

# الآية

: قال تعالى

ويسئلونك عن الروح قل الروح من امر ربي  
..... وما اوتيتم من العلم الا قليلا

(سورة الاسراء 85)

DEDICATION

This thesis is dedicated to my father ALTYEB, who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to the soul of my mother AYESHA, who taught me that even the largest task can be accomplished if it is done one step at time.

I dedicated the benefits of this humble work to my beloved sisters SHADEIAH and FATEMAH whom pray always for my success. Sisters Iam indebted to you.

My sincere gratitude and dedication for my friends and colloquies, for their endless support, great motivation and sincere encouragement to do this thesis.

## **ACKNOWLEDGMENT**

First of all, I would like to say thank to Allah, for giving me the strength and health to do this project work until it done completely.

I express my gratitude to Dr. Mohammed Ahmed Ali my supervisor of this study for his steadfast support was greatly needed and deeply appreciated.

I would like to express my utmost gratitude to Dr. M. Gabandi who guided me through this thesis, my thankful is for his sage advice, insightful criticisms, and patient encouragement aided the writing of this thesis in innumerable ways.

## **Abstract**

The findings of this research which is about evaluation of the myocardial perfusion SPECT scan in diagnose of coronary heart diseases which is the most common disease that cause death now a days and early diagnosis help us to control and reduce the risk factors and complication of this disease. The results of this study has been obtained out of 394 patients that had symptoms and sign of coronary heart diseases, that patients presented to Nuclear Medicine department for myocardial perfusion SPECT Scan test as low hazard with a high accuracy and sensitivity to diagnosis coronary heart diseases during the period from 1/2/2010 to 1/5/2011 and after that they went to cardiac catheterization lab for coronary angiogram within two month. The SPECT Scan included rest/stress myocardial perfusion to show the wall up take and left ventricle ejection fraction (LVEFs) and wall motion. The SPECT scan is high sensitifity in diagnosis of CHDs by assess myocardial perfusion and function in noninvasive with low radiation dose. And the cardiac catheterization included selective coronary arteries angiogram and left ventricle angiogram to detect the percent of stenosis of the arteries and length, LV function, ejection fraction and wall motion. The cardiac catheterization more accurate in diagnose of CHDs but it is invasive with high risk and radiation dose. The patients were referred to nuclear medicine department and cardiac catheterization lab from different hospitals and clinics in Kuwait state.

The main objective of this study was to evaluate the accuracy, sensitivity and specificity of nuclear myocardial perfusion SPECT scan in diagnosis of CHDs relative to cardiac catheterization as gold standard and determined the incidence of coronary heart diseases in population. And to find out the most affected age and gender. And to highlight the advantages and disadvantages of nuclear myocardial perfusion SPECT

scan in diagnosis of CHDs. And to estimate the common risk factors of CHDs

The age of the patient varied from 38 years up to 80 years in this study. And firstly the patients divided according to the gender and under that we made graph for the age in male and female. And also analyze the accuracy, sensitivity and specificity of nuclear myocardial perfusion SPECT scan in diagnosis of CHDs. And the incidence of coronary heart diseases and their risk factors and function of left ventricle. All statistical analyses in this study were performed using excel software.

The results obtained in this study indicated that The incidence of coronary heart diseases were more common among male than female by using coronary angiography. And the number of male (305 male) is more than the female (89 female) in the population of the study, and coronary heart disease is more likely: with increasing age, in male start in earlier in life rather than in female, Increasing age increase percent of people who had coronary heart disease. At older women ages that had heart attacks are more likely than men. It was also observed that the sensitivity of MPSPECT scan was slightly higher in male than in female. The specificity was higher in female than in male. The accuracy of MPSPECT scan all most same for both genders. In angiographically verified group of patients the selection bias was obvious. Patients with CHDs dominated (75%) and the fraction of patients with CHDs in male's group (83%) was significantly higher than in female's group(49%).And the study found that there's so many risk factors increase the percent of the coronary heart diseases smoking, diabetic, HTN, hypercholesterolemia and life style.

