

The Infection Control Measures Taken in MRI Examination During the COVID-19 Pandemic Prevention and Control Period

Xinying Zhang, Han Ying, Qin Yan, Minghui Zhao*

Affiliated Hospital of Hebei University, Baoding 050031, Hebei Province, China

*Corresponding author: Minghui Zhao, hdfyzxy@163.com

Copyright: © 2023 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: *Objective:* To optimize the magnetic resonance imaging (MRI) detection process in view of the COVID-19 pandemic, standardize and strengthen the infection control and management MRI rooms. *Methods:* According to the Technical Guide for COVID-19 Prevention and Control in Medical Institutions (3rd Edition), with reference to the current COVID-19 infection control plan, there are three aspects involved in the planning of MRI examination: MRI room management, medical staff management and protection, and patient management, especially the use of full plastic nose strip medical masks. Infection prevention measures are formulated, scientific prevention and control are made, and accurate policies are implemented. *Results:* MRI examination was carried out according to the infection control and management of MRI room plan during the epidemic, so as to ensure the safety of examination, the safety of patients and the safety of medical staff and no cross infection in hospital. *Conclusion:* The implementation of proper infection prevention measures during MRI examination in light of COVID-19 ensures that patients wear medical surgical masks with full plastic nose strips throughout the process to avoid cross-infection, ensure the safety of doctors and patients, and maintain the health of the population.

Keywords: Novel coronavirus; MRI examination; Infection control; Medical surgical mask with full plastic bridge of nose strip

Online publication: January 31, 2023

1. Introduction

On March 11, 2020, the World Health Organization announced that the COVID-19 epidemic had entered a global pandemic [1-2]. In the past two years, thanks to the joint efforts of the people, the situation of the COVID-19 pandemic in China has been effectively controlled. However, nosocomial infection of COVID-19 occurred in many provinces and cities, which once again highlighted the prevention and control work of medical institutions. Computerized tomography (CT) as one of the important means of diagnosing COVID-19, the management and infection control measures of CT room is relatively mature, but there are few literatures about infection control in the MRI room. COVID-19 patients who are asymptomatic [3-5] before MRI examination will contaminate the equipment, the environment, and medical personnel, causing cross-infection. MRI room is an environment with strong magnetic field. During MRI examination, do not carry any metal objects, including masks containing metal nose strips; MRI room space is airtight, MRI examination usually takes about 15 minutes, some will take more than half an hour [6]. MRI is a high-precision electronic equipment, the terminal disinfection method is limited; the usual method is the “manual wipe” method, and it is difficult to carry out thorough disinfection. Considering the above characteristics

of MRI room, it is clear that there is a high risk of infection in MRI room, so it is very necessary to implement infection control measures for MRI rooms. According to the relevant protocols of medical institutions and the guidelines for the prevention and control of COVID-19, and referring to the infection control measures of COVID-19 in CT room, this paper summarizes and modifies the existing infection control measures of COVID-19 epidemic situation in MRI room, so as to avoid cross-infection and ensure the safety of patients and medical staff.

2. Management of MRI room

2.1. Infection control zone of magnetic resonance room

An independent security zone and a special passage are set up for transporting novel coronavirus infected people. According to the layout of the medical institution, the MRI rooms are divided into contaminated area, semi-contaminated area, buffer zone, and clean area. The contaminated area includes waiting area, examination room, enhanced preparation room, patient passageway, patient toilet; the semi-contaminated area includes operation room, magnet room, equipment room; the buffer zone is located between semi-contaminated area and contaminated area; the clean area includes doctors' office, duty room, changing room, medical channel, and so on [7-10]. Technicians and paramedics were to wear protective equipment in the clean area and remove it in the buffer zone. Positioning technicians working in contaminated areas are not allowed to enter the clean area at will. When changing posts, they can enter the clean area only after taking off protective clothing in strict accordance with the protective equipment process. The entrances and exits of all areas should be equipped with quick-drying hand disinfectant, and medical staff should disinfect their hands while going in and out of an area.

