EVALUATION OF DOSIMETRIC PARAMETERS OF GZP6 HDR BRACHYTHERAPY UNIT BY MONTE CARLO SIMULATION, TREATMENT PLANNING SYSTEM, RADIOCHROMIC FILM AND THERMOLUMINESCENCE DOSIMETRY

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Evaluation of the accuracy of a treatment planning system plays a vital role in the quality assurance of the treatment of patients. The aim of this study is to assess dosimetric characteristics of a GZP6 brachytherapy unit, being used in Reza Radiation Oncology Center (in Mashhad, Iran). GZP6 ^{60}Co afterloading HDR unit (Nuclear Power Institute of China) has 6 channels with five non-stepping sources in channels 1-5 and a stepping source in channel 6. Dosimetric parameters introduced by Task Group No. 43 (TG-43) of American Association of Physicists in Medicine were obtained by MCNPX Monte Carlo (MC) code simulations for the GZP6 No. 3 brachytherapy source. Dose distributions around sources No. 1, 2 and 5 when loaded in tandem applicator were measured by radiochromic film (RCF) dosimetry. For this purpose EBT radiochromic film was employed. The latter results were compared with those obtained by simulation and the GZP6 treatment planning system (TPS). Maximum rectum and bladder doses incurred during 40 treatment sessions by patients who endured brachytherapy of cervical or vaginal cavity were measured. The rectum dose measurement was performed by thermo luminescence dosimetry (TLD) method. The TLD results were compared with corresponding values provided by TPS and also with the values reported by the Reza Radiation Oncology Center for rectum and bladder dose. Air kerma strength for source No. 3 obtained by in-air measurement, Monte Carlo simulation and TPS were respectively equal to 16991.83, 17240.01 and 15355 μGym^2h^{-1}. Dose rate constant for the source No. 3 was also obtained as 1.104 ± 0.03 $cGyh^{-1}U^{-1}$ by Monte Carlo simulation. Comparisons of dose distributions in the longitudinal plane acquired by the three mentioned methods for sources No. 1, 2 and 5 revealed that (when considering the associated errors with the methods) there is a good agreement between the results attained for sources No. 1 and 2 (differences of 4% and 7% exist between simulation and measurement respectively for sources 1 and 2; and differences of 4% and 5% exist between simulation and TPS respectively for sources 1 and 2). As sample, dose distributions around tandem applicator for source No. 1 from MC, GZP6 TPS and RCF dosimetry are presented in Figure 1 and Figure 2. However, the agreement is not so good for source No. 5 (differences up to 16% exist between simulation and measurement at some points). The average of maximum rectal and bladder dose values were found to be 7.62 Gy (range 1.72-18.55 Gy) and 5.17 Gy (range 0.72-15.85 Gy) respectively. A summary of measured rectum and bladder dose relative to the prescribed dose, in the form of various relative dose ranges and the number of cases in each dose range, is listed in Table 1. It has been recommended by the ICRU that the maximum dose to rectum and bladder in intracavitary treatment of vaginal or cervical cancer should be lower than 80% of the prescribed dose to point A in the Manchester system. In this study among the total number of 40 insertions, maximum rectal dose in 29 insertions (72.5% of treatments sessions) and maximum bladder dose in 18 insertions (45% of treatments sessions) were higher than 80% of the prescribed dose to the point of dose prescription. The results of

dose measurement for rectum are in agreement with the results acquired by the GZP6 treatment planning system. The agreement is poor for the bladder dose. The results of rectum and bladder dosimetry were different from the dose values reported by Reza Radiation Oncology Center for the dose of rectum and bladder. The dosimetric parameters acquired for the GZP6 source No. 3 can be used as input to the GZP6 treatment planning system toward improvement of the accuracy of dose values presented by this system. The accuracy of dose distributions achieved by the GZP6 treatment planning system for the sources No. 1 and 2 are acceptable, but dose distribution consistency accordingly in the regions near the tip and body of the applicator is not satisfactory. The differences between dose distributions for source No. 5 can be related to the errors in the activities of active pellets' present in this source, certified by the source manufacturer. In-vivo dosimetry for patients undergoing treatment by GZP6 brachytherapy system can be used for evaluation of the quality of brachytherapy treatments by this system. The information presented here can be used as a base for developing the strategy for treatment of patients treated with GZP6 system.

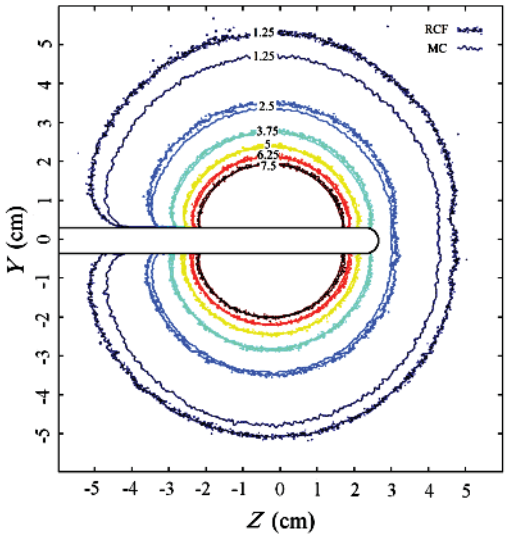

Figure 1. Dose distributions (in Gy) for the source No. 1 around the tandem applicator in longitudinal plane as obtained by RCF measurements and MC simulations.

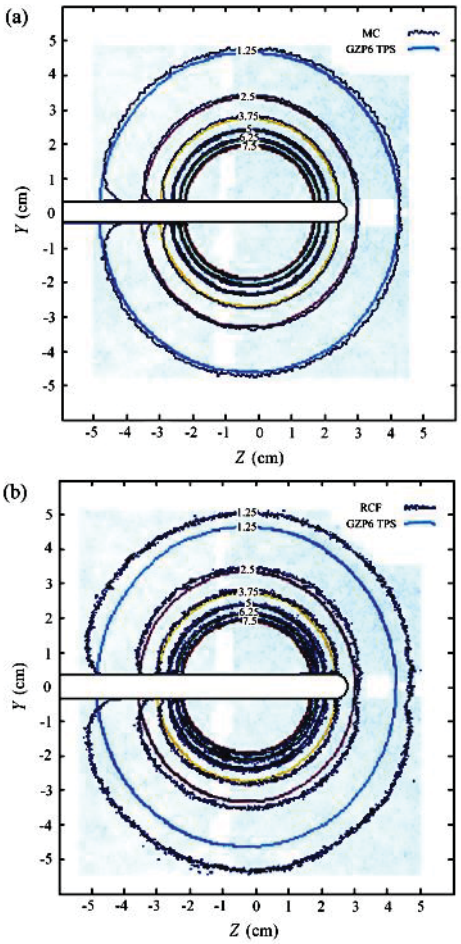

Figure 2. Dose distributions (in Gy) for the source No. 1 around the tandem applicator in longitudinal plane: (a) GZP6 TPS versus MC calculations, (b) GZP6 TPS versus RCF measurement.

Table 1. Summary of measured rectum and bladder dose relative to the prescribed dose.

Relative measured dose to the prescribed dose (%)	Number of cases	
	Rectum	Bladder
0-50%	5	12
50-100%	11	13
100-200%	14	12
200-300%	7	2
300-350%	1	1
350-400%	2	0

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