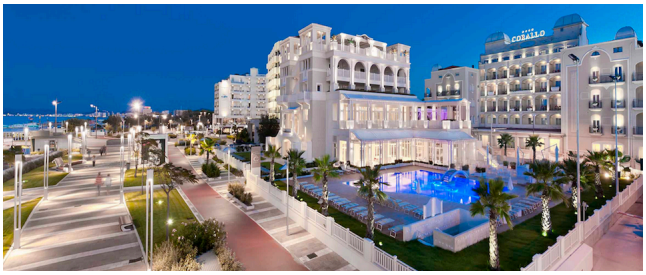

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Electron beam modulation by 3D printed plastic samples

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Nowadays, modulation of the electron beam depth dose distributions in radiation therapy sessions is provided by sets of tissue equivalent plates or individually shaped thermoplastic boluses.
In this study we propose to use 3D printed samples for depth dose distribution modulation in electron radiotherapy. This approach allows producing patient-specific boluses and compensators. The aim of this study is to prove possibility of electron beam dose modulation by plastic samples produced with 3D printed approach.
The 3D printed test samples with 10x10 cm2 transverse size made of ABS plastic is used for experimental study. This sample has three different functional areas: for partial beam absorption (2 cm thicknesses) with two collimation holes of 0.5 cm and 1 cm diameters; the wedge filter with thickness varied linearly from 5 cm to 0 cm, and semicircle shaped non-linear absorber of 5 cm radius.
The experimental study is performed using Elekta Synergy accelerator as a source of electron beams of 6 and 12 MeV energies. The modulated beam shape is obtained by Gafchromic EBT3 dosimetry film and universal detector array MatriXX. Experimental study is performed for two geometries: with test sample set in accelerator applicator and on the surface of tissue equivalent. The first geometry means sample application as compensator, while second one as a bolus.
In this study we prove the possibility of electron beam modulation by plastic sample produced by fused deposition modeling. The 1 cm collimation hole allows circular beam shaping. It is revealed that collimator positioning in applicator causes broadening of the shaped radiation field because of influence of electrons scattered in air. Propagation of electron beam through 0.5 cm collimation hole leads to dose increasing in its area by less than 5%. The latter is caused by electron scattering at the edge of two media. Wedge-shaped filter allows radiation field modification. The semicircle shaped absorber provide total absorption for 6 MeV and 12 MeV electrons and dose increasing on its edges is obtained only for bolus geometry and both considered beam energies.
Performed investigation shows applicability of 3D printed samples to modulate clinical electron beam. The efficiency of beam modulation is compared for two geometries, simulating bolus and compensator application.

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