CASE STUDY

Advantages of an Comprehensive MRI System From the Viewpoints of Clinical Practice and Hospital Management

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The Shimizu Hospital Group includes four hospitals, a clinic, a geriatric care center, and other health service facilities which provide both acute and long-term medical care and home nursing services. The Rakusai New Town Hospital offers healthcare services covering a relatively wide range of clinical specialties within the hospital group. Our facility has 20 clinical departments, including internal medicine, cardiology, gastroenterology, urology, gynecology, plastic surgery, ophthalmology, neurosurgery, and orthopedics.

Within the Shimizu Hospital Group, some MRI examinations that cannot be performed at the other three hospitals due to capacity limitations of current MR technology at the sites, are referred to Rakusai New Town Hospital so the hospitals in the group can work together to efficiently handle all patients who require MRI examinations.

In December 2018, Rakusai New Town Hospital decided to install a new 1.5-T MRI system to replace our previous 1.5-T MRI system which had been operating since January 2001. In this report, we discuss the reasons for selecting the new MR system and our experience after installation from both clinical and hospital management viewpoints.

Why we focused on the comprehensive capabilities of the MRI system

Our hospital focused on the keyword "comprehensive" as the primary selection criterion for our new MRI system. This was based on an appreciation of the fact that the versatility of an MRI system is directly related to the range of examinations that can be offered.

When we formulate plans to upgrade any of our diagnostic imaging systems, the number of examinations that can be performed is an important consideration from the viewpoint of hospital management and economics. In particular, the average number of MRI examinations performed at our hospital up to October 2018 plateaued at 3.6 examinations per day. This was identified by our hospital management as an important issue that needed to be addressed.

Our hospital has a variety of clinical departments specializing in either medical or surgical care, which meant that selecting an MRI system that is limited to neurosurgery or orthopedics would not be able to satisfy the requirements of all the clinical departments. We needed an MR solution that was able to perform a variety of clinical exams across multiple specialty areas.

In addition, the 7th National Strategic Plan for Medical Care launched by the Japanese Ministry of Health, Labour and Welfare includes policies focusing on the prevention, treatment, and care of patients with five major diseases, including lifestyle-related diseases. As a result, the demand for MRI examinations is expected to increase in all clinical fields, not just neurosurgery and orthopedics. Strengthening the infrastructure for performing such examinations will help to promote

closer cooperation between the hospital and the community in providing healthcare services and will ultimately determine the sustainability of the hospital.

Given the above considerations, our hospital decided that our next MRI system should provide robust whole-body imaging capabilities as well as high image quality. We also wanted a versatile MRI system that could not only meet our current clinical needs but also satisfy changing demands over the next 10 years and beyond.

In December 2018, as a result of careful deliberation based on the criteria discussed above, we decided to install a Vantage Orian 1.5-T MRI system manufactured by Canon Medical Systems. This is a high-end 1.5-T MRI system with a large bore measuring 71 cm in diameter.

Improvements in clinical practice and hospital management due to the versatility of Vantage Orian

[1] Diffusion-weighted whole-body imaging with background body signal suppression (DWIBS)

Such images are often referred to as "PET-like" because, like FDG-PET images, they have been reported to be useful for evaluating the spread of cancer throughout the body. Because FDG-PET is not available at our hospital, our surgeons were previously forced to refer their patients to other medical institutions for FDG-PET examinations. However, our new system overcomes a number of technological limitations that are characteristic of MRI, such as high image distortion and low SNR. This means that it is now possible for us to reliably obtain DWIBS images for the non-invasive evaluation of the spread of cancer in all parts of the body.

Following the installation of our Vantage Orian system, there has been an increase in the number of DWIBS examinations requested by our surgeons for cancer screening. In addition, when PET examinations are performed in patients with diabetes (who are often elderly), the decision to use contrast agents such as 18F-FDG must be based on careful consideration of the risks involved. Because examinations performed using Vantage Orian do not require the administration of contrast agents, there are no restrictions in the patients who can be examined.

DWIBS examinations performed using Vantage Orian are highly valued because they are economical, non-invasive, and suitable for all patients.

