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Enlarged Axillary Nodes and Position of the Arms in Axillary Irradiation

A Computed Tomography and Magnetic Resonance Imaging Evaluation

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The purpose of this study was to evaluate the axillary node displacement away from chest wall and their anatomical location in relation to the humeral head, according to the position of the arms, when the axilla is the site of enlarged nodes. In 13 patients with enlarged axillary nodes, the anatomical span of the nodes according to two arms positions, akimbo (A) and up over the head (U), was prospectively evaluated using computed tomography (CT) and magnetic resonance imaging (MRI). The nodes were classified into two groups, i.e. the lower and upper groups. The mean distances of the lower node group from the chest wall when the patients were in A, and U positions were 3 cm and 6.4 cm, respectively ($p = 0.002$). The upper group nodes showed a smaller difference in the distance from the chest wall: in A position, mean 2.1 cm; in U position 2.8 cm ($p = 0.03$). In U position, there was always a node of the lower group that was displaced in front of the humeral head. This study demonstrates the displacement of enlarged axillary nodes according to the position of the arms. In patients with axillary node involvement, CT planning should be considered when they have their arms held up over their heads.

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Radiotherapy has an important role in the treatment of Hodgkin's disease (HD) both as a single modality and as a part of combined therapy. Up-to-date, mantle field irradiation is less frequently used for HD; instead, most large centers and groups use some form of combined modality therapy with a brief course of chemotherapy followed by radiotherapy to the initially involved area.

Mantle field is a technique, developed in 1957 by the Stanford group (1), which permits the irradiation in continuity of the lymph nodes above the diaphragm and under the inferior mastoid tip. The involved-field technique refers to the treatment delivered using smaller treatment fields on the involved area.

In both the mantle field and the involved field techniques, small technical details, such as the positions of the arms, can greatly influence the amount of normal tissue treated and have to be considered carefully (2, 3).

In treating axillary nodes, the treatment is complicated by the proximity to normal tissues such as the humeral head and lung. In a previous paper (4), using surgical clips apposed at the time of axillary dissection for invasive breast cancer, we demonstrated the displacement of the axillary nodes according to the position of the arms.

Because the surgical clips in all likelihood represent the minimum lymph node span, they would not represent the full anatomic span of abnormal, enlarged, lymph nodes.

Since the radiation oncologist needs to have precise knowledge about a patient's anatomy so that target volumes and their relationship to normal tissue are clearly delineated, we have prospectively evaluated, using computed tomography (CT) and magnetic resonance imaging (MRI), two classic positions of the arms, 'akimbo' (A) (5) and 'up over the head' (U) (6, 7) in patients with enlarged axillary nodes. The choice to complete the CT studies with MRI was due to the better definition of the anatomical relationship between axillary nodes and humeral head in sagittal view. To the best of our knowledge this report is the first to evaluate location of axillary nodes in relation to the position of the arms, using CT and MR, with the purpose of treat HD.

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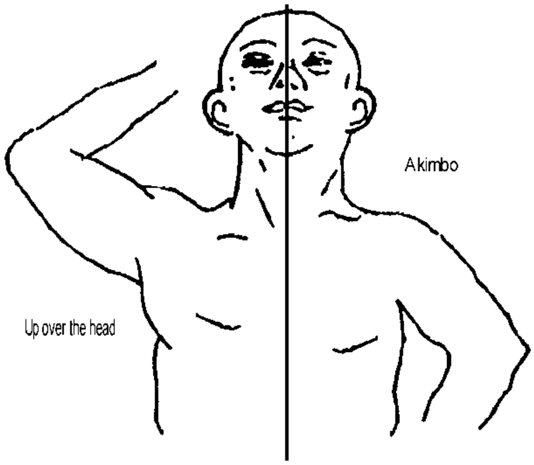

Fig. 1. Two classic positions of the arms utilized in both mantle field and any axillary irradiation.

MATERIAL AND METHODS

During a period of 3 months, 13 consecutive patients (4 males and 9 females) with clinically palpable, enlarged, axillary nodes were prospectively enrolled in this study. Two of the patients had Hodgkin's lymphoma, 4 had non-Hodgkin's lymphoma and 7 patients had breast cancer. Written informed consent was obtained from all patients before inclusion in the study.

Setup of the patients was carried out in supine position in accordance with two standardized positions of the arms used both in 'mantle field' irradiation for Hodgkin's disease and in any axillary irradiation (Fig. 1): position A (5) and position U (6, 7).

CT examinations were performed in 13 patients with a third-generation CT scanner (Somatom Plus 4, Siemens, Erlangen, Germany). During administration of non-ionic intravenous contrast material, 4-mm-thick CT scans were obtained from the lower neck to the diaphragm. All detected nodes were carefully outlined on each CT image by using a three-dimensional treatment planning system (Plato, Nucletron, Veenendaal, The Netherlands).

