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Variability of Medial and Lateral Borders Delineation in Guidelines for Post-Mastectomy Irradiation and its effect on Radiation Dose Received by Left Lung and Heart

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Abstract:

Background: Clinical Target Volume (CTV) delineation is an essential step in post-mastectomy irradiation. Due to the anatomical positioning of the affected breast, it is anticipated that the delineation of the lateral margin will impact on the standard tangential fields, consequently affecting the volumes of the ipsilateral lung and heart (on the left side) that are exposed to high doses of radiation. **Aim of work:** Assessment of impact of different guidelines for chest wall CTV delineation on the doses received by the contralateral breast and left lung, and a comparison with wire-based delineation (WBD) results. **Methodology**: Following surgery, Chest wall(CW) 3-Dimensional(3D) Conformal radiation was planned for 13 left breast cancer women with T3/4 &/or Nodal +ve. One radiation oncologist's CW delineation was followed by several ESTRO recommendations, along with a 3D WBD of CW beneath the diseased breast

based on anatomy.We compared between the 2 plans regarding coverage, homogeneity, radiation dose received by heart, lt lung and contralateral breast. **Results:** The 2 plans was equal regarding coverage and homogeneity. For heart dose(D50%) in plans based on wire delineation was (89.0 + 9.8 cGy) Vs (121.4 +/-24.5 cGy , p= 0.001) in ESTRO guidelines. The chest wall volume in the plan based on wire was smaller than the ESTRO plan. Regarding lt lung there was a significant difference in V20(15.2 +/- 2.1%) for ESRTO delineation Vs(12.4 +/- 1.8%) for wire based delineation **.Conclusion**: Using a wire in post modified radical mastectomy irradiation had an effect on radiation dose received by heart, lung and contralateral breast .

1. Introduction:

Chest wall delineation is a fundamental stage in 3 Dimensional Conformal (3DCRT)[1]. Modified Radical Mastectomy is still a commonly used breast cancer surgery specially in developing countries, including Egypt [2,3,4] . CTV is defined as the demonstrable tumor plus the microscopic disease or only microscopic-submicroscopic disease if tumor was removed (ICRU report 52 & 60)[5,6]. However, there is a noticeable difference between the various guidelines for defining the chest wall CTV, particularly for the lateral edge. which is defined as mid-axillary line or anterior end of latissimus dorsi muscle by Radiation Therapy Oncology Group (RTOG)[7], while the European Society of Therapeutic Radiology and Oncology (ESTRO) defined it as same level of lateral end of contralateral breast [8]. However, Some researcher have used wire markers for the anatomical identification of the affected breast[9]. It is expected that the delineation of the lateral margin will impact the standard tangential fields, thereby affecting the volumes of the ipsilateral lung, heart (on the left side), and contralateral breast that are irradiated to high doses.. It is known that these volumes are significant predictors of subsequent late toxicities

[10]. A decrease of these volumes can improve toxicity, quality of life & even survival through decreasing of cardiac mortality [11].

2. Aim of work:

To compare the results of wire-based delineation with the impact of utilizing different criteria for chest wall delineation on the doses received by the heart and left lung (in post-left modified radical mastectomy radiotherapy)..

Methodology:

This study was conducted at Fayoum oncology center .It involved thirteen patient who underwent lt MRM

Inclusion craiteria

1. Age: more than 18
2. sex: females
3. Pathology: T3 &T4 & Lymph node +ve
4. surgery: left MRM

Exclusion criteria:

