Six-Dual

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Dose Characteristics of Total-Skin Electron-Beam Irradiation with Six-Dual Electron Fields

Tae Jin Choi, Ph.D., Jin Hee Kim, M.D. and Ok Bae Kim, M.D.

Department of Therapeutic Radiology, School of Medicine Keimyung University, Taegu, Korea

Purpose : To obtain the uniform dose at limited depth to entire surface of the body, the dose characteristics of degraded electron beam of the large target-skin distance and the dose distribution of the six-dual electron fields were investigated.

Materials and Method : The experimental dose distributions included the depth dose curve, spatial dose and attenuated electron beam were determined with 300 cm of target-skin distance (TSD) and full collimator size (35×35 cm^2 on TSD 100 cm) in 4 MeV electron beam energy. Actual collimated field size of 105 cm $\times$ 105 cm at the distance of 300 cm could include entire hemibody. A patient was standing on step board with hands up and holding the pole to stabilize his/her positions for the six-dual fields technique. As a scatter-degrader, 0.5 cm of acrylic plate was inserted at 20 cm from the body surface on the electron beam path to induce ray scattering and to increase the skin dose .

Results : The full width at half maximum(FWHM) of dose profile was 130 cm in large field of 105 $\times$ 105 cm^2. The width of 100$\pm$ 10% of the resultant dose from two adjacent fields which were separated at 25 cm from field edge for obtaining the dose unifomity was extended to 186 cm. The depth of maximum dose lies at 5 mm and the 80% depth dose lies between 7 and 8 mm for the degraded electron beam by using the 0.5 cm thickness of acrylic absorber. Total skin electron beam irradiation (TSEBI) was carried out using the six dual fields has been developed at Stanford University. The dose distribution in TSEBI showed relatively uniform around the flat region of skin except the protruding and deeply curvatured portion of the body, which showed excess of dose at the former and less dose at the latter.

Conclusion : The percent depth dose, profile curves and superimposed dose

distribution were investigated using the degraded electron beam through the beam absorber. The dose distribution obtained by experiments of TSEBI showed within± 10% difference except the protruding area of skin which needs a shield and deeply curvatured region of skin which needs b o o s t i n g d o s e .

Key Words : Total-skin electron-beam irradiation

[7)
,

Mycosis fungoids   T-cell   ,

                    Salzman

          ,   ,   8)
    1, 2)   .

                              Antolak   13 mm $E_{p,0}$ 4.4 MeV
          180 cm (   )× 100 cm (   )   80%   1.12 cm
    10%
                                                    , 12

                    ,
    .   8)
                                                              Gaussian

          .   .

                                                    4 MeV
    10%   ,   -   300 cm   ,
          30%   7-8 mm   80%
          3) El-Khatib   4, 5)   ,
    6   ,
          ,   21   Stanford   9)   -6
                                        ,   74
    .   .
                                        ,
                              ,
                                                  ,
          Sewchand   6)
                                                            .
    .

          ,
                                        (ML-15MDX, Mitsubishi)   4 MeV
                    6)   ,
Brahme   10× 10 cm^2 -

100 cm 50-800 cGy
. (Total
Skin Electron Beam Irradiaton, TSEBI)
800 cGy/min .
TSEBI -
X - (35× 35 cm²) -
(Target-Skin Distance, TSD) 300 cm
105× 105 cm² .
20 cm
0.5 cm (240× 120 cm²)
(Fig. 1).
IC-10
(Capintec-192) ,

(180 cm× 180 cm× 3 cm)
,
20 cm ,
300 cm .

(25× 25× 25 cm)
(30× 30× 30 cm³) 2

,

.

0.5 mm, 10 cm
mm
, (latex) PS-
033 .
TG-21
.[10)
d PDD(d)
50 cm (Off-Axis Beam)
,
OAR(x, y) .
d
D(d) y , x ,
$$D(d) = Dmax \cdot PDD(d) \cdot OAR(x, y) \quad (1)$$
. , Dmax
(105× 105 cm²)
( ) .

