

A Dosimetric Study on the Optimal Beam Arrangement of the Gastroesophageal Junction: A Comparison of Coplanar and Non-coplanar VMAT Techniques

Introduction

Approximately 80% of esophageal cancers in the U.S. are adenocarcinoma of the gastroesophageal junction with a steady 2.5 rate of incidences increased over the past couple decades. The prognosis is poor, with less than a 20% five-year survival rate (Baus, 2013). These trends call for greater efforts towards developing better treatment mechanisms.

Volumetric Modulated Arc Therapy (VMAT) is supported as the optimal technique of external radiation therapy for treatment of gastroesophageal junction tumors (Wang, 2013). Multi-arcs and a non-coplanar are used to compare the dosimetric qualities of plans. This study tested these theories on gastroesophageal junction plans.

Methods

This was a retrospective study conducted on the scans of eleven patients with histologically confirmed GE junction tumors treated at St. Vincent Cancer Center in Green Bay, WI. All patients had some nodal involvement. All PTVs had to have a volume of 250 cm³ or greater.

Three different VMAT beam arrangements were created on the eleven samples.

VMAT Beam Arrangements

- Dual Arc**- The first arc rotated clockwise from 180.1° to 179.9°. The second arc rotated counterclockwise from 179.9° to 180.1°.
- Triple Arc**- The first arc rotated clockwise from 180.1° to 179.9°. The second arc rotated counterclockwise from 179.9° to 180.1°. The third arc rotated clockwise from 180.1° to 179.9°.
- Non-Coplanar Arc**- The first arc rotated counterclockwise from 0° to 270° with a 340° couch angle. The second arc rotated clockwise from 180.1° to 179.9° with a 20° couch angle. The third arc rotated clockwise from 180.1° to 179.9° with a 0° couch angle. Testing was done to insure no collision would occur during treatment.

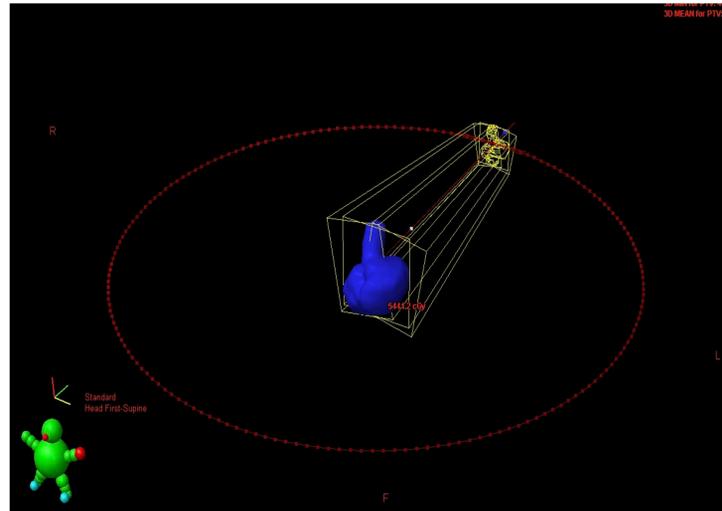


Fig 1. Standard coplanar triple arc arrangement on sample 11.

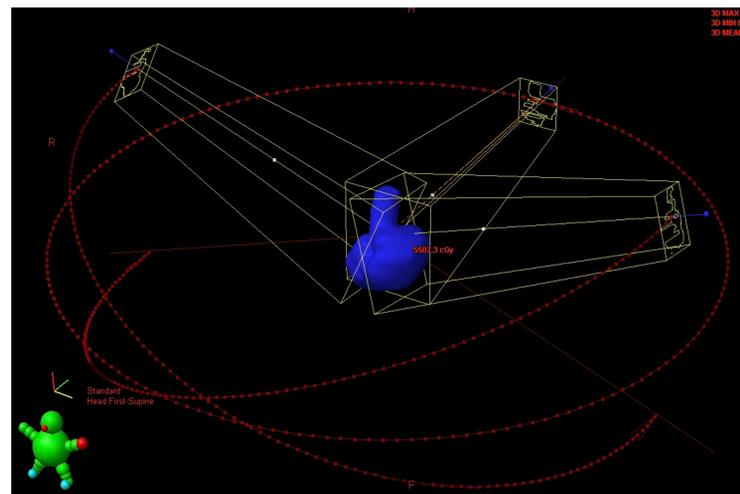


Fig 2. Testing arrangement of a non-coplanar triple arc on sample 11.

Results

Organ	Plan	Mean Dose	P-value	Mauchly's W	GreenHouse
Lung	Dual Arc	1,020 cGy	<.001	.008	.502
	Triple Arc	1,446 cGy			
	Non-Coplanar	1,049 cGy			
Heart	Dual Arc	2,093 cGy	.881	.972	.973
	Triple Arc	2,018 cGy			
	Non-Coplanar	2,185 cGy			
Liver	Dual Arc	1,386 cGy	.055	.678	.678
	Triple Arc	1,384 cGy			
	Non-Coplanar	1,400 cGy			
Small Bowel	Dual Arc	428 cGy	<.001	.036	.509
	Triple Arc	423 cGy			
	Non-Coplanar	480cGy			
Large Bowel	Dual Arc	573 cGy	.011	.368	.613
	Triple Arc	571 cGy			
	Non-Coplanar	614 cGy			

Table 1. Mauchly's Test of Sphericity was done to examine the variance differences in the mean of the OARs. (p < .05 for statistically significant)

Conclusion

There was no significant difference between the three plans for the heart (p = .881) and liver (p = .055). There was a significant difference between the plans for lung (p < .001), small bowel (p < .001), and large bowel (p = .011).

Little improvement of the overall plan is made between the three different beam arrangements. The triple arc co-planar arrangement had the most OARs with the lowest mean dose, but the dual arc and non-coplanar surpassed it when looking at a lower mean dose to the lungs.

This conclusion suggests that overall simplicity can create an acceptable plan without costing more time to both the patient and employees of the treatment center.

Limitations

One of the major limitations of this study was sample. There was no contact with or identifiable information about the patients and the sample size was small. Without knowledge of the demographic and medical history of the sample, it impossible to know if the sample is comparable to the majority of GE junction tumor cases. A larger sample size from multiple institutions/hospitals in different regions with more demographic and medical history information of the patients could improve this study.

References

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