

Clinical Efficacy of Localized Salvage Prostate Cancer Reirradiation with Proton Scanning Beam Therapy

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Abstract : Purpose: Over the past decade, proton therapy utilizing pencil beam scanning has emerged as a preferred treatment modality in radiation oncology, particularly for prostate cancer. This retrospective study aims to assess the clinical and radiobiological efficacy of proton scanning beam therapy in the treatment of localized salvage prostate cancer, following initial radiation therapy with a different modality. Despite the previously delivered high radiation doses, this investigation explores the potential of proton reirradiation in controlling recurrent prostate cancer and detrimental quality of life side effects. Methods and Materials: A retrospective analysis was conducted on 45 cases of locally recurrent prostate cancer that underwent salvage proton reirradiation. Patients were followed for 24.6 ± 13.1 months post-treatment. These patients had experienced an average remission of 8.5 ± 7.9 years after definitive radiotherapy for localized prostate cancer (n=41) or post-prostatectomy (n=4), followed by rising PSA levels. Recurrent disease was confirmed by FDG-PET (n=31), PSMA-PET (n=10), or positive local biopsy (n=4). Gross tumor volume (GTV) was delineated based on PET and MR imaging, with the planning target volume (PTV) expanding to an average of 10.9 cm^3 . Patients received proton reirradiation using two oblique coplanar beams, delivering total doses ranging from 30.06 to 60.00 GyE in 17-30 fractions. All treatments were administered using the ProBeam Compact system with CT image guidance. The International Prostate Symptom Scores (IPSS) and prostate-specific antigen (PSA) levels were evaluated to assess treatment-related toxicity and tumor control. Results and Discussions: In this cohort (mean age: 76.7 ± 7.3 years), 60% (27/45) of patients showed sustained reductions in PSA levels post-treatment, while 36% (16/45) experienced a PSA decline of more than 0.8 ng/mL. Additionally, 73% (33/45) of patients exhibited an initial PSA reduction, though some showed later PSA increases, indicating the potential presence of undetected metastatic lesions. The median post-retreatment IPSS score was 4, significantly lower than scores reported in other treatment studies. Overall, 69% of patients reported mild urinary symptoms, with 96% (43/45) experiencing mild to moderate symptoms. Three patients experienced grade I or II proctitis, while one patient reported grade III proctitis. These findings suggest that regional organs, including the urethra, bladder, and rectum, demonstrate significant radiobiological recovery from prior radiation exposure, enabling tolerance to additional proton scanning beam therapy. Conclusions: This retrospective analysis of 45 patients with recurrent localized prostate cancer treated with salvage proton reirradiation demonstrates favorable outcomes, with a median follow-up of two years. The post-retreatment IPSS scores were comparable to those reported in follow-up studies of initial radiation therapy treatments, indicating stable or improved urinary symptoms compared to the end of initial treatment. These results highlight the efficacy of proton scanning beam therapy in providing effective salvage treatment while minimizing adverse effects on critical organs. The findings also enhance the understanding of radiobiological responses to reirradiation and support proton therapy as a viable option for patients with recurrent localized prostate cancer following previous definitive radiation therapy.

Keywords : prostate salvage radiotherapy, proton therapy, biological radiation tolerance, radiobiology of organs

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