Sudan University of Science and Technology

College of Graduate Studies

Evaluation of Performance of the Gamma Camera in Nuclear Medicine Department in the National Cancer Institute –Al Gezira University

تقويم أداء جهاز قاما كاميرا بقسم الطب النووي بالمعهد القومي للسرطان –جامعة الجزيرة

A thesis Submitted in Partial Fulfillment for the Requirements of M.Sc. in Medical Physics

By:

Mudather Ahmed Ibrahim Abdla

Supervisor:

Dr.Awad Abdalla Adlan

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الآية

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صدق الله العظيم

“. . . and over every lord of knowledge, there is ONE more knowing”

Yousuf (12:76)

Dedication

- to the soul of my father .
- to my mother who sacrificed her life and enlightened me throughout my journey in this study helped me to continue .
- to my family , brothers and sisters who encouraged and gave me ahope in this life .
- to Shadia Mergani for all her help and support.

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Also I would like to extend my appreciation to the staff of the Nuclear Medicine Department at National Cancer Institute ,Gezira University who facilitated my mission , and special thanks to Dr/ Seddig Mohamed Ahmed the head of Nuclear Medicine department .

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Abstract

This study was performed to evaluate the performance of gamma camera machine in Nuclear Medicine Department at the National Cancer Institute of Al-Gezira University . Quality control tests including ; Uniformity , Sensitivity and linearity were done . The study was conducted in the period between March to May 2017 .

The data of the uniformity test were collected experimentally by preparing 200µCi of TC -99m and its volume was 0.5mL then we put the point source at the 2m distance from the detector and from the main menu we choose patient study then we choose F3 ,the computer well calculated the uniformity . The activity used in the sensitivity was 1mCi and we use a collimator Low Energy High Resolution (LEHR). The data of the linearity test were collected by using linearity phantom then we put the point source at the 2m distance from the detector and from the main menu we choose patient study then we choose F3 ,the computer well calculated the linearity . then the results were compared with the International Standard and we found that they were within the acceptable range .

The results revealed that the differential Uniformity UFOV , CFOV were 1.6% for both of them which were within the acceptable value as well as the integral Uniformity UFOV and the CFOV were 2.0% for both of them .

Also the result showed the average of sensitivity and we found that the current sensitivity was 84.382166 cps/µBq and new sensitivity 87.828936 cps/µBq and the sensitivity compared with NEMA2001 should be greater than 70 cps/µBq .

In addition to that the results revealed the data of central field of view for linearity test and we found that the Intrinsic Spatial resolution (ISR) in x was 1.18mm and in y was 1.19mm and the average was 1.18mm .

The Absolute spatial linearity (ASL) in x was 1mm and in y was 0.94mm and the standard was 0.5 mm in both X and Y and Differential spatial linearity(DSL)in x was 0.17 mm and in y was o.21mm and the standard was 0.25 mm in both X and Y .

Also the result demonstrated the data of the useful of view for head(2)we found that the Intrinsic Spatial resolution(ISR) in x was 1.22 mm and in y was 1.21mm and the average was 1.22 mm and the Absolute spatial linearity (ASL)in x was1.00mm and in y is 0.94mm and the standard was 0.17 mm , 0.17mm for both and DSL in x was 0.17 mm and in y was 0.21 mm and the standard is 0.25mm for both.

المستلخص

أجريت هذه الدراسة لتقييم أداء جهاز القاما كاميرا في وحدة قسم الطب النووي في المركز القومي للسرطان –جامعة الجزيرة . تقويم اختبارات ضبط الجودة تشمل : التجانس ,الحساسية والخطية ، وقد أجريت الدراسة في الفترة بين مارس إلي مايو 2017.

بيانات اختبارات التجانس جمعت عمليا بتجهيز 200مايكروكوري من ال TC-99m في حجم من سائل 0,5ملليتر ومن ثم وضع المصدر المشع علي بعد 2متر من الكاشف ، ومن ألوحه الأساسية تم اختيار دراسة مريض ثم F3 ثم قام الكمبيوتر بحساب التجانس .

الإشعاع المستخدم لقياس الحساسية 1 ملي كوري وقد استخدم محدد طاقه منخفضة عالي الوضوح .

اختبار الخطية تم باستخدام شبح الخطية ووضع المصدر علي بعد 2متر من الجهاز ، ومن ألوحه الأساسية تم اختيار دراسة مريض ثم F3 ثم قام الكمبيوتر بحساب الخطية.ثم تمت مقارنة النتائج مع المعيار العالمي وقد وجد أنها جميعا في حدود المسموح بها .

توضح الدراسة أن تفاضل التجانس لل CFOVو UFOV يساوي 1,6% لكل واحد منهما بالإضافة للتكامل ألتجانسي لل CFOVو UFOV 2,0 % لكل واحد منهما .

وأيضا" النتائج توضح أن متوسط الحساسية السابقة 85.382166cps/MBqومتوسط الحساسية الجديدة 87.828936cps/MBq والمسوح به حسب معيار نيما 70cps/MBq<

كذالك أوضحت الدراسة CFOVبالنسبه للخطية وقد وجد أن ISR عند X تساوي 1,18مليمتر وعند Y تساوي 1,19 وان المتوسط يساوي 1,18مليمتر ، وعمليا وجد أن ASL عند X يساوي مليمتر وعند Y يساوي 0,95مليمتر وحسب المعيار XوY تساوي 0,5مليمتر لكل واحد منهما . ووجد أن DSL عند X تساوي 0,17وعند Y تساوي 0,21مليمتر وحسب المعيار X و Y تساوي 0,25مليميتر.

