

Potential Safety Risks of High Field Strength Magnetic Resonance Inspection In Hypophysoma Operation and Protection of Patients

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Abstract

In this research existing potential safety risks of high field strength magnetic resonance in hypophysoma operation and effective countermeasures of protecting patients were explored. 68 cases of hypophysoma patients undergone operation in our hospital (First Affiliated Hospital of Sun Yat-Sen University) from December 2014 to November 2015 were collected. The hospital conducted high field strength intraoperative magnetic resonance inspection for them after carrying out comprehensive nurse and safety inspection for them. All patients finished the inspection smoothly and safety of both patients and medical staff were ensured. Via comprehensive and high quality nursing, corresponding protection measures were taken to remove potential safety risks. High field strength intraoperative magnetic resonance inspection for hypophysoma patients is a safe and effective one.

Keywords: Magnetic resonance; Hypophysoma; Safety; Protection

1. Introduction

Magnetic resonance imaging (MRI) is a kind of new and non-traumatic imaging method. When compared with CT, it has such advantages as clearer image, high-resolution ratio, no ionizing radiation, imaging at any plane and functional imaging etc. For high field strength of intraoperative high field strength magnetic resonance system is used at present, or magnetic field of Siemens 3.0 t (Tesla - unit of magnetic field intensity) superconducting magnet is permanently existent under normal circumstances. In order to ensure safety of patients and medical staff, nursing management of such special operation room becomes more important. Our hospital applies the latest model high definition (HD) MRI and its advanced and comprehensive software support for examining diseases of skeleton, digestion, circulation, nerve, muscular system and soft tissue. Existing potential safety risks in inspection of hypophysoma patients and countermeasures of protection are summarized in the following parts of this research ^[1].

2. Materials and methods

2.1 Clinical materials

68 cases of hypophysoma patients who received high field strength intraoperative magnetic resonance inspection in our department from December 2014 to November 2015 were selected. The gender-wise distributions of these cases are 37 and 31 male patients and female patients respectively. The age ranges from 10-68 years, with average age of 48.26 years. Inspection result of hypophysoma were classified as 51 cases of sella routine scan and seller enhanced scan, 12 cases of head routine scan and head enhanced scan, 3 cases of head routine scan and 2 cases of sella routine scan.

2.2 Nursing methods

(1) Cleaning and maintenance of special articles:

This involves two steps. First avoid collision and contact of wall touch screen and displayer with sharp

instruments and second is to prohibit soaking any part of RF coil and fixed device of head in water.

(2) Pre-operative training:

Training is conducted on safety of magnetic resonance for members of magnetic resonance team, make clear specialty of magnetic resonance operation room and understand the necessity of strictly implementing safety norms.

(3) Safety interview of magnetic resonance with pre-operative patients:

Through visiting the patients before operation respect their right of patients to know and agree and offer safety publicity, education and interview to them.

(4) Intraoperative safety inspection before scanning:

5 steps are involved in intraoperative safety inspecting prior to scanning. The first step is to fix the body position and ensure no contact of skin in large area and prevent forming conductive loop. Second step is to Ensure thermometer of monitor, ECG lines and optical fiber lines not to be crossed or coiled and to seal external auditory canal with bone wax. The third step covers incision with developing-free gauze. Fourth step is to carefully check operative instruments and prevent the risks of their projection. The last step is to cover body of patients with two pieces of 2m-long sterile operational towels before entry of magnet ^[2-3].

(5) Methods of transferring intraoperative patients:

The method of transferring intraoperative patients is split into three main steps. Initially nurses of magnetic field room should carefully check channel of transfer and ensure it not to have any obstacle, and guarantee ground not to have any missing article. This step is



followed by second step in this stage which says that Anesthetist should be responsible for ensuring length of infusion tube; monitoring line and anesthetic incubate to meet the needs of transfer. Lastly must ensure transfer bed to be completely connected with operative bed, fix trundles of transfer bed and slowly pull operative patients to transfer bed. Then, anesthetist should connect magnetic field-compatible anesthesia machine and monitor. Finally after all this process gets completed nurse of magnetic field room sends patients into scanning room to receive magnetic resonance scanning.

