Dosimetric implications for post-mastectomy radiation treatment (PMRT) with AlloX2 tissue expander

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INTRODUCTION

The AlloX2 (Sientra Inc) tissue expander is a new breast tissue expander with a dual port system. One port is used for traditional saline injection, and second port facilitates fluid drainage. It is used to reduce seroma and infection for patients who require tissue expanders after mastectomy. For patients will receive post-mastectomy radiation treatment (PMRT) with AlloX2 tissue expander, two high density ports perturb the radiation and increase scatter.

AIM

This study investigated the dosimetric implications of using AlloX2 tissue expander for PMRT. A retrospective study was done on three patients with AlloX2 tissue expanders. Three different models for metallic ports were compared in RayStation treatment planning system (TPS).

Furthermore, by using an in-house built phantom and nanodot Optically Stimulated luminescence dosimeter (OSLD) measurements, three metallic models were evaluated against point dose measurement. This study evaluated he accuracy of the modelling of the AlloX2 tissue expander in RayStation TPS using Collapsed Cone algorithm.

METHOD

- Simulation: Siemens CT with Iterative Metal Artifact Reduction (iMAR)
- Treatment planning: RayStation TPS, 6X MV photon, VMAT or IMRT technique for patients, 3D technique for in-house phantom
- Treatment machine: Varian TrueBeam
- AlloX2 models:
  - Model 1: uniform density override (titanium) based on visual inspection on CT images
  - Model 2: based on vendor specified values of dimensions and material (magnet and titanium)
  - Model 3: no density override
- Evaluated dose perturbation and planned target (PTV_Eval) coverage on three patients with three models in RayStation TPS.
- Built an in-house phantom with AlloX2 tissue expander.
- Compared nanoDot (OSLD) measurement with TPS calculated dose.

RESULTS

To investigate dosimetric implications with AlloX2 tissue expanders, three patients clinical plans were calculated with three AlloX2 models in RayStation TPS. With the same beam setting for each patient, the Target (PTV_EVAL) coverage at prescription (2Gy x 25 fractions) between three models varied between 0.6% - 2.9%. Model 3 had the highest target coverage and Model 1 had the lowest target coverage. Results are listed in Table 1.

		V100 for PTV_EVAL (%)		
Patient	Technique	Model 1	Model 2	Model 3
PT A	VMAT	91.71	92.3	93
PT B	IMRT	88.74	89.4	90
PT C	VMAT	92.14	94.02	95

Table 1 Calculated Target Coverage on different models for three PMRT patients

To further compare and validate three AlloX2 models, an in-house phantom was built with AlloX2 metallic ports imbedded. OSLD were placed to measure the dose around metallic ports as shown in Figure 4. A simple AP beam was applied to the phantom and TPS calculated point dose in three different models was compared with OSLD measurements. Results showed that Model 1 had better agreement with measurements at shallow depth (1cm) but overestimated dose (<1%) , whereas Model 3 had better agreement with measurements at deep depth (2.5cm) but underestimated dose (<5%). OSLD measurements away from metallic port edge showed minimum discrepancies (< 2.2%) for all models. Interestingly, Model 2 which had the most accurate geometry and composition of AlloX2 had the largest discrepancy (~8%) from OSLD measurements at 2-3cm depth. Detailed results are listed in Table 2.

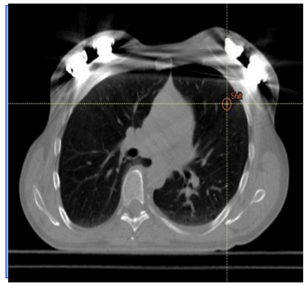

Fig. 1. CT Axial view of a patient with bilateral AlloX2

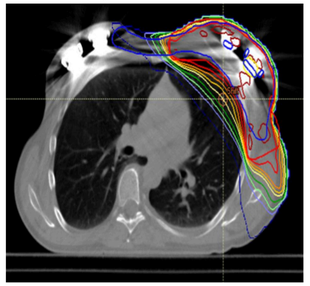

Fig. 2. Axial view with isodose lines of a patient with bilateral AlloX2

Fig. 3. Schematic of AlloX2 tissue expander

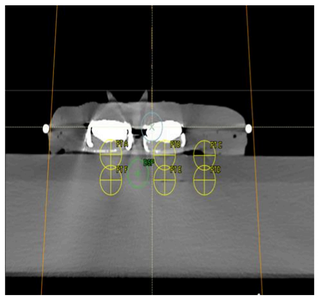

Fig. 4. CT Axial view of in-house phantom

		Model 1		Model 2		Model 3	
Location	Measured Dose (cGy)	Calculated Dose (cGy)	Difference (%)	Calculated Dose (cGy)	Difference (%)	Calculated Dose (cGy)	Difference (%)
Pt A	189.4	191	0.9%	184	-2.8%	192	1.4%
Pt B	186.1	188	1.0%	182	-2.2%	190	2.1%
Pt C	199.1	198	-0.5%	199	0.0%	198	-0.5%
Pt D	191.1	187	-2.2%	188	-1.6%	187	-2.2%
Pt E	182.4	176	-3.5%	169	-7.4%	178	-2.4%
Pt F	189.6	178	-6.1%	171	-9.8%	180	-5.1%

Table 2 Measured (OSLD) and calculated dose comparing different models

CONCLUSIONS

We have compared three different metallic port models within AlloX2 tissue expanders in RayStation TPS for PMRT patient cases. We found that target coverage varied less then 3%. Point dose and dose distribution difference can be more complex and specific patient dependent.

With our three models, point dose measurements with in-house phantom showed that all three models underestimated dose at deep depth (2.5cm) and the discrepancy can be more significant (more than 5%) . Good agreement between measurements and calculated dose were found at shallow depth of direct transmission and adjacent region. However, this result only came from simple AP beam setup. For clinical cases, tangential beams or VAMT setup should be further investigated.

PMRT with AlloX2 presents significant clinical challenge. CT images can suffer from CT number saturation and streak artifacts. Density override of tissue expander can be complicated due to geometry and material used for AlloX2. We also found that the dose calculation accuracy is limited with the Collapsed Cone (CC) dose algorithm used in RayStation TPS due to high density material used in model (magnet and titanium). Further studies will be conducted to find the best approach for PMRT with AlloX2.

REFERENCES

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