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Evaluation of dose variation at the vertex during Total Skin Electron Beam

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Purpose : The vertex scalp is always tangentially irradiated during total skin electron beam(TSEB) This study was discuss to the dose distribution at the vertex scalp and to evaluate the use of an electron reflector, positioned above the head as a means of improving the dose uniformity.

Methods and Materials : Vetex dosimetry was performed using ion-chamber and TLD. Measurements were 6 MeV electron beam obtained by placing an acrylic beam spoiler in the beam line. Studies were performed to investigate the effect of electron scattering on vertex dose when a lead reflector, 40×40 cm in area, was positioned above the phantom.

Results : The surface dose at the vertex, in the without of the reflector was found to be less than 37.8% of the skin dose. Use of the lead reflector increased this value to 62.2% for the 6 MeV beam.

Conclusion : The vertex may be significantly under-dosed using standard techniques for total skin electron beam. Use of an electron reflector improves the dose uniformity at the vertex and may reduce or eliminate the need for supplemental irradiation.

= 국문 초록 =

전신 피부 전자선 조사(TSEB)시 두정부(Vertex)에서의 선량 변화 평가

목적

전신피부 전자선 치료시 두정부의 scalp는 항상 사방향으로 입사된다. 본 연구는 두정부에서의 선량균등성을 향상시키기 위한 목적으로 본원에서 자체 제작한 전자선 반사체(electron reflector)를 두정부의 scalp 위치에 놓아 반사되는 전자선을 이용하여 선량변화를 조사하고 전자선 반사체의 효용성을 평가하고자 한다.

대상 및 방법

두정부에서의 선량측정은 6 MeV 전자선을 이용한 전리조(Ion-chamber)와 열형광선량계(TLD)를 사용하였고, 산란되는 전자선의 영향을 평가하기 위해 자체 제작한 40×40 cm^2, 1 mm 두께의 전자선 반사체를 팬톰위에 위치시켜 선량을 측정하였다

결과

두정부에서의 표면선량은 전자선 반사체를 사용하지 않았을 때에 37.8%로 나타났으며, 이에 반해 반사체를 사용하였을 때는 62.2%의 선량증가를 나타내었다.

결론

일반적으로 시행되는 전신피부전자선조사는 두정부에서의 under-dose를 확인할 수 있었고, 본원에서 자체 제작한 전자선 반사체 사용시 두정부에서의 선량 균등성이 향상되어 추가적인 치료가 필요치 않을 것으로 생각된다.

Introduction

Mycosis fungoides(MF) is the most common type of cutaneous T-cell lymphoma. The natural history of mycosis fungoides last for a months or may extend over decades. Before involving nodes and viscera, the clinical course is usually confined to the skin for a long time. Mycosis Fungoides is a highly radio-sensitive disease that total skin electron beam therapy (TSEB) can cure localized disease.

Total skin electron beam is an effective treatment for mycosis fungoides. The goal is to deliver a uniform dose to the skin, generally patients were treated with total skin electron beam therapy in the standing position.

A six-dual fields techniques was used to deliver 2 Gy in two days, treating 4days per week, to a total dose of 35 to 40 Gy using a degraded 6 MeV electron beam with an effective central axis energy of 6 MeV is used to treat three anterior and three posterior stationary treatment fields, each having a superior and inferior portal with beam angulation 18 degrees above and 18 degrees below the horizontal axis(Fig. 1). The patient is placed in front of the beam in six positions during treatment the straight anterior, right posterior oblique, and left posterior oblique, fields are treated on the first day of each treatment cycle and the straight posterior, right anterior oblique and left anterior oblique fields are treated on the second day of each cycle(Fig. 1).

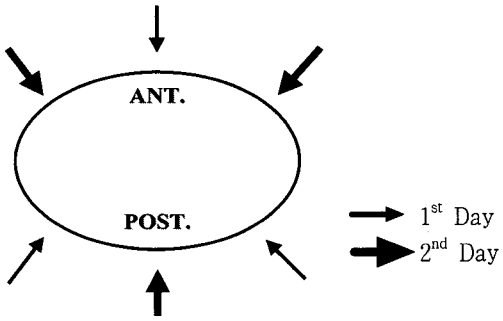

Fig. 1. Actual six-dual field techniques for TSEB radiotherapy.
- 1st day : (AP / RPO / LPO) × 2
- 2st day : (PA / RAO / LAO × 2

The vertex of the scalp is always tangentially irradiated during total skin electron beam. This study was to discuss the dose variation at the vertex scalp for a commonly used irradiation technique and to evaluate the use of electron reflector, positioned above the head as a means of improving the dose uniformity.

