Optimization of CORVUS Planning System with PRIMART Linac for Intensity Modulated Radiation Therapy

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ABSTRACT

Yonsei Cancer Center introduced an IMRT System at the beginning of February, 2002. The system consists of CORVUS(NOMOS) inverse planning machine, LANTIS(SIEMENS), PRIMEVIEW and PRIMART Linac(SIEMENS). The optimization of CORVUS planning system with PRIMART is an important work to get an efficient treatment plan. So, we studied two Finite Size Pencil Beams, 1.0 x 1.0 cm^2 and 0.5 x 1.0 cm^2, and four leaf transmission sets, 5%, 10%, 20%, 33%. We compared the dose distribution of target volume and delivery efficiency of the plan results.

Keywords: Intensity Modulated Radiation Therapy(IMRT), Finite Size Pencil Beams(FSPB), Dose Volume Histogram(DVH), delivery efficiency, multileaf collimator(MLC).

1. INTRODUCTION

The intensity modulated radiation therapy has revolutionized the implementation of conformal treatment. It can serve excellent tumor coverage and saving of critical organs.[1] Our clinic center has the experience of Radiation therapy since 1937 and we introduced IMRT system to achieve more effective radiation treatment. The main parts of it are the inverse planning system and the multileaf collimator for it. We introduced CORVUS (NOMOS) inverse planning system and it is known to give more conformality than other planning system. The PRIMART(SIEMENS) linac is designed for IMRT with only 6MV x-ray. The IMRT planning depends on the algorithm of each planning system and MLC properties of each Linac system. So, the treatment machine and delivery options were studied to get a optimized IMRT plan.[2]

2. MATERIALS AND METHODS

The MLC of PRIMART(SIEMENS) is designed with 29 pairs of opposed leaves. The inner 27 pairs of leaves individually projects a beam width of 10 mm and the outer most pairs produce a width of 65 mm providing a field size of 40 cm long.[3] The CORVUS has prescription mode to make a treatment plan. It is consisted of Planning Goals & Optimization, Immobilizer & Localizer and Treatment Machine & Delivery Options. Here, we just considered the Treatment Machine and Leaf Transmission set. The combination of MLCs and jaws can make the minimum field of 3 mm (MLCs) x 10 mm (jaws). We tried "PRIMART 6MV MLC(1.0 x 1.0 cm^2)" and "PRIMART 6MV MLC(0.5 x 1.0 cm^2)" for Treatment Machine mode,[4] and 5%, 10%, 20% and 33% Leaf Transmission sets that modulate the beam intensity on the field.

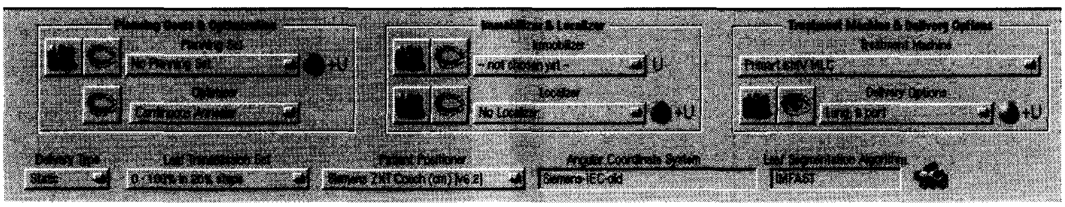

Fig. 1. Prescription panel of CORVUS

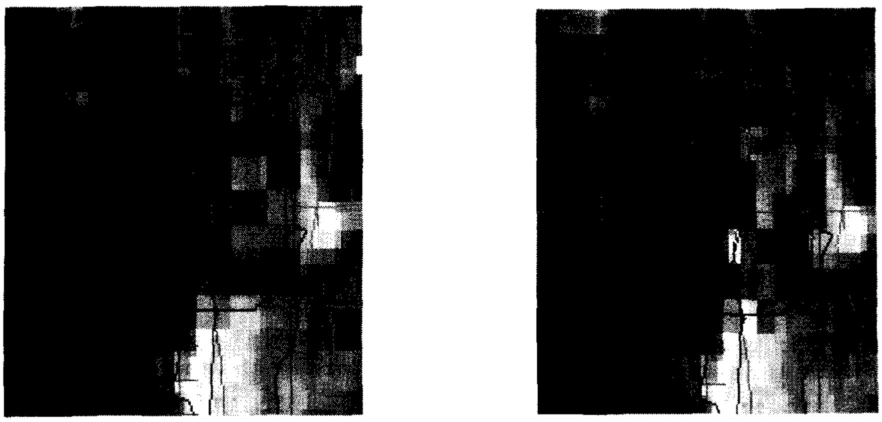

Fig. 2. An Example of planned Intensity Map at Gantry 0 degree. The Right is 1.0 x 1.0 cm^2 FSPB and the left 0.5 x 1.0 cm^2.

We sampled 4 patient cases. The case 1 has 117.2 cc PTV at chest region and it was set 6 beam ports. The case 2 has 137.2 cc PTV at head and it was set 9 beam ports. The case 3 has 198.6 cc PTV at head and it was set 9 beam ports. The last case has 710.2 cc PTV at abdomen region and it was set 6 beam ports. We tried inverse planning with the following conditions. At the first step, we made a standard inverse plan with 1.0x1.0 cm^2 FSPB and 20% leaf transmission set. At the 2nd step, we tried 4 rival plans with different FSPBs and leaf transmission sets, (1.0 x 1.0 cm^2, 5%), (1.0 x 1.0 cm^2, 10 %), (0.5 x 1.0 cm^2, 20%), and (0.5 x 1.0 cm^2, 33%) for each case. We compared the results of each plans.

