Documentaţie pentru fizicieni medicali

Radioterapia cancerului de sân

Cancerul de sân îşi are originea în ţesutul mamar, în principal în canalele de lapte şi glandele mamare. Neoplasmul mamar apare atunci când celulele mamare se modifică şi cresc necontrolat, creând o masă de ţesut denumită tumoare. O tumoare începe de obicei ca un nodul sau un depozit de calciu care se dezvoltă ca urmare a creşterii anormale a celulelor. Majoritatea nodulilor la sân sunt benigni, dar unii pot fi premaligni (pot deveni cancer) sau maligni. Cancerul la sân este unul dintre cele mai frecvente tipuri de cancer în rândul femeilor, afectând cu preponderenţă femeile de peste 50 de ani. Radioterapiaeste una dintre metodele de tratament in acest tip de cancer.

Radioterapia se aplică local şi implică distrugerea tumorii maligne şi a celulelor tumorale ajunse în ganglionii limfatici axilari, cu ajutorul unui tip special de radiaţii. Trebuie spus însă că radioterapia are şi efecte secundare care diferă de la persoană la persoană, de tratamentul urmat şi de starea generală de sănătate a pacientei. Tehnicile de radioterapiei înalt conformaţionale permit reducerea considerabilă ca frecvenţă şi intensitate a reacţiilor adverse la radioterapie precum obşinerea de rezultate din ce în ce mai bune în vindecare.

În acest document raportăm o serie de articole ştiinţifice noi, publicate în literatura de specialitate, referitoare la folosirea tehnicilor noi de radioterapie în tratarea cancerului de sân. Aceste articole vor fi puse la dispoziţia studenţilor pe canalele de comunicare on-line (platform Teams, site-ul proiectului).

Documentul este organizat în felul următor:

1. datele de identificare a articolelor (autori, titlu, anul apariţiei, volum, pagina de început şi sfârşit/numărul articolului, adresa DOI.
2. abstractul articolului
3. concluziile articolului

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Lista articolelor propuse

Articol 1

1. Jose A. Baeza, Catharina M.L. Zegers, Nienke A. de Groot, Sebastiaan M.J.J.G. Nijsten, Lars H.P. Murrer, Karolien Verhoeven, Liesbeth Boersma, Frank Verhaegen, Wouter van Elmpt

Automatic dose verification system for breast radiotherapy: Method validation, contour propagation and DVH parameters evaluation

Physica Medica 97 (2022) 44–49, https://doi.org/10.1016/j.ejmp.2022.03.017

Abstract

Purpose: Image guided radiotherapy (IGRT) strategies allow detecting and monitoring anatomical changes during external beam radiotherapy (EBRT). However, assessing the dosimetric impact of anatomical changes is not straightforward. In current IGRT strategies dose volume histograms (DVH) are not available due to lack of contours and dose recalculations on the cone-beam CT (CBCT) scan. This study investigates the feasibility of using automatically calculated DVH parameters in CBCTs using an independent dose calculation engine and propagated contours. *Method:* A prospective study (NCT03385031) of thirty-one breast cancer patients who received additional CBCT imaging (N = 70) was performed. Manual and automatically propagated contours were generated for all CBCTs and an automatic dose recalculation was performed. Differences between planned and CBCT-derived DVH parameters (mean and maximum dose to targets, 95% volume coverage to targets and mean heart dose (MHD)) were calculated using the dose verification system with manual and propagated contours and, in both cases, benchmarked against DVH differences quantified in the TPS using anually contoured CBCTs. *Results:* Differences in DVH parameters between the TPS and dose verification system with propagated contours were - 1.3% to 0.7% (95% CI) for mean dose to the target volume, - 0.3 to 0.2 Gy (95% CI) in MHD and - 3.9% to 2.9% (95% CI) in target volume coverage.

Concluzii

Conclusion: The use of an independent fully automatic dose verification system with contour propagation showed to be feasible and sufficiently reliable to recalculate CBCT based DVHs during breast EBRT. Volume coverage parameters, i.e. V95%, proved to be especially sensitive to contouring differences.*Keywords:* Breast cancer Dose guided radiotherapy Automatic dose verification Contour propagation

