

DECLARATION BY THE STUDENT

I, (Mr. Ravi Kant), declare that the thesis entitled “**DOSIMETRIC EVALUATION IN CARCINOMA LUNG BY INTRALUMINAL BRACHYTHERAPY AND CORRELATION IN PHANTOM MODEL**” is my own work conducted under the supervision of Prof. (Dr.) Meenu Gupta at Department of Radiation Oncology, Cancer Research Institute, Himalayan Institute of Medical Sciences, Swami Rama Himalayan University approved by D.R.C.

I further declare that to the best of my knowledge the thesis does not contain any part of any work which has been submitted for the award of any degree either in this University or in any other University/ Deemed University without proper citation.

BESIDES THIS:

I have successfully completed the course work of one semester as per UGC-Regulation 2016 norms.

I have also given a pre-Ph.D. presentation and successfully incorporated the changes suggested on the basis of feedback and comments received.

I have also published one research paper in a journal from the research work of the thesis and presented two papers in the Conference and has produced an evidence of the same in the form of acceptance letter/ or the reprint/ certificate of presentation. I have been awarded with Young Scientist award by the UCOST for presenting my thesis research work.

Mr. Ravi Kant

CERTIFICATE

This is to certify that Mr. Ravi Kant in the department of Radiation Oncology of this University has fulfilled the requirements prescribed for the Ph.D. degree of the Swami Rama Himalayan University, Dehradun.

The Thesis entitled, “**DOSIMETRIC EVALUATION IN CARCINOMA LUNG BY INTRALUMINAL BRACHYTHERAPY AND CORRELATION IN PHANTOM MODEL**” was carried out under my direct supervision. No part of the thesis was submitted for the award of any degree or diploma prior to this date.

Clearance was obtained from the University Ethics Committee for carrying out the study.

PROF. (DR.) MEENU GUPTA

SUPERVISOR

CERTIFICATE FOR PLAGIARISM

It is certified that Ph.D. thesis entitled “**DOSIMETRIC EVALUATION IN CARCINOMA LUNG BY INTRALUMINAL BRACHYTHERAPY AND CORRELATION IN PHANTOM MODEL**” by Mr. Ravi Kant has been examined by us. We undertake & declare that:

- a. This thesis has significant new work/knowledge as compared to already published or are under consideration to be published elsewhere. No sentence, equation, diagram, table, paragraph or section has been copied verbatim from previous work unless it is placed under quotation marks and duly referenced.
- b. The work presented is original and own work of the author (i.e. there is no plagiarism). No ideas, processes, results or words of others have been presented as Author’s own work.
- c. There is no fabrication of data or results which have been compiled/ analyzed.
- d. There is no falsification by manipulating research materials, equipment or processes, or changing or omitting data or results such that the research is not accurately represented in the research record.
- e. The thesis has been checked using TURNITIN (copy of the originality report attached).

MR. RAVI KANT

PROF. (DR.) MEENU GUPTA

DOSIMETRIC EVALUATION IN CARCINOMA LUNG BY INTRALUMINAL BRACHYTHERAPY AND CORRELATION IN PHANTOM MODEL

by Ravi Kant

Submission date: 17-Feb-2024 10:10AM (UTC+0530)

Submission ID: 2296976195

File name: Final_PHD_Thesis_Submission_to_Supervisor_Ravi_Kant.doc (13.84M)

Word count: 22133

Character count: 117922



Director Research
Research and Development Cell
Swami Rama Himalayan University
Swam: Ram Nagar, Jolly Grant
Dehradun-248015, Uttarakhand, India

**DOSIMETRIC EVALUATION IN CARCINOMA LUNG
BY INTRALUMINAL BRACHYTHERAPY AND
CORRELATION IN PHANTOM MODEL.**



Thesis submitted in partial fulfillment of the Award of
degree of Doctor of Philosophy in
Faculty of Medicine

SUBMITTED BY
MR. RAVI KANT

SUPERVISOR
PROF. (DR.) MEENU GUPTA

Swami Rama Himalayan University
Swami Ram Nagar, Jolly Grant, Dehradun
Year 2023

Ravi Kant

Meenu Gupta

Director Research
Research and Development Cell
Swami Rama Himalayan University
Swami Ram Nagar, Jolly Grant
Dehradun, Uttarakhand, India

