White Paper

Simulation and data analysis in RT with *syngo*.via RT Image Suite

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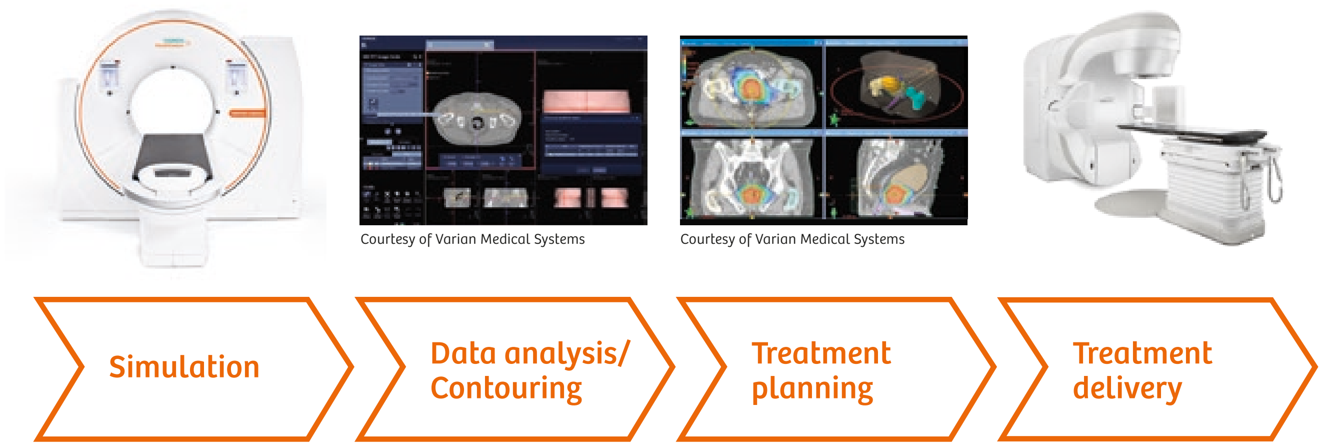

Figure 1: Overview of radiation therapy workflow

Introduction

With the increasing rate of cancer, it is crucial to have software-supported solutions that help manage cancer patients selected for radiation therapy.

Once the patient has been diagnosed and referred for radiation therapy, radiation therapy professionals such as the radiation oncologist, therapist, dosimetrist, and physicist work together to deliver the patient's treatment through the radiation therapy workflow, which begins with simulation.

During simulation, imaging scans are acquired showing the location and extent of a patient's tumor and the normal structures around it. These scans are usually computed tomography (CT) scans, but they can also include positron emission tomography (PET) and/or magnetic resonance imaging (MRI).

After simulation, the acquired data needs to be assessed. The radiation oncologist delineates the exact tumor volume that will be targeted with radiation. Often, the CT scan is used because it contains the tissue electron density information necessary for dose calculation. However, in order to delineate tumor volume more accurately, other imaging such as PET and MRI could be beneficial. In addition, organs-at-risk, i.e., normal tissue and structures that surround the tumor and that could be sensitive to radiation, have to be contoured to protect the healthy tissue from radiation.

During treatment planning, the radiation oncologist determines the total radiation dose that will be delivered to the tumor and how much dose will be allowed for the normal structures around the tumor. The physicists and dosimetrists working with the radiation oncologist use a treatment planning system (TPS) to design the details of the exact radiation plan that will be used. After approving the plan, the radiation oncologist authorizes the start of treatment. On the first day of treatment, and usually weekly after that, checks are made to ensure that the treatments are being delivered exactly the way they were planned.

This white paper describes how the *syngo*.via RT Image Suite helped Centre de Cancérologie du Grand Montpellier (CCGM) in making radiation therapy workflow more efficient. It will first detail the simulation and data analysis steps and then describe workflows prior to and after introduction of *syngo*.via RT Image Suite.

