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Research Article

Investigation from Different Calculation Solutions in Vertebra Plans and the Reliability of Different Dose Rate Dose

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Abstract:

In this study, it was aimed to investigate the effect of different dose rate and different computational resolutions on stereotactic vertebrae irradiation with the results of the verification schemes on Gamma analysis and the effect on dose for critical organ and target volume. Ten patients with vertebrae participated in the study. Patients participating in the study were investigated for their effect on doses for critical organ and target volume by recalculating treatment plans at different dose rates and different computational resolutions without changing the optimization parameters using Intensity Modulated Radiation Therapy (IMRT) technique and Anisotropic Analytical Algorithm (AAA) in the Eclipse (V15.3) treatment planning system with Varian Trilogy Linear Accelerator located in Şişli Hamidiye Etfal Training and Research Hospital, Radiation Oncology Department. Verification schedules of all the treatment plans The results were compared by using the Electronic Portal Imaging Device (EPID). Using different dose rates did not affect our treatment planning accuracy. However, it was seen that the high resolution calculated plans represented the target and critical organ doses better.

1. Introduction

The main purpose of radiotherapy; while giving the desired dose to the target volume, it is to protect the critical organs and tissues around the target volume from the unwanted radiation dose level. For this, accurate determination of the target volume is very important [1]. New radiotherapy methods with renewed technology are very successful in achieving this goal. The most important of these Technologies is the stereotactic radiosurgery method. Stereotactic Radio Surgery / Therapy (SRC / SRT) is a treatment method in which very small radiation fields are directed from the different points to the target volume. In this method, treatments are administered at higher doses than fraction doses administered in conventional treatment methods [2]. Because of the irregular shape of the brain tumors that cannot be operated due to their location and clinical features, or the structures close to the critical structures of the spine, stereotactic radiosurgery and stereotactic radiotherapy are a good option in the treatment of these tumors in order to better protect the critical structures. In stereotactic radiosurgery, one or more fractions can be given a high radiation dose to the accurately defined target, while normal tissues and critical structures can be protected with a precision below millimeters [3, 4]. Protection of critical structures such as spinal cord is of vital importance in spinal irradiation. High-dose radiation is usually given in a single fraction by SBRT therapy in targets adjacent to the spinal cord. Local tumor control can be achieved with SBRT treatment in spinal metastasis [5, 6] but in a few fractions we have given a high dose to the target should give the same results as the plans made. For a successful treatment, a good plan should be planned and the plan should be correctly applied to the patient [7]. The aim of Stereotactic Body Radiotherapy (SBRT) is to give the maximum dose to the target area and to minimize the dose taken by the healthy tissues. Technological developments in radiotherapy have been in line with this purpose. With the technological developments, the margins given to Gross Target Volume (GTV) are gradually decreasing. Conformal therapies have wide margins and a smaller number of beam areas, which require a certain time to repair sublethal damage, so low doses are administered in a large number of fractions [8]. Developments in imaging technology, Magnetic resonance imaging (MRI) in soft tissues, Computed Tomography (CT) was successful in distinguishing bone structure, half of the life of the radioactive elements used in the very short time of the tumor with a high amount of involvement in the use of drugs used in the Positron Emission Tomography (PET) technique [9]. With these advances, the localization of benign tumors and malignant tumors could be determined with greater accuracy. In particular, the accuracy of tumor localization by fusion of different imaging techniques dropped to less than 2 mm [9]. The focus is on the treatment of high doses. It was used for treatment of first brain tumors. This treatment is called SRC. The treatments used for the same purpose in the body were called SBRT [10]. While many researchers limit the tumor diameter to a maximum of 5 cm, some centers are treated with SBRT technique in tumors up to 7 cm in diameter [9, 11, 12, 13]. With SBRT technique, rapid dose reduction can be achieved in normal tissue. By administering high doses with a small number of fractions, treatments with higher Biological Effective Dosage (BED) values can be applied than conformal treatment techniques [9]. Radiotherapy with high doses in the range of 1 to 5 fractions with a very high accuracy rate can be applied to the targets located within the body with SBRT [16].