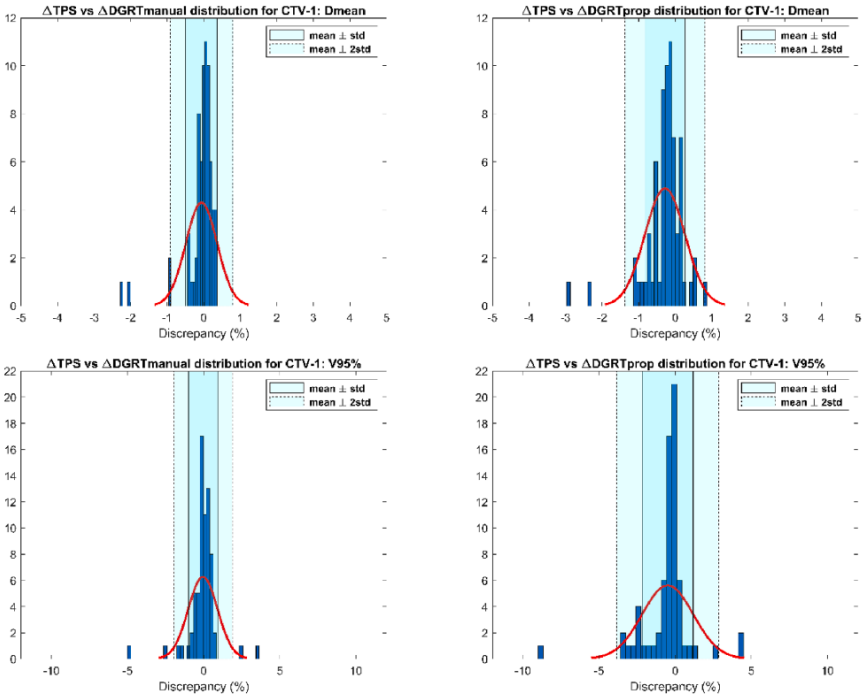

Fig. 4. Distribution of differences between dose calculation methods for the mean dose to the CTV-1 (top) and the CTV-1 vol covered by 95% of its prescription dose (bottom). On the left, distribution of differences for manual contours. On the right, distribution of differences for automatically propagated contours. Notice the difference in X-axes between mean dose (top) and V95% (bottom).

Concluzii

Limitations of this study are that 1) none of the patients included in the prospective study were adapted due to anatomical variations, which may be due to the relative low incidence of adaptions in breast cancer (3% in 2016 at our clinic) compared to our sample size of 31 patients. A wider cohort including patients with more obvious anatomical differences would increase the reliability of these results as the contour propagation system would have been exposed to more significant anatomical changes and the differences between dose distributions could have arisen higher deviations. 2) The

intrinsic differences between CT and CBCT images and their impact in the dose calculation. These differences, which are outside the scope of this work, can vary notably between vendors, but had limited impact in our previous work comparing CBCT versus re-CT imaging in breast cancer patients. 3) The craniocaudally stitching of the CBCT in the CT may influence the dose calculation, affecting especially OAR that may not be contained to the CBCT FOV. To conclude, a fully automatic dose verification system based on differences in DVH parameters has been presented. The verification system, which does not require extra clinical workload, aims to assist clinical specialists in decision-making for breast cancer treatment adaptation. Careful manual review of dose distributions and propagated contours on CBCT scans is recommended when significant DVH changes are reported.

Articol 2

2. Puntiwa Oonsiri, Chonnipa Nantavithya, Chawalit Lertbutsayanukul, Thanaporn Sarsitthithum, Mananchaya Vimolnoch, Tanawat Tawonwong, Kitwadee Saksornchai

Dosimetric evaluation of photons versus protons in postmastectomy planning for ultrahypofractionated breast radiotherapy

Radiation Oncology (2022) 17:20, https://doi.org/10.1186/s13014-022-01992-w

Abstract

Background: Ultrahypofractionation can shorten the irradiation period. This study is the first dosimetric investigation comparing ultrahypofractionation using volumetric arc radiation therapy (VMAT) and intensity-modulated proton radiation therapy (IMPT) techniques in postmastectomy treatment planning. Materials and methods: Twenty postmastectomy patients (10-left and 10-right sided) were replanned with both VMAT and IMPT techniques. There were four scenarios: left chest wall, left chest wall including regional nodes, right chest wall, and right chest wall including regional nodes. The prescribed dose was 26 Gy(RBE) in 5 fractions. For VMAT, a 1-cm bolus was added for 2 in 5 fractions. For IMPT, robust optimization was performed on the CTV structure with a

3-mm setup uncertainty and a 3.5% range uncertainty. This study aimed to compare the dosimetric parameters of the PTV, ipsilateral lung, contralateral lung, heart, skin, esophageal, and thyroid doses.

Results: The PTV-D95 was kept above 24.7 Gy(RBE) in both VMAT and IMPT plans. The ipsilateral lung mean dose of the IMPT plans was comparable to that of the VMAT plans. In three of four scenarios, the V5 of the ipsilateral lung in IMPT plans was lower than in VMAT plans. The Dmean and V5 of heart dose were reduced by a factor of 4 in the IMPT plans of the left side. For the right side, the Dmean of the heart was less than 1 Gy(RBE) for IMPT, while the VMAT delivered approximately 3 Gy(RBE). The IMPT plans showed a significantly higher skin dose owing to the lack of a skinsparing effect in the proton beam. The IMPT plans provided lower esophageal and thyroid mean dose.

Conclusion: Despite the higher skin dose with the proton plan, IMPT significantly reduced the dose to adjacent organs at risk, which might translate into the reduction of late toxicities when compared with the photon plan.

Keywords: Proton therapy, Ultrahypofractionation, Postmastectomy, Breast irradiation

