



بسم الله الرحمن الرحيم

∞∞∞∞

تم رفع هذه الرسالة بواسطة / سلوي محمود عقل

بقسم التوثيق الإلكتروني بمركز الشبكات وتكنولوجيا المعلومات دون أدنى

مسئولية عن محتوى هذه الرسالة.

ملاحظات: لا يوجد





Faculty of Women for Arts,
Science and Education
Ain Shams University

Evaluation Study of the Dose Volume Histogram (DVH) Calculated and Measured of the Radiotherapy for Prostate Cancer Patients

A Thesis Submitted for the Requirements of
The M.Sc. Degree in Radiation Physics

Presented to

**Physics Department Faculty of Women for Arts, Science and
Education; Ain Shams University**

A Thesis Submitted by

Ibrahim Ahmed El Hamamsi

Bachelor of Science, Physics Department – Tanta University

Supervisors

Prof. Dr.

Amal Mahmoud El-Shershaby

Prof. of Radiation Physics
Faculty of Women for Arts, Science
& Education-Ain Shams University

Prof. Dr.

Tarek M. EDsoky

Prof. of Radiation Physics
Faculty of Women for Arts, Science &
Education-Ain Shams University

Prof. Dr.

Khaled Mohamed El Shahat

Prof. of Medical Radiation Physics
Faculty of Medicine
Al Azhar University

Department of Radiation Physics
Faculty of Women for Arts, Science & Education
Ain Shams University
(2022)



Faculty of Women for Arts,
Science and Education
Ain Shams University

Approval Sheet

The Thesis Entitled

**Evaluation Study of the Dose Volume Histogram (DVH) Calculated and
Measured of the Radiotherapy for Prostate Cancer Patients**

Submitted By

Ibrahim Ahmed El Hamamsi

The M.Sc. Degree in Radiation Physics

Radiation Oncology Medical Physicist

This thesis has been approved by supervisor committee.

Supervisors

Signature

Prof. Dr. Amal Mahmoud El-Shershaby

Prof. of Radiation Physics

Faculty of Women for Arts, Science & Education

Ain Shams University

Prof. Dr. Tarek M. EDSoky

Prof. of Radiation Physics

Faculty of Women for Arts, Science & Education

Ain Shams University

Prof. Dr. Khaled Mohamed El Shahat

Prof. of Medical Radiation Physics

Faculty of Medicine

Al Azhar University

To **Allah**, everything in life is resumed. In this work, Allah has helped me a lot. Allah offered me what I didn't know and what I have to know. So, before I begin the acknowledgment, I must kneel thanking Allah who inspired me, took my hand and provided me with power, patience and guidance.

Acknowledgements

My sincere appreciation goes to my late supervisor, *Prof. Dr. Amal Mahmoud El Shershaby* for her helpful discussions to improve this work, thorough practical sessions and continuous encouragement through the course of this study. May she continue to enjoy eternal peace.

I am highly grateful also to my co- supervisors *Prof. Dr. Tarek Mohamed El Desoky* and *Prof. Dr. Khaled Mohamed El Shahat* for their on-going support, insight and ideas that were a huge contribution to this work.

Thanks also to *Dar Al Fouad Hospital* for providing the time and resources necessary to conduct this study. A special thanks to *My Wife and My Family* for always being there for me to talk to and helping me through the most stressful parts of this study. Finally, I appreciate my lecturers who taught me throughout my postgraduate other.

Ibrahim Hamamsi

Contents

Chapter	Item	Page
	List of Tables	III
	List of Figures	IV
	List of Abbreviations	VI
I	Introduction	1
	1.1 Background of the study	1
	1.2 What is the cancer	2
	1.2.1Types of cancer	3
	1.3. Prostate and prostate cancer	4
	1.3.1Types of prostate cancer	4
	1.3.2Prostate cancer Treatment	5
	1.4History of Radiography	6
	1.5Radiation Therapy	7
	1.5.1Types of Radiation Therapy	8
	1.6External beam radiotherapy workflow for prostate cancer	10
	1.6.1Diagnosis	10
	1.6.2 Image acquisition	11
	1.6.3 Volume Delineation for Radiotherapy	14
	1.6.4 Contouring (Image segmentation)	17
	1.6.5 Treatment Planning	18
	1.6.6 System software and dose calculation algorithms	23
	1.6.6.1 Dose calculation algorithms	24
	1.6.6.2 Dose volume histogram (DVH	25
	1.6.7 Patient specific quality assurance	26
	1.7 Advanced treatment planning techniques in EBRT	27
	1.7.1 Three-dimensional conformal radiation therapy (3D-CRT)	28
	1.7.2 Intensity-modulated radiation therapy (IMRT)	29
	1.7.3 Volumetric modulated arc therapy (VMAT)	30
	1.8 AAPM Task Group 119	31
	1.9 Aim and objectives	32
	1.9.1 Specific objectives	32
	1.10 Significance of study	32