Methods and Materials

Total skin electron beam is delivered at our institution using 6 MeV electron produsd by a

varian 2100 C/D accelerator(Varian Associates Inc., Palo Alto, CA). Phantom are exposed at a source to skin distance(SSD) of 370 cm with dual fields angled 18° above and below the horizontal(Fig. 2). An archylic beam spoiler 1cm in thickness, can be positioned in front of phantom. The phantom was positioned in the treatment plane with the upper surface at a height of 170 cm to simulate the top of a phantom head.

The effects of electron backscattering were measured using a sheet of lead positioned above the phantom as shown in Fig. 3. The size of the electron reflector was 40×40 cm with a thickness of 1.0 mm to ensure full back-scatter. the effect of the reflector on vertex dose and to evaluate the variation of dose with the angulation(20°, 30, 40°, 50°) of the reflector and its distance(5 cm, 10 cm, 15 cm, 20 cm, 25 cm, 30 cm) above the phantom.

Dosimetry at the vertex scalp was measured using a parallel plate ionization chamber(Model ps-033, Capintec Inc., Montvale, NJ) and thermoluminescent dosimeter(TLD)(Fig. 3).

Results and Discussion

Results of the ion chamber measurements are

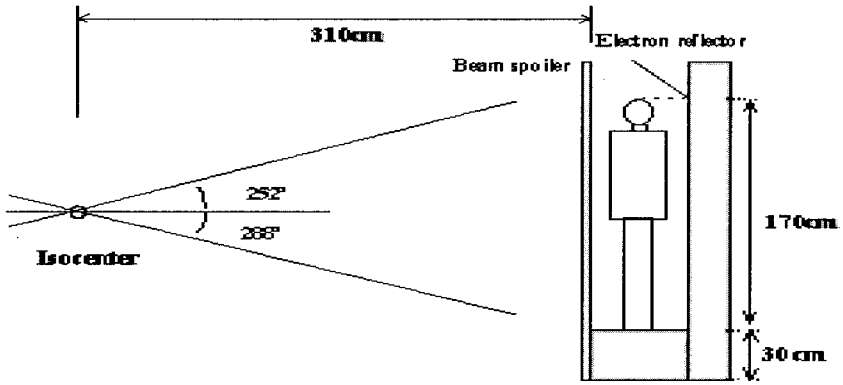

Fig. 2. The geometry for TSEB using dual angled fields. Phantoms were positioned as shown for the investigation of vertex dose.

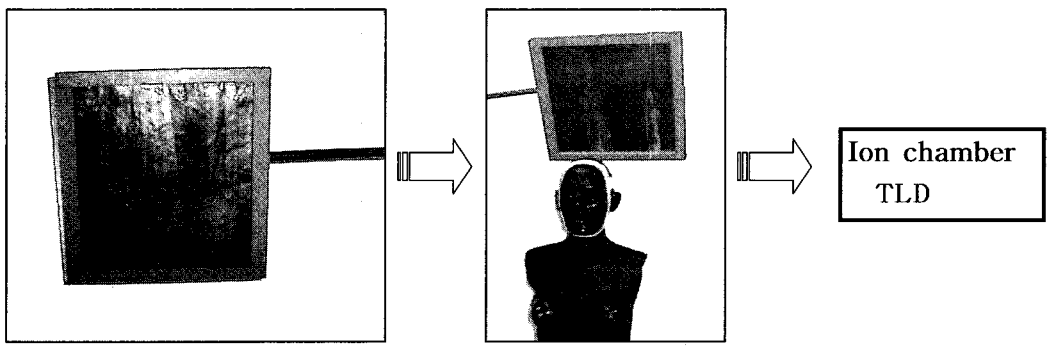

Fig. 3. Illustration of experimental process.

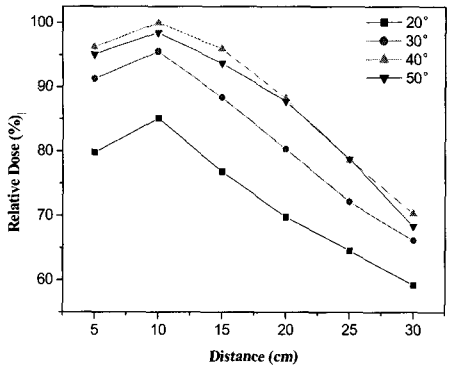

Fig. 4. Variation of surface dose at the vertex with electron reflector. Measurements were using ion-chamber

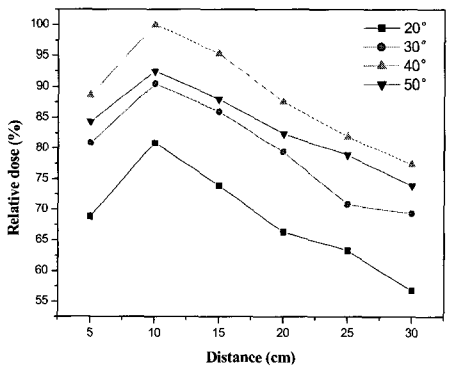

Fig. 5. Variation of surface dose at the vertex with electron reflector. Measurements were using TLD

shown in fig. 4, 6, Fig. 5, Shows TLD measurements were relative dose (%) to 100% at a electron reflector angle of the reflector to phantom distance was 10 cm measurements.

