Radiation exposure public members after prostate brachytherapy

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Abstract. Transrectal ultrasound (TRUS) based prostate brachytherapy is rapidly gaining popularity. Patients with prostate cancer frequently opt to treat their disease with permanent seed implants that deliver a dose of radiation directly to the tumour. According to the Centers for Medicare and Medicaid Services, permanents prostate brachytherapy was performed on approximately 19200 men in the year 2000. The purpose is determinate the degree and variability of radiation exposure to the general public form patients after I-125 prostate brachytherapy.

Preoperative weight, average activity and number of sources implanted were recorded. Within 24 hours after the procedure, before to go home, radiation measurements were taken at the skin and at 1 meter perpendicular from the skin, using a RAM GENE-1, model 4-0015 ionization chamber.

The exposure rate at the anterior skin surface a I-125 implant range from 6.7-145 microSv/h (average 41.85). The time required to reach the annual limit at the anterior skin surface would be 5.5 hours and for exposure at the lateral surface the time would exceed 100 hours.

This study demonstrates that radiation exposure to family members from a prostate brachytherapy patient is very low.

1. Introduction

Prostate cancer is a common malignancy in men, the present treatment options include radical prostatectomy, external beam radiation therapy (EBRT), temporary and permanent brachytherapy, hormonal therapy and watchful waiting. The relative efficacy of each methods is controversial. It has been noted that the proportion of patients treated by permanent brachytherapy is rapidly increasing, because brachytherapy offers several practical and theoretical advantages over EBRT in selected patients. Firstly, due to the physics of radiation emanation from the implanted radioisotope, there is dose escalation within the prostate, with rapid dose fall in surrounding normal tissues. Target motion, set-up variation and location errors from day-to-day are not of mayor concern as they are with EBRT.

Brachytherapy is a simple, outpatient procedure that avoids hospitalization and allows the patient an early recover and rapid return to normal activity. It has produced good 10 years outcome with relatively low morbidity. With widespread patient education of the available treatment options, its advantages have become more apparent to the general public. With the advent of the internet, there has been increased communication between patients, which has futher increased the awareness of prostate brachytherapy as a treatment option [1].

Prostate brachytherapy, using permanent radioactive implants, is increasingly becoming an accepted form of treatment for early-stage prostate cancer. Transrectal ultrasound (TRUS) based prostate brachytherapy is rapidly gaining popularity. Many patients are attracted to it because the treatment may be administered as a day-case procedure with a low long-term risk urinary incontinence. Impotence also seems to be less likely than with some of the other conventional therapies, e.g. radical prostatectomy. Brachytherapy may alter the balance in the risk of treating a non-lethal disease in the patient against the success of the treatment and its morbidity [2].

Prostate brachytherapy patients are given instruction regarding precautions against unnecessary exposure to others, are generally told to limit their time around children and potentially pregnant women. Because a general fear of radiation among the public, the authors are frequently asked for more detailed information regarding the true exposures rates and associated risk that patients pose to the public.
It is theoretically possible for a seed to be expelled in the semen on ejaculation. In the very rare event that this happens it is usually in the first one or two ejaculations. Some centres advise the use of a condom for the first two to three occasions of intercourse following implantation. Patients should be warned that prostate brachytherapy does not guarantee infertility and that pregnancy remains possible [3].

2. Methods and materials

Twenty nine prostate brachytherapy patients treated at the University Hospital Carlos Haya of Málaga between the years 2002-2003 were studied. All the patients had transperineal I-125 implants and the dose brachytherapy monotherapy prescription was 145Gy. A properly calibrated ion chamber survey meter is used to measured the maximum exposure rate at the surface and 1 meter from the implanted patient for documentation. Preoperative weight, number and activity of source implanted were recorded. The day after the procedure, radiation measurements were taken at the skin and at 1 meter perpendicular from the skin using a RAM GENE-1, model 4-0015 ionization chamber. For skin exposures rates, the meter was scanned over the anterior or lateral skin surface of the pelvis to obtain the highest reading possible.

Different types of seed distribution are in current use and a consensus on the optimal seed distribution does not exist. The classic approach is to space the seeds a 1 cm apart, center-to-center, throughout the prostate, this approach referred to as uniform loading, requires higher number of lower strength seeds, and is characterized by relatively high doses in the center of the prostate. We use 0.572 and 0.526 U for I-125 [4].

I-125 are encased in titanium and delivered and delivered as sealed source (seed), his size is 4.5mm x 0.8mm outer dimensions for model 6711 seeds. The average energy for all emissions is approximately 27.4 keV, which results in a half value layer in lead of approximately 0.025 mm. The half life is 59.4 days, ninety percent of total dose is delivery in 197 days. I-125 encased is stiffened absorbable suture material, commercially available from Amersham Healthcare as Rapid Strand. AAPM recommends that 10% of the seeds be assayed [5]. An insert for Standard Imaging HDR 1000 Plus well chamber was designed to accommodate Amersham’s plastic spacing jig to be exposed within the well chamber.

3. Results

The total activity I-125 implanted ranged from 0.949 to 1.438 GBq (median: 1.182 GBq). The exposure rate at the anterior skin surface ranged from 6.7-145 microSv/h (average 41.85). The lateral skin surface exposure rates were much lower than the anterior skin doses, 0.37-8 microSv/h (average: 1.77microSv/h). In all the patients, the exposures rate at 1 meter from the skin surface were below 10 microSv/h the day after implant when patient go home.

There were a correlation between the total activity implanted and the exposure rates at the skin, explained partly in that the skin exposure rates were lower as the distance between the center of the prostate and the skin surface increased, which increased in heavier patients. The low energy of I-125 seeds is such that the dose rate at the skin surface is extremely small.

4. Discussion

The ICRP60 recommended limit the total annual dose in average to 1 mSv/year for the general public [6]. Based in this regulations, the time required to reach annual limit are calculate to take into account a naturally decaying isotope during exposure:
\[ t = \frac{T_{1/2}}{\ln 2} \cdot \ln \left( \frac{L.D.}{D(24h) \cdot \frac{\ln 2}{T_{1/2}} - 1} \right) \]  

(1)

where

- \( T_{1/2} \)  half life I-125
- L.D. total annual dose for the general public
- \( D(24h) \)  exposure rate the day after the implant

At the anterior skin surface would be 5.5 hours to reach annual limit in the more adverse patient, for exposure at the lateral skin surface the time exceed 5 days (129 hours), at 1 meter, it would take a minimum 45 hours from anterior exposure.

It appears that prostate brachytherapy patients present little exposure risk to the public, even at close contact. The only conceivable risk would be to a significant other who spent a large amount of time with the patient.

5. Conclusion

Written and oral instructions on minimizing radiation doses to the public should therefore be provided to each prostate brachytherapy patient. Specific recommendations for keeping radiation exposure to others will depend on the living situation of the patient. A patient living with no young children around, would have minimal restrictions on activities as compared to a patient living in a household that includes infants and children [7,8].

Because of the significantly higher exposure rates at close anterior distances, prostate brachytherapy patients should be instructed to avoid extended close contact with others until after several radiactive half-lives have elapsed and contact dose rates are reduced to minimal. This includes not holding infants or young children in their lap. Also, radiation dose to a spouse would be reduced if the patients sleeps on his back rather than on his side.

Radiation exposure to family and household members from patients receiving a radioactive prostate brachytherapy implant is very low and should be a minor factor in the decision making process for his primary therapy. This study demonstrate that the lifetime exposure to household members is below the limit set by the ICRP60 of the lay public.

REFERENCES
