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The comparison of standard lead with individual mold shielding on patient dose

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► *Technical note*

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ABSTRACT

Background: The Shielding methods in radiotherapy due to delivering an accurate radiation dose to cancer tissues and avoiding unnecessary dose to normal tissues are very important. These methods include Lead standard blocks, individual molding and multi leaf collimator (MLC). The MLC method is not still common in Iran radiotherapy centers. Individual molding is better than the lead block shielding because of lower operator error and time consuming. ***Materials and Methods***: This study was performed in Shahid Ramazanzade radiotherapy center of Yazd and intended to compare radiation dose due to the two shielding methods of lead and Cerrobend. The radiation field sizes of head and neck, pelvis, and breast cancer treated by Cobalt unit, 9MV, and 6MV photon beams of Neptun and Compact linear accelerators were studied, respectively. The Absolute and Relative dosimetry were achieved by Farmer ionic chamber and diod detector. ***Results***: The Absolute and Relative dose values which were measured at the two shielding methods of lead standard and Cerrobend individual molding were similar without significantly difference. ***Conclusion***: The miss difference dose between these two methods shielding and the advantages such as saving time, precision, and accuracy lead to preference of individual molding method rather than the lead block shielding.

Keywords: *Shielding, Cerrobend block, lead block, absorbed dose, relative dose, percent depth dose, absolute dose.*

INTRODUCTION

The aim of radiotherapy is to deliver an accurate dose to cancerous tissues and simultaneously to avoid unnecessary dose to normal tissues. Therefore, it is essential that the radiation field shape be as perfectly individualized for the patient as possible. The shielding methods include: Lead standard blocks, Cerrobend molding blocks, and Multi Leaf Collimator. The standard blocks shielding cannot be used for all the patients and in conformal radiotherapy planning, beam field shapes are created by Multi Leaf Collimator (MLC) [(1)]. In Iran the uses of the LINACs equipped with MLC are not still usual, but the Cerrobend shielding method is equipped with automatic cutter system is common.

The purpose of the present study was to study the effect of the two shielding methods, lead standard block and Cerrobend molding block on Absolute and Relative absorbed dose in the clinical conditions. As known, the individual patient shielding method reduces operational errors and increases facility and precision operation. In this study, dose distribution in the various water depths, due to the 6 MV, 9 MV and ^{60}Co photon beams was exposed to various field sizes shielded by the two methods of Cerrobend and lead blocks were compared.

MATERIALS AND METHODS

This study was performed in Shahid Ramazanzade Radiotherapy Center, Yazd, Iran. The information of radiation field shapes of 23 patients with head and neck cancers treated by ^{60}Co unit (Phoenix, Nordiac, Canada) and 6 patients with breast cancer treated by 6MV X-ray beams (Elekta, Compact, England) and 10 patients with pelvic cancer treated by 9 MV photon (Neptun, 10PC, Poland) were used. The mold shielding system used an auto cutter (PAR Scientific Model ACD-4MK4, Denmark) and material of molding was Cerrobend (Cerron Metal Products Company, Bellefonte, PA) (2-6). The Cerrobend was Cadmium free alloy contained 50% bismuth, 13% tin and 32 % lead. The standard lead block shapes were cubic, pyramidal, and cylindrical shapes with different thicknesses which were proportional to photon energy (7, 8). The use of Cerrobend alloy is common due to its low melting point, high attenuation coefficient of photon beam, non-toxicity and less Bremsstrahlung ray due to electron beam (9). The thicknesses of standard block and the Cerrobend shields of ^{60}Co-machine, was 5 cm and for 6MV and 9MV Photon beams were 7 cm.

The field sizes data of 23 patients with head and neck cancers treated by Cobalt unit were randomly selected. Scanditronicx Wellhofer Farmer type ionization chamber (FC65-G) with active volume of 0.65 cm^3 and Dose-1 electrometer were used. The detector was positioned at isocentric beam at 1.5, 3, 5, 7, 10 and 12 cm water depth (SSD= 80cm) in a 30×30×30 cm^3 water phantom. All of the measurements were achieved for 23 irregular fields shielded by Cerrobend and lead blocks. Percent depth dose (PDD) data were collected by RFA-300 Plus water phantom, Wellhofer Omni Pro software. The radiation field shapes were shielded by Cerrobend and lead blocks methods. The field sizes of 8 patients with pelvic cancer treated by 6MV photon beam of Elekta linear accelerator was selected randomly. The Dosimetry was carried out by FC65-G chamber and Dose-1 Electrometer for 8 irregular fields shielded by Cerrobend and lead blocks methods. The measurement conditions were SSD=100cm, and 1.5, 3, 5 cm water depth. These conditions were repeated for irregular field sizes of 6 patient with breast cancer treated by 6 MV photon (Elekta LINAC) and 10 patient with pelvic cancer by 9MV photon beam (Neptun LINAC) and dosimetry was achieved only at 3cm solid water depth by a Daily QA3 (Sun Nuclear).

