Boolean Method for Optimization: Simple, Fast and Reproducible Method for IMRT Optimization

Purpose:
IMRT is becoming the standard of care in many tumor sites however it is still time-consuming. The aim of this study is to develop a new and simple method for plan optimization using a simple tool in treatment planning system. This method is simple, reproducible and easily applied.

Methods and Materials:
Fifteen patients successive patients diagnosed with high-risk prostate cancer. Roch formula used to define indication for whole pelvic irradiation (risk more than 15%), all patients were contoured by one consultant using RTOG guidelines for. Dose for whole pelvis irradiation kept at 45Gy in 25 treatment over 5 weeks.

Treatment related toxicity was recorded using the EORTC/RTOG common toxicity criteria. Eclipse planning system has a Boolean statistics (hence the name) option in its contouring partition which enable the planner to perform many statistical functions like addition or subtraction to different structures.

For each patient 3 plans were done: one 3D conformal plan using box technique, a second IMRT plan with the usual methods of optimization and a third one with the Boolean method.

Results

A- General view of isodose lines.

B- Indices Evaluation:

The RTOG coverage index $PITV$ is defined as

$$PITV = \frac{P}{TV}$$
Where PI is the volume of the prescription isodose line, and TV is the target volume.
PITV for the Boolean IMRT is 0.73 and for the usual IMRT is 0.44 for the isodose line 100%.

The conformity index is defined as

$$\text{conformity index} = \frac{DV_{PI}}{TV}$$

Where $DV_{PI}$ = dose volume of the prescribed isodose

The conformity index for Boolean IMRT is 0.63 and for the usual IMRT is 0.59

The homogeneity index is defined as

$$\text{Homogeneity index} = \frac{D_{max}}{D_{PI}}$$

Where $D_{max}$ = maximum dose at any point 2 mm beyond the target Volume; and $D_{PI}$ = dose value of the prescribed isodose.

The homogeneity index for Boolean IMRT is 1.15 and for the usual IMRT is 1.16

The dose gradient index that is defined as

$$\text{Dose gradient index} = \frac{DV_{PI}}{TV}$$

Where $DV_{PI}$ = dose volume of half the prescribed isodose

The dose gradient index is the same for the two methods.

C- The time factor:

Boolean method take less time and less effort in planning and optimization than the conventional IMRT planning.

D- Monitor Unit (MU) And Segments Number:

Boolean method has less MU and less number of segments than the conventional method. The main advantages of the our new optimization method are (i) its ability to generate plans that meet the clinical goals and very conformal dose distribution, without much tuning any weighting factors or much dose-volume constraints so it’s a direct optimization method, and (ii) the ability to conveniently include more terms such as the normal tissues surrounding the target in more effective way. The (Boolean method) method allows for a more intuitive and human-time-efficient way of dealing with conflicting goals compared to the conventional trial-and-error method of varying weighting factors and dose-volume constraints.

Conclusion

Boolean method for IMRT optimization is a simple, rapid, reproducible and more homogenous method for IMRT planning optimization.

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<th>partial dose</th>
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<th>Mean</th>
<th>Median</th>
<th>Maximum</th>
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Reference:
3. Huntzinger C.;“The Revolution in Radiation Therapy” Varian Medical Systems