

Skin sparing radiation approach using helical tomotherapy without compromising target coverage in early breast cancer after lumpectomy



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Partial breast irradiation with helical tomotherapy: Skin dose less than conventional RT (Hui et al Technol. Res. Treat 2004)

Background

IMRT better cosmesis than conventional tangential RT in breast cancer. RCT Yarnold et al Abs EJC 2005

Skin sparing mastectomy trials in DCIS/T1/T2 without increase in local failure.

Skin as OAR using IMRT → skin dose reduction in head neck cancer. Lee et al IJROBP 2002

Feasibility of skin sparing RT to whole breast by helical tomotherapy (HT) by configuring skin as OAR

Purpose

Dosimetric comparison of whole breast RT by HT with and without skin dose restrictions

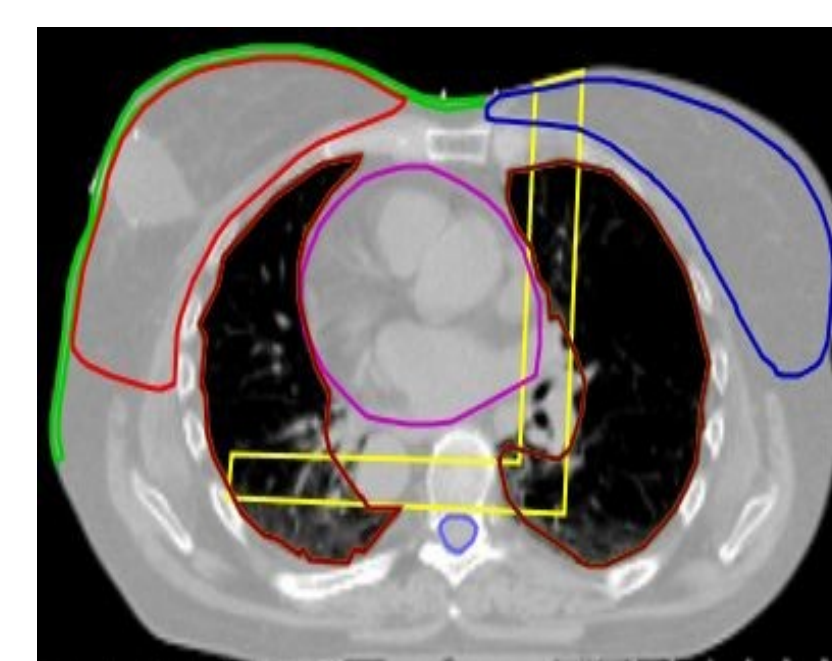
Skin dose validation of both methods by TLD measurements

Methods

Archival CT images of 14 left sided early breast cases

PTV (Breast only; no regional nodes) drawn as per tangential markers/CT. Ant margin 5mm from outline.

Skin contoured as 4- 5 mm strip over the breast



To restrict gantry angles of tomotherapy, a dummy structure (block) was created & completely blocked

HT plan 1 → 50Gy to PTV & minimize dose to OARs like heart, lungs and contralateral breast

HT plan 2 → minimize vol of skin receiving 50 Gy without compromising PTV and other OARs

paired student's 't' test(2-sided) for statistical comparison

Methods

TLD skin dose measurements in anthropometric phantom using the same plans

3 TLD readings in 5 different positions in breast for each plan(15 each for both plans)

Results

Skin dose reduction was achieved with HT plan 1 by using skin dose restrictions

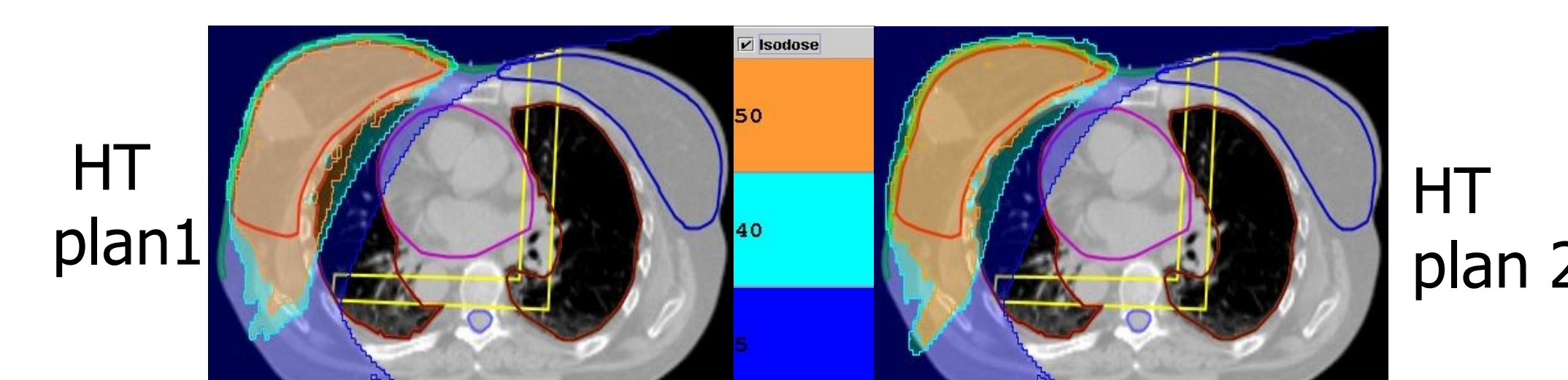
| | HT plan 1 mean ± SD | HT plan 2 mean ± SD | p-value |
|------------------------|------------------------|------------------------|---------|
| Skin V _{40Gy} | 70.8 ± 6.4% | 88.2 ± 3.2% | < 0.001 |
| V _{45Gy} | 47.3 ± 7.1% | 83.3 ± 3.9% | < 0.001 |
| V _{50Gy} | 12.2 ± 5.8% | 57.8 ± 7.3% | < 0.001 |
| mean dose | 42.3 ± 1.4 Gy | 47.7 ± 1.2 Gy | < 0.001 |