RESULTS

Table 1 shows the mean values and standard deviations of percent depth doses at the 0.5, 1, 5, 10, 15 and 20 cm water depths for different field sizes of 23 patients with head and neck cancers treated by Cobalt machine. All of these 23 field sizes were shielded by Cerrobend and lead block methods. The mean PDD values in the various water depths for two methods of shielding statistically were not significantly different according to one-way ANOVA.

Table 2 shows the Mean ± SD of doses in the water depths include 1.5, 3, 5, 7, 10, and 12 cm for the 23 different field sizes shielded by Cerrobend and lead blocks methods. The mean Absolute doses in the various water depths due to these two methods of shielding were not statistically significantly different.

Table 3 shows the Mean ± SD doses at 1.5, 3 and 5 cm water depths for the 8 various field sizes. These field sizes belonged to the 8 pelvis cancer patients shielded by Cerrobend and lead blocks methods and treated by 6 MV photon beam.

Table 4 shows the Mean ± SD doses at 3 cm solid water depth of 6 various radiation field sizes of breast cancer patients shielded by

Table 1. The Mean ± SD percent depth doses in 0.5 to 20 cm water depths for the 23 different field sizes shielded by lead, Cerrobend block methods, and exposed by Co^{60} machine.

Depth (cm)	Dose (cGy) Lead shielding	Dose (cGy) Cerrobend shielding	P, value
0.5	100±0	100±0	-
1	98.97±0.68	99.12±0.64	0.45
5	80.92±2.48	80.67±2.39	0.72
10	58.08±2.89	58.4±3.17	0.72
15	41.52±2.88	41.5±3.36	0.98
20	29.55±2.58	29.44±3.02	0.8

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Cerrobend and lead blocks methods, and treated by 6 MV photon beam. At the second row of this table, it is shown, the Mean and SD doses at 3 cm solid water depth of the 10 various radiation field sizes of pelvis cancer shielded by lead and Cerrobend methods and treated by 9MV photon beam.

Table 2. Mean ± SD of doses in the various water depths include 1.5, 3, 5, 7, 10 and 12 cm for the 23 patient field sizes exposed by Co^{60}, SSD = 80 cm.

Depth (cm)	Dose (cGy) Lead shielding	Dose (cGy) Cerrobend shielding	P, value
1.5	113.98±23.58	114.3±23.29	0.96
3	105.42±20.66	105.73±20.98	0.96
5	93.33±18.5	93.42±16.92	0.98
7	81.35±14.4	81.85±14.23	0.91
10	66.64±10.84	67.17±10.73	0.86
12	58.02±10.13	58±9.61	0.99

Table 3. Mean ± SD doses in 1.5, 3 and 5 cm water depths of phantom for the 8 patient various field sizes, SSD = 100 cm.

Depth (Cm)	Dose (cGy) Lead shield	Dose (cGy) Cerrobend Shield	P, value
1.5	103±4.73	103 ±4.58	0.94
3	101.18±5.15	100.13±5.17	0.97
5	98.17±6.67	96.66±7.18	0.97

DISCUSSION

In this study, the effect of lead block and Cerrobend shielding methods on Absolute and Relatively dose in various patient field sizes was compared.

The dose distribution assessment in various field sizes shielded by Cerrobend was recommended by Taherkhani *et al* . [10].

Iftekhar *et al.* reported that the effects of field size, beam energy and shield size on the beam output had almost the same pattern for both lead and Cerrobend shielding blocks [11]. The influences of shielding on the output of a Cobalt unit and seven various accelerators were investigated and the loss in output due to shielding blocks was calculated by Dam *et al* .[12]. The results showed that the calculation algorithm is correct in the most clinical conditions; however, for the blocks close to the central beam axis, an output overestimate was found by the algorithm [12]. When a block and tray are placed in an X-ray beam the dose to a point in a phantom is changed by the following factors: (1) attenuation of photon and electron beams due to the accelerator head (2) decrease in phantom scatter due to reduction of expose to phantom volume, and (3) scattering off due to tray and block. The scatter off a block could affect on incident photon fluency as much as 2 %. This block scatter amount depends on the length of inner block edge and block size which is irradiated [12].

