THE QUALITY OF DENTAL X-RAY IMAGES THAT ARE REFERRED TO ORAL SURGEONS

A MULTINATIONAL STUDY IN THE MIDDLE EAST AND UNITED KINGDOM

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ABSTRACT

Title: The quality of dental X-ray images that are referred to oral surgeons

A multinational study in the Middle East and United Kingdom

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Background: The dental profession is committed to delivering the highest quality of care to each of its individual patient and applying advancements in technology and science to continually improve the oral health status of the population. Several guidelines have been developed to serve as an adjunct to the dentist's professional judgment on how to best use diagnostic imaging for a patient. Radiographs can help the dental practitioner evaluate and definitively diagnose a number of oral diseases and conditions. However, the dentist must weigh the benefits of taking dental radiographs against the risk of exposing a patient to radiation, the effects of which accumulate from multiple sources over time. The dentist, knowing the patient's health history and vulnerability to oral disease, is in the best position to make this judgment in the interest of the patient.

Objective: The purpose of this study is to evaluate the different perceptions of what makes a proper dental X-ray image, and to compare if there is a difference in dentists' perspectives of the quality of dental X-ray images against established criteria in the "National Radiological Protection Board (NRPB)", between dentists in the Middle East and the dentists in the United Kingdom.

Material and methods: This was a cross-sectional study of a total of 400 dentists of all specialties, who were invited to participate in a survey, using a structured questionnaire shown on a tablet screen that included 10 different X-ray images of teeth intended for extraction. These images were selected for the questionnaire by expert radiologists and oral surgery consultants from a pool of referred dental X-ray images to oral surgeon in UK. The criteria used for answering the questionnaire is an adaptation of the "National Radiological Protection Board (NRPB)" criteria which uses subjective quality rating of radiographs. The criteria included two ratings (acceptable and unacceptable) for the purpose of the extraction of a tooth. All ten images were pre-evaluated by a calibrated panel of experts composed of seven specialists in the field of maxillofacial radiology. The questionnaire also included other information obtained for the purposes of comparison and description regarding the area of specialty, years of experience, location of current practice and country of qualification in dentistry.

Results: A total of 342 participants were included in the study out of 400 with a response rate of 85.5%. The inclusion criteria of the selected questionnaire depended on completion of all elements of the questions included. There were 215 (62.9 %) males and 127 (37.1 %) females. The experience in dentistry ranged from 1 year to 45 years with a mean range of experience of 13.28 years. The distribution of participants according to the place of qualification was 182 (53.7%) from the Middle-East, while 160 (46.8%) were from the United Kingdom. The average of the score of reading the ten photos correctly in agreement of the panel of experts was 4.95 (S.D. 1.62) overall in both groups of participants from the Middle East and from the United Kingdom. There is no association between the number of years of experience and the score of correct answers (p-value=0.113). This study has

revealed that there is a significant difference in the overall correct score of the questionnaire in favour of the participants group with a qualification in dentistry from the United Kingdom (p-value= 0.013).

Conclusion: The participants qualified from the United Kingdom performed better than the Eastern participants in answering the questionnaire. The perception of dentists of varying specialties in the Middle East in regards to the quality of referred dental X-ray images needs to be addressed. This perception affects the quality of care that the patients receive, through either repeated X-ray exposure or by management of patients with inadequate X-ray images. More attention is needed to highlight this issue and strict protocols for the quality of referred dental X-ray images must be put in place.

DEDICATION

It is with humility that I dedicate my post graduate dissertation to my role model and inspiration, "my father" who has been my rock throughout all my milestones in life, always inspiring me to peruse my dreams.

I also dedicate it to "my mother" who stood by my side throughout my life and especially during the years of my studies. I would not have done it without her.

I would like to also dedicate my dissertation to my sweet and loving brother and sisters, who gave me endless love and support.

A special dedication goes to my best friend Afraa Abdulfattah for being a wonderful source of encouragement, kindness and a special friendship.

DECLARATION

I, **Taghrid Mohammed Sebeeh**, declare that this dissertation is my own original work and that it has not been presented and will not be presented to any other University for a similar or any other degree award.

Signature..... Date .....

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L IST OF ABBREVIATIONS

ALARA: As Low As Reasonably Achievable

CBCT: Cone Beam Computed Tomography

CME: Continuous Medical Education

CQC: Care Quality Commission

CT: Computerized Tomography

DHA: Dubai Health Authority

DRL: Diagnostic Reference Level

FDA: Food and Drugs Administration

FGDP: Faculty of General Dental Practice

°F: Degree Fahrenheit

GDC: General Dental Council

GDP: General Dental Practitioner

HBMCDM: Hamdan Bin Mohammed College of Dental Medicine

IR(ME)R : Ionising Radiation (Medical Exposure) Regulations

JPEG: Joint Photographic Experts Group

mSv: MilliSievert

mGy: Milligray

NCRP: National Council on Radiation Protection and Measurements

NRPB: National Radiological Protection Board

OPG: Orthopantomograph

UK: United Kingdom

UAE: United Arab Emirates

CHAPTER ONE:

Introduction & Literature review

1.0 Introduction

The dental profession is committed to delivering the highest quality of care to each of its individual patients and applying advancements in technology and science to continually improve the oral health status of the population. Several guidelines have been developed to serve as an adjunct to the dentist's professional judgment on how best to use diagnostic imaging for a patient. Radiographs can help the dental practitioner evaluate and definitively diagnose a number of oral diseases and conditions, however, the dentist must weigh the benefits of taking dental radiographs against the risk of exposing a patient to radiation, the effects of which accumulate from multiple sources over time. The dentist, knowing the patient's health history and vulnerability to oral disease, is in the best position to make this judgment in the interest of the patient (American Dental Association, 2012).

Any amount of exposure to ionizing radiation represents an incremental risk to the person being exposed to any subsequent issue (National Research Council, 2001). A number of medical and scientific groups agree that there remains an unproductive radiation exposure from X-ray use that could, and should, be reduced (Crownover et al., 2013).

There is a continuing evidence of poor image quality of panoramic radiographs taken in primary dental care (Helminen et al., 2000). Any faults in the radiographs will certainly lead to lessening the diagnostic value of the examination. It is vital that particular care is taken in monitoring and maintaining high image quality by paying close attention to the precise imaging techniques and procedures. The dental service provider should employ vigorous quality assurance techniques as this is a statutory requirement of the Ionising Radiation (Medical Exposure) Regulations of 1999.

Therefore, poor quality or absence of X-ray dental images referred to the oral surgeon can dramatically affect the diagnostic process and the quality of treatment delivered. Over 50% of the population receives at least one radiographic examination annually. Although many procedures now require less exposure per film, an increased number of procedures have resulted in an increase in the radiation exposure (American College of Radiology, Chicago, 2009).

1.1 Literature review

Radiographs and other imaging modalities are used to diagnose and monitor oral diseases, as well as to monitor dentofacial development and the progress or prognosis of therapy. Radiographic examinations can be performed using digital imaging or conventional films. The available evidence suggests that either is still a suitable diagnostic method (Anbiaee, et al. 2010). Digital imaging may offer reduced radiation exposure and the advantage that image analysis may enhance sensitivity and reduce error introduced by subjective analysis (Tracy et al., 2011).

A study of 490 patients found that basing selection criteria on clinical evaluations for asymptomatic patients, combined with selected periapical radiographs for symptomatic patients, can result in a 43 % reduction in the number of radiographs taken without an increase in the rate of undiagnosed disease (Assessing the FDA guidelines for ordering dental radiographs, 1995).The development and progress of many oral conditions are associated with the patient's age, stage of dental development, and vulnerability to known risk factors. All guidelines assume that diagnostically adequate radiographs can be obtained. If not, appropriate management techniques should be used after consideration of the relative risks and benefits for the patient.

The additional exposure related with dentistry represents a minor contribution to the total exposure from all sources. The National Council on Radiation Protection and Measurements (NCRP) has estimated that the mean effective radiation dose from all sources in the United States is 6.2 millisieverts (mSv) per year, with approximately 3.1mSv of this dose from natural sources and approximately 3.1mSv from man-made sources (National Research Council, 2001).

The guidelines regarding dental radiography safety and protection in the Middle East remain limited. Since 2005, the United Arab Emirates (UAE) has participated in the International Atomic Energy Agency's regional technical co-operation projects. In these projects, radiology and medical physics teams at the Dubai Health Authority (DHA) managed to reduce patient radiation doses by up to 50% for common computed tomography (CT) examinations (head, chest, and combined abdomen and pelvis) (AlSuwaidi et al., 2013). Such projects have not been conducted in dental radiographs. Moreover, patient dose monitoring was initiated within conventional radiology practices, and was further enhanced with the introduction of digital radiology systems at DHA hospitals. The AlSuwaidi study presents some DHA patient data obtained from the practices of general radiology, mammography, interventional radiology, as well as intra oral and panoramic radiology. The aim of the AlSuwaidi study was to evaluate radiation exposure levels to DHA patients, and to help to introduce steps towards forming local diagnostic reference levels (DRLs) for common radiological examinations. The diagnostic reference level is a form of investigation to identify unusually high levels of radiation doses, which calls for local review if consistently exceeded. The author concluded that in the UAE and the Gulf region, more initiations can be done to establish

DRLs. In addition to improvements in patient safety, this dose assessment limitation has provided new opportunities for applied research.

