TANGENTIAL FIELD SETTING TOOL FOR BREAST IRRADIATION

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Purpose/Objective:

To design and construct a tool for accurate set up and planning of tangential fields irradiation in breast cancer patients.

Material and method:

A tool for tangential fields setting in breast irradiation is made of acrylic sheet of various thickness using pin and arch principle. Two pins are set perpendiculary, and the third one is set as a front pointer. All pins are set on an adjustable arch. The pins and arch set is attached on the axis between two arms of caliper and on the caliper axis, an angle meter is attached to read the axis angle. When the wall and ceiling lasers are aligned on the perpendicular pins, while two arms of caliper are placed along the chestwall separation of the breast, the gantry angles of medial and lateral tangential fields are determined by the axis angle and breast thickness.

Results:

The tool is used to set up and plan for tangential field irradiation of 66 breast cancer patients. The gantry angles of lateral tangential field, medial tangential field and the angle between the two fields are measured and calculated by the tool. The results show that the difference of measured and calculated values are within 0-2 degrees from the angles set by simulator. No significant difference of right breast and left breast are found.

Conclusion:

A simple tangential field setting tool for breast irradiation has been constructed and using at the National Cancer Institute of Thailand with satisfied application in accuracy and practicality.

INTRODUCTION

Radiation therapy is an effective treatment for early carcinoma of the breast [1]. The application for a primary local treatment for early carcinoma of the breast acquires high levels of local tumor control and good cosmetic results. A number of important technical factors have been shown to influence the likelihood of fulfilling these requirements [2]. Because of the highly complex target volume irradiation, breast with or without the reginal lymph nodes, internal mammary lymph nodes, axilla and supraclavicular lymph nodes, a number of techniques have been developed to produce uniform dose distribution for this treatment. However, a pair of medial and lateral tangential fields are essential to irradiate chest wall for most reports [1-10].

It is very complicated to set up a breast for irradiation without CT slices or other tools. In this report a tool for set up and planning for tangential fields irradiation of the breast is designed and constructed. Using this tool, the patient's breast is accurately set up with simplified setting and somewhat less time consuming.

MATERIAL AND METHOD

A tool for tangential fields setting in breast irradiation is made of acrylic sheet of various thickness using pin and arch principle. Two pins are set perpendiculary on an adjustable arch. The arch is attached on the third pin, which is the front pointer pin. The front pointer is divided into two parts, the lower part is adjusted to set the depth of isocenter under the skin. The pin and arch set is attached on the axis between two arms of caliper, and on the caliper axis a commercial angle meter is attached to read the axis angle.

The tangential fields are positioned to encompass the entire breast, lower axilla and chestwall. They may extend to include the internal mammary lymph nodes. To include the nodes, the entrance of medial tangential field is typically placed about 3 cm contralateral to midline [6]. The procedure for the tangential field setting is described in the following sequence.

1. The patient lies supine on the breastboard which is placed on the simulator couch with the ipsilateral arm extended above the head to avoid the exposure of primary beam. The breastboard is raised up until the sternum is parallel to the horizontal plane to make the edge of entrance and exit beams parallel to the horizontal plane and coincide. The midline of the patient is also parallel to central axis of the simulator. In our technique for tangential fields, the inferior half of 45 degree wedges are used to irradiate with fall off of superior half of the beam.

2. The chestwall separation (a) is measured by two arms of caliper of the tool. The separation is divided into bisector by the front pointer pin. The mark on skin for isocenter is demonstrated at the tip of front pointer where the perpendicular line to bisector of the chestwall separation line and the skin intersect. The thickness of the breast (b), the length of perpendicular line, is determined by reading on the scale of the front pointer when the arms of caliper are placed along the edges of medial and lateral tangential fields and the front pointer tip is contacted to skin. At this setting

condition, the angle of tool axis which is the angle between chestwall separation line and the horizontal plane (α) is read from the angle meter (Fig. 1).

