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Original research article

Comparison of CT-volumed supraclavicular fossa radiotherapy planning and conventional simulator-planned defined by bony landmarks for early breast cancer☆

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ABSTRACT

Aim: A comparison of techniques, CT planning of the supraclavicular fossa and field based simulation. We highlight CT planned SCF radiotherapy which would be useful for a centre introducing the technique.

Background: Development of radiotherapy technique includes a move from field-based simulation to CT planning.

Materials and methods: We conducted a retrospective review of the first 50 patients receiving radiotherapy according to the 3D CT planning protocol. Production of the previous field based technique, by virtual simulation methods on the same 50 patient CT data sets allowed both techniques to be compared for beam energy, field size, planning target volume (PTV) minimum and maximum, mean doses, depth dose normalisation, V40% lung volume and brachial plexus.

Results: 88% CT-volumed plans received mean dose within ICRU recommended limits compared with only 8% using previous conventional technique. 76% required 10 MV to improve coverage and one patient (2%) an opposed posterior field. The mean normalisation depth was 4.5 cm (range 1.9–7.7 cm) compared with pre-set 3 cm of the conventional technique. With CT-volumed technique the whole lung volume exposed to V40%, including the tangential fields, reduced from 10.79% to 9.64% ($p < 0.001$) but the mean maximum brachial plexus dose increased from 48.9 Gy to 51.6 Gy ($p < 0.001$).

Conclusions: Dose coverage of the SCF PTV was greatly improved for plans produced from 3DCT volumes compared to field based techniques.

☆ The work was carried out at the Royal Stoke University Hospital.

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1. Background

Breast cancer is a common condition with the lifetime risk of developing breast cancer for women in the United Kingdom (UK) calculated as 1 in 9. In 2007 there were 50,286 (44,782 invasive) new cases of breast cancer diagnosed in the UK of which over 99% were women.[1] The majority of these cases are early breast cancer. The loco-regional management consists of surgery and radiotherapy. Radiotherapy is given to the breast/chest wall and also to nodal drainage areas in selected cases, particularly the SCF.

Radiotherapy to the SCF has generally been given when four or more axillary lymph nodes are positive on axillary node clearance[2] and is established as reducing local recurrence and the risk of metastases.[3,4] The EBCTCG meta-analysis of individual patient data of 1314 patients with 1–3 positive nodes following mastectomy and axillary dissection showed an advantage for radiotherapy to the chest wall and regional lymph nodes[5] and the indications for SCF radiotherapy are increasing. The morbidity from conventionally fractionated radiotherapy is low,[6] with the addition of nodal radiotherapy it is important to anticipate the small increase in risk for pneumonitis, lymphoedema and brachial plexus injury.

UK radiotherapy centres were audited[7] about their supraclavicular techniques and indications for use in 1999. Landau and Laing reported that 10% indicated no routine use of SCF radiotherapy, 15% used it for all node-positive patients and 75% were guided by the pattern of axillary nodal involvement. In 2009 in our department we treated the SCF of 71 breast cancer patients, 25 (35.2%) also had axillary radiotherapy. 90% of centres in the UK in 1999 were treating with a single anterior field of which one-third routinely angled away from the spinal cord.[7]

Adjuvant radiation used to be delivered to the breast and SCF at our hospital using a conventional technique which consisted of planned isocentric tangential fields to the breast and a direct field to the SCF. We had the concern that conventional planning might lead to inadequate coverage of the SCF. By December 2005 confidence in 3D conformal techniques in our department for other cancer types had grown to the extent that it was decided to take a similar approach for breast cancer patients. Initially this approach was used for the breast, then the chest wall and finally the nodal drainage areas. Some patients have level 3 of the axilla irradiated in addition to the SCF, either because a level 2 clearance was performed or the surgical changes are only noted up to level 2 on the CT-planning scan. For this study we decided to evaluate those having the SCF irradiated as the only nodal drainage area.

2. Aim

This study aims to evaluate the dosimetric differences between the direct field approach to SCF planning and dose distributions produced from a CT-planned volume.

3. Materials and methods

A consecutive cohort of 50 patients was identified retrospectively from the initial patients receiving 3D treatment planning to the SCF (all patients also had breast or chest wall radiotherapy using 3D planning) in accordance with the new protocol. Patients receiving axillary radiotherapy in addition were excluded. A retrospective detailed comparison of both techniques was undertaken by comparing two plans for each patient. The first plan was the actual treatment plan produced according to the new protocol and the second plan was generated using virtual simulation on the acquired CT volume data sets using our previous planning parameters. The new planning protocol required that both breast/chest wall and SCF CTVs/PTVs were delineated on the planning CT scan. Radiotherapy to the whole breast or chest wall was delivered using asymmetric, parallel opposed tangential fields half beam blocked to the lung edge (posterior). Radiotherapy planning was to conform to the requirements of ICRU50[8] regarding dose variation with the reference point, as defined by the START trial[9] half way between the lung surface and the skin surface on the perpendicular bisector of the posterior beam edge. The prescription was 50 Gy in 25 fractions over 5 weeks in 43 patients and 40 Gy in 15 fractions over 3 weeks (which is now the standard prescription for all our patients) in 7 patients. Compensation is made where hotspots greater than 107% occur using forward planned IMRT (field-in-field technique).

The CTV for the SCF is marked up according to the boundaries in Table 1. The PTV for the SCF is generated with margins from the CTV determined for the individual patient. For the majority of patients this is 1 cm superior and lateral and 0.5 cm medial margin. The inferior margin is usually nil inferiorly (unless there is a gap from the tangential fields allowing up to a 1 cm margin as in 9 patients) and up to 1 cm as anatomy allows on the other margins. The plan usually consists of an anterior isocentric field which may be angled if necessary to avoid treating the spinal cord. A posterior field is used if the separation is large or the SCF volume is particularly deep. Care

Table 1 – Supraclavicular fossa boundaries.

Margin	CT scan margins	Conventional
Superior	Up to but excluding the thyroid gland and cartilage	To allow at least a 1 cm corridor of skin
Anterior	Deep surface of sternocleidomastoid muscle and deep cervical fascia	Skin
Medial	Lateral edge of trachea	Lateral bony edge of the vertebrae
Posteromedial	Carotid artery and internal jugular vein	
Posterolateral	Anterior scalene muscle	Lateral 2/3 of the clavicle
Inferior	Subclavian artery	Inferior aspect of sternoclavicular joint