بسم الله الرحمن الرحيم

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Department: Physics

Comparative study of different radiation therapy techniques in large volume head and neck tumors

A Thesis submitted in Partial Fulfillment of the requirement for the Master Degree in Science in physics

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Master Degree Approval sheet

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Contents

List of abbreviation

3DCRT	Three dimension conformal radiotherapy
AAA	Anisotropic analytical algorithm
AMAT	Aperture modulated arc therapy
AMCBT	Arc-modulated cone beam therapy
AMRT	Arc-modulated radiotherapy
AVG	Average
BEV	Beam eye view
CF	Conformity function
CI	Conformity index
CN	Conformity number
CT	Computed tomography
CTV	Clinical target volume
DICOM	Digital imaging and communications in medicine
Dmax	Maximum dose
DRR	Digital reconstructed radiograph
DVH	Dose–volume histogram
GI	Dose gradient index
GTV	Gross tumor volume

HNC	Head and neck cancer
HI	Homogeneity index
ICRU	International commission on radiation units
IMAT	Intensity modulated arc therapy
IMRT	Intensity-modulated radiation therapy
ITV	Internal Target Volume
MLC	Multi-leaf collimator
MRI	Magnetic resonance imaging
MU	Monitor unit
OAR	Organ at risk
PET	Positron emission tomography
PRV	Planning organ at risk volume
PTV	Planning target volume
QI	Quality index
RVR	Remaining volume at risk
SSD	Source to surface distance
SWAT	Sweeping-window arc therapy
TPS	Treatment planning system
VMAT	Volumetric modulated arc therapy

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ABSTRACT

The most used methods for head and neck cancer treatment are surgery, chemotherapy and radiotherapy.

The radiation therapy aims to deliver a prescribed dose to target volumes, to kill the tumour cells, with a good protection of organs at risk OAR.

More than half of all patients assessed to receive radiotherapy during their treatment.

Radical radiation therapy is indicated either in the primary treatment of head and neck cancer with concurrent chemotherapy for locally advanced disease or in the postoperative setting with or without concurrent chemotherapy.

Radiation therapy for advanced head and neck cancer has developed from the three dimensional conformal radiotherapy 3DCRT to intensity modulated radiation therapy IMRT and Volumetric modulated arc therapy VMAT.

The aim of present work is to compare treatment planning for a large volume head and neck cancer patients using IMRT and VMAT techniques to evaluate and find out optimal technique for treating large volume head and neck tumor.

Eleven patients with advanced head and neck tumors that previously treated were selected for the planning study. The patients are planned using the two different techniques (IMRT and VMAT) and optimized to evaluate highly conformal target coverage and sparing OAR.

Standard fractionation is 33 fractions with 5 fractions weekly, the prescribed doses70Gy, 59.4Gy and 54Gy for the high, intermediate and low risk targets by simultaneous integrated boost.

Evaluation of plan was depend on target dose coverage, homogeneity, conformity and gradient, dose statistics of the OARs, total monitor units and the remaining volume at risk RVR.

The study showed that the two techniques are equal for target dose conformity index (0.94), and comparable in homogeneity index (0.91,0.93) for VMAT and IMRT respectively, while VMAT is more superior clearly in CN and GI (0.76, 44) than (0.68, 55) for IMRT. Furthermore VMAT has an advantage over IMRT in the most of OAR

For the total monitor unit, IMRT is considered as a second choice, which gives more than three times monitor units for VMAT.

However for low dose effect RVR, VMAT has the upper hand, that the average volume of **RVR** that received 15Gy, 10Gy and 5Gy are (4327, 5281 and 6703cc) and 1019cGy mean dose in **VMAT** techniques, while in **IMRT** are (4435, 5311 and 6543cc) and 1051cGy mean dose.

Finally Results of the dosimetric comparison between both techniques showed that VMAT had a priority than IMRT in a lot of comparison points especially the time on the machine, that make VMAT is the first choice in the treatment plan selection.

Chapter (I)

Introduction and literature review

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Introduction and literature review

1.1 Introduction

Radiation oncology is a human medicine which interested in the knowledge on the prevention, causes and treatment of cancer and other diseases need a special expertise in the therapeutic applications of ionizing radiation.

Radiation therapy is a clinical application using the ionizing radiations in the treatment of patients with malignant tumors and sometimes benign diseases. Radiation therapy aims to deliver a precisely dose of irradiation to a specific tumor volume with minimal damage to surrounding healthy tissue.

In addition to radical treatment radiation therapy plays an important role in palliative cancer management by prevention of symptoms of the disease and decreasing pain. (Halperin et al. 2018)

Tobacco and alcohol abuse and human papillomavirus infection are two primary causes of head and neck cancer (**HNC)**. **It** was commonly spreads in some countries around the world, the estimated percentage of **HNC** is 4% of malignancies tumour.

The clinical management of **HNC** needs precise diagnosis, accurate staging and a standardized multidisciplinary treatment approach. (Xie et al. 2017)

Surgery has the longer history, which the primary method of treatment in many tumour types that non-metastatic.

Radiotherapy is a good alternative to surgery for the long term control of many tumours of the head and neck, lung, cervix, bladder, prostate and skin that can achieves a reasonable tumour control with good cosmetic results.

Also many patients received valuable palliation by radiation. Chemotherapy is the third most important treatment type at the present time. More than half of all patients assessed to receive radiotherapy during their treatment. (Joiner et al. 2009)

The percentage of cancer patients who should receive radiotherapy during treatment is representing in (Table 1.1). (Delaney et al. 2005)

Table 1.1 Percentage of cancer patients received radiotherapy (Delaney et al. 2005)

Tumour type	Proportion of all cancer (%)	Proportion of patients receiving radiotherapy (%)	patients receiving radiotherapy (% of all cancers)
Breast	13	83	10.8
Lung	10	76	7.6
Melanoma	11	23	2.5
Prostate	12	60	7.2
Gynecological	5	35	1.8
Colon	9	14	1.3
Rectum	5	61	3.1
Head and neck	4	78	3.1
Gall bladder	1	13	0.1
Liver	1	0	0
Esophageal	1	80	0.8
Stomach	2	68	1.4
Pancreas	2	57	1.1
Lymphoma	4	65	2.6
Leukemia	3	4	0.1
Myeloma	1	38	0.4
Central nervous system	2	92	1.8
Renal	3	27	0.8
Bladder	3	58	1.7
Testis	1	49	0.5
Thyroid	1	10	0.1
Unknown primary	4	61	2.4
Other	2	50	1
Total	100	-	52.3