1. Comorbidity: known cardiac patient
2. Previously irradiated chest wall
3. Pregnant female
4. Metastatic disease.

Thirteen patients with left mastectomy indicated for post-operative irradiation to chest wall (T3, T4 or N+) were CT scan in the treatment position. from 4th cervical vertebra (C4) to below costo-phrenic angles. Wire was placed on patient chest wall anatomically followed presumed breast insertion from upper border of 2nd rib above to medial border of sternum medially till 4th rib where the wire was shifted laterally till lower border of the 6th rib in a mirror image fashion to the contralateral breast. Wire reached lower border of 6th rib below and followed the anterior axillary line laterally from 6th rib below to lower border of 3rd rib above then it was shifted laterally to mid-axillary line till the level of upper border to cover the presumed breast tail (the exact anatomical lateral extension). CT scan was sent to Treatment Planning System (TPS) ECLIPS v.11..... Delineation by one radiation oncologist followed by ESTRO (Offersen BV et al 2015) in addition to delineation of chest wall underlying the wire from skin to rib-pleural interface (figure-1). All CTVs were delineated in the same day. Accordingly, 2 CTVs for chest wall were presented to the same medical radiation physicist. Two tangential plans were accomplished (plan for each CTV) aiming at 50Gy in 25 fractions homogenously to CTV with maximum sparing of OAR mainly heart & left lung.

Ethical considerations :

The thesis received agreement from the local ethical research committee at Bani suef faculty of medicine

Approval No :FMBSUREC/02102022/Badwy

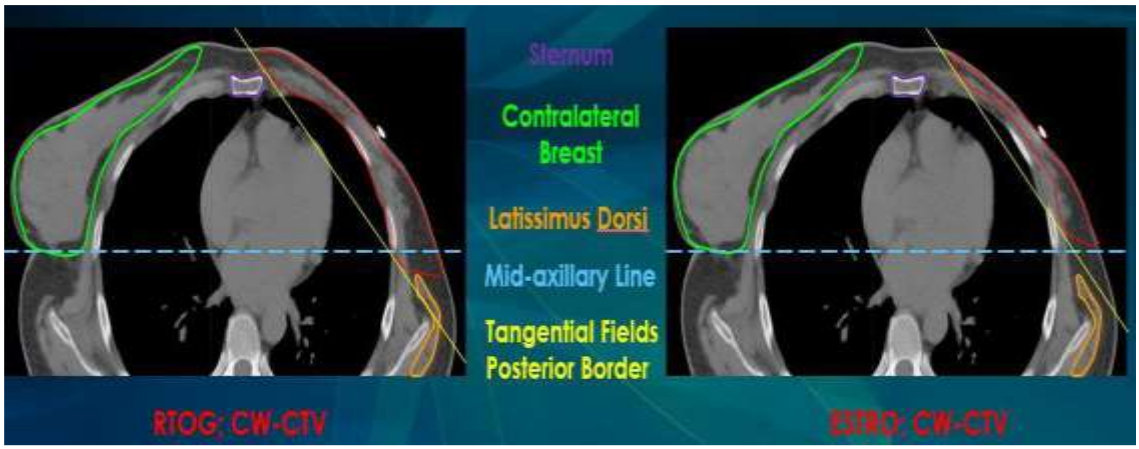
Statistical Analysis

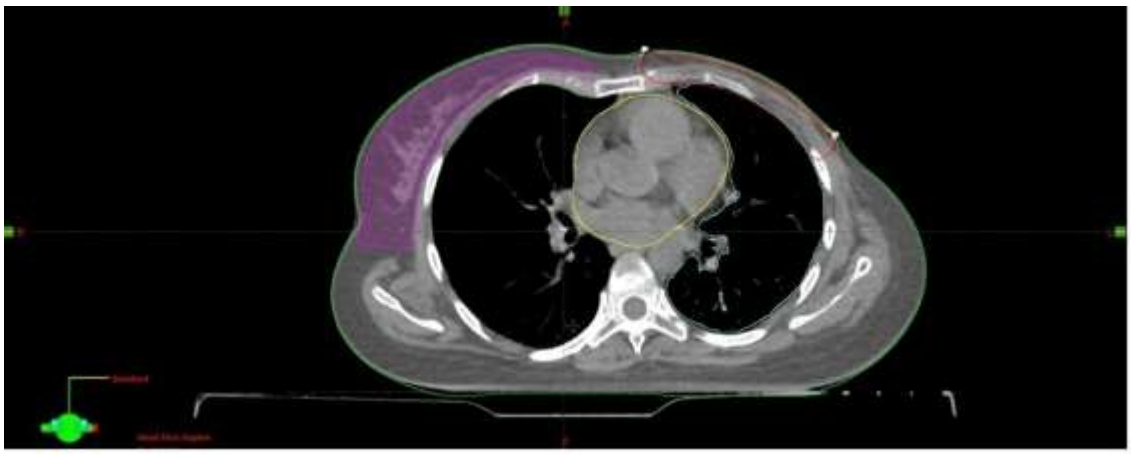
Sample size calculation: The sample size was determining using Open Epi, Version 3, open-source calculator—SS Proportion. Based on an assumption detected using the finding by (Al sheriff etal., 2021)the minimal number should be included is 13 patients ; for a confidence level 95% and power 80%

