

CT-based versus clinically based delineation of boost volumes in breast conserving therapy



B. Hanbeukers^{1*}, J. Berger^{1,2}, P. van den Ende^{1,2}, J. Jager^{1,2}, L. Boersma^{1,2,3}

¹ Maastricht Clinic, Radiation Oncology, Maastricht, Netherlands,

² University Hospital Maastricht - Maastricht, Radiation Oncology, Maastricht, Netherlands

³ University Maastricht, GROW - Maastricht - Radiation Oncology, Maastricht, Netherlands

*correspondence: Bianca.Hanbeukers@maastro.nl



Introduction

Several studies have suggested that CT-based localization of the boost volume is more accurate than clinically defined localization. However, it has also been suggested that these CT-based boost volumes are considerably larger than the clinically defined boost volumes, thereby possibly compromising cosmesis.

Aim

- To determine the difference in irradiated boost volumes between treatment plans for CT-based PTVs (PTV-CT) and clinically defined PTVs (PTV-clin).
- To investigate whether variables could be identified that may be useful in reducing the PTV.

Patients and Methods

- For 3 differently defined PTVs a 3 beam photon treatment plan was designed.
- The volumes receiving at least 95% of the prescribed dose (V95) were calculated for all three plans. These volumes were analyzed by using a paired t-test.
- Linear regression was used to investigate:
 - which factors were related to the V95, and
 - which factors were related to the size of the excision cavity.

The 3 different PTV volumes

- PTV-clin** (*N* = 49 patients): The original tumour (GTV-clin) was reconstructed in the central plane using pathological tumour size, clinical information, and clips. The PTV-clin was defined as the GTV-clin expanded with 2 cm, but not extending beyond the thoracic wall and up to 0.5 cm beneath the skin.
- PTV-CT** (*N* = 49 patients): The excision cavity was delineated in 3D based on the CT; the CTV-CT was defined as the excision cavity expanded with 1.5 cm margin minus the minimally free resection margin (PA-report), but not extending beyond the glandular breast tissue. The PTV-CT was defined as the CTV-CT expanded with 0.5 cm margin, but excluding the first 5 mm beneath the skin.
- PTV-margin** (*N* = 35 patients): The excision cavity was delineated in 3D based on the CT; the CTV-margin was defined as the excision cavity expanded with 1.5 margin minus the free resection margin individually determined in 6 directions (PA-report), but not extending beyond the glandular breast tissue. The PTV-margin was defined as the CTV-margin expanded with 0.5 cm margin, but excluding the first 5 mm beneath the skin.

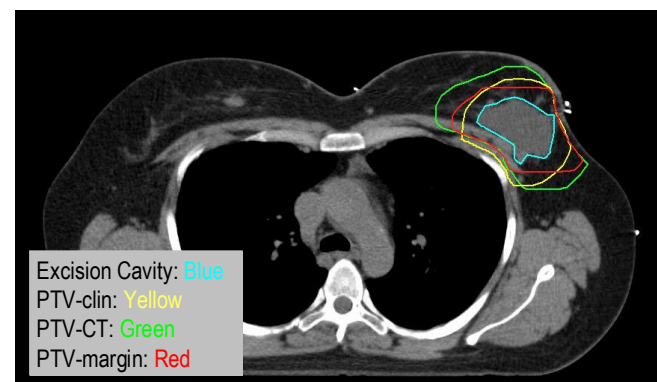


Figure 1. Illustration of the delineated structures.

Results

Comparison of the V95

- The V95 for the PTV-clin based plan was significantly smaller than for the PTV-CT based plan: 147 cc vs 237 cc for V95 ($p < 0.001$), respectively.
- Analyzing the 35 patients with customized PTV- margins, showed that taking into account the individualized margins in 6 directions only resulted in a statistically non-significant difference with the PTV-clin based V95: 178 cc vs 154 cc ($p = 0.224$), respectively.

Factors related to irradiated volume

- The tumour diameter was related to the V95 of the PTV-clin based plan and of the PTV-margin based plan.
- The volume of the excision cavity was related to the V95 of the PTV-CT based plan and of the PTV-margin based plan.

Factors related to the volume of the excision cavity

- The size of the excision cavity was significantly related to the number of days after the surgery, but not to the technique of the surgical procedure (excision cavity reported to be closed, yes or no).

Figure 2. Relation between days after surgery and volumes of the excision cavity.

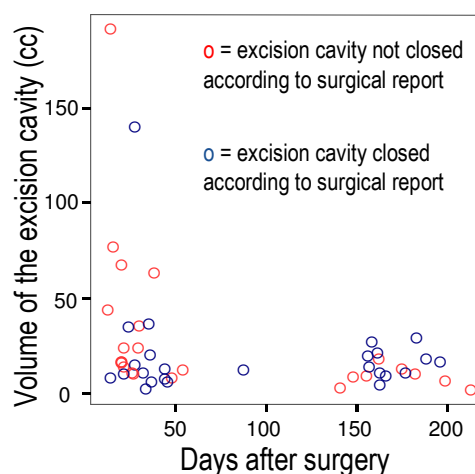


Table 2. Factors influencing the V95.

PTV-clin based plan	R ²	Beta	P-Value
Tumour diameter (cm)	0.665	0.816	< 0.001

PTV-CT based plan	R ²	Beta	P-Value
Excision cavity (cc)	0.479	0.663	< 0.001
Tumour diameter (cm)		0.117	0.290
Minimal free margin (cm)		-0.176	0.115

PTV-margin based plan	R ²	Beta	P-Value
Excision cavity (cc)	0.767	0.817	< 0.001
Tumour diameter (cm)		0.224	0.016
Minimal free margin (cm)		-0.052	0.560

Table 3. Factors influencing the volume of the excision cavity.

	R ²	Beta	P-Value
Days after surgery	0.163	-2.631	0.012
Excision cavity closed according to surgical report (yes/no)		-0.66	0.636
Tumour diameter (cm)		0.252	0.084

Table 1. Comparison of the different irradiated boost volumes.

	N	mean (\pm SD) (cc)
V95 PTV-clin based plan	49	147 (\pm 75)
V95 PTV-CT based plan	49	237 (\pm 149)
V95 PTV-clin based plan	35	154 (\pm 77)
V95 PTV-CT based plan	35	263 (\pm 165)
V95 PTV-margin based plan	35	178 (\pm 122)

Conclusion

- Delineation of the PTV using CT information led to 1.62 times larger irradiated boost volumes than the PTV based on clinical information and tumour diameter.
- Approximation of tissue at the tumour site by the surgeon did not result in smaller excision cavities as seen on the CT-scan. However, applying customized CTV-margins in 6 directions led to acceptable sizes of the irradiated boost volumes (only 1.16 times larger than the clinically determined boost volumes).
- Consequently, effort should be directed at obtaining reliable spatial information from the surgeon and pathologist on the free excision margins in all 6 directions.