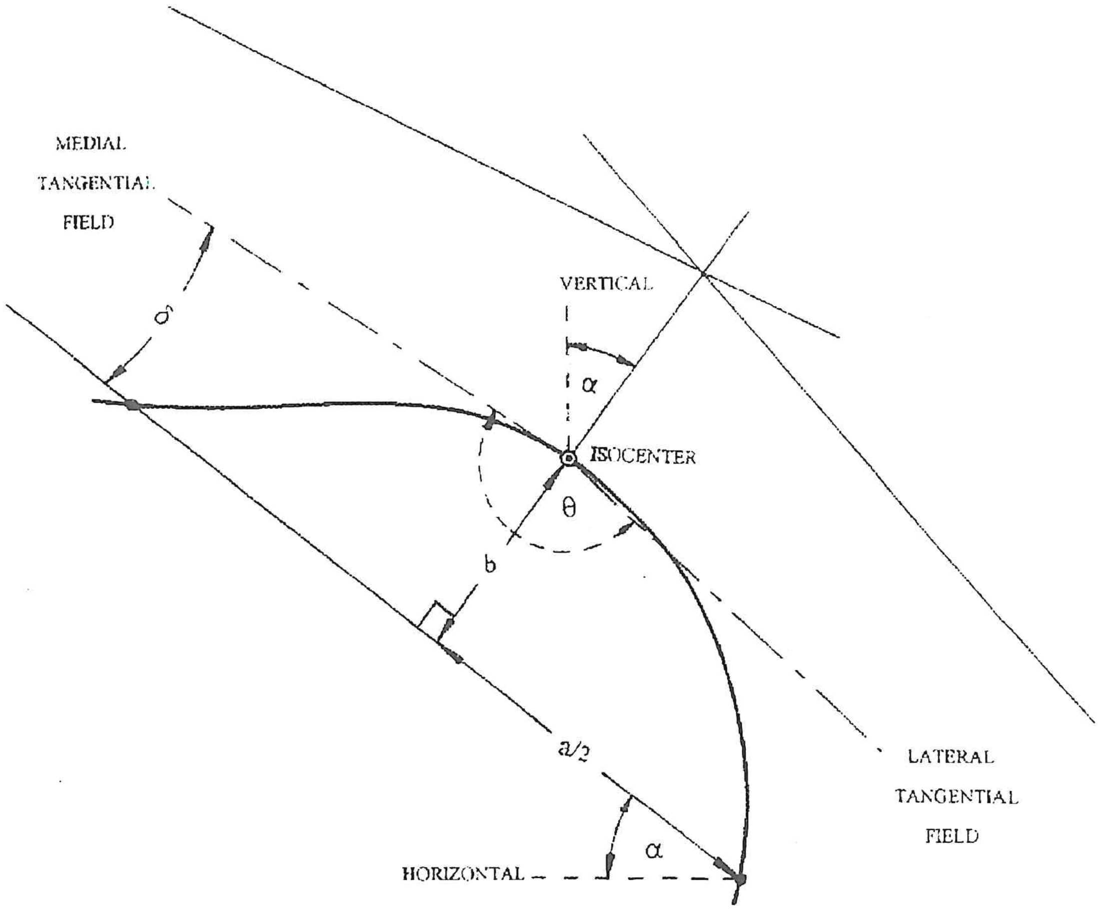


Fig. 1. Transverse patient plane containing the tangential field isocenter. The chestwall separation a , chestwall angle α , and breast thickness b are measured parameter. The breast thickness b is perpendicular distance from the bisector of separation line intersects to skin. The angle δ is half the divergence angle of the width of tangential fields.

3. The tungsten wire is placed on the opposite side of the beam edge. The simulation film is taken at the gantry angle where the two edges are coincidence. When the isocenter is set at the marking point, the gantry is rotated to 90 + α degree , the lateral tangential beam edge shifts from chestwall separation line by δ, where δ is half divergence angle of the beam width.

$$\delta = \sin^{-1}\left(\frac{b}{SAD}\right)$$

SAD = source to isocenter distance

Gantry angle for lateral field = $90 + \alpha + \delta$

To achieve the angle of medial tangential field, the gantry is further rotated by $180 - 2\delta$ degree.

$$\text{Gantry angle for medial field} = 90 + \alpha + \delta + (180 - 2\delta)$$
$$= 270 + \alpha - \delta$$

4. For a large breast, the front pointer pin is adjusted to set isocenter at the depth d under the skin along the perpendicular bisector of the separation line. The arch is rotated by α, skin marks for ceiling and wall lasers are pointed at the tips of perpendicular pins, and b is the half width of the beams. The setting angles are obtained by the same calculation (Fig.2).

