3-D Conformal HDR Brachytherapy as Monotherapy for Localized Prostate Cancer

A Pilot Study

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Purpose: Pilot study to evaluate feasibility, acute toxicity and conformal quality of three-dimensional (3-D) conformal high-dose-rate (HDR) brachytherapy as monotherapy for localized prostate cancer using intraoperative real-time planning.

Patients and Methods: Between 05/2002 and 05/2003, 52 patients with prostate cancer, prostate-specific antigen (PSA) ≤ 10 ng/ml, Gleason score ≤ 7 and clinical stage ≤ T2a were treated. Median PSA was 6.4 ng/ml and median Gleason score 5. 24/52 patients had stage T1c and 28/52 stage T2a. For transrectal ultrasound-(TRUS-)guided transperineal implantation of flexible plastic needles into the prostate, the real-time HDR planning system SWIFT® was used. After implantation, CT-based 3-D postplanning was performed. All patients received one implant for four fractions of HDR brachytherapy in 48 h using a reference dose ($D_{ref}$) of 9.5 Gy to a total dose of 38.0 Gy. Dose-volume histograms (DVHs) were analyzed to evaluate the conformal quality of each implant using $D_{90}$ urethra, and $D_{10}$ rectum. Acute toxicity was evaluated using the CTC (Common Toxicity Criteria) scales.

Results: Median $D_{90}$ was 106% of $D_{ref}$ (range: 93–115%), median $D_{10}$ urethra 159% of $D_{ref}$ (range: 127–192%), and median $D_{10}$ rectum 55% of $D_{ref}$ (range: 35–68%). Median follow-up is currently 8 months. In 2/52 patients acute grade 3 genitourinary toxicity was observed. No gastrointestinal toxicity > grade 1 occurred.

Conclusion: 3-D conformal HDR brachytherapy as monotherapy using intraoperative real-time planning is a feasible and highly conformal treatment for localized prostate cancer associated with minimal acute toxicity. Longer follow-up is needed to evaluate late toxicity and biochemical control.

Key Words: Prostate cancer · Brachytherapy · HDR monotherapy · Intraoperative real-time planning

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Konformale 3-D-HDR-Brachytherapie als Monotherapie beim lokal begrenzten Prostatakarzinom. Eine Pilotstudie

Ziel: Pilotstudie zur Evaluation der Praktikabilität, Akuttoxizität und konformer Qualität der konformalen dreidimensionalen (3-D) High-Dose-Rate-(HDR-)Brachytherapie als Monotherapie beim lokal begrenzten Prostatakarzinom unter Einsatz intraoperativer Real-Time-Planung.


Ergebnisse: Die medianen $D_{90}$ betrug 106% von $D_{ref}$ (Range: 93–115%), die medianen $D_{10}$ Urethra 159% von $D_{ref}$ (Range: 127–192%), die medianen $D_{10}$ Rectum 55% von $D_{ref}$ (Range: 35–68%). Die mediane Nachbeobachtungszeit beträgt gegenwärtig 8 Monate. Bei 2/52 Patienten wurden akute urogenitale Grad-3-Toxizitäten beobachtet. Gastrointestinale Toxizitäten > Grad 1 traten nicht auf.

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Introduction

The incidence of prostate cancer is increasing rapidly and has reached 700,000 cases annually in Europe and North America at the beginning of the 21st century [4]. For 2002, there were an estimated 189,000 new cases of prostate cancer diagnosed in the USA alone [11]. The widespread use of the prostate-specific antigen (PSA) test and transrectal ultrasound (TRUS), allowing earlier detection, has resulted in a significant stage downmigration with a majority of patients newly diagnosed with organ-confined disease [12]. Gleason score and pretreatment PSA level have a major impact on the risk of extraprostatic disease, seminal vesicle infiltration and regional lymph node involvement and can be used as prognostic factors for the definition of risk categories in patients with clinically organ-confined stages [25]. Patients with pretreatment PSA levels ≤10 ng/ml and Gleason scores 2–6 are considered to belong to the low-risk group, patients with PSA levels ≤10 ng/ml and Gleason score 7 to the intermediate-risk group. Curative treatment options for these risk groups of localized prostate cancer include radical prostatectomy (RP), three-dimensional conformal external-beam irradiation (3-D CRT), and interstitial brachytherapy.

Low-dose-rate (LDR) brachytherapy using permanent implants of 125I or 103Pd seeds as monotherapy has become a very popular treatment option in the USA during the last decade. In Germany and other European countries more and more institutions have just started to establish LDR brachytherapy as an alternative to RP and 3-D CRT [35]. Long-term results from large series in North America are now available with encouraging biochemical control rates and acceptable toxicity [10, 27]. However, although improvements have been made in implantation techniques and dose-planning procedures for permanent seed implantation, there are still a number of critical issues to discuss. First of all, there are still potential difficulties to deliver the prescription dose to the entire prostate because of an inherent lack of total control in depositing the seeds precisely to the preplanned position inside the gland [28]. In addition, the postimplant prostate edema results in varying changes of the target volume during several weeks after implantation [34]. Other critical issues concerning the patient and his family are radiation protection after the implantation of permanent radioactive seeds and the risk of seed migration.

High-dose-rate (HDR) brachytherapy using temporary 192Ir implants as a boost in combination with external-beam ir-