2.2. Disinfection of MRI equipment and environment

The medical devices, environment and article surfaces in MRI room are disinfected in strict accordance to the norms and standards such as "Management Standard for Environmental Surface cleaning and Disinfection of Medical institutions," [11] using "Recommended Scheme for Prevention of COVID-19 Infection: Medical Devices and Objects' Surface Disinfection Method" [12], combined with the manufacturers' instructions on the disinfection of equipment.

(1) Disinfection of MRI equipment

The cleaning and disinfection of MRI equipment is mainly focused on the parts that are in direct contact with patients, such as magnets, coils, examination beds and so on. The patient is in close contact with the magnet for a long time, thus the surface and the inside magnet pores need to be disinfected. Movable tools such as coils should be removed from the magnet room when not needed to reduce the chance of contamination. Ultraviolet rays can be used for disinfection outside the magnet room (disinfect for at least 30 min, at about 1 m), or 75% ethanol is used for wipe disinfection [13]. Coil and other accessories are disinfected according to the manufacturer's instructions; corrosives, soluble disinfectants, or sterilizers are not used to not cause damage. Daily disinfection of MRI equipment: disinfection of magnetic pore surface and pores using wet wipes, disinfection with disposable disinfection wipes or 75% ethanol, twice a day. Inspect beds with disposable medical sheets, mattresses can be disinfected with 75% ethanol or special detergent, at least twice a day.

When patients who are diagnosed with or suspected of COVID-19 undergo MRI examination, two layers of disposable medical sheets can be pasted on the inner wall of the magnetic hole, which can prevent the patients from contaminating the equipment, and terminal disinfection should be carried out immediately after the examination.

(2) Environmental disinfection in MRI room

The environment of MRI room is divided into magnet room and non-magnet room (operation room, preparation room, and so on). The air, ground, and object surface are disinfected in different ways. The magnet chamber is in a strong magnetic field environment, thus any magnetic material or equipment that may cause interference is prohibited. Daily disinfection of MRI room environment: a non-magnetic ultraviolet lamp is used to disinfect the air of the magnet room, 30 min each time, twice a day. Medical institutions can use non-magnetic air disinfector for circulating disinfection between magnets; if there is no non-magnetic air disinfector, a general air disinfector can be placed in the equipment room for 24h cycle disinfection. The floor and surface of the magnet room were disinfected with a chlorine-containing disinfectant containing 2000 mg/L free chlorine ^[13]. The non-magnetic room shall be cleaned and disinfected in accordance with the “Technical Specification for Disinfection of Medical Institutions” ^[14]. The ground is wet-cleaned with a chlorine-containing disinfectant containing 500 mg/L of free chlorine. When there are no obvious contaminants, disinfect directly; when there are obvious contaminants, clean them first and then disinfect them. Door handles, surfaces of tables and chairs, power switches, and other surfaces are wiped with disposable disinfection wipes which contains 75% ethanol or 500 mg/L chlorine-containing disinfectants, at least twice a day, and sterilized and wiped at any time in case of contamination. Computers, telephones, keyboards, and other electronic devices are wiped with disposable disinfection wipes once a day or covered with a protective film. Cloth towels and floor towels used for disinfection should be “one towel for one area,” and should be cleaned and stored in different areas. When patients infected with COVID-19 (including patients diagnosed by COVID-19, suspected patients, and asymptomatic infection) undergo MRI examination, turn off the ventilation and air conditioning in the inspection room, and disinfect the surface and ground with 2000 mg/L chlorine disinfectant immediately after the inspection.