DOSIMETRIC EVALUATION IN CARCINOMA LUNG BY INTRALUMINAL BRACHYTHERAPY AND CORRELATION IN PHANTOM MODEL

ORIGINALITY REPORT



PRIMARY SOURCES

1	jcdr.net Internet Source	2%
2	Ravi Kant, Meenu Gupta, Jyoti Bisht, Vipul Nautiyal, Viney Kumar, Rishabh Dobhal, Mushtaq Ahmad, Sunil Saini. "Dosimetric and Volumetric Analysis in Endobronchial Brachytherapy in Lung Carcinoma: A Cross-sectional Study", JOURNAL OF CLINICAL AND DIAGNOSTIC RESEARCH, 2023 Publication	1%
3	www.hbni.ac.in Internet Source	<1%
4	IFMBE Proceedings, 2009. Publication	<1%
5	magru.net Internet Source	<1%
6	"Technical Basis of Radiation Therapy", Springer Nature, 2012 Publication	<1%

Director Research
Research and Development Cell
Swami Rama Himalayan University
Swami Rama Nilaya, Dehra Dun, India

7	coek.info Internet Source	<1 %
8	www.science.gov Internet Source	<1 %
9	"Scientific Abstracts and Sessions", Medical Physics, 2017 Publication	<1 %
10	www.utrgv.edu Internet Source	<1 %
11	www.ncbi.nlm.nih.gov Internet Source	<1 %
12	fp.amegroups.cn Internet Source	<1 %
13	srhu.edu.in Internet Source	<1 %
14	"Scientific Abstracts and Sessions", Medical Physics, 2018 Publication	<1 %
15	epdf.tips Internet Source	<1 %
16	www.researchgate.net Internet Source	<1 %
17	doaj.org Internet Source	<1 %

Handwritten signature

Handwritten signature

Director Research
Research and Development Cell
Swami Rama Himalayan University
Swami Ram Nagar, Jolly Grant
Dehradun-248005, Uttarakhand, India

18	Ngangom Robert, RP Chauhan, Arun Oinam, Bhavana Rai. "Angular dependency correction of 2D planar detector I'mRT MatriXX an offline dosimetry system used for IMRT pre-treatment verification", Biomedical Physics & Engineering Express, 2018 Publication	<1 %
19	Baltas, . "Source Specification and Source Calibration", Series in Medical Physics and Biomedical Engineering, 2006. Publication	<1 %
20	R Pizzutiello, M Svatos. "SU-A-BRE-01: AAPM Medical Physics Student Meeting", Medical Physics, 2014 Publication	<1 %
21	Uniyal, S.C., S.D. Sharma, and U.C. Naithani. "Dosimetric verification of a high dose rate brachytherapy treatment planning system in homogeneous and heterogeneous media", Physica Medica, 2013. Publication	<1 %
22	www.omicsonline.org Internet Source	<1 %
23	academic.oup.com Internet Source	<1 %
24	healthdocbox.com Internet Source	<1 %

Handwritten signature

Handwritten signature

Handwritten signature
 Director, Research
 Research and Development Cell
 Swami Rama Himalayan University
 Swam. Ram Nagar, Jolly Grant
 Dehradun-248026, Uttarakhand, India

25	inba.info Internet Source	<1 %
26	Submitted to University of Western Australia Student Paper	<1 %
27	mafiadoc.com Internet Source	<1 %
28	repository.tudelft.nl Internet Source	<1 %
29	"New Technologies in Radiation Oncology", Springer Nature, 2006 Publication	<1 %
30	"World Congress on Medical Physics and Biomedical Engineering 2006", Springer Science and Business Media LLC, 2007 Publication	<1 %
31	escholarship.mcgill.ca Internet Source	<1 %
32	jacmp.org Internet Source	<1 %
33	www.msjonline.org Internet Source	<1 %
34	Review of Medical Dosimetry, 2015. Publication	<1 %
35	aocmp-seacomp2014.vn Internet Source	<1 %