Chapter	Item	Page
II	Literature review	33
III	Materials and Methods	44
	3.1 Patient selection, preparation and radiation delivery	44
	3.2 Patient Specific Quality Assurance	45
	3.2.1 Gamma Analysis	46
	3.2.2 Dose Differences	47
	3.3 ArcCHECK patient-specific QA protocol	48
	3.4 3DVH Analysis	50
	3.5 Analysis of dose volume histogram (DVH)-based metrics	52
IV	Results and discussion	53
	4.1 Results	53
	Discussion	63
V	Conclusion	67
VI	References	68
VII	Arabic summary	

List of Tables

Number	Table	Page no.
4.1	Gamma pass rates and standard deviations for VMAT.	56
4.2	Gamma pass rates and standard deviations for IMRT.	56
4.3	Percentage dose difference and correlation between %DD and gamma pass rate. r = Pearson correlation coefficient	58

List of Figures

Number	Figures	Page no.
1.1	Global Cancer Data “GLOBOCAN 2018”	1
1.2	Normal and Malignant cells	3
1.3	Prostate anatomy	5
1.4	HDR Brachytherapy for prostate cancer case	8
1.5	External Beam Radiotherapy for prostate cancer case	9
1.6	Radiotherapy Workflow	10
1.7	Prostate cancer examinations	11
1.8	CT simulation for prostate cancer irradiation	12
1.9	CT-Simulation for prostate case guided with MRI investigation	13
1.10	CT-MRI fusion for delineation of prostate and risk organs	14
1.11	Target volume definition	15
1.12	RapidArc technique for prostate cancer case	19
1.13	A cumulative integral DVH of Prostate case planned with IMRT technique	26
1.14	Comparison of treatment plans in a patient with prostate	29
3.1	An Axial View Created by IMRT Plan with Five fields	44
3.2	An Axial View Created by VMAT Plan with two partial arcs	45
3.3	ArcCHECK device from Sun Nuclear Inc	50
3.4	ArcCHECK planned dose perturbation (ACPD) calculation in 3DVH software (Sun nuclear)	51
4.1	Correlation between percentage dose difference and gamma pass rate for each structure in the cases of IMRT Technique	59

Number	Figures	Page no.
4.2a	Correlation between percentage dose difference and gamma pass rate for each structure in the cases of RapidArc Technique	61
4.2b	Correlation between percentage dose difference and gamma pass rate for each structure in the cases of RapidArc Technique	62

List of Abbreviations

Symbol	Full word
%DD	Percentage Dose Differences
%DE	Percentage Dosimetric Errors
3D-CRT	Three Dimensional Conformal Radiation Therapy
3DVH	Dose Volume Histogram Analysis Software
AAA	Anisotropic Analytical Algorithm
AAPM	American Association of Physics in Medicine
ACPD	ArcCHECK Planned Dose Perturbation
ACR	American College of Radiology
ASTRO	American Society for Radiation Oncology
CCW	Counter Clockwise
CT	Computed Tomography
CTV	Clinical Target Volume
CW	Clockwise
D3DVH	The Dose Represented by 3DVH Software
DBDR	Dynalog-Based Dose Reconstruction
DICOM	Digital Imaging and Communications in Medicine
DNA	Deoxyribonucleic Acid
DRE	Digital Rectal Examination
DTA	Distance To Agreement
DTPS	The Dose Represented by The Treatment Planning System
DVH	Dose Volume Histogram
EBRT	External Beam Radiation Therapy
EPID	Electronic Portal Imaging Device
GPR	Gamma Pass Rate
GTV	Gross Target Volume
HDR	High dose-rate brachytherapy