Statistical methods:

The data were analyzed All tests were two-tailed a p- p-value < 0.05 was conside using the Statistical Package of Social Science (SPSS) (version 26). Data were presented as mean ± SD. The comparison between groups was done using the Friedman test followed by the post hoc test for pairwise comparison between groups

Figure-1: Delineation of chest wall CTV according to ESTRO & wire based





3. Results:

Table 1: The difference in chest wall volumes between ESTRO guidelines, and wire-based delineation

	Techniques		**p-value**
	ESTERO	Wire based	Wire/ESTRO
Chest wall (cc)	492.9±131.3	440.9±128.2	.019

shows chest wall volumes according to different techniques. There was a statistically significant difference in the mean chest wall .

Chest Wall volumes between the two techniques (overall p-value <.019)

Table 2:Heart dose for ESTRO guidelines, and wire-based delineation

	Techniques		**p-value**
	ESTERO	Wire based	Wire/ESTRO
Heart V50 Gy (%)	.14±.1	.09±.1	0.53
Heart V40Gy (%)	3.4±.8	2.9±.8	.001
Heart V25Gy (%)	5.6±.9	4.4±1.0	<.001
Heart D50% (cGy)	121.4±24.5	89.0±19.8	.010

Table 2: shows the heart dose for ESTRO guidelines, and wire-based delineation. The wire-based was lower than ESTERO with borderline significance (p-value=.052).

Regarding heart V40 Gy (%): There was a statistically significant difference between the two techniques (overall p-value <.001).

Regarding heart V25 Gy (%): There was a statistically significant difference between the two techniques (overall p-value <.001).

Regarding heart D50% (cGy): There was a statistically significant difference between the two techniques (overall p-value <.001).

