Modified Five Field Technique for Primary and Postop Breast Cancer Irradiation

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In breast cancer, the treatment volume presents a relatively complex three dimensional structure. Effective radiation therapy requires the delivery of adequate dose to a large target volume using complex beam arrangements.

The technique proposed here is our department's method using asymmetric jaw with appropriate couch, collimator and gantry rotation.

This technique has the following advantages: 1) all treatments are given in a single clinical set up 2) it does not require half beam blocks 3) it produces exact geomatric match 4) it is very convenient and easy to use 5) it has daily reproducibility.

Key Words: Breast cancer, Five field technique

INTRODUCTION

The technical goal of radiation therapy is delivery of a uniform dose to the target volume while maintaining the dose to the surrounding normal tissues to a minimum. In the case of breast cancer, the treatment volume presents a relatively complex three dimensional structure. It is defined by the breast itself, the internal mammary chain, the supraclavicular fossa and axilla.

In recent years, it has become apparent to many radiation oncologists and physists that the standard technique for irradiation of the breast and/or chest wall is less than satisfactory. 1) The technique is usually a combination of two parallel opposed tangential fields covering the breast and/or chest wall, an irregular anterior field (hockey stick shaped) covering the internal mammary chain, the apex of the axilla and the supraclavicular region, and an optional posterior axillary boost field. The matching of fields on the skin surface and at depth in tissue is inadequate because of beam divergence, resulting in some regions of the treatment volume being significantly overdosed or underdosed. A number of technique have been reported to produce uniform dose distributions for this treatment and much attention has been directed toward the match region at the inferior border of the supraclavicular field and superior borders of tangential breast fields[1~9].

A perfect geometric match can be achieved by making the adjoining field borders of all radiation beams nondivergent in the transverse plane.

This can be achieved by using half beam blocks[1,2], gravity oriented hanging blocks[9], or custom made beam alignment protractor[7] in conjunction with appropriate gantry, collimator and couch settings[10]. The technique proposed here is our department's method using asymmetric jaw and appropriate couch, collimator and gantry rotations.

METHODS AND MATERIALS

Patients receiving radiation therapy are immobilized on an adjustable breast angle board in the supine position with ipsilateral arms extended above their heads.(Fig. 1) The slope of the chest wall can be reduced by placing the patient on a breast tilt board. The supraclavicular field is simulated first with the gantry rotated 10°~15° to exclude the spinal cord from the treatment field (Fig. 2). The inferior border of the supraclavicular field is usually the 2nd intercostal space and made nondivergent in the transverse plane using the split beam technique by asymmetric jaws. To produce a geometrically perfect match, the superior berders of the tangential fields also need to be nondivergent in the same transverse plane. The tangential fields are positioned to encompass the entire breast/chest wall and lower axilla. The simulation procedure for the tangential fields is done in the following sequence.

The medial and lateral field borders are marked on the patient and the straight line connecting the