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List of abbreviations

RS	relative sensitivity
ASL	Absolute spatial linearity
DSL	Differential spatial linearity
NEMA	National Electrical Magnifications Association
IAEA	International Atomic Energy Agency
UFOV	Useful field of view
CFOV	Central Field of view
Diff	Differential
Intt	Inttegral
NM	Nuclear Medicine
QC	Quality Control
PMT	Photomultiplier tube
PET	Positron Emission Tomography
IU	Intrinsic Uniformity
KeV	Kilo electron Voltage
NRC	Nuclear Regulatory Commission
CT	Computed Tomography
MRI	Magnetic Resonance Imaging
SPECT	Single photon emission computed tomography

Chapter one

Introduction

1-1 Introduction :

Nuclear Medicine(NM) can be defined quite simply as the use of radioactive materials for the diagnosis and treatment of patients, **(**Shankar , **2009) ,** and it is medical specialty concerned with the use of unsealed sources of radiation in the diagnosis and treatment of disease. Disease usually begins as disordered function. While an exception to this might be trauma, many accidents also may be due to altered behavior. Thus altered function often anticipates structural or morphological change by months or even years. Other techniques used in diagnostic imaging (e.g., radiography, computed tomography [CT] and magnetic resonance imaging [MRI]) largely focus on the identification of disordered structure although with the emergence of advanced MRI methods this is beginning to change. The power of nuclear medicine in clinical diagnosis rests with its ability to detect altered function with great sensitivity. For this reason nuclear medicine has contributed not only to clinical diagnosis but, to a degree unmatched by other imaging methods, to an understanding of disease mechanisms. (*William* D el at ,2003).

Quality control (QC) is crucial to all aspects of nuclear medicine practice, including the measurement of radioactivity, the preparation of radiopharmaceuticals, the use of instrumentation to obtain images, computations to calculate functional parameters, and the interpretation of the results by the physician. It plays an integral part in fulfilling the regulatory requirement for establishing a comprehensive quality assurance programme as described in the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources(IAEA,2009).

The Nuclear Medicine Department is a section of radiotherapy department attached to National Cancer Institute Gezira University and it is located in Wadmadani at Jamia street beside renal hospital its mean function is to treat cancer and other disease as well as diagnoses by using radioactive isotope , the idea of establishing this hospital was initiated by Gezira University , the staff work in the nuclear medicine department composed of nuclear medicine physics, nuclear medicine technologist , chemical engineers . the department has planner and SPECT machine .The reason that motivated me to take this path is the spread of cancer disease in the recent years and it become like dilemma which need to be tackle and also I had my uncle who have been treated in the same hospital since 2014 he suffer from cancer all these things are strongly encouraged me to make this research .

1.2 Problem of the study:

Quality Control gamma camera (SPECT) are not performed on a regular manner which can lead to wrong diagnosis and therefore wrong interpretation by the physician .

1.3 Objectives of the study:

1.3.1 General Objective:

To evaluate the performance of the Gamma Camera (SPECT) and to deliver optimal health care .

1.3.2 Specific Objectives:

To evaluate the:

sensitivity of the gamma camera

uniformity of the gamma camera

linearity of the gamma camera

1.4 Study outlines:

The following research skeleton was consisted of five chapters , chapter one was deal with introduction , problem of the study , objectives and methodology. chapter two was consist literature review related to the current study. chapter three showed the methodology . chapter four showed the results and discussion and chapter five showed the conclusion , recommendations and references .

Chapter two

Literature review

2.1 Theoretical Background:

Gamma Camera is a major imaging device used in Nuclear Medicine. It is a diagnostic instrument which is used to image the radiation from a radiotracer inserted into patient's body. It scans the radiation area of the radiotracer and produces an image. The main purpose of Gamma Camera is to identify cancer tissues, proper abnormalities and other internal problems inside a patient's body. In the 1950s, Hal Anger conducted studies on medical imaging and from 1952 to 1958; he gradually developed the scintillation camera, also known as the Anger camera . After developing gamma camera we get multiple gamma camera which generate a three dimensional image. Single photon emission computed tomography (SPECT) and positron emission tomography (PET) obeys this technology. In SPECT system, we get a scintillation camera mounted around the patient's body and it is connected to a proper computer system. The basic principle of a SPECT system dependent on the rotating camera concept is that a series of planar images are collected while the camera is rotated through either 180˚ or 360˚ around the patient . The main purpose of Gamma camera with SPECT system is to scan brain, heart, respiratory, liver and kidney. It is used for clinical studies producing better image and making diagnosis easier. The SPECT system is more sensitive than an ordinary gamma camera, so we should take a special technical support. The SPECT gamma camera is much more complex diagnostic instrument and it is more expensive to purchase and maintain. (Razibul el at,2017).