The nuclear myocardial perfusion SPECT imaging is used to detect the efficiency of myocardial muscle before some surgery especially in old

people. And also used to check coronary arteries diseases in diabetic patient. And to detect the viability of myocardial muscle in patient after myocardial infarction. And is used before angioplasty and coronary artery bypass graft. Also used to evaluate the efficiency of medicine in treatment of CHDs and after angioplasty and coronary artery bypass graft to assess the viability of myocardial muscle and the efficiency of the operation and treatment.

# الخلاصة

نتائج هذا البحث الذي هو عبارة عن تقييم دقة التصوير النووي (الومضائي) لعضلة القلب في تشخيص امراض شرايين القلب التاجية. و تعتبر أمراض القلب والشرايين من أكثر الأمراض شيوعاً وأكثرها سبباً للوفاة في عصرنا الحاضر والتشخيص المبكر لهذه الأمراض يعتبر من الوسائل الناجحة لمكافحتها والحد من أخطارها ومضاعفاتها و قد استخلصت هذه النتائج من الدراسة التي اجريت على (394) مريض لديهم علامات واعراض لها علاقة مع امراض شرايين القلب التاجية. و قد ارسلوا هؤلاء المرضى الى قسم الطب النووي لاجراء فحوصات التصوير النووي (الومضائي) لعضلة القلب بالمجهود او اثنا الراحة. ك فحص اقل خطورة و شديد الحساسية على الدقة لتشخيص امراض شرايين القلب التاجية واداء عضلة القلب. فى الفترة من 2010\2\1 الى 2010\5\1 و من بعد ذلك ارسلوا الى قسم قسرة القلب لاجراء فحص قسرة القلب التشخيصية لتصوير شرايين القلب التاجية خلال فترة شهرين. ان التصوير النووي لعضلة القلب قد يكون بالمجهود او اثنا الراحة ونجد ان له دور هام فى تشخيص امراض شرايين القلب التاجية و واداء عضلة القلب وكفاءة الانقباض والانقباض فى العضلة. وهو دقيق فى التشخيص و اقل خطورة ويتعرض فيه المريض الى اقل جرعة اشعاعية بكثير من تلك التى يتعرض لها فى عمليات القسرة. وان التصوير النووي فى كثير من الاحيان يحدد حاجة المريض الى القسرة من عدمها و يعتبر التصوير النووي خطوة هامة فى التشخيص قبل ارسال المريض لعمل القسرة. ان التصوير النووي لا يصور الشرايين التاجية بشكل مباشر ولكنه يصور عضلة القلب للبحث فيها عن اثار ضيق او انسداد فى الشرايين التاجية ويصور حركة عضلة القلب والبطين الايسر. اما عمليات القسرة هي اكثر دقة وحساسية فى تشخيص امراض شرايين القلب التاجية وتصويرها بصورة مباشرة لتحديد نسبة الضيق او الانسداد وطولة وتصوير حركة عضلة القلب والبطين الايسر ولكنها اكثر خطورة ويتعرض فيها المريض الى جرعة اشعاعية عالية. ان المرض يرسلون الى قسم الطب النووي و قسرة القلب من كل المستشفيات والمراكز و فى دولة الكويت.

الهدف من هذه الدراسة هو تقييم دقة وحساسية التصوير النووي لعضلة القلب في تشخيص امراض شرايين القلب التاجية مقارنة مع عمليات قسرة القلب باعتبارها

المقياس الاساسي في التشخيص وتحديد نسبة حدوث امراض شرايين القلب التاجية في مجتمع الدراسة واكثر الاعمار من بين الرجال والنساء اصابة بامراض شرايين القلب التاجية. ومعرفة ميزات وسليبات التصوير النووي لعضلة القلب في تشخيص امراض الشرايين التاجية والعوامل التي تزيد من نسبة الاصابة بهذه الامراض.

نجد ان الاعمار تتفاوت من بين 38 الى 80 سنة في مجتمع الدراسة. اولا تم تقسيم المرض على حسب الجنس الي رجال ونساء ومن ثم تم عمل رسم بياني للاعمار. وتم عمل رسم بياني لتحليل ومعرفة دقة وحساسية فحص التصوير النووي لعضلة القلب في تشخيص امراض شرايين القلب التاجية. وكذلك تم عمل تخطيط لمعرفة نسبة حدوث امراض شرايين القلب التاجية والعوامل التي تزيد من نسبة الاصابة و لمعرفة نسبة كفاءة عضلة القلب والبطين اليسر. وقد تم استخدام البرامج الاحصائية التحليلية لتحليل البيانات في هذه الدراسة.