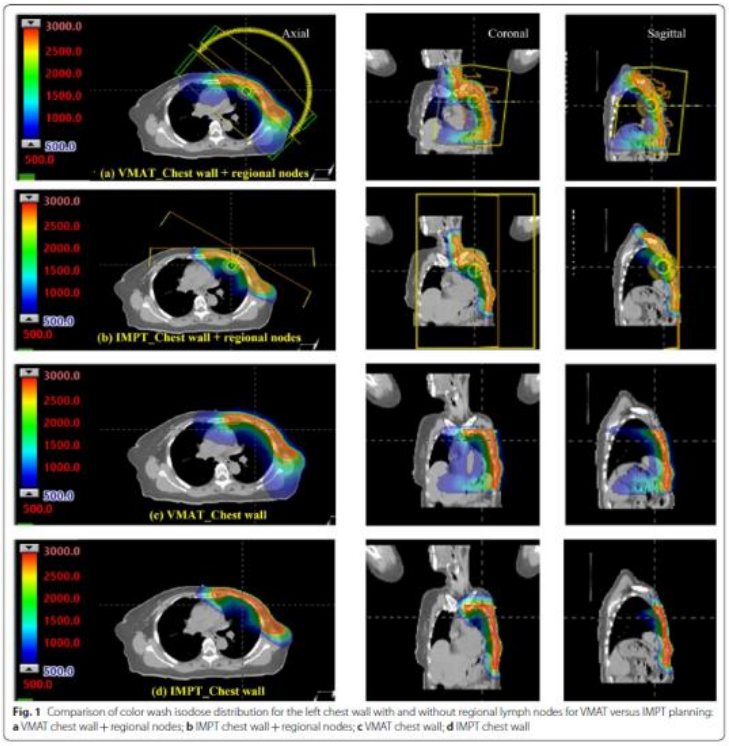

Fig. 1 Comparison of color wash isodose distribution for the left chest wall with and without regional lymph nodes for VMAT versus IMPT planning: **a** VMAT chest wall + regional nodes; **b** IMPT chest wall + regional nodes; **c** VMAT chest wall; **d** IMPT chest wall

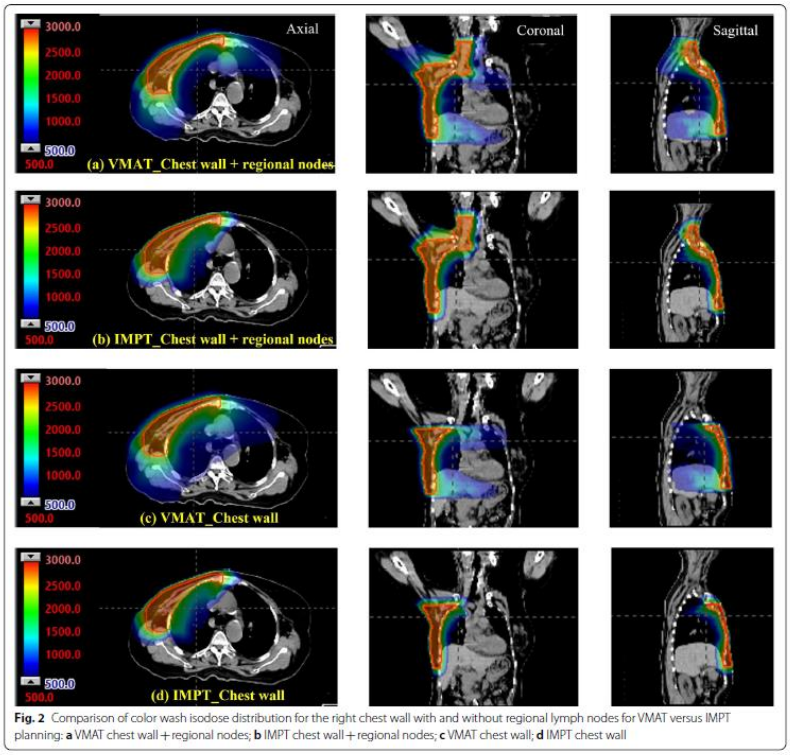

Fig. 2 Comparison of color wash isodose distribution for the right chest wall with and without regional lymph nodes for VMAT versus IMPT planning: **a** VMAT chest wall + regional nodes; **b** IMPT chest wall + regional nodes; **c** VMAT chest wall; **d** IMPT chest wall

Concluzii

Conclusion

IMPT showed better normal tissue sparing while maintaining PTV coverage than VMAT in postmastectomy irradiation using ultrahypofractionation. Despite higher the dose to the skin in the IMPT group, the actual difference was negligible. IMPT could significantly reduce the dose to adjacent organs at risk, which could translate into reduced late toxicities compared with those of the photon plan. Further clinical studies are needed to prove the feasibility of this dose fractionation regimen using proton beam therapy. Our proposed dosing scheme would not strongly affect the acute toxicities and would be more convenient to use in COVID-19 pandemic situations.

Articol 3

3. Pier Giorgio Esposito, Roberta Castriconi, Paola Mangili, Sara Broggi , Andrei Fodor, Marcella Pasetti, Alessia Tudda, Nadia Gisella Di Muzio, Antonella del

Vecchio, Claudio Fiorino

Knowledge-based automatic plan optimization for left-sided whole breast tomotherapy
Physics and Imaging in Radiation Oncology 23 (2022) 54–59,
https://doi.org/10.1016/j.phro.2022.06.009

Abstract

Background/Purpose: Tomotherapy may deliver high-quality whole breast irradiation at static angles. The aim of this study was to implement Knowledge-Based (KB) automatic planning for left-sided whole breast using this modality. *Materials/Methods:* Virtual volumetric plans were associated to the dose distributions of 69 Tomotherapy (TT) clinical plans of previously treated patients, aiming to train a KB-model using a commercial tool completely implemented in our treatment planning system. An individually optimized template based on the resulting KB-model was generated for automatic plan optimization. Thirty patients of the training set and ten new patients were considered for internal/external validation. Fully-automatic plans (KB-TT) were generated and compared using the same geometry/number of fields of the corresponding clinical plans. *Results:* KB-TT plans were successfully generated in 26/30 and 10/10 patients of the internal/external validation sets; for 4 patients whose original plans used only two fields, the manual insertion of one/two fields before running the automatic template was sufficient to obtain acceptable plans. Concerning internal validation, planning target volume V95%/D1%/dose distribution standard deviation improved by 0.9%/0.4Gy/0.2Gy ($p < 0.05$) against clinical plans; Organs at risk mean doses were also slightly improved ($p < 0.05$) by 0.07/0.4/0.2/ 0.01 Gy for left lung/heart/right breast/right lung respectively. Similarly satisfactory results were replicated in the external validation set. The resulting treatment duration was 8 ± 1 min, consistent with our clinical experience. The active planner time per patient was 5–10 minutes.

