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Contribution of interventional nuclear medicine in early breast cancer: from ROLL (Radioguided Occult Lesion Localization) to IART® (Intra-operative Avidination for Radionuclide Therapy)

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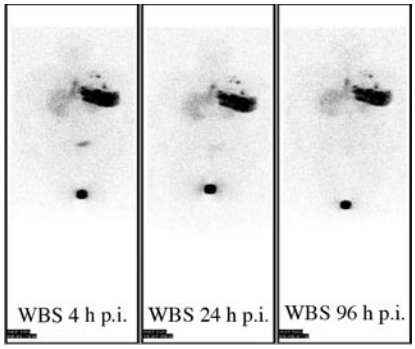
The conservative surgery with axillary dissection and additional radiotherapy represents the treatment of choice for patients with early breast cancer. A standard course of whole-breast external-beam radiation therapy (EBRT) followed by a boost to the tumour bed generally require 5/7 week to complete. This can represent a logistical problem for many patients, particularly the elderly and those who reside a considerably distance from a radiation treatment facility. As alternative to the traditional treatment of radiotherapy, the intraoperative radiotherapy (IORT) has been recently proposed. This is a radiotherapy technique which allows within the same surgical procedure to supply a sole dose of radiations (electrons) directly in the anatomical area of the tumour, immediately after the surgical excision of the neoplasia. This technique, although valid, is limited by two major points: i) the availability of a dedicated intraopertive linear accelerator, ii) a restricted field of irradiation which limits the management of positive surgical margins.

The experience developed in our Institute for locoregional treatment of cerebral gliomas (1) as well as the ROLL (2) technique in non palpable breast lesion, lead us to assume that the application of the already tested avidin-biotin pre-targeting system could deliver a radiation dose capable to control recurrence, as for EBRT and IORT (3) with several logistic advantages. This new approach named I.A.R.T. (Intraoperative Avidination for RadionuclideTherapy) is a simple, low cost and easy to perform approach that may represent an alternative to external beam radiotherapy and IORT in early breast cancer. The IART procedure consists of a first step where the surgeon intraoperatively injects avidin directly into the tumour bed followed by a second step of an intravenous injection of ^{90}Y / ^{177}Lu radiolabelled biotin, 1-2 days later.

The avidin injection can be done with a syringe or with a dedicated spray -device (disposable and ready for inraoperative use) in the frame time while the surgeon is waiting for the sentinel node pathological analysis or after axillary clearance. Avidin will percolate the tissue of the index quadrant as well as it will be drained by locoregional lymph nodes including internal mammary chain and upper clavicular. If necessary, avidin can be injected into the nipple area or into adjacent quadrants. Due to its positive electric charge (pI 10.7) and the great inflammatory reaction after surgery, avidin will be retained at site of injection for several days (Paganelli unpublished data) and constitute a sort of new "artificial receptor", only expressed in the breast area, able to homing radioactive biotin with very high affinity (kd 10^{-15}) and specificity (avidin is not present in human tissues). An example, in a pilot case, is reported in fig. 1 which represents a whole body scan of a patient operated on for breast cancer where avidin was injected according to the method describe above. The day after surgery, the patient received an intravenous injection of ^{111}In biotin and the images clearly show the excellent radioactivity biodistribution (over the time) of the targeted breast including lymph nodes. This treatment can be done on an outpatient basis, in any Nuclear Medicine unit, even far away from the surgical centre, at a lower cost compared to EBRT and IORT within few hours and with minimal discomfort and side effects for the patients.

Fig. 1



Whole Body Scan in anterior view of a patient operated on for left breast cancer. Note the excellent ^{111}In-Biotin uptake (~ 6-7 % I.D.) in the index quadrant and the very low background in critical organs such as liver, kidney and bone marrow.

References

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