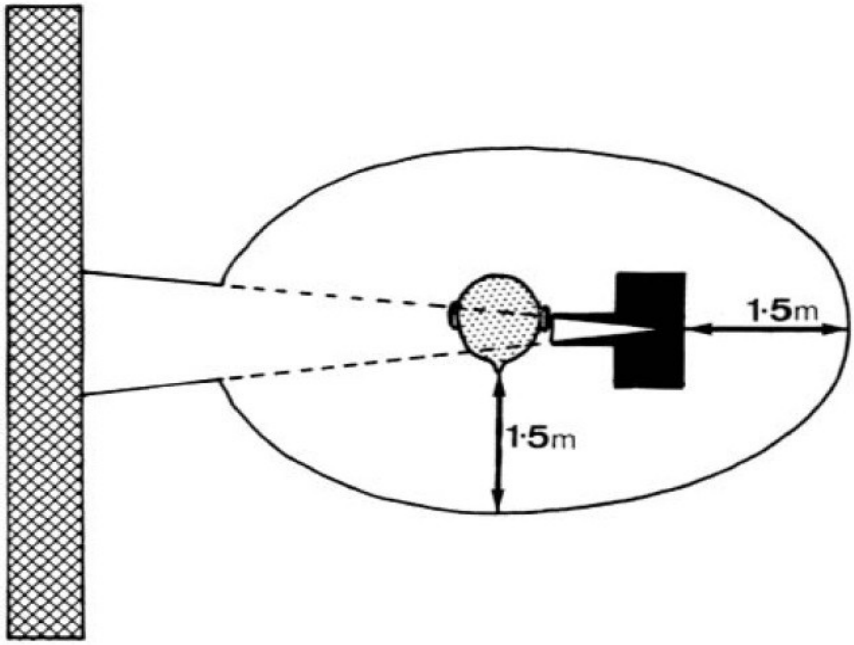

Fig 2.3: Diagram showing the size of the controlled area (Bean and Devore, 1969).

2.1.29 ALARA concept:

All exposure to radiation must be kept to a minimum, or as reasonably achievable to provide both protections to the patients and operators, every possible method should be employed to minimize risk (Alcox, 1978).

2.2 Previous studies:

WM Ediri Arachchi, WMDTM Chandrasena and R Tudugala, RD Jayasinghe, (2015): Reject Analysis of Intra-Oral Periapical (IOPA) Radiographs of Department of Radiology, Dental Teaching Hospital, Peradeniya, Sri Lanka, Proceedings of 8th International Research Conference, KDU, Published November 2015.

The authors found that the highest percentage of rejected teeth region was molar (48%) following premolar (27.9%) and anterior teeth (24.1%). According to the study positioning error was the most prominent error for the rejection of teeth molar in IOPA imaging. Elongation was the mostly affected error for the rejection of anterior teeth due to incorrect vertical angulation during the patient positioning. Further, a significant association between the elongation & anterior teeth region was evident. The aim of this study was to identify the most susceptible region to be repeated in IOPA imaging and to find out the mostly affected error on image repetition.

Results of the present study were similar to the results published in literatures by many authors e.g (Patel *et al*. 1986, Peker *et al*. 2009). The study done by Peker and Alkurt (2009) also reported statistically significant difference between errors and anatomical location. They found that the most common area to get errors were the maxillary molar

area followed by maxillary premolar area and mandibular molar area. This study suggested that modifications and improvements of techniques involved in IOPA molar imaging are required to minimize the frequent repetitions of them. Further, it is also required to remedy the error of elongation by applying correct positioning of film and tube at the region of anterior teeth, and these measures would contribute to minimize the frequent repetitions of IOPA Radiographs.

P P NIXON, BDS, FDSRCS (1995): The British Journal of Radiology: An audit of film reject and repeat rates in a department of dental radiology. In that subject, a study of film reject and repeat rates was undertaken in the Department of Dental Radiology of King's College School of Medicine and Dentistry over a 6 months period.

The authors found that the overall reject rates were (3.06 %, 1.84 %) which were less than recorded in the earlier study, and the repeat rate was 0.93 %. Positioning errors were the most frequent cause of rejection. Significant differences in reject rates were noted between different projections, and also between qualified staff and those in training. The rejection rate for patients under 16 years was not significantly higher than for patients over 16 years. The most frequent cause of rejection was still positioning faults, but patient movement accounted for a larger proportion of the rejects than was the case in adult patients. The results demonstrated the role of audit in isolating factors leading to

additional exposures. The effectiveness of changes implemented following a reject film analysis was also shown. The aim of the study was to assess the effects of changes implemented after a previous audit, and to carry out a more detailed analysis of the factors influencing the reject and repeat rates using a larger volume of data. The information recorded included the equipment, projection used, and the age of the patient if under 16 years.