1.2 Overview of radiographic dental imaging

Radiographs are defined as two-dimensional images that are generated by the interaction of X-rays and tissue. These images depend of the type and nature of the tissue in terms of atomic number, density and thickness. The images are permanently recorded in emulsion, supported by a plastic base and there are essential factors that are needed to produce a suitable image:

1- Suitable exposure factors are important to produce an appropriate pattern of X-ray energy in the beam after passing through the object, in order to sensitise the film emulsion and create a latent image.

2- The processing procedures must be correctly done to make the latent image visible and non-degradable.

3- The storage system must be adequate to ensure that images can be retrieved when needed.

These three factors are related to the images on radiographic films, which is a method used for the majority of dental radiographs. More recently, there is an increased use of digital radiography, using computer systems in conjunction with a source of X-rays.

To summarize the production of a radiograph used with practical scientific background in the dental maxillofacial region, the following must be looked at carefully:

1. Use of X-ray source

2. Interaction between X-ray and the object matter
3. An object requiring X-ray examination
4. An appropriate image receptor
5. A storage system
6. A viewing system

Moreover, the sufficient knowledge of normal anatomy of the region and its radiological appearance is essential as a basis for radiological examination in order to aid the recognition of abnormal structures and features (Brocklebank et al., 1997).

1.3 Types of radiographic projections

Many types of dental X-ray projections are available depending on the field, the area required for viewing, and the angle needed (Brocklebank et al., 1997). Those include:

Intra-oral radiographs:

- Bitewing
- Periapical
- Occlusal (oblique or cross-sectional)

Extra-oral radiographs:

- Panoramic
- Oblique lateral
- Lateral cephalometric
- Other extra-oral views: (occipitomental / posterior-anterior mandible / Submentovertex)

1.4 Image quality in dental radiography

In the practice of radiation protection, there is a an essential rule which is that the production of a radiograph should be of high diagnostic quality with significance to the treatment, while exposing the patient to the lowest practicable dose (Horner et al.,1994). However, it has been shown that there are a considerable number of radiographs exposed in dentistry that are of minimal or non-diagnostic quality. The value of a panoramic radiograph is reduced when it is of poor diagnostic quality. Low quality radiographs can lead to misinterpretation, resulting in incorrect diagnosis and treatment planning and misguidance in intra operative techniques. A non-diagnostic quality image often requires a need for additional images and repetition of examinations (Rushton et al., 1999). Repetition of panoramic radiography carries an accompanying risk of inducing cancer which has been estimated as a range of 0.21 or 1.9 cases per million examinations. A non-diagnostic quality image which leads to repetition is not necessarily a result of an inherent limitation of the equipment but rather a result of errors made by the operator during patient positioning and processing of the image (Dhillon et al., 2012).

Compared with intraoral radiography, panoramic radiography poses particular challenges in both of these aspects of image production. Processing errors can be eliminated by the use of digital processing, which has lately been increasing in status among dentists. However, the suitable positioning and preparation of the patient is essential for a sharp, accurate, and undistorted image, which is not affected by ghost images (Rushton et al., 1999). Furthermore, panoramic radiographs may contain radiopaque and radiolucent spots that are reflections of structures on the examined areas as well as shadows of soft tissues and anatomical air spaces making patient positioning even more important. Inaccuracies in patient positioning lead to discrepancies between horizontal and vertical

magnification, with consequent distortion of the image. The goal of all radiography should be to produce a quality radiograph. Such a radiograph will exhibit maximum detail to resolve fine objects. It will show the teeth and anatomical structures accurately without distortion or magnification. It will have the optimal density and contrast and visual characteristics to maximize its use for the detection of dental disease. To create such a film, attention must be paid to all three steps in the production of the radiograph, positioning, exposure and processing (McDavid et al., 1983).

1.5 Radiographic errors and artifacts

The ideal radiograph is one that shows optimum density, optimum contrast, is accurate and covers the area of interest completely. When any of these conditions are not satisfied, the radiograph may be termed faulty.

An artefact is a structure or an appearance that is not normally present on the radiograph and is produced by artificial means. Radiographic errors may be due to technical errors or processing errors. Artefacts may occur as a result of errors in processing, exposure, or handling and storage of films. In addition, mistakes in patient preparation are common. The following is a list of errors that may occur in an image of reduced quality: (Akarslan et al., 2003).

- Patient preparation error:

➢ Radiopaque artefact: This is a result of objects that the patient was wearing during exposure such as dental appliances, body piercings, jewellery & spectacles. This radiopaque artefact is superimposed over the dental image.

➢ Blurred image: This error results from the movement of the film, patient or X-ray tube head during exposure.

- Pressure mask: This error results from the pressure on the incisal edge & cusps of the teeth and may appear black or white.

- Processing errors:

These include hyporetention, pi-lines, guide shoe mark, static entrance roller mark, crinkle mark, finger marks, emulsion pick-off and water stains.

- Exposure errors:

These include motion, improper positioning, poor film screen contact, double exposure, foreign objects, back-scatter, upside-down cassette, broken cassette, and improper use of grid.

- Film handling and storage errors:

The ideal film storage temperatures are between 50 °F and 70 °F and between 30% and 50% relative humidity. Any increase is known to cause increased sensitization of the film emulsion. Extra oral films should be stored in a vertical orientation to prevent pressure artefacts. Failure to maintain these cardinal rules in the radiographic unit leads to production of artefacts such as:

- Tree like artefacts caused by static electricity resulting in dark tree like lines running across the film.
- Smudge static when the electricity produced by polyester clothing causes black smudges on the film.
- Crescent or half-moon artefact causing a dark crescent on the film.
- A finger print pattern resulting in a dark finger prints on the film.
- Scratches.

1.6 Radiation doses in dental practice

There are three common terms used to describe the radiation dose, which are:

Absorbed dose (D): This is the concentration of energy deposited in tissue as a result of an exposure to ionizing radiation. It means the energy absorbed by human tissue from the ionising radiation. The unit of measurement for the absorbed dose is the milligray (mGy) (Valentin et al., 2007).

Equivalent dose (H_T): This is an amount that takes the damaging properties of different types of radiation into account. The differences between the absorbed dose in tissue and the equivalent dose are firstly, the absorbed dose shows the energy deposit in a small volume of tissue and secondly the equivalent dose addresses the impact that the type of radiation has on that tissue. Given that all radiation used in diagnostic medicine has the same low-harm potential, the absorbed dose and the equivalent dose are numerically the same and only the units are different. The equivalent dose unit is the milliSievert (mSv).

Effective dose (E): This is a calculated value, measured in mSv, which takes three factors into account, which are: the absorbed dose to all organs of the body, the sensitivities of each organ to radiation and the relative level of harm of the radiation. The effective dose relates to the overall long-term risk to a person from a procedure and is useful for comparing risks from different procedures (Horner et al., 2004). The factor by which the equivalent dose in tissue or an organ is weighted is called the "tissue weighting factor", which represents the relative contribution of that organ or tissue to the total detriment resulting from uniform irradiation of the whole body (Mountford et al., 1992) as shown in figure1.

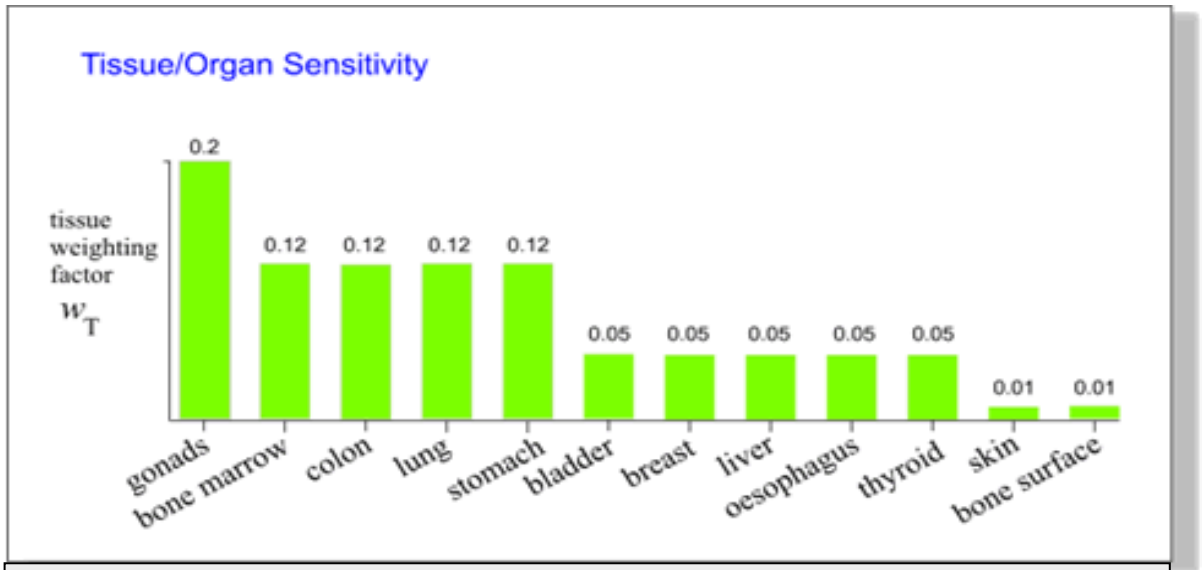


Figure.1: The tissue weighting factor of each irradiated involved organ (Mountford et al., 1992)

1.7 Radiation risk in dental practice

Radiography is an essential tool for the clinician, providing information that clinical examination cannot obtain. Out of all X-rays taken in the United Kingdom, approximately 26% are taken by the general dental practitioner (GDP). In 2008 it was estimated that 20.5 million dental radiographs were taken by dentists in the National Health Service (NHS) and private practice, and of these, 2.7 million were panoramic radiographs (Hart et al., 2008).