Conclusion: Automatic TT left-sided breast KB-plans are comparable to or slightly better than clinical plans and can be obtained with limited planner time. The approach is currently under clinical implementation.

Keywords: Radiotherapy planning optimization Tomotherapy Breast cancer Knowledge-based models AI in Radiation Oncology

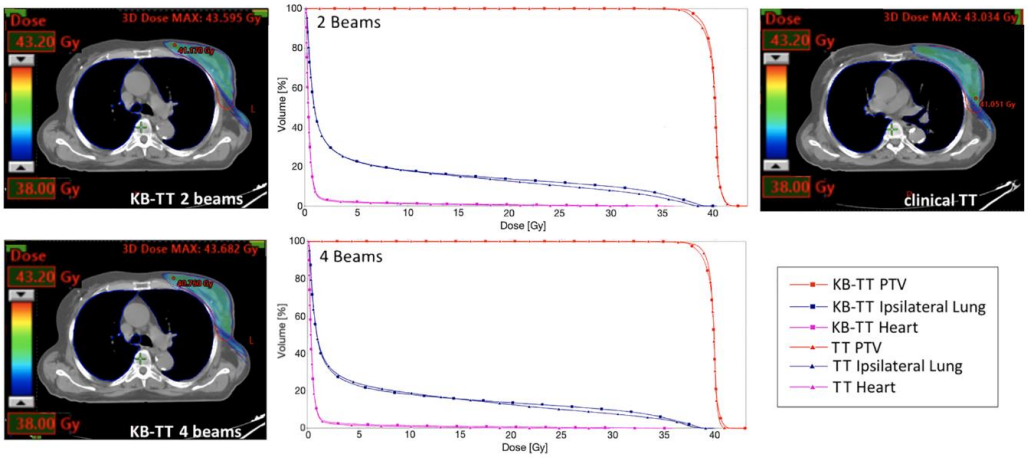

Fig. 2. Example of an unacceptable plan using two beams and modification in dose distribution adding two segments to a total of four. The color wash in the transversal CT image show the 95% of the prescription dose (38 Gy) for the two beam cases (four beam, and clinical). DVHs show the automatic plans (KB-TT) against the clinical ones (TT).

Concluzii

It is important to notice that user personalization is limited due to the use of a protocol with fixed field width, pitch and modulation factors. Only four plans out of thirty were found to be unacceptable; in fact they were associated with the use of only two fields. Adding other two segments to a total of four (modifying the entrance angle by 5◦ from the clinical ones) and re-starting the automatic optimization, it was possible to obtain acceptable plans, with better PTV coverage compared to the original clinical ones.

The use of four beams allowed the generation of the totality of acceptable plans; it is therefore suggested always to select four segments, instead of just two, in order to increase coverage and modulation. The dimension of the internal validation cohort was sufficiently high to highlight the significant differences; unfortunately, due to the small number of patients included in the set, only 10 patients were available for the external validation cohort at the time of the present study. Due to the small number of patients, the significance of the reported differences, with respect to the internal validation case, was lost; however, the results showed a pattern very similar to that found in the internal set. When possible, by increasing the number of patients in the external validation set, it

is expected that a higher level of significance will be reached with the same results. The delivery time of KB-TT plans is 8 ± 1 min, due mainly to the historical patients) are delivered in 6 ± 1 min, it was deemed necessary to use the 2.5 cm field width in order to obtain an optimal plan for the remaining 35% of patients, with the smaller field width leading to a higher modulation factor and lower pitch. In fact, smaller field width is associated with a higher conformity of the PTV dose distribution. It is expected that the use of our KB approach will reduce planning time, and importantly improve plan homogeneity between planners, avoiding sub-optimal plans. The entire process requires 25–30 min for the generation of a plan. Active planner time is from 5 to 10 min for plan template selection, ROI generation and script launching. The automatic optimization process requires approximately 20 min, but as it is a passive activity, the planner is free to work on other tasks. Preparation and optimization of a manually optimized plan would require at least 1 h. The generation of a manual WBI plans would, on the other hand, generally require significantly more time, depending on the peculiarity of the anatomy or on special requests by the clinician. The KB approach makes it possible to obtain a high quality plan from the first cycle of optimization, but if necessary, the KB-TT plan may be used as a starting point for any further refinements. Currently, the choice of the treating beam angles is still manual and user dependent. It was decided to use the same criteria of the clinical plans for angle selection in the validation sets. This approach demonstrated that even without modifying the angles, it is possible to obtain the same or slightly better plan quality while reducing the time required to obtain it. The angle selection results in residual inter-planner variability. In principle, this process is, in principle automatable: this objective could be achieved by means of various approaches proposed in the literature. the number of manual refinements would be then further reduced for this reason this could be the focus of further improvements on our approach. The static angles modality is often preferred to helical modality or, in general, to rotational techniques as it allows the reduction of the low dose bath and it is expected to be one of the most widely used techniques in centers where TT is available, due to its high performance, reported to be generally comparable or superior to the best WBI modalities. The approach presented here demonstrates the possibility of replacing the manual optimization of TT

planning for WBI, with KB automatic planning increasing efficiency and plan homogeneity. This approach is versatile, and the use of a commercial system is expected to facilitate a large-scale implementation.