Jayasinghe R. D, *et al* (2013): Quality of working length radiographs taken and used by dental students during endodontic treatment, International Journal of Modern and Alternative Medicine Research.

The aim of that study was to identify the type and frequency of radiographic errors observed in working length (WL) radiographs taken and used by dental students. All WL radiographs taken by final year dental students during 2000-2010 were analyzed. All radiographs were taken with the same kind of X-ray equipment and film; and were processed with the same automatic processor. Side, jaw and tooth were recorded together with technical errors (if any). These were assessed under standard viewing conditions and magnification. A total of 1523 WL radiographs were analyzed. There were 1474 errors, and overlapping was the commonest error (16.9%) followed by crown cutting (13.4%) and incorrect film orientation (11.7%). Significantly higher number of errors was observed in maxillary teeth. A

statistically significant difference (P>0.05) was observed for the technical errors according to the anatomical area. Apex of tooth was not visible in 39 intra-oral periapical (IOPA) radiographs (2.6%). In conclusion, high number of errors was observed in WL radiographs but only few errors affected the outcome.

Shruthi Acharya, Keerthilatha M. Pai, and Shashidhar Acharya (2015): Repeat film analysis and its implications for quality assurance in dental radiology: An institutional case study, Contemporary Clinical Dentistry.

The study pointed to a need for more targeted interventions to achieve the goal of keeping patient exposure ALARA in a dental school setting. The results of this study suggested that in order to achieve greater improvements in repeat rates, change in teaching techniques should be done and teaching should pay particular attention to the problems of patient positioning. The dental schools play an important role in providing adequate training to the students, so that they can practice the principle of ALARA. The onus is on the dental schools to teach dose reducing strategies to the students so that they will continue to use them in their practice and thus provide radiation protection to the public. Like all audit tools, however, the ability to learn from one’s mistakes is fundamental to make the process work.

Chapter Three

Materials and Methods

3.1 Materials:

3.1.1 X-ray machine:

TUBE HOSING ASSEMBLY Model: 8461406502, S.N.: 31091031, Manufactured: July 2009, Output max: 70 kVp – 8mA – 3.2s, 230V~, X-ray beam: <= 6 cm at FFD 20 cm, 0.8 IEC 336, Total filtration >= 2 mm Al, preheating time: 100 ms, X RAY TUBE Model 4695005400, serial number: 880282, The X RAY CONTROL Model:8361307402, S/N: 27090432, Line: 230 V~,4A (at 253 V~) 50 Hz, Duty cycle:1/32 Max exposure time:3.2s, Manufactured: July 2009, made in MILANO-ITALY.

The x-ray machine was tested by the quality control team of the department of radiation protection.

3.1.2 Digital meter:

All tests of this machine were done by using digital meter (9 VDC, 500 mA, Manufactured 07.2008, Made in Germany), which can give a reading for different tests of the dental x-ray machine by applying a single exposure.

3.1.3 Fresh films:

The x-ray films were tested by using fresh film test to check newly opened box of films.

3.1.4 Viewbox:

The viewbox was examined weekly for dirt and discoloration of the plexiglass surface.

3.1.5 Coin:

For determination of the darkroom integrity and the light leak tests were done to check for tightness, and then the safelight was tested using the coin test.

For screens and cassettes no test was done, because they were not available in the department, this department does only intraoral examinations.

Due to lack of test tools many tests were not done.

3.2 Methods:

3.2.1 Sample size:

45 periapical films.

3.2.2 Data collection:

The data were collected from the intraoral radiographs done in dental x-ray department in Al Neelain clinic. The radiographs were assessed for techniques and processed by oral radiologist.

The data regarding infection control system were collected from the patients and the dentists in the dental x-ray department in Al Neelain clinic using questionnaire.

The department's staff who participated in assessing the quality control included one oral radiologist, two x-ray technologists, three periodontists, two oral surgeons, and three dentists.

The data regarding the images quality were collected from the intraoral radiographs done in the mentioned department, and about 45 faulty radiographs were being assessed for errors in techniques and processing. The rejected films were

collected for three months, to investigate the causes of their rejection, and to suggest the corrective actions that can prevent technical errors.

The data were collected and analyzed by using reject analysis chart to a count the number of the rejected films.

The overall repeat rate is the total of repeated films divided by the total number of films exposed during the test period, and classification of these rejects in relation to the area being examined and the causes of the faults. The percentage of repeats should guide the x ray dental technologists to focus their efforts to those areas needing more attention.