X-rays are a type of electromagnetic (EM) radiation that also includes visible light, radiowaves, cosmic radiation and several other varieties of rays. When X-rays hit the atoms its high energy can be transferred, causing ionization of the atom that can damage the molecules. But, the damage to the DNA in the chromosomes is of particular importance, as most of the DNA damage can be successfully repaired, but rarely a portion of a chromosome may be permanently mutated. This suggests that it may lead to uncontrolled cell replication which my lead to the formation of a tumour. It has been stated that the latent period between exposure to X-rays and diagnosis of a tumour may

be several years (Horner et al., 2004). The likelihood of a tumour being created is related to the radiation dose, therefore the knowledge of the doses delivered is essential. Such effects where the magnitude of the risk is related to dose can be considered as 'chance' (stochastic) effects (Horner et al., 2004).

There remain no clear evidence about the existence of a safe level of radiation dose. It is currently assumed that any level of dose could lead to tumour induction. So the lower the radiation dose, the lower the risk of radiation-induced tumours (Valentin et al., 2007).

There is well-documented epidemiological evidence that exposure to radiation doses above tens of millisieverts is associated with an increased risk of developing cancer (Mobbs et al., 2011). It has been published by the United Kingdom Health Protection Agency that there is a 1 in 15,000 (for men) and 1 in 18,000 (for women) risk of cancer being introduced for every 1mSv effective dose received from dental radiography. Unfortunately 1 in 2 people in the UK die from cancer (Ahmed et al., 2015). Radiography increases the chance of developing cancer, and it is estimated that diagnostic radiology, medical and dental, causes 700 cancer cases per year in the UK. The collective dose to the population from dental radiography is low, so only a small proportion of these cancers can be attributed to dental radiography (Hart et al., 2004)

There are other known harmful effects of radiation, such as skin erythema, hair loss and effects on fertility, that have threshold doses below which they may not occur (Valentin et al., 2007). It is useful to understand the magnitude of the risk associated with dental radiography when considering the justification of individual dental exposures and the effect of dental exposures on the entire population. Risk factors are regularly published

and are continually being sophisticated as new data becomes available (Wall et al., 2011).

Moreover, radiation risk is age-dependent, being highest for the young and lowest for the elderly. The tissue of a younger individual is more radiosensitive and their protective life span is likely to exceed the latent period. For the elderly, life expectancy is expected to be less than the latency period, which can be anything from five years and higher. This risk could be considered insignificant (Wall et al., 2011).

In addition, the risk is often with considerable concern in pregnant women because of possible risk to the foetus. As the subject of radiography during pregnancy is sensitive and of some debate, it is recommended that practitioners offer pregnant patients the option of delaying non-urgent radiography (Holroyd et al., 2009).

1.8 Limiting radiation exposure

Dental radiographs account for approximately 2.5% of the effective dose received from medical radiographs. Even though radiation exposure from dental radiographs is low, once a decision to obtain radiographs is made, it is the dentist's responsibility to follow the ALARA Principle (As Low as Reasonably Achievable) to minimize the patient's exposure (American Dental Association, 2015). Examples of good practices in radiography to limit the radiation exposure include:

- The use of the fastest image receptor compatible with the diagnostic task. The use of F-speed film or digital as switching from D to E speed film can produce a 30% to 40% reduction in radiation exposure (Drug Administration Center for Devices and Radiological Health, 2011).
- Collimation of the beam to the size of the receptor whenever feasible.

- Proper film exposure and processing techniques.
- Use of protective aprons and thyroid collars, when appropriate.
- Limiting the number of images obtained to the minimum necessary to obtain essential diagnostic information.

1.9 Justifications in radiology

X-ray exposure involves risk to patients therefore, it is of essence that any radiological examination must show a potential net benefit to the patient. This is achieved by weighing the total diagnostic benefit that it will produce against the harm the exposure may cause. The efficacy, benefits and risk of available alternatives techniques should be taken into account (Hirschmann, et al., 1995). This decision making process is termed "justification" and is an ethical and a legal requirement in dental practice (IR(ME)R, 2000). In order for the justification process to be carried out properly, it is essential that the selection of dental radiographs is based on the individual patient's history and a clinical examination. The routine use of X-rays for diagnosis based on a generalized approach rather than an individual prescription is incorrect. Choosing a radiograph should be based upon consideration of the prevalence of the disease, the rate of progression and the diagnostic accuracy of the imaging techniques (Horner et al., 2004).

The most effective way to reduce dose in dental radiography is to avoid unnecessary X-ray examination. Routine dental X-ray examination for all patients is not justified. In addition, the patient dose for each X-ray examination should be optimized so that it is "As Low As Reasonably Achievable"(ALARA) and consistent with producing the required image quality (The Royal College of Radiologists, 2008).

1.10 The need for guidelines in dental radiography

When a useful diagnostic investigation is defined, it is one that would result in a confirmation or an alteration in the clinician's diagnosis and course of treatment planning as well as guidance through operative techniques. This is of particular interest since there is a wide variation in dental practice when it comes to radiographic selection criteria. There is an increased need to minimize and prevent some radiographic examination, including:

- Radiographs which have no input and are unlikely to affect the patients management, diagnosis or prognosis
- Radiographs which are repeated unnecessarily
- Duplication of previously taken radiographs

There is also a need to ensure that radiographic information contributes to achieving optimal standards of diagnosis and patient care, and that clinically significant disease is not overlooked. This means that some operators may perform more radiographic examinations whilst others would undertake less, depending on the need of each individual patient. In addition, the history taking and clinical examination must be taken into consideration when selecting radiographs. It is a legal requirement that those using X-rays on patients are adequately trained, especially when using more recent techniques, such as cone beam CT (CBCT). Strict guidelines must be in place to ensure the safe use of dental radiography and ensure optimum care for patients (Horner et al., 2004).

Guidelines in the Middle East are based on international protocols, but there is a concern regarding compliance. A survey performed in the United Arab Emirates in 2015, which

included 60 intra-oral machines (22 conventional film-based intra-oral X-ray machines and 38 digital intra-oral X-ray machines) and 9 panoramic (OPG) dental radiology units in Dubai Health Authority (DHA) hospitals and clinics presented the dosimetric results of digital intra-oral and OPG systems. Radiation exposures from intra-oral machines were measured using an electronic dental dosimeter. The dose survey for the OPG machines was performed using a CT cylindrical ionisation chamber. The authors looked at the radiation exposure parameters data and compared the results with a United Kingdom review undertaken in 2010 plus other international references. The results revealed that the total dose value from radiation in UAE is 2.5mGy compared to 1.7 in the United Kingdom. (AlSuwaidi et al., 2015) as shown in figure 2.

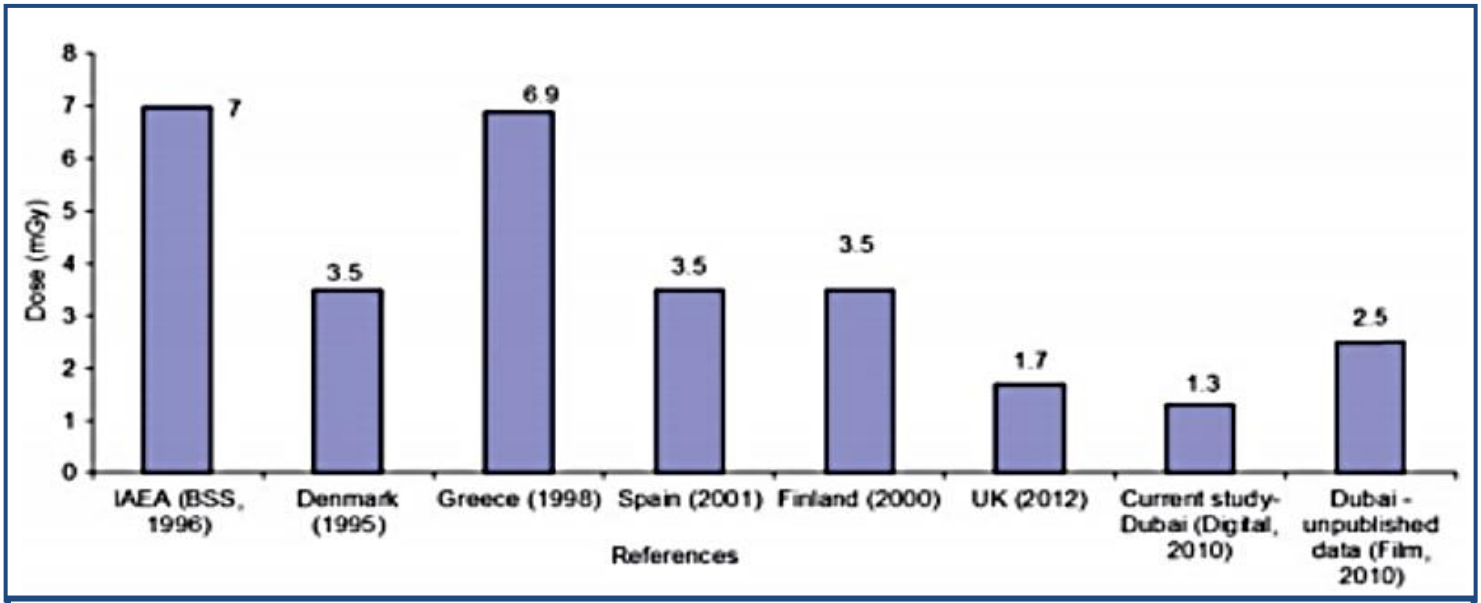


Figure.2: Comparison of intra-oral dose values from Dubai Health Authority with international references* IAEA (1996), Denmark (1995), Greece (1998), Spain(2001), and Finland (2000) are cited in EC (2004), UK (2010) is cited in Hart et al.(2012).

