



Figure 1: Cumulative distributions for the interactive and dynamic technique of the prostate volume (a) and the volume outside the prostate (b) receiving a dose of 160 Gy or more.

182 oral

### A novel approach for high accuracy and automatic 3D seeds localization from ct scans for prostate implants

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**Purpose:** To present and validate a conceptually novel method for high accuracy and automatic 3D reconstruction of prostate seed implants from CT scans.

**Materials and Methods:** Unlike existing methods for implant reconstruction from CT transverse images, the proposed algorithm uses raw CT data (sinograms) instead of reconstructed slices. Using sinograms solve several inevitable problems related to the reconstruction from CT slices. First, reconstruction artifacts in the presence of metallic objects and the seeds themselves in the patient body do not affect the sinograms. Secondly, the scanning axis of the sinograms is densely sampled, each seed being typically represented from several hundreds to a thousand samples. By comparison, on CT slices, a seed is represented by 1 to 4 samples depending on the slice thickness. Therefore, there is no partial volume effect on the sinograms. Furthermore, the shape of a single seed in a sinogram can be modelled exactly thus facilitating the detection. All this allows very accurate and automated 3D reconstruction of both position and the orientation of the seeds from a CT dataset. All the steps necessary to detect the trace of each seed on the sinogram will be presented.

**Results:** The implemented algorithms have been tested on two phantom designs made on a computer controlled milling machine for an intrinsic precision of 0.05 mm or 1 degree to validate the proposed approach. The results indicate that seed positions can be estimated with 0.15 mm accuracy (max 0.45 mm,  $\sigma = 0.11$  mm), while the orientation is extracted with an accuracy of 2.6 degrees on average (max 6.3 degrees). Moreover, the present algorithm takes 2 minutes of processing time on an Athlon XP 2600 processor, without any optimization for speed.

**Conclusion:** Overall, this is a major advance for automated clinical post-implant dosimetry, as previous methods, based on CT slices only, involved active (and time consuming) interventions by the users to extract the seed positions, especially in the presence of artifacts or group of seeds (blobs). These older techniques gave average errors around 3 mm and maximum error up to 7 mm (e.g. Liu et al., PMB 2003).

183 oral

### <sup>192</sup>Ir LDR Brachytherapy(BT) is at least as efficient as HDR options for boosting unfavourable prostate cancers after EBRT. Proposals for future prospects

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**Materials and methods:** Between 01/1997 and 12/2001, 201 patients were treated with EBRT and BT boost. The latter included 4 to 8 lines implanted following the principles of the Paris System. The majority of implants included a central square of 2.0-2.2 cm side. In function of the volume of the prostate, 2-4 additional lines were placed laterally in triangular shapes. Catheters were inserted manually without template, under endorectal echographic control to avoid pelvic bone arch or prostate volume interference. The optimization of the delivered dose was based on the rules of the Paris System and a selective loading of <sup>192</sup>Ir wires thereafter. This LDR BT ( $\pm 15$  Gy/day) intended to deliver 40-45 Gy to the CTV after pelvic EBRT of 40 Gy. 52 Gy and 25 Gy were the maximal accepted doses delivered by BT respectively to 20% of the urethra and rectum.

**Results:** The median age of patients at diagnosis is 70,3 years. The median follow up time is 3,5 years. Tumors were classified in intermediate (n=64) or unfavourable (n=137) prognosis categories when they included respectively only one or at least two of the following criteria: PSA>10ng/ml, Gleason Score>6, T>2a (UICC2002). The median PSA value at diagnosis was 14 ng/ml. The median gleason score value was 6 and the median T value was T2c. 33 patients reported a TURP. 103 patients received simultaneous hormone therapy during 3-6 months depending on referring urologists. The combined total dose to the CTV was 82 $\pm$ 3,4 Gy. 5 y bNED is 82,8 % for the whole population and respectively 96,9 % and 75,8 % for intermediate and unfavourable prognosis categories. In the population without hormone therapy, PSA nadir  $\leq 1$  ng/ml and  $\leq 0,5$  ng/ml were achieved in respectively 80% and 76 % of cases. In univariate analysis, gleason score and T classification were the only significant factors to predict a biochemical control. Preoperative PSA values were at the level of borderline significance but hormone therapy was not. In multivariate analysis, gleason score (p=0,0018) and T classification (p=0,0028) remained significant. The rate of grade II rectal complications was 4% and no grade III toxicity was recorded. Urinary complications of grade II and III appeared in respectively 6,5% and 6% of patients. Previous TURP was a powerful predictor of urethral toxicity (p=0,0003). In the beginning of the study one bladder grade IV late side effect needing surgery was recorded.

**Conclusion:** With respectively >95% and >75% 5 y bNED for intermediate and unfavourable prognosis groups, this <sup>192</sup>Ir LDR Bt boost to EBRT is as efficient as the most modern HDR Bt techniques [Martinez et al.,2002]. So the argument usually advocated to favour the HDR due to an  $\alpha/\beta$  ratio around 1,5 Gy for prostate tumours is only one of the different explanations of BT efficacy. Are the present results due to the Bt technic requiring a small number of tubes, inducing thus higher V150 in the periperal zone or to radiobiologic parameters specific to a continuous mode of irradiation? The very low dose rates (VLDR) afforded by the permanent implants as a boost have indeed given encouraging results too. So new concepts such as the EUD calculations should be included in the new treatment planning to understand more clearly these ballistic and dose rate interactions. They will be helpful in the development of new radioisotopes presentations that will be soon available.