

Improving Plan Quality Through Automation of Treatment Planning Processes Using Scripting in RayStation

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PUSHING AUTOMATION FORWARD

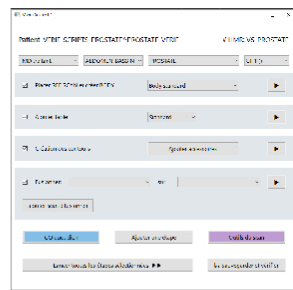
Standardization of treatment planning processes through their **automation** can reduce the risk of error and **increase the dosimetric quality** of the resulting plan.

In 2019, our center implemented automation of our planning processes using **scripting**, a **graphical user interface** (GUI) and a **centralized database**.

The new tools and workflow have been implemented at all levels of the planning process, from CT-simulation to the treatment room.

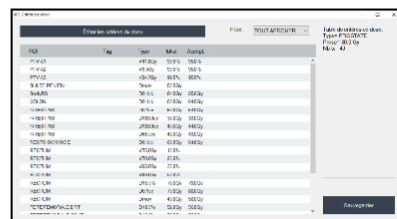
AUTOMATED TREATMENT WORKFLOW

Simulating



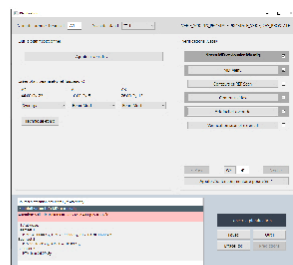
A GUI guides the techs via automatic scripts: localization points, body contour, table model, organ-at-risk contours and fusion are automated. All relevant pieces of information are stored in a new patient-specific entry in a centralized database.

Prescribing



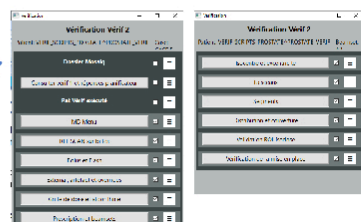
Through a GUI, the radiation oncologists adds two critical pieces of information to the database: (1) the prescription and (2) the dosimetric clinical goals.

Dosimetry



The treatment planning algorithm uses the database information: to create optimisation contours, establish optimisation objectives and drive the iterative optimisation process.

Chart Check



Automated chart checking tools are used throughout the planning process to ensure that the treatment plans are safe and of the highest quality.

IMPROVING TREATMENT PLAN QUALITY

PROSTATE PLANS

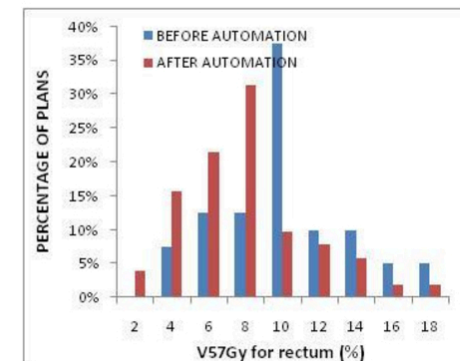


Figure 1a: Histogram distribution of the rectum V57Gy for prostate plans (60Gy/20) before and after automation was implemented

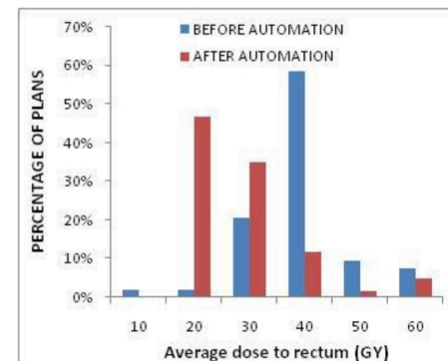


Figure 1b: Histogram distribution of average dose to rectum for prostate plans before and after automation was implemented

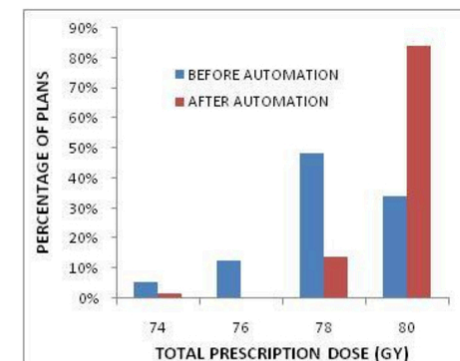


Figure 1c: Percentage of prostate plans receiving different level of prescription dose

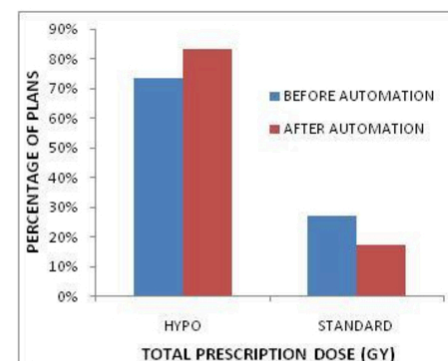


Figure 1d: Percentage of standard vs hypofractionated plans

For prostate plan automation and standardization of the optimization processes has lead to a **reduction in rectal dose**:

- DVH for rectum has been reduced by 5 % in average (figure 1a).
- Average rectal dose has been reduced by 9 Gy in average (figure 1b).