Director Research
Research and Development Cell
Swami Rama Himalayan University
Swami Ram Nagar, Jolly Grant
Dohadun-248016, Uttarakhand, India

36	de.scribd.com Internet Source	<1 %
37	synapse.koreamed.org Internet Source	<1 %
38	worldwidescience.org Internet Source	<1 %
39	www-pub.iaea.org Internet Source	<1 %
40	www.jacmp.org Internet Source	<1 %
41	www.scribd.com Internet Source	<1 %
42	IFMBE Proceedings, 2015. Publication	<1 %
43	Ibrahim Duhaini, Bilal Shahine, Youssef Zeidan, Ahmad Maarouf, Mahmoud Korek. "Dosimetry comparison and evaluation of 3D and IMRT for left breast cancer radiotherapy techniques treated at ain wazein medical village hospital in Lebanon", Health and Technology, 2021 Publication	<1 %
44	www.jcdr.net Internet Source	<1 %


 Director Research
 Research and Development Cell
 Swami Rama Himalayan University
 Swam. Ram Nagar, Jolly Grant
 Tehradup-248016, Uttarakhand, India

45 C. Knotts, S. Falls, C. Allen, P. Wagner, D. Bartlett, D. Monga, S. Schiffman. "Overutilization of PET-CT in staging of pancreatic neoplasms", HPB, 2023
Publication <1%

46 tudr.thapar.edu:8080 Internet Source <1%

Exclude quotes On
Exclude bibliography On

Exclude matches < 14 words



Director Research
Research and Development Cell
Swami Rama Himalayan University
Swami Ram Nagar, Jolly Grant
Dehradun-248016, Uttarakhand, India



UNDERTAKING FOR SUBMISSION OF Ph.D. THESIS

I solemnly declare that research work presented in the thesis titled “DOSIMETRIC EVALUATION IN CARCINOMA LUNG BY INTRALUMINAL BRACHYTHERAPY AND CORRELATION IN PHANTOM MODEL” is solely my research work with no significant contribution from any other person. Small contribution/help whenever taken has been duly acknowledged and that complete thesis has been written by me.

I understand the zero tolerance policy of the Swami Rama Himalayan University (SRHU) towards plagiarism. Therefore I as an author of the above titled thesis declare that no portion of my thesis has been plagiarized and an material used as reference is properly referred/ cited.

I undertake that material of the thesis submitted in hard bound and soft copy is same and no alteration has been done. If it is found guilty in future, University may take any action against me.

I undertake that if I am found guilty of any formal plagiarism in the above titled thesis even after award of PhD degree, the University reserves the rights to withdraw/revoke my PhD degree.



Mr. Ravi Kant
Enrolment No.: SRHU190000002
Department of Radiation Oncology
Cancer Research Institute
Himalayan Institute of Medical Sciences
Swami Rama Himalayan University
248001, Dehradun Uttarakhand India

CERTIFICATE OF VIVA-VOCE OF Ph.D. STUDENT

**DOSIMETRIC EVALUATION IN CARCINOMA LUNG BY
INTRALUMINAL BRACHYTHERAPY AND CORRELATION IN
PHANTOM MODEL**

Submitted by

Mr. Ravi Kant

For the degree of

Doctor of Philosophy in

Faculty of Medicine

is evaluated and approved by

PROF. (DR.) MEENU GUPTA

SUPERVISOR

EXAMINER

ACKNOWLEDGEMENTS

I take this opportunity to convey my profound indebtedness and deep sense of gratitude to my guide Dr. Meenu Gupta, Professor, Department of Radiation Oncology, Himalayan Institute of Medical Sciences Swami Rama Himalayan University, Jolly Grant Dehradun. Her keen patronage, noble guidance, spontaneous support and constant encouragement were the driving force for the successful completion of this work.

I owe a heavy debt of gratitude to Dr. Mushtaq Ahmad, Professor Radiation Oncology & Director Medical Services, HIMS SRHU for his valuable support, guidance and encouragement.

I gave my special thanks to Dr. Sunil Saini, Professor Surgical Oncology & Director Cancer Research Institute, HIMS SRHU for providing me radiation facilities to carry out the research work.