For the assessment of the infection control system, the data were collected by using questionnaires and continuous registration for the observations for the protective measures that prevent the infection transmission. The questionnaire was filled by the oral radiologist and the technologist working in this department.

The data collected covered the availability and the use of disinfectant, and other materials that used in the infection control procedure such as disposable container, and barriers.

Regarding the darkroom, the processing time was monitored and registered, the processing system in this department was manual using three processing tanks without master tank.

For the assessment of radiation protection, the radiation output was measured by using a digital meter.

3.2.3 Study duration:

This study was conducted during the period from October 2015 to February 2016.

3.2.4 Data analysis:

The data were analysis using the ratios chart, average.

3.2.5 Ethics:

The study received approval from the clinic manger, and the patients were informed by the technologist before participating in the study.

Chapter Four

Results

4.1 Results for quality control tests:

Table 4.1: Reading of the digital meter

Time in ms	kVp	ms	mGy	mGy/s	HVL
320	92.8	302.9	1.468	4.846	3.20
500	90.5	463.3	2.307	4.979	3.27
630	89.4	583.7	2.964	5.078	3.31

Table 4.2: Films Developing and fixing time

Date	Developing time in sec	Fixing time in sec
3-12-2015	25	130
6-12-2015	25	130
9-12-2015	30	150
12-12-2015	30	170
15-12-2015	45	250
18-12-2015	50	300

Table 4.3: Reject Films analysis

Investigation	a	b	c	d	e	f	g	h	i	j
Upper anterior	1	0	0	0	1	0	0	1	0	3
Upper premolar	1	0	0	0	2	0	1	0	1	5
Upper molar	0	1	0	0	4	1	2	3	0	11
Lower anterior	1	0	0	0	1	2	0	0	0	4
Lower premolar	0	1	0	0	0	2	1	3	1	8
Lower molar	2	1	0	0	4	1	2	3	1	14
Films total	5	3	0	0	12	6	6	10	3	45

*key points:

(a) Overdeveloped, (b) Underdeveloped, (c) Overexposed, (d) Underexposed, (e) patient movement, (f) Horizontal angulation error, (g) Vertical angulation error, (h) Con-cut, (i) Machine failure, (j) Films total.

Fig 4.1: Number of rejected films

Table 4.4: The percentage of rejects according to examined regions

Investigation	Percentage of fault
Upper anterior	6.7%
Upper premolar	11.1%
Upper molar	24.4%
Lower anterior	8.9%
Lower premolar	17.8%
Lower molar	31.1%

Fig 4.2: The percentage of rejects according to examined regions

Table 4.5: The percentage of rejects according to causes

Cause of fault	Percentage
Overdeveloping	11.1%
Under developing	6.7%
Patient movement	26.7%
Horizontal angulation	13.3%
Vertical angulation	13.3%
Con-cut	22.2%
Machine failure	6.7%

Fig 4.3: The percentage of rejects according to the causes

4.2 Observed results for other tests:

4.2.1 Results of testing darkroom integrity:

The result of this test showed a light leakage in the area near to the roof and the darkroom door but it did not cause film fog.

4.2.2 Safe light test:

The power of the bulb was about 25 watts, which is acceptable. The coin test done showed that the safe light was safe.

4.3 Results for questionnaire:

Table 4.6: The results of the questionnaire:

Q1 Answer:	Q2 Answer:	Q3 Answer:	Q4 Answer:	Q5 Answer:
There is no quality control officer and programme.	There is an infection control officer and programme.	There are no documented radiation protection rules, and there was no radiation measuring devices.	There is no regular reject analysis programme.	The department needs Q.C programme.

Chapter Five
Discussion, Conclusion and Recommendations

5.1 Discussion

The test showed by table 4.1 was performed using a digital meter. The results show a noted variation in kVp. The kVp of this machine was fixed at 70 kV; there was an increasing in the kV ranging from -22.8 to -19.4 kV. Also there was a drop in the exposure time ranging from 17.1 to 46.3 ms.

The average for kVp = 90.9

The percentage of the error in kVp =

{(Standard kVp- the average of kVp)/standard kVp} x100

(70 -90.9)/70 x100 = -20.9/70 x100 = -29.86%

Table 4.2 showed results regarding the assessment of the developing and fixing time, a timer was used to evaluate the activity of the processing solution. There was no thermometer to check the solution temperature, and there was a mild difference in developing and fixing time, because the processing solutions were changed continuously every two weeks.

