Clinical Development of an Automated RayStation Scripting Tool for Osteoarthritis Treatment Planning

Danielle Daiger, MSBS[1] and Nicholas Sperling, Ph.D [1]
[1]University of Toledo

2026 JULY 19–22 VANCOUVER, BC
JOINT AAPM | COMP MEETING

ABSTRACT

Purpose: To develop and clinically implement a Python-based RayStation scripting tool that automates three-dimensional radiotherapy planning for osteoarthritis (OA) in a single execution.
Methods: A Python-based automated script was developed within the RayStation (RaySearch) scripting environment and implemented clinically to standardize knee OA treatment planning. The script replaces manual forward planning tasks with a single execution workflow. Upon execution, the script automatically determines treatment laterality, selects the appropriate treatment machine and prescription, places the isocenter within the joint space, and generates anterior-posterior and posterior-anterior beam arrangements. The script configures beam geometry, energy selection, jaw limits, dose calculation, and prescription scaling. The script includes optional support for control point implementation; however, following physician review and clinical approval, routine clinical use transitioned away from control points without compromising plan quality. The automated workflow was implemented on Varian TrueBeam and Edge systems using RayStation 11B. All generated plans were normalized to deliver at least 300cGy to the joint space in six fractions delivered every other day. **Results:** The scripting tool consistently generated clinically acceptable knee OA treatment plans in a single execution with correct isocenter placement, beam geometry, energy selection, jaw limits, and prescription assignment. Automated plans met institutional planning criteria and demonstrated dose distributions consistent with established clinical practice. Elimination of routine control point usage did not adversely affect clinical acceptability following physician review. The automated workflow reduced reliance on manual planner input and improved planning efficiency while maintaining consistent plan quality.
Conclusion: This work demonstrates the successful development and clinical implementation of an automated RayStation scripting tool for knee OA treatment planning. The tool standardizes plan configuration, reduces manual user input, and produces consistent, clinically acceptable plans. This workflow is readily transferable and provides a foundation for extending automation to additional OA treatment sites and other radiotherapy applications.

CONTACT

Danielle Daiger
2nd Year Medical Physics Resident
University of Toledo Dana Cancer Center
Danielle.Daiger@utoledo.edu
419.383.4466

INTRODUCTION

Osteoarthritis (OA) is the most common form of arthritis, affecting over 32 million Americans and representing a leading cause of pain and disability. Low-dose radiotherapy (LDRT) has emerged as a safe, noninvasive treatment option for selected patients with symptomatic OA and has demonstrated pain relief with minimal toxicity in numerous international studies.

Current treatment planning for knee OA at our institution is performed using three-dimensional conformal radiotherapy (3DCRT) with parallel opposed anterior-posterior (AP) and posterior-anterior (PA) fields. Although treatment geometry is relatively straightforward, the planning process requires multiple repetitive manual steps, including machine selection, isocenter placement, beam creation, jaw configuration, dose calculation, and prescription assignment. These repetitive tasks increase planning time and may introduce planner-to-planner variability.

To improve workflow efficiency and standardize treatment planning, a Python-based scripting tool was developed within RayStation to automate the planning process in a single execution.

METHODS AND MATERIALS

A Python-based automated scripting tool was developed using the RayStation 11B scripting environment and implemented clinically for knee osteoarthritis treatment planning on Varian TrueBeam and Edge linear accelerators. Upon execution, the script automatically determines treatment laterality, selects the appropriate treatment machine and prescription, places the isocenter within the knee joint, and generates anterior-posterior and posterior-anterior beam arrangements. Beam geometry, energy selection, jaw configuration, dose calculation, and prescription scaling are completed without additional user interaction. All plans are normalized to deliver 300cGy in six fractions delivered every other day according to the institutional treatment protocol. During development, optional support for control points was incorporated; however, following physician review and clinical implementation, routine use transitioned away from control points without compromising plan quality.

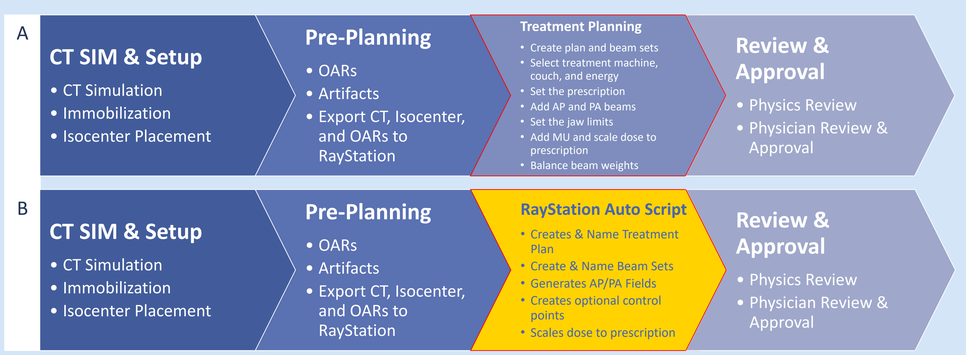


Figure 1. Clinical workflow diagram comparing the process from CT simulation to physician approval for patients being treated with OA. A) Initial clinical workflow with all manual steps. B) Newly implemented clinical workflow utilizing automated script. All the steps highlighted in blue are manual. The gold highlighted step is automated in the new workflow.