PTV and other OARs were not compromised by adding skin dose constraints

| | HT plan1 mean ± SD | HT plan 2 mean ± SD | P value | |
|---------------|-----------------------|------------------------|--------------|------|
| PTV | V _{90%} | 97.9 ± 0.8% | 98.4 ± 1% | 0.21 |
| | V _{95%} | 96.4 ± 1.3% | 97.2 ± 1.1% | 0.06 |
| | V _{107%} | 9.2 ± 4.2% | 3.9 ± 2.6% | 0.05 |
| | mean dose | 51.7 ± 0.6Gy | 51.3 ± 0.2Gy | 0.03 |
| | max dose | 54.2 ± 0.7Gy | 54.2 ± 0.5Gy | 0.91 |
| heart | V _{30Gy} | 5.4 ± 4% | 4.4 ± 4% | 0.42 |
| | mean dose | 5.3 ± 2.1Gy | 5 ± 1.9Gy | 0.62 |
| ipsi lung | V _{20Gy} | 28.4 ± 4.8% | 28.3 ± 5.8% | 0.96 |
| contra lung | mean dose | 0.7 ± 0.2Gy | 0.7 ± 0.2Gy | 1 |
| contra breast | mean dose | 0.8 ± 0.2Gy | 0.7 ± 0.4Gy | 0.8 |

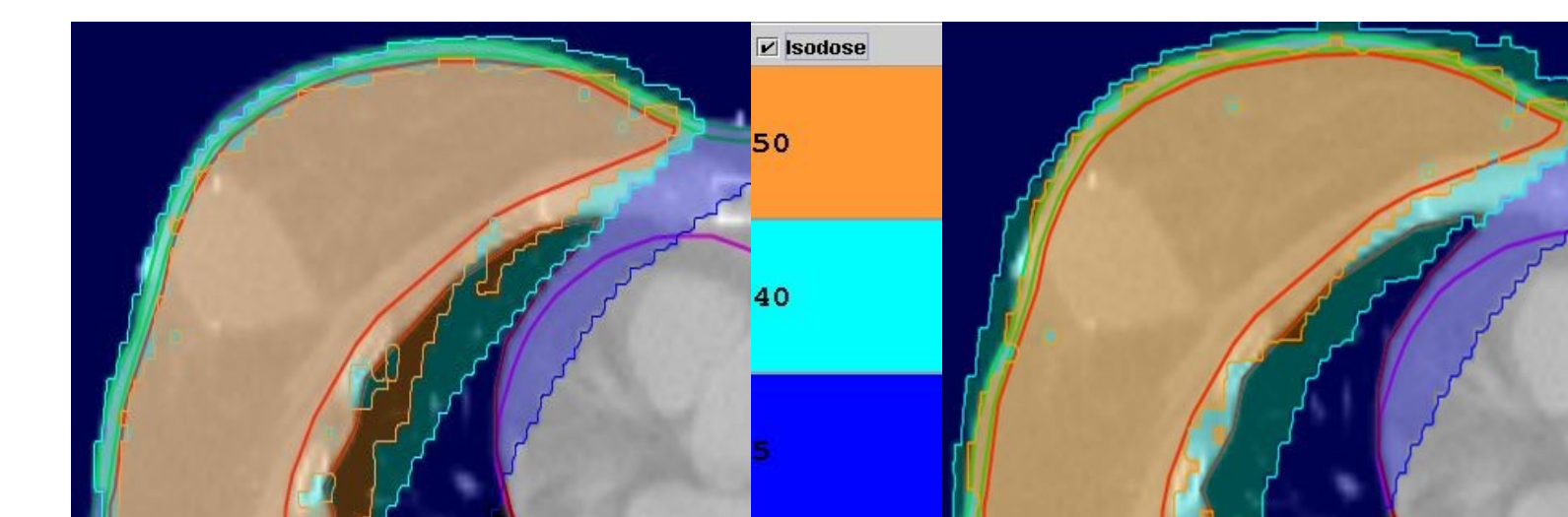
Only clinically significant difference was slightly increased V_{107%} in HT plan 1 but max dose was similar in both plans