The table 4.3 showed that there was no regular reject analysis in the department under study. A number of 45 films was collected over the period of three months, and the percentage of reject films is about (6%) of the total films used.

Reject rate = total reject films/total used films

= 45/748 = 6%

Figure 4.1 showed the distribution of the reject films according to their causes and the investigation region. The

highest number of reject films (4) was in the lower and upper molar region due to Patient movement.

Figure 4.2 presented the classification of these rejects according to the investigated region which showed that the highest reject rate occurred in the lower molar region was about (31.1%) of the total rejects, (24.4%) in the upper molar, (17.8%) in the lower premolar, (11.1%) in the upper premolar, (8.9%) in the lower anterior, (6.7%) in the upper anterior teeth.

Figure 4.3 showed Distribution of these rejects according to their causes. The percentage showed that (26.7%) of rejects were due to Patient movement, (22.2%) due to con-cut, (13.3%) due to horizontal angulation, (13.3%) due to error in vertical angulation, (11.1%) due to overdeveloping, (6.7%) due to under-developing, (6.7%) due to machine failure.

Table 4.6 showed the answers of the questionnaire designed for the oral technologist and technologist, who had the same answers to the raised questions.

The study within the department showed that there was a good radiation protection system, therefore there was no radiation detected behind the protective shield.

The co-patients did are not usually allowed to stay in the department during the exposure.

Moreover, the dental radiographer keeps attention to the application of the ten-day rule to protect the pregnant ladies and their fetuses. Regarding the availability of the protective

devices, there was a lead apron beside the protective shield, but there was no thyroid collar.

The study also showed that there was no quality control officer, and no quality control tests programme at all, except some tests which are usually done by the quality control team of the Sudanese Atomic Energy Commotion on the x-ray machine only (SAEC).

The questionnaire revealed the difficulties in setting a quality control system including the absence of quality control test tools, and the written quality control programme.

The results of the data regarding the infection control showed that there was no written infection control system, no continuous supply of disinfection solutions, and no barrier to cover the x-ray machine and working surfaces.

This may result in infection transmission among the patients and staff.

The results of the data obtained from the reject analysis chart showed that the common cause of the retakes was Patient movement in the upper and lower molar region (4 films), which constituted the highest percentage of all the causes of film rejection (26.7%), that means this region needs more attention when being radiographed.

Results of the present study are similar to the results in literatures by many authors, including (Ediri Arachchi W. M, *et al.* 2015, Patel *et al*. 1986, Peker *et al*. 2009, P P NIXON, BDS, FDSRCS, *et al.* 1995, Shruthi Acharya, *et al.* 2015).

They found that the most common area to get errors were the maxillary molar area and mandibular molar area, and the common causes were positioning errors.

The second common cause for film rejection was miss centering (con-cut), which constituted of percent (22.2%) from the total percentage of film rejection, and most commonly occurred in the lower and upper molar region, and in the lower premolar region. This cause was also mentioned by (Jayasinghe R. D, *et al*. 2013), who found that miss centering was the second common cause, and the higher number of errors was observed in maxillary teeth.

The third one was an error in the horizontal angulation in the lower anterior and lower premolar region. That error was also attributed to the vertical angulation in the upper and lower molar, which constituted a percentage of (13.3%) of the total percentage of film rejection. This does not exactly match the result of the study carried out by (Ediri Arachchi W. M, *et al.* 2015), as this reason had come in the second place of rejection reasons.

The highest number of retakes was in the lower molar region (14 films), and the common causes were Patient movement and miss centering errors.

The Patient movement was due to difficulty in placing the film in this region, because of gag reflex or because the patient is usually unable to stabilize the film properly.

The second common cause for retakes in the lower molar region was miss centering of the x-ray beam, and the cause for con-cut was that there were no specific points of entry to keep the PID centered on the film, beside the difficulty in placing and stabilizing the film in this region.

The second region in a high number of retakes was the upper molar region (11 films), whose cause was similar to the lower region.

The third region in high number of retakes was the lower premolar region (8films), and the common cause was miss direction of the x-ray beam horizontally and vertically; and this was due to difficulty in estimating the suitable horizontal, vertical angulation since there was no scale to read the angulation.

The other causes for film rejection were less common and had a lower percentage when compared with the mentioned above causes.

5.2 Conclusion

From the results in chapter four, and from the discussion in chapter five, the tests were done for the x-ray machine by using a digital meter and showed a noted variation in kV, which drop degrades the image quality. The evaluation of the quality control system revealed that the absence of regular

reject analysis resulted in the repetition of the same errors. The study also showed that the mentioned department should have a quality control officer to observe the quality control programme, and the department should also provide quality control test tools.

