Establishment of a Machine Transfer Procedure for Patient Treatments on Helical Delivery Machines

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PURPOSE

- In clinics operating multiple helical delivery machines, treatment plan transfer between machines is often required to improve scheduling flexibility, minimize treatment interruptions, and reduce missing treatments when a machine goes down.
- Vendor guidance commonly recommends repeating full patient-specific IMRT QA after plan transfer, which consumes valuable treatment machine time and limits clinical throughput.
- The purpose of this work is to establish an efficient, practical, and standardized workflow for machine transfer of patient treatments on helical delivery systems that maintains dosimetric accuracy and delivery confidence while reducing treatment machine utilization.

METHODS AND MATERIALS

A comprehensive in advance machine transfer workflow was established for two Accuray Radixact® systems and applied to all patients scheduled on either machine (Figure 1).

- After physician approval, each plan was transferred to the alternate machine.
- Transferred plan doses were exported to MIM and compared with the original planned dose using gamma analysis.
- Patient-specific IMRT QA (3 mm, 3%, others all 2 mm 3%) using Sun Nuclear ArcCheck was performed for the original plan only.
- Following transfer, therapists performed dry-run deliveries on the destination machine triggered by automatically generated quality checklist items (QCLs).
- An in-house MATLAB program was developed to reconstruct the delivered plans, using gantry, couch, and MLC positional information retrieved from the log-files.
- Delivery dose reconstruction was performed using MIM SureCalc.
- Reconstructed delivered doses were compared with the original planned dose using gamma analysis.
- All QA results were documented in the clinical record-and-verify system.

The workflow was validated using 10 clinical cases spanning pelvis, prostate, pancreas, brain, head and neck, and extremity treatments. Time required for each workflow step was recorded.

RESULTS

- Planned dose comparisons between original and transferred plans showed excellent agreement, with gamma passing rates of 98.83%–99.91%.
- ArcCheck IMRT QA passing rates for transferred plans ranged from 95.5% to 100.0%.
- Log-file–based reconstructed dose comparisons demonstrated gamma passing rates of 91.01%–100.00%.
- Data preparation required approximately 3–9 minutes per case, while plan reconstruction was completed within seconds and SureCalc dose calculation and gamma analysis required approximately 3–11 minutes. Eliminating repeated phantom-based IMRT QA on the transferred machine avoided ~20 minutes of additional setup and calibration time per patient.

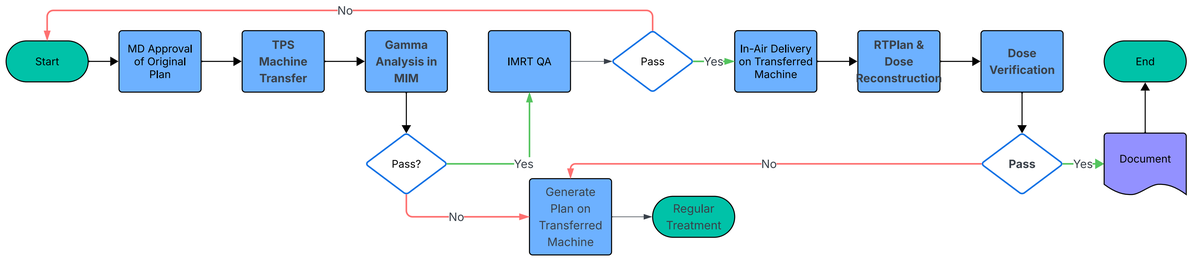

Figure 1: Workflow chart illustrating the machine transfer and verification process

Table 1. Summary of IMRT QA, reconstructed dose gamma passing rates, and time required for each step.

Disease Site	*IMRT QA Passing Rate (3 mm, 3%)*	*Plan Recon Time*	*SureCalc/Gamma Analysis Time*	*Recon Passing Rate (2 mm, 3%)*
Pelvis	*100.0%*	*12"*	*5'52"*	*99.27%*
Prostate&Nodes	*95.5%*	*16"*	*9'20"*	*99.99%*
Pancreas	*99.9%*	*12"*	*6'24"*	*100.00%*
Brain	*100.0%*	*14"*	*4'48"*	*93.11%*
Pancreas	*99.2%*	*14"*	*3'57"*	*99.99%*
Prostate&Nodes	*100.0%*	*17"*	*11'15"*	*99.74%*
Pancreas	*100.0%*	*15"*	*2'46"*	*99.82%*
Lt Thigh	*99.4%*	*20"*	*10'23"*	*91.01%*
H&N	*99.5%*	*10"*	*2'47"*	*93.72%*
Prostate&Nodes	*98.6%*	*10"*	*6'18"*	*99.60%*

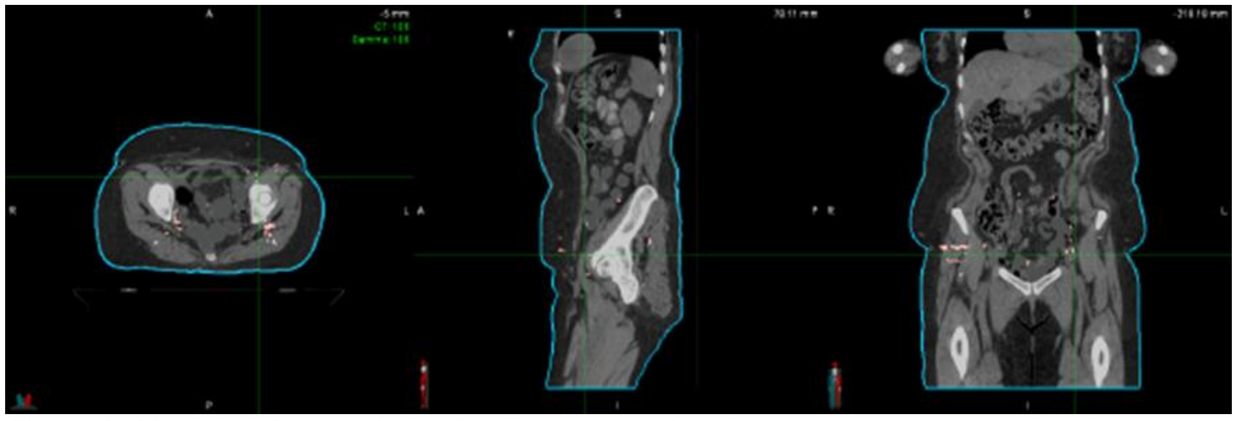

Figure 2: 3D global Gamma index for dose comparison between reconstructed and transferred TPS plan doses for a female pelvis patient, with pink shown for high gamma regions.

CONCLUSIONS

An efficient and clinically practical machine transfer procedure for helical delivery systems was successfully implemented. Replacing routine phantom-based IMRT QA on the destination machine with log-file–based dose reconstruction improves operational efficiency and treatment machine availability while maintaining high dosimetric confidence and patient safety.

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