Practical Solutions for Dealing With Varian Field Size Limitations When Planning Large IMRT fields with Pinnacle[3]

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Purpose:

To determine the best method to minimize the practical consequences of large IMRT fields, given the field width limitation on Varian linear accelerators. There is a maximum field width on the Varian machines that is often smaller than the width of some PTV's in large IMRT cases. The maximum field width allowed on the Varian machines is 15 cm wide. The Pinnacle[3] treatment planning system offers several different ways of dealing with the limitation and obtaining a clinically acceptable treatment plan. This often presents a difficult planning problem that must be navigated around during the planning process in order to achieve the best clinical result and minimize practical inefficiencies of delivery and MU.

Materials Methods:

- 5 head and neck patients and 5 pelvis patients were planned using the Philips Pinnacle[3] treatment planning system.
- The head and neck plans all contained 9 beams. All plans for each patient were planned using the same beam configuration. The same number of segments were allowed on each of the MLC based plans for each patient.
- The pelvis plans all contained 7 beams. All plans for each patient were planned using the same beam configuration. As with the head and neck plans, the same maximum number of segments was allowed on each of the MLC based plans for each patient.
- All plans were planned using four different treatment planning techniques: Split Field, Wide Field, Limited Field, and compensator based IMRT utilizing .decimal Solid IMRT technology.
- All plans were planning using Philips Pinnacle[3] treatment planning system version 7.4.
- MLC-based modulation was planned using direct machine parameters optimization (DMPO) where solid IMRT plans were generated in conjunction with a program called "p.d" Using DMPO allowed for the best distribution possible when utilizing the MLC's. It has also been shown that DMPO produces plans with fewer monitor units than non-DMPO plans.
- All plans were prescribed to the mean dose to the highest dose PTV.
- The isodose line for treatment was chosen based on the isodose line which allowed for 95% of each PTV to receive the prescription dose.

Split Field Technique:

This method is the automatic method within the Pinnacle[3] treatment planning system. Within Pinnacle an option is given as to whether or not to allow jaw movement and beams to split. If the beams are all set to 'yes' than any beams larger than a width of 15 cm will split into multiple beams. (Figure 1a & 1b). Plans can either be originally run in intensity modulation and then set to run in DMPO where segments are created. Or, they can be run from the beginning optimization in DMPO. The treatment planning system will automatically split fields and allow the overlap between the two split fields that was entered in the IMRT parameters box. The default overlap in the planning system is 0.5 cm.