90%
.

Stanford 6
.
90%

.
4 MeV
6
,
(Monitor Unit, MU) .
$$MU = \frac{TD}{UIC} \cdot CDOT \cdot Wt \quad (2)$$
TD (cGy), UIC(useful
isodose curve)
, Wt .
1
100 cGy , Fig. 1 120
3 (A),
(B)
.

Fig. 1
(odd fraction) (even
fraction) 6
.
(X-omat V,
Kodak), WP-102(Wellope,),
, (CaSO4:Dy)
(System 310, Teledyne) .
(Rando-Humanoid
Phantom)
6 12
,
(MU) .

1 mm 6 mm
CaSO4 : Dy
.

100 cGy
24 3 3%

.

10×
10 mm
44 30

4

, 25 mm ,

2 mm .

- 35× 35 cm^2 , -
300 cm 105 x 105 cm^2
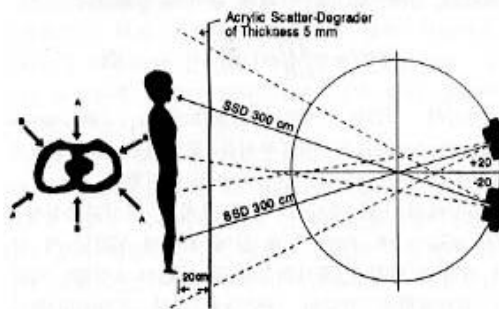. Fig. 1
20

.

TSD 300 cm

.

Fig. 1. Schematic diagram of the treatment set-up position. Patient is located at 300 cm distance from electron target. The irradiated gantry angles were 70° and 110° for each of six positions. The arrows of body cross-section indicates the direction of beam incidence (See text).

20 cm 0.5 cm
(120× 240 cm) .

(Full width at half maximum, FWHM) Fig. 2 a)
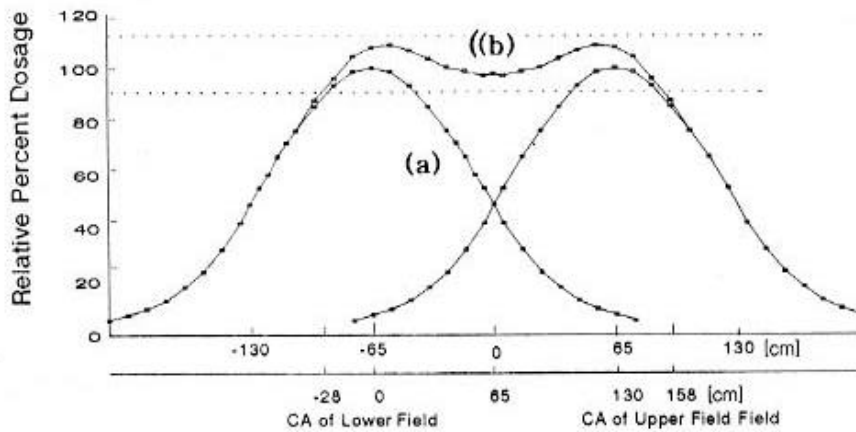130 cm , 80% 70 cm
.

130 cm ,
± 10% 186
cm ,
25 cm .

Fig. 2. The vertical beam profiles in free-space dose at 300 cm from the electron target is shown for a single beam beam with 5 mm thickness of acrylic spoiler (a) and for a resultant dose profiles of dual beam(b) with 25 cm off the field edge. The scale of lower axis represents the nomalized distance to central-axis of a lower single field.

4   cm^2 Fig. 3   a)   dmax

MeV   , TSD 100 cm   10× 10   8 mm, 80% d_{80} 15 mm   .

7-8 mm   80%

2-3 MeV

,   -   300cm

20cm   ,

Fig. 3   b)   105× 105 cm^2

d_{max} 5 mm, d_{80} 7.4mm,

d_{50} 10.7 mm   ,   15.5

mm   , E_o

2.5 MeV   .

4 MeV   2 %

,   2.3 %   .