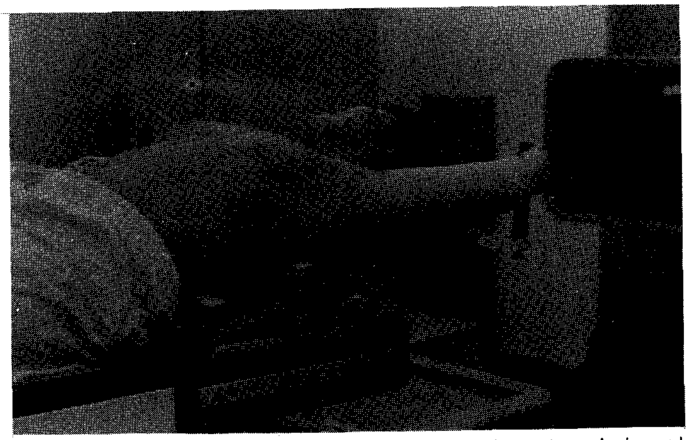

Fig. 1. The set up position of the patient on the breast angle board

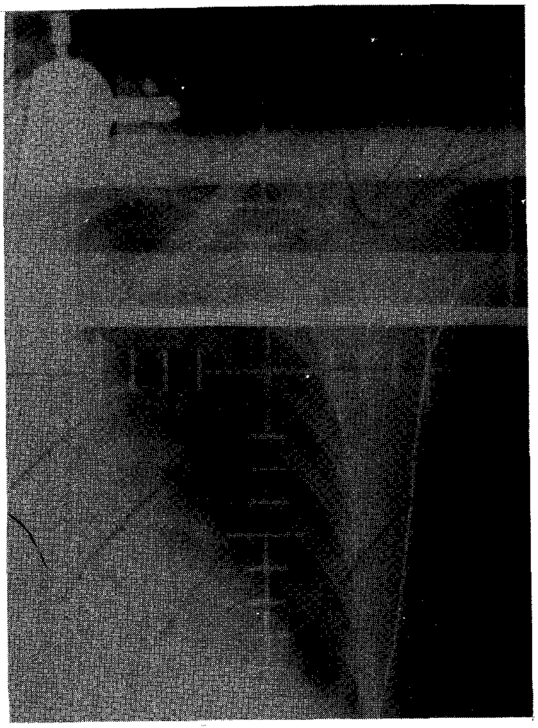

Fig. 2. Simulation film of the supraclavicular field: The gantry is rotated 10°-12° to exclude the spinal cord

two borders establishes the patient separation, S and the posterior angle of the treatment volume, θ.

The isocenter location is determined by the vertical depth, D, and the horizontal shift, H. The medial and lateral gantry angles $\theta 1$ and $\theta 2$ are calculated.

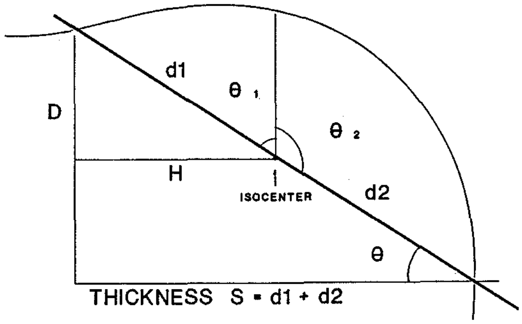

Fig. 3. Transverse plane containing the tangential field isocenter. The chest wall separation S, chest wall angle θ

$$D=S/2 \sin\theta \qquad \text{(Fig. 3)}$$
$$H=S/2 \cos\theta$$
$$\theta 1=90-\theta$$
$$\theta 2=90+\theta$$

The overlap between the tangential and supraclavicular fields is eliminated since the beam divergence of the superior border of the tangential field is eliminated by the couch rotation. (Fig. 4) The angle of couch rotation is calculated from the following equation.

$$\theta=\tan\ (Fl/2/100)$$

Fl; the length of the tangential field

The proper couch angle may be confirmed by observing the lead mark shadow of match line as the couch is rotated. Sometimes we rotate the collimator angle depending on the shape of the chest wall. The overlap between the collimator rotation of the tangential fields and supraclavicular fields is eliminated by a cerrobend block. To avoid excessive lung irradiation, we use asymmetric jaw

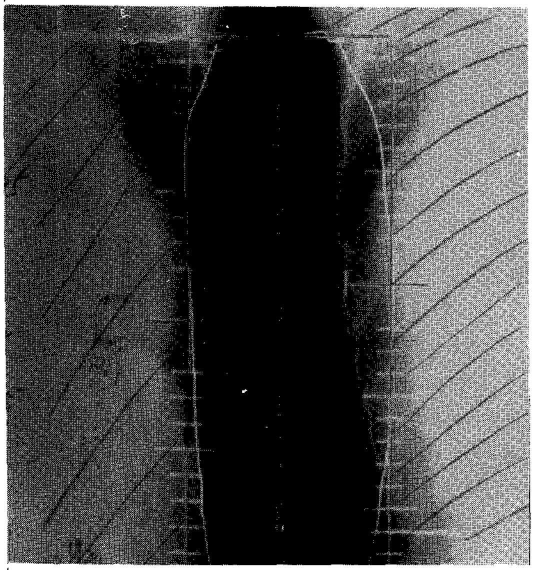

Fig. 4. Simulation film of the medial and lateral tangential fields. Match line is confirmed by lead mark

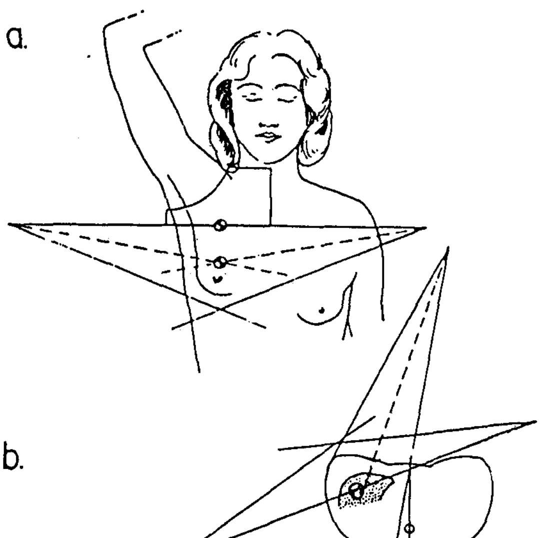

Fig. 5. Set up geometry of the treatment technique in the transverse and sagittal planes

so that the two tangent beam edges traversing the lung coincide. (Fig. 5) Then contour is taken in the center of the breast/chest wall treatment field for treatment planning.