RESULTS

The automated scripting tool consistently generated clinically acceptable treatment plans in a single execution with correct isocenter placement, beam geometry, energy selection, jaw configuration, and prescription assignment. Generated plans met institutional planning standards and produced dose distributions consistent with current clinical practice. Following physician evaluation, routine use of control points was eliminated without adversely affecting clinical acceptability. Clinical implementation of the script reduced manual planner interaction while improving workflow efficiency and standardizing treatment plan generation across patients.

Figure 2. RayStation scripting user interface to execute automated planning script

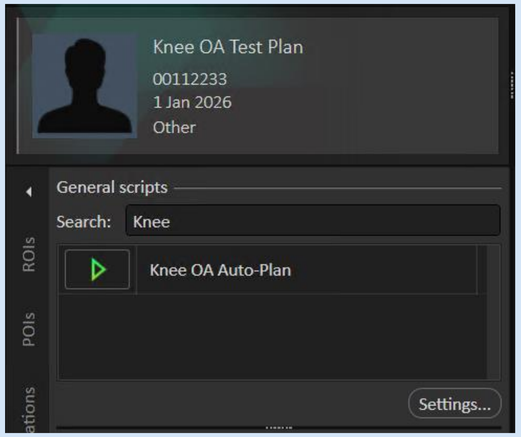


Figure 3. BEV of the jaw limitations for a right knee OA plan from the AP and PA beam

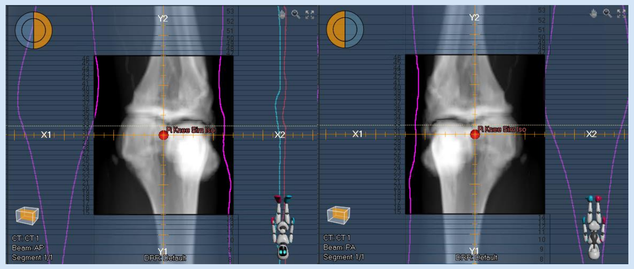
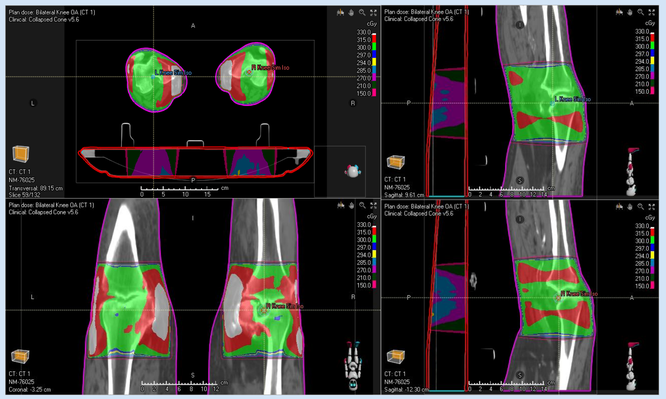


Figure 4. Dose distribution for a Bilateral Knee OA plan once the script has been executed at the simulation isocenter



DISCUSSION

The automated RayStation scripting tool successfully standardized the institutional workflow for knee osteoarthritis treatment planning by replacing repetitive forward-planning tasks with a single automated process. Clinical implementation reduced planner interaction while maintaining consistent, clinically acceptable treatment plans. Although the script automates a majority of the planning process, minor modifications may occasionally be required to accommodate patient-specific anatomy or physician preferences. These adjustments are typically minimal and are performed during the routine plan review process.

CONCLUSIONS

To improve planning efficiency, reduce repetitive manual tasks, and ensure consistent application of institutional planning standards, a Python-based scripting tool was developed and clinically implemented within RayStation. The automated workflow provides a reliable framework for generating clinically acceptable knee OA treatment plans while reducing planning time and improving consistency. This work demonstrates the successful integration of automation into routine clinical practice and provides a foundation for extending scripting solutions to additional treatment sites and radiotherapy applications.

REFERENCES

1. Dove, Austin P.H., et al. “The Use of Low-Dose Radiation Therapy in Osteoarthritis: A Review.” *International Journal of Radiation Oncology*Biology*Physics*, vol. 114, no. 2, Oct. 2022, https://doi.org/10.1016/j.ijrobp.2022.04.029.
2. RaySearch Laboratories. *RayStation 11B Scripting Guidelines.* Stockholm, Sweden: RaySearch Laboratories; 2022.