

Dedication

To the most precious gift that a human ever has, my parents.

My small family husband and lovely (Tasneem & Maab).

My brothers and sisters.

My friends and colleagues.

My teachers.

To all those dedicate my simple research daughters.

Acknowledgement

First of all I thank Allah without whom this project would not have been possible.

I would like to extend my gratitude to my supervisor Dr. Alnazier Osman Moh. Hamza for his valuable advice, support and extreme patience to accomplish this study with mine.

I should also thank the Radiation Safety Institute in Sudan Atomic Energy Commission for their cooperation in data collection in this study.

I should thank the Bio Medical Engineering department in Sudan University of Science & Technology.

Last, but certainly not least, I would like to express my most sincere gratitude to my family and in particular my husband, daughters for their support and encouragement throughout my study.

Content

Dedication	I
Acknowledgement	II
Content	III
List of figures	VI
List of tables	VIII
Abbreviation	IX
Abstract	X
المستخلص	XI

Chapter one: Introduction

1.1 Problem statement	2
1.2 Objective	2
1.2.1 General objective	2
1.2.2 Specific objectives.....	3
1.3 Methodology	3
1.4 Thesis layout	4

chapter two : theoretical background

2.1 physical principle of conventional X-ray.....	5
2.1.1 X-ray tube	5
2.1.1.1 The cathode	6
2.1.1.2 The anode	7
2.1.1.3 Protective housing	8
2.1.1.4 Tube glass envelope	8
2.1.1.5 Tube cooling system	9
2.1.2 High tension source	9
2.1.3 Kilovoltage control	9
2.1.4 Milliamperage control	10
2.1.5 Timer	11
2.1.6 Collimator	12
2.2 Radiation protection	12
2.2.1 Principles of patient radiation protection and ALARA	13
2.2.1.1 Beam filtration	13
2.2.1.2 Achieving ALARA through technique selection	13
2.2.1.3 Principles of beam restriction and types of beam limiting devices.....	14

2.2.1.4 Patient shielding	14
2.2.2 Distance	17
2.2.3 X-ray room design	17
2.2.3.1 Design principles	18
2.2.3.2 General guideline with regard to the design of the X-ray room....	19
2.2.4 Image quality.....	21
2.3 Quality management.....	21
2.3.1 Image quality improvement	22
2.3.2 Radiographic quality assurance	22
2.3.3 Radiographic quality control	25
2.3.3.1 Types of QC tests.....	25
2.3.4 Quality control of conventional X-ray.....	26
2.3.4.1 Visual inspection.....	26
2.3.4.2 Environmental inspection	26
2.3.4.3 Quality control tests	27

Chapter three : Literature reviews32

Chapter four : Material and methods

4.1 Data collection	34
4.1.1 Visual inspection	34
4.1.2 X-ray room dimension.....	34
4.1.3 Scattered radiation.....	34
4.1.4 Output accuracy	35
4.1.4.1 KVP accuracy	35
4.1.4.2 Exposure timer accuracy.....	36
4.1.5 Linearity	36
4.1.6 Reproducibility	36
4.1.7 Collimator test	36
4.1.8 Filtration.....	37
4.1.9 Beam alignment.....	37
4.2 Data analysis.....	38
4.3 Result presentation	38

Chapter five : result and modification

5.1 Radiation protection	40
5.1.1 Visual inspection	40
5.1.2 X-ray room dimension.....	41

5.1.3 Scattered radiation.....	43
5.1.3.1 Control area	43
5.1.3.2 Waiting area	44
5.2 Quality control	45
5.2.1 Output accuracy	45
5.2.1.1 KVp.....	45
5.2.1.2 Timer	48
5.2.2 Linearity	49
5.2.3 Reproducibility	51
5.2.3.1 KVp.....	51
5.2.3.2 Timer.....	52
5.2.4 Collimator test	53
5.2.5 Filtration	55
5.2.6 Beam alignment	56

Chapter six : conclusion and recommendation

6.1 Conclusions.....	58
6.2 Recommendations.....	59
References	60
Appendices.....	I

List of figures

Figure (2-1): Block diagram of X-ray component.....	5
Figure (2-2): External design of X-ray tube	6
Figure (2-3): The main part of X-ray tube	6
Figure (2-4): Structure of the cathode	6
Figure(2-5): Structure of the anode	7
Figure (2-6): The circuit of step-up transformer.....	9
Figure (2-7): The autotransformer that controls the KVP selector	10
Figure (2-8): The filament circuit that controls the mA	11
Figure (2-9): The external design of the collimator.....	12
Figure (2-10): These assortments of contact shields can be used to Protect the patient’s breast, thyroid, and gonads	15
Figure (2-11): Lead gloves used to protect hands during flourosopic exam	16
Figure (2-12): Thyroid shields used to help reduce exposure to the thyroid gland during conventional X-ray exams.....	16
Figure (2-13): The diagram of quality management component	22
Figure (2-14): The medical imaging departments	25
Figure (2-15): Image (A) shows the radiography image with too low KVP and Image (B) proper KVP	28
Figure (2-16): image (A) show the radiography image with too much mAs and image (B) too little mAs	29
Figure (4-1): The manual meter used to measure X-ray room dimension.....	35
Figure (4-2): The RADOS used to measure scattered radiation. (Manufacture by RADOS TECHNOLOGY-Finland).....	35
Figure (4-3): The RMI 240A Multi-Function Meter. used to measure KVP, mA, time (Manufacture by DAMMES –USA).....	36

