**Supplement**

**Table S1.** Additional patient characteristics and p-values for the correlation between the D95 > 95% requirement in PTV70 and occurrence of local recurrence for a given calculation mode ($AXB_m$, $AXB_{m,FFF}$, $AXB_w$ or $AXB_{w,FFF}$)

| Patient | Age | Sex | Site | T stage | N stage | D95 > 66.5 Gy with $AXB_m$ (p = 0.117) | D95 > 66.5 Gy with $AXB_w$ (p = 0.211) | D95 > 66.5 Gy with $AXB_{m,FFF}$ (p = 0.53) | D95 > 66.5 Gy with $AXB_{w,FFF}$ (p = 0.178) | Time of occurrence of recurrence since completion of treatment (months) |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 60 | M | Larynx | T4 | 4a | NO | YES | NO | NO | 2.8 |
| **2** | 66 | M | Hypoph | T2 | 1 | YES | YES | NO | YES | No recurrence |
| **3** | 62 | M | Larynx | T4 | 2c | YES | YES | YES | YES | 1.3 |
| **4** | 62 | M | Larynx | T4 | 0 | YES | YES | YES | YES | No recurrence |
| **5** | 53 | F | Oral | T4 | 0 | YES | YES | NO | YES | No recurrence |
| **6** | 59 | M | Larynx | T3 | 1 | NO | YES | NO | YES | No recurrence |
| **7** | 71 | M | Nasopha | T1 | 0 | YES | YES | NO | NO | No recurrence |
| **8** | 66 | M | Orophar | T3 | 0 | YES | YES | YES | YES | No recurrence |
| **9** | 56 | M | Larynx | T2 | 0 | YES | YES | NO | YES | No recurrence |
| **10** | 55 | M | Hypoph | T3 | 2 | YES | YES | YES | YES | No recurrence |
| **11** | 60 | F | Oral | T4 | 2b | NO | YES | NO | YES | No recurrence |
| **12** | 78 | F | Larynx | T2 | 2b | NO | YES | NO | YES | No recurrence |
| **13** | 65 | M | Nasopha | T4 | 1 | YES | YES | NO | YES | No recurrence |
| **14** | 69 | M | Orophar | T4 | 2 | YES | YES | NO | YES | No recurrence |
| **15** | 71 | F | Larynx | T3 | 2c | YES | YES | NO | YES | No recurrence |
| **16** | 52 | M | Larynx | T4 | 2b | NO | YES | NO | NO | No recurrence |
| **17** | 67 | M | Hypoph | T3 | 0 | YES | YES | NO | YES | No recurrence |
| **18** | 70 | M | Larynx | T3 | 0 | YES | YES | NO | YES | No recurrence |
| **19** | 60 | M | Larynx | T1 | 2 | NO | NO | NO | NO | No recurrence |
| **20** | 65 | M | Larynx | T4 | 2c | NO | YES | NO | YES | 7.2 |

## Appendix A: Measurement of ion recombination and volume-averaging effects

Two small-volume chambers, namely, the IBA CC013 scanning chamber and the PTW 31021 Semiflex 3D chamber, and the PTW 30013 Farmer-type chamber were used to assess the difference between the corrected and uncorrected PDD(10) in terms of ion recombination efficiency. The corrected PDD(10) was calculated using the relation [33]:

$$\mathrm{PDD(10)_c} = 100\frac{\mathrm{M_{d10}}\ \mathrm{k_{S,d10}}}{\mathrm{M_{dmax}}\ \mathrm{k_{S,dmax}}}$$

where $k_{s,dmax}$ and $k_{s,d10}$ are the ion recombination correction factors at the depth of the maximum dose and at 10 cm depth, respectively. The two-voltage technique for both polarities was used to obtain these factors, which is an accurate method for determining the ion recombination correction in FFF beams [48–51]. $M_{d10}$ and $M_{dmax}$ are the raw measurements of the collected charge at 10 cm depth and the depth of the maximum dose, respectively.

The relative error between the uncorrected and the corrected $PDD(10)_c$ was calculated as follows [33]:

$$\Delta_{\%\mathrm{PDD(10)}} = 100\ \frac{(\mathrm{PDD(10)_c} - \mathrm{PDD(10)_u})}{\mathrm{PDD(10)_c}}$$

where $PDD(10)_u$ is the uncorrected value for ion recombination PDD(10), which is typically used to calculate the absolute dosimetry.

In addition, to assess the error in the absolute dosimetry that was due to volume-averaging effects in the unflattened beam, the simplified formalism that was proposed by Sudhyadhom et al. [32] was used to determine the volume-averaging effect correction factor, $P_{rp}$, according to the following equation:

$$\mathrm{P_{rp}} = \left(\mathrm{OAR}\left(\frac{\mathrm{L}}{\sqrt{12}}\right)\right)^{-1}$$

where factor $P_{rp}$ accounts for any off-axis variation in the intensity profile of the radiation field over the sensitive volume of the ionization chamber [31], and OAR is the off-axis ratio (along the long axis of the chamber) that is obtained at a distance of $L/\sqrt{12}$ (where L is the nominal chamber length) for the unflattened beam under the calibration conditions. OAR was obtained with a Semiflex 3D PTW 31021 ion chamber, and $P_{rp}$ was calculated for the Farmer-type PTW 30016 ion chamber, which was used to determine the absorbed dose to water in the unflattened beam.

As a result, the relative error in the measurements for the determination of the absorbed dose to water that was due to volume-averaging effects in the unflattened beam was calculated as follows:

$$\Delta_{\%vol} = 100 \text{ x } (1 - P_{rp})$$