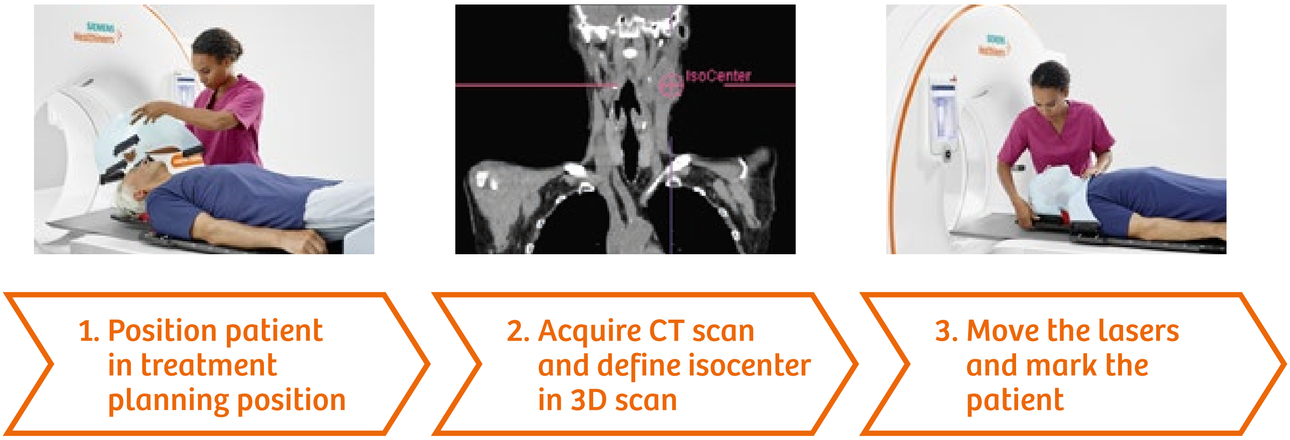

Figure 2: Overview of a simulation workflow

Overview: Simulation & data analysis

As mentioned earlier, the first step in the radiation treatment workflow is the simulation. The purpose of the simulation is to acquire a planning CT image in treatment position in order to plan treatment and make sure that radiation therapy is targeted consistently to the tumor. Therefore, precise and reproducible positioning is essential: at the scanner, this is achieved by using a flat indexed tabletop immobilization devices, and a laser system to mark the patient to match treatment positioning. The precision of simulation set-up is even more crucial with the type of treatment delivery options that are being used today, i.e., stereotactic body radiation therapy and stereotactic radiation surgery.

There are different approaches to perform simulation and the approaches differ according to the clinic or department preferences. In one instance the simulation workflow only requires the identification of the isocenter of the scanner after the CT scan. In this scenario, the isocenter is identified on the CT scan, typically with the help of the radiation oncologist or therapist, then the lasers are moved to that position and external marks are made on the patient's skin or immobilization devices. Often this workflow is not used because of the lack of tools and software facilitating this task. Other workflows do not identify the isocenter during simulation but later in the treatment planning step. This approach requires a systematic shift of the patient position later on at the treatment machine.

After the simulation scan, the second step in the radiation therapy workflow is the data analysis. The CT scan acquired provides anatomical information to determine the precise location and extent of the tumor as the target volume and surrounding healthy tissue and organs-at-risk to be spared. Other modalities can provide additional information for more precise delineation in this step: PET can provide insights into tumor metabolism; MRI images can add better soft tissue contrast or insights into tumor cell structure, for example, using Diffusion Weighted Imaging.

While precise delineation is a crucial basis for the actual treatment plan, the task of contouring organs-at-risk such as the heart, brain, lungs, etc., is most time consuming, and automated tools are lacking.

The CT scan and the contours of tumor volumes and organs-at-risk can then be exported to the radiation treatment planning system (TPS) for dose calculation.

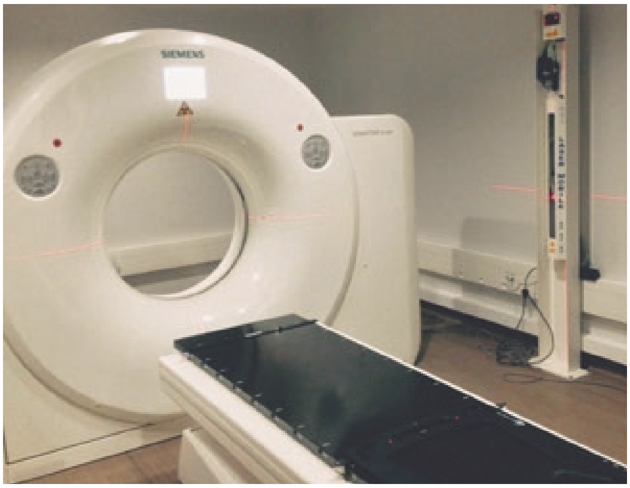

Figure 3: SOMATOM Scope Power scanner at CCGM

Figure 4: Example of patient marking and laser steering functionality[1]

Figure 5: Example of deformable registration results visualized with vector map and deformation magnitude color map

syngo.via RT Image Suite at Centre de Cancérologie du Grand Montpellier

syngo.via RT Image Suite is a Siemens Healthineers software solution to support RT planning that was developed for Radiation Oncology professionals and was designed as a user-friendly work aid to make simulation, image assessment, contouring and beam placement easier and better integrated. *syngo*.via RT Image Suite allowed Centre de Cancérologie du Grand Montpellier (CCGM) to simplify its simulation approach and manage patients differently and more efficiently, according to Dr. Stéphane Muraro, physicist at CCGM.

CCGM uses a SOMATOM Scope Power scanner and a LAP laser system to perform 12 – 15 planning CT simulations per day. The team at CCGM have recently integrated the *syngo*.via RT Image Suite into their Clinical Workflow (Figure 3). Previously, CCGM used to mark the patient with three markers, then acquire the simulation CT scan. The isocenter was subsequently defined during treatment planning. The patient was then positioned at the treatment machine with initial markers and then moved every time to the isocenter, inevitably consuming valuable time at the treatment machine.