Use of block restricted the gantry angles of HT to get optimal & similar sparing of OARs in both plans



Results

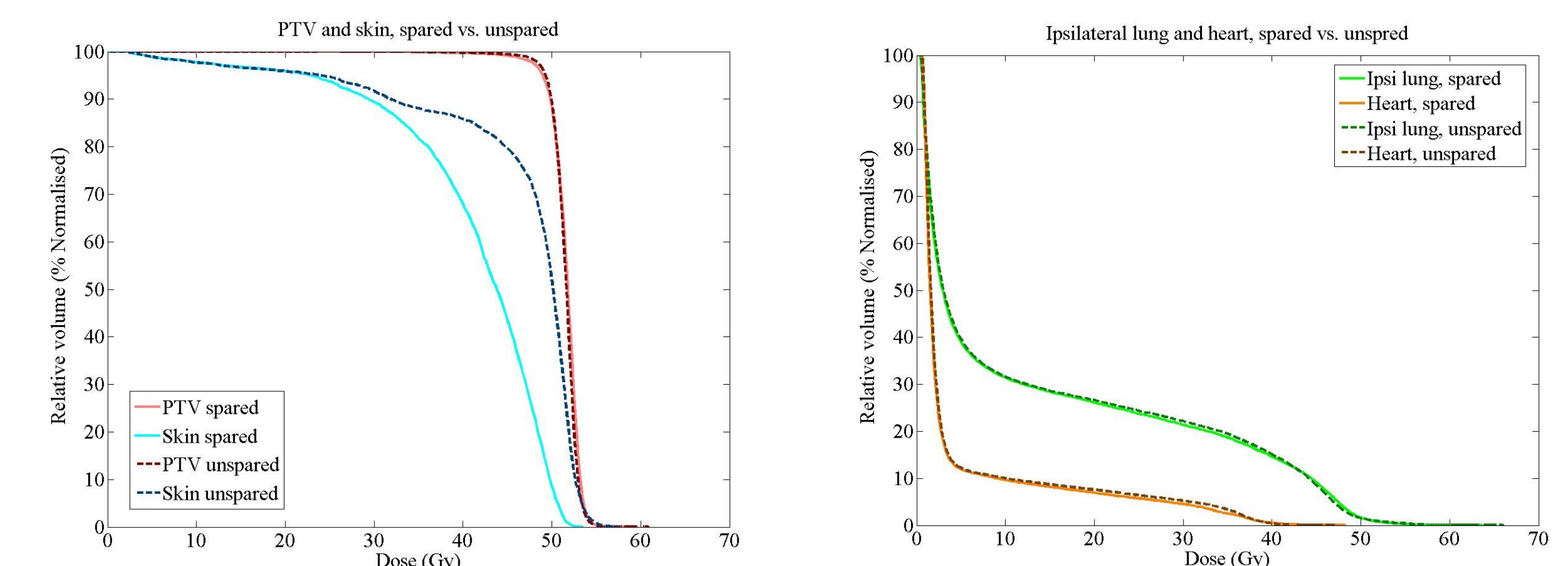
Skin-PTV inter phase



HT plan1

HT plan 2

DVH of a typical patient



TLD measurements in phantom (for given dose of 200 cGy) confirmed the skin dose difference between the plans

| TLD location | HT plan 1 mean ± CI (cGy) | HT plan 2 mean ± CI (cGy) | Difference mean ± CI (cGy) |
|-------------------|------------------------------|------------------------------|-------------------------------|
| central | 136.4 ± 1.3 | 206.5 ± 3.9 | 70.1 ± 1.7 |
| lateral | 147.5 ± 3.7 | 191.6 ± 22.8 | 44.1 ± 12.5 |
| inferior | 139.6 ± 14.2 | 199.1 ± 6.8 | 59.4 ± 9.7 |
| medial | 147.2 ± 8.4 | 194.9 ± 15.7 | 47.7 ± 11.1 |
| superior | 136.4 ± 11 | 195.2 ± 6.5 | 58.8 ± 7.9 |
| Overall mean ± CI | 141.4 ± 11.2 | 197.5 ± 11.4 | 56 ± 20.8 |

Clinical trial using helical tomotherapy to spare skin underway

Conclusions

By configuring skin as OAR, skin dose reduction was achieved using helical tomotherapy

TLD measurements confirmed the skin dose reduction achieved by the helical tomotherapy plan

Skin dose restrictions did not compromise PTV and other OARs