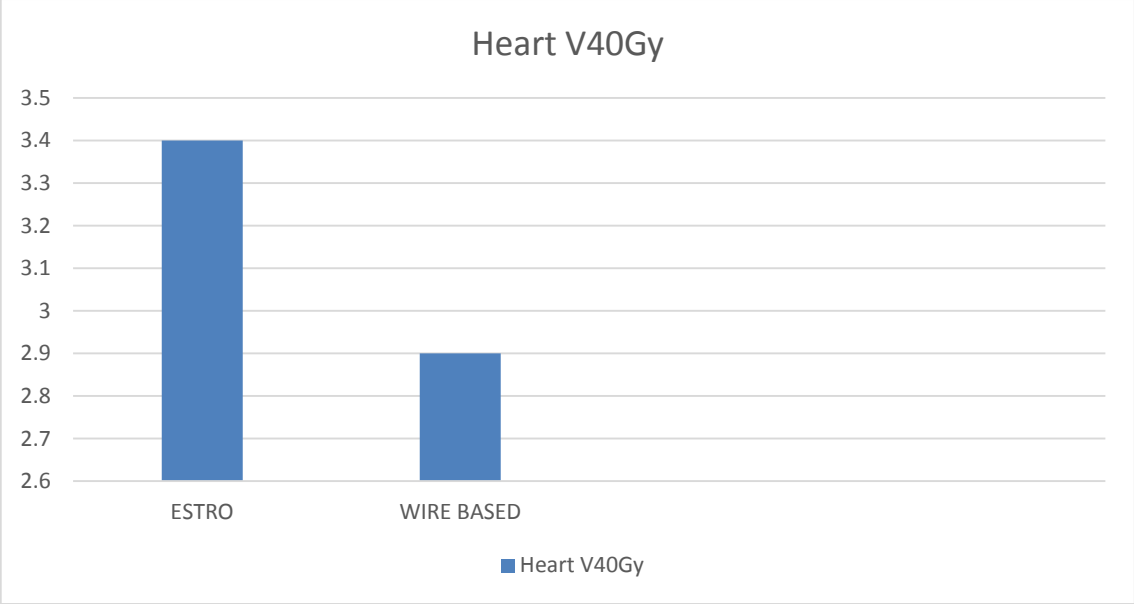


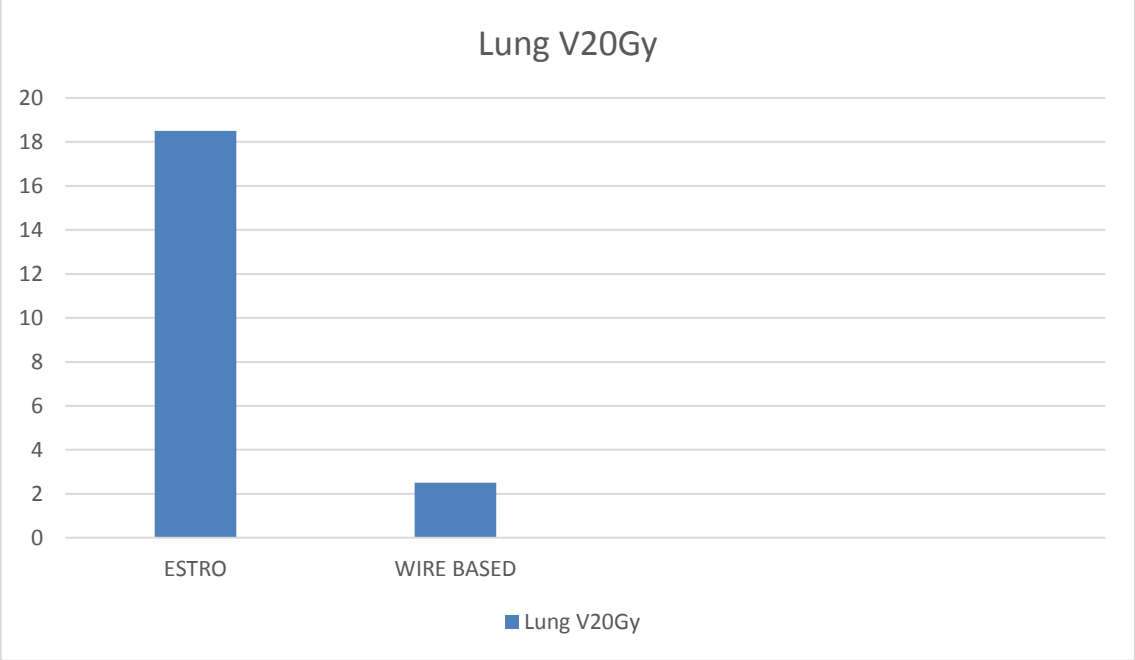
Table 3: Lung dose for ESTRO guidelines, and wire-based delineation

	Techniques		**p-value**
	ESTERO	Wire based	Wire/ESTRO
Lung V20 Gy(%)	18.5±1.3	15.2±2.1	<.001
Lung V30 Gy (%)	15.9±1.5	12.4±1.8	<.001

Table 3 shows the lung dose for ESTRO guidelines, and wire-based delineation.

Regarding Lung V20 Gy (%): There was a statistically significant difference between the two techniques (overall p-value <.001), after doing a pairwise comparison the wire-based is lower than ESTRO (adjusted p-value <.001).

Regarding lung V30 Gy (%): There was a statistically significant difference between the two techniques (overall p-value <.001), after doing a pairwise comparison the wire-based is lower than ESTRO (adjusted p-value <.001).