ومن خلال النتائج التي استخلصت من هذه الدراسة نجد ان نسبة الاصابة بامراض شرايين القلب التاجية في الرجال اعلى من نسبة اصابة النساء باستخدام عمليات القسطرة. وكذلك نجد ان نسبة عدد الرجال في مجتمع الدراسة اعلى من النساء فعدد الرجال (305) مريض اما عدد النساء (89). ونجد بصورة عامة ان نسبة الاصابة بامراض شرايين القلب التاجية تزيد بزيادة العمر وفي الرجال تبدأ مبكرة اما النساء تكون عادة في الاعمار المتقدمة ونجد ان متوسط العمر في الرجال (50.5) وعند النساء (60.6). وقد اثبتت الدراسة ان فحص التصوير النووي لعضلة القلب ذو حساسية عالية في تشخيص امراض شرايين القلب التاجية ونسبة الحساسية التشخيص في الرجال اعلى من النساء. ونسبة التحديد في النساء اعلى من الرجال اما الدقة فتكاد تكون متساوية في الرجال والنساء وكذلك يستخدم للكشف على مدى تحمل عضلة القلب للعمليات الجراحية خصوصا لكبار السن وكذلك يستخدم لمرضى السكر للكشف عن أمراض الشرايين واحتمالية الإصابة بالجلطات القلبية، وكذلك للمرضى الذين اصابوا بجلطات في القلب لاستكشاف الخلايا النشطة في عضلة القلب المجلطة، وكذلك يستخدم قبل اجراء عمليات توسيع أو استبدال الشرايين حين يكون هناك ضعف في عضلة القلب لإثبات فائدة العملية المراد تنفيذها وكذلك من الفوائد التي يمكن الحصول عليها يحصل عليها من التصوير النووي هو التشخيص السريع لجلطات القلب في غرف الطوارئ، وهذه من الاستخدامات الحديثة للتصوير النووي، وكذلك تقاس كفاءة الأدوية المستخدمة لأمراض الشرايين وفعاليتها في علاج المريض الذي يعاني من انسداد في الشرايين والتعرف

على حجم الجزء المتأثر من عضلة القلب وتقويم حيويته وفاعليته. ولدراسة  
عودة التروية القلبية بعد العمليات القلبية الجراحية لزراعة الشرايين او بعد توسيع  
الشرايين بالبالون وتركيب الشبكة الدعامية عن طريق القسطرة العلاجية

## TABLE OF CONTENTS

| SUBJECT               | Page |
|-----------------------|------|
| الاية                 |      |
| ii                    |      |
| DEDICATION            | iii  |
| ACKNOWLEDGEMENT       | iv   |
| ABSTRACT              | v    |
| الخلاصة               |      |
| vii                   |      |
| TABLE OF CONTENTS     | ix   |
| LIST OF TABLES        | xvii |
| LIST OF FIGURES       | xix  |
| LIST OF ABBREVIATIONS | xxi  |

