Background

Current standard practice in the UK is to treat the whole breast or chest wall with radiotherapy following breast conservation surgery or mastectomy. Due to the anastomotic position of the heart, patients treated with radiotherapy for left sided breast cancer are at a greater risk of cardiac morbidity due to radiation exposure of cardiac tissue. This risk is further increased due to cardiotoxic effects observed with chemotherapy agents such as anthracyclines and taxanes, or by breast cancer drugs such as Herceptin.

It is well accepted that DIBH can consistently reduce cardiac dose4-6. However, due to additional time and resource implications it is necessary to identify cases where maximum benefit from DIBH techniques can be achieved. While work is on-going to assess whether DIBH can safely be delivered without the use of patient monitoring systems such as RPM, it is vital to understand what level of amplitude increase is required in order to achieve sufficient cardiac sparing.

Aim:

To investigate the impact of breath hold amplitude on subsequent cardiac V30 and mean cardiac dose in women treated for a left sided breast cancer in relation to the use of DIBH technique during radiotherapy.

Results

- Patients ages ranged between 35 and 63 years.
- All patients achieved decreased cardiac V30 and mean cardiac dose reduction using DIBH technique.
- Cardiac V30
  - Moderate positive correlation was identified between DIBH amplitude and cardiac V30 reduction, (R=0.48 p=0.007) (fig 2).
- Cardiac mean dose reduction
  - ranges from 15.1%-81.1% (85% CI 52.4%-65.0%).
  - DIBH amplitude and mean cardiac dose reduction were moderately correlated and statistically significant (R=0.52, p=0.003), with 77% of patients achieving a mean cardiac dose reduction greater than 50% with amplitudes ranging from 1.04cm-5.46cm. No patient achieved full cardiac dose reduction despite patients achieving up to a maximum ratio increase in amplitude of 27.2 times that of normal breathing (5.46cm amplitude). However, plans were not optimised, instead for consistency, set field borders were adhered to in practice it may be possible to achieve full cardiac dose reduction as plans can be compromised on an individual basis dependent on histogram and tumour bed location.
  - Is there a minimum ratio increase in amplitude of breath hold below which no benefit in minimising cardiac dose is achieved?
  - All patients achieved mean cardiac dose reduction and V30 reduction with DIBH, despite the amplitude increase achieved. Only 10% of patients achieved less than 70% in V30, and 23% patients less than 50% in cardiac mean dose.
  - The patients in the study were dual scanned due to significant heart in the field prior to DIBH scan. If the sample included all left sided breast cancer patients it is anticipated there would be a proportion of patients with no heart in the field with or without the DIBH technique, potentially leading to different results.

Discussion

Is there a correlation between breath hold level and cardiac V30?

A cardiac V30 reduction of at least 90% was achieved by 73% of patients with ratio increase ranging from 6.25 times-22.2 times that of normal breathing. However, a 99-100% reduction was observed for all patients when a ratio increase of at least 15 times normal breathing was reached for DIBH. These results are comparable with existing literature from Nissen and Appelt (2013) who identified a 91 reduction in 319 patients aged under 60 years old using DIBH. Results from the present study indicate a statistically significant (R=0.38, p=0.04) weak positive correlation between ratio of amplitude increase and V30 reduction.

Is there a correlation between breath hold level and mean cardiac dose reduction?

Cardiac mean dose reduction ranged from 15.1%-81.1% (85% CI 52.4%-65.0%). DIBH amplitude and mean cardiac dose reduction were moderately correlated and statistically significant (R=0.523, p=0.003), with 77% of patients achieving a mean cardiac dose reduction greater than 50% with amplitudes ranging from 1.04cm-5.46cm. No patient achieved full cardiac dose reduction despite patients achieving up to a maximum ratio increase in amplitude of 27.2 times that of normal breathing (5.46cm amplitude). However, plans were not optimised, instead for consistency, set field borders were adhered to in practice it may be possible to achieve full cardiac dose reduction as plans can be compromised on an individual basis dependent on histogram and tumour bed location.

Is there a minimum ratio increase in amplitude of breath hold below which no benefit in minimising cardiac dose is achieved?

All patients achieved mean cardiac dose reduction and V30 reduction with DIBH, despite the amplitude increase achieved. Only 10% of patients achieved less than 70% in V30, and 23% patients less than 50% in cardiac mean dose.

Mean Cardiac Dose

- A positive correlation between DIBH amplitude and mean cardiac dose reduction was identified (R=0.523 p=0.003) (fig 4).

Discussion

Correlation of ratio of amplitude increase and reduction in cardiac V30

- 27% of patients achieved full cardiac V30 reduction.
- 73% of patients achieved over 90% cardiac V30 reduction.

Correlation of DIBH amplitude and reduction in cardiac V30

- Ratio of amplitude increase from FB to DIBH ranged from 4-27.2 ratios. Ratios of at least 15 times FB achieved 100% cardiac reduction but this was also observed with amplitude of ratio increase as low as 6.25 times FB.

Conclusion

Results indicated statistical significance in relation to the correlation of DIBH amplitude and mean cardiac dose reduction (R=0.523, p=0.003). DIBH amplitude and cardiac V30 reduction (R=0.48, p=0.007) showed statistically significant correlation. Applying a ratio increase of 15 times normal breathing for DIBH is known to achieve 100% V30 reduction in cardiac V30.

Mean Cardiac Dose

- A positive correlation between DIBH amplitude and mean cardiac dose reduction was identified (R=0.523 p=0.003). (fig 4)