1.11 IR(ME)R

An essential legislation that considers the importance of radiography regulations and monitoring are the Ionising Radiation (Medical Exposure) Regulations IR(ME)R. A Working Party brought together representatives from the professional bodies of clinical oncology, therapeutic radiography and radiotherapy physics to produce a guide to help employers and clinical colleagues in UK cancer centres understand and implement IR(ME)R legislation as it pertains to radiotherapy.

IR(ME)R is legislation intended to protect the patient against the dangers associated with ionising radiation. Violation would be considered in criminal law rather than a civil law. To differentiate between the two torts, if there is a breach of civil law then the law tries to establish fault and award compensation, whereas in criminal law, an illegal act is punishable and compensation is a secondary issue.

IR(ME)R (2000) defines the role of each duty holder in a clinical setting to explain how the cycle of justification for the radiological exposure maybe explained. Firstly, the referrer who requests the radiograph is required to provide sufficient clinical information to allow the justification of the treatment to be determined. Secondly, it is the practitioner who is responsible for the medical exposure and for justifying any radiation exposure and thirdly, it is the operator who carries out any practical aspect of the process including, for example, machine calibration or treatment planning. It is important to be able to track the pathway in which the exposure is performed and then referred to minimise the error (IR(ME)R, 2000).

1.12 Selection criteria for dental radiographs

In radiology, guidelines assist the process of selecting the appropriate imaging pathway. Such guidelines, called 'selection criteria' or 'referral criteria' are available for both dental and medical radiographic imaging. The radiology referral criteria have been defined as a "description of clinical conditions derived from the patient history and the signs and symptom that identify patients who are likely to benefit from a particular radiographic technique" (Preston-Martin et al., 1990). The criteria regarding patient selection for dental radiographs is crucial. The American Dental Association panel has published guidelines in 2004 justifying pre-operative imaging for new and recall patients. The panel also made recommendations that are applicable to all categories. Their recommendations include the following:

1. Intraoral radiography is useful for the evaluation of dentoalveolar trauma. If the area of interest extends beyond the dentoalveolar complex, extra oral imaging may be indicated.

2. Care should be taken to examine all radiographs for any evidence of caries, bone loss from periodontal disease, developmental anomalies and occult disease.

3. Radiographic screening for the purpose of detecting disease before clinical examination should not be performed.

A thorough clinical examination, consideration of the patient's history, review of any prior radiographs, caries risk assessment and consideration of both the dental and the general health needs of the patient should be accurately performed before any radiographic examination (American Dental Association, 2012).

1.13 Dental radiography prior to oral surgery

It has been stated by the Scottish Intercollegiate Guidelines Network that routine radiography of unerupted third molars is not recommended. The panoramic radiograph is commonly used to assess and examine third molars before surgical removal but this does not need to be done at the initial examination (Scottish Intercollegiate Guidelines Network, 1999). When it comes to mandibular third molars the radiograph must provide information about the distance to the lower border of the mandible and some information regarding the relationship of the tooth to the inferior dental canal. Panoramic radiographs do not however provide an accurate indication of a close relationship to the inferior dental canal. In case there is a close relationship between the tooth and the canal it is suggested to use a different projection geometry, or if available, a localized "Cone beam computed tomography" (CBCT) examination is carried out if it is likely to provide additional information or a change in the surgical management (Horner et al., 2004). It should be noted that a CBCT must not be used routinely in all cases, as improvement of the patient outcome is still not supported by the evidence in such surgical cases (Flygare, et al. and Öhman, et al., 2008). In other surgical cases such as the enucleation of small cysts, apicectomies, and removal of roots, an intraoral radiograph may be all that is required to carry out the treatment planning (Horner et al., 2004).

In many oral surgery cases, a complete preoperative assessment cannot be completed by clinical examination only, if not supplemented by a dental radiograph. In some protocols it is not essential to take an X-ray before every extraction, unless the following indications are present (Howe et al., 1980).

- Difficulty in previous extraction attempts

- A tooth that is abnormally resistant to extraction forceps
- If tooth extraction is likely to require dissection
- Any tooth or roots suspected to have a close relationship to either the maxillary antrum or the inferior alveolar canal or the mental nerve
- Impacted premolars, or misplaced canines
- All symptomatic mandibular third molars
- Heavily restored or pulpless teeth
- Any tooth affected by periodontal disease accompanied by sclerosis of the supporting bone
- Any tooth which has been subjected to trauma
- Over-erupted maxillary molars with no opposing teeth as the bony support of such a tooth is often weakened by the extension of the maxillary antrum
- Any partially erupted tooth or retained roots
- Any tooth with an abnormal crown morphology or delayed eruption which may indicate the presence of dilacerations, gemination or presence of a dilated odontome.
- Any condition which predisposes to a dental or alveolar abnormality such as cleido-cranial dysostosis, radiation therapy, and osteopetrosis (Howe et al., 1980).

A good quality radiograph is one which shows all the details needed to perform a safe procedure with competence. These details include the morphology of the roots and curvature, the pathology associated with the tooth such as caries and periapical infections, the important anatomical landmarks associated such as the border of the mandible, the inferior alveolar canal and the floor of the maxillary sinus (Howe et al., 1980).

1.14 The referral pathway of patients

Many strict protocols of referrals to dental specialists have been placed by the National Health Service (NHS) in the United Kingdom. Such protocols remain vague in some countries in the Middle East, including the United Arab Emirates. In order for the referring clinician to appropriately refer the patient, there must a sufficient transfer of patient data, normally in the form of a dental referral form. Minimizing additional invasive procedures can be achieved by attaching any relevant test results, diagnostics, study models and radiographs to the referral. The radiographs attached should be recent, relevant, of good quality and marked appropriately. Delivering quality information will make certain that an accurate picture is obtained of the nature of the referral so preventing any unnecessary delays and re-exposing the patient to radiation. (Dental Referral Protocols NHS, 2015)

Referrals may come from specialist colleagues, or general dental or medical practitioners, therefore a clear and effective communication process is essential. Referring practitioners should enclose relevant radiographs in an attempt to prevent subjecting the patients to further X-ray exposure. All patients are entitled to the highest standards of care possible therefore referred X-ray images should be of good quality, relevant, clear and include adequate information needed to confirm the diagnosis and proceed with the treatment (Good Practice in the Dental Specialties, November 2001).

Both Shaffie et al. and Cheng et al. looked at the quality of the referrals from the general dental practitioners (GDPs) to oral and maxillofacial departments in the United Kingdom in 2012. They conducted an initial audit of 100 referrals against a set standard. The audit included many elements to evaluate, such as stating the type of anesthesia, medical

history, duration of symptoms and other elements. When they looked at the "inclusion of radiograph" section, it was found that 93% failed to include a radiograph, in clear breach of the IR(ME)R to ensure that the patients do not get exposed to unnecessary radiation. Furthermore, only 7% of referrals stated the urgency justified with an explanation. They mentioned that this appears to be a fault within the culture of the referring GDPs, rather than the design of the referral forms themselves (Shaffie et al., 2012).

Moreover, the method of referral also has an impact on its quality of the referral as a whole. There are many means of referring dental X-ray images that have been taken by the GDP which include paper-based referrals and email referrals. Both have issues that affect the quality of the referred image. With the paper-based referrals, the image is subjected to damage by many ways such as folding. This suggests that the oral surgeon may receive a damaged X-ray which in turn may subject the patient to an additional exposure of radiation if a repeat X-ray is required. If the damage is to a degree that landmarks are poorly distinguished then this puts the patient at risk, if surgery was to proceed.

In recent years, one of the growing concerns in dentistry is the increase of email use to transfer patient health records. As dental treatments have traditionally required referring patients to outside clinicians, there has been a growing need to send their health records electronically but this method is compromised. The reason for this is that emailing images compresses a file before it arrives in the receiver's inbox. Often, the downloading process will fail to restore original quality. An alternative method is the use of good quality file-sharing services that can preserve the images in their original format, ensuring the receiver will not have to retake the X-ray (Lorne et al., 2016).

Careful consideration needs to be given to confidentiality issues when referring patient's sensitive data including X-ray images. The use of email accounts that send information without encryption is in breach of basic clinical governance philosophies. Referrers may therefore be more tempted to post the X-ray in a sealed envelope for the attention of the addressee only.

1.15 Statement of the problem

There is a tendency to over radiate patients attending dental clinical practices in the Middle East and such a trend has not been studied extensively. An understanding of how the patients are being exposed to dental radiation in countries with established protocols is needed to set a baseline for comparison with a view of proposing appropriate recommendations to create equivalent protocols that will ensure the quality of the dental X-ray images and patient safety.

1.16 Rationale

Carrying out this study is with an intention to provide results with useful information and knowledge regarding the perception of dentists of what makes a suitable X-ray for diagnosis and treatment. In the Middle East, there is no such data available to evaluate the understanding of the quality of a dental X-ray, and to what extent dentists are prepared to either re-expose the patients or utilise a sub-standard image.

