Proton versus Photon Comprehensive Nodal Breast Irradiation

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Purpose

- Comprehensive nodal breast irradiation is traditionally treated utilizing 3DCRT planning with a three or four field technique
- This technique may be the standard of care for comprehensive nodal breast treatment, the ipsilateral lung dose and heart mean can often be of concern dependent on patient's anatomy
- Double scattering proton therapy treatment has a significant advantage over photons in reducing the ipsilateral lung and heart dose due the Spread-Out Bragg Peak and rapid dose drop off
- Within this study, a comparison of ipsilateral lung and heart mean doses will be evaluated using both photon three/four field technique and double scattering proton therapy technique.

Methods and Materials

- A cohort of 20 previously patients were selected for this study. Out of the 20 patients, 10 were left breast, 8 were right breast, and two patients were treated bilaterally
- The prescription was the same for all 20 patients; standard fractionation (5000cGy in 25 fractions)
- Mevion s250 double scattering proton treatment machine was used to generate all proton plans
- The standard beam arrangement for a proton breast treatment typically involves two matching fields; one enface field treating the breast and the second field treating the superior nodal region
- The enface beam angle in proton allows for robust treatment planning, optimal coverage of the PTV (planning target volume) and a homogenous dose distribution
- For photon plans that were conducted, a standard mono-isocentric or dual iso-centric technique was used dependent on patient anatomy. A mixed beam energy technique of 6MV, 10MV and 15MV were used in majority of photon plans
- Often, when treating the internal mammary nodes with the three-field photon technique, the field may encompass the medial part of the contralateral breast. With the field arrangement of the proton beam, that is often minimized or avoided
- Coverage of the nodal volumes were evaluated for a minimum of 95% of the prescription dose covering 95% of the target volume for both proton and photon treatment plans

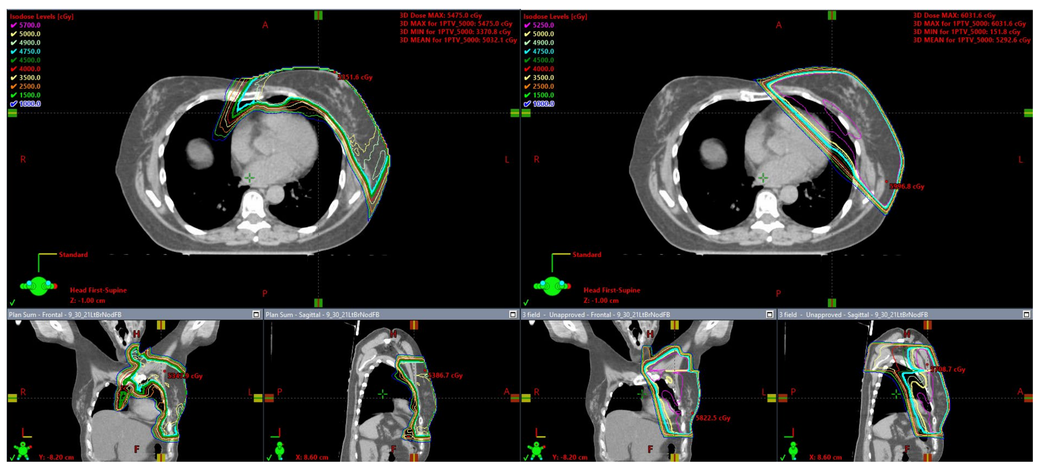

Figure 1: Displaying a comparison of dose distributions to proton (left) and three field photon (right). There is a more homogenous isodose distribution and less contribution to ipsilateral lung and heart

Results and Discussion

- A decreased ipsilateral lung V20 can be correlated to all proton plans that were conducted in the study (Table 1).
- A lower heart mean can also be correlated to all proton plans conducted in the study (Table 2)

Modality	Ipsilateral Lung V20 Average
Proton	19.75%
Photon 3DCRT	40.62%

Table 1: Demonstrates a decrease in ipsilateral lung V20 when planned with a double scatter proton beam versus a photon 3DCRT plan.

Modality	Heart Mean
Proton	62.135 cGy
Photon 3DCRT	374.609 cGy

Table 2: Demonstrates a decrease in heart mean when planned with double scatter proton beam versus a photon 3DCRT plan

- The breath hold technique may help reduce the heart mean although proton treatment can further reduce this value
- "It is difficult to know the absolute risks, given uncertainties in historical data, but estimates found a 7.4% increase in relative risk for cardiac mortality for each incremental increase in mean heart dose of 1 Gy^{-1}"
- One of the most challenging factors in receiving proton therapy treatment is insurance authorizations for these patients
- Double scattering protons do not have the same skin sparing effect as photons do and are unable to be modulated as a scattering proton beam would
- Patients whom have breast expanders, raise some concerns for treatment planning with proton therapy as the expander is a metal port that must be overridden to a known Hounsfield unit to assure the correct stopping power ratio is applied

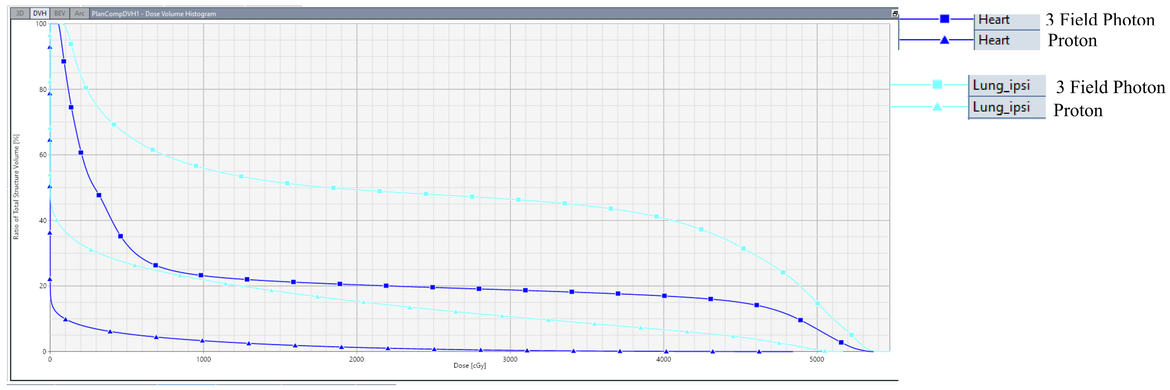

Figure 2: A DVH comparison of proton versus photon for the heart and ipsilateral lung. Displaying a significant decrease in ipsilateral V20 and heart mean.

CONCLUSION

- The presented results show that the dosimetry impact of reducing ipsilateral lung and heart mean doses is most significant with double scattering proton therapy
- This technique provided a lower ipsilateral lung V20 in all plans and a lower heart mean in all but one plan
- All while maintaining 95% of the prescription encompassing 95% of the PTV coverage

Reference

1. Bradley, J. A., Ho, M. W., Li, Z., Liang, X., Rutenberg, M., Dagan, R., & Mendenhall, N. P. (2017). *A technical guide for passive scattering proton radiation therapy for breast cancer*. International journal of particle therapy. Retrieved April 3, 2023, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6871562/#i2331-5180-3-4-473-b05