# Jaw Tracking VMAT:
# A Robust Option in Delivering WBRT+SIB

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## INTRODUCTION

VMAT affords clinicians the ability to deliver conformal dose distributions to target volumes of varied prescriptions. Low dose spray attributed to VMAT has been an issue in planning breast cases, as this modality commonly struggles to reduce low dose to the heart and lungs as well as 3D planning. Jaw tracking has been successful in reducing low and intermediate dose to OARs in head and neck patients. We devised a jaw tracking VMAT technique that delivers WBRT+SIB that achieves ideal PTV coverage, provides excellent conformity, and maintains low OAR doses seen in 3D planning.

## AIM

- Hypofractionationated WBRT + SIB presents an opportunity to reduce treatment time to three weeks.
- Our goal was to determine the efficacy of Jaw Tracking VMAT in breast planning.
- Jaw Tracking-enabled VMAT could deliver a highly conformal and homogenous dose to the breast while simultaneously boosting the lumpectomy bed.
- Use of pseudo skin flash in VMAT optimization can be used to mitigate setup geometry issues.[1]

## METHOD

- 11 previously-treated patients (5 left-sided, 6 right-sided)
- Prescription: 4005cGy/4800cGy in 15 fractions
- All constraints based on RTOG 1005
- 3D plans consisted of FiF tangents and a 3D boost
- VMAT plans utilized five partial arcs:
  - ***2 medial and 2 lateral "tangential" arcs*** – 60 degrees each, CW/CCW, collimated to Breast PTV plus flash
  - ***1 lumpectomy boost arc*** – 90 degrees, collimated to Lumpectomy PTV
- All arcs utilized 6MV as the photon energy
- Jaw Tracking was enabled for all VMAT plans
- VMAT plans were optimized with on a dataset that utilized 1cm virtual bolus (HU set to -400)[2]
  - *Pseudo skin flash for VMAT arcs can ensure a robust plan that mitigates setup uncertainties, similar to how flash is provided in tangents*
- VMAT plans were then calculated on the original dataset and compared to their counterparts in terms of coverage, conformity, OAR dose, and delivery
- A 3D array was used for VMAT plan delivery QA

## RESULTS

- VMAT consistently delivered excellent coverage to the PTVeval volumes, as seen in Figure 1 (right). Lumpectomy PTVeval coverage was improved upon by VMAT planning; V100% for VMAT was 94.1%, a vast improvement from 3D (77.6%).
- VMAT planning achieved similar results in terms of Breast PTVeval D95 [0.7% difference] while reducing D30 by 2.8%. The volume receiving 107% (4285cGy) of the whole breast Rx was reduced by over 5%.
- VMAT yielded more conformal plans than 3D across the board; breast and lumpectomy CI95% values were improved from 1.62 to 1.22 and 2.39 to 1.69, respectively.
- VMAT plans improved mean heart dose for left-sided cases while matching 3D in various lung dosimetric guidelines, as seen in Figure 1 and 2. While the Ipsilateral Lung V5Gy for 3D and VMAT were 25.5% and 27.7%, respectively, VMAT reduced intermediate and high dose-volumes.
- Using an SNC ArcCheck, patient-specific QA was performed for each VMAT plan. Gamma analysis for all VMAT plans averaged over 99.2% pass rate at 3%/3mm.
- Arcs were timed during delivery; 60-degree "tangential" arcs averaged 15 seconds of delivery time, while lumpectomy boost arcs were no longer than 22 seconds. Arcs can be delivered within a breath hold period.

**Average DVH Data compared to RTOG 1005 Constraints**

| Structure | Constraint | Ideal | VMAT (cGy) | 3D (cGy) |
|---|---|---|---|---|
| Breast PTVeval | D95 | 3800 | 3919 | 3948 |
| | D50 | 4320 | 4255 | 4285 |
| | D30 | 4800 | 4463 | 4593 |
| | *CI95* | *.95-2* | *1.22* | *1.62* |
| Lumpectomy PTVeval | D95 | 4560 | 4791 | 4744 |
| | D5 | 5280 | 5088 | 5013 |
| | Max | 5520 | 5184 | 5068 |
| | *CI95* | *.95-2.5* | *1.69* | *2.39* |
| Heart (Left) | D5 | 1600 | 419 | 474 |
| | D30 | 800 | 164 | 191 |
| | Mean | 320 | 158 | 182 |
| Heart (Right) | Max | 1600 | 722 | 478 |
| | D10 | 800 | 211 | 162 |
| | Mean | 320 | 107 | 64 |
| Ipsilateral Lung | D15 | 1600 | 1100 | 1207 |
| | D35 | 800 | 372 | 367 |
| | D50 | 400 | 236 | 228 |

