Radiation Therapy using Simultaneous Integrated Boost Technique for Head and Neck Cancer

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ABSTRACT: Purpose/Objectives: comparison the results between standard dose 2Gy/fraction technique and simultaneous integrated boost (SIB) with 2.2Gy/fraction technique.

Materials/Methods: use Eclipse 13 software to do the treatment planning for head and neck cancer patients by two methods:
- Simultaneous integrated boost radiation therapy with 3 different doses 2.2Gy/fraction for primary tumor and clinical nodes, 2Gy/fraction for high risk nodes and 1.8Gy/fraction for low risk nodes.
- Radiation therapy with 2Gy standard doses, including three stages namely stage I with 50Gy to target volume and high risk nodes; stage II with 10Gy boost to target volume and stage III with 10Gy boost to the target volume.

Results: there is no significant difference in dose of both the target volume and OARs (Organ at risk). However, simultaneous integrated boost radiation therapy is performed with on a treatment plan, the control of the treatment planning will be better than standard dose 2Gy/fraction technique in process of planning and controlling QA. With the SIB technique, the treatment time will be decreased.

KEYWORDS: head and neck cancers, simultaneous integrated boost, inverse planning, intensity modulated radiation therapy.

I. INTRODUCTION

Since October 2015, the Oncology Hospital has begun applying intensity modulated radiation therapy to treat cancer patients. Head and neck cancer is planned for beams with prescribed dose of 70Gy including standard dose 2Gy, so patients undergo treatment for 35 times with radiation therapy. However, if we use simultaneous integrated boost radiation therapy with 2.2Gy/fraction for primary tumor and clinical nodes, patients need only about 30 times of treatment with radiotherapy.

In this work, we would like to compare the results between standard dose 2Gy/fraction technique and simultaneous integrated boost in 2.2Gy/fraction.

SIB-IMRT treatment is planned for a large irradiation and this technique allows the simultaneous delivery of different dose levels to different target volumes within a single fraction. [1]
II. METHOD AND MATERIALS

1. Patients selection:
20 patients (12 with larynx and 8 hypopharynx cancers) of the Oncology Hospital were treated between April 2015 and December 2017 including 14 males and 6 females with mean age of 46.
2. Planning techniques
Patients were treated with 70Gy to target volume, 60Gy to high risk nodes and 50Gy to low risk nodes. The treatment plans were performed by 2 methods:
- Simultaneous integrated boost radiation therapy with 3 different doses 2.2Gy/fraction for target volume, 2Gy/fraction for high risk nodes and 1.8Gy/fraction for low risk nodes. The total fraction is 30.
- Radiation therapy with 2Gy standard doses, including 3 stages as follows:
  • Stage I: irradiate 50Gy to target volume, high risk and low risk nodes.
  • Stage II: irradiate 10Gy boost to target volume.
  • Stage III: irradiate 10Gy boost to target volume.

III. RESULTS
The SIB-IMRT plans were created and calculated by Eclipse13 [2], [3], [4] for structures of PTV 50, PTV 60 and PTV 70.
Figures 1, 2, 3 and 4 show overlapping by objectives

We have set up the structures and the overlap between PTV and health organ as fig.5 and fig.6 below:
Setting irradiation field: SIB with IMRT plans were designed with nine coplanar IMRT beams and they weren’t symmetrical parallelism. The beam geometry used nine none-coplanar radiation beams, gantry angles: 320°, 280°, 240°, 0°, 40°, 120° and 160°, see fig.7:

We have set the dose limit outside PTV and created values to smooth for MLC (fig.8) and we have also set a dose limit on OAR. (fig.9)
Table 2 is the dose distribution to PTV for patient with the name is Dang Ngoc Huynh who has cancer of nasopharyngeal (T2N0M0)

