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Retrospective Dosimetric Study of a Novel Automation Software for Whole Brain Planning Field-in-Field Treatment Plans

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INTRODUCTION

Traditional whole brain Field-in-Field (FiF) planning involves the manual generation of an open field with hot spot volume-blocked subfields, that are merged to create one treatment field. This technique results in a reduction of the overall maximum dose and improved dose homogeneity control in the brain.[1]

While often dosimetrically advantageous, forward planned FiF calculations can be time consuming as the planner works to reduce the hotspot through the manipulation of blocked segments. The opportunity of pushing a plan too far in which compromised coverage results is an additional possibility with this planning method.

AIM

The purpose of this study is to compare traditional whole brain Field-in-Field (FiF) treatment plans with those created using RADformation's EZFluence software.

METHOD

A retrospective study on dosimetric comparison and feasibility of FiF plans created by EZFluence for 24 Whole Brain plans was conducted. Treatment plans included mixed energy fields of 6 and 18 MV in Eclipse TPS.

EZFluence, an embedded script in Eclipse, allows the planner to automate the FiF process. The target and critical structures are based on user specification with the desired coverage reviewed prior to creation of a FiF plan in the software. Through optimization parameters chosen by the planner, such as maximum dose or normalization value, maximum number of segments, and automated creation of a planning target volume (PTV), EZFluence generates the subfields along with multiple plans for review. An optimal plan, based on dose volume histogram (DVH) statistics and associated visualization of the dose distribution, is then selected. The segments for the FiF are compiled and sent to Eclipse for a final calculation and review by the planner.

Comparison to the original plan's prescription dose coverage, maximum dose to the target (brain), lens, globe of the eye and total MU of each field were evaluated. A randomly-selected portion of the traditional and EZFluence plans were reviewed simultaneously and anonymously by a physician with intent in determining which plan was of greater dosimetric quality.

Each plan was additionally verified for accuracy with RadCalc® and the delivery validated using the MapCHECK®2 2D array.

RESULTS

The retrospective plan evaluation consisted of twenty-four whole brain plans. The number of treatment fields utilized in the plans were 2(n=3) and 4(n=21). Three plans employed 6MV, and twenty-one used dual energy 6/18MV fields. Seventeen plans were prescribed to a dose of 30Gy in 10 fractions, four to a dose of 25Gy in 10 fractions, two to a dose of 36Gy in 12 fractions, and one to a dose of 37.5Gy in 15 fractions.

The results in Table 1 show the comparison of EZFluence to the tradition planning method for FiF. A minimum of 90-95% PTV coverage was part of the plan evaluation. There was a 0.6% average increase in the coverage and a 0.12% average increase in maximum dose to the whole brain. The average decrease in dose to both eye globes and lenses was 0.5% and 0.15%, respectively.

Rx Dose coverage of Target (90-95%)	Max Dose of Target (%)	Rt Globe Max Dose (% of Rx dose)	Lt Globe Max Dose (% of Rx dose)	Rt Lens Max Dose (% of Rx dose)	Lt Lens Max Dose (% of Rx dose)
0.63% average increase of coverage	0.12% average increase of Max Dose	0.23% average decrease to the Right Globe	0.78% average decrease to the Left Globe	0.21% average decrease to the Right Lens	0.10% average decrease to the Left Lens

Table 1. Comparison of EZFluence plans to the traditional FiF planning for whole brains.

Below is an example of a whole brain plan that consisted of 4 dual energy fields. The EZFluence plan was normalized to achieve comparable dose coverage the traditional planning method.

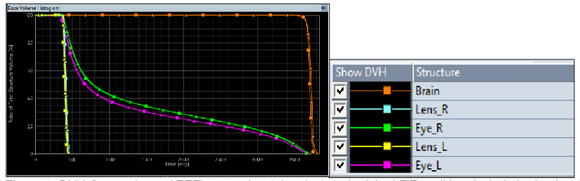

Figure 1. DVH Comparison of EZFluence plan (triangles) and original FiF traditional whole brain plan (squares). EZFluence plan is normalized to give the same coverage as displayed in the DVH (36Gy in 12 fractions).

