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ISODOSE CURVES RECORDED IN RADIOCHROMIC FILM OF AN IODINE SEED ARRAY

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ABSTRACT

Brachytherapy seeds are frequently used in cancer treatment. Iodine seeds are ranked among the top choices when it comes to the treatment of prostate cancer. Iodine-125 emits X and gamma photons with an average energy of 28 keV and a half-life of 59.4 days. A set of four iodine-125 seeds, model 6711 produced by Amersham Health, were used in this work. The dosimetric characteristics for a seed were obtained taking into account the recommendations of TG-43 protocol, developed by the AAPM (American Association of Physicists in Medicine). To realize the experiment three plates of Standard Grade Solid Water, model 457 ® Gammex were used. One solid water plate was machined for accommodate the seed set. The set of seeds was placed in a symmetrical configuration trying to simulate an arrangement which may occur in vivo during treatment. A radiochromic film sheet was placed on the plate machined after the seed charge. The machined plate charged and with the film sheet was placed between two others solid water plate to recorder the radiation dose. The machined plate was placed between the other two plates for better reliability in measurements. The radio chromic film was irradiated by an equivalente X-ray beam using the reference radiation RQR 3 IEC (International Electrotechnical Commission) with different doses (0.5 to 1.0 Gy) to obtain the calibration curve in the dose region measured. After validation of the methodology, the study of the interaction between the radiation fields of the set of seeds became possible and the survey of isodose curves of these setting was conducted.

Keywords: isodose curves, iodine seeds, radiochromic film

1. INTRODUCTION

The number of new cases of prostate cancer is estimated as 60,180 for 2012 [1]. Brachytherapy seeds are frequently used in cancer treatment. Brachytherapy is presented as a treatment option because it is less invasive and significantly reduce the need for the organ removal [2-5]. The iodine-125 seeds are much used in this procedure. Iodine-125 is a gamma emitter with low energy which allows the deposition of high doses of radiation in the region of interest, thereby preserving the healthy tissue situated in the proximities [6].

In a prostate cancer treatment from 80 to 120 iodine-125 seeds are used depending on the volume of the tumor. Seed implantation is a minimally invasive procedure. The inclusion of seeds into the patient is performed with the aid of tomographic images and needles guided by a template, which assists the seeds positioning in accordance with the planning [7].

The procedure for the implant and the moving of soft tissues cause the implanted seeds undergo slight displacements relative to the position originally planned and these displacements cause changes in the dose distribution in the tumor volume [7,8].

This work proposes an approach with the conditions of treatment taking into account the displacement of the seeds inside the body during and after implantation in order to verify the real impact of these changes on a radiotherapy procedure.

2. MATERIAL AND METHODS

Four iodine-125 seeds, model 6711 produced by Amersham Health, were used in this work. These seeds are ranked among the top choices in the treatment of prostate cancer. These sources emit X and gamma photons with an average energy of 28 keV and a half-life of 59.4 days. Fig. 1 presents iodine seeds.

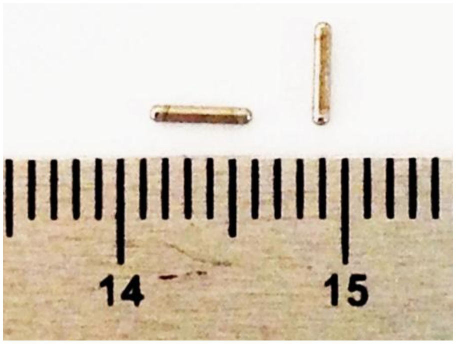

Figure 1: Iodine seeds.

The dosimetric characteristics for a iodine-125 seed were obtained according to the recommendations of TG-43 protocol, developed by the AAPM (American Association of Physicists in Medicine). Three plates of Standard Grade Solid Water, model 457 ® Gammex were used to realize the experiment . The density of the material is 1.043 ± 0.05 g.cm^{-3} and its chemical composition is shown in Tab.1.

One solid water plate was machined to accommodate the seed set and radiochromic films were used on the machined plate and under another solid water plate to record the radiation dose. The set of seeds was placed in a configuration that tried to simulate an arrangement which may occur in vivo during treatment. The machined plate was placed between the two other plates for better reliability in measurements. Fig. 2 presents the solid water plates.

Table 1: Percentual chemical composition of Gammex 457 plates

H	C	N	O	Cl	Ca
8.1%	67.2%	2.4%	19.9%	0,1%	2.3%

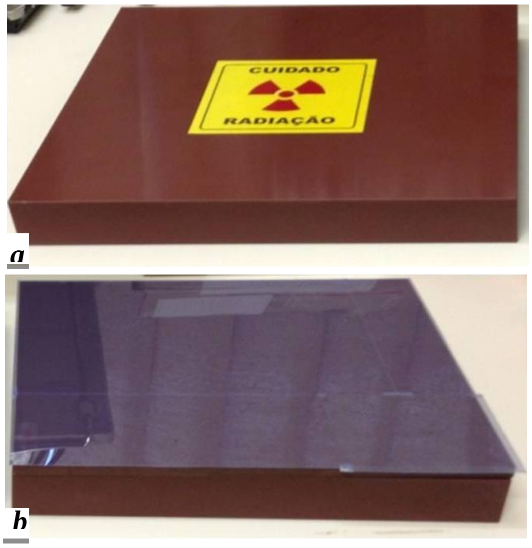

Figure 2: Solid water plates: cover plate (*a*) and film on machined plate (*b*).

