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Editorial

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To irradiate or to wait: practical considerations when planning for stereotactic radiosurgery for kidney tumors using magnetic resonance–guided online adaptive radiotherapy

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Radiotherapy (RT) is rapidly evolving due to the advances in radiation delivery and image-guidance technologies. The integration of magnetic resonance imaging (MRI) with linear accelerators has resulted in the most advanced type of image-guided RT, and is expected to lead to a paradigm shift in radiation oncology [1].

Compared with computed tomography (CT)–guided offline adaptive RT, which requires halting treatment, re-simulation, and re-planning before resuming treatment, magnetic resonance (MR)–guided online adaptive RT (MRgoART), aided by high-quality pretreatment MRI and cine MRI for motion monitoring, allows online adaptation for which the patient remains on the treatment table during recontouring and adaptive planning [2]. MRgoART has the potential to improve both oncologic outcomes due to dose escalation and hypofractionation and decrease toxicity due to improved targeting accuracy by inter- and intrafractional adaptation. However, the adaptive workflow is also time-consuming and resource-intensive compared with conventional CT-guided RT [3].

MRgoART is useful for tumors near gastrointestinal organs at risk (OARs), particularly in stereotactic ablative RT or radiosurgery, where the prescribed doses often exceed the dose constraints of the OARs [4]. Various factors, including peristalsis, accumulation of food or fecal residue, intestinal gases, and the level of muscular tension at the time of treatment, may change the relative positions of radiosensitive OARs and the target [5], and an adaptive plan for a particular day may not allow delivery of the planned dose to the target. In such a situation, the radiation oncologist must decide whether to treat the patient with a reduced dose than what was initially prescribed or to attempt the treatment on another day when the conditions are met for the optimum delivery of stereotactic RT.

In a recent issue of the *Radiation Oncology Journal*, Yamamoto et al. [5] created 26-Gy single-fraction stereotactic radiosurgery (SRS) plans based on patients who were treated with 3-fraction stereotactic RT using MRgoART for kidney tumors and evaluated the feasibility of waiting for a suitable timing for SRS based on the comparison of SRS plans for simulation, MRgoART1, MRgoART2, and MRgoART3. If the prescribed dose covered ≥95% of the planning target volume (PTV) or if the prescribed dose coverage of the PTV improved by ≥5% from pretreatment plans within the dose constraints, these plans were regarded as acceptable and MRgoART timing of these two plans was regarded as good timing. On the other hand, if the change of PTV coverage of the prescribed dose was within 5%

or decreased by ≥5% to fulfill the dose constraints, the MRgoART timing was regarded as fair timing and bad timing, respectively, and the MRgoART plans were unacceptable. Among the 18 tumors included in the study, 16 tumors were irradiated at a good time within the three-time chance of MRgoART, whereas only nine of the 18 tumors were irradiated at a good time at the first MRgoART. The authors concluded that waiting for the optimal irradiation timing could be an option in cases of suboptimal PTV coverage.

This study is the first to investigate the dose coverage differences at MRgoART timing and the value of waiting for an appropriate timing to perform SRS. However, the practicality of this procedure needs to be carefully evaluated. Although the authors agree that multifraction RT, such as a 10-fraction schedule, is an option to deliver a higher total dose to the target when kidney cancer is close to the OAR [6], they argue that the disadvantage of multifraction RT includes the long machine time of MRgoART, which may take 30–65 minutes. In a real-world situation, the number of patients treated with an MR linear accelerator per day is much lesser than the number of patients treated with the conventional linear accelerator, and it is impractical to reserve multiple time slots for SRS in case the attempt for SRS fails. Furthermore, additional costs are incurred for additional SRS attempts, and no government or insurance company reimburses the costs of failed SRS attempts in most countries.

Among the 18 tumors in the current study, four tumors achieved 100% dose coverage of 99% of the PTV through pretreatment planning and MRgoART, while two tumors had consistently low percentages of PTV coverage by the prescribed dose and were not considered good candidates for SRS. These results suggest that stricter inclusion criteria may ensure successful SRS delivery at any given time, and that patients who do not meet these criteria may be better treated with multifraction stereotactic RT. For example, the TROG 1503 trial allows two alternate fractionation schedules, a single fraction of 26 Gy for tumors ≤4 cm and 42 Gy in three fractions for tumors >4 cm [7]. Efforts to ensure successful SRS using MRgoART include limiting the tumor size to ≤4 cm [7], excluding tumors abutting or invading the OAR [4], defining the planning organ at risk volume using 4-dimensional CT in simulation [8], and using a smaller PTV margin when using MR guidance with motion monitoring [9]. MRgoART with automated gating can reduce the required PTV margin [10] and has the potential to increase the success rate of SRS delivery. However, the addition of automated gating also requires additional treatment time and resources, and the rescheduling of failed SRS with gating is even more difficult.

All things considered, waiting for a suitable MRgoART timing for SRS is a valid option and can lead to improved treatment outcomes and reduced toxicity. Careful selection of the candidates and improved patient understanding of the treatment process will ensure the successful delivery of SRS using MRgoART.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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