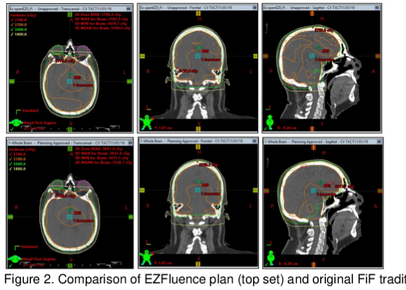

Figure 2. Comparison of EZFluence plan (top set) and original FiF traditional whole brain plan (bottom set).

For whole brain planning, the EZFluence monitor units were on average 4.4% (14 MU) greater than the traditional planning. The average time for the creation of FiFs using EZFluence was 11.8 minutes. Planning time again decreased with familiarity of the software.

RESULTS (CON'T)

Physician review
With intent in determining which planning technique was clinically preferred from an unbiased approach, ten whole brain studies previously planned with the traditional FiF method were additionally planned with EZFluence, and anonymized.

The planned pairs were presented to a radiation oncologist within Plan Evaluation of Eclipse. A plan was deemed clinically superior based on the maximum dose, hot spot, dose coverage, and clinical endpoint. The planner made it a priority to maintain both the hot spot within clinically acceptable values and a maximum dose at or around 105%. The EZFluence plans were normalized for comparable coverage to the original delivered plan, and with critical organs such as the eye globes and lenses spared.

While in some cases the maximum dose was higher in the EZFluence plans, the hot spots were observed to be sporadically distributed over a greater area and with some near the skull (Figure 2). Of the 10 anonymized whole brain studies reviewed, the EZFluence plan was consistently chosen by the radiation oncologist (Table 2).

No.	Txt Site	Total Dose (Gy)	# fxn	Plans	Physician Selection
1	Whole Brain	30	10	Traditional EZFluence	EZFluence
2	Whole Brain	30	10	Traditional EZFluence	EZFluence
3	Whole Brain	30	10	Traditional EZFluence	EZFluence
4	Whole Brain	36	20	Traditional EZFluence	EZFluence
5	Whole Brain	30	10	Traditional EZFluence	EZFluence
6	Whole Brain	30	10	Traditional EZFluence	EZFluence
7	Whole Brain	30	10	Traditional EZFluence	EZFluence
8	Whole Brain	25	10	Traditional EZFluence	EZFluence
9	Whole Brain	25	10	Traditional EZFluence	EZFluence
10	Whole Brain	30	10	Traditional EZFluence	EZFluence

Table 2. Blinded physician review and preference of 10 whole brain plans.

CONCLUSIONS

EZFluence produced comparable plans in a relatively shorter time. When normalized to produce the same coverage of the original plan, the dose distribution, hotspot and dose to normal tissue structures were on the average within 1% of the original plan. Total MUs increased, on average, 4.6% (14MUs). The average hotspot to homogenous plans was 106%. RadCalc® was within 5% and MapCHECK®2 demonstrated agreement of a passing rate of 95% (using 2%/2cm/10TH). Average time commitment for the creation of FiF plans through traditional steps was 7-20 minutes. A reduction in planning time was observed with EZFluence, with a range between 4-8 minutes.

The physician review of the EZFluence generated plans was a critical component in determining whether the studies were clinically acceptable and qualitatively comparable to those calculated through the traditional planning approach. Preliminary findings in the quality of the EZFluence plans were encouraging however, a whole brain plan is most often straightforward, with minimal time required for an experienced medical dosimetrist. While all studies chosen by the radiation oncologist were completed with EZFluence, it was noted that the plans originally produced by dosimetrists were also clinically acceptable. It would be beneficial to expand the physician review to other treatment sites such as breast tangents to validate the quality and feasibility of EZFluence for treatment planning.

REFERENCES

1. S. Karlovits, et. Al. Forward Planned (FP) Whole Brain Radiotherapy (WBRT): A Straightforward Technique to Reduce Parenchymal Dose Inhomogeneity and Tangential Scalp Dose. Int J Radiat Oncol Biol Phys. 2010; 78(3): 839-840.

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CONTACT INFORMATION

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