The results of this study showed there was no statistically significant difference between the Cerrobend and lead blocks scattering at various water depths in the clinical conditions. The Cerrobend block was made divergent; therefore, they produced lower penumbra compared to standard lead block and the normal tissues around of tumor were received lower dose. This property together with user facility, saving time, and accuracy in shielding were advantages of using Cerrobend block instead of lead standard block. Furthermore, relatively and Absolute dose in different depths under the shielded fields by these two methods in the clinical conditions were no statistically significant different. These results were consistent with Buenfil *et al.* report, in which; “dose values measured by TLD for fields blocked by lead and Cerrobend blocks were statistically consistent”. They showed lower values output radiation when lead blocks were used ,due to the lead blocks and the Cerrobend thickness were 8.2 and 7.6 cm, respectively, and lead density was 1.2 times of Cerrobend density;

Table 4. Dose value of patients with breast and pelvis cancer at 3 cm depth shielded by Cerrobend and lead blocks.

Cancer	Photon beam	Dose (cGy) Lead shield	Dose (cGy) Cerrobend shield	n	P, value
Breast	6MV	209.23±21.5	209.2±21.7	6	0.99
Pelvis	9MV	94.96±16.9	94.75±16.88	10	0.95

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therefore, in a given Cerrobend thickness, lower radiation transmission would be expected[13]. In the present study Cerrobend and lead blocks thickness were 5 cm for Co unit and 7 cm for 9 MV and 6 MV photon beams.

CONCLSIONS

Based on the results and comparisons with the some previous studies it was concluded that the use of Cerrobend shielding method, in addition to the advantages such as saving time, reproducibility, penumbra decreasing, user facility and precision does not exhibit any statistically significant differences in isocenter doses compared with lead block; therefore, using the Cerrobend shielding method is recommended.

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Conflicts of interest: *none to declare.*

REFERENCES

1. Jeraj M and Robar V (2004) Multi leaf collimator in radiotherapy. *Radiol Oncol, **38(3):** 235-40.*
2. Famiglietti R, Noriega B, Sanders R (1990) A standardized block fabrication technique. *Med Dosim, **15**:151-8.*
3. Blackwell CR and Amundson KD (1990) Cadmium free lead alloy for reusable radiotherapy shielding. *Med Dosim, **15**:127-9.*
4. Li FM, Luo W, He ZC (2007) Dosimetric analysis of radiotherapy with middle shielding blocks of different widths at the lower cervical supraclavicular field for stage N2-3 nasopharyngeal carcinoma. *Ai Zheng, **10**:1127-32.*
5. Ravichandran R, Binukumar JP, Davis CA (2009) Simple technique for fabrication of shielding blocks for total body irradiation at extended treatment distances. *Indian J of Med Phy, **34** (4): 223-5.*
6. Ravichandran R, Krishnamurthy K, Sivakumar SS, Davis CA, Mohanti BK, Ghamrawy KE (2006) Dosimetry of large field photon irradiations at extended treatment distances with linear accelerators. *J Med Phys, **31**:126-7.*
7. Ravichandran R, Binukumar JP, Kannad hasan S (2008) Testicular shield for para-aortic radiotherapy and estimation of gonad doses. *Med Phys, **33(4):** 158-61*
8. Wojcicka JB, Yankelevich R, Werner BL, Lasher SE (2008) Technical Note: Cerrobend shielding for 18-22 MeV electron beams. *Med Phys, **35(10):** 4625-4629.*
9. Cruzet RU (2009) Comparison between clinically used irregular fields shaped by Cerrobend blocks and by multileaf collimator using a Clarkson sector integration computer program. *IFMBE Proceedings, **25**:867-70.*
10. Taherkhani A, Mohammadi M, Saboori MS, Changizi V (2010) Evauation of the physical characteristic of Cerrobend blocks used for radiation therapy. *Iran J Radiat Res, **8(2):** 93-101.*
11. Iftikhar A, Wazir M, Kakakhali MB, Sbilal A, Amjad H, Khwaja A (2010) Comparison of Lead and Cerrobend Blocks for Incident Photon Flux of 6 and 15 MV X-ray. *Iran J cancer Prev, **1:** 10-14.*
12. Dam JV, Bridier A, Lasselin C, Blanckaert N, Dutreix A (1992) Influence of shielding blocks on the output of photon beams as a function of energy and type of treatment unit. *Radiotherapy and Oncology, **24**; 55-59.*
13. Buenfil AE, Rodriguez-Gonzalez MF, Gonzalez GR, Brandan ME (2006) Absorbed dose and transmission factor in blocked fields for radiotherapy treatments with 6MV X-ray. *Clin Transl Oncol, **8(4)**:279-83.*

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