Articol 4

4. Andrew Johnson, Nicolas Depauw, Stephen Zieminski, Rachel Jimenez

Proton radiotherapy for patients with oligometastatic breast cancer involving the sternum

International Journal of Particle Therapy, doi: 10.14338/IJPT-21-00014

Abstract

Introduction: A subset of metastatic breast cancer patients present with oligometastatic disease involving the sternum. Given the proximity to traditional target structures, a proton radiation field can be expanded to include this region, providing definitive therapy for patients who are otherwise metastatic. We evaluated the feasibility and outcomes of a small series of patients who received comprehensive nodal irradiation inclusive of an isolated sternal metastasis using proton pencil beam scanning.

Materials and Methods: Four patients with a diagnosis of metastatic breast cancer with an isolated metastasis to the sternum received multimodality therapy with curative intent and then underwent adjuvant pencil beam scanning with definitive treatment to the sternum. Dosimetric parameters and treatment outcomes were evaluated.

Results: With respect to treatment coverage, proton therapy was able to deliver comprehensive target structure coverage while maintaining modest doses to the organs at risk compared with photon techniques. At a median follow-up of 28 months from diagnosis, none of the patients have experienced relapse within the radiation portal or developed additional sites of metastatic disease.

Conclusion: Pencil beam scanning for oligometastatic breast cancer with isolated sternal lesions appears feasible without undue normal tissue exposure. Current treatment outcomes appear promising.

Keywords: oligometastatic breast cancer; proton radiotherapy; pencil beam scanning

Concluzii

Our dosimetric comparisons highlight these tradeoffs, demonstrating that comprehensive coverage of the metastatic site and regional lymphatics with proton therapy need not come at the expense of excessively high doses to the heart and lungs, as would be required with photon techniques.

While this case series is too small to make definitive conclusions, it lends support to the other reports in that there may be something particularly unique biologically among patients who manifest with isolated sternal metastases, given its proximity to the primary tumor site, and this could provide a superior chance of successful salvage therapy. The SABR-COMET trial showed an improvement in overall and progression free survival among various cancer types including breast cancer when bone metastases were treated with conventional palliative dosing (EQD2 , 36, assuming alpha/beta ratio of breast cancer of 3) . The currently accruing NRG BR002 is exploring the use of stereotactic radiation to oligometastatic disease to further address if definitive radiation improves survival specifically among patients with breast cancer. BR002 only uses photon therapy, but the study advises a dose and fractionation scheme for bone metastases of 30 Gy in 3 fractions of 10 Gy, (EQD2 . 73, alpha/betaĽ3). Most of the patients in our series received an EQD2 of 65 Gy(RBE) and have promising short-term local control, but pending the results of BR002, future patients may benefit from slightly higher equivalent doses (EQD2 . 70) to maximize the chance of long-term control.

