Should we implement TRS 483 recommended correction factors for Cyberknife cones output in various detector types

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INTRODUCTION

Small field dosimetry is a critical aspect of modern dosimetry, especially in the context of Stereotactic Radiosurgery (SRS) and Stereotactic Body Radiation Therapy (SBRT) treatments. Accurate measurement of small field output factors (OF) is essential for precise photon beam modeling and accurate dose calculations. Errors in OF determination can significantly impact the accuracy of dose delivery, making it crucial to use appropriate detectors and correction factors.

Small fields present challenges due to steep dose gradients and lack of charged-particle equilibrium.

Conventional detectors may not accurately measure dose in small fields due to volume averaging effects.

The output factor (OF) is a fundamental dosimetric parameter that quantifies the dose at a specific point in a small field relative to a reference field of larger dimensions.

Accurate determination of OF is crucial for precise dose calculations in treatment planning.

Specialized detectors are required for accurate small field measurements.

Different types of detectors may exhibit variations in their response to small fields, necessitating careful selection and characterization.

IAEA TRS 483 provides correction factors that can be applied to improve the accuracy of OF determination in small field sizes.

These correction factors address detector-specific variations, enhancing the reliability of measurements.

OBJECTIVES

To compare three types of small volume detectors with composite data from Accuray for small field dosimetry.

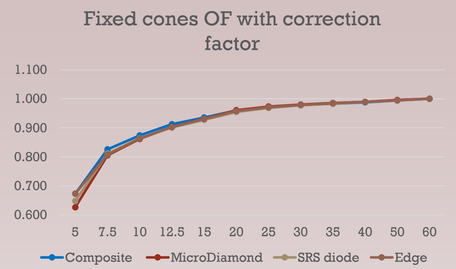
To assess the impact of applying and ignoring correction factors recommended in IAEA Technical Report Series (TRS) 483 on OF determination.

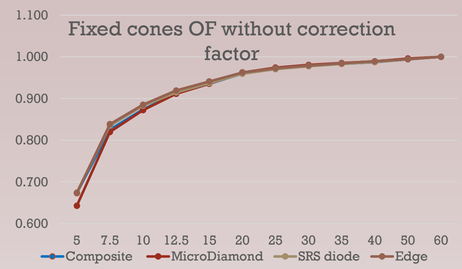
MATERIAL AND METHOD

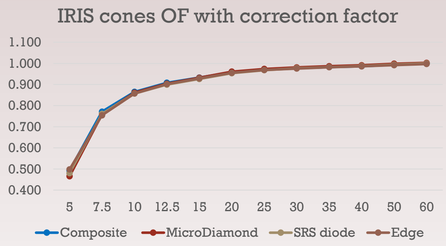
PTW 60019 CVD detector, PTW 60018 unshielded diode, and Sun Nuclear Edge detectors are used in these output factor measurements for 24 Fixed and Iris cones (5mm to 60mm) of Cyberknife S7.

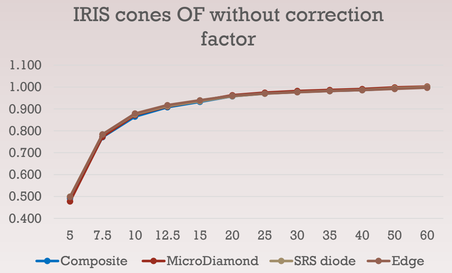
RESULTS

The study results are divided into three groups based on cone size, namely Group A (20 to 60mm cones), Group B (10 to 15mm cones), and Group C (5 and 7.5mm cones). The comparison is made between our study data and composite data from Accuray, with and without applying correction factors (CF).









Cone Size Group	Applying CF	Average Variance Percentage (%)	Maximum Variance Percentage (%)
Fixed Cones		No	
A (20-60mm)	No	0.12	0.3
B (10-15mm)	No	0.49	1.31
C (5-7.5mm)	No	1.63	4.52
Fixed Cones		Yes	
A (20-60mm)	Yes	0.13	0.52
B (10-15mm)	Yes	0.99	1.39
C (5-7.5mm)	Yes	3.42	6.91
Iris Cones		No	
A (20-60mm)	No	0.2	0.49
B (10-15mm)	No	0.8	1.64
C (5-7.5mm)	No	1.6	2.95
Iris Cones		Yes	
A (20-60mm)	Yes	0.23	0.49
B (10-15mm)	Yes	0.6	0.95
C (5-7.5mm)	Yes	2.58	5.38

1.Applying CF generally reduces the variance percentages and improves the accuracy of the measurements in all groups.
2.Smaller cone sizes (Group C) tend to exhibit higher variance percentages compared to larger cones (Group A).
3.The maximum variance is higher for Group C, indicating more significant uncertainties in measurements with the smallest cones.

CONCLUSIONS

The study findings indicate that the variance percentage between the measured data and composite data from Accuray is lower when not applying correction factors (CF), particularly for small fixed and iris CyberKnife cones (7.5, and 5 mm). In other words, without using CF, the measured values align more closely with the composite data provided by Accuray for these specific cone sizes.

This observation that for certain small field measurements (5 and 7.5 mm) fixed and iris cones, the application of CF may introduce additional uncertainties or discrepancies between the measured and reference data. As a result, omitting CF could potentially yield more accurate dose calculations in these specific cones.

REFERENCES

1. Dosimetry of Small Static Fields Used in External Beam Radiotherapy TRS 483
2. AAPM TG155 Megavoltage photon beam dosimetry in small fields and non-equilibrium conditions.