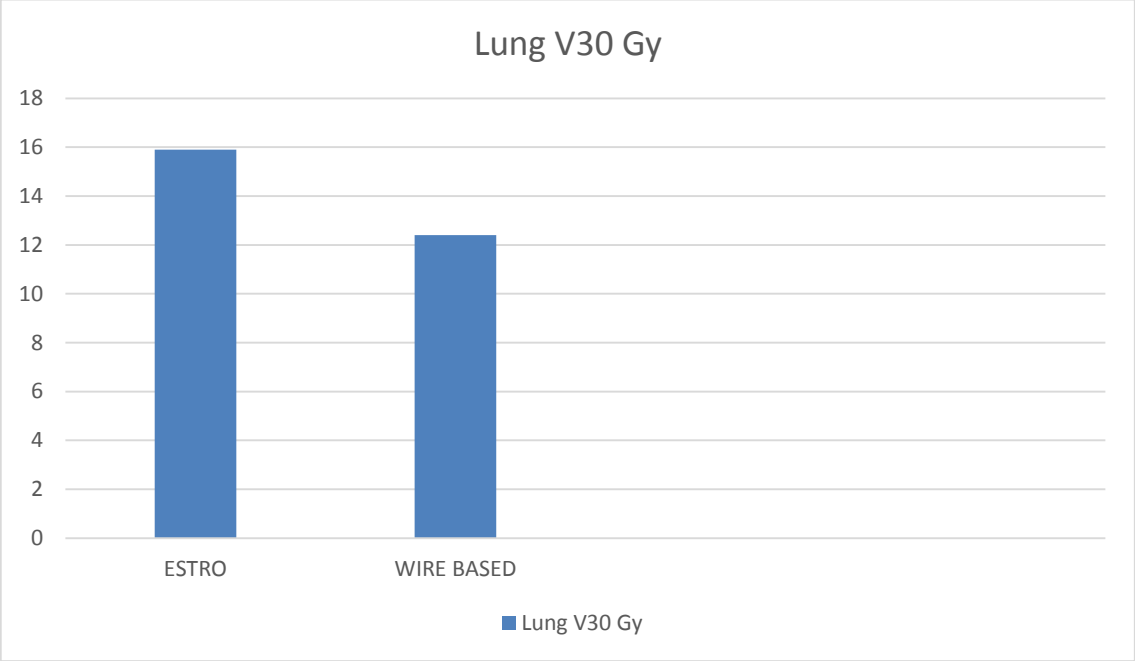
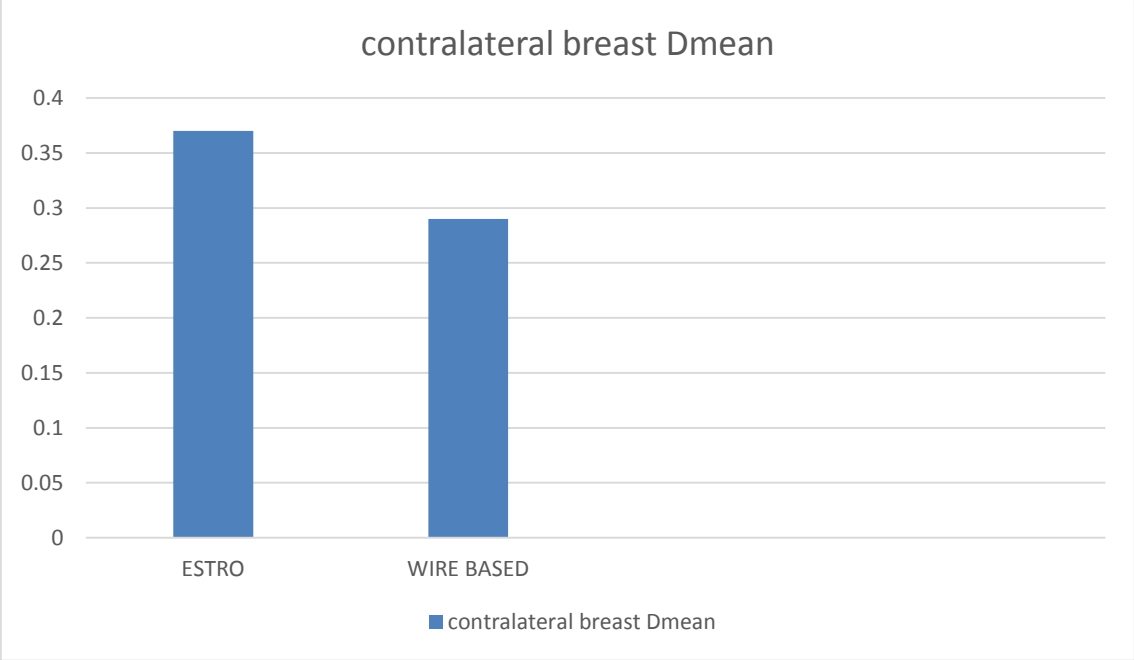


Table 4: contralateral breast dose for ESTRO, RTOG guidelines, and wire-based delineation

There was a statistically significant difference between the two techniques (overall p-value <.001) in dose reaching Contralateral breast V3, after doing a pairwise comparison the wire-based is lower than ESTRO (adjusted p-value. ,041).