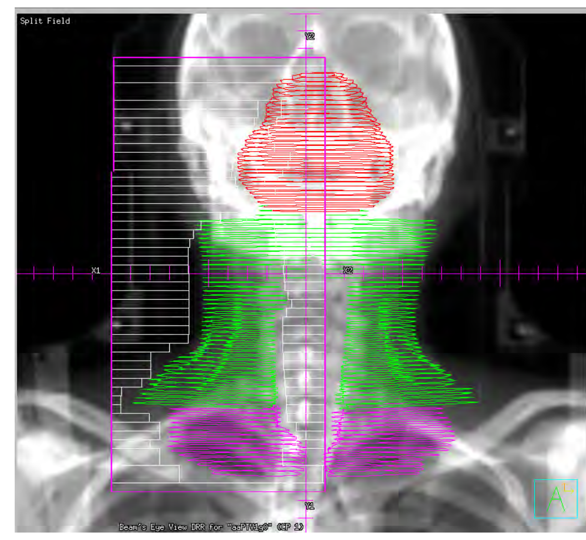

Figure 1a-Split Field

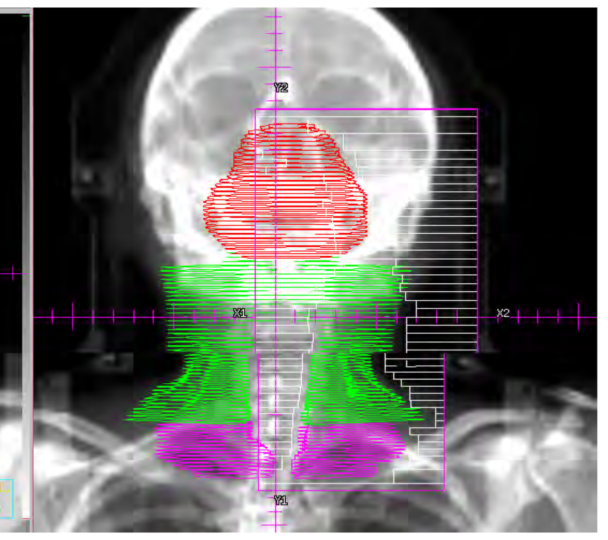

Figure 1-Split Field

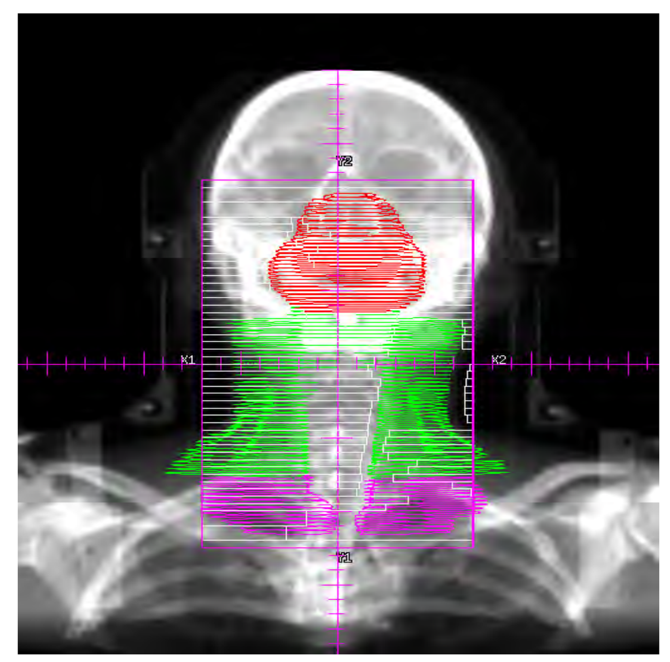

Figure 2-Limited Field

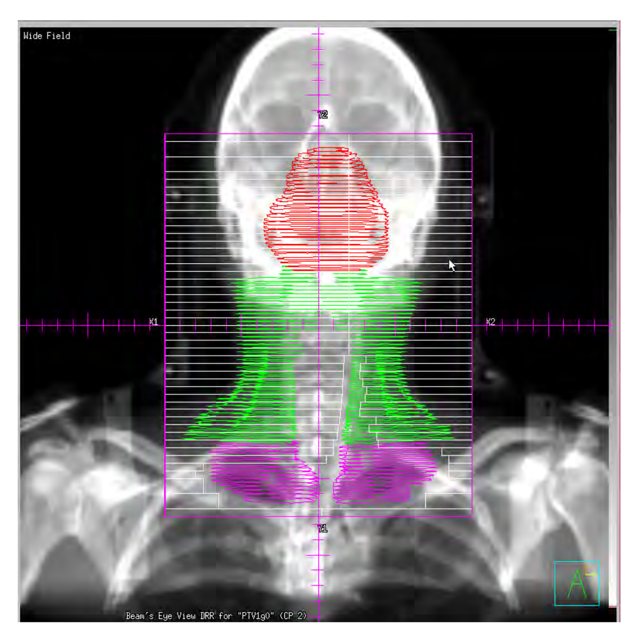

Figure 3-Wide Field

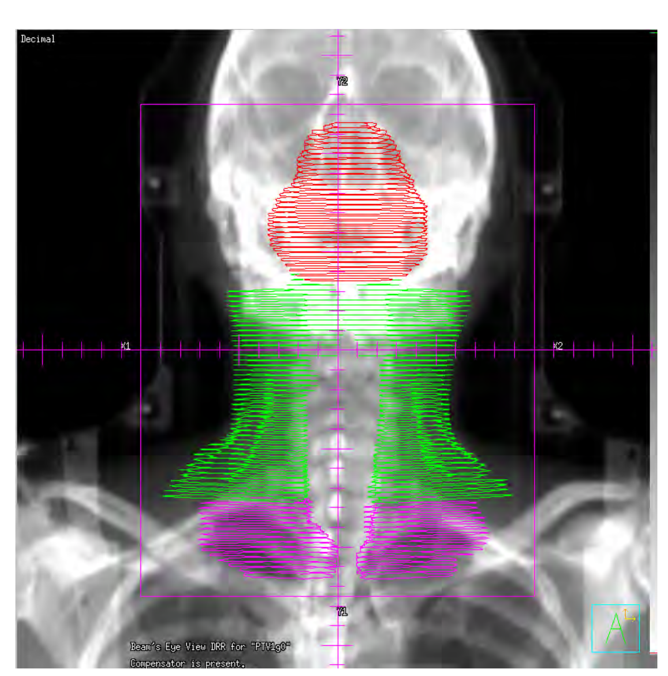

Figure 4a-Solid Compensator open field

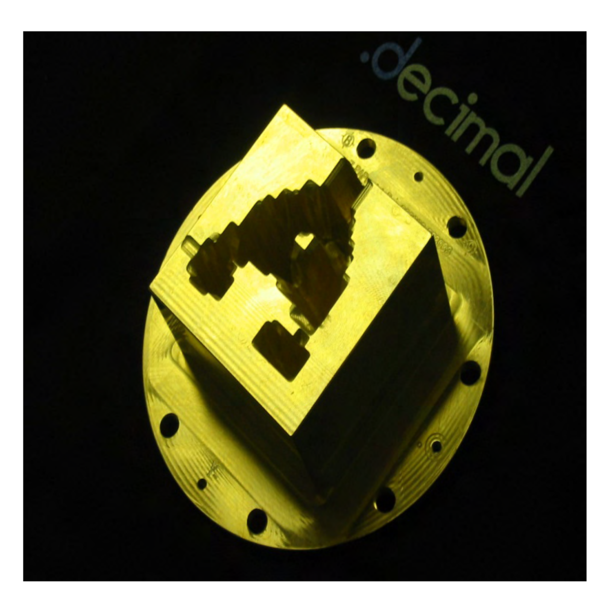

Figure 4b-.decimal brass compensator

Limited Field Technique:

This technique was initially used when planning IMRT in prior versions of Pinnacle. Each beam with is limited to a width of 14cm. This does need to be done manually. This allows the unused leaf pairs to meet 0.5 cm under the jaw. All PTV's will not necessarily be covered fully by every beam (Figure 2). In some instances, additional beams may need to be added in order to adequately cover the treatment volumes.

Wide Field Technique:

This method is a new treatment planning method to be used within the Pinnacle[3] system. To achieve this method a plan must be run first in intensity modulation. Once complete, all beams are set to DMPO. For each beam 'no' is then selected in the "allow jaw movement/split beam" column. This will force the unused MLC leaf pairs to meet within the open field rather than under the jaw. (Figure 3) The wide field technique cannot be used on fields wider than 28 cm. These fields, if using the split field technique, would have been split into 3 fields. If the wide field technique is attempted with fields this wide, the user will receive a fatal system error immediately when DMPO is trying to calculate that given beam.