MRI examinations were performed in 11 patients using a 1.5 T scanner (Somatom Vision, Siemens, Erlangen, Germany). In each patient, axial, coronal and sagittal spin-echo T1- and T2-weighted images were obtained. Two patients refused the MRI examination.

Nodes were considered enlarged when their maximum transverse diameter was greater than 8 mm.

The axillary nodes were arbitrarily separated into two groups: lower group, between the axillary vein and the latissimus dorsi muscle and the outer half of the pectoralis minor muscle; upper group, between the inner half of the pectoralis minor muscle and the apex of axilla. The two groups of nodes were identified by three senior radiologists (G.A., A.B. and M.G.).

The distance between the nodes and the chest wall was measured in each patient. For each node, the measurement was made between the midpoint of the node and the nearest point outside the surface of the chest wall.

RESULTS

Seven patients had enlarged nodes in the right axilla, six in the left axilla. A total of 71 enlarged nodes were detected (median 5, range 3–8): 29 nodes were assigned to the upper group (median 2, range 1–5), and 42 nodes to the lower group (median 3, range 2–5). Differences of opinion between observers were resolved by consensus. These data are summarized in the Table 1.

A total of 71 measurements were taken, 42 for the lower group and 29 for the upper group.

When the patients were in A and U position, the mean displacement of the 42 lower nodes away from the chest wall was, respectively, 3 cm (range 1.8–4.7 cm) and 6.4 cm (range 2.3–7.8 cm). The 29 upper group nodes showed a smaller variation in distance from the chest wall: mean of

Table 1

Patients, tumors, and node characteristics

Patient	Diagnosis	Total no. of nodes	Upper-group nodes	Lower-group nodes	CT	MR
1	HD	5	2	3	Yes	Yes
2	nHL	3	1	2	Yes	Yes
3	BC	6	2	4	Yes	Yes
4	BC	7	2	5	Yes	No
5	HD	6	3	3	Yes	Yes
6	nHL	8	5	3	Yes	Yes
7	BC	6	2	4	Yes	Yes
8	BC	5	2	3	Yes	Yes
9	nHL	7	4	3	Yes	Yes
10	BC	4	1	3	Yes	Yes
11	BC	4	2	2	Yes	Yes
12	nHL	5	2	3	Yes	No
13	BC	5	1	4	Yes	Yes

Abbreviations: HD = Hodgkin's disease; nHL = non-Hodgkin's lymphoma; BC = breast cancer.

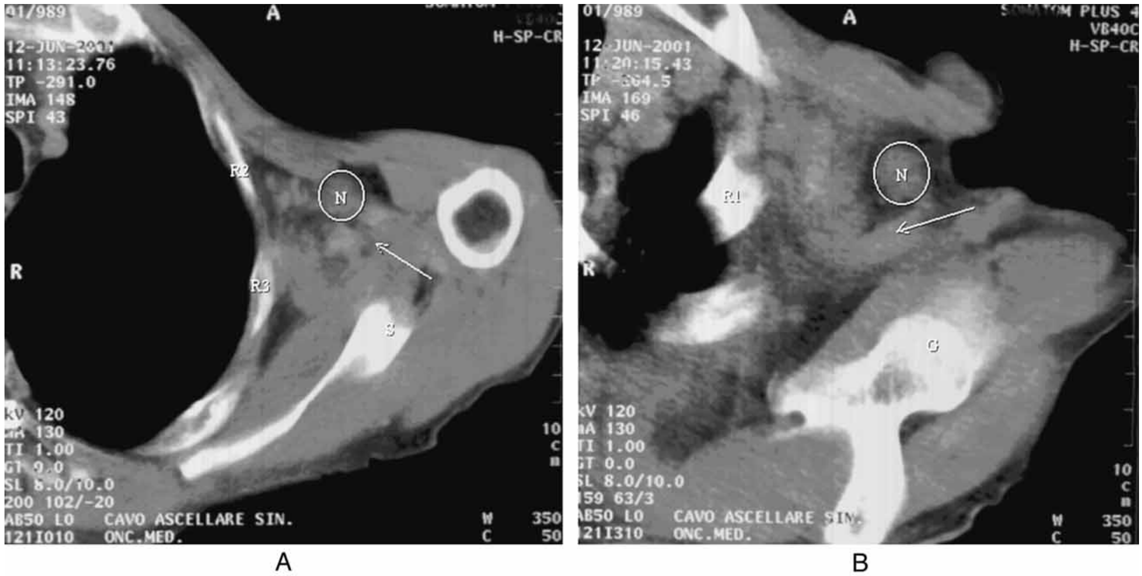

Fig. 2. A 35-year-old man with Hodgkin's disease. A: A 4-mm-thick CT scan through the left axilla in akimbo position shows enlarged lower axillary node (N) at the level of the second intercostal space and scapular body (S). Axillary vessels (arrow) can be seen behind the enlarged node. R2: Second rib; R3: Third rib. B: A 4-mm-thick CT scan obtained with arms held up over the head demonstrates that the enlarged node (N) is displaced at the level of the first rib (R1) and inferior glenoid rim (G).