Internal mammary field is varied according to the tumor location and axillary node status. But

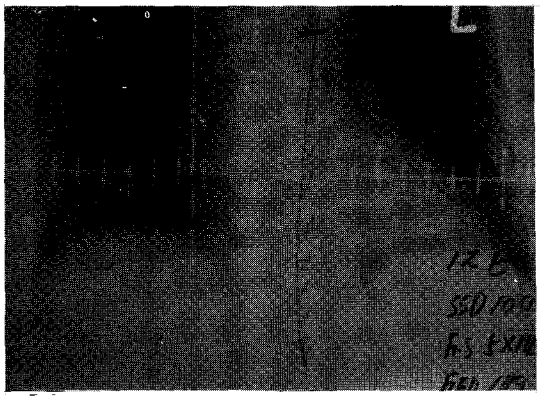

Fig. 6. Simulation film of the internal mammary field: Internal mammary field border and medial tangent border are abutted

usually we treat the internal mammary field separately from the tangential field using 9 MeV electron and 4 MV photon beam appropriately. (Fig. 6) Internal mammary field border and medial tangent border are abutted without overlapping. After computerised treatment planning, we select the isodose line. (Fig. 7) Following the simulation of the four fields, the posterior axillary boost field is simulated without a change in the treatment position. A wire is placed on the upper breast border to locate the match line to block the overlap with the tangent fields. At the time of simulation, skin marking for the posterior boost field are placed anteriorly on the patient. But the treatments are delivered by rotating the gantry to the posterior position. (Fig 8) In primary breast treatment, we use interstitial implant for the boost irradiation of the primary site. But the details of the interstitial irradiation will be discussed later.

RESULTS

In this set-up, the supraclavicular field and the tangential fields join together properly, not only on the skin but at all depth as well. This is accomplished by the asymmetric jaw of the supraclavicular field and the couch rotation of the tangential fields. Isodose curve obtained by the computer shows ideal dose distribution at the junction of the supraclavicular field and tangential fields. (Fig. 9) In tangential fields, excessive lung irradiation is avoided by using the asymmetric jaw. In this set up all calculation is done in simulator room quickly and easily. All set up is reproducible in treatment room daily without difficulty. We followed up 25 patients

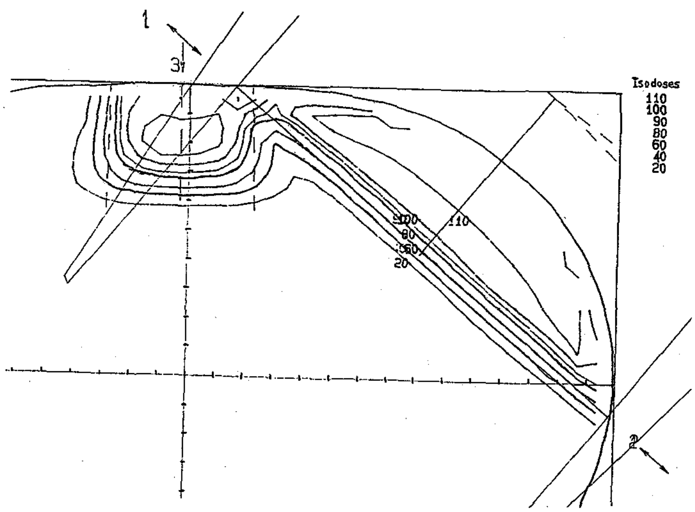

Fig. 7. Isodose curve obtained by computer planning in the cenrtal axis of the tangential fields

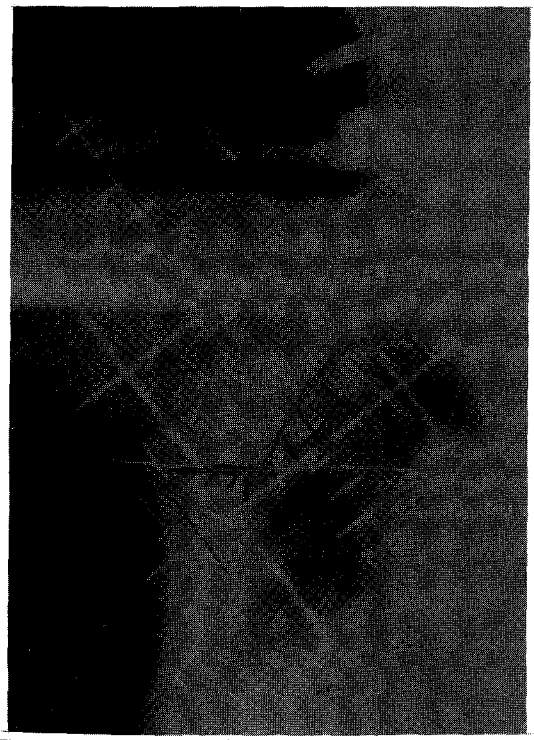

Fig. 8. Posterior axillary boost fiels: A wire is used to identify the match line between the breast tangents and the axillary boost field. Block is used inferior to the match line.