2.3. Medical waste management

The medical waste in MRI room shall be treated in accordance with the “Regulations on the Management of Medical Waste and the Measures for the Management of Medical Waste in Medical and Health Institutions.” The regulations include the separate collection of medical waste, safe transportation, and standardized storage and handover. The medical waste produced by ordinary patients is disposed of as conventional medical waste. All waste produced by patients diagnosed or suspected of COVID-19 shall be disposed of as infectious waste, using double-layer yellow medical waste bags, when the bags are three quarter full, they are then sealed with a gooseneck seal, with layered sealing; spray 5000mg/L chlorine-containing disinfectant into the inner and onto the surface of the inner bag; a special logo is pasted on the outer bag, spray 5000mg/L chlorine-containing disinfectant on the surface of the outer bag, and store it in the medical waste storage area of the department. Infectious medical waste is to be collected by cleaners or full-time medical waste collectors (level II protection), and handover registration, airtight transfer, and temporary storage in hospitals needs to be done properly ^[15]. 1000 mg/L chlorine-containing disinfectant is used to disinfect the floor of the temporary storage of medical waste twice a day. The quilt clothes and dirty clothes are placed in the yellow garbage bag with a special logo pasted on it, and is sent to a laundry company to for special cleaning and disinfection. The transportation tools were wiped and disinfected twice with 2000 mg/L chlorine-containing disinfectant. Cleaners or full-time medical waste collectors should do a good job of self-protection and strictly enforce hand hygiene.

3. Management and protection of medical staff

The medical staff are required to measure their body temperature every day, and pay attention to whether they have symptoms such as fever, cough, diarrhea, and so on, and pay attention to whether they are in

contact with feverish patients and have a history of travel in areas with medium and high risk. If the above symptoms or conditions are reported, they shall be isolated at home for 14 days ^[16,17].

Medical staff should be trained on COVID-19 related knowledge, including COVID-19's epidemiological characteristics, infection control measures, types and usage of protective equipment, hand hygiene standards, disinfection standards, and so on, and assessments should be conducted. Medical staff wearing appropriate personal protective equipment can effectively reduce or even stop the spread of respiratory infectious diseases ^[18]. Medical staff are required to wear protective equipment correctly, especially the wearing and taking-off sequence of protective equipment according to the protective requirements of different posts. Medical staffs must perform general protection in the clean area, wear overalls, disposable medical masks, work hats and gloves if necessary. First-level protection should be carried out in the MRI inspection area, wearing disposable work caps, disposable medical masks (contact with N95 protective masks with epidemiological history), overalls, isolation clothes, and disposable latex gloves if necessary. If a person comes into contact with a confirmed or suspected COVID-19 patient, he/she should carry out secondary protection like wearing disposable work cap, protective glasses or mask (anti-fog type), medical protective mask, protective clothing or isolation clothing, disposable latex gloves, and disposable shoe cover ^[19]. Contact transmission is one of the main ways of transmission of novel coronavirus, so medical staff are required to master the "seven-step washing techniques" and carry out hand hygiene in strict accordance with the "Code for Hand Hygiene of Medical Personnel," and special personnel can be set up to supervise. In particular, hand hygiene must be carried out before and after contact with COVID-19 diagnosed or suspected patients. Minimize contact with patients and maintain a distance of 1 m among each other.

4. Patient management and protection

The patients are classified into ordinary patients, febrile patients, and COVID-19 infected patients. Patients are examined by an appointment registration system, which can be booked by telephone or WeChat official account, but not on the spot. In order to avoid the gathering of patients, the number of patients for daily examination should be reasonable, and patients should be examined at different times according to the notice given at the ward or clinic. Medical personnel accompanying the patients should be limited, and only accompany them if necessary ^[20]. Ordinary patients should carry out COVID-19 tests before examination to make sure that they are negative. The itinerary code should be checked to make sure they have no history of medium-and high-risk travel and contact with febrile patients. Then, take the patient's temperature, and ask whether he/she has fever, cough, diarrhea, or other symptoms, and ask if there are contraindications for MRI examination. Patients with fever and patients diagnosed or suspected of COVID-19 are led by special transport personnel to take a special channel ^[21] for MRI examination. If the patient needs enhanced MRI examination, the nurse is required to puncture the vein with a needle in advance in the enhancement preparation room, and then carry out secondary protection during the operation. It is important to maintain good hand hygiene when the patient enters the examination room to achieve the goal of "one room, one disease."