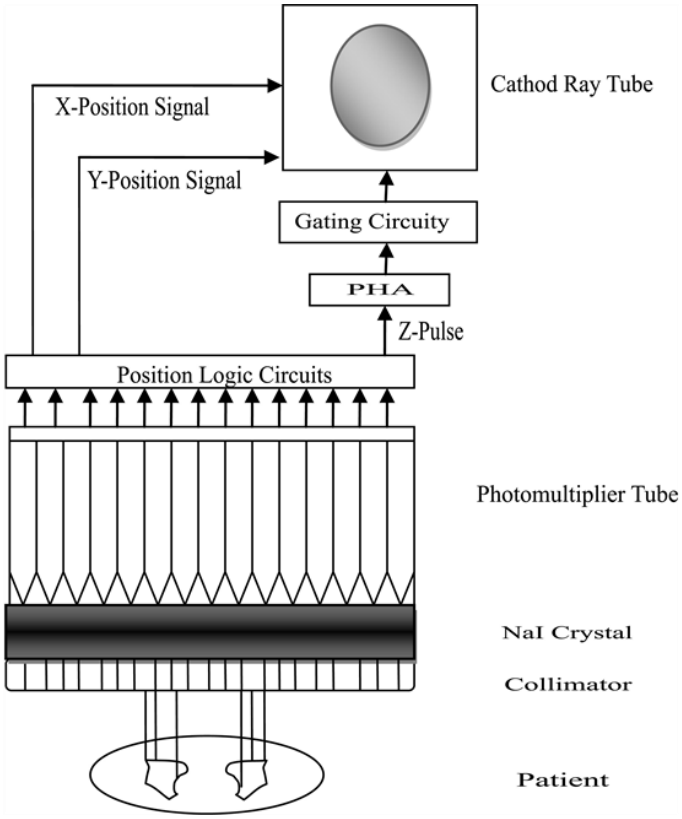

Figure 1.1 Basic principles and components of the gamma camera.

The gamma camera is made up of many parts, each part performs as a specific function in converting gamma rays into light images and finally we get appropriate viewing image. The basic components of gamma camera are collimator, sodium iodide (NaI) crystal, photomultiplier tubes (PMT) and position logic circuit The gamma rays have to pass through the collimators which ensure that it travels at a specified angle with respect to the detector crystal((. Razibul el at,2017).

The collimator functions as a mechanical lens: The collimator accomplishes this by preventing photons emitted along directions that do not lie along the LOR from reaching the detector.(IAEA,2014).

The sodium iodide crystal converts the gamma rays into light (Razibul el at,2017) There are some favorable properties based on which the

crystal needs to be selected before implementation in gamma camera design. Scintillators of high density, high atomic number, short decay time, high light output, and low cost are desired and allow better imaging performance.((Magdy ,2011).

The photomultiplier tube is a vacuum tube consisting of an entrance window, a photocathode, focusing electrodes, electron multiplier (dynodes), and anode.((Magdy , 2011) It is converts the light into electrical signals. Finally these electrical signals are used to determine the position and the energy signals of the gamma rays.

(. Razibul el at,2017)

Quality control (QC), which may be defined as an established set of ongoing measurements and analyses designed to ensure that the performance of a procedure or instrument is within a predefined acceptable range(Zanzonico, 2017).

A fundamental principle in the quality control of nuclear medicine instruments is that the quality control should be undertaken as an integral part of the routine work of the nuclear medicine department and should be performed by members of the departmental staff themselves. However, some aspects must be carried out in collaboration with maintenance staff. The quality control of each instrument should have as its starting point the selection and acquisition of the instrument itself, since instruments may differ widely in their characteristics and performance. The choice of an appropriate site for installation of the instrument should likewise be considered within the scope of quality control, since it may influence performance. Once received and installed, an instrument should be submitted to a series of acceptance tests designed to establish whether its initial performance conforms to the

manufacturer's specifications. At the same time, reference tests should be carried out to provide data against which its subsequent performance can be assessed by routine testing that is performed on a weekly, monthly, quarterly and annual basis. Finally, operational checks, carried out each day the instrument is used, should be put in force. Careful records of the results of all these tests should be kept and, if these reveal unsatisfactory performance appropriate corrective action should follow. These quality control procedures do not, of course, obviate the need for the usual preventive maintenance procedures, which should still be carried out on a regular basis. The success of such a scheme depends above all on the understanding and acceptance of all concerned. It further requires a clear definition of responsibilities and adherence to test schedules, protocols and proper procedures for the follow-up of test results(IAEA ,2009).

Quality control has three essential ingredients: standards, surveillance, and responsiveness , or corrective action . When surveillance indicates substandard products or performance , the quality is restored by taking the appropriate corrections . standards for quality control checking of radiopharmaceuticals and instrumentation performance are still evolving , Standards for intercomparing radioactivity measurements are well established and traceable to national and international standards(Buck ,1975).

2.1.1 Dose Calibrator :

The dose calibrator is a particularly important instrument for patient protection . It assures the user that the appropriate amount of radiopharmaceutical is about to be administered to the patient .It is the physician responsibility to determine that the correction dosage is being given to the patient . If the radiopharmaceutical has been prepared at an outside licensed radiopharmacy as an individual patient unit dosage , this

may be done assay of the dosage or by decay correction . the U.S Nuclear regulatory commission (NRC) requires that all other radiopharmaceutical be assayed for activity before administration , and the accuracy must be within +or- 10% of intended dosage(FRED A. 2006) .