Solid IMRT Technique:

These plans were planned using the .decimal solid compensators. All plans were initially optimized in Pinnacle. ODM's were then transferred to p.d (.decimal's solid IMRT integration program). The ODM's that are able to be milled into solid compensators are then transferred back into Pinnacle for final calculation. All plans were planned using 3" brass compensators. This planning method took the least amount of time to complete from start to finish. In addition, the solid IMRT plans resulted in the lowest number of MU's. As shown below, most of the solid compensator plans also had the lowest maximum dose point. (Figure 5). Of note, there is a minimum transmission of roughly 8-9% through the brass compensators that can be partially accounted for in the planning process. In all cases, it was the solid compensator technique that provided the highest doses to the critical structures. Those doses can be lowered in some cases by adding a block or MLC's in conjunction with the compensator. These plans did not account for the addition of an additional beam modifier. (Figure 5A)

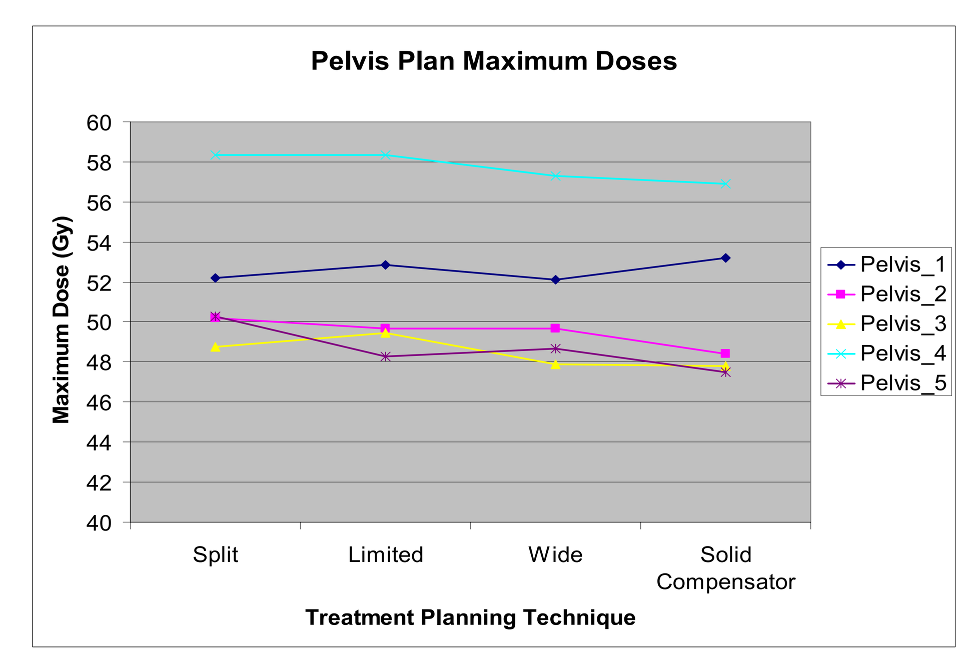

Figure 5-Maximum doses in the Pelvis Treatment Plans

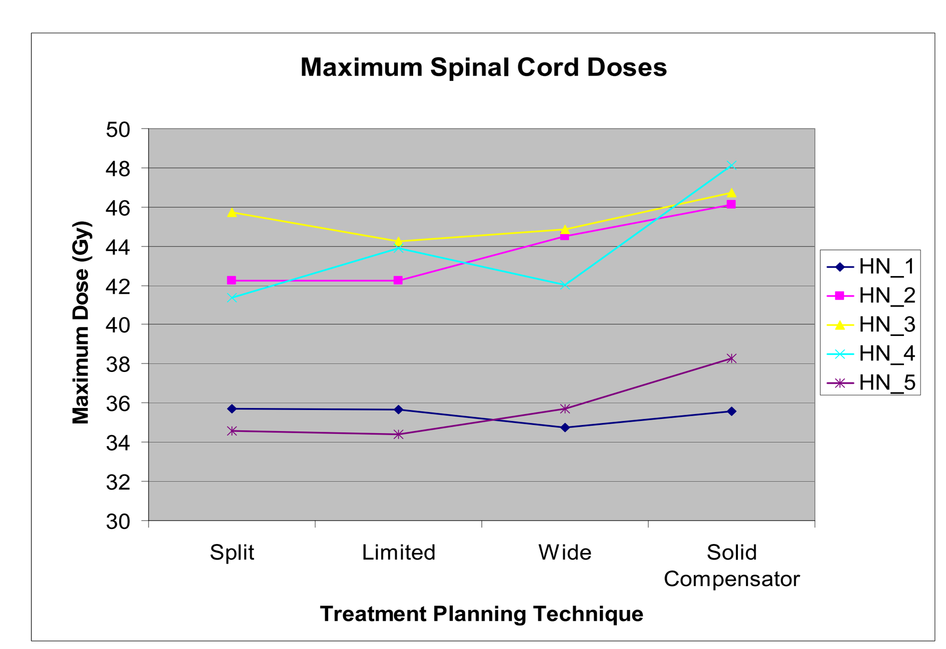

Figure 5a-Maximum Spinal Cord Doses

Results:

Each of the different planning techniques showed advantages and disadvantages.

- The split field technique allowed the PTV's to be completely covered in each beam angle but also ended up having the highest number of MU's. The split field technique also took the longest time to run on the planning system.