The patients are informed of the matters needing attention in the MRI examination and is given a medical surgical mask without metal strips. Considering that most of the medical surgical masks in the market have metal nose strips, it is suggested that medical institutions purchase medical surgical masks with full plastic nose strips, distribute them to the patients before MRI examination, and guide the patients on how to wear them correctly. The full plastic nose bridge is made of polyolefin polymer material with moderate hardness and does not contain metal, it also has the following advantages: good plasticity, malleable, retains the existing shape for a long time, and has a good shaping effect. Besides, the thickness of the strips is better controlled, with good tightness and less compression, making them more comfortable

to wear. The material of the strips is the same as the mask, which is convenient for environmental protection treatment. All patients should wear masks during the whole examination [22].

Health education for patients and their families can be carried out by placing display boards of relevant knowledge of COVID-19 and issuing health education manuals, so that patients and their families can understand COVID-19, take correct measures to prevent COVID-19, and develop good hygiene. The content of health education are as follows: COVID-19 symptoms, route of transmission; timely medical treatment with fever and other symptoms. The masks should be worn and discarded properly. Cover your nose and mouth with a tissue or elbow when coughing or sneezing and wash your hands frequently with the correct method; avoid contact with contaminated objects, or wash your hands in time after coming into contact, avoid touching your eyes, mouth, nose, and other body parts with dirty hands; maintain a 1 m distance from other people.

Funding

- (1) Medical Science Research Program of Hebei Province: Analysis and Prevention and Control of Drug Resistance of Main Pathogenic Bacteria in Third-Class A Hospitals in the Recent 3 Years (No. 20210845)
- (2) Hebei University Affiliated Hospital: The Effect of Improving Hand Hygiene of Medical Staff on Nosocomial Infection During the Normalization Period of the Pandemic 2021 (2021Z010)
- (3) National Natural Science Foundation of China: Interaction of *NEDD4L* with eEF1A1 in VEC Autophagy and Tumor Angiogenesis Via Ubiquitination Activity (No.82103181)
- (4) Natural Science Foundation of Hebei Province: Study on the Role of Sal-Mir-58 in Transspecies Regulation KLF3 in the Proliferation and Migration of Vascular Endothelial Cells (No. C2020201052)

Disclosure statement

The authors declare no conflict of interest.

References

- [1] National Health Commission, 2021, Technical Guide for Prevention and Control of Novel Coronavirus Infection in Medical Institutions (3rd Edition).
- [2] Shen X, Meng J, Wang Q, et al., 2020, Coronavirus Disease 2019: MRI Examination Procedures and Infection Prevention and Protection. *Ann Transl Med*, 8(17): 1074.
- [3] Rothe C, Schunk M, Sothmann P, et al., 2020, Transmission of 2019-nCoV infection from an Asymptomatic Contact in Germany. *New Engl J Med*, 382: 970–971. <https://www.nejm.org/doi/full/10.1056/NEJMc2001468>
- [4] Ashari MA, Zainal IA, Zaki FM, 2020, Strategies for Radiology Departments in Handling the COVID-19 Pandemic. *DiagnInterv Radiol*, 26(4): 296–300.
- [5] Zhao L, Wu D, Xiong J, et al., 2020, Prevention and Control Management of Nosocomial Sensation by CT Examination of COVID-19 Patients. *China Medical Equipment*, 35(06): 40–43 + 58.
- [6] Zhong L, A Brief Discussion on Nuclear Magnetic Resonance Examination. *Leisure*, 2019(05): 287.
- [7] Tian M, Liu CC, Long L, et al., 2020, Management and Reconfiguration of a Radiology Department under the Threat of Coronavirus Disease 2019: Experience from Wuhan. *Curr Med Sci*, 40(4): 608–

613.