I would like to thank to Dr. Satish Uniyal Professor & Head, Department of Medical Physics, Himalayan Institute of Medical Sciences Swami Rama Himalayan University Jolly Grant Dehradun to allow me to carry out the dosimetric analysis work with his film dosimetry system. His scientific insight, unstinting support, valuable guidance and helpful suggestions remained the key factors in making my endeavor successful.

I record my grateful acknowledgement to Dr. Jyoti Bisht Assistant Professor Department of Medical Physics, HIMS SRHU for her selfless support and suggestion during the course of the research work.

I thank to Dr. Vipul Nautiyal Professor & Head Department of Radiation Oncology, Dr. Viney Kumar Assistant Professor Department of Radiation Oncology and Mr. Rishabh Dobhal Lecturer Department of Medical Physics HIMS SRHU for their support.

Many thanks to Mr. Ajeet Singh, Mrs. Kanchan Prakash, Mr. Pankaj Dhasmana, Mr. Pankaj Laman, Ms. Prachi Joshi, Mr. Tarun Chauhan, Ms. Anuradha Rana Department of Radiation Oncology and Dr. Nisha Bhatia Radiation Safety Officer Department of Nuclear Medicine for their assistance in the experimental process in this research work.

I gave my sincere thanks to Research Committee, Ethics Committee and Finance Committee of SRHU for their support in the work.

I am especially thankful to the learned authors of different books and research papers from which I have tried to enrich my knowledge. I have barely touched the hem of the garment by referring their work at appropriate places as I owe a lot to them.

I would never have succeeded without the support of my Family member, nears and dears and well wishers. My inspiration and success are due to the boundless blessings of my parents, Mrs. Manorama Devi (Mother) and Mr. Satish Kumar (Father). The excellent cooperation and support of my wife Mrs. POOJA [Advocate] helped me a lot in achieving my goal and without her support I cannot complete the thesis work. Full Moral Support and lots of love from my dearest daughters Ms. Kanika Kant and Ms. Pranavi Kant are acknowledged.



Ravi Kant
Ph. D. Research Scholar

LIST OF ABBREVIATIONS

S. No.	Abbreviations	Full Forms
1.	EBRT	External Beam Radiation Therapy
2.	EBBT	Endo Bronchial Brachy Therapy
3.	TPS	Treatment Planning System
4.	CT	Computed Tomography
5.	DVH	Dose Volume Histogram
6.	ABS	American Brachytherapy Society
7.	OAR	Organs At Risk
8.	TV	Target Volume
9.	cm	centimeters
10.	ISP	International Specialty Products
11.	HDR	High Dose Rate
12.	OD	Optical Density

13.	Gy	Grey
14.	Eq.	Equation
15.	MOD	Mean Optical Density
16.	EBT	External Beam Therapy
17.	TLD	Thermoluminescence Dosimeter
18.	AAPM	American Association of Physicists in Medicine
19.	LiF	Lithium Fluoride
20.	MRI	Magnetic Resonance Imaging
21.	PET-CT	Positron Emission Tomotherapy Computed Tomography
22.	Ir-192	Iridium-192
23.	NSCLC	Non-Small Cell Lung Cancer
24.	SBRT	Stereotactic Body Irradiation Therapy
25.	MCC	Monte Carlo Code
26.	ILRT	Intraluminal Brachytherapy
27.	ESTRO	European Society for Radiotherapy & Oncology

28.	SRHU	Swami Rama Himalayan University
29.	SPSS	Statistical Package for the Social Sciences
30.	MS	Microsoft
31.	OMP	Oncentra Master Plan
32.	RAL	Remote afterloading
33.	Ci	Curie
34.	PMMA	Poly Methyl Meth Acrylate
35.	IMRT	Intensity Modulated Radiation Therapy
36.	VMAT	Volumetric Modulated Arc Therapy
37.	IGRT	Image Guided Radiation Therapy
38.	MU	Monitor Unit
39.	6F	6 French
40.	DICOM	Digital Imaging and Communications in Medicine
41.	SAD	source to axis distance
42.	ICWG	Interactive Collaboration Working Group
43.	USA	United state of America