50 c m

Fig. 3   C

.

6   2

,

100%

(MU)   .

6

.   dmax

(100 cGy)

Fig. 4a, 4b   ,   4 mm

, 8 mm   80%   .

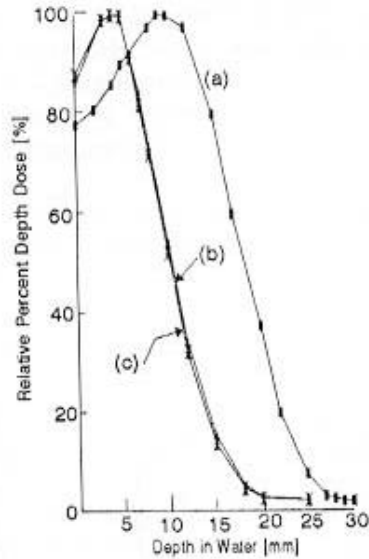90%   .

Fig. 3. The percent depth doses were measured in a water phantom to obtain the treatment planning data; (a) the percent depth dose of nominal energy 4 MeV, (b) the percent depth dose at central axis and (c) the percent depth dose at 50 cm off-axis distance of degraded electron beam energy E_o 2.5 MeV.
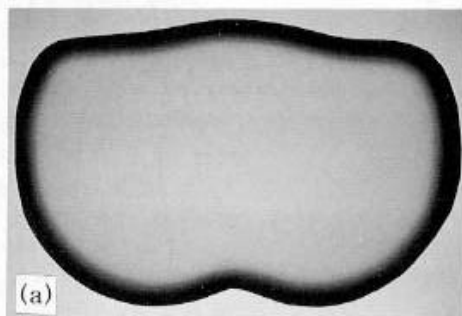

Fig. 4. The superficial irradiated with six-dual TSEBI showed an uniform dose below the skin surface except the concave region using the humanoid pelvic phantom (a) and dose distribution in-depth normalized to the dmax (4mm) in film dosimetry(b).

6

TSEBI . ± 3%

, .

, 30% Fig. 5a 5b

. , , ,

Fig. 5a 5b ,

74 , , , ,

3 2 6

. ,

Fig. 1

7 .

mm 200 cGy ,

6
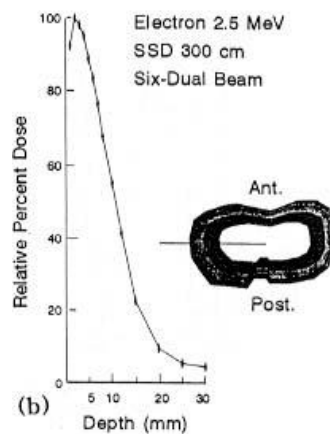
180± 20 .

cGy

Fig. 5. Radiation-absorbed doses measured using the TLD at various positons on a patient skin irradiated with six-dual beams angled ± 20 degrees and 0.5 cm acrylic degrader. All doses are in cGy relative to 180 cGy/fraction of anterior (a) and posterior(b).