3. Potential safety risks

3.1 Safety problems caused by strong magnetic field

Strong magnetic field produced by magnet can absorb ferromagnetic substance within magnetic field into the center of magnet, which will not only cause the death of the inspected, but also cause damage to magnet and RF coils. So, it is a must to ensure not to bring ferromagnetic substance into magnetic field. Moreover, set striking sign of strong magnetic field and safety warning outside magnet room. Strong magnetic field also disturbs normal work of electronic lines, especially cardiac pacemaker and operative instruments. In addition, mechanical watches, credit card, mobile phones will be damaged by magnetic field. So, they should not be brought into magnetic field.

3.2 Safety problems caused by radio frequency

Human body is a kind of conductor with certain bio-resistance. So, the power of radio frequency pulse in magnetic resonance scanning will be partially or totally absorbed by human body and its bio-effect mainly

lies on changes of body temperature. When imaging position is different, limit value of SAR will be different. Generally, it is lower than 0.4W/kg for somatic part and 3.2W/kg for head. In addition, increase of temperature caused by any impulse sequence must not exceed 1 °C . The temperature of trunk cannot exceed 39 °C and temperature of limbs cannot exceed 40 °C .

3.3 Safety problems caused by refrigerant

Superconducting magnet is applied for medium and high magnetic resonance imaging device and 77.4k liquid nitrogen and 4.2k liquid nitrogen are applied as two kinds of refrigerant. Usually, it needs to regularly supplement liquid nitrogen to prevent quenching. Hydrogen is a kind of non-toxic and tasteless inert gas, makes people suffocated. Once magnet quenches or realizes de-magnetization for certain reason, plenty of refrigerant will be rapidly volatilized. As a result, the narrow space will be filled with hydrogen and nitrogen and people inside will be short of oxygen. So, under such circumstance, all people should leave immediately. When ventilation is realized well and hydrogen is released, they can go back to dispose it ^[4].

3.4 Safety problems caused by intraoperative medical staff

(1) Nurses of magnetic field room should remind intraoperative medical staff of making preparations for entering magnetic field room well before entering it.

(2) Iatrogenic infection. In enhanced inspection, remaining needle of venipuncture is demanded; and disinfection, hand sanitation and environment do not conform to requirements. When connecting hose of high pressure injector is not connected solidly, blood will flow back to contaminate connecting hose, thus resulting in iatrogenic infection ^[1].

(3) As patients are at general anesthesia state, vital signs of patients should be carefully observed by doctors and anesthetist.

4. Protection countermeasures

4.1 Countermeasures of protecting instruments and device

(1) Routine management of instruments and equipment. Check instruments and equipment routine each day before operation and ensure instruments to be normally used after operation, timely record using situation of instruments and clean them well. After ending operation, anesthetist should check and ensure all instruments and equipment to be closed and nurses of operation room should check operative instruments and place them well. Before entering magnetic field room, it is nurses of magnetic field room that confirm preparations of anesthetist and nurses of operation room to be qualified. Nurses of magnetic field room should connect contrast medium injector with venous tube, position patients and send them into instrument to receive scanning conducted by technician. Inspection and maintenance of instruments and equipment of magnetic field room should be registered well, aiming to ensure safe and effective work of instruments and equipment.

(2) Cleaning and maintenance of special articles: Nurses of magnetic field room should be held responsible for post-operative cleaning of fixed device of head and RF coils and ensure their cleaning quality to be high and their safety. Fixed device of head should be scrubbed with special wet tissue of operation room and soft cloth after being used and nurses should check whether its parts are complete. Outside package of RF foil should be replaced after being used in operation. In its storage and movement process, nurses should prevent dropping coil and connector.

4.2 Countermeasures of protecting patients

(1) Safety publicity and education of patients. One day before operation, medical staff should visit patients and specifically introduce precautions of MRI inspection and specialty of operation; understand somatic situation of patients, ask patients whether they have implant inside

their body, confirm whether implant inside body is compatible with magnetic resonance and fill in consent to safety of magnetic resonance scanning carefully.