treated by this technique from 3 to 22 months: No patient shows match line fibrosis or radiation pneumonitis.

DISCUSSION

The task of ensuring a geometrically perfect match between the supraclavicular and tangential fields during the irradiation of breast has been investigated extensively[2,3,8,9]. Lichter et al[5] used analytical formulas to calculate the correct patient set-up parameters during simulation. Podgorsak et al[1] and Conte et al[2] used half beam blocks in both the supraclavicular and tangential fields. But the disadvantage of their techniques is the necessity of using heavy half beam blocks that limit the useful length to only one-half of what is available. We use asymmetric jaw instead of half beam blocks. In general, the axillary apex and supraclavicular region are treated with one field followed by posterior boost to bring the midplane axilla to adequate dose.

However, delivery of the posterior boost is problematic because of the anatomic shape of the axilla. One method is to position the patient prone, but this change in patient positioning alters the target volume relative to the anterior field.

The advantage of the technique reported here is that all treatments are given in a single clinical set

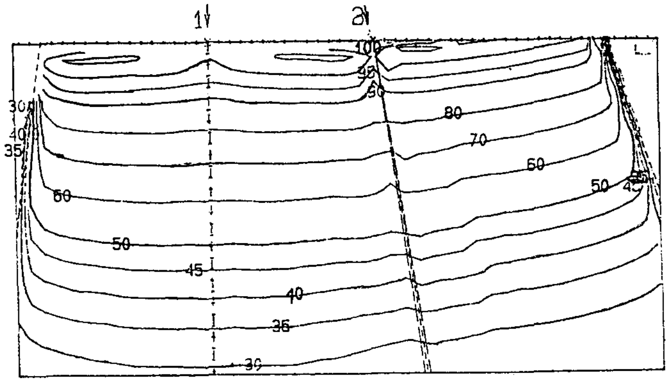

Fig. 9. Isodose curve obtained by computer at the junction of the supraclavicular field and tangential fields.

up with the patient on a breast board which assures excellent daily reproducibility[11]. All anatomic relationships remain constant which allows for accurate dose calculations and accurate delineation of target volumes. Also, potential matching problems are eliminated using asymmetric jaws and couch rotations instead of half beam blocks.

The technique reported here has the following advantages: 1) all treatments are given in a single clinical set up 2) it does not require half beam blocks 3) it produces exact geometric match 4) it is very convenient and easy to use 5) it has daily reproducibility. As the technical ability to deliver radiation therapy is optimized, these gains will maximize the potential for long-term control while minimizing the potential for complications[12].

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＝국문초록＝

유방암에서의 근치적 또는 수술후 방사선 치료방법 : 5문 조사법

아산재단 서울중앙병원, 울산대학교 의과대학 치료방사선과학교실

최 은 경·장 혜 숙·이 병 용

유방암의 근치적 또는 수술후 방사선 조사시 치료해야 할 부위는 유방과 주위임파 조직으로 매우 복잡한 3차원적 구조이다. 여러 방향의 조사에 의한 조사부위의 중복을 피하고 부작용을 최소화하기 위한 여러 방법이 시도돼 왔으나 계산과정이나 치료방법이 매우 복잡하여 여러가지 문제점이 있었다. 이에 저자들은 Asymmetric jaw를 이용하고 gantry, collimator와 couch를 적절히 회전시켜 조사야가 만나는 부분에서 beam의 divergence를 없애줌으로써 가장 이상적으로 치료할 수 있는 방법을 소개하고자 한다. 5문 조사 방법은 다음과 같은 장점을 가진다.

1. 모든 조사야의 set up이 같은 위치에서 시행되므로 환자의 위치변동에 의한 target volume의 변화를 막을수 있다.
2. Half beam block을 사용하지 않아도 된다.
3. 조사야가 만나는 선(match line)에서 beam의 divergence가 없으므로 정확하다.
4. 계산이 쉽고 환자 set up이 용이하다.
5. 매일 치료를 같은 방법으로 정확하게 반복할 수 있다.