1.17 Objectives

- The purpose of this study is to evaluate the perceptions of dentists of varying experience and fields of dentistry in assessing the quality of referred dental images to the oral surgeon for the purpose of exodontia and establishing if they meet an appropriate standard in terms of quality and reliability for diagnosis and treatment.

- Another purpose of this study is to find if there is a difference in dentists' perspectives of the quality of dental X-ray images against an adaptation of established criteria from the National Radiological Protection Board (NRPB), when comparing dentists from the Middle East and the United Kingdom.

CHAPTER TWO:

Materials and methods

2.0 MATERIAL AND METHODS

2.1 Study settings.

The study was conducted at HBMCDM. The data of the study was collected from a number of countries including: UAE: (Dubai, Sharjah, Ajman, Abu Dhabi, and AlFujairah), Saudi Arabia (Jeddah, Riyadh), and United Kingdom (Manchester, London, Birmingham, Glasgow, and Edinburgh).

2.2 Study design

Cross-sectional design.

2.3 Study duration

The study duration was from February 2015 until February 2016.

2.4 Study population

Participants who attended dental conferences, exhibitions and showcases in the United Kingdom and in the Middle East.

2.5 Inclusion and exclusion criteria

*Inclusion criteria***:**

- All currently practicing qualified dentists willing to participate in the questionnaire**.**

Exclusion criteria:

- Nurses, dental assistants and health care managers without a degree in dentistry.
- Those who were not prepared to commit adequate time for the study.

2.6 Sample size estimation

There has been no precedent for such a study. 200 completed questionnaires were

allocated in the Middle East with a response rate of 91%. Similarly 200 questionnaires were distributed in the United Kingdom with a response rate of 80%.

2.7 Sampling procedure

A total of 400 dentists of all specialties were invited to participate in a survey, using a structured questionnaire that included 10 X-ray images of teeth intended for extraction shown on an iPad screen. These images were selected for the questionnaire by expert radiologists and oral surgery consultants from a pool of referred dental X-ray images to an oral surgery service in UK. The criteria used for answering the questionnaire was derived from the "National Radiological Protection Board (NRPB)" criteria which uses subjective quality rating of radiographs (Appendix 2). The adaptation of the criteria included two ratings (acceptable and unacceptable) (Appendix 2) for the purpose of the intended treatment which is extraction of the tooth. A simple closed question which was asked: "would you use this X-ray image to perform the stated extraction or would you request another X-ray?". It follows that those who answered that they would perform the procedure without the need for a repeat x-ray considered the existing X-ray acceptable. Those who would have requested another X-ray therefore considered the existing X-ray unacceptable. The questionnaire also included further information obtained for the purposes of comparison and description, which were specialty, years of experience, location of current practice and country of graduation.

2.8 METHODS

2.8.1 Calibration method

The panel of collaboration consisted of seven experts. The interpretation of the images that was pre-evaluated by expert radiologists and oral surgery consultants was calibrated using Cohen's kappa coefficient test (κ).The agreement between the experts' results was (87.3% to 100%).

2.8.2 Anonymising method

The X-ray rays used in the questionnaire were anonymised with no information indicating the patients name or chart number. In addition, the participant's names were not asked for in the questionnaire.

2.8.3 Analysis

Descriptive statistics were used for categorical and continuous variables. Chi-square and Fischer Exact test were used to test the dependency between two categorical variables. T-test was used to compare two continuous variables. A correlation coefficient test was used to test the linear association between two continuous variables. Analysis of variance was used to compare between three continuous variables. In the entire test, the level of significance used was 0.05.

2.8.4 Ethical clearance

This study was channeled successfully through the Research Ethical committees of the HBMCDM for clearance.

CHAPTER THREE

Results

3.0 RESULTS

3.1 Socio-demographic details

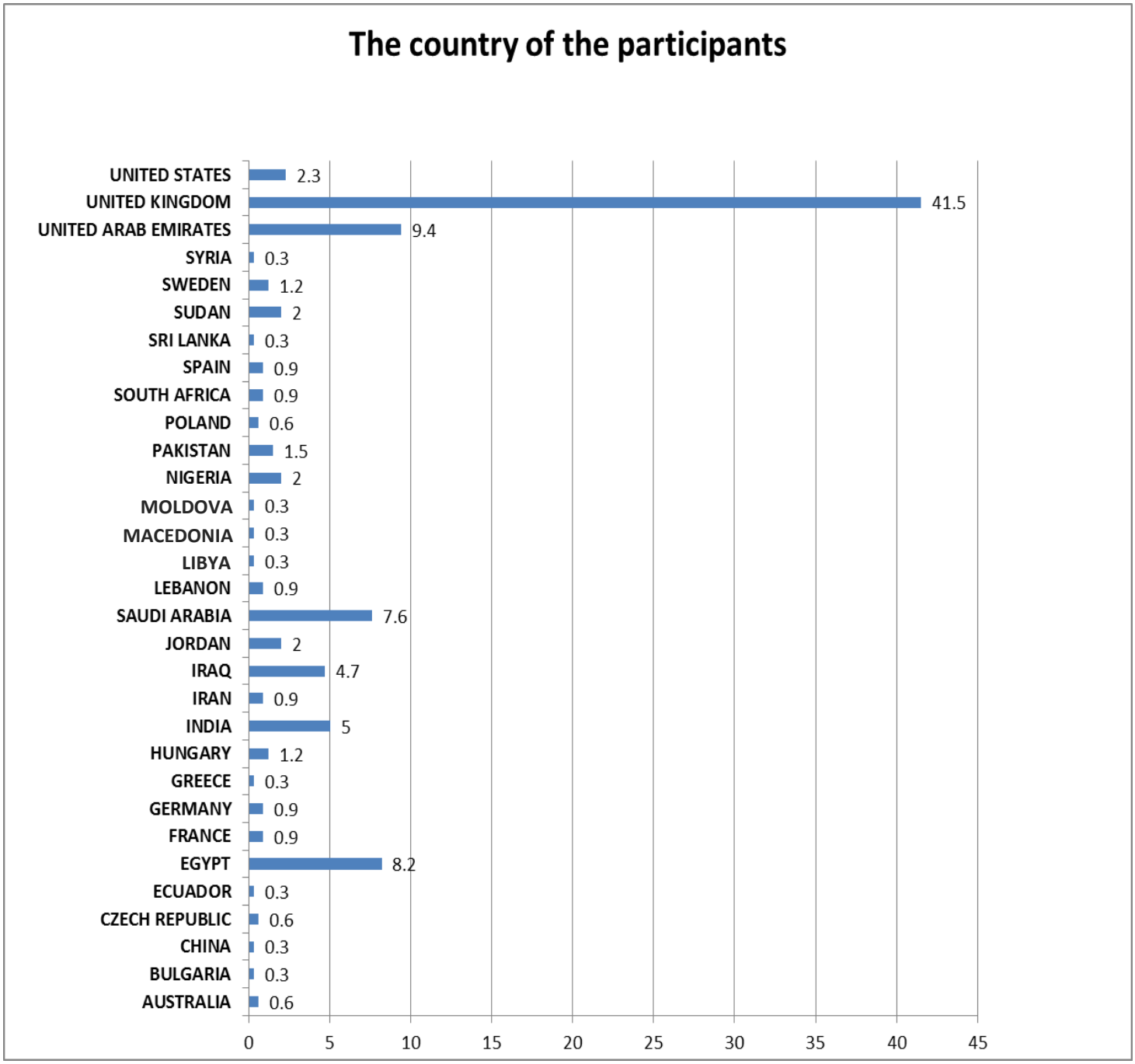
The study comprised a total of 342 participants holding a dental degree. 215 (62.9%) were males while 127 (37.1%) were females with M:F ratio of 1.6:1. The average range of years of experience of the participants was 13.28 (±10.27). The variation of the specialties of the participant dentists were: general dental practitioners 202 (59.1%), oral surgeon 82 (24%) and other specialties (paedodontists, orthodontists, periodontists, endodontists and prosthodontists) 58 (17%). The distribution of the place of qualification was 182 (53.7%) from the Middle East, while 160 (46.8%) were from the United Kingdom. (Table 1)

The participants in the study are from 32 different countries in the world (Fig.3). The country of qualification in dentistry was obtained from colleges from 15 countries. (Fig. 4)

Table 1: Characteristics of the population under study

Variables	**No. (%)**
Gender	
Male	215 (62.9)
Female	127 (37.1)
Specialty	
General practitioner	202 (59.1)
Oral surgeon	82 (24)
Others	58 (17)
Place of qualification	
Middle East	182 (53.2)
United Kingdom	160 (46.8)