- [8] Shi W, Shi W, Ji Z, et al., 2020, Prevention and Control Measures of PET/CT Inspection During COVID-19 Epidemic Situation. *Chinese Medical Imaging Technology*, 36(03): 471–473.
- [9] Yu J, Ding N, Chen H, et al. 2021, Loopholes in Current Infection Control and Prevention Practices Against COVID-19 in Radiology Department and Improvement Suggestions. *Canadian Association of Radiologists Journal*, 72(2): 215–221.
- [10] Chen Q, Zu ZY, Jiang MD, et al., 2020, Infection Control and Management Strategy for COVID-19 in the Radiology Department: Focusing on Experiences from China. *Korean J Radiol*, 21(7): 851–858.
- [11] National Commission of Health, 2016, Code for Management of Environmental Surface Cleaning and Disinfection in Medical Institutions, WS/T 512-2016.
- [12] Franks TJ, Chong PY, Chui P, et al., 2003, Lung Pathology of Severe Acute Respiratory Syndrome (SARS): A Study of 8 Autopsy Cases from Singapore. *Human Pathology*, 34(8): 743–748
- [13] Magnetic Resonance Group, Imaging Technology Branch of Chinese Medical Association, 2020, Management Strategy of Infection Prevention and Control by MRI Inspection During COVID-19 Epidemic. *Chinese Journal of Radiology*, 54(05): 399 + 402.
- [14] Zhi N, Mo Q, Yang S, et al., 2021, Treatment of Pulmonary Fibrosis in One Convalescent Patient With Corona Virus Disease 2019 By Oral Traditional Chinese Medicine Decoction: A Case Report. *Journal of Integrative Medicine*, 19(2): 185–190.
- [15] Ministry of Health of the People’s Republic of China, 2009, Health Protection Management of Medical Radioactive Wastes, GBZ 133 Mel 2009.
- [16] Zhang X, Pan K, Cao G, et al., 2020, Infection Management Practice of Non-Isolated Computer Room in Radiology Department During COVID-19 Epidemic Period. *Journal of Wenzhou Medical University*, 50(03): 191–194.
- [17] Tian R, 2020, Analysis of Disinfection, Isolation and Protective Measures of CT Room in COVID-19 Outbreak Period. *Wind of Science and Technology*, 2020(17): 295–296.
- [18] Li S, Zong Z, Sun X, et al., 2020, New Evidence-Based Clinical Practice Guideline Timely Supports Hospital Infection Control of Coronavirus Disease 2019. *Precision Clinical Medicine*, 3(1): 1–2. <https://academic.oup.com/pcm/advance-article/doi/10.1093/pcmedi/pbaa008/5748339>
- [19] Committee of Infectious Diseases Imaging Technology Experts of Chinese Medical Imaging Technology Branch, 2020, Novel Coronavirus (2019-nCoV) Radiological Examination Program and Infection Prevention and Control Expert Consensus (1st Edition). *Electronic Journal of Emerging Infectious Diseases*, 5(1): 1–9.
- [20] Liao W, Li X, Yang Q, et al., 2021, Management and Prevention and Control Measures of CT Room During COVID-19 Epidemic Situation. *Chinese Contemporary Medicine*, 28(06): 171–173.
- [21] Zanardo M, Martini C, Monti CB, et al., 2020, Management of Patients with Suspected Or Confirmed COVID-19, in the Radiology Department. *Radiography (Lond)*, 26(3): 264–268.
- [22] Kooraki S, Hosseiny M, Myers, L, et al., 2020, Coronavirus (COVID-19) Outbreak: What the Department of Radiology Should Know. *J Am Coll Radiol*, 17(4): 447–451.

Publisher’s note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.