2.1 cm (range 1.4–4 cm) in A position, 2.8 cm (range 1.4–4.7 cm) in U position.

A statistically significant difference in node displacement between the two positions of the arms was demonstrated using an ANOVA analysis: lower group, $p = 0.002$; upper group, $p = 0.03$. In 13/13 patients, a node of the lower group was detectable ahead the humeral head. In Fig. 2 we show CT in both A and U positions; MRI in sagittal view is shown in Fig. 3.

Fig. 3. An 80-year-old man with non-Hodgkin's lymphoma. A 5-mm-thick sagittal spin-echo T1 weighted (TR 350/TE 15) image obtained with arms held up over the head reveals that an enlarged lower axillary node (N) covers part of humeral head (H).

DISCUSSION

Irradiation is the most effective single agent for the treatment of patients with HD that can be cured, in selected cases, using radiotherapy alone. In this instance, i.e. mostly in HD in clinical-pathological stages I and II with favorable prognostic factors, the mantle field technique is used to treat all the nodes above the diaphragm with a dose associated with a high likelihood of tumor eradication. The necessity to treat all the nodes, including uninvolved sites, is linked to the theory of contiguity of spread (8) and is a key component in curative radiation therapy programs. The need for and type of systemic therapy are determined primarily on the basis of node size, stage and histological characteristics of the disease, as well as patient-related factors. Nowadays, however, most HD patients are treated with some form of combined modality therapy with chemotherapy followed by radiotherapy to the initially involved area.

In this study, we analyzed the anatomical span of enlarged axillary nodes as well as the relationship between these nodes and normal structures such as the lung and humeral head.

In typical mantle field treatment, and in involved field axillary irradiation, in addition to lung blocks, blocks can be placed over the humeral heads both anteriorly and posteriorly (9).

In an effort to shield more of the lung parenchyma, some investigators (6, 7) suggest the U position with (10) or without (7) blocks on the humeral heads. It is clear that greater the distance of the nodes from the chest wall, the greater the lung parenchyma that can be shielded.

We recorded an average distance between the chest wall and the lower and upper nodes groups of 3 cm and 2.1 cm respectively, in A position and 6.4 cm and 2.8 cm, respectively, in U position.

The above-mentioned data confirm the advantage of the U position in relation to the A position in shielding more of the lung parenchyma when the axilla is the site of enlarged nodes.

It is well known that the location of the nodal stations located proximally in the limbs varies greatly depending on simulation positioning (11) and that it is important to consider this matter when treating HD with mantle field irradiation (4). This variability in node location could be responsible for an inaccurate dose being delivered in axilla; in fact, in 16 patients treated with mantle fields for HD, Naida et al. (12) reported that the axillary region had the highest localization error rate. Moreover localization errors were more likely with increasing tumor size. These investigators concluded that the use of beam's eye view treatment planning for tumors in the axillary region could reduce the incidence of geographic misses.

In our study we demonstrated that in U position a lower node group is detectable in front of the humeral head. Consequently, a standard block on this structure will determine an undesirable 'geographic miss' which could affect the efficacy of the treatment. This topic confirms our previous results with surgical clips (4) and Weisenburger & Juillard's (13) report using axillary lymphangiograms.

Considering the results observed using surgical clips (4), lymphangiograms (13), CT and MRI in enlarged nodes (present paper), it can be affirmed that there is strong evidence to suggest that lower axillary nodes in U position go up to the level of the inferior aspect of the humeral head. It is probable that even non-pathological nodes could display the same anatomic 'behavior'. We think that this situation should be borne in mind in every treatment that is designed to treat clinically uninvolved axillary nodes (i.e. breast cancer).

Furthermore, in the context related to the involved field irradiation, the findings observed in the present study are important, since treatment fields concentrating on the involved area are now much smaller, making the precision of the treatment field planning even more crucial. Also, treatment planning is often done at a time when patients are usually in remission after chemotherapy, making it necessary to plan the radiation field using images made before the chemotherapy. Here it is crucial that the patient is positioned in the same way at both the initial scanning and the subsequent planning scan, and that meticulous CT-based planning is used, otherwise initially involved lymph node areas may well be missed in the subsequent radiotherapy. Last but not least, with our present awareness of the long-term risks of treatment sequelae, particularly with regard second tumors, the possibility of sparing lung tissue, and, incidentally, lateral breast tissue in female patients, is a strong argument for the 'up over the head' position of the arms.

In conclusion we want to stress the findings of this study that are valid; namely, that enlarged axillary nodes vary in position according to the patients' setup, that in U position it is possible to spare more of the lung parenchyma, that a humeral head block should be avoided in U position when three-dimensional planning is not used. We are aware that simulation based on CT scans increases the time required for the procedure, but we think that this is justified especially for young patients because they are likely to be at risk for the consequences of unnecessary irradiation of healthy structures.

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