2-1-2 Intrinsic Uniformity (IU):

The intrinsic flood field uniformity of a scintillation camera is the ability of the camera to produce a uniform image when exposed to a homogeneous spatial distribution of gamma rays. Most modern cameras are not designed to be intrinsically uniform because gains in spatial resolution can be obtained by sacrificing intrinsic uniformity. Therefore, these systems require some mechanism of uniformity correction. Typically, the uniformity correction involves computer corrected registration of regional photo peak Z signal and X and Y coordinate position signals. The monitoring of cam uniformity is probably the most sensitive indicator of camera performance and should be performed daily prior to patient studies. Most nuclear medicine facilities perform daily uncorrected (when possible) and corrected flood images that are subjectively evaluated. For a more quantitative evaluation, the flood image can be digitized and numerically or graphically analyzed. The NEMA protocol for intrinsic flood field uniformity analyzes both differential and integral uniformity over the useful and central fields of view. The integral uniformity represents the maximum pixel count rate change over the indicated field of view expressed as a percent. The differential uniformity is the maximum change over a five pixel distance in either the X or Y directions thereby representing the maximum rate of change of the regional count rate**.** Flood field images should be evaluated under the same energy conditions used for patient imaging. If off peak technetium-99m (99mTc) imaging is performed then the flood should be

checked for uniformity at this pulse height setting. Also, the user should verify that floods obtained with gamma ray energies other than those used for uniformity correction are acceptably uniform for clinical studies. This is particularly true for thallium-201, gallium-67 (67Ga), and iodine-131. If these floods do not appear adequately uniform then a correction flood of the same energy is indicated. (paual H ,1987).

Not only is it desirable that the camera performance be optimized but also performance should not vary significantly between different points in the crystal . Any variability is demonstrated most reality by the image of uniform distribution of radioactivity , the so , called flood image . Areas of above or below average count density are indicative of region where the camera performance has altered the effect of variations in linearity and intrinsic resolution is to dispositions gamma - rays , putting them closer to gather or further apart than expected spatial variation in the value of the 2 signal will result in local changes in the apparent sensitivity of the camera as a greater pulse height analyzer -Digital correction circuit for linearity and the energy signal are now to be found in most new cameras (Sharp el at , 1989)

2.1.3 Sensitivity:

Sensitivity (or efficiency) is the detected count rate per unit activity (e.g. in counts per minute per mega Becquerel). As the count rate detected from a given activity is highly dependent on the source–detector geometry and intervening media, characterization of sensitivity can be ambiguous. There are two distinct components of overall sensitivity, geometric sensitivity and intrinsic sensitivity. Geometric sensitivity is the fraction of emitted radiations which intersect, or strike, the detector, that is, the fraction of the total solid angle subtended at the detector by the source. It is, therefore, directly proportional to the radiation-sensitive

detector area and, for a point source, inversely proportional to the square of the source–detector distance. Intrinsic sensitivity is the fraction of radiation striking the detector which is stopped within the detector. Intrinsic sensitivity is directly related to the detector thickness, effective atomic number and mass density, and decreases with increasing photon energy, since higher energy photons are more penetrating and are more likely to pass through a detector without interacting. Characteristic X rays and γ rays are emitted from radioactively decaying atoms with well defined discrete energies. Even in the absence of scatter, however, output pulses from absorption of these radiations will appear to originate over a range of energies, reflecting the relatively coarse energy resolution of the detector. For this reason, many radiation detectors employ some sort of energy-selective counting using an energy range, or window, such that radiations are only counted if their detected energies lie within that range (Figs. 10.3 and 10.4(a)). At least for scintillation detectors, a so-called '20% photo peak energy window', $E\gamma \pm 10\%$ of $E\gamma$, (e.g. 126–154 keV for the 140 keV γ ray of 99mTc) is employed, where $E\gamma$ is the photo peak energy of the X ray or γ ray being counted. For such energy selective counting, overall sensitivity appears to increase as the photo peak energy window is widened. However, this results in acceptance of more scattered as well as primary (i.e. unscattered radiation)(IAEA, 2014).

2.1.4 Linearity:

Spatial linearity is one of the parameters that influence flood field uniformity. In the ideal system, a straight line source of gamma rays should yield a straight line in the image. Any deviation from a straight line represents distortion. Because of the finite number of PM tubes in scintillation cameras there is a wave like distortion in the image of a line source. Quantitative linearity correction is accomplished by many manufacturers by storing in a microprocessor a correction al gorithm that

shifts the positions of scintillation events the appropriate direction and distance to yield a straight line. The NEMA protocol for measuring linearity involves the acquisition along the X and Y directions of an image from a multi-slit phantom, the same one used for the spatial resolution measurement, followed by an analysis of the line spread peak positions. Deviations of the peak position from the true location of the center of the slits is a measure of the deviation from linearity. Typically, most departments do not measure linearity separate from either spatial resolution or flood field uniformity. A subjective evaluation of linearity is oh tamed when a bar phantom or an orthogonal hole phantom is image(Paul H ,1987).

2.2 Previous studies:

Many considerable studies were carried out in the scope of survey and assessment of the gamma camera (SPECT) performance through quality control tests.

