1. INTRODUCTION

1.1 OVERVIEW:

The Development of computer technology has led to the availability of sophisticated treatment planning systems (TPS) for use in many radiotherapy centers. The entire process to prepare the radiation treatment of a cancer patient is the main aim for using the TPS. This process includes imaging studies, definition of target volumes, design and optimization of the irradiation technique, evaluation of the treatment plan and implementation of the plan on the treatment unit.

In the TPS the patient data are entered, the anatomy is defined, beams are set up, the dose distribution is calculated, the plan is evaluated in terms of dose volume (and biological effect) and output is prepared for documentation and for transfer of data to block cutter simulator or treatment machine(Desrosiers, 2013). There are many types of Calculation but the most common used is Monte Carlo method.

There are Different types of medical radiotherapy systems which use alternative modules of TPS with different calculation Algorithm for example: Elekta XiO (Clarkson, FFT Convolution, Multigrid Convolution, Superposition and Fast Superposition), Phillips Pinnacle (Collapsed Cone Convolution and Pencil Beam), AndVarian ECLIPSE (AAA Collapsed Cone Convolution and Pencil Beam).

One aim of introducing such sophisticated TPSs is to improve the accuracy of dose calculations in radiotherapy planning. The accuracy in radiation therapy has been discussed in several reports which showed that errors in dose delivery should not exceed ± 5% (BrahmeA,1984). Values as low as ± 3% have, however, been also mentioned (ChavaudraJ.et.al,1994).

To investigate the accuracy of the TPSs, several quality assurance (QA) programs have been introduced and discussed in the literature (Dahlin H,et.al,1983). These QA programs mainly check the agreement of the output data from the system with the measured data.

There are many objectives to using external radiotherapy in cancer treatment using high radiation doses from photon or electron beams. One of these Radiotherapy Machines is the linear accelerator (LINAC) which is the most commonly used for external beam radiation treatments for patients with cancer.

The linear accelerator is used to treat all parts or organs of the body;it delivers high energy x-rays to the region of the patient's tumor.These x-ray treatments can be designed in such a way that they destroy the cancer cells while sparing the surrounding normal tissue.

These high energy x-rays are shaped as they exit the machine to conform to the shape of the patient's tumor and the customized beam is directed to the patient's tumor.The beam may be shaped either by blocks that are placed in the head of the machine or by a multileaf collimator that is incorporated into the head of the machine. The patient lies on a moveable treatment couch and lasers are used to make sure the patient is in the proper position

Radiation can be delivered to the tumor from any angle by rotating the gantry and moving the treatment couch. Healthy tissues and organs at risk surrounding the tumor should be preserved during treatment by the optimization of the irradiation parameters using a convenient Treatment Planning System (TPS) ,this radiation treatment planning System is the system in which a team consisting of radiation oncologists, radiation therapist,medical physicists and medical dosimetristsplan the appropriate external beam radiotherapy or Internal brachytherapy treatment technique for a patient with cancer. However, a quality control program should be implemented to compare the results provided by the TPS with experimental data. The experimental data are obtained by measurement of dosimetric parameters such as dose profile, relative output factor and percentage depth dose (PDD) (J. V. Ramírez,et.al,2012).

Determination of dosimetric characteristics of all radiation beams is vital so that the most appropriate set of treatment planning parameters is chosen. Data on the percentage depth dose of diagnostic X-rays are important in evaluating patient dose from medical exposure (H. Kato,et.al 2004).

In radiotherapy, quality of a radiation beam is most usefully expressed in terms of its penetrating power, which is a function mainly of the mean photon energy, and may be fully described by its depth dose characteristics in water (S. A. Buzdar,et.al, 2009) but an increase in surface dose with field size is also noted due to electron scattering from intervening materials (T. J. Jordan, 1996).

