Sudan University of Science and Technology
College of Graduate Studies

Optimization of Radiation Dose in Abdominal using Computerized Tomography

تقدير الجرعة الاشعاعية المثلى أثناء فحص البطن بالاشعة المقطعية

A thesis submitted for partial fulfillments of the requirement of M.Sc degree in Diagnostic Radiologic Technology

By:

Abdelrahman Mohamed ElNour

B.Sc honour in Diagnostic Radiologic Technology

Supervisor

Dr. Abdelmoneim Adam Mohamed

Assitant Professor

December 2009

Contents

Page No.

Dedication i

Acknowledgments ii

Abstract [English] iii

Abstract [Arabic] iv

List of Tables v

List of Figures vi

Chapter One: Introduction

1.1 Historical background 1

1.2 Radiation Risk 3

1.3 Radiation dose optimization..... 4

1.4 Statement of the problem..... 5

1.5 Objectives of the study..... 6

1.6 Thesis outline 7

1.7 Thesis outcome..... 8

Chapter Two: Background

2.1 CT scanning..... 10

2.1.1 Principle of CT..... 11

2.1.2 Principles of MSCT 11

2.1.2.1 MSCT Detectors 12

2.1.2.2 MSCT Era 14
2.1.2.3 MSCT Data Acquisition..... 14
2.1.3 16-Channel (16-Slice) Scanners—and More 17
2.1.4 MSCT Concepts: Differences between MSCT and SSCT 18
2.2 Optimization of MDCT Technique 19
2.2.1 CT Parameter..... 19
2.2.1.1 Tube Potential (kVp)..... 19
2.2.1.2 Tube Current – Time Product (mAs) 20
2.3 Radiation Dose Units 21
2.4 CT dose Measurements 22
2.4.1 CT Dose measurements units 23
2.4.2 CT Dose Descriptors..... 23
2.4.3 Computed Tomography Dose Index (CTDI) 24
2.4.4 Dose – Length Product (DLP) Unit (mGy-cm)..... 25

2.4.5 Effective Dose..... 27
2.5 Equipment – related factors..... 27
2.5.1 Beam filtration..... 27
2.5.2 Beam Shaper..... 29
2.5.3 Beam Collimation..... 29
2.5.4 Detector Array..... 30
2.5.5 Data Agnistion System (DAS)..... 31
2.5.6 Spiral Interpolation..... 31
2.5.7 Adaptive Filtration (AF)..... 31
2.5.8 Over ranging..... 32
2.5.9 Devices For Automatic Dose Control..... 33
2.5.9.1 Longitudinal dose modulation (LDM)..... 34
2.5.9.2 Angular dose modulation (ADM)..... 34
2.5.9.3 Temporal dose modulation (TDM)..... 36
2.5.10 Dose Display..... 36

2.6 Application – related factors..... 37
2.6.1 Brook's formula..... 37
2.6.2 Scan Parameter..... 38
2.6.2.1 Tube current – Time product (Q)..... 38
2.6.2.2 Tube potential (kVp)..... 38
2.6.2.3 Slice collimation (hcol) and slice thickness (hrec) 39
2.6.2.4 Pitch..... 41
2.6.2.5 Gantry rotation time..... 41
2.6.2.6 Object diameter (d) or patient (m)..... 42
2.6.3 Examination Parameters..... 43
2.6.3.1 Scan Length (L)..... 43
2.6.3.2 Number of scan series (nser)..... 43
2.6.3.3 Number of rotation in dynamic CT studies (n)..... 43
2.7 Patient dose from CT: previous studies..... 44

Chapter Three : Materials and Methods

3.1 CT Machine..... 53
3.2 Patient Data..... 53
3.3 CT dose measurements..... 55
3.4 Organ dose determinations..... 58
3.5 Radiation dose optimization steps were included..... 58
3.6 Estimation of absorbed organ doses and effective doses..59
3.7 Cancer risk estimation.....60
3.8 Data analysis..... 62

Chapter Four: Results

Results 63

Chapter Five: Discussion, Conclusion and Recommendations

5.1 Discussion 71
5.2 Conclusion 80
5.3 Recommendations 81

References 83

Appendices 89