Hongwei Xie et al (2013), Evaluation of Major Factors Affecting Spatial Resolution of Gamma-Rays Camera, The spatial resolution of the gamma-rays camera was measured on a 60Co gamma-rays source with edge method. The gamma-rays camera is consisting with rays-fluorescence convertor, optical imaging system, MCP image intensifier, CCD camera, electronic control system and other devices, and is mainly used in the image diagnostics of the intense pulse radiation sources . Due to the relatively big quantum detective efficiency (DQE) and quantum gain of the gamma-rays, etc., the experimental data were processed by averaging multiple images and fitting curves. According to the experimental results, the spatial resolution MTF (modulation transfer function) at the 10% intensity was about 2 lp/mm. Meanwhile, because of the relatively big dispersion effects of the fluorescence transmissions in the scintillator and the optical imaging system, the maximal single-noise

ratio (SNR) of the camera was found to be about 5:1. In addition, the spatial resolution of the camera was measured with pulse X-rays with 0.3 MeV in average energy and exclusion of the effects of secondary electrons from consideration. Accordingly, the spatial resolution MTF at the 10% intensity was about 5 lp/mm. This could be an additional evidence to verify the effects of secondary electrons induced by the 1.25 MeV gamma-rays in the scintillator upon the spatial resolution. Based on our analysis, the dispersion sizes of the secondary electrons in the scintillator are about 0.4 mm - 0.6 mm. Comparatively, as indicated by the detailed analysis of the spatial resolutions of the MCP image intensifier and CCD devices, both of them have little effect on the spatial resolution of the gamma-rays camera that could be well neglected.

Another study in quality control measurement in 2015 by Sabrina Sarah et al (2015), Effect of Source to Camera Distance and Count Rate on Intrinsic Uniformity of SPECT Gamma Camera, In this research, the excellent parameter for regular Quality Control (QC) testing of intrinsic uniformity for dual-head Single Photon Emission Computed Tomography (SPECT) gamma camera is determined. The integral and differential intrinsic uniformity tests for both Useful Field Of View (UFOV) and Centre Field Of View (CFOV) were done by insertion a point-source of 99mTc in front of the detectors with detached collimators to measure the effect of source to camera distance and a count rate on intrinsic uniformity. The result reveals that the best intrinsic uniformity image is obtained at source-to-camera distance of 3 m and a count rate between 16 and 60 M.

Another study of quality control in nuclear medicine department in 2015 by Mohamed E. M. Gar-Elnabi et al, (2015) The aim of this study was to develop a cheap, locally made and friendly applicable phantom for gamma camera quality control and to test its validity relative to standard

results (intrinsic and extrinsic spatial linearity and intrinsic and extrinsic uniformity) of gamma camera SPECT. And the significance of this experimental study was to introduce a multi-purpose phantom for gamma camera which could overcome the risk accompanied by quality control test procedure such as detector crystal damage and the appearance of moiré patterns. The results of the developed phantom showed an average count difference of 0.7% relative to the standard phantom and about 4% in X- to Y-axis directions relative to the standard phantom. Also, the measured absolute linearity was 0.63 mm in X direction and 0.64 mm in Y direction for the UFOV compare with 0.70 mm value of acceptance test. And the I.U. and D.U. of the developed phantom were 3.18% and 2.27% respectively for the UFOV relative to the standard phantom I.U. and D.U. (2.0% and 1.5%) for the UFOV respectively.

Chapter three

Materials and methods

Materials and Methods

3-1 Material :

3-1-1Gamma camera (SPECT):

Specification: Nucline TM SPIRIT DH-V,variable angle dual – head gamma camera

3-1-2 Dose Calibrator :

Specification: Freiburg , Germany

Radiation Dosimeter

Elektrometer CURIEMENTOR3 [REF]T12001[SN] 000106

Detector T233652-001395

Detector type Ionization chamber

Manufacturer PTW-Freiburg

3-1-3 Vials and Syringes:

Specification : 5mL evacuated syringe

3-1-4- Linearity phantom:

Specifications:

LIN . 10AD Phantom

LIN . Test

3-1-5 Tc-99m source

3-1-6 Tc-99m generator:

Specifications:

Manufacturer : Nonrol company – Turkey

Activity : 30 G/Bq

Dray generator

3-2 Methods :

3.2.1 QC evaluation :

The activity of the point source was 200µCi and its volume was 0.5mL the distance from point source to detector was at least 2m from the detector ,camera surface and the room were cleaned to insure there were no contamination .

The activity used in measuring the sensitivity was 1mCi and we use a collimator Low Energy High Resolution (LEHR) .

3-2-2 Reference Conditions:

Temperature : 293.6k(20^{o}C)

Air pressure : 1013.2hpa

Relative Humidity : 50%

Chamber voltage /Polarity +400 V

Ion Collection Efficiency 100%

3.2.3 Intrinsic Uniformity :

3.2.3.1 Procedure :

Remove the collimator , use matrix size 256*256*16.

Make the two head of collimator perpendicular to each other

Place the Tc-99m point source at distance 5FOV from the camera head.

From main menu select patient study , uniformity test and press F3e, The computer will calculate the integral and differential uniformity.

3.2.4 Sensitivity :

3.2.4.1Procedure:

Measure the activity in the syringe.

Measure the time in which we take the activity.

Measure the activity of the background to make sure there is no source.

Use collimator LEHR.

From the main menu patient acquisition , use test (system sensitivity)and press F3 , The computer will calculate the sensitivity.

3.2.5 Intrinsic Linearity:

3.2.5.1 Procedure:

Place the test partten in the detector (the center slit is centered on the detector).

Place the center slit perpendicular to the axis of measurement .

Aligned the center slit within +or – 1mm at the edge of FOV .

