Dosimetric and biological comparison of treatment plans between LINAC and robot systems in stereotactic body radiation therapy for localized prostate cancer

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Abstract

Aims

The aim of this study was to make a quantitative comparison of plan quality between MLC-based EDGE system and the cone-based CyberKnife system in stereotactic body radiation therapy (SBRT) for patients with localized prostate cancer.

Materials and methods

Ten patients with prostate volumes ranging from 34.65 to 82.16 cc were used for prostate SBRT. Treatment plans were created for both EDGE and CyberKnife G4 systems using the same dose-volume constraints. Dosimetric indices including Planning Tumor Volume (PTV) coverage, conformity index ($CI$), new conformity index ($nCI$), homogeneity index ($HI$), gradient index ($GI$) were applied for target, while the sparing of critical organs, including bladder, rectum, femoral heads, urethra, penile bulk and normal tissue outside PTV, were evaluated in terms of various dose-volume metrics and integral dose (ID). Meanwhile, the required delivery time and number of monitor units (MUs) during irradiation were measured to estimate the treatment efficiency. The radiobiological indices such as equivalent uniform dose ($EUD$), tumor control probability ($TCP$) and the normal tissue complication probability ($NTCP$) were also analyzed.

Results

All dose constraints were achieved by both systems. It showed that the DEGE plans results were closest to the CK plans results in terms of PTV coverage, $HI$ and $GI$. For EDGE, more conformal dose distribution in the target as well as reduced exposure of critical organs were obtained together with reduction of 91% delivery time and 72% monitor units. EDGE plans also got lower EUD for bladder, rectum, urethra and penile bulk, which associated with reduction of NTCPs. However, higher values of EUD and TCP for tumor were obtained with CK plans.

Conclusions

Our study indicated that both systems were capable of producing almost equivalent plan quality and can meet clinical requirements. CyberKnife G4 system has higher target dose while EDGE system has more advantages based on the considerations of normal tissue sparing and delivery efficiency. With abundant clinical experience, CK provides accurate SBRT treatment with high quality. EDGE system also can be considered to be an option for SBRT treatment for localized prostate cancer treatment.

Full Text
Due to technical limitations, full-text HTML conversion of this manuscript could not be completed. However, the latest manuscript can be downloaded and accessed as a PDF.

**Figures**

**Figure 1**

Dose distribution of EDGE (a) and Cyberknife (b) plans for a selected case. The 100% isodose line of both plans were normalized to 36.25 Gy.

**Figure 2**
Averaged DVH comparison of (a) CTV, (b) PTV, (c) bladder, (d) rectum, (e) left femur, (f) right femur, (g) urethral and (h) penile bulk between EDGE and CK plans collected from 10 patients. The red curves are for EDGE plans and the black ones are for the CK plans.

Figure 3

Comparisons of dose distribution outside PTV. (a) Average DVH comparison of normal tissue; (b)-(d) Normal tissue volumes covered by 20%, 50% and 100% of prescription isodose lines; (e) Integral dose of normal tissue outside PTV. The red lines are for EDGE plans and the black ones are for the CK plans.