The reduction of rectal dose through automation has allowed radiation oncologists to choose optimal prescription regimen for prostate patients:

- Automation has allowed to increase by a factor 2.5 the number of patients that can receive the **full prescription dose** (figure 1c)
- Similarly, the number of patients eligible for **hypofractionnation**, based on being able to attain the DVH dose criteria, has increased by 10 % (figure 1d)

TANGENTIAL BREAST PLANS

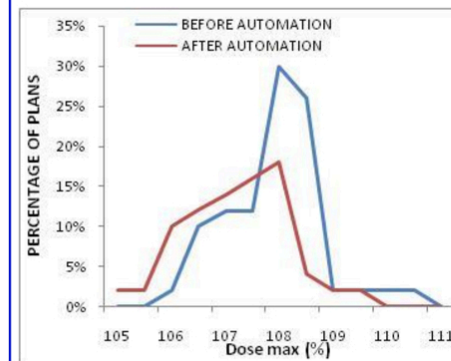


Figure 2a: Distribution of the maximal dose for tangential breast plans before and after automation was implemented

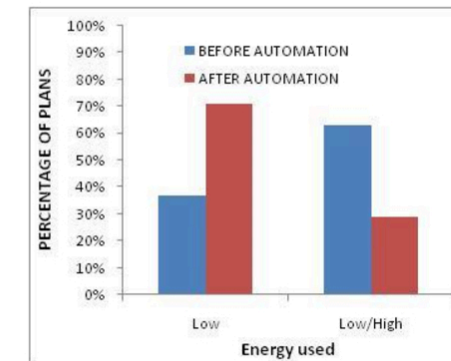


Figure 2b: Distribution of the tangential breast plans using only low energy beams and using high and low energy beams before and after automation was implemented

For tangential breast plans, automation and standardization of the beam placement, energy selection and optimization processes has lead to a :

- **Reduction of the dose maximum** by 1% in average (figure 2a)
- **Reduction of plans having a dose maximum superior to 108%** by 24 % which proportionally increases the number of patient being eligible for **hypofractionnation** (figure 2a)
- **Reduction of the use of higher energy beams** which **reduces treatment time**. A significant improvement for patient undergoing deep inspiration breath-hold technique (figure 2b)

HEAD AND NECK PLANS

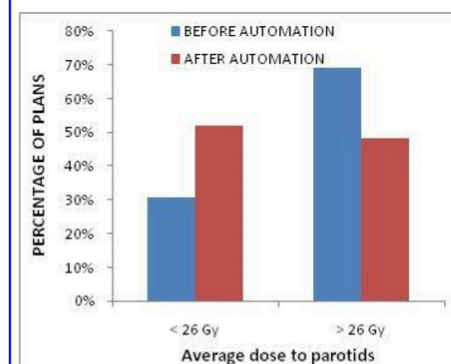


Figure 3: Percentage plans having parotids average dose below vs above 26 Gy

For head and neck plans, automation and standardization of the optimization process has lead to a :

- **Reduction of the average dose to the parotids** by 3.5 Gy in average
- Increase of 20 % in the number of plans having parotids receiving less than 26 Gy (figure 3)

A LITTLE BIT TO THINK ABOUT

Automation has allowed us to:

- Standardize our techniques
- Give clearer dosimetric goals to dosimetrists reducing the back and forth between them and the radiation oncologists
- Reduce the inter-planners biases and preferences which can lead to a sub-optimal plan
- Give more time to planners to push the plan further increasing the dosimetric quality of the plans

As more automation is introduced in our clinical processes it becomes essential to put in place:

- Test for quality control of the automated processes
- Frequent review of our automated processes to ensure they evolve with clinical practice

WHAT'S NEXT?

- Improve our contouring using automatic contouring based on machine learning
- Use the data we are collecting on our treatment plans
 - To develop tools to help radiation oncologists select better, more realistic dosimetric goals
 - To improve further our automated planning algorithms
- Develop a fast planning track requiring minimal human involvement for standard plans

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