Place the radionuclide point source at 5 times FOV .

From the main menu acquire patient study , user test and press F3 ,the computer will calculate the linearity.

Chapter four

Results

RESULTS

4.1 Uniformity test:

Table (4.1.1):

Show the uniformity test for head one

	UFOV	CFOV
Diff	1.6%	1.6%
Intt	2.0%	2.0%

Table(4.1.2): shows the uniformity tests for head two

	UFOV	CFOV
Diff	1.7%	1.6%
Intt	2.1%	2.0%

Table (4.1.3):shows intrinsic uniformity of IAEA standard

	UFOV	CFOV
Differential uniformity	4.0%	3.0%
Integral uniformity	3.0%	2.5%

4.2 sensitivity test :

Current sensitivity:85.382166 cps/MBq

Measured sensitivity :87.828936 cps/MBq

The standard sensitivity compared with NEMA2001 standard >70cps/MBq

4.3 Linearity test :

Table (4-3-1): Show the central field of view for the head one

CFOV	X(mm)	Y(mm) r	Ave
ISR	1.91	1.25	1.60
ISR	3.36	2.40	2.88
ASL	0.89	0.79	
DSl	0.12	0.25	

Table(4.3.2): Show the useful field of view for the head one

UFOV	X(mm)	Y(mm)	Aver
ISR	1.96	1.37	1.67
ISR	3.42	2.59	3.01
ASL	1.02	0.89	
DSL	0.18	0.26	

Table(4.3.3): Shows the central field of view for head two

CFOV	X(mm)	Y(mm)	Aver
ISR	1.18	1.19	1.18
ISR	2.29	2.31	2.30
ASL	0.71	0.73	
DSL	0.11	0.20	

Table(4.3.4): Shows the useful field of view for head two

UFOV	X(mm)	Y(mm)	Aver
ISR	1.22	1.21	1.22
ISR	2.37	2.36	2.36
ASL	1.00	0.94	
DSL	0.17	0.21	

Table (4.3.5):shows IAEA standard of intrinsic spatial linearity

	CFOV		UFOV	
	X(mm)	Y(mm)	X(mm)	Y(mm)
ASL	o.5	0.5	0.7	0.7
DSL	0.25	0.25	0.25	0.25

Chapter five

Discussion, conclusion and recommendations

CAPTER FIVE

Discussion , Conclusion and Recommendations

5.1 Discussion :

The research came out with many result as shown in the tables and figures . The analysis of the results is shown as follows :

Table (4.1.1)show the result of uniformity test for the head one and the data reveal that the comparison between the practical and standard differential uniformity and integral uniformity , for differential uniformity we found that the UFOV in the practical is about 1.6% and the standard is about 4.0% the difference between practical and the standard is 3.4% and the CFOV in the practical is about 1.6% and the standard about 3.0% the difference between the practical and standard 2.4% . for integral uniformity we found that the UFOV in the practical about 2.0% and the standard 3.0% the difference between practical and standard 1.0% and the CFOV in the practical about 2.0% and the standard about 2.5% the difference between the practical and the standard about 0.5%.

Figure (4.2) reveal the measurement of the sensitivity using a matrix size 256 *256*16 and the total time is 60sec and we found that the current sensitivity 85.382166cps/MBq and the new sensitivity 87.828936 cps /MBq and the sensitivity compared with NEMA 2001 standard >70cps/MBq .

The table (4-3-3)reveal the data of central field of view for linearity test and we found that the ISR ()in x is 1.18mm and in y is 1.19mm and the average is 1.18mm .

And the practical ASL () in x is 1mm and in y is 0.94mm and the standard is 0.5 mm in x and 0.5mm in y and DSL ()in x is 0.17 mm and in y is o.21mm and the standard is 0.25 mm in x and 0.5 mm in y .

The table (4-3-4) demonstrate the result of the useful of view for head two and we found that the ISR () in x is 1.22 mm and in y is 1.21mm and the average is 1.22 mm and the practical ASL in x is 1.00mm and in y is 0.94mm and the standard is 0.17 mm , 0.17mm respectively and the

practical DSL in x is 0.17 mm and in y is 0.21 mm and the standard is 0.25mm and 0.25mm respectively .

5.2 Conclusion:

This is an experimental study deals with the evaluation of QC program of (SPECT) Gamma camera .

The researcher managed to evaluate the quality control of the (SPECT) Gamma camera which was done in National Cancer Institute University of Gezira by using three quality control tests Intrinsic Uniformity, Sensitivity and linearity . The result of quality control tests revealed that the parameters that were traced for (SPECT)Gamma camera within the limit of International standards (IAEA and LEMA 2001).

5.3 Recommendations:

Regular quality control testing of Gamma camera is essential to ensure proper function of the device .

The surrounding environmental conditions of the test and operation should always be consider and recorded .

Raising the standards of technologists through training to increase the image quality .

Applying the ALARA (As Low As Reasonably Achievable) principle in nuclear medicine diagnostic to reduce the radiation dose for patients .