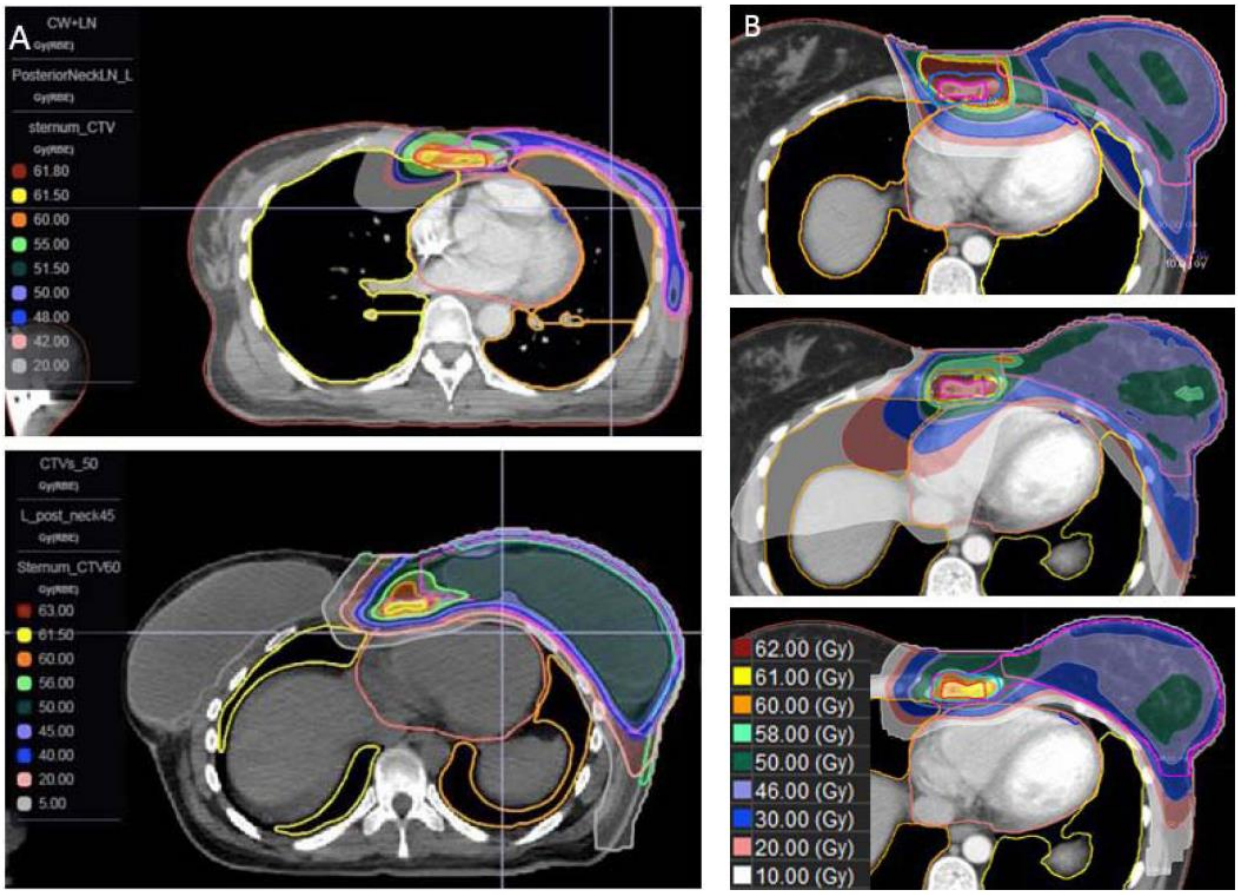

Figure 2. (A) Example pencil beam scanning (PBS) plans. (B) Example comparison plan of 3-dimesional (3D), volumetric modulated arc therapy (VMAT), and PBS. ([A] top) Depicts a postmastectomy plan without reconstruction (Patient B). ([A] bottom) Depicts a postmastectomy. plan with implant-based reconstruction (Patient C). ([B] top) 3D; ([B] middle) VMAT; and ([B] bottom) PBS (Patient A).

Articol 5

5. Ana Ribeiro, Jessica Rodrigues, Luís Antunes, Sandra Sarmento

Radiation doses in mammography exams: Effects of oncological treatments

Radiation Physics and Chemistry 198 (2022) 110286,

https://doi.org/10.1016/j.radphyschem.2022.110286

Abstract

Breast cancer treatments cause breast changes that are detectable in subsequent mammography exams. This work investigates if these changes are perceived as differences in breast composition by automatic exposure systems, and if such differences are high enough to have impact in exam doses. *Methods:* Data was obtained for 226

patients treated with unilateral conservative surgery followed by radiotherapy (S&RT) of the left (114) or right (112) breast, who had mammographic exams in direct digital GE units, Senographe DS (SenoDS) or Senographe Essential (Essential). The relevant data was extracted from Digital Imaging and Communications in Medicine (DICOM) images, and the Mean Glandular Dose (MGD) was calculated using the model of Dance. *Results:* Compression force and area were 15–30% lower for treated breasts (S&RT) relative to untreated, while compressed breast thickness (CBT), incident air kerma (Ki) and MGD were 14–17%, 22–28% and 10–18% higher, respectively. The variation of MGD and Ki with CBT is similar for treated and untreated breasts. High values of Ki, MGD and CBT occur for some treated breasts with relatively small areas, probably as a result of less compressible breast tissue. Equipment-determined composition was found to be similar for treated and untreated breasts. *Conclusion:* Treated breasts are imaged with slightly higher doses as a result of higher CBT, but the dependence of Ki and MGD on CBT remains unchanged. There is no need to separate data for treated and untreated breasts in large-scale analysis of exam doses.

Concluzii

When breast cancer patients undergo conservative surgery followed by radiotherapy (S&RT), the resulting long term changes to the breast are not interpreted as alteration of composition by the AEC systems of GE digital mammography units. The machine-determined BD is similar for treated and untreated breasts. Treated breasts are imaged with slightly higher doses (22–28% higher Ki and 10–18% higher MGD in this study) as a result of higher compressed breast thickness (CBT). CBT in this study was found to be 14–17% higher for S&RT breasts (compared to contralateral), probably as a result of lower compression force and more rigid (less compressible) breast tissue. The increase in exam doses as a result of increased CBT seems modest, compared to expected variations as a result of age group and population characteristics. There is no need to separate data of treated and untreated breasts for large scale analysis, unless the intended analysis is extremely detailed.

Articol 6

6. A. Ranger, A. Dunlop, V.N. Hansen, G. Princewill, S. Landeg, E.M. Donovan, E.J. Harris, H.A. McNair, J. Haviland, A.M. Kirby

A randomised phase ii clinical trial comparing the deliverability and acute toxicity of wide tangent versus volumetric modulated arc therapy to the breast and internal mammary chain

Clinical Oncology 34 (2022) 526-533, https://doi.org/10.1016/j.clon.2022.03.020

Abstract

Aims: Inclusion of the internal mammary chain in the radiotherapy target volume (IMC-RT) improves disease-free and overall survival in higher risk breast cancer patients, but increases radiation doses to heart and lungs. Dosimetric data show that either modified wide-tangential fields (WT) or volumetric modulated arc therapy (VMAT) together with [AQ1]voluntary deep inspiration breath hold (vDIBH) keep mean heart doses below 4 Gy in most patients. However, the impact on departmental resources has not yet been documented. This phase II clinical trial compared the time taken to deliver IMC-RT using either WT and vDIBH or VMAT and vDIBH, together with planning time, dosimetry, set-up reproducibility and toxicity.

