Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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FRACTIONATION AND CHANGES IN PATIENT CARE

MRI in Radiation Oncology After the COVID-19 Pandemic

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The COVID-19 pandemic presents new challenges for many aspects of health care delivery, including diagnostic and therapeutic procedures in radiation oncology. Because the date of COVID-19 elimination is not yet known, efforts to take precautions against transmission of COVID-19, and similar viruses, will likely continue. One area that will likely be changed after the pandemic is magnetic resonance imaging (MRI) use in radiation oncology. National guidelines released during the COVID-19 pandemic addressed MRI use in diagnostic radiology, with applications to radiation oncology.[1-3] MRI is used in many radiation oncology departments for magnetic resonance linear accelerator (MR-linac) treatments and for MRI simulations. Given the risks imposed by a strong magnetic field, all MRI scans require a careful assessment of devices implanted in, or accompanying the patient; in cases in which MRI presents a risk, a risk−benefit analysis is used.[4-6] Post-pandemic, the possibility of virus transmission should continue to be included in patient risk assessment, requiring new mitigation strategies. Here, we reassess the benefits and risks of MRI use in post−COVID-19 radiation oncology and present recommendations for a path forward.

MRI plays a crucial role in radiation oncology, with established applications in defining brain and spine targets for stereotactic treatments and facilitating image guided brachytherapy for cervical cancer.[7,8] MRI simulation and MR-linac use has grown, and MRI is used for contouring and image guidance across a broad set of malignancies owing to its superior soft tissue contrast compared with computed tomography, its lack of ionizing radiation making it well suited for continuous imaging, and its ability to support online adaptive radiation therapy workflows with real-time tumor tracking.[9,10] Single-institution prospective trials[11-13] and multi-institutional retrospective studies[14,15] provide early evidence regarding the value of MR-linac use in radiation oncology, but a higher level of evidence is needed through randomized trials.

The financial impact of COVID-19 is expected to persist after the pandemic, and higher levels of evidence will be needed to justify the acquisition of often costly MRI simulators and MR-linacs in radiation oncology. Although the need for evidence-based medicine has always existed in our field, the pandemic is expected to increase this requirement. For a device that is both costly and incorporates a strong magnetic field that presents a risk to vulnerable categories of patients and staff, randomized trials establishing a broader role for MRI will be crucial. Master protocols may provide an efficient mechanism for conducting multiple prospective trials across disease sites.[16,17]

In the aftermath of COVID-19, the number of available employees in health care facilities may decrease. Personnel allocation may be reassessed to minimize room occupancy and to keep a safe distance among staff and patients where possible. MRI application in radiation oncology requires multidisciplinary collaboration of personnel including physicists, technologists, physicians, and nurses. Training

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of multidisciplinary teams can incorporate off-site and virtual simulations to reduce the number of staff in the clinic in the postpandemic world. This is especially relevant to MR-linac training, in which radiation therapists often benefit from cross-training in radiology with magnetic resonance technologists. The success of MRI growth postpandemic will require cross-institutional collaboration to ensure safe MRI delivery.

The risks of MRI relate to the strong magnetic fields that are not encountered in other areas of radiation oncology. The MRI environment imposes unique considerations regarding the safety of items that may enter the scanner room. During the COVID outbreak, an additional risk factor for the MRI environment emerged: personal protective equipment (PPE), such as face masks, respirators, face shields, goggles, and gowns. After the pandemic, continued consideration of the safety of PPE in the MRI environment will be required. PPE and any devices accompanying the patient should be tested for ferromagnetic components using a ferromagnetic detector or portable magnet before entering zone IV. Ferromagnetic parts should be replaced if possible[1] without compromising PPE or device function; otherwise, a minimum allowed distance to the scanner at which magnetic forces are not strong enough to attract a specific metallic item should be estimated and adhered to, and options to secure or safely replace the item should be considered.

The COVID-19 outbreak has also sensitized health care providers to the possibility that even asymptomatic patients may carry viruses transmittable through droplets that can remain in the air for a few hours and fall on nearby surfaces. To minimize potential transmission to persons subsequently entering the scanner room, patients should be required to wear face masks continuously during the whole examination and treatment procedure. Masks containing metallic parts should be replaced with MR safe masks when possible, or the metallic components should be removed.[1] Even if patients' masks with metallic parts are well secured and not pulled by the scanner magnet, they could cause artifacts on the images[18] and present heating hazards due to the radiofrequency fields present during MRI scanning.

The COVID-19 pandemic prompted many MRI facilities to reevaluate their air-conditioning and filtration systems with the goal of limiting transmission of airborne diseases. Although room ventilation is important to decrease droplet concentration in the air, strong air circulation may aid this spread. Therefore, scanner bore fan speed should be reassessed to achieve a balance between droplet precautions and avoiding patient heating.[19] It is recommended to turn the fan off to allow droplets to settle before terminal cleaning. MRI scanner cleaning regimens have been enhanced to better disinfect scanner surfaces and coils between patients and to include a more thorough terminal cleaning. Nevertheless, the ingredients of additional cleaning agents should be checked against scanner manufacturer cleaning recommendations to avoid degrading of the equipment.

Despite these additional risks to MRI scanning presented by COVID-19, we continued to scan patients in radiation oncology during the pandemic, considering anticipated patient benefit and necessary precautions. A previously published workflow[20] for treating COVID-19–positive patients in radiation oncology can be adapted for the MRI environment, to scan patients with confirmed or suspected infectious viruses. Once the pandemic has ended, we anticipate continued use of MRI in radiation oncology, with prolonged need for PPE and for magnetic resonance safety analysis of this PPE. Post-COVID, risks imposed by respiratory-transmitted viruses in the MRI environment can be mitigated using the measures outlined here. With well-designed clinical trials and comprehensive safety analyses that include PPE and viral transmission, MRI will continue to have a promising future in radiation oncology after the pandemic.

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