2. Material Method

Ten stereotactic vertebra patients treated at Şişli Hamidiye Etfal Training and Research Hospital were planned according to RTOG 0631 values by using AAA algorithm on Eclipse (V 15.3) treatment planning system. CT sections of 10 patients with vertebrae cancer were obtained at 1 mm intervals. Patients were placed in a supine position with a T-bar and the arms were fixed and CT images were taken. Studies have been conducted in terms of investigating which is the best technique for tumor volume and critical organ doses. The patients plans were made using 6 MV energy. The plans of the treated patients were evaluated with the Varian Trilogy Linear Accelerator in the Eclipse (Version 15,3) treatment planning system; Treatment plans were developed using intensity modulated radiation therapy (IMRT). Patients were treated with IGRT by online correction with CT every day and CBCT taken every day. The treatment plan was re-calculated at different dose rates (300,MU/min, 400MU/min, 600MU/min) and at different computational resolutions minimum and maximum (0,1; 0,5) without changing the optimization parameters and the effects on dose for critical organ and target volume were investigated.

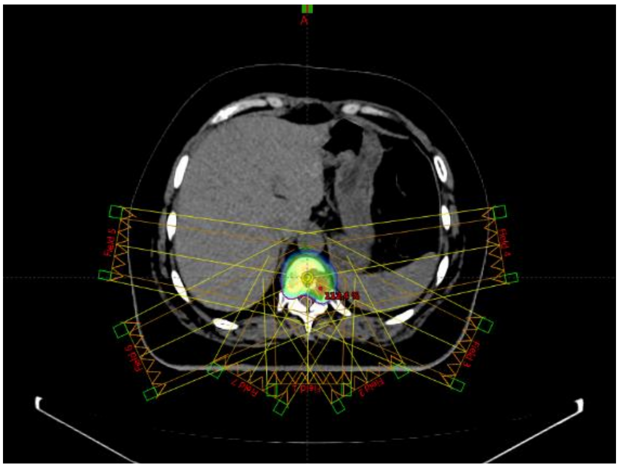

Figure 1. *Display of IMRT fields.*

3. Results

Calculation and measurement results with a calculation resolution of 0,1 cm evaluated by 3-DVH irradiation arc check were found to be 98,7% compatible with Gamma analysis with 3% dose difference and 3mm DTA criteria. The same for plans with calculation resolution of 0,5 cm 88.6 %

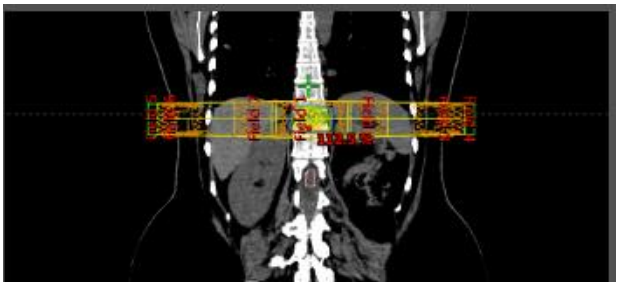

Figure 2. *Display of IMRT dose distribution.*

Figure 3. *Image of the dose distribution from the lateral area.*

agreement was obtained in the Gamma analysis with the criteria. Gamma analysis yielded a 99,4% compatible result when compared to two separate plan 3-DVH software, which were calculated using 0,1 and 0,5 cm resolution in the planning system.

Verification schedules of all the treatment plans.The results were compared by using the Electronic Portal Imaging System (EPID) and the dose rate measurements were made for each patient in the linear accelerator with 3% dose difference and 3 mm distance difference criteria.

In comparison with 3-DVH software, the partial spinal cord V10 value of 0,1 cm and 0,5 cm resolution plans were 6.78 Gy and 8.62 Gy respectively. The dose taken by the spinal cord 0.35 cc is 7.32 Gy and 9.13 Gy.

The average area gamma values calculated using the Gamma Analysis method of all the plans of the plans that were calculated at different dose rates yielded over 98%.

4. Conclusions

The main aim of radiotherapy is to keep the dose of risky organ at a minimum level and to give the required dose for the target volume homogeneously. In order for the treatment to be carried out successfully, the dose must be transferred to the patient correctly. While planning the treatment planning system in order to not exceed the tolerance doses of very critical structures such as medulla in the treatment of SBRT of the vertebrae lesions, it is very important that the dose given to the target volume and the dose taken by the target volume during the irradiation overlap with each other. Because of the complexity of the SBRT treatment plan and the application techniques, it is very important to check the accuracy of the plan.Stereotactic body radiotherapy (SBRT) is a technique used to deliver high, ablative doses of radiation in a limited number of fractions to extracranial targets [17, 18]. SBRT has the potential to improve the clinical outcomes of patients with a variety of primary and metastatic tumors by allowing the delivery of higher than conventional doses and the retreatment of previously irradiated patients.

Using different dose rates did not affect our treatment planning accuracy. However, it was seen that the high resolution calculated plans represented the target and critical organ doses better.

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