## CHAPTER ONE

### 1 INTRODUCTION

1

1.1 Introduction 1

1.2 Problem of the study 4

1.3 Important of the study 5

1.4 Objectives of the study 5

1.5 Thesis out lines 5

## **CHAPTER TOW**

### **LITERATURE REVIEW**

|  |          |
|--|----------|
| <b>2.1 Anatomy</b>                     | <b>6</b> |
| 2.1.1 Cardiac chambers                 | 6        |
| 2.1.1.1 Right atrium                   | 6        |
| 2.1.1.2 Left atrium                    | 7        |
| 2.1.1.3 Right ventricle                | 7        |
| 2.1.1.4 Left ventricle                 | 8        |
| 2.1.2 Great vessels and septi          | 9        |
| 2.1.2.1 Aorta                          | 9        |
| 2.1.2.2 Pulmonary artery               | 9        |
| 2.1.2.3 Ventricular septum             | 10       |
| 2.1.2.4 Atrioventricular septum        | 10       |
| 2.1.3 Conduction system                | 10       |
| 2.1.3.1 Sinus node                     | 10       |
| 2.1.3.2 Internodal pathways            | 10       |
| 2.1.3.3 Atrioventricular node          | 11       |
| 2.1.3.4 His bundle and bundle branches | 11       |
| 2.1.4 Cardiac valves                   | 11       |
| 2.1.4.1 Mitral valve                   | 12       |
| 2.1.4.2 Tricuspid valve                | 12       |
| 2.1.4.3 Aortic valve                   | 13       |

|   |    |
|---|----|
| 2.1.4.4 Pulmonary valve   | 13 |
| 2.1.5 Coronary arteries   | 14 |
| 2.1.5.1 Left main coronary artery   | 15 |
| 2.1.5.2 Left anterior descending artery   | 15 |
| 2.1.5.3 Left circumflex artery  | 16 |
| 2.1.5.4 Right coronary artery   | 16 |
| 2.1.6 Coronary veins  | 17 |
| 2.1.7 Structure of cardiac muscle   | 20 |
| <b>2.2 Physiology</b>   | 22 |
| 2.2.1 The Cardiac Cycle and the Actions of the Valves                           | 22 |
| 2.2.2 Heart electrical activity   | 24 |
| <b>2.3 Coronary Artery Disease</b>  | 26 |
| 2.3.1 Introduction:   | 26 |
| 2.3.2 Coronary Blood Flow   | 26 |
| 2.3.3 Perfusion pressure (vessel resistance)                                    | 26 |
| 2.3.4 The Determinants of Myocardial O <sub>2</sub> Consumption                 | 28 |
| 2.3.5 The Pathogenesis of the Atherosclerotic Plaque                            | 29 |
| 2.3.6 Risk Factors for Atherosclerotic Coronary Artery Disease                  | 30 |
| 2.3.7 Consequences of Atherosclerosis   | 31 |
| 2.3.8 Consequences of Reduced Blood Flow to the Myocardium                      | 31 |
| 2.3.9 Clinical Consequences of Coronary Artery Disease                          | 33 |
| 2.3.10 Clinical Consequences of Myocardial Infarction                           | 40 |
| 2.3.11 Determinants of Prognosis in Patients with<br>Coronary Arterial Diseases | 42 |
| <b>2.4 Myocardial perfusion scan studies</b>                                    | 43 |
| <b>CHAPTER THREE</b>  |    |
| <b>SECTION ONE THEORY OF THE STUDY</b>  |    |
| <b>3.1.1 Introduction</b>   | 51 |

|   |                     |
|---|---------------------|
| <b>3.1.2 Nuclear Medicine imaging procedure</b> | 52                  |
| <b>3.1.3 Theory of SPECT</b>                    | 52                  |
| 3.1.3.1 Projection,Back-projection              | 54                  |
| 3.1.3.2 Filters                                 | 57                  |
| 3.1.3.3 Data Sampling                           | 63                  |
| 3.1.3.4 Attenuation Correction                  | 64                  |
| 3.1.3.5 Iterative Reconstruction                | 69                  |
| 3.1.3.6 Scatter                                 | 70                  |
| 3.1.3.7 Noise                                   | 70                  |
| 3.1.3.8 Collimation                             | 71                  |
| <b>3.1.4 Instrumentation</b>                    |                     |
| 3.1.4.1 Rotating Gamma Cameras                  | 72                  |
| 3.1.4.2 Single- or Multiple-section             | 73                  |
| <b>3.1.5 Quality Issues</b>                     | 74                  |
| 3.1.5.1 Data Correction                         | 74                  |
| 3.1.5.2 The Role of the Operator                | 75                  |
| 3.1.5.3 Center of Rotation                      | 75                  |
| 3.1.5.4 Limited Angle Acquisition               | 76                  |
| <b>SECTION TWO</b>                              |                     |
| <b>Methodology</b>                              |                     |
| <b>3.2.1 Patient population.</b>                | 78                  |
| <b>3.2.2 Tools and equipment</b>                | 78                  |
| 3.2.2.1 Gamma camera                            | 78                  |
| 3.2.2.2 The Couch                               | 79                  |
| 3.2.3.2 Collimator                              | 80                  |
| <b>3.2.2.4</b>                                  | <b>Radiotracers</b> |
| 80  |                     |
| 3.2.2.5 Treadmill                               | 81                  |
| 3.2.2.6 ECG                                     | 81                  |