Figure 3: Description of the participant's countries



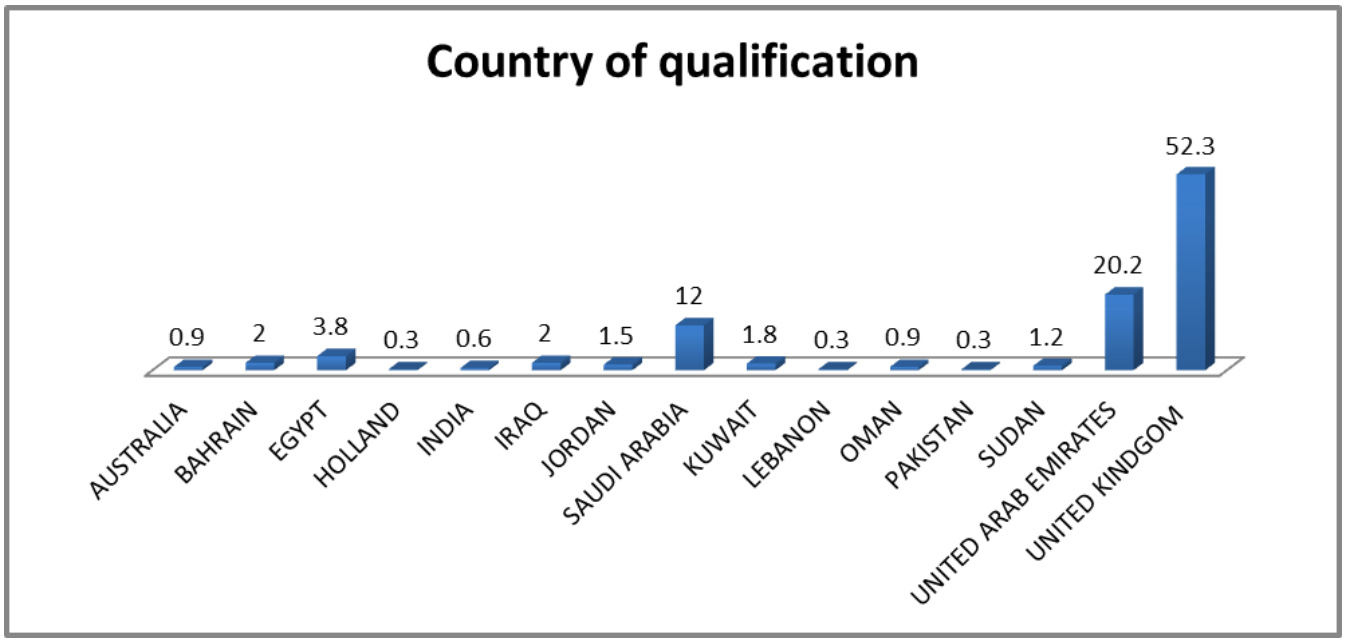


Figure 4: Description of the participant's country of qualification

3.2 Results of reading and scoring the questionnaire images

The average of the score of reading the ten photos in agreement with the calibrated experts is 4.95 (S.D 1.62). The image most rated in disagreement with the panel of experts was image 1 with a percentage of 94.2%, which was a periapical X-ray image, pertaining for the extraction of an upper left premolar. The image with the highest agreement with a percentage of 90.4% was image number 10 which was a panoramic dental X-ray image indicated for an extraction of a lower left third molar in agreement with the initial scoring by the panel of experts in the study. (Table 2), (Appendix 3)

In relation to the other images in the questionnaire, image number 2, which was a periapical X-ray image pertaining to the extraction a lower left second molar, was mostly scored incorrectly by 220(64.3%) of the participates in disagreement with the calibrated experts. As for image 3, which was a bitewing X-ray image referred for the extraction of a lower left second molar, this was scored mostly incorrectly by 281(82.2%) participants. Image 4 which was a periapical X-ray image pertaining to the extraction of an upper left

lateral incisor was also scored incorrectly by 173 (50.6%) of the participants. In addition, image 5 which was a periapical X-ray image for the purpose of extraction of an upper left first molar scored mostly incorrectly in disagreement with the score of the calibrated experts by 262 (76.6%) participants. The last image which was scored mostly incorrectly by 242 (70.8) participants was image number 9 which was a periapical X-ray image taken for the extraction of a lower left second molar (Table 2).

On the other hand, the images which were mostly scored correctly in agreement of the panel of experts in the study were images number 6, 7, and 8. Regarding image 6 which was a panoramic X-ray image referred for the extraction of the lower right third molar it was scored mostly correctly by 230 (67.3%) of the participants. As for image 7 which was a periapical X-ray image for the extraction of an upper left second premolar it was mostly scored correctly by 181 (52.9%) of the participants. Lastly, image 8 which was a paper printed panoramic X-ray image pertaining to the extraction of the lower left third molar was mostly scored correctly by 203 (59.4) of the participants in this study (Table 2).

Table 2: The distribution of rating score outcomes per image

Number of Image	Incorrect rating score	Correct rating score
1	**322(94.2)**	**20 (5.8)**
2	**220 (64.3)**	**122 (35.7)**
3	**281 (82.2)**	**61 (17.8)**
4	**173 (50.6)**	**169 (49.4)**
5	**262 (76.6)**	**80 (23.4)**
6	**112 (32.7)**	**230 (67.3)**
7	**161 (47.1)**	**181 (52.9)**
8	**139 (40.6)**	**203 (59.4)**
9	**242 (70.8)**	**100 (29.2)**
10	**33 (9.6)**	**309 (90.4)**

3.3 Comparison results

3.3.1 The association between the years of experience in dentistry and the questionnaire results.

There was no association between years of experience and the score of the correct questionnaire answer (r=0.086, p-value = 0.113).

3.3.2 Comparison of the reading of images between genders.

There was no significant difference of the overall score of the correct reading of the images in the questionnaire between male and female participants (p-value = 0.805). (Table 5)

3.3.3 Comparison of the reading of images between different dental specialties.

When comparing between different dental specialty groups; general dental practitioners, oral surgeon and other specialties (paedodontists, orthodontists, periodontists, endodontists and prosthodontists) in scoring each image in the questionnaire, the general dental practitioners scored each image mostly correctly than the other two groups. Image number 2, 4, 5 and 10 were scored mostly correctly by the general practitioner with significant difference (p-value = 0.004, 0.004, 0.001, 0.005) respectively (Table 3). When looking at the overall correct score of all the images together, the other specialties (paedodontists, orthodontists, periodontists, endodontists, prosthodontists and radiologists) scored the highest among the other two groups with an average score of 5.3, followed by the oral surgeons group with a score of 5.0 and lastly, the general dental practitioners group that had an average of 4.8 in the overall correct score. (Fig. 1)

Table 3: Comparison of the reading of images between different dental specialties

Image number		GP	OS	Others	p-value
1	Incorrect	188 (93.1)	80 (97.6)	54 (93.1)	
	Correct	14 (6.9)	2 (2.4)	4 (6.9)	0.32
2	Incorrect	143 (70.8)	49 (59.8)	28 (48.3)	
	Correct	59 (29.1)	33 (40.2)	30 (51.7)	0.004
3	Incorrect	162 (80.2)	69 (84.1)	50 (86.2)	
	Correct	40 (19.8)	13 (15.9)	8 (13.8)	0.497
4	Incorrect	117 (57.9)	31 (37.8)	25 (43.1)	
	Correct	85 (42.1)	51 (62.2)	33 (17)	0.004
5	Incorrect	150 (74.3)	74 (90.2)	38 (65.5)	
	Correct	52 (25.7)	8 (9.8)	20 (34.5)	0.001
6	Incorrect	70 (34.7)	20 (24.4)	22 (37.9)	
	Correct	132 (65.3)	62 (75.6)	36 (62.1)	0.162
7	Incorrect	96 (47.5)	37 (45.1)	28 (48.3)	
	Correct	106 (52.5)	45 (54.9)	30 (51.7)	0.916
8	Incorrect	75 (37.1)	41 (50)	23 (39.70	
	Correct	127 (62.9)	41 (50)	35 (17.2)	0.133
9	Incorrect	144 (71.3)	61 (74.4)	37 (63.8)	
	Correct	58 (287)	21 (25.6)	21 (36.2)	0.385
10	Incorrect	20 (9.9)	2 (2.4)	11 (19)	
	Correct	182 (90.1)	80 (97.6)	47 (81)	0.005

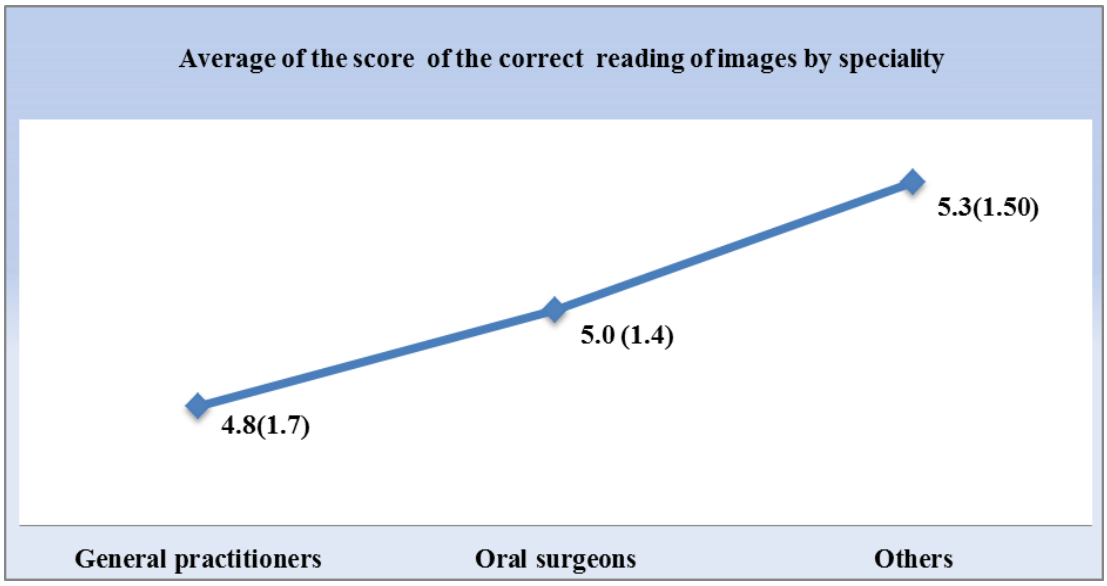


Figure 5: Average of the score of the correct reading of images per specialty

3.3.4 Comparison of the reading of images between places of qualification

When comparing the two groups based on where dentists obtained their dental qualification, the Middle East and United Kingdom differed greatly in scoring the questionnaire images.