Fig. 4, 5 shown the skin dose increase for electron reflector angle 40 degrees, distance 10cm. Figure. 6. show results comparison with and without the electron reflector. use of electron reflector results in additional scatter that increases the surface dose at the vertex to 62.2%.

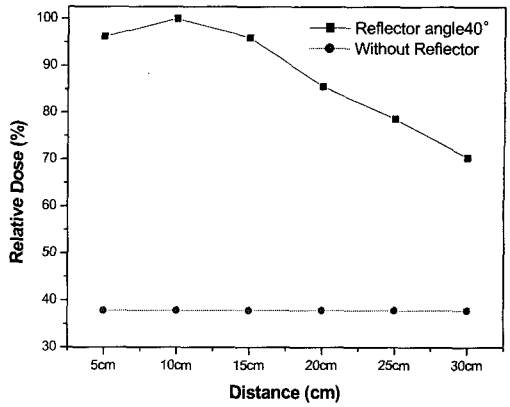

Fig. 6. Variation of skin dose at the vertex Comparison with and without electron reflector. Measurements were performed using ion-chamber

Conclusion

The vertex scalp may be significantly underdosed using standard techniques for total skin electron beam therapy. Use of an electron reflector may improve vertex dose as a result of increased scattering of electrons in the forward direction ; however a greater enhancement of dose can be achieved using electrons backscatter from a reflector positioned above the head.

References

1. Bjarngard BE, Chen GTY, Piontek RW, et al. Analysis of dose distributions in whole boby superficial electron therapy. Int J Radiat Oncol Biol Phys 1977 ; 2 : 319-324.
2. Kumar PP, Patel IS. Comparison of dose distribution with different techniques of total skin electron beam therapy. Clin Radiol 1982;33:495-497
3. Fraass BA, Roberson PL, Glatstein E. Wholeskin electron treatment:Patient skin dose

distribution. Radiology 1983;146:811:814.
4. Weaver RD, Gerbi BJ, Dusenbery KE. Evaluation of dose variation during total skin electron irradiation using thermoluminescent dosimeters. Int J Radiat Oncol Biol Phys 1995 ; 33 : 475-478. for radiation therapy. Int J Radiat Oncol Biol Phys 1995; 33 : 695-703.
5. Peters VG, Jaywant SM. Implementation of total skin electron therapy using an optional high doserate mode on a conventional linear accelerator. Med Dosimetry 1995 ; 20 : 99-104.
6. Jones GW, Hoppe RT, Glatstein E. Electron beam treatment for cutaneous T-cell lymphoma. hematol/Oncol Clin North Am 1995 ; 9 : 1057-1076.
7. Antolak JA, Cundiff JH, Ha CS. Utilization of thermoluminescent dosimetry in total skin electron beam radiotherapy of mycosis fungoides. Int J Radiat Oncol Biol Phys 1998 ; 40 : 101-108.
8. Meyler TS, Blumberg AL, Purser P. Total skin electron beam therapy in mycosis fungoides. Cancer 1978 ; 42 : 1171-1176.
9. Tadros AAM, Tepperman BS, Hryniuk WM, et al. Total skin electron irradiation for mycosis fungoides : Failure analysis and prognostic factors. Int J Radiat Oncol Biol Phys 1983 ; 9 : 1279-1287
10. Nisce LZ, Chu FCH, Lee HS, et al. Total skin electron beam therapy for cutaneous lymphomas and leukemias. Int J Radiat Oncol Biol Phys 1982;8:1587-1592.
11. Lambert GD, Sandland MR, Whitton AC, et al. Combining backscattered electrons and low energy photons to improve the dose distribution to an eyelid. Int J Radiat Oncol Biol Phys 1985 ; 11 : 617-620.
12. Das IJ, Coia LR, Tabata T. Harvesting backscatter electrons
13. Saunders JE, Peters VG. Back-scattering from metals in superficial therapy with high energy electrons. Br J Radiol 1974 ; 47 : 467-470.