

INTRODUCTION

This work is to investigate the dosimetric impact on small brain tumors treatment in Cyberknife when a ratio of the dosimeter readings between a cone and the reference field is simply taken as a field output factor (FOF).

METHOD

A ratio of dosimeter readings needs to be multiplied by an output correction factor to obtain the FOF unless the FOF is very near a unity. The correction factors for the detector (PTW 60012) used in our institution are 0.962 and 0.977, respectively for 5 mm and 7.5 mm cone sizes based on an IAEA report 483. The five plans that used 5 mm cone and another five plans that used 7.5 mm cone were recalculated with the correction factors included. The changes of PTV coverage and the minimum dose received by PTV with the correction factors included were evaluated against the previous plans without the correction factors included.

RESULTS

For the 5 mm cone plans, the PTV coverages decrease by from about 1% to 19% with the average of 9.3% while the minimum PTV doses only decrease up to 3.7% with the average of 2.6% (relative to the prescription dose). The changes, for the 7 mm cone plans, are much smaller, with PTV coverage change ranging from 2.1% to 5.2% (the average is 3.3%) and the minimum PTV doses change about 2.3% for all plans.

Table1: Calculated PTV coverage and minimum PTV dose from Multi-Plan planning system for 5 mm cone plans (No output correction factors applied to the ratios of readings)

| Without output correction factor | PTV1 | PTV2 | PTV3 | PTV4 | PTV5 |
|----------------------------------|-------|--------|--------|--------|--------|
| PTV volume (cc) | 0.15 | 0.03 | 0.01 | 0.05 | 0.02 |
| PTV coverage (%) | 98.7% | 100.0% | 100.0% | 100.0% | 100.0% |
| Minimum PTV dose (%) | 99.9% | 100.0% | 100.0% | 100.0% | 100.0% |

Table2: Calculated PTV coverage and minimum PTV dose from Multi-Plan planning system for 5 mm cone plans (output correction factors applied to the ratios of readings)

| With output correction factor | PTV1 | PTV2 | PTV3 | PTV4 | PTV5 |
|-------------------------------|-------|-------|-------|-------|-------|
| PTV volume (cc) | 0.15 | 0.03 | 0.01 | 0.05 | 0.02 |
| PTV coverage (%) | 90.0% | 93.4% | 89.2% | 98.9% | 80.9% |
| Minimum PTV dose (%) | 96.2% | 97.4% | 98.2% | 97.6% | 97.5% |

Table3: Difference between Table 2 and Table 3, giving quantitative dose error if the correction factors are not included

| | PTV1 | PTV2 | PTV3 | PTV4 | PTV5 | Average |
|-----------------------------|-------|-------|--------|-------|--------|---------|
| PTV volume (cc) | 0.15 | 0.03 | 0.01 | 0.05 | 0.02 | |
| PTV coverage change (%) | -8.7% | -6.6% | -10.8% | -1.1% | -19.1% | -9.3% |
| Minimum PTV dose change (%) | -3.7% | -2.6% | -1.8% | -2.4% | -2.5% | -2.6% |

Table4: The same as Table 3, but for 7 mm cone plans

| | PTV1 | PTV2 | PTV3 | PTV4 | PTV5 | Average Change |
|-----------------------------|-------|-------|-------|-------|-------|----------------|
| PTV volume (cc) | 0.15 | 0.03 | 0.01 | 0.05 | 0.02 | |
| PTV coverage change (%) | -3.1% | -3.2% | -5.2% | -2.1% | -2.9% | -3.3% |
| Minimum PTV dose change (%) | -2.3% | -2.2% | -2.2% | -2.3% | -2.3% | -2.3% |

CONCLUSIONS

Without including output correction factors in the field output factors for small cone in the Cyberknife could make calculated PTV coverage and PTV minimum dose much higher than true values, especially for the use of 5 mm cone. Therefore, implementing the output correction factors for the calculations of the FOF for small cone sizes in the Cyberknife is necessary to improve the treatment accuracy.

REFERENCES

Technical Reports Series No. 483
Dosimetry of Small Static Fields Used in External Beam Radiotherapy
An International Code of Practice for Reference and Relative Dose Determination, IAEA/AAPM

CONTACT INFORMATION

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