The retina dose as a risk factor for worse visual outcome in 106Ru eye plaque brachytherapy of uveal melanomas

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Objective

Visual acuity is a common side effect in 106Ru plaque brachytherapy. The purpose of this study was to evaluate the retina dose as a risk factor associated with visual outcome.

Patients and Methods

45 Patients with uveal melanoma treated with 106Ru eye plaque brachytherapy were included in this retrospective study. Patients were selected for brachytherapy following common recommendations:

- tumor dimensions were assessed using standard imaging techniques
- minimum of 100 Gy was prescribed to the tumor apex
- using one of two available plaque types (CCB, CCA) manufactured by BEBIG (Eckert & Ziegler, Germany)

Dose calculation:

- Treatment planning and dose calculation were performed using an in-house developed treatment planning system with Monte Carlo based dose calculation [1].
- Dose volume histograms (DVH) were generated for both physical and biologically effective dose [2].

Statistics:

- Visual acuity was reported using Snellen charts.
- To analyze potential predictors in anterior tumor locations, a subgroup of 20 patients with a minimum distance of 5 mm between tumor and macula was selected.
- Risk factors associated with loss of visual acuity were evaluated using the Cox proportional hazards models and Kaplan-Meier estimations.
- Loss of visual acuity was correlated to risk factors using Pearson correlation coefficient.

Reference

http://www.meduniwien.ac.at/hp/radonc

Table 1: Summary of parameters associated with loss of visual acuity and worse post treatment visualacuity outcomes from Pearson correlation analysis

<table>
<thead>
<tr>
<th>Factors</th>
<th>Loss of visual acuity in Snellen equivalent</th>
<th>Worse post treatment visual acuity in Snellen equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pearson Correlation</td>
<td>p</td>
</tr>
<tr>
<td>Max retina dose  D₂⁰</td>
<td>0.472</td>
<td>0.001</td>
</tr>
<tr>
<td>Mean retina dose  Dmax</td>
<td>0.492</td>
<td>0.001</td>
</tr>
<tr>
<td>Basal diameter smallest</td>
<td>0.475</td>
<td>0.001</td>
</tr>
<tr>
<td>Max macula dose  D₂⁰</td>
<td>0.238</td>
<td>0.115</td>
</tr>
<tr>
<td></td>
<td>Pearson Correlation</td>
<td>p</td>
</tr>
<tr>
<td></td>
<td>-0.538</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td></td>
<td>-0.552</td>
<td>&lt; 0.001</td>
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<tr>
<td></td>
<td>-0.622</td>
<td>&lt; 0.001</td>
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<tr>
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<td>-0.577</td>
<td>&lt; 0.001</td>
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<tr>
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<td>-0.188</td>
<td>0.216</td>
</tr>
<tr>
<td></td>
<td>-0.195</td>
<td>0.199</td>
</tr>
</tbody>
</table>

Results

Patient cohort:

- Median follow-up time was 29.5 months (IQR, 15.0–29.8)
- Median apex dose of 131 Gy (IQR, 113.0–150.4)
- Median apex heights of 4.6 mm (IQR, 3.5–6.0)
- Largest basal diameters of 10.8 mm (IQR, 8.3–12.6)
- Smallest basal diameter of 9.3 mm (IQR, 7.9–11.4)

Statistical analysis:

The baseline visual acuity (Snellen 0.82 ± 0.23 SD) was significantly higher (p < 0.001) than the mean visual acuity at last individual follow-up (0.59 ± 0.028 SD).

Correlation of dose with visual acuity loss:

- The Pearson Correlation analysis showed a significant correlation of visual acuity loss with:
  - mean retina dose: r = 0.49, p = 0.001
  - near maximum retina dose: r = 0.47, p = 0.001
  - tumor basal diameter: r = 0.50, p < 0.001
- The dose to the macula showed no correlation with visual outcome: r = 0.24, p = 0.12

Anterior tumors:

- In the subgroup of patients with anterior tumor locations the retina dose remained the only predictive factor (r = 0.46, p = 0.043).

Risk factors:

- Evaluating the Kaplan-Meier estimation and Cox proportional hazards model yielded a significantly higher risk for visual acuity loss (of more than 0.3 Snellen) for patients receiving a maximum dose of 500 Gy or higher (p = 0.009).
- A Cox multivariate analysis including the macula dose (p = 0.11) and basal diameter (p = 0.78) showed that a high maximum retinal dose is the best risk factor (p = 0.017).

Biologically effective dose:

- The evaluation of BED metrics showed no better correlation with the investigated endpoints and were in some cases even inferior.

Conclusion

The study showed that retina dose (D2 and Dmax) is a suitable predictor for visual acuity loss, especially in anterior tumors in which other risk factors (i.e. basal diameter) fail.

References


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