4. Discussion:

In the current thesis, the mean chest wall volume for wire-based is lower than ESTRO (adjusted p-value <.019).

In the same line was the results of ***120***who aimed to evaluate the effect of using various guidelines (WBD, ESTRO) Compare the results of CTV delineation of the chest wall with those of wire-based delineation in terms of the doses received by the heart and left lung. Thirteen patients were scheduled for post-mastectomy for T3/4 and/or Nodal +ve left breast malignancy. CW-3DCRT. Chest wall volume was significantly lower in wire-based than ESTRO.

In another study ***Fontanilla et al.,*** [12]Treatment plans for 20 consecutive women who received postmastectomy radiotherapy (RT) targeting the chest wall (CW) were analyzed. New treatment plans were generated with the objective of covering 95% of the anatomical contours to a dose of 45 Gy

According to our findings we didn't find a statistically significant differences in HI between the two techniques (p-value= .343).

Regarding CI no statistically significant difference in **CI** between the three techniques (p-value= .617).

In line was a previous study ***Alsherif& Mousa,*** [13] noted that there was no statistically significant difference between the WBD and ESTRO regarding coverage and homogeneity parameters.

In the current study, there were a statistically significant differences

between the two studied techniques regarding heart V40 Gy, heart V25 Gy and heart D50% (cGy) after doing a pairwise comparison the wire-based was lower than ESTRO. This may be related to decreasing of medial border.

Darby et al., [14] Research indicates that radiation to the heart can lead to some cardiac disease eg; pericarditis, pericardial fibrosis, diffuse myocardial fibrosis and coronary artery disease. Evidence has shown that radiation-related heart disease can occur with maximum doses exceeding 20 Gy.

In a similar previous study ***Alsherif& Mousa,*** [13] noted that, for cardiac dosage, plans based on WB delineation had a statistically significant lesser D50% received by the heart (101.6 ± 41.2 Gy) than plans based on ESTRO guidelines based on CTV (141 +/- 81cGy, p=0.00001).

The present results observed that, there was a statistically significant difference between the two techniques regarding Lung V20 Gy and lung V30 Gy, after doing a pairwise comparison the wire-based was lower than ESTRO; p-values were <0.001. The decrease in Lung V20 Gy may be due to decreasing lateral border.

According to ***Lee et al.,*** [15] The lungs, located beneath the breasts, are among the most critical organs in radiation therapy for breast cancer treatment planning. As the essential organ for respiration, it is important to minimize lung damage during breast cancer treatment with radiotherapy.

Alsherif and Mousa's results, [13] which showed that wire-based delineation produced a highly statistically significant (lower) V20Gy & V30Gy when compared to ESTRO approaches, These results were consistent with our findings. In a previous study, ***Fontanilla et al.***,[12] reported that the mean lung V20 for the left lung in patients treated for left-sided breast tumors was 32%.

Our findings showed that, there was a statistically significant difference between the two techniques (overall p-value <0.001) in dose reaching Contralateral breast V3, after doing a pairwise comparison the wire-based is lower than ESTRO (adjusted p-value 0.041).

Taylor et al.,[17] demonstrated that the absolute risk of contralateral breast malignant disease from modern radiotherapy is expected to be well below 1%, with the risk of death from this late radiation effect being even smaller .

Given that younger patients had a statistically significant chance of developing contralateral breast cancer,

the study by ***Ayata et al.*** [16] showed that the larger dose to the contralateral breast is particularly crucial for them.

5. Conclusion:

We deduced from our results that anatomical-based wire demarcation of post-left mastectomy irradiation chest wall delineation considerably decreased the harmful dosage that the heart and lungs received. larger study with clinical monitoring to ensure that it is not less effective than treatment based on ESRTO guidelines for local recurrence. Also, these findings require confirmation by more-powered study with larger sample size.

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