|   |           |
|---|-----------|
| <b>3.2.3 Methods:</b>   |           |
| 3.2.3.1 Myocardial perfusion study  | 81        |
| 3.2.3.2 Method of Administration  | 82        |
| 3.2.3.3 Patient Preparation   | 82        |
| 3.2.3.4 Acquisition protocol  | 83        |
| 3.2.3.5 Pharmacologic Stress Agents   | 84        |
| <b>3.2.3.6 Protocols</b>  | <b>85</b> |
| <b>3.2.3.7 Gating</b>   |           |
| 88  |           |
| <b>3.2.3.8 Framing</b>  |           |
| 88  |           |
| 3.2.4 Normal Results  | 89        |
| 3.2.5 Abnormal Results  | 89        |
| 3.2.6 Artifacts   | 90        |
| 3.2.7 Note  | 91        |
| 3.2.8 Cardiac catheterization   | 91        |
| <br><b>CHAPTER FOUR</b>   |           |
| <b>Results and Discussions</b>  |           |
| 4.1 Patient population.   | 92        |
| 4.2 Classification of patients according to gender  | 92        |
| 4.3 left ventricle ejection fraction  | 93        |
| 4.4 The positives and negatives patients of coronary<br>heart diseases according to the myocardial perfusion<br>SPECT imaging and coronary angiography report | 95        |
| 4.5 Accuracy, sensitivity and specificity of myocardial perfusion<br>SPECT imaging in diagnosis of CHDs in all population                                     | 97        |
| 4.6 Accuracy, sensitivity and specificity of myocardial perfusion<br>SPECT imaging in diagnosis of CHDs in male and female                                    | 98        |
| 4.7 Accuracy, sensitivity and specificity of myocardial   | 99        |

perfusion SPECT imaging in diagnosis of CHDs by using  
physical and pharmacological exercise

|   |     |
|---|-----|
| 4.8 Incidence of coronary heart diseases                    | 101 |
| in all population of the study                              |     |
| 4.9 Incidence of coronary heart diseases in male and female | 101 |
| 4.10 Therisk factors of coronary heart diseases             | 102 |

## **CHAPTER FIVE**

|  |     |
|--|-----|
| 5.1 Conclusion   | 105 |
| 5.2The advantages of myocardial perfusion SPECT scan study | 107 |
| 5.3 Disadvantages  | 108 |
| 5.4 Limitations of MPS                                     | 108 |
| 5.5 Recommendations  | 108 |
| References   | 109 |
| Appendices. (A) Myocardial perfusion imaging               |     |
| (B) Coronary angiogram (C) Table                           | 112 |

## List of tables

| Table  | page |
|--|------|
| 3.1 Operator choices in SPECT  | 56   |
| 4.1 The mean age and percentage of male and female   | 92   |
| 4.2 The correlation of myocardial perfusion SPECT imaging and coronary angiography.                                      | 95   |
| 5.1 Represent the average percentage of left ventricle ejection fraction (LVEF) by C. Cath and SPECT                     |      |
| 5.2 Represented the percentage of sensitivity, specificity and accuracy of myocardial perfusion SPECT Scan in population |      |
| 5.3 Represented percentage of sensitivity, specificity and accuracy of MPSPECT Scan in male and female                   |      |
| 5.4 Show percentage of sensitivity, specificity and accuracy   |      |

of MPI scan by using physical and pharmacological exercise

- 5.5 Represent percentage of diseases and normal patients of CHDs in all population by coronary angioplasty
- 5.6 Represented diseases and normal patients of CHDs in male & female in all Population using cardiac catheterization
- 5.7 Show percentage of risks factor of CHDs in male and female
- 5.8 showing TP, TN, FP, FN meaning