[2] ECG-gated non-contrast MRA

Another advantage of Vantage Orian is that the accuracy of ECG-gated non-contrast vascular imaging is markedly improved.

In recent years, the adverse effects associated with the use of contrast agents in patients with impaired renal function have become an important concern, however non-contrast MRA allows vascular imaging to be performed in such patients. Many of the patients who receive care at our hospital have impaired renal function, and we have therefore found non-contrast MRA to be of great clinical value.

Before the installation of Vantage Orian, the ECG-gated non-contrast MRA examinations performed at our hospital showed a wide variation in image quality. Vantage Orian employs a new method in which gating is performed with high-precision extraction of the R waves and precise triggering based on machine-learning of ECG waveforms, this ensures highly quality non-contrast MRA.

[3] Tilt scanning of the head and neck

Tilt scanning of the head and neck is a very useful scanning method, particularly when examining elderly patients. It is often impossible for elderly patients with spinal deformities to lie comfortably in the supine position. Examining such patients was difficult using our previous MRI system because the patient's head could not be placed properly in the coil. Our new Vantage Orian is provided with a head and neck tilting mechanism that allows us to perform head and neck scanning easily in most of our elderly patients. In addition to its advanced software applications and superior image quality, Vantage Orian's patient-friendly design, particularly with regard to elderly patients, has further expanded the range of clinical applications we can perform at our institution.

As discussed above, because the system supports a wide range of examinations and exhibits extremely stable operation, the average number of examinations performed per day has increased at our facility by a factor of three. (Figure 2)

Effective use of the spare time created by faster scanning and higher examination accuracy

Following installation of our Vantage Orian, the time needed to perform an examination has been reduced from 45 minutes to 20 minutes when the high-speed scanning technique is employed. As a result, we sometimes perform as many as 20 MRI examinations in a single day. When a large number of examinations are scheduled for the same day, it is important for us to use any spare time we may have as efficiently as possible in order to handle the large number of patients to be examined.

If it is possible to complete an examination that was originally scheduled to take 20 minutes in only 15 minutes, 5 minutes of time savings are created. By taking advantage of the time savings that accumulates during the day, we can often perform emergency examinations between the scheduled examinations. Such time savings

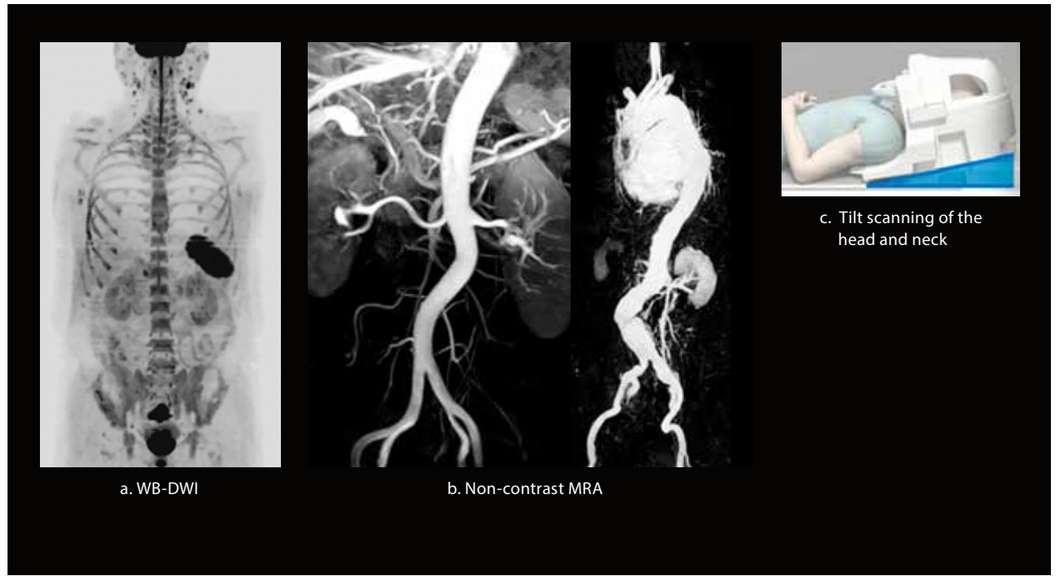

Figure 1 Range of MRI examination types at our facility

