



Assessment of beam and delivery quality for interchanging intensity-modulated treatment plans with two 6MV beam-matched linear accelerators

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INTRODUCTION

After beam matching, the obvious advantage of the linear accelerators (Linacs) is to improve the efficiency and flexibility of the treatment of patients, and to avoid the impact of accidental shutdown of an accelerator on the normal treatment . Therefore, in view of the convenience of clinical use of the Linacs after beam matching, using one beam model as a benchmark to guide beam matching between different machines in a single center or even multiple centers has gradually become a major trend in the development of accelerator technology in the future .And this center has two Elekta medical Linacs, Versa HD and Synergy, which makes this research possible.

AIM

The purpose of this study is to compare the beam characteristics and explore the feasibility of interchanging intensity-modulated treatment plans without replanning with two beam-matched Linacs .

METHOD

The beam data of 6MV X-ray with two beam-matched Linacs (Elekta VersaHD and Synergy with Agility™ head) were measured and analyzed using IBA Blue Phantom². 12 plans of nasopharyngeal carcinoma (NPC), lung and prostate cancer, respectively, were generated using IMRT and VMAT with the same beam model. Doses were measured using A1SL ion chamber and ArcCheck. The measured doses were compared with the calculated those using gamma methods with 3%/2mm and 3%/3mm criteria. The correlation between the differences of passing rates between beam-matched Linacs was evaluated using the Pearson coefficient.

RESULTS

For the beam characteristics, the difference in PDDs, beam profiles and output factors of two beam-matched Linacs were all within $\pm 1\%$. The deviations of point doses in two Linacs were within $\pm 2\%$ with a Pearson's correlation coefficient of 0.725 ($p < 0.0001$) and the differences had no statistical significance. For all 36 cases for three diseases, the passing rates of measured doses on two Linacs were well higher than 95% when using 2mm/3% and 3mm/3% gamma criterias with 10% threshold. A strong correlation was observed between the passing rates of two Linacs with Pearson's correlation coefficients of 0.674 ($p < 0.0001$) and 0.745 ($p < 0.0001$).

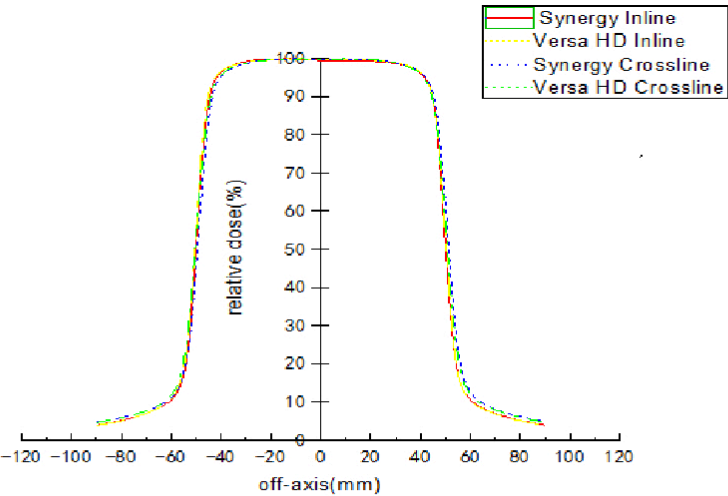


Fig. 1. Profiles at 10cm depth for 10cm×10cm field size of 6 MV under SSD=90cm for two Linacs

Tab. 1. %dd(10)_x of different fields for 6MV of two Linacs

Fields Linacs	3cm×3cm	10cm×10cm	20cm×20cm	40cm×40cm
Versa HD	60.00%	65.60%	68.40%	70.90%
Synergy	60.10%	65.50%	68.50%	70.90%
Diff	0.10%	-0.10%	0.10%	0.00%