The films were irradiated by an equivalent X-ray beam using the reference radiation RQR 3 IEC (International Electrotechnical Commission) with different doses (0.5 to 5.0 Gy) to obtain the calibration curve in the region of measured doses[6].

3. RESULTS

After validation of the methodology, it was possible to study the radiation field interactions and the isodose curves of the seed array were conducted. Fig. 3 presents the seed configuration used in this experiment, where the origin (0,0) was set in the center of the seeds.

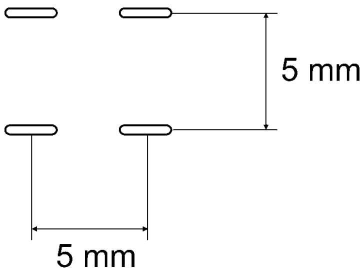

Figure 3: Seed configuration.

Fig. 4 presents the percentual isodose curves obtained after 96 hours of irradiation, after the film processing. The maximum dose recorded was 5.07±0.36 Gy, next one seed. Doses beyond 2 cm from the center of the seed array were less than 10% of the maximum dose.

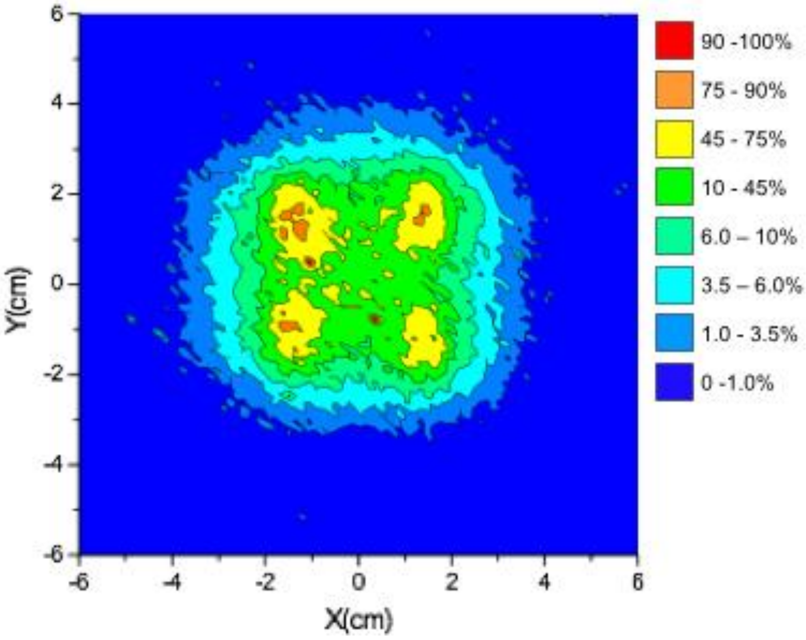

Figure 4: Isodose curves.

4. CONCLUSIONS

The study was conducted to show differences in the dose distribution using a solid water phantom, caused by a specific configuration adopted in an array with four seeds OncoSeed 6711. It was observed that there is a significant difference in the dose deposition, mainly in the central area. Doses beyond 2 cm from the central point of the seed array are 55% lower than the maximum dose.

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REFERENCES

1. INCA. *Estimativa 2012: incidência de câncer no Brasil*. Rio de Janeiro: 2011.
2. NORI, D. “Conformal brachytherapy of prostate cancer: an effective outpatient treatment,” *Cancer*. Watch. **v.1**, pp.124-126 (1992).
3. RUSSEL, K.J. AND BLASKO, J.C. “Recent advances in interstitial brachytherapy for localized prostate cancer,” *Probl. Urology*, **v. 7**, pp.260-278, 1993.

4. SAHGAL, A.; ROACH, M. “Permanent prostate seed brachytherapy: a current perspective the evolution of the technique and its application,” *Nature Clinical Pratice Urology*, **v. 4**, n. 12, pp.658-670 (2007).
5. ONCURA INC. *Instructions for the use of Iodine-125 Seeds for Medical Brachytherapy Treatments.* USA, Rev. Set 2005.
6. INTERNATIONAL ELECTROTECHNICAL COMISSION. *IEC 61267 :Medical diagnostic x-ray equimament- Radiation conditions for use in the determination of characteristics.* Geneva, Suiça (2005).
7. SHARMA, S.D; BASU, M; SHANTA, A; PALANI SELVAM, T; TRIPATHI, U.B; BHATT, B.C. “Dosimetry parameters of BARC OcuProsta I-125 seed source,” *Australian Physical e Engineering Sciences in Medicine*, **v.28**, n.1, pp.14-20 (2005).
8. CALATAYUD, J; GRANERO, D; BELLESTER, F. “Phantom size in brachytherapy source dosimetric studies,” *Med. Phys*, **v.31**, pp.2075-2081 (2004).