THE TREATMENT PLANNING OF RECTUM TUMORS AND THE USE OF THE WEDGE FILTER FOR ENSURING THE CORRECT ISODOSES

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ABSTRACT

A correct distribution of the dose around the volume of interest or planning target volume (PTV) is very important to radiotherapy. The process requires the exact isodose in a treatment plan to cover the PTV. Here, the wedge which is a part of the linear accelerator head is used. Wedge plays the role of a filter and usually it is called wedge filter. The wedge filter is used almost in all treatment plans, for all the parts of the body. The present paper provides information about the use of the wedge filter for treatment of rectum tumors. The process starts with the scanning of the patient and the deliantion of the interest's volumes in the Monaco system. The rectum imaging has been sent in the treatment planning system for appropriate treatment plans. Two plans were done, one with the use of the wedge and the other without using it. The dose volume histogram compares the results of the plans. The use of wedge through volume of interest, which is planning target volume (PTV), showed the best conformity of the isodoses.
Keywords*: treatment planning, rectum tumors, wedge filter, correct isodoses*

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1. INTRODUCTION

Radiotherapy aims at giving the correct dose to the PTV and protecting maximally the organs at risk and the healthy tissue around PTV. This could be achieved by having the correct isodose line in the target. This homogeneity is hard to be gained. Wedge filters were first conceived and used in radiotherapy by Frank Ellis in 1944. The intensity of the beam is reduced gradually by a filter in a form of a wedge across the radiation field to shape the isodose curves. The wedge was placed between the patient and the source head at a fixed distance. The present paper focuses on the plans for rectum tumors. As the irradiating fields are one posterior and two laterals, the uniformity of the isodoses in the PTV could not be provided. Some parts of PTV are irradiated more than the prescribed dose line and some parts are irridated less than the prescribed dose line. In these cases, the wedge is a means to address the correct uniform isodose around PTV. For the same patients there were created two plans, one without wedge in the path of the beam and the other with wedge in path of the beam.

2. METHODS AND MATERIALS

In radiotherapy wedge are placed to modify the path of photon beams for correct isodose distribution purposes (Figure 1).

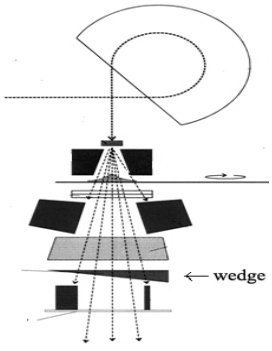

Fig. 1: The wedge in the path of the beam.

The modified isodose distributions are invaluable in the treatment planning to achieve homogeneous isodose distributions. A wedge filter, which is usually made of dense materials such as steel, lead, brass, copper or any other heavy metal, is designed to create differential attenuation and hence progressive change in the intensity across the photon beam width. The resulting isodose distributions present tilting of isodose curves with respect to the normal of the photon beam central axis. The degree of isodose curve tilt towards the thin end of the wedge filter depends on the physical slope of the wedge filter.
Rectum cancer is a common tumor for both men and women. The deaths are reduced significantly due to radiotherapy (NIH 1990). Plan of patient with rectum tumor (Swedish Rectal Cancer Trial, 1997) is in the present paper reported. The main point is to show the effect of the wedge filter in the dose distribution through rectum volume. Before in radiotherapy, by using the physical leaf or by reducing the size of the field, it was achieved the wedge effect during the course of treatment (Cherry and Duxbury 1998). Now the physical wedge in the linear accelerators is considered a standard accessory. Once the patients were scanned in the CT simulator, the images were sent to the Monaco system. Monaco is a system where the doctors contur the tumor and the organs at risk. The belly step is the accessory which was used to immobilize the patient. In this kind of tumors, the organs at risk which should be protected are bladder, intestine and femur heads (Stephens *et. al*., 2010). Once contoured, the treatment planning system begins (Parker and Patrocinio 2005). There were created two different plans. The first plan involves three beams; one posterior beam and two lateral beams. The normalization point is the same for the three beams. Here, the wedge was not used (Figure 2). The isodose 110 % covers a big part of the PTV, i.e., 10 % dose more than prescription. So, some parts of the PTV are covered at a higher rate than prescribed and some parts are covered at a lower rate than prescribed providing bad unsucessful treatment results.