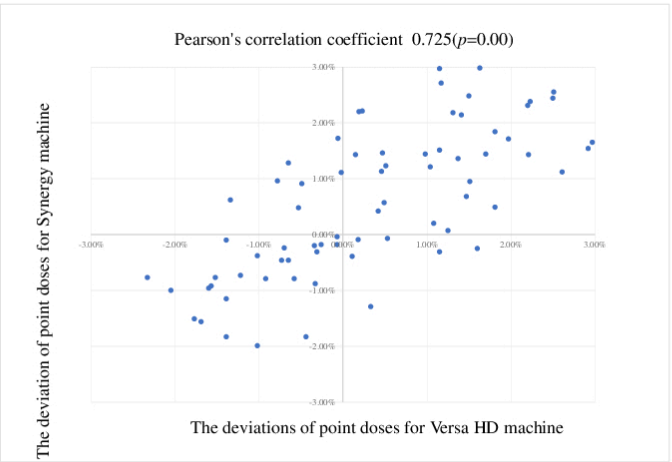


Fig. 2. Deviations between the measured and calculated point doses for two Linacs

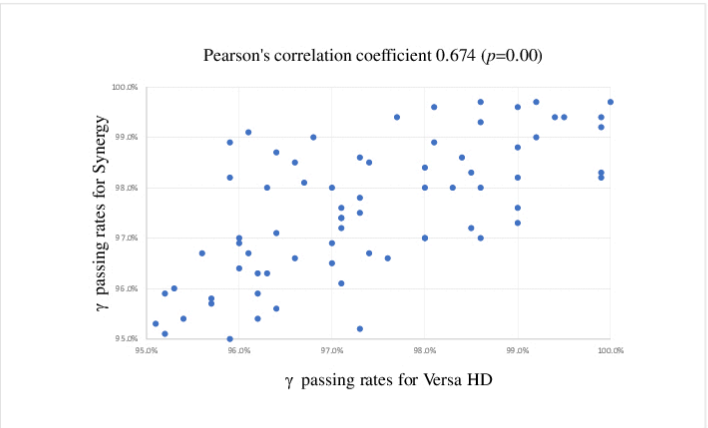


Fig. 3. The γ passing rates with 2mm/3% criteria using Arccheck for two Linacs

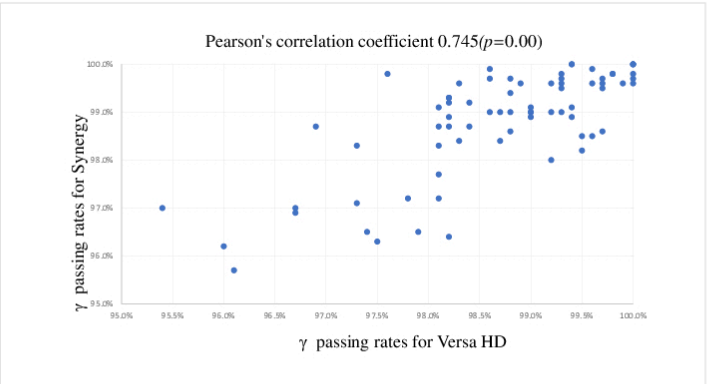


Fig. 4. The γ passing rates with 3mm/3% criteria using Arccheck for two Linacs

Tab. 2. Comparison of the measured and planned doses using ionization chamber for various diseases and treatment techniques

	NPC		Lung		Prostate	
	IMRT	VMAT	IMRT	VMAT	IMRT	VMAT
Diff _(Versa HD)	-0.24% ±1.27%	1.05% ±1.39%	-0.53% ±0.93%	0.18% ±1.39%	0.74% ±1.32%	0.72% ±0.69%
Diff _(Synergy)	-0.05% ±1.16%	1.15% ±1.30%	-0.08% ±1.10%	0.43% ±1.43%	0.68% ±1.00%	1.13% ±1.12%
t/p	0.514/0.618	0.348/0.734	2.124/0.057	0.891/0.392	-0.237/0.817	1.386/0.193
Diff _(Versa HD vs Synergy)	0.20% ±1.24%	0.11% ±1.00%	0.45% ±0.70%	0.25% ±0.92%	-0.05% ±0.78%	0.41% ±0.97%

CONCLUSIONS

The beam parameters between two Linacs showed a good matching. And the minimal differences and strong correlations in point doses and passing rates proved the feasibility of swapping IMRT and VMAT plans between the beam-matched Linacs.

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