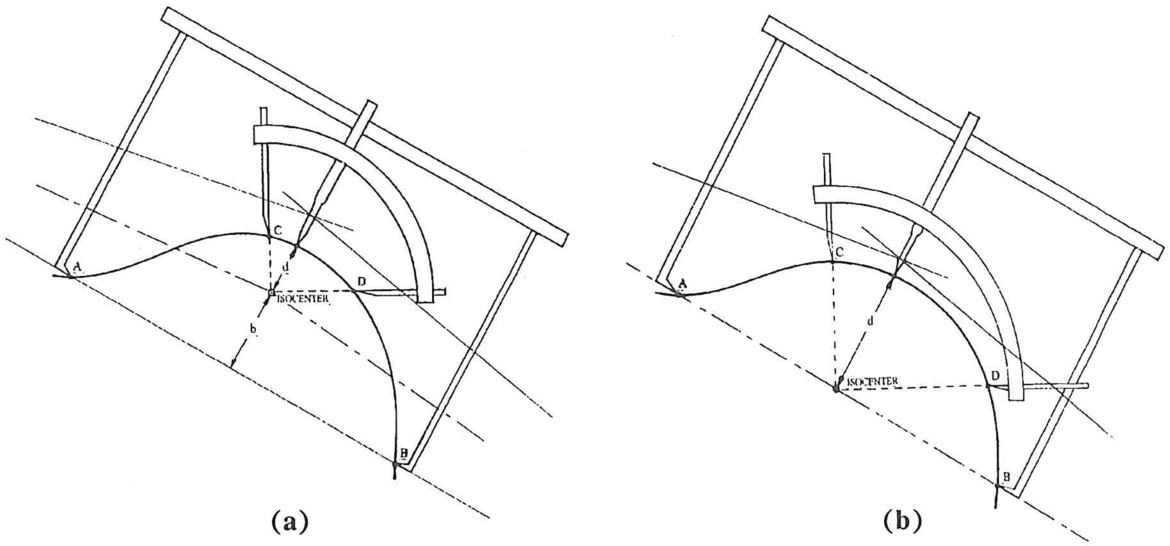


Fig. 2. Set-up geometry of the tangential fields using the tool (a) for a large breast. The distance b is the perpendicular of the isocenter to the separation line, while d is the depth of isocenter. Points A, B are the points of the edges of medial and lateral fields entrance and exit. Points C, D are the reference points for ceiling and wall lasers alignment. Fig. (b) is the set-up geometry for half beam block.

