

# Radiation dose to the pectoralis major is associated with shoulder function after radiotherapy for breast cancer

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## Summary

The relationship between radiation dose to the pectoralis major and shoulder function was examined in breast cancer survivors treated with lumpectomy, sentinel node biopsy and radiotherapy. Every additional 1 Gy of radiation to the pectoralis major was associated with range of motion reductions of up to 1.45° and an increase in QuickDASH scores by 0.79. Thus, breast cancer patients receiving a higher radiation dose to the pectoralis major may be at greater risk of developing shoulder mobility impairments after treatment.

## Introduction

Radiotherapy (RT) is a critical breast cancer (BC) treatment, but it is often associated with shoulder functional deficits after treatment [1]. BC survivors referred to physical therapy tend to have higher incidental radiation doses to the pectoralis major [2] than those who were not, but it is unclear if the radiation dose is related to measures of shoulder impairment.

This study aimed to investigate the relationship between mean radiation dose to the pectoralis major with shoulder range of motion and self-reported shoulder function in breast cancer survivors previously managed with RT.

## Methods

We examined the treated shoulder in twelve BC survivors after RT to breast and axilla (age  $57.5 \pm 7.7$  yrs, ht  $162.9 \pm 6.6$  cm, wt  $81.2 \pm 11.3$  kg), twelve BC survivors after RT to the breast only (age  $59.7 \pm 5.9$  yrs, ht  $163.7 \pm 7.8$  cm, wt  $72.4 \pm 9.3$  kg) and a randomly chosen shoulder in twelve cancer-free controls (age  $61.2 \pm 7.7$  yrs, ht  $162.7 \pm 6.5$  cm, wt  $61.6 \pm 12.4$  kg). All BC survivors had lumpectomy with sentinel node biopsy and completed RT 12-60 months prior. Active abduction, flexion and extension ROMs were assessed with an inertial measurement unit on the upper arm (Opal, APDM Inc.). Participants completed the short version of the disability of arm, shoulder and hand (QuickDASH) questionnaire. The mean radiation dose to the pectoralis major was calculated from computed tomography RT plans. Differences between groups were tested with separate linear mixed-effects models with the three ROMs and QuickDASH scores as outcome variables, respectively, and group as between-subjects factor. Similarly, relationships between the outcome variables and radiation dose were examined with linear mixed-effects models with dose as continuous variable. In all models, participant was treated as random intercept.

## Results and Discussion

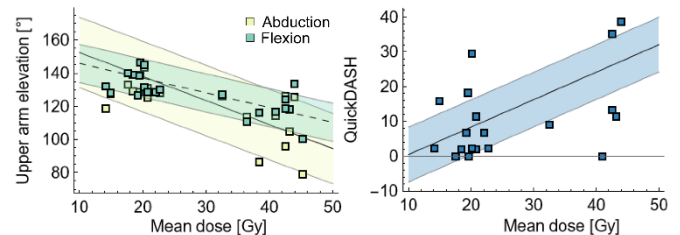
There were significant differences between the groups for abduction ROM ( $p < 0.001$ ), flexion ROM ( $p = 0.01$ ) and QuickDASH scores ( $p = 0.02$ ) (Table 1). The mean radiation dose to the pectoralis major was significantly associated with

abduction ROM ( $p = 0.02$ ,  $R^2 = 0.49$ ), flexion ROM ( $p = 0.01$ ,  $R^2 = 0.49$ ) and QuickDASH scores ( $p = 0.01$ ,  $R^2 = 0.47$ ) (Figure 1). The linear mixed-effects models showed that abduction ROM and flexion ROM are reduced by 1.45 (0.54)° and 0.89 (0.3)°, respectively, and QuickDASH score increases by 0.79 (0.26) points for each additional 1 Gy in mean radiation dose delivered to the pectoralis major.

**Table 1.** Differences in range of motion and QuickDASH scores between the groups as mean  $\pm$  standard deviation.

	Breast +Axilla	Breast only	Control
Abduction [°]	111.0 $\pm$ 19.3	129.5 $\pm$ 6.3*	137.1 $\pm$ 10.4*
Flexion [°]	121.9 $\pm$ 12.2	133.9 $\pm$ 6.2*	138.9 $\pm$ 9.1*
Extension [°]	37.7 $\pm$ 10.1	46.6 $\pm$ 15.4	46.1 $\pm$ 12.3
QuickDASH	20.0 $\pm$ 22.1	8.44 $\pm$ 9.4	4.0 $\pm$ 4.6*

\*significantly different to Breast + Axilla group;  $p < 0.05$



**Figure 1:** Mean radiation dose to the pectoralis major significantly influenced range of motion (left) and QuickDASH scores (right). The resultant fit of the linear mixed-effects models is shown as solid line (abduction, QuickDASH) and dashed line (flexion) with shaded regions representing standard error.

## Conclusions

BC survivors are more likely to experience shoulder impairments if their pectoralis major receives a higher mean radiation dose. Our results support future work using pectoralis major dosimetric data to screen patients in need of post-RT rehabilitation.

## Acknowledgments

This study was funded by a University of Michigan Rogel Cancer Center Postdoctoral Small Grant and an American Cancer Society Research Scholar Grant (RSG2001601CCE).

## References

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