Today, with *syngo*.via RT Image Suite integrated at the scanner acquisition workstation, it is possible to use efficient patient marking and laser steering features. The patient marking functionality is configurable and adaptable to the department or clinic simulation workflow. Once the planning CT is acquired, the isocenter is identified in the area of the target tumor and the offset between the isocenter and the original position of the lasers is calculated. The offset is then sent as a DICOM file to the laser system console to move the lasers' positions to the patient isocenter.

Figure 6: Once the user has pre-configured the structure set template and AutoContouring at the scan protocol assistant at the scanner (left), AutoContouring is then automatically started before opening the case. That eliminates the needs of 1: structure set template assignment and 2: execute AutoContouring at the TPS side. Mostly, AutoContouring is already finished when the case is opened (right), according to Dr Muraro.

Body regions (organs-at-risk contouring)	**Duration of contouring without *syngo*.via RT Image Suite (min)**	**Duration of contouring with AutoContouring in *syngo*.via RT Image Suite (min)**	**Time saving (min)**
Head and neck (Brain, eyeballs, larynx, lips, mandible bone, spinal cord, and submandibular glands)	**25**	**12**	**13**
Lung, abdomen (Lung, liver, kidney, spinal cord and heart)	**10**	**5**	**5**
Pelvic (Femoral bone left and right)	**3**	**1**	**2**

Figure 7: Duration of contouring organs-at-risk for different body regions without and with AutoContouring included in *syngo*.via RT Image Suite and resultant time saving

Finally, the therapist marks the patient at the location of the identified isocenter. As a result, at the time of treatment delivery the patient is positioned in the treatment location directly and there is no need to shift the patient position. *syngo*.via RT Image Suite also provides visual feedback of the laser position for patient marking thanks to the Virtual Laser View, which displays the laser lines on 3D patient model. This helps Dr. Muraro and his team to make sure that the patient has been correctly marked before leaving the simulation room. (Figure 4).

At CCGM, when a patient is referred for radiation treatment, he would have typically already gone through other diagnostic imaging such as diagnostic CT, PET or/and MRI. *syngo*.via RT Image Suite allows automatic DICOM data import from previous scans and the different modalities are displayed side-by-side for convenient visualization and contouring. Rigid and deformable registration² tools in *syngo*.via RT Image Suite ensure the correct alignment of images taken in different patient positions, e.g., diagnostic scan on a curved table and a planning scan on a flat tabletop. The results of the deformable registration can be checked with several tools, such as spyglass, deformation vector map, and deformation magnitude color map (Figure 5). The results of the deformable registration can also be saved so that the radiation oncologist can reopen the case at later point in time in order to perform target tumor volume contouring.

As described earlier, one of the most time-consuming tasks in radiation therapy planning is the contouring of organs-at-risk. To save time and ease the contouring task, *syngo*.via RT Image Suite offers AutoContouring to automatically delineate nineteen organs-at-risk. AutoContouring is triggered at the scanner for the acquired study. Once the user has pre-configured the structure set template according to his clinical workflow, AutoContouring is then automatically started before opening the case for further analysis. AutoContouring is an AI-assisted technology that uses machine learning to delineate organs-at-risk for reproducible and reliable results. It makes virtual simulation part of the standard acquisition task (Figure 6). According to Dr. Muraro, the nineteen auto-contoured organs in *syngo*.via RT Image Suite are accurate and reliable and allow for significant time-saving (Figure 7).

Dr. Muraro was also inspired by the Synthetic CT functionality, that offers MR-only simulation for the brain and pelvis (female and male). A Synthetic CT image is derived from a series of MR acquisitions and used for dose calculation, to enable a CT free approach.

This could potentially decreases the number of scans, patient inconvenience, and costs associated with the planning.

Conclusion

At this stage, while the patient is still in the simulation step, the patient is accurately marked at the isocenter in the area of the tumor, different modalities are aligned with deformable registration, and up to nineteen organs-at-risk contoured accurately. The data can then be reviewed by other radiation therapy professionals for further analysis, for example tumor contouring and delineation of further structures. These results are then sent to the treatment planning system for planning.

By introducing *syngo*.via RT Image Suite and combining the above-mentioned steps into the simulation part of the workflow, Dr. Muraro and the team at CCGM shortened this step to an estimated 20 minutes[3] and thereby have saved significant time for the whole radiation therapy department.

Notes

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[1] Direct Laser Steering supports direct transfer of coordinates to compatible LAP laser systems without the need to access an additional workstation, helping you to create a fast, seamless, and less error prone workflow for patient marking. Requires compatible laser system.

[2] Deformable registration may be optional in *syngo*.via RT Image Suite

[3] The statements by Siemens' customers described herein are based on results that were achieved in the customer's unique setting. Since there is no "typical" hospital and many variables exist (e.g., hospital size, case mix, level of IT adoption) there can be no guarantee that other customers will achieve the same results.

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