,   ,

60-100%

mm   ,

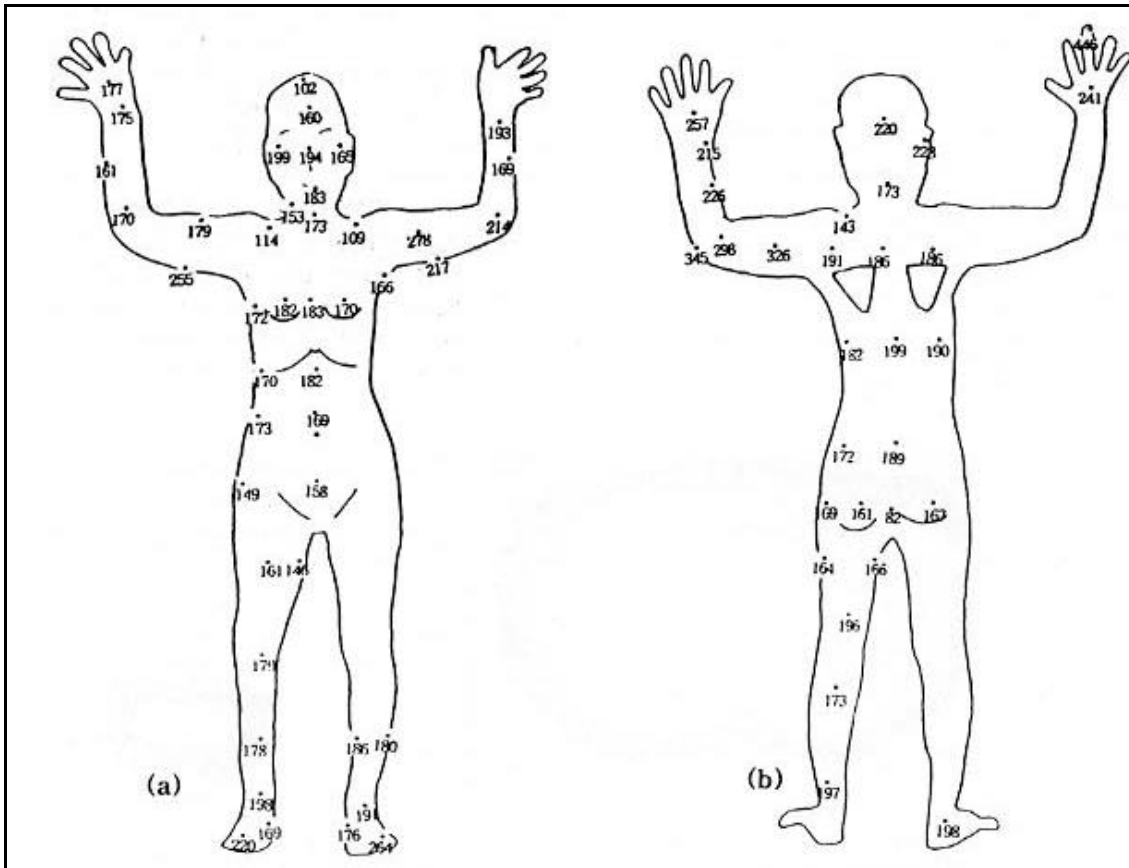. Mycosis fungoids   2 mm   .

7-8 mm   ,

2-3 MeV   2 mm

,[4]   ,   .

2-30 cm

.   ,

4 MeV   5 mm

E_o 2.5 MeV   ,   7-8   ,

mm   80 %   .

.

-                    Fig. 5a, 5b   Head

(TSD)   ,   ,

800 cGy/   TSD 300 cm   5 cGy/min

.   ,

,   .

.

,   (Slit

Beam)   ,

,   .

(Arc Beam)   6   in vivo

,   ,

[8]   .

20

,   ,

,   ,

4 MeV

.   .

3200 cGy   1   20 cm

7 mm   200 cGy/   TSD 300 cm   4

.   MeV   4 mm

Stanford   ,   7-8 mm   80%

6   .

± 15%

[9]   50 cm

6

30%   .

,   6

.

8

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Six-Dual

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:   mm
,   6
.
:   -   300 cm   ,
105× 105 cm² (-   35× 35 cm², TSD 100 cm)   4 MeV
,   ,   .
6
. 4 MeV
20 cm   0.5 cm
.
CaSO4:Dy   (1 mm   × 6 mm   )
74   .
:   -   300 cm   105× 105 cm²
130 cm   , 80%   86 cm   ,   FWHM
25 cm   100± 10%
186 cm   .   20 cm   0.5 cm   , 4 MeV
5 mm, 80%   7 mm, 50%   10.7 mm
2.5 MeV   .   50 cm
.

,
30%   60-100%   ,
,
.
:   2-3 MeV   mm   80%
,   .
6
± 10%   ,
,
.