*Figure 2: 3D and VMAT DVH Data averaged across all 11 patients. Conformity indexes*

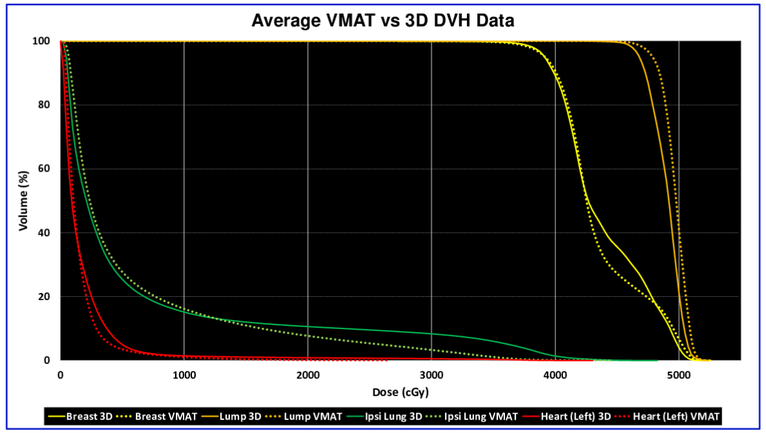


*Figure 1: 3D (solid) and VMAT (dashed) DVH Data averaged across all 11 patients.*

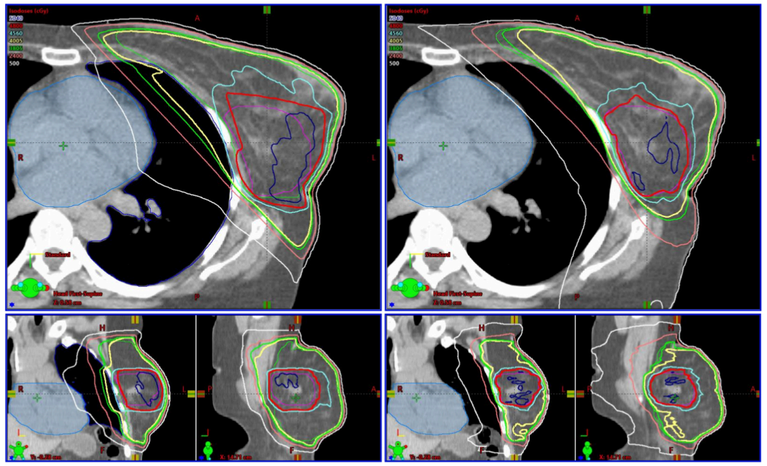

*Figure 3: Patient 9 in the retrospective study. Both the 3D (left) and VMAT (right) plans achieved Lumpectomy $PTV_{eval}$ D95 of 100%; **however**, VMAT improved the CI95 of the breast and lumpectomy $PTV_{eval}$ volumes from 1.51 to 1.12 and 2.68 to 1.67, respectively.*

## CONCLUSIONS

- Jaw tracking VMAT can deliver a more conformal WBRT+SIB plan while sparing the ipsilateral lung and heart at levels achieved by 3D planning.
- Jaw tracking can reduce the low dose spray that is associated with VMAT plans; this option can allow the planner to achieve ipsilateral lung and heart constraints that are typically achieved with 3D.
- VMAT planning can provide a more homogenous dose to the whole breast while delivering a conformal SIB. Other studies have shown that a more homogenous breast dose could potentially improve cosmetic outcomes.
- Optimizing with a virtual bolus ensures the MLCs will extend beyond the patient surface, providing flash for VMAT arcs. This technique could alleviate issues with setup or patient changes throughout a course of treatment.
- Arcs can be delivered within 15 seconds, ensuring that arc delivery could be coupled with DIBH techniques.
- Delivering an SIB to the tumor bed spares the patient a week of treatments.
- By optimizing for skin flash and enabling jaw tracking, planners can consistently generate reproducible plans that not only achieve desired target volume coverage, but also minimize dose to nearby OARs below accepted standards for both left and right sided cases.

## ACKNOWLEDGEMENTS

A big THANK YOU to all of the healthcare professionals and community leaders during these times.

## REFERENCES

1. Tyran, M, et.al. Safety and benefit of using a virtual bolus during treatment planning for breast cancer treated with arc therapy. *J Appl Clin Med Phys.* 2018 Sep; 19(5): 463–472.
2. Lizondo, M, et.al. Pseudo skin flash on VMAT in breast radiotherapy: Optimization of virtual bolus thickness and HU values. *Physica Medica.* 2019; (63): Page: 56-62

## CONTACT INFORMATION

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