- The limited field technique decreased the total monitor units but the tumor was not fully covered in every beam. In some cases, additional beams can be needed and added in order to obtain adequate coverage.
- The wide field technique allowed the volumes to be covered fully in every beam but there was an increased amount of leakage where the MLC's closed within the field. This is of concern, clinically, when the junctions occurred over critical structures (ie: spinal cord, brainstem, and chiasm).
- The last technique, solid IMRT with 3" brass compensators, provided the most uniform tumor dose coverage but some of the critical structures received higher doses due to the minimum transmission through the compensators. The solid IMRT plans also were delivered using the lowest number of monitor units.

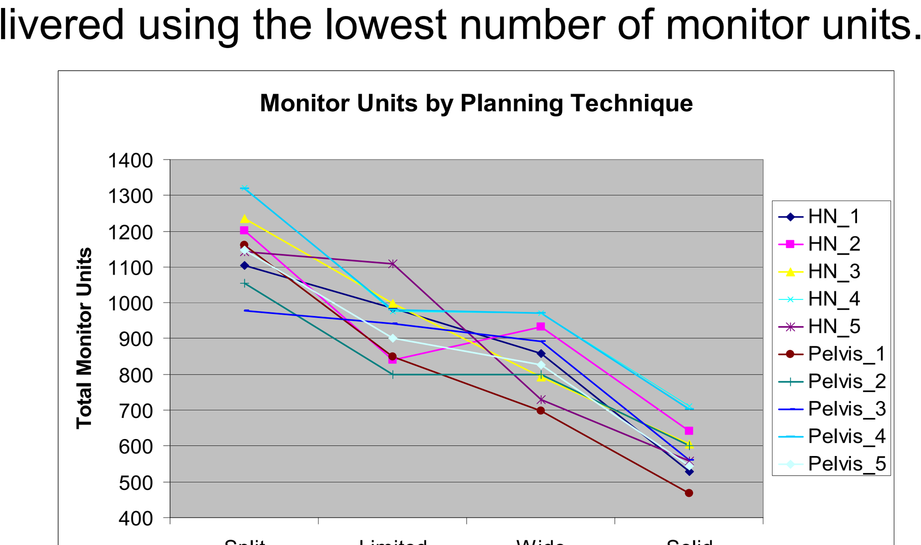

Figure 6-Planning Technique monitor unit comparison

Conclusion:

The wide and limited field techniques provided adequate coverage while lowering the total monitor units of the plan. The technique that seemed to be most undesirable, due to the high number of monitor units, while most widely used within the therapy community, was the split field technique. Of all of the techniques the solid compensators provided the most uniform dose distribution to our PTV volumes. The solid compensator plan also had the fewest total of monitor units of all of the planning techniques.