Images 1, 2, 3, 5, 7, 8 and 9 were scored correctly among the United Kingdom group with a significant difference (p-value = <0.001, <0.001, 0.001, <0.001, 0.028, 0.003 and <0.001) respectively.

Image numbers 6 and 10 were scored mostly correctly in the Middle East group with a significant difference (p-value= <0.001). As for image 4, it was mostly scored correctly in the Middle East group but with no significant difference (p-value = 0.077) (Table 4).

This study has revealed that there is a significant difference of overall correct score (p-value=0.013) in favour of the participants group with a qualification in dentistry from the United Kingdom (Table 5).

Table 4: Comparison between places of qualification for the reading of images

Image number		Middle East	United Kingdom	p-value
1	Incorrect	180 (98.9)	142 (88.8)	
	Correct	2 (1.10)	**18 (11.2)**	<0.001**
2	Incorrect	128 (70.3)	92 (57.5)	
	Correct	54 (29.7)	**68 (42.50**	<0.001**
3	Incorrect	160 (87.90	121 (75.6)	
	Correct	22 (12.1)	**39 (24.4**)	0.002**
4	Incorrect	85 (46.7)	88 (55)	
	Correct	**97 (53.3)**	72 (45)	0.077
5	Incorrect	165 (90.7)	97 (60.6)	
	Correct	17 (9.3)	**63 (39.4)**	<0.001**
6	Incorrect	43 (23.6)	69 (43.1)	
	Correct	**139 (76.4)**	91 (56.9)	<0.001**
7	Incorrect	95 (52.2)	66 (41.2)	
	Correct	87 (47.8)	**94 (58.80)**	0.028**
8	Incorrect	87 (47.8)	52 (32.5)	
	Correct	95 (52.2)	**108 (67.5)**	0.003**
9	Incorrect	144 (79.1)	98 (61.20	
	Correct	38 (20.9)	**62 (38.8)**	< 0.001**
10	Incorrect	6 (3.3)	27 (16.9)	
	Correct	**176 (96.7)**	133 (83.1)	<0.001**

**** p-value less than 0.05**

Table 5: Comparison of score of correct answers with respect to gender, specialty and place of qualification

Item	Mean (SD)	p-value
Gender		
Male	4.94 (1.65)	
Female	4.98 (1.56)	**0.805**
Specialty		
General dental practitioners	4.84 (1.73)	
Oral surgeons	5.02 (1.41)	**0.383**
Place of qualification		
Middle East	4.75 (1.51)	
United Kingdom	5.188 (1.71)	**0.013****

**** p-value less than 0.05**

CHAPTER FOUR

Discussion

4.0 DISCUSSION

X-ray exposure carries a risk to any patient therefore it is essential that any x-ray examination must demonstrate benefit to the patient justified against the risks that may occur. A useful diagnostic investigation is one that has an effect on the diagnosis and treatment planning and which may alter the decision of the clinician as well as aiding the surgeon intraoperatively. There is a need to keep radiography to a minimum by avoiding the unnecessary repetition of x-rays that have been taken previously but not immediately accessible with surgical techniques (Malone et al, 2014).

Practicing evidence-based dentistry is an essential ethical professional responsibility. There remains weak evidence assessing the compliance to this in dental radiology. The gap in the evidence highlights some clinical issues involving many dental aspects (Bridges et al., 2011). This study has produced some concerns regarding the justification of pre-extraction x-rays, and how to accurately assess the quality of the x-ray before treatment commences.

When there are existing radiographs, these must be referred before extraction of teeth. There remains no convincing evidence to support the need for routine radiography before an extraction (Harris et al., 2002), although this remains an area of some controversy. There is a clear need for further studies to assess a link between extractions associated complications and lack of x-rays.

In some selected cases a pre-extraction radiograph would be sensible according to Horner's selection criteria, which he defined as the following. A history of difficult extraction, a clinical suspicion of unusual anatomy, a medical history placing the patient

at special risk if compliance were encountered prior to orthodontic extractions, extraction of impacted teeth or roots which may have a close relation to vital anatomical structures (Horner et al., 2004).

The expert panel of maxillo-facial radiologists considered the opinions of Horner and Eaton (2004) and Howe (1980) to determine whether the quality of x-rays included with a referral was acceptable or not to utilize prior to a dental extraction. Amongst the images for the participants to assess (Appendix 3) were x-rays with film faults that did not affect the image of the tooth in question, x-rays with film faults that did disrupt the image of the tooth in question, but not to a level that would compromise the safe completion of the surgical procedure, and those that were considered to not provide enough information to support the safe completion of the surgical procedure. The latter included x-rays where the tooth in question fell outside of the focal trough in the image, where printing produced a poor copy, and a bitewing x-ray that did not show the anatomy of the tooth to be removed.

The ALARA principle clearly advocates the transfer of x-rays between clinicians if a patient is being referred in order to avoid the need for exposing the patient to a repeat x-ray to be utilsed by the oral surgeon providing the referral service. There is much concern about what happens to a dental x-ray during this transfer. Ideally, clinicians should transfer images confidentially using software that encrypts the data or secure messaging systems. This task is often considered tedious, expensive and time consuming by the referrer, who may then be tempted to transfer images in a way that markedly reduces the quality, so much so that it may detrimentally affect the surgical procedure. A common example of this is when a dentist prints a JPEG image using a standard printer onto paper

that is not photographic paper. This undermines the quality of the image compared to that which may be viewable by the referrer. Another common example in the UK is pertinent to the way referrals are processed. In the absence of the development of a nationwide electronic patient referral system, referrers are using the post. Commonly, an OPG is printed on A4 size paper and folded into an A5 size envelope or even smaller. The folding often ruins the image by marking a line through it. An example of such an image was included in the study for the participants.

What has been highlighted in this study is that there is a tendency to willingly expose the patient to further radiation in order to take a better quality x-ray that would offer no additional information or alter the clinical decision making process. Conversely, the study has also demonstrated a tendency to utilize x-rays that lack clarity of essential landmarks potentially leading to diagnostic information that may alter the diagnosis or treatment.

Based on this study's results, the image most rated incorrectly was image 1 with a percentage of 94.2%, which was a periapical x-ray image, pertaining to a treatment plan of the extraction of an upper left premolar. This suggests that this x-ray would have been repeated for this patient by 322 of the participants. The image which was mostly scored correctly with a percentage of 90.4% was image number 10 which was a panoramic dental x-ray indicated for an extraction of a lower left third molar. This suggested that 309 participants would repeat this particular x-ray or use other methods of imaging such as a CBCT, in agreement with the panel of experts.

The significant difference in the overall correct score of the questionnaire was in favour

of the participants from Manchester, London, Birmingham, Glasgow and Edinburgh. These participants hold a dental qualification and a specialisation degree from colleges across the United Kingdom and some European countries.

The Western participants performed better than the Eastern participants in answering the questions, albeit with a markedly reduced score in comparison with the panel of experts and a number of suggested reasons could be contributing to this.

One suggested contributing factor could be the pattern of increasing litigation that has been noted in the UK (Lewis et al., 2006). Naturally there is a strong sense of resentment in the dental profession about the level of litigation, but one positive outcome of such a change in culture in an ever increasingly informed patient population is that dentists are more likely to adopt professional practice in line with that of advice arising from professional bodies. In the Middle East however, there continues to be a sense of paternalism with the medical profession such that dentists continue to deploy their own opinions in the management of their patients rather than those that arise from peer reviewed evidence. This study supports this concept in demonstrating that Eastern based dentists were much more likely to answer the questions related to the quality of dental images incorrectly, in contrast to the Western based dentists that appeared to be answering the questions more in line with the expert panel.

The GDC in UK have identified three core topics that dentists should complete within their Continuing Professional Development (CPD) within each five-year cycle, namely Medical Emergencies, Infection Control, and Radiography and Radiation Protection. That the latter is grouped exclusively with two topics of such gravity when considering patient

safety illustrates the degree of importance the licencing authority considers radiology to hold. The GDC advise that five hours of verifiable CPD is allocated to Radiology and Radiation Protection. The Ionising Radiations (Medical Exposure) Regulations (IR(ME)R) forms the spine of information that delegates of radiology training courses are provided. Despite there being strict regulations in the Middle East about the level of Continuing Medical Education (CME) required to maintain licensure to practice dentistry, there is no obligation for a licensee to commit to continuing education in radiology. This is of some concern and may go some way to explaining why the Eastern dentists have scored significantly lower in this study than their Western counterparts.

Healthcare in the United Kingdom has developed strong clinical governance schemes following the Bristol Heart Inquiry (2001) and in doing so dental practices arrange their work to comply with health and safety legislation, such as the general duties of the Health and Safety at Work, the Management of Health and Safety at Work Regulations and the Provision and Use of Work Equipment Regulations. All such practices are strictly overseen and verified by the Care Quality Commission (CQC) which is the independent regulator of health and social services in England. Whilst the Middle East has its own strict regulatory bodies, it can be argued that regulation may be somewhat haphazard and varying greatly between different regulatory and licencing bodies that operate within the same country.