Figure (4-4): The metal coins on cassette that was used as a collimator Test tool.....	37
Figure (4-5): The aluminum sheets that used to measure the HVL.....	37
Figure (4-6): The RAD-CHECK BLUS used to measure radiation dose.(Manufacture by VICTOREEM –USA).....	38
Figure (4-7): The beam alignment test tool.....	38
Figure (5-1): The visual inspection result of unit no 1.....	40
Figure (5-2): The visual inspection result of unit no 2.....	40
Figure (5-3): The visual inspection result of department no 5.....	41
Figure (5-4): The X-ray room dimension result for 15 units.....	42
Figure (5-5): The scattered radiation in control area result for 15 units.....	44
Figure (5-6): The scattered radiation in waiting area result for 15 units.....	45
Figure (5-7): The KVp accuracy result for 15 units.....	47
Figure (5-8): The timer accuracy result for 15 units.....	48
Figure (5-9): The linearity test result for 15 units.....	50
Figure (5-10): The KVp reproducibility results for 15 units.....	52
Figure (5-11): The timer reproducibility result for 15 units.....	53
Figure (5-12): The collimator test result for 15 units.....	54
Figure (5-13): The HVL test result for 15 units.....	56
Figure (5-14): The beam alignment test result for 15 units.....	57

List of Tables

Table (5-1) : X-ray room dimensions result	42
Table (5-2) : Control area results	43
Table (5-3) : Waiting area results	45
Table (5-4) : KVp accuracy results	46
Table (5-5) : Timer accuracy results	48
Table (5-6) : Linearity of mA/mAs versus KVp results	49
Table (5-7) : KVp reproducibility results	51
Table (5-8) : Timer reproducibility results	52
Table (5-9) : collimation test results	53
Table (5-10) : HVL results	55
Table (5-11) : Beam alignment result	56

Abbreviations

QC	Quality control
QA	Quality assurance
rpm	Revolution per minute
ev	Electron vault
Kev	kilo electron vault
KVp	Peak kilovoltage
mA	Milli-amperage
mAs	Milliamperere seconds
ALARA	As Low As Reasonably Achievable
NCRP	National council on radiation protection
FDA	Food and drug administration
EAC	Automatic exposure control
HVL	Half value layer
PACS	Picture archiving and communication system
QM	Quality management
NRL	National radiation laboratory
A.E.R.B	Atomic Energy Regulatory Board

Abstract

Conventional radiography or X-ray is part of diagnostic imaging tool for detection and diagnosis of diseases. Since the X-ray was discovered in 1895 to 2010 more than 5 billion medical imaging studies were published worldwide. However, there are certain harmful biological effects were recorded; for that the concept of quality control and radiation protection was developed to minimize these effects.

But now in most of developing countries there is lack of awareness and interest of radiation protection and quality control in radiology department even sometimes there is no QC tools, which can lead to improper dose, risk to the machine, error in reading and image quality.

The present study had been carried out to evaluate the radiation protection and quality control measures in 15 radiology department in Khartoum state. Data had been collected divided in to two main parts, first part radiation protection tests, which include visual inspection test, room dimension, and scattered radiation. Secondly quality control tests which include output accuracy, linearity, reproducibility, collimator, filtration, beam alignment. The data were processed, analyzed and compared with standard tolerance of radiation protection and quality control test to determine whether these units comply with standards or not, and suggest any modification should be necessary to correct the observed defects.

The result of this study showed that, the average of acceptable percentage in all the units was 70% and 74% in radiation protection test and quality control test respectively. This percentage generally acceptable for all units.

المستخلص

جهازالتصوير الاشعاعي الثابت أو التقليدي بالأشعة السينية هو نوع من أدوات التصوير التشخيصي يستعمل لكشف و تشخيص الأمراض. منذ اكتشاف الأشعة السينية مي العام 1895 الى عام 2010 أكثر من 5 بليون دراسة أصدرت عن التصوير الطبي. لكن تم تسجيل بعض الاثار الحيوية الضارة الناتجة من التصوير الاشعاعي, لذلك تم عمل وتطوير مبادئ ضبط الجودة والوقاية من الاشعاع للتقليل من تلك الاثار.

لكن الان في معظم الدول النامية يوجد نقص في الوعي و الاهتمام بالوقاية من الاشعاع و ضبط الجودة في أقسام الاشعة حتى أحيانا لا توجد أدوات ضبط الجودة في القسم مما يؤدي الى اعطاء جرعات غير صحيحة, وخطر على جهاز الاشعة و أخطاء في جودة الصورة .

هذه الدراسة تعمل على تقييم اختبارات ضبط الجودة و الوقاية من الاشعاع في 15 قسم للاشعة في ولاية الخرطوم. البيانات المجموعة من وحدات الاشعة الثابتة في هذه الاقسام تنقسم الى نوعين من الاختبارات الاول اختبارات الوقاية من الاشعاع و تشمل اختبارات التفتيش البصري, ابعاد الغرفة وتشتت الاشعاع. الثاني اختبارات ضبط الجودة و تشمل اختبارات دقة الخرج, الخطية, اعادة انتاج الجرعة, المحدد, ترشيح الاشعة, محاذاة الشعاع. تم تحليل البيانات و مقارنتها بالمعيير القياسية لهذه الاختبارات و تحديد هل نتائج الوحدات مقبولة او لا و اقتراح التعديلات الضرورية لتصحيح الاخطاء الملاحظة في الدراسة. أوضحت نتائج الدراسة ان متوسط الوحدات التي كانت نسبة الخطأ لديها مقبولة بلغت 70% و 74% لاختبارات الوقاية من الاشعاع وضبط الجودة على التوالي. وهذه النسبة مقبولة لكل الوحدات.