A Dosimetric Comparison on the Efficiency of Philips Pinnacle's 9.10v Auto-Plan Algorithm: Comparison of VMAT Manual Plan vs. VMAT Auto-Plan in the Treatment of Glioblastomas

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INTRODUCTION

According to the National Cancer Institute, Glioblastomas multiforme (GBM) account for approximately 52% of all primary brain tumors, which occur in the range of 45 to 70 years of age (AANS, 2015). Recent clinical history shows that the development of GBM treatment plans can be labor intensive and complex due to the abundance of organs at risk (OARs) present in the treatment vicinity. Volumetric Modulated Arc Therapy (VMAT) is a modern external beam radiation modality that generally delivers optimal radiation treatment plans. Nonetheless, the medical industry continues to innovate techniques that can reduce the planning time and maintain the quality of the treatment plans. Recently, Philips released an auto-plan feature within Pinnacle’s treatment planning software (TPS) that claims to provide clinically acceptable treatment plans at a faster rate versus manually crafted plans. Therefore, the objective of this research is to provide a dosimetric comparison between VMAT auto-plan versus VMAT manual plan for Glioblastoma cases.

METHODS & MATERIALS

Patient & Tumor Information

- Twelve patients diagnosed with GBM were retrospectively studied.
- GTV size ranged from 36.68 cc to 205.3 cc.
- Tumor location were multi-regionally located in the brain.

Volumes Considered

- GTV
- PTV = GTV + 2.5 cm
- Boost PTV = GTV + 0.5 cm

Organs at Risk Toxicity Constraints

<table>
<thead>
<tr>
<th>Organs</th>
<th>Dose Constraints</th>
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<tbody>
<tr>
<td>Lenses</td>
<td>150 – 500 cGy</td>
</tr>
<tr>
<td>Optic Nerves</td>
<td>Max dose ≤ 54 Gy</td>
</tr>
<tr>
<td>Optic Chiasm</td>
<td>Max dose ≤ 54 Gy</td>
</tr>
<tr>
<td>Brainstem</td>
<td>Max dose ≤ 54 Gy</td>
</tr>
<tr>
<td>Brainstem (GTV, chiasm, brainstem)</td>
<td>Max dose ≤ 54 Gy</td>
</tr>
<tr>
<td>Brain</td>
<td>Mean dose of 30 Gy</td>
</tr>
<tr>
<td>Brainstem (GTV, chiasm, brainstem)</td>
<td>V30 ≤ 50 Gy</td>
</tr>
<tr>
<td>Eyes</td>
<td>Mean dose ≤ 40 Gy</td>
</tr>
<tr>
<td>Brainstem (GTV, chiasm, brainstem)</td>
<td>Mean dose ≤ 30 Gy</td>
</tr>
</tbody>
</table>

Planning Process Details

- TPS: Philips Pinnacle 9.10v
- Plans were re-optimized twice (manual and auto-plan)
- VMAT smart arc was utilized
  - Two full arcs
  - Start & Stop angles: 182° clockwise and 178° counter clockwise
- Collimator angles
  - 10° and 350° respectively in order to minimize MLC leakage

Planning Goals

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Parameters</th>
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<tbody>
<tr>
<td>GTV</td>
<td>100% coverage</td>
</tr>
<tr>
<td>Boost PTV</td>
<td>100% coverage</td>
</tr>
<tr>
<td>PTV</td>
<td>≥ 95% coverage</td>
</tr>
<tr>
<td>OARs</td>
<td>Meet toxicity levels &amp; ALARA without jeopardizing target coverage</td>
</tr>
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Data Collection & Analysis

- For all plans, the start of the timer began after the planner loaded the initial plan scan and it ended after the planner met the goals.
- All of the data was analyzed by an average of percent difference calculation.

RESULTS

- The planning time on auto-plans was on average 24.6% faster than manual plans.
- Both methods achieved 100% of GTV coverage.
- Target dose conformity & low dose control was improved by 4.2% in auto-plan.
- Most OAR max and mean dose tolerances were on average superior in manual plans.

DISCUSSION

With the vast diversity in experience among dosimetrists, manually crafted plans range between sub-optimal to nearly perfect depending on who constructs the plan. Despite the fact that this study highlighted the comparison of auto-plans solely generated by the TPS versus manually crafted plans, it is recognized that in a clinical setting the combination of both planning techniques is applied in order to produce optimal plans. A major benefit of auto-planning is the elimination of sub-optimal plans due to inexperience. With one optimization using auto-planning, a plan that requires minor adjustments is usually produced. By increasing the quality of plans produced with the auto-plan technique, the quality of care patients receive is increased, and their likelihood of radiation toxicity and side effects are decreased.

CONCLUSIONS

- The auto-plan algorithm was able to meet the OARs dose constraints and reduce planning time by an average of 24.6%.
- Manual plans maintained the ability to further tailor the dose contamination to the critical structures.
- As a standalone technique, the auto-plan algorithm was not adequate enough as it did not ensure maximum sparing of OARs.
- As technological advancements aim to automate the radiation treatment planning process, it is of utmost importance to actively continue to investigate the efficiency and reliability of such practices.

REFERENCES

4. Y. Jeong et al., Dosimetric comparison of volumetric modulated arc therapy (VMAT) and non-coplanar intensity modulated radiotherapy (IMRT) for nasal cavity and paranasal sinus cancer. Radiation Oncology. 9, 193. (2014)

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