3. RESULTS

We used customer made program to make comparison. The figure 3 shows integral DVH and differential DVH for the target of a case.[5]

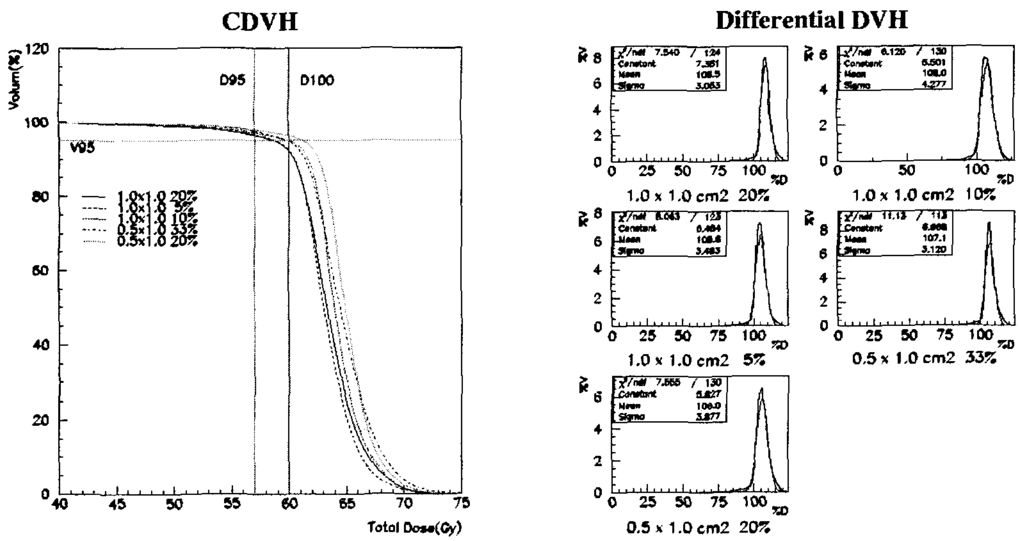

Fig. 3. Integral DVH and Differential DVH.

There was not so dramatic difference between the each plan for maximum, minimum, mean and standard deviation of target dose(figure 4). Where, the goal dose of target is 100. 1.0x1.0 cm^2 @10% leaf transmission and 0.5x1.0 cm^2 @20% plans tended to have more homogeneity. The figure 5 shows the delivery efficiency of each plan.We normalized the total MU and the segment number of each plan to 1.0x1.0 cm2 @20%. The same FSPB case showed almost same total MU values and the total MU of 0.5x1.0 cm^2 FSPB had 2 or 3 times of 1.0x1.0 cm^2 @20%. There was a dependency of target volume at the MU increasing. The lower part plot of figure 5 says the segment rate at each trial plan.

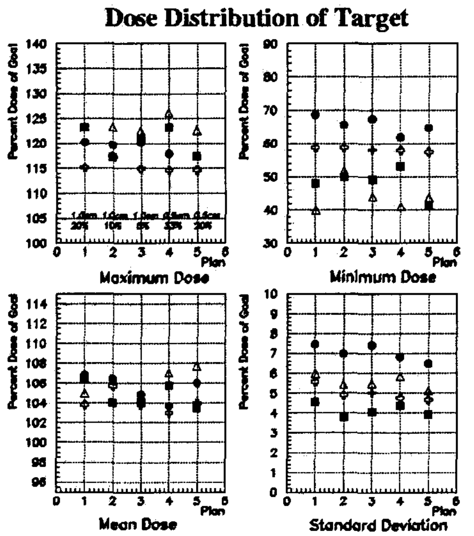

Fig. 4. Summary of Dose Distribution of Target.

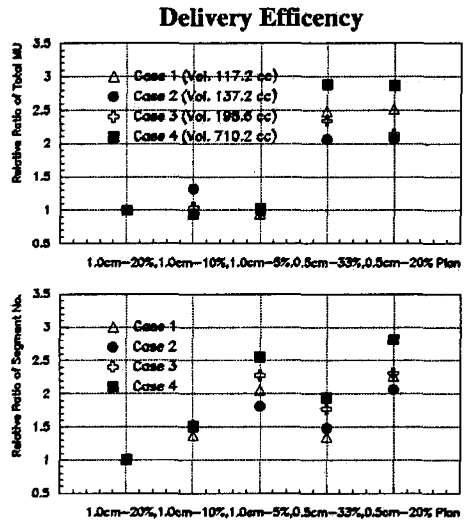

Fig. 5. Summary of Delivery Efficiency.

The segment number of each port was 8 to 13 segments at 1.0x1.0 cm^2 @20%. It was increasing according to the number of beam intensity modulation level.

4. DISCUSSIONS AND CONCLUSION

Although the DVH results don't show a dramatic difference at the changing of FSPB and leaf transmission set and the delivery efficiency is worse at the small field and more intensity modulation, small FSPB and less leaf transmission rate improve the target conformality and it possibly can give critical clinical effect at a special case.

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