5.3 Recommendations

1. The x-ray machine of Al Neelain clinic needs to be calibrated in such a way as to be close to the standard.
2. The department should be provided by a thyroid collar.
3. Establishment of a written quality control programme with quality control officer.
4. The disinfectant solutions, barriers, and film holding devices should be continuously available in the department.
5. The light leakage in the darkroom should be laminated.
6. Correction of high rate of the retakes radiographs by establishing regular reject analysis programme.
7. Providing the department staff with personnel radiation dose monitoring devices.
8. All new X-ray installations should undergo a critical examination and detailed acceptance tests before use, to ensure that radiation protection for staff, members of the public and patients are optimal.
9. The dental x-ray machine should undergo regular routine tests to ensure that radiation protection, for both staff and patients, has not significantly deteriorated.

10. A QC system for monitoring darkroom and processing conditions should be applied in this department. For instance, the temperature of the developer should be checked prior to film processing and the development time should be adjusted in accordance.

11. All those involved in radiography should have received adequate theoretical and practical training for the purpose of radiological practices and relevant competence in radiation protection. Continuing education and training after qualification is required, particularly when new equipment or techniques are used.

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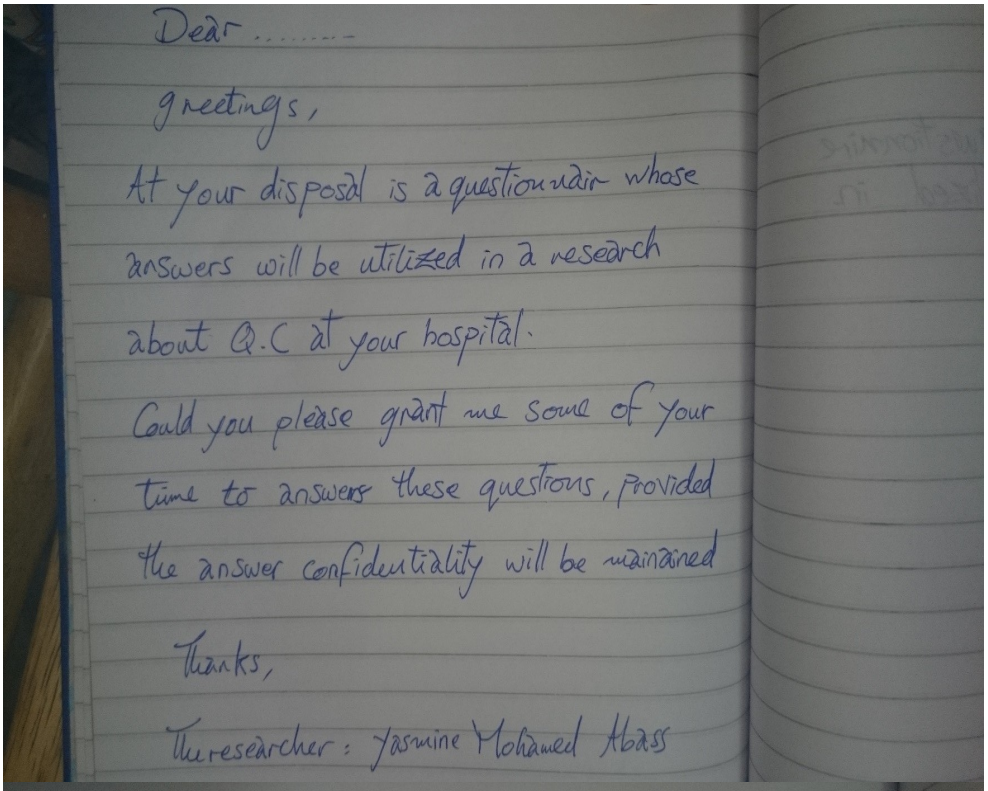
Appendices:

The dental x-ray machine

Parts of x-ray machine: Panel, Tube housing.

Film quality is bad (Vertical angulation error)

Film quality is good (Roots view is clear)



Dear .....

greetings,

At your disposal is a questionnair whose answers will be utilized in a research about Q.C at your hospital.

Could you please grant me some of your time to answers these questions, provided the answer confidentiality will be mainained

Thanks,

The researcher: Yasmine Mohamed Abass

Q_1: Is there any Q.C officer and Q.C programme at your hospital?

Q_2: Is there any infection control officer and programme at your hospital?

Q_3: Are there any documented radiation protection rules and radiation measurement devices?

Q_4: Is there any regular reject analysis programme?

Q_5: Dose your department need Q.C programme?