Data on dose distribution are almost entirely derived from measurements in phantoms, and then are used in a dose calculation system devised to predict dose distribution in an actual patient (M. Ravikumar and R. Ravichandran, 2002). Dosimetry is a very significant element of radiotherapy treatment as all the treatment planning is based on the data obtained during Dosimetry. Optimization of treatment plan and calculation of dose for certain plan is performed when radiation physicists have measured Dosimetry data. This data is actually representing different physics characteristics of the machine, beam and its energies in the form of dosimetric quantities.

Physicists are always interested in obtaining these parameters, first to use in radiotherapy treatment and second to evaluate and investigate physics of radiation beams field size, photon energy and Source to Surface Distance (SSD).Measurement of absorbed dose is performed using water or any other equivalent media phantom, which is kept perpendicular on the path of beam. This measurement is expressed as percent of dose which gives a unique value for a certain set of parameters like beam energy, depth, and SSD and field size. Variation in this value can be noted by change in any of these parameters (WHO,report4,2004).

A new Treatment Planning System (Planw2000- TPS, UJP, 2011) was installed in the National Cancer Institute, Wad Medani. This TPS is based on the pencil beam model (AhnesjoA.,et.al, 1992).Where physical quantities, estimated using conventional measured quantities, are used. The photon dose calculation model in this treatment planning system is based on a convolution algorithm.

Briefly, the model is used to compute weight for depth dose curves from monoenergetic photons. These monoenergetic depth doses, calculated with the convolution method from Mont Carlo generated point spread functions (PSF), are added to yield the pure photon depth dose distribution (AhnesjoA.,et.al, 1989).

The hereby obtained poly energetic pencil beam is then used to calculate the dose distribution for a given case by convolution with the machine specific energy fluence matrix modulated by the actual field shape. Inversely, the energy fluence matrix is obtained as a convolution of the pencil beam form the measured dose distribution under the reference situation (Trepp A,1991). One of the features of the system is that it calculates the monitor settings for the planned fields (Trepp A,1992)

1.2 Research problem:

There are many treatment planning systems(TPSs) are manufactured commercially, each therapeutic linear accelerator has its own data and machine configuration, and these configuration are normally compatible with specific TPS. A Varian MDX Clinac® 2100C Medical linear accelerator system was installed at National Cancer Institute in Wad Medani without an operating and licensed TPS ;due to the ban United States and its sanctions on Sudan.

1.3 objective of the study:

1.3.1 General objectives of study :

- To investigate the possibility of using the treatment Planning System (Planw2000, UJP, 2011), with Varian MDX Clinac® 2100C linear accelerator.

1.3.2 Specific objectives of the study:

- To compare the photon beam data (PDD, Profiles, Isodose) of the Varian MDX Linear Accelerator with the Calculated data from the treatment planning system (planW2000) based on pencil beam model .
- To compare the absolute dose measurements for 6 MV beam energy of a Varian MDX Clinac® 2100C linear accelerator with the calculated dose from the treatment Planning system.
- To Estimate the possible errors and Discrepancies in the (Algorithm Calculations) from the PlanW2000 Treatment Planning system .

The aims of this study is to synthesis the Treatment Planning system (PlanW2000, UJP, 2011) and verifythe validity of the calculated photon beam data in comparison with the measured photon data from the Varian MDX Clinac® 2100C linear accelerator at different treatment situations.

1.4Organization of the Thesis:

The Chapters of this thesis detail the research undertaken during the MSc candidacy and provide the necessary background to understand it.

Chapter 2 presents the background theory the discussion of radiotherapy and describing the production of clinically useful beam, provide a general Dosimetry concepts, Absolute Dosimetry, Relative Dosimetry, Dosimeters, reference condition of measurement, the biological effect of radiation ,theRadiotherapy treatment planning system, and Calculation algorithms for TPS.

Chapter 3 presents theEquipment used for extracting the data and the Method of extracting the Datasets for PlanW2000 for 6MV Photon beam and the Experimental measurements. The method of comparing the Calculated and Measured Data are also included.

The remaining chapters of the thesis discuss the original work and the description of the Results and outcomes of this research in Chapter 4. Finally the thesis is then concluded and recommendation outcomes of this research in Chapter 5.