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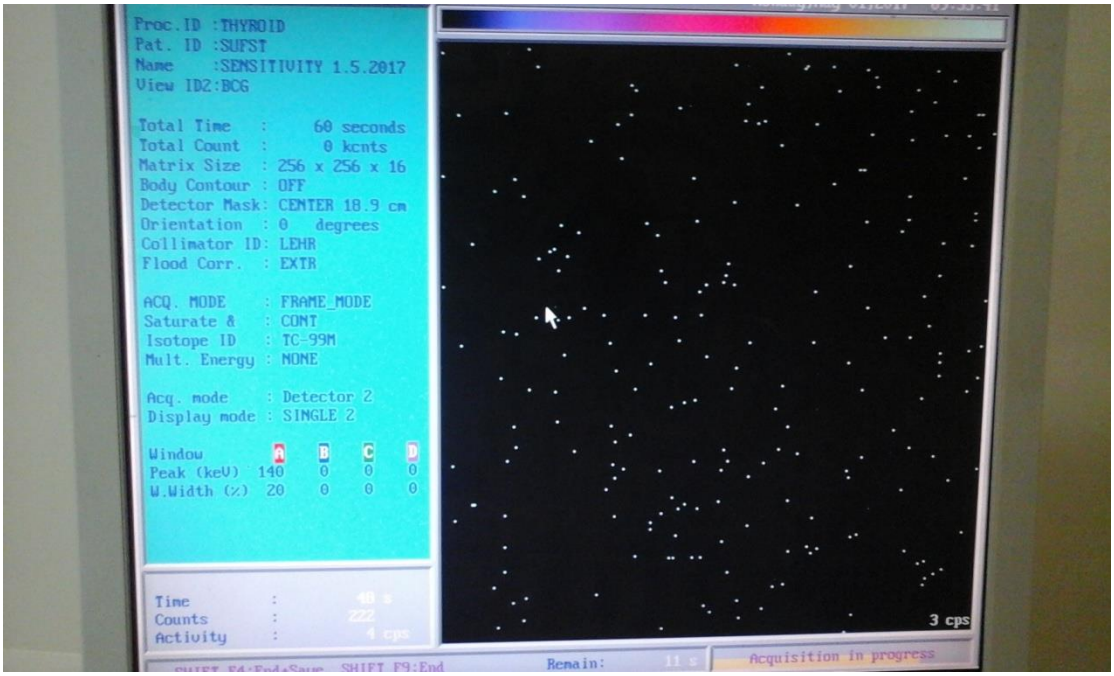
Appendix

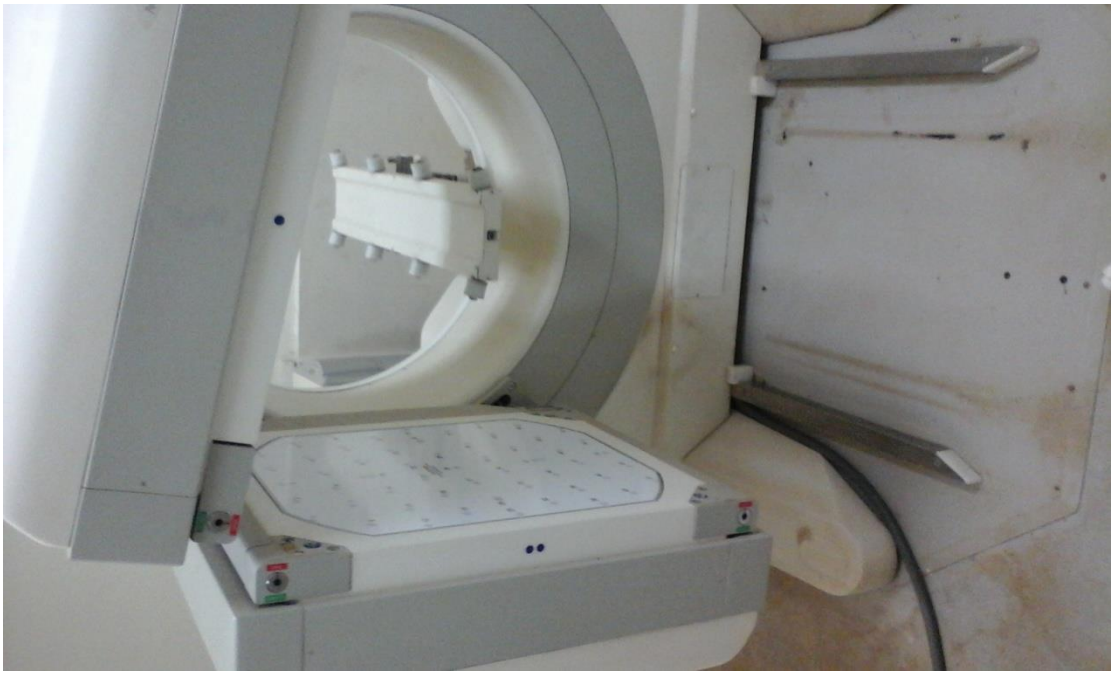
Appendices

Appendix (1) shows camera sensitivity calibration (activity image)