(2) Pre-operative safety preparations: At the morning of operation, patients are to be sent into operation room, confirm whether patients have metal things on their body or not and remove the ones found timely. Patients should lie on their back on operation bed and their upper limbs should be covered with medium towel and fixed at two sides of body, gasket should be placed between lower limbs to ensure them not to be crossed, all of which aim to prevent contact of skin in large area and formation of conducting loop. Special earplugs or cleaning cotton ball should be inserted into external auditory canal to protect their audition.

(3) Intraoperative safety inspection before scanning: All monitoring lines and optical fiber lines for body of patients should not be coiled or crossed or contact skin of patients directly, aiming to prevent burning skin due to back flow of current. Lines and tubes of instruments around operation bed should be cleaned to ensure transfer to be safe and smooth. Responsible nurses of instruments and devices and tour nurses should carefully check operative instruments and devices and nurses of magnetic field room should confirm no magnetic resonance-compatible instruments left on the body of patients.

4.3 Countermeasures of protecting medical staff

(1) Safety training: Before operation, it is the professional that conducts safety education and training of magnetic resonance for all participating workers of intraoperative magnetic resonance inspection. Through theoretical instructions, electrified education and consent to safety of magnetic resonance and practice, and safety training of other forms, the workers who obtain approval of department directors and are confirmed to be qualified via evaluation can enter iMRI integrated operation room to participate in operation and magnetic field work.

(2) Safety supervision: All workers who enter iMRI integrated operation room must consciously observe



related management regulations of magnetic field room, conduct self check on their carried articles, and place non-compatible articles of magnetic resonances into special basket prepared well inside magnetic field room and not take any metal article into magnetic resonance inspection room. Nurses of magnetic field room should strictly implement management regulations and check and remind related workers again before their entry to inspection room to ensure their personal safety.

(3) Management of cleaning workers: It is important to designate special personnel to finish cleaning work of magnetic resonance inspection room. Cleaning workers must receive safety training of magnetic resonance and start their work when they are assessed to be qualified. In doing cleaning work of inspection room each time, it is a must to have nurses on site to conduct safety interview and site supervision and guidance to avoid random movement of instruments and articles inside ^[5].

5. Discussion

Formulating management regulations of magnetic field room of operation room is the precondition to ensure safe use of instruments and device and smooth implementation of operation. All participants and observing staff of operation must follow it. Meanwhile, set related warning signs inside magnetic field room of operation room, mark precautions clearly, and remind workers of observing them consciously. Moreover, improve management system constantly in its using process and ensure operations to be safe.

For safety of personnel and smooth operation of magnetic resonance scanning inside operation room, higher requirements are proposed for nursing management of magnetic field room of operation room. Carefully check them and perform the ones as specified. Nursing work of magnetic field room of operation room should be precise and orderly, and various regulations should be strictly implemented and magnetic resonance operation room should be managed well, so as to ensure safety of personnel and smooth operation of magnetic resonance scanning

of operation room. In addition to setting of striking warning board, it is better to make a partition to avoid entry of irrelevant personnel or companions to magnetic field room ^[4].

By safety training, ensure workers to improve their safety awareness, have clear understanding on their own responsibilities and shape a cultural atmosphere on safety. Through video and field display, ensure them to recognize the necessity of high field strength intraoperative resonance's safety ideologically and avoid occurrence of injuries.

Before scanning, nurses are required to do their work precisely according to 'list of safety inspection' and check related items together with nurses of magnetic field room. Strict working attitude will avoid causing any harm to operation participants and patients. Due to permanent existence of 3.0T high magnetic field, we should strictly conduct safety interview of magnetic resonance, and carefully perform list of safety inspection of magnetic resonance to ensure safety of patients and medical staff of operation and ensure magnetic resonance scanning inside the room to be smooth ^[6].

By formulating and gradually improving corresponding management systems of operation room and magnetic field room, setting specialist to manage them, carefully finishing preoperative safety preparations of patients, strictly implementing safety inspection of magnetic resonance, normalizing operation and maintenance of instruments and equipment and conducting safety training, workers are required to improve their safety awareness, and strengthen self management so as to constantly strengthen safety management of magnetic field room of operation room and ensure operation participants and patients to be safe ^[7].

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Competing Financial Interests

The authors declare no competing financial interests.

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