44.	RAD	Radiation Absorbed Dose
45.	OT	Operation Theater
46.	QA	Quality Assurance
47.	BT	Brachytherapy
48.	MV	Mega Voltage
49.	cc	centimeter cube
50.	LDR	Low Dose Rate
51.	MDR	Medium Dose Rate
52.	ICRU	International Commission on Radiation Units and Measurements
53.	CI	Conformity Index

LIST OF CHARTS

S. No.	Chart Title	Page
1	Showing Esophagus mean doses in three EBBT sessions	60
2	Showing Esophagus maximum doses in three EBBT sessions	61
3	A Graph showing Heart Maximum doses in three EBBT sessions	62
4	A Graph showing Heart mean doses in three EBBT sessions	62
5	A Graph showing Contraletral Lung Maximum doses in three EBBT sessions.	63
6	A Graph showing Lt. Coronary artery Maximum doses in three EBBT sessions.	64
7	A Graph showing Spinal Cord Maximum doses in three EBBT sessions	65
8	A Graph showing Trachea Maximum doses in three EBBT sessions	66
9	A Graph showing Descending Aorta maximum doses in three EBBT sessions	67
10	A Graph showing Liver Maximum doses received in three EBBT sessions for thirty patients	67
11	A Graph showing Kidney Maximum doses received in three EBBT sessions for thirty patients.	68

LIST OF FIGURES

S. No.	Figure Title	Page
1	Showing the classification of different type of radiation	1
2	Showing the radiation delivery methods in radiotherapy	1
3	Design of HDR192Ir Brachytherapy Source capsule (Nucletron Pvt. Ltd. Make)	24
4	Sievert integral model for dose calculation in brachytherapy	27
5	Dose calculation formalism TG-43 of AAPM	28
6	Structure of GAF-Chromic Dosimetry EBT3 Film	33
7	Diagram of the locally fabricated Tissue Equivalent Phantom correlating with thoracic cavity axial image	36
8(a) & 8(b)	Showing a Gafchromic EBT3 Film Dosimeter Calibration setup at TrueBeam Linac	38
9(a) & 9(b)	Showing a EPSON flat bed scanner used for the film scanning purpose	39
10	Irradiated EBT3 films exposed for the calibration	41
11	Calibration Curve for Film Dosimeters	42
12	Schematic block diagram of the phantom for experimental setup	43
13	Schematic diagram of the phantom in Axial (A) & sagittal (B) view for experimental setup	43-44

14	CT scan acquisition of the Thorax phantom fabricated locally	45
15	Showing EBBT treatment plan on Thoracic phantom	46
16	Showing a Phantom Connected to HDR machine for irradiation	47
17	Showing the scan images of irradiated EBT3 films at different locations in the phantom	48
18	Showing a source position simulator tool at the time of CT Scan	50
19	Showing a Dummy source cable used at the time of CT Scan	50
20	Showing an EBBT treatment planning of a patient with OARs and Target Volume delineated for dosimetric analysis	52
21	Showing the percentage variation in between the doses measured in phantom and calculated in TPS for OARs	55
22	A chart showing total mean doses to OARs in three sessions of EBBT	59
23	A Chart showing a variation in target volume from 1 st to 3 rd EBBT sessions	73
24	A chart showing the conformity Index (CI) of the target volume in 1 st and 3 rd EBBT sessions	74

LIST OF TABLES

S. No.	Table Title	Page
1.	Physical characteristic of radionuclide used commonly in RALs	24
2.	showing tissue densities used in Phantom fabrication	35
3.	Showing the MOD values for corresponding dose	40
4.	Showing the doses measured in phantom and Calculated in TPS for OARs	54
5.	Showing the film measured Dose values for OARs at five points on a plane	57
6.	Showing the Percentage variation in doses measured at five points between phantom and TPS	58
7.	Showing the effect of tumor site on doses to OARs in EBBT sessions	69
8.	Showing the effects of tumor location on the OARs doses in the EBBT Session	70
9.	Showing the effect of Target Volume >22cc on the OARs doses in the EBBT session	71
10.	Showing the affect of Target Volume <22cc on the OARs doses in the EBBT session	72