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A statistical comparison of IMRT and conventional external beam therapy for soft tissue sarcoma of the thigh

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Background and purpose

Sarcomas are rare, representing <1% of all new cancers [1]. Prospective randomized trials indicated adjuvant radiotherapy significantly improved local control after limb-sparing surgery [2, 3]. However, post radiotherapy pathological femur fracture rate is 8.3%, increasing with dose escalation and can reach 29% with periosteum stripping [4, 5]. Reduced fracture rates after brachytherapy imply that sparing some bone circumference from high dose is beneficial [5].

The advent of IMRT allows dose "painting", and thus can avoid treating the whole femur circumference [7]. One previous dosimetric study investigated IMRT for soft tissue sarcoma of limbs. It covered 10 patients and showed IMRT reduced femur dose without compromising target coverage [8]. This study differs because it uses clinical margins and treatment phasing employed at WPH, and applies two statistical measures of significance to a number of outcome criteria.

Method

Twelve soft tissue thigh sarcoma patients previously treated with radiotherapy were identified. PTV for phases I and II were re-contoured by a research clinician. A planning technician used these contours to plan each patient according to the standard two phase prescription of 50Gy in 25# and 10Gy in 5#. PTV2 was identical to PTV1 in the transverse direction but reduced to a 2.5cm margin on the GTV in the cranio-caudal direction.

Although IMRT would have allowed both phases to be combined to create a simultaneous integrated boost, they were inverse planned as separate phases to clarify the comparison between treatment regimes. For inverse planning purposes some volumes were modified, but all analyses were performed on original volumes. DVH of summed phase I and II plans were analysed to quantify primary outcomes of $V_{100\%,\ Fem}$ and $V_{95\%,\ PTV}$ and a number of secondary outcome criteria.

Results

All subjects' IMRT plans exhibited reduced high and mean femur doses. This result was balanced by a reduction in $V_{95\%}$ PTV2 coverage in all but two subjects, however, it must be noted that PTV2 overlapped the femur in many cases.

Criteria	Median	Range
PTV2 $V_{95\%}$	-5.5%	-14.5% to +12.0%
Femur $V_{100\%}$	-9.8%	-0.7% to -55.5%
Femur D_{mean}	-12.2%	-1.5 % to -18.2%
Soft tissue $V_{100\%}$	-2.6%	-0.2% to -9.5%
Soft tissue D_{mean}	-0.3%	-4.7% to +3.6%

Table 1: Basic statistics: IMRT results with respect to conformal results.

Wilcoxon signed rank tests and Students' t tests were performed on multiple end points using a significance level of 2.5% (including modest Bonferroni correction). Results corroborated the reduced femur doses and suggested that PTV2 coverage was not significantly compromised. Contrary to many opinions IMRT had no significant effect on mean soft tissue dose and high soft tissue doses were significantly reduced. This is postulated to be mainly due to the complexity of conforming conventional fields with restricted gantry angles due to the contralateral limb.

Conclusions

Compared with standard 3D conformal methods, results demonstrate that IMRT offers improved femur sparing in soft-tissue sarcomas of the thigh. Statistical analyses suggest slightly poorer PTV coverage from IMRT is not

significant and observation shows indicates that the decreased coverage is entirely related to the femur volume within the PTV.

References

[1] Jemal A et al. Cancer statistics, 2006. CA Cancer J Clin, 2006:56(2):106-30.
[2] Pisters PW et al. Long-term results of a prospective randomized trial of adjuvant brachytherapy in soft tissue sarcoma. J Clin Oncol, 1996:14(3):859-68.
[3] Yang JC et al. Randomized prospective study of the benefit of adjuvant radiation therapy in the treatment of soft tissue sarcomas of the extremity. J Clin Oncol, 1998:16(1):197-203.
[4] Holt GE et al. Fractures following radiotherapy & limb-salvage surgery for lower extremity soft-tissue sarcomas. J Bone Joint Surg Am, 2005:87:315-19.
[5] Lin PP et al. Pathologic femoral fracture after periosteal excision & radiation for the treatment of soft tissue sarcoma. Cancer, 1998:82(12):2356-65.
[6] Lin PP et al. Treatment of femoral fractures after irradiation. Clin Ortho Rela Res, 1998(352):168-78.
[7] Alektiar KM et al. Intensity modulated radiation therapy for primary soft tissue sarcoma of the extremity: preliminary results. Int J Rad Oncol Biol Phys, 2007:68(2):458-64.
[8] Hong L et al. Intensity-modulated radiotherapy for soft tissue sarcoma of the thigh. Int J Rad Oncol Biol Phys, 2004:59(3):752-9.