### **List of figures**

| Figure  | page |
|---|------|
| 2.1 Heart valves, superior view.  | 14   |
| 2.2 Heart chambers and vessels anterior view  | 18   |
| 2.3 Heart chambers and vessels posterior view   | 19   |
| 2.4 Heart chambers, great vessels and valves  | 19   |
| 2.5 Anatomosing muscular fibers of heart  | 21   |
| 2.6 Normal ECG  | 25   |
| 3.1 A contrast of 4:1 in the object becomes a contrast of 2:1 in planar imaging.  | 53   |
| 3.2 a Profiles relating to a single transaxial section from a distribution of radioactivity comprising two point sources.                   | 56   |
| 3.2 b Back-projection of these profiles builds up an image of the point sources by superimposition but at the expense of a high background. | 58   |

|       |  |     |
|-------|--|-----|
| 3.3 a | The filter acts on each point in the profile in turn. The values obtained are added to obtain the filtered profile, which includes negative as well as positive points.                                      | 59  |
| 3.3 b | When the negative values associated with the positive values in each profile are back projected they tend to cancel out the positive background.   | 61  |
| 3.4   | An idealized line spread function (top), a realistic line spread function (middle) and a filter typical of those used in SPECT (bottom) are shown in a “real” and b “frequency” space.                       | 69  |
| 3.5   | In the pre-processing attenuation correction method the correction factor applied to each element in the profile collected at angle $\theta$ will depend on the patient thickness L at the appropriate angle | 71  |
| 3.2.1 | Gamma camera equipment   | 79  |
| 3.2.2 | Pharmaceutical   | 80  |
| 3.2.3 | Treadmill  | 81  |
| 4.1   | The percentage of left ventricle ejection fraction (LVEF) by C.cath  | 93  |
| 4.2   | The percentage of left ventricle ejection fraction (LVEF) by SPECT   | 94  |
| 4.3   | The sensitivity, specificity and accuracy of myocardial perfusion SPECT imaging in population  | 97  |
| 4.4)  | Represented sensitivity, specificity and accuracy of MPSPECT scan in male and female (used coronary angiography as the standard)   | 99  |
| 4.5   | Show percentage of sensitivity, specificity and accuracy of MPSPECT scan by using physical and pharmacological exercise  | 100 |
| 4.6   | Represent percentage of diseases and normal patients of CHDs in all population by using coronary angiography   | 101 |

|     |  |     |
|-----|--|-----|
| 4.7 | Incidence of CHDs in the population of patients verified by coronary | 102 |
|     | Angiography, the significantly higher incidence in men.              |     |
| 4.8 | Represented risks factor of CHDs in male & female                    | 103 |

## **LIST OF ABBREVIATIONS**

|        |                                 |
|--------|---------------------------------|
| ACS    | Acute Coronary Syndromes        |
| CAD    | Coronary Artery Diseases        |
| C.Cath | Cardiac Catheterization         |
| CHDs   | Coronary Heart Diseases         |
| DM     | Diabetes Mellitus               |
| ECG    | Electrocardiogram               |
| FBP    | Filtered Back-Projection        |
| FN     | False Negatives                 |
| FOV    | Field Of View                   |
| FP     | False Positives                 |
| HTN    | Hypertension                    |
| IV     | Intravenous                     |
| GHA    | Gulf Heart Association          |
| LAD    | Left anterior descending artery |

LAO Left Anterior Oblige  
LCX Left circumflex  
LVEF Left Ventricle Ejection Fraction  
SPECT Single Photon Emission Computed Tomography  
MI Myocardial Infarction  
MLEM Maximum Likelihood, Expectation Maximization  
MRI Magnetic Resonance Imaging  
MPI Myocardial perfusion imaging  
MUGA Multi-Gated Acquisition  
NSTEMI Non ST-segment Elevation Myocardial Infarction  
OM Obtuse Marginal  
OSEM Ordered Subsets, Expectation Maximization  
PDA Posterior Descending Artery  
TN True Negatives  
TP True Positives  
RAO Right Anterior Oblige  
RCA Right Coronary Artery  
VSDs Ventricular septal defects  
WHO World Health Organization