Materials and methods: Left-sided breast cancer patients requiring IMC-RT were randomised to receive either WT(vDIBH) or VMAT radiotherapy. The primary outcome was treatment time, powered to detect a minimum difference of 75 min (5 min/fraction) between techniques. The population mean displacement, systematic error and random error for cone beam computed tomography chest wall matches in three directions of movement were calculated. Target volume and organ at risk doses were compared between groups. Side-effects, including skin (Radiation Therapy Oncology Group), lung and oesophageal toxicity (Common Terminology Criteria for Adverse Events v 4.03) rates, were compared between the groups over 3 months. Patient-reported outcome measures, including shoulder toxicity at baseline, 6 months and 1 year, were compared.

Results: Twenty-one patients were recruited from a single UK centre between February 2017 and January 2018. The mean (standard deviation) total treatment time per fraction

for VMAT treatments was 13.2 min (1.7 min) compared with 28.1 min (3.3 min) for WT(vDIBH). There were no statistically significant differences in patient set-up errors in between groups. The average mean heart dose forWT(vDIBH) was 2.6 Gy compared with 3.4 Gy for VMAT(vDIBH) (P ¼ 0.13). The mean ipsilateral lung V17Gy was 32.8% in the WT(vDIBH) group versus 34.4% in the VMAT group (P ¼ 0.2). The humeral head (mean dose 16.8 Gy versus 2.8 Gy), oesophagus (maximum dose 37.3 Gy versus 20.1 Gy) and thyroid (mean dose 22.0 Gy versus 11.2 Gy) all received a statistically significantly higher dose in the VMAT group. There were no statistically significant differences in skin, lung or oesophageal toxicity within 3 months of treatment. Patient-reported outcomes of shoulder toxicity, pain, fatigue, breathlessness and breast symptoms were similar between groups at 1 year.

Conclusion: VMAT(vDIBH) and WT(vDIBH) are feasible options for locoregional breast radiotherapy including the IMC. VMAT improves nodal coverage and delivers treatment more quickly, resulting in less breath holds for the patient. This is at the cost of increased dose to some non-target tissues. The latter does not appear to translate into increased toxicity in this small study.

Key words: Breast radiotherapy; heart-sparing radiotherapy; toxicity breast radiotherapy; VMAT

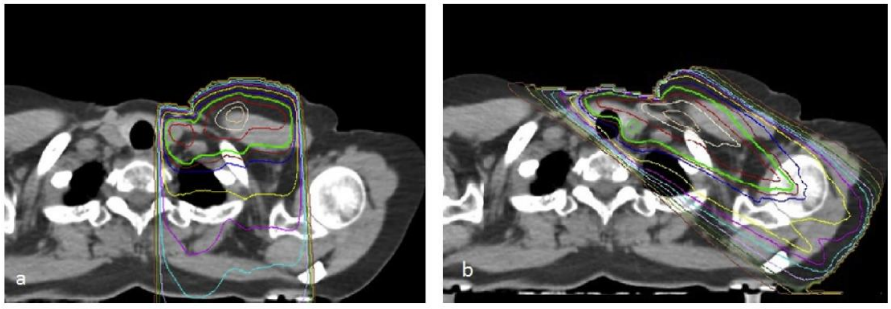

Fig 2. Differences in shoulder dose for wide-tangential fields (WT) versus volumetric modulated arc therapy (VMAT). (a) Isodose coverage around the shoulder region for a WT with voluntary deep inspiration breath hold [WT(vDIBH)] plan. (b) Isodose distribution for the same patient around the shoulder region with a VMAT plan. Isodoses cover the humeral head in (b) with VMAT therapy, but the humeral head is spared using WT(vDIBH).

Concluzii

VMAT(vDIBH) and WT(vDIBH) are feasible options for locoregional breast radiotherapy including the IMC. VMAT improves nodal coverage and delivers treatment more quickly,

resulting in less breath holds for the patient. This is at the cost of increased dose to some non-target tissues. The latter does not appear to translate into increased toxicity in this small study.

Articol 7

7. Na-Hyun Hwang, Myungsoo Kim, Nam Kwon Lee, Suk Lee, Jinho Hwang

Dosimetric effect of injection ports in tissue expanders on post-mastectomy Volumetric Modulated Arc Therapy (VMAT) planning for left-sided breast cancer

Appl. Sci. 2022, 12, 6461. https://doi.org/10.3390/app12136461

Abstract

This study aimed to compare the dosimetric effect of traditional metallic ports and radio frequency identification (RFID) ports (Motiva Flora®) on post-mastectomy volumetric modulated arc therapy (VMAT) planning for left-sided breast cancer. Computed tomography (CT) simulation was performed on an anthropomorphic torso phantom by attaching two types of tissue expander on the left chest wall. For the comparison of CT artifacts, five points of interest were selected and compared: point A = central chest wall, B = medial chest wall, point C = lateral chest wall, point D = axilla, and point E = left anterior descending artery. VMAT planning using two partial arcs with a single isocenter was generated, and dosimetric parameters were investigated. Compared to metallic ports, RFID ports tremendously decreased distortion on CT images, with the exception of point D. The V5Gy, V10Gy, V15Gy, V20Gy, V30Gy, and Dmean values of the heart in RFID ports were lower than those in metallic ports. The V5Gy, V15Gy, V20Gy, V30Gy, and Dmean values of the ipsilateral lung in RFID ports were also lower than those in metallic ports. RFID ports showed superior dosimetric results for doses to the heart and lungs as compared to that in metallic ports.