Furthermore, these results may be attributed to the routine clinical audits which form statutory requirement and continual verification that all members of the dental team meet the expected standards. As a part of clinical governance concepts, such analysis must be continually performed (Harris et al., 2002). Audits to measure the quality of radiographs

should be compared to standards set by the National Radiology Protection Board (NRPB) which describes three grades of radiograph quality based on the clinical value of the image. They assigned the grades as excellent, diagnostically acceptable, and unacceptable as shown in figure 6.

Rating	Quality	Basis
1	Excellent	No errors of patient preparation, exposure, positioning, processing or film handling
2	Diagnostically acceptable	Some errors of patient preparation, exposure, positioning, processing or film handling, but which do not detract from the diagnostic utility of the radiograph
3	Unacceptable	Errors of patient preparation, exposure, positioning, processing, or film handling, which render the radiograph diagnostically unacceptable

Figure.6: National Radiology Protection Board (NRPB) criteria describing subjective quality rating of radiographs

The focus of such audit is on whether or not the patient is gaining maximum benefit from the radiation exposure. It remains important to record why a radiograph may not meet the required standard. The performance of the x-ray prescriber and whoever is involved in making the radiation exposure should all be audited.

In the Middle East, there is still a need for harmonious and strict local and national protocols to limit this concern. Issues that are of great importance in patient radiation safety in the UAE include support of educational programs, education and instruction of radiology teams to avoid overexposure, recommendation of simple methods for patient dose evaluation, emphasis on dose recording within patients' medical reports and a

uniform, accurate, and calibrated dose registry at local and national levels.

This study suggests that there is a need to develop further radiation protection and education programs, along with patient dosimetric monitoring and recording, within the UAE. These radiation protection requirements are considered to be an essential prerequisite to a radiation safety culture within the healthcare community.

CHAPTER FIVE

Conclusion

5.0 Conclusion:

This study highlighted that the perception of dentists of differing specialties in the Middle East in regards to the quality of referred dental X-ray images needs adaptation. This perception affects the patients through either repeated X-ray exposure or by management of patients with inadequate X-ray images. More attention is needed to highlight this issue and strict protocols for the quality of referred dental X-ray images must be put in place to help with this issue.

5.1 Recommendations

In light of this study the following recommendations are given:

1- Rigid protocols must be established in the governmental and private dental sectors in the Middle East regarding the patient radiation exposure safety.

2- These protocols must be unified and set against Gold Standards to ensure coherence and equality at least within the same country.

3- Dentists must undergo continuous learning courses in Oral Radiology and understanding of regulations such as IR(ME)R to ensure optimum care and reduce over exposure of the patients.

4- Such training must be compulsory as a part of requirement of continuing medical education (CME) and evidence of strict audits demonstrating compliance should be produced. It is recommended that this becomes a prerequisite to the biennial renewal of a license to practice dentistry.

5.2 Recommendations for further studies

1. More X-ray images could be included in the questionnaire
2. Geographical variation comparisons by using X-ray images from different areas
3. More countries can be included in the study
4. Other dental specialties may be included for comparison such as: paedodontists orthodontists and prosthodontists.
5. Increasing the participation response rate
6. Using alternative forms of methodology such as interviews and emailed questionnaires.

CHAPTER SIX

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6.0 REFERENCES:

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CHAPTER SEVEN

Appendices

Appendix 1

ADEEC – Middle East Questionnaire

Participant no. :

Sex: □Male □Female

Specialty: □GP □ OS □ Prostho □Perio □Ortho □Paedo □Endo □Radiologist □Implantologist □Maxillofacial □other:….

Years of experience:

Country of qualification:

Location of current practice:

X-ray Images evaluation: Scale of image quality (1/2/3)

1- ☐

2- ☐

3- ☐

4- ☐

5- ☐

6- ☐

7- ☐

8- ☐

9- ☐

10- ☐

Appendix 2

The National Radiology Practice Board (NRPB) subjective quality rating of radiographs*

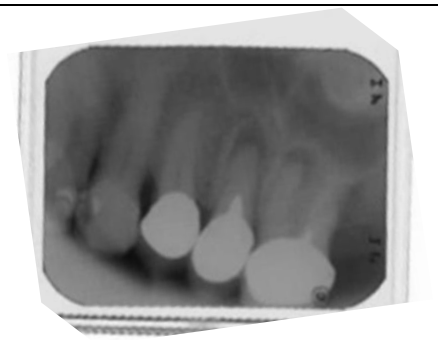
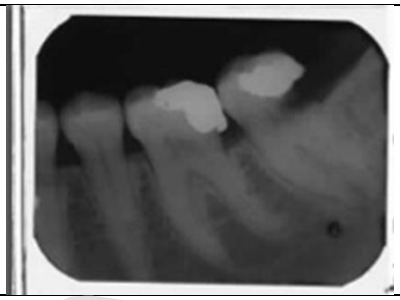
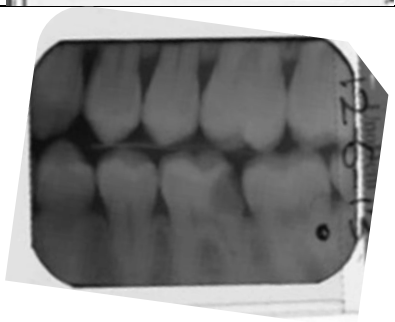
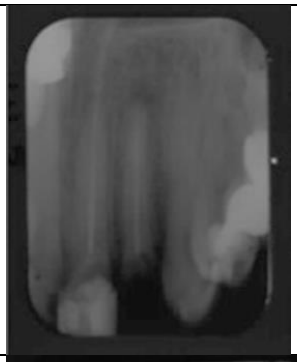
Rating	Quality	Basis
1	Excellent	No errors of patient preparation, exposure, positioning, processing or film handling
2	Diagnostically acceptable	Some errors of patient preparation, exposure, positioning, processing or film handling, but which do not detract from the diagnostic utility of the radiograph
3	Unacceptable	Errors of patient preparation, exposure, positioning, processing, or film handling, which render the radiograph diagnostically unacceptable

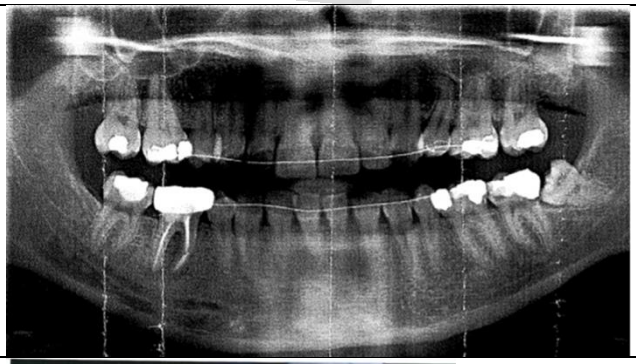
*Hirschmann PN. Guidelines on radiology standards for primary dental care: a résumé. Royal College of Radiologists and the National Radiological Protection Board. Brit Dent J, 1995.

The rating system used in the study from the adaptation of the NRPB criteria

Rating	Quality	Basis
1	**Acceptable**	**The image is excellent or satisfactory to be used in the treatment indicated**
2	**Unacceptable**	**The image is not adequate to be used in the treatment indicated**

Appendix 3

Sequence of images	The X-ray image used in the questionnaire :	Treatment required & the expert panel rating:
1		Extraction of the upper left second premolar Rated 1 by expert panel: Acceptable
2		Extraction of the lower left second molar Rated 1 by expert panel: Acceptable
3		Extraction of the lower left second molar Rated 2 by expert panel: Unacceptable
4		Extraction of the upper left lateral incisor Rated 1 by expert panel: Acceptable
5		Extraction of the upper left first molar Rated 1 by expert panel: Acceptable

6		**Extraction of the lower left third molar** **Rated 1 by expert panel: Acceptable**
7		**Extraction of the upper left second premolar** **Rated 1 by expert panel: Acceptable**
8		**Extraction of the lower left third molar** **Rated 2 by expert panel: Unacceptable**
9		**Extraction of the lower left second molar** **Rated 1 by expert panel: Acceptable**
10		**Extraction of the lower right third molar** **Rated 2 by expert panel: Unacceptable**

Appendix 4:

Hamdan Bin Mohammed College of Dental Medicine
Mohammed Bin Rashid UMHS

كلية حمدان بن محمد لطب الأسنان
جامعة محمد بن راشد للطب والعلوم الصحية

David Wray, MD, FDS, F Med Sci.
Dean & Professor of Oral Medicine
Hamdan Bin Mohammed College of Dental Medicine

Ref: HBMCDM/EC/2015
Date: May 7, 2015

Dr. Taghrid Mohammed Sebeeh
Resident, Oral Surgery Department
Hamdan Bin Mohammed College of Dental Medicine
PO Box 505097
Dubai Healthcare City
Dubai

Title of project: The importance of the quality of referred dental x-ray images to the oral surgeon
Reference: EC0415-005

Dear Dr. Taghrid,

Thank you for submission of your proposal for approval to the Ethics Committee.

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion, effective 4th May, 2015, on the basis described in the application form.

The favourable opinion is given provided that all data used for the study and that are archived are anonymous. There should not be any patient identifiers on the study casts.

Yours sincerely

Professor David Wray
Chairman, Ethics Committee

كلية حمدان بن محمد لطب الأسنان
جامعة محمد بن راشد للطب والعلوم الصحية
Hamdan Bin Mohammed College of Dental Medicine
Mohammed Bin Rashid UMHS
David Wray
MD, BDS, MB ChB, FDS RCS, FDS RCPS, F Med Sci
DHCE License Number : DS0122112
Signature