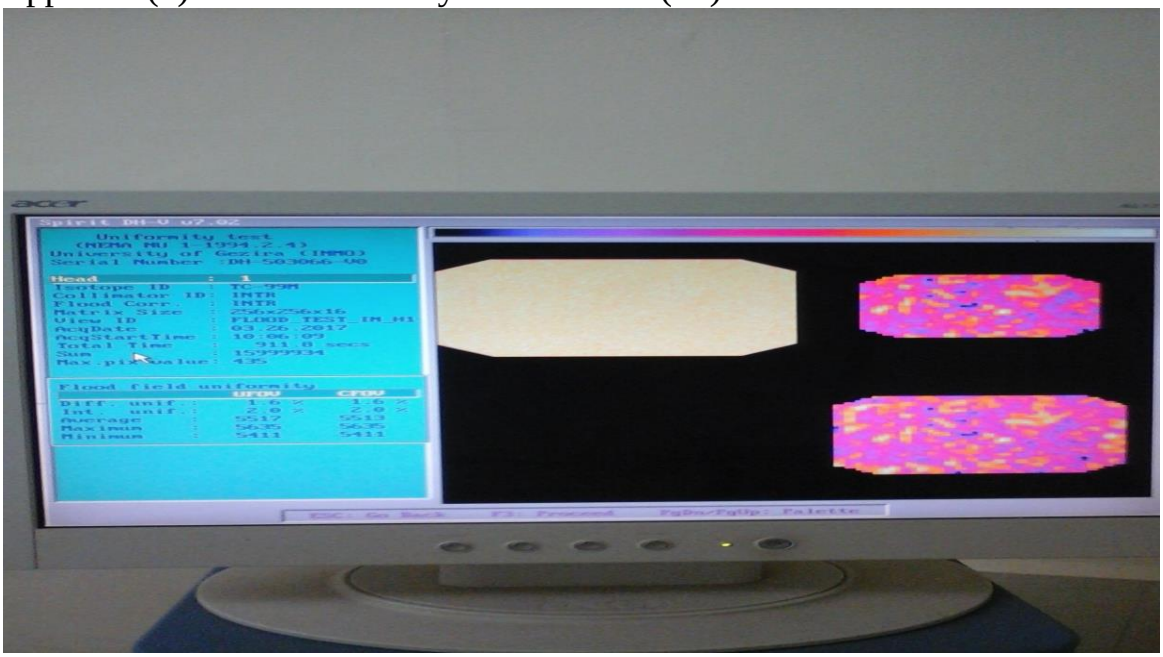
Appendix(2) shows camera sensitivity calibration (background image)



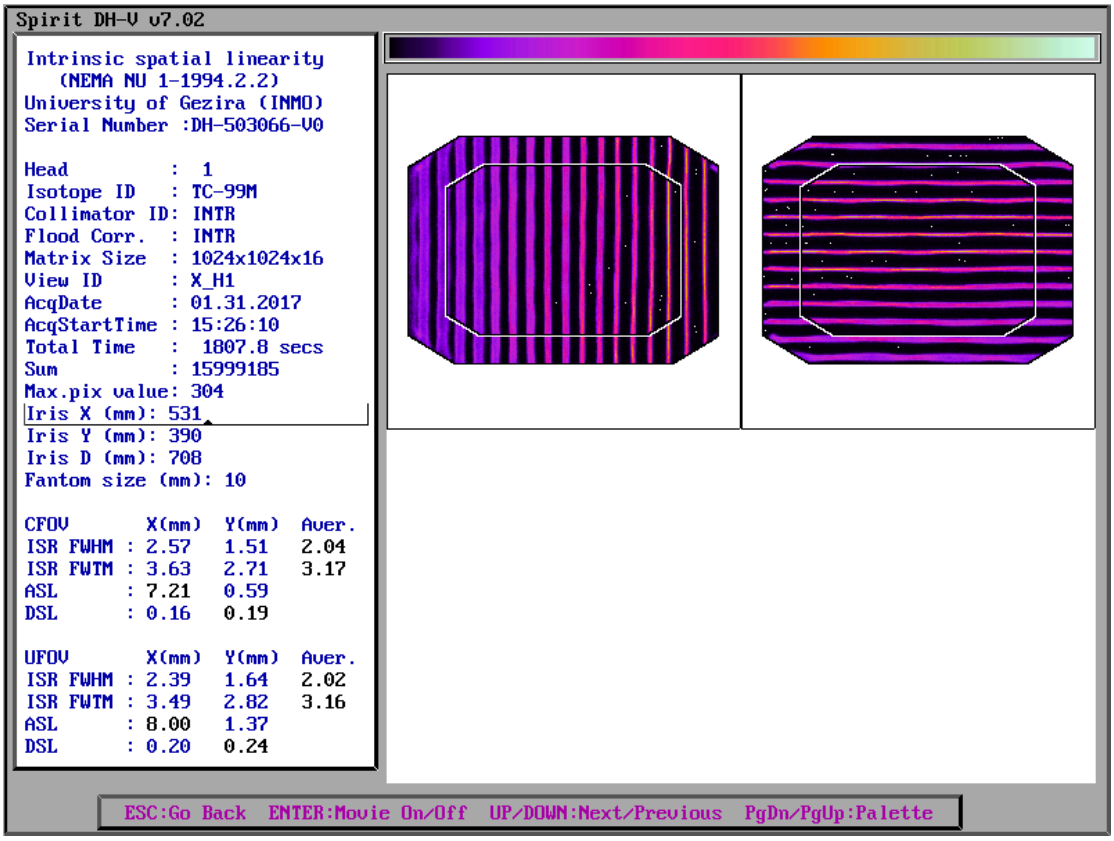
Appendix(3)shows the dual head Gamma Camera



Appendix(4) show uniformity test for head (2)



Appendix(5) show linearity test for head (1)



Appendix(6) Picture show linearity test for head (2)