Keywords: tissue expander; breast cancer; radiotherapy; volumetric modulated arc therapy

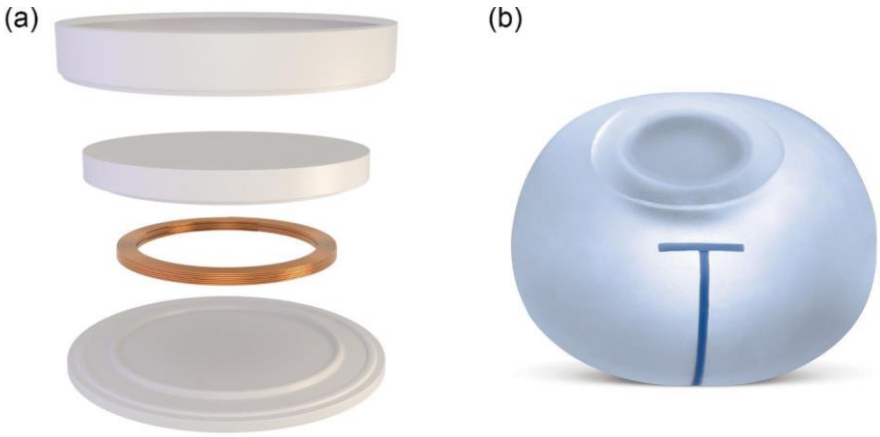

Figure 1. The schematic diagram of the radio frequency identification port (**a**) in the Motiva Flora® tissue expander (**b**).

Figure 2. Computed tomography simulation. A tissue expander was attached to the left chest wall of the phantom.

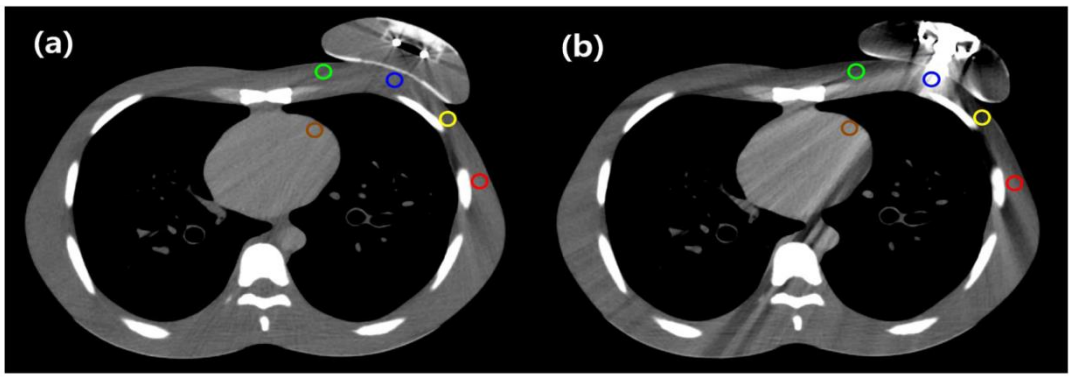

Figure 3. An example of the CT image (**a**) RFID port, (**b**) metallic port analysis using the five reference points; point A—central chest wall (blue), point B—medial chest wall (green), point C—lateral chest wall (yellow), point D—axilla (red), point E—left anterior descending artery (brown).

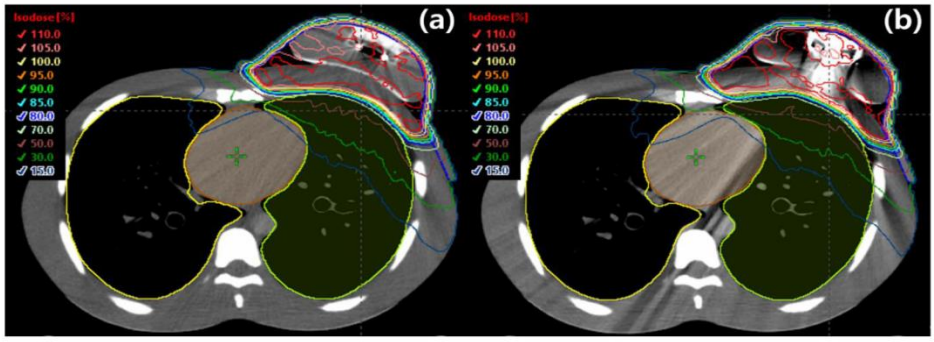

Figure 4. The dose distributions for the radio frequency identification ports and metallic ports in axial view. The isodose lines correspond to 110% (red), 105% (pink), 100% (yellow), 95% (orange), 90% (green), 85% (cyan), 80% (blue), 70% (light green), 50% (brown), 30% (dark green), and 15% isodose (dark blue). (**a**) RFID port; (**b**) metallic port.

Concluzii

The RFID ports (Motiva Flora®) showed superior dosimetric results for doses to the heart and lungs, as compared to traditional metallic ports. Given that PMRT are usually for patients with more advanced breast cancer, minimizing damage to surrounding healthy tissues is more critical. It is expected that risk of side effects may be reduced by decreasing the radiation dose to the heart and lungs by applying an RFID port. However, further studies are needed to assess how RFID ports may affect different types of radiation techniques and clinical outcomes.