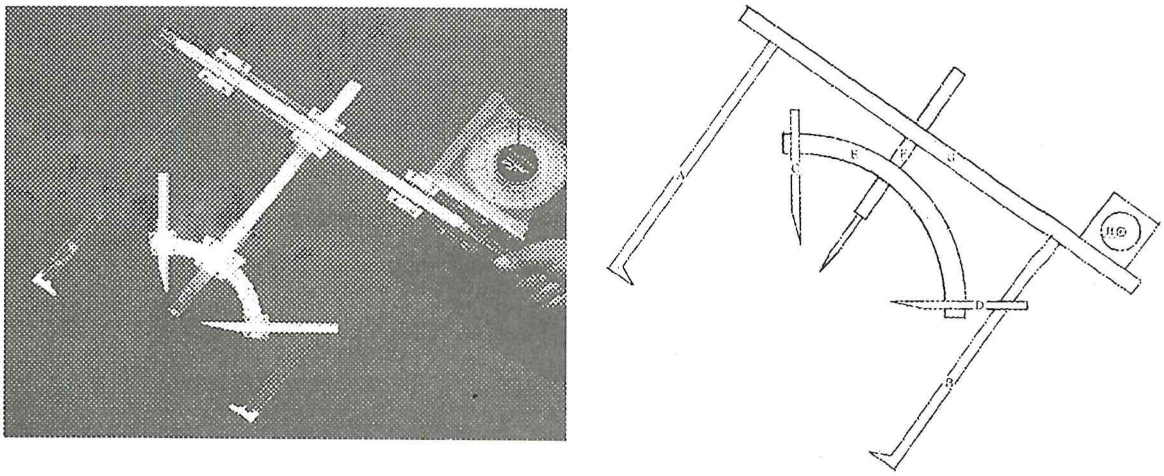
RESULT

A tool for tangential field setting for breast irradiation has been constructed. The caliper of the tool can be used to measure and set the chestwall separation from 6 to 30 cm. The breast thickness can be measured and set by front pointer pin from 0 to 14 cm. The isocenter can be set from 0 to 5.5 cm beneath the breast skin and the arch can be set from 20 to 70 degree clockwise and counter clockwise (Fig. 3). The weight of the complete set of the tool is approximately 690 grams.

Table 1. The difference of angles determined by the tool and simulator

	n	b(cm)	medial (˚)	lateral (˚)	θ (˚)
Total	66	4.21 ± 1.19	1.03 ± 0.83	0.77 ± 0.64	1.17 ± 0.74
Rt breast	30	4.10 ± 1.13	0.87 ± 0.72	0.92 ± 0.71	1.05 ± 0.64
Lt breast	36	4.31 ± 1.24	1.16 ± 0.90	0.66 ± 0.55	1.26 ± 0.81
		NS,p = 0.47	NS,p = 0.171	NS,p = 0.081	NS,p = 0.261

Sixty-six patients are set up by the tangential field setting tool for breast irradiation. There are 30 patients (45 %) of right breast cancer and 36 patients (55 %) of left breast cancer. The thickness of irradiated breast is 2.3 - 8.0 cm, which is no difference in means of thickness of right and left breast (p = 0.47). The difference of gantry angles of medial and lateral tangential breast fields, and angle between 2 fields are determined by the tool and simulator is ranged from 0-2 degrees. From table 1, it is shown that there is no significant difference between right breast and left breast.



(a) (b)

Fig. 3 (a). Shows a complete set of tangential field setting tool for breast irradiation. Fig. 3 (b). Shows the diagram, where A and B are the arms of caliper, C and D are the perpendicular pins, E is the arch, F is the front pointer pin, G is the angle meter, and H is the axis of which two arms of caliper, front pointer pin and angle meter are attached on.

DISCUSSION AND CONCLUSION

A simple tangential field setting tool for breast irradiation has been constructed. The tangential breast fields are treated with inferior half of beam with 45° wedges by the coincidence of edges of opposing fields. The isocenter of beam is set on skin at the center of chestwall separation of the breast. Simulation film is taken while a tungsten wire placed on the opposite side of beam edge and rotate the gantry until two edges are coincidence. The difference between setting by the tool and simulator verification sometimes caused by the curvature of skin and tilt of beam edges marked on skin of patient. The measurement of breast thickness and width of chestwall separation of the breast to set rotation point on skin by the tool helps to set beam dimension and direction easier and safe time for setting. If the thickness of the breast is bigger, the beam will be reduced, the depth of isocenter is set by front pointer pin and the arch is rotated by α. The medial and lateral tangential fields are set by the calculation when the wall and ceiling laser beams align on the perpendicular pins. Treatment by superior half beam may be set by the same modification using $\delta = 0$.

The match plane technique as previously described by the others is reguired [5, 6, 8, 9], however, in this series it is not used due to the sophisticate setting with the heavy and cumbersome of cerrobend blocks. Using the breastboard to make the tangential beam edges parallel to horizontal line causes the small gap or overlap of tangential field and supraclavicular field. To achieve the perfect matching of three fields, the supraclavicular area may be irradiated by half cephalad field as described by James, et.al.[10], whereas caudad half of tangential fields are also used. The half beams are accomplished by using the asymmetric jaws available from modern accelerators.

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