



بسم الله الرحمن الرحيم

**Sudan University of Science and Technology**

**College of Graduate Studies**



## **Estimation of patient radiation doses in nuclear medicine during bone scan**

**تقدير الجرعات الإشعاعية للمرضى في الطب النووي  
اثناء فحص العظام**

*A Thesis Submitted in Partial Fulfillment of the Requirements  
for the M.Sc. Degree in Medical Physics*

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# الآية

قال الله تعالى:

بسم الله الرحمن الرحيم

وَعَلَّمَ آدَمَ الْأَسْمَاءَ كُلَّهَا ثُمَّ عَرَضَهُمْ عَلَى الْمَلَائِكَةِ فَقَالَ أَنْبِئُونِي بِأَسْمَاءِ هَؤُلَاءِ إِنْ كُنْتُمْ صَادِقِينَ ﴿٣١﴾ قَالُوا

سُبْحَانَكَ لَا عِلْمَ لَنَا إِلَّا مَا عَلَّمْتَنَا إِنَّكَ أَنْتَ الْعَلِيمُ الْحَكِيمُ ﴿٣٢﴾ قَالَ يَا آدَمُ أَنْبِئْهُمْ بِأَسْمَائِهِمْ فَلَمَّا أَنْبَأَهُمْ

بِأَسْمَائِهِمْ قَالَ أَلَمْ أَقُلْ لَكُمْ إِنِّي أَعْلَمُ الْغَيْبِ السَّمَاوَاتِ وَالْأَرْضِ وَأَعْلَمُ مَا تُبْدُونَ وَمَا كُنْتُمْ تَكْتُمُونَ ﴿٣٣﴾

سورة البقرة الآية

٣١ - ٣٣

## DEDICATION

*To my parents*

*To my brothers and sisters*

*To my all friends*

*To my teachers*

*To everyone whom Give me a bit of wise advice*

## *Acknowledgement*

*I would like to express my grateful thanks to my supervisor Mr. Suhaib for his advice and persistent help through out of this study.*

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## Abstract

Bone scan or bone scintigraphy is one of common procedures in routine nuclear medicine. Bone scan helps to diagnose and evaluate a variety of bone diseases, cancers and conditions using amount of radioactive materials called radiotracers. That it injected to the bloodstream.

The purpose of this study was to estimation of the effective dose and radiation absorbed doses to 100 patients from three hospitals following bone scans examinations with Tc99m MDP by using gamma camera scanner. Dosisrad and RADAR software's were used to estimate effective dose and absorbed organ doses in this study and was compared between them of effective dose calculated with both and effective dose calculated with the Dosisrad and RADAR software's was 4.25 mSv and 3.86 mSv respectively The mean effective dose estimated in this study was 4.06 mSv. And this value was compared with different countries and world commissions and it was agreed with international values. The absorbed organ doses values obtained in this study were selected for much radiosensitive organs from gamma camera according to the injected activity of three centers (A, B and c) respectively was: bladder ( $34.1 \pm 2.91$ ,  $37.8 \pm 4.25$  and  $35.6 \pm 3.23$ ), bone surface ( $44.8 \pm 3.71$ ,  $49.5 \pm 5.6$  and  $46.3 \pm 4.37$ ), red marrow ( $6.5 \pm 0.52$ ,  $7.2 \pm 0.81$  and  $5.4 \pm 0.48$ ) mSv respectively.

The results of this study may be useful to estimate and optimize the amount of activity that can be administered to patient during bone scan examinations and also showed the methods used in this study for effective dose and absorbed organ doses calculation by the Dosisrad and RADAR software's.

## المستخلص

مسح او تصوير العظام هو احد الإجراءات المعتادة في الطب النووي. تصوير العظام يساعد في تشخيص وتقييم مختلف امراض العظام والسرطانات ومختلف حالات العظام بإستخدام كمية من المواد المشعة تدعى المقتنيات الإشعاعية وهي تحقن للأوعية الدموية.

الغرض من هذه الدراسة هو تقييم الجرعة الفعالة والجرعات الإشعاعية الممتصة ل 100 مريض عقب فحوصات العظام بإستخدام Tc99m MDP بواسطة gamma camera scanner. ال Dosisrad و RADAR برامج استخدمت لتقييم الجرعة الفعالة و الجرعات الممتصة للأعضاء في هذه الدراسة و اجريت مقارنة بينهم. متوسط الجرعة الفعالة التي قيمت بواسطة برامج ال Dosisrad و RADAR كانت 4.25 و 3.86 على التوالي. متوسط الجرعة الفعالة التي قيمت في هذه الدراسة كانت 4.06 mSv. وهذه القيمة قورنت مع قيم دول ولجان عالمية مختلفة وكانت متوافقة مع القيم العالمية. قيم الجرعات الممتصة للأعضاء الموضحة في هذه الدراسة اختيرت لأكثر الأعضاء حساسية للإشعاع من جهاز تصوير اشعة غاما من ثلاث مراكز (A,B and C) على التوالي كانت:

(44.8 ±3.71, 49.5 ±5.6 and 46.3 و (34.1 ±2.91, 37.8 ±4.25 and 35.6 ±3.23) mSv و mSv.±4.37) (6.5 ±0.52, 7.2±0.81 and 5.4 ±0.48) mSv للمثانة، سطح العظم ونخاع العظم على التوالي.

النتائج في هذه الدراسة ربما تكون مفيدة لتقييم وتجويد كمية الجرعات المحقونة للمرضى و ايضا في التعرف على الطرق التي استخدمت في هذه الدراسة لحساب الجرعة الفعالة و جرعات الأعضاء، برامج ال Dosisrad و RADAR.

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## Abbreviations

SPECT	Single Photon Emission Computed Tomography
PET	positron Emission Tomography
CT	Computed Tomography
MRI	Magnetic Resonance Imaging
US	Ultrasonography
ICRP	International Commission Radiological Protection
EDE	Effective Dose Equivalent
ED	Effective Dose
H <sub>t</sub>	Organ Equivalent Dose
LD	Lethal Dose
NaI	Sodium iodide
PMT	Photomultiplier tubes
PHA	Pulse Height Analyzer
PACS	Picture Archiving and Communication System
mSv	millisievert
Bq	Becquerel
MBq	Megabecquerel
Ci	Curie
mCi	millicurie
Gy	gray
Kev	kilo electron volts
BeV	billion electron volts
BSS	Basic Standard System

DRL	Diagnostic reference levels
Tc	Technetium
Mo	Molybdenum
(Na <sup>99m</sup> TcO <sub>4</sub> )	Sodium pertechnetate
MDP	methylene diphosphonate Planar
BS	Bone Scan
NM	nuclear medicine
NCA	non carrier free
QC	Quality control
QA	Quality assurance
IAEA	International Atomic Energy Agency
US.NRC	United States Nuclear Regulatory Commission
LET	Linear Energy Transfer
D	absorbed dose
rad	radiation absorbed dose
$W_R$	radiation weighting factor
$W_T$	Tissue weighting factor
$D_T$	Organ dose
$\epsilon$	Energy imparted
A	activity
$T_p$	Physical half life
$T_b$	biological half life
$T_e$	effective half life
RADAR	Radiation Dose Assessment Resource
MIRD	Medical Internal Radiation Dose
OLINDA	Organ Level Internal Dose Assessment