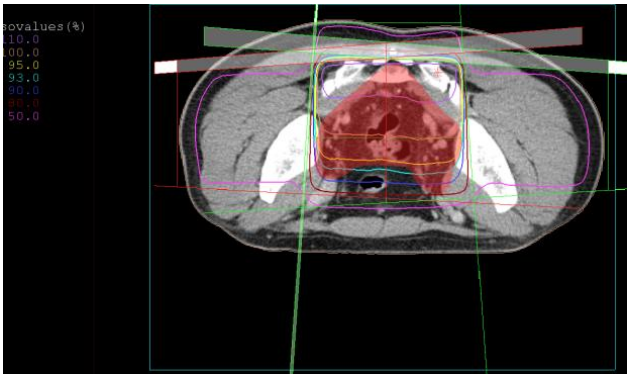

Fig. 2: The plan for rectum without wedge filter.

The second method involves the wedges in the path of the beam. The directions of the beams were the same (Figure 3). The isodose 110 % is disappeared in the volume of PTV. So, we have 100 % isodose around the PTV. This is the way for controlling maximally the rectum tumors, because all the part of the interest volume takes the correct isodose.

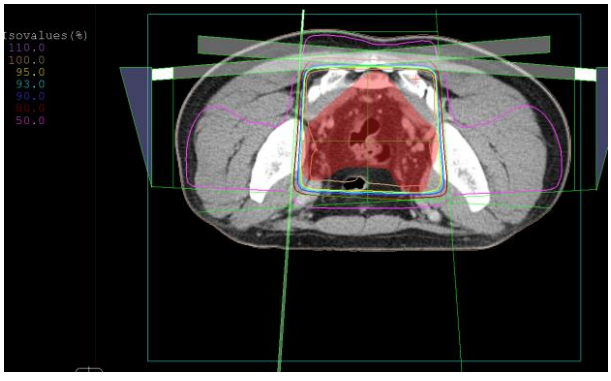

Fig. 3: The plan for rectum with wedge filter.

3. RESULTS AND RECOMANDATIONS

The number of patients diagnosed with rectum tumor has recently increased. In mean time, patients undergo radiotehrapy, the treatment of disease, usually cancer, by ionizing radiation in order to deliver an optimal dose of either particulate or electromagnetic radiation to a particular area of the body with minimal damage to normal tissues. The most important part of the procedure is to have uniform dose in all PTV. In the present paper two plans for the same patient are reported; one with wedges in the path of the beam and the other without it. Once made, the plans were compared according to the dose volume histograms. The results reported that the plan in which was not used the wedge (the solid line) has some part of PTV irradiated with more than prescribed dose and the other part with lower dose, which means the uniformity is not. On the other hand, the other line shows that the distribution in the PTV is uniform and under the correct dose which should be delivered to the patient (Figure 4).

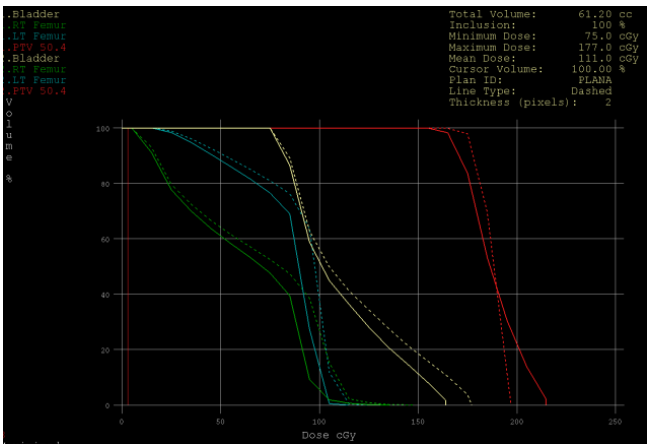

Fig. 4: The comparison of histograms.

The wedge filter is the most commonly used beam modifier in the field of radiotherapy. In the treatment planning, the use of wedge is unavoidable. The primary objective is to have uniform dose in the tumor volume when the use of normal fields is hard to achieve for different reasons. It is recommended the use of wedges to ensure the correct isodose line around PTV so it is possible a higher control to the tumor. The wedges help for compensating for the irregular shape of the isodoses.

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