<table>
<thead>
<tr>
<th>PTV</th>
<th>Volume</th>
<th>Standard dose</th>
<th>SIB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2Gy</td>
<td>1.8, 2.0, 2.2Gy/fraction</td>
</tr>
<tr>
<td>PTV50</td>
<td>99%</td>
<td>48</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>95%</td>
<td>50</td>
<td>54</td>
</tr>
<tr>
<td>PTV60</td>
<td>99%</td>
<td>57.5</td>
<td>57.8</td>
</tr>
<tr>
<td></td>
<td>95%</td>
<td>59.5</td>
<td>59.4</td>
</tr>
<tr>
<td></td>
<td>99%</td>
<td>66.3</td>
<td>64.5</td>
</tr>
<tr>
<td>PTV70</td>
<td>95%</td>
<td>70</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>20%</td>
<td>≤77</td>
<td>72</td>
</tr>
</tbody>
</table>

Table 2: The dose distribution to PTV of patient Dang Ngoc Huynh

Table 3 is the dose distribution to OARs for patient Dang Ngoc Huynh:

<table>
<thead>
<tr>
<th>OAR</th>
<th>Volume</th>
<th>Dosage limit</th>
<th>Standard dose</th>
<th>SIB: 2Gy</th>
<th>1.8, 2.0, 2.2Gy/fraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brainstem</td>
<td>max</td>
<td>≤54Gy</td>
<td>48.2</td>
<td>47.89</td>
<td></td>
</tr>
<tr>
<td>Brainstem+1mm</td>
<td>1%</td>
<td>max ≤60Gy</td>
<td>48</td>
<td>47.45</td>
<td></td>
</tr>
<tr>
<td>Spinal cord</td>
<td>max</td>
<td>≤45Gy</td>
<td>33</td>
<td>35.08</td>
<td></td>
</tr>
<tr>
<td>Spinal cord+1mm</td>
<td>1cc</td>
<td>max ≤50Gy</td>
<td>32.2</td>
<td>35.41</td>
<td></td>
</tr>
<tr>
<td>Optic chiasma</td>
<td>max</td>
<td>≤54Gy</td>
<td>13</td>
<td>14.69</td>
<td></td>
</tr>
<tr>
<td>Optic nerve</td>
<td>max</td>
<td>≤54Gy</td>
<td>9</td>
<td>8.59</td>
<td></td>
</tr>
<tr>
<td>Parotid gland</td>
<td>mean</td>
<td>≤26Gy</td>
<td>24.5</td>
<td>23.6</td>
<td></td>
</tr>
<tr>
<td>Eye</td>
<td>mean</td>
<td>≤35Gy</td>
<td>6.5</td>
<td>4.71</td>
<td></td>
</tr>
<tr>
<td>Lens</td>
<td>max</td>
<td>≤10Gy</td>
<td>6.4</td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>Inner ear</td>
<td>mean</td>
<td>≤50Gy</td>
<td>40.5</td>
<td>40.81</td>
<td></td>
</tr>
</tbody>
</table>

All these treatment plans were performed on the subsequently (SIB) and conventional (conv.) IMRT plans were compared using dosimetric parameters from dose volume histograms. (fig. 10)

Target and OAR dose results are shown on dose volume histogram DVH after simultaneous integrated IMRT plan for patient Dang Ngoc Huynh.
IV. CONCLUSION

From the results of PTV and OARs, there is no significant differences between SIB-IMRT [5], [6], [7], [8] planning and conventional IMRT planning

- SIB IMRT is more efficient and more accurate on tumor coverage than conventional IMRT.
- The SIB approach provides the ability to deliver higher than conventional doses safely to the tumor and involved lymph nodes while reducing the overall treatment course.
- SIB-IMRT technique allows the planning and irradiation of different targets at different dose levels in a single treatment session instead of treatment plans in daily sessions [9]
- Patients treated in this fashion are able to complete treatment faster than patients treated with conventional techniques. Not only is treatment delivered faster, it is more effective than standard approaches.

REFERENCES

[5] Ester Orlandi, Mauro Palazzi, Emanuele, Carlo Fallai, Antonella Giostra and Patrizia Olmi, “Radiobiological basis and clinical results of the simultaneous integrated boost (SIB) in intensity modulated radiotherapy (IMRT) for head and neck cancer”, vol. 73, issue 2, pages 111-125, 2010

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