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CyberKnife radiotherapy for localized prostate cancer: rationale and technical feasibility.

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There is a clear dose response for localized prostate cancer radiotherapy and there probably is a radiobiological rationale for hypo-fractionation. Combining the two should maximize tumor control and increase the therapeutic ratio. This study examines the rationale and technical feasibility of CyberKnife radiotherapy (a robotic arm-driven linear accelerator) for localized prostate cancer. Its ability to deliver non-coplanar non-isocentric arcs can yield maximally conformal isodoses. It is the only integrated system capable of target position verification and real-time tracking during delivery of conformal stereotactic radiotherapy. Inverse planning with the CyberKnife is used to design a course of radiotherapy for localized prostate cancer. Fiducial markers within the gland are used to verify organ position and track organ motion via an orthogonal pair of electronic x-ray imaging devices and provide real-time feedback correction to the robotic arm during delivery. Conformal isodose curves and dose volume histograms (DVH) are used to compare with an optimized Intensity-Modulated Radiotherapy (IMRT) plan actually delivered to the study patient based upon CT scan-derived organ volumes. The CyberKnife can produce superior DVHs for sparing of rectum and bladder and excellent DVHs for target coverage compared with IMRT, and possesses dose heterogeneities to the same degree as IMRT plans. Because of the significantly longer delivery times required it would be best suited for hypo-fractionated regimens. Such dose regimens might allow for biologically equivalent dose escalation without increased normal tissue toxicity. Since the CyberKnife can verify organ position and motion and correct for this in real-time it is the ideal means of achieving such excellent DVHs without a compromise in doses to normal tissues. These capabilities are essential if one contemplates hypo-fractionated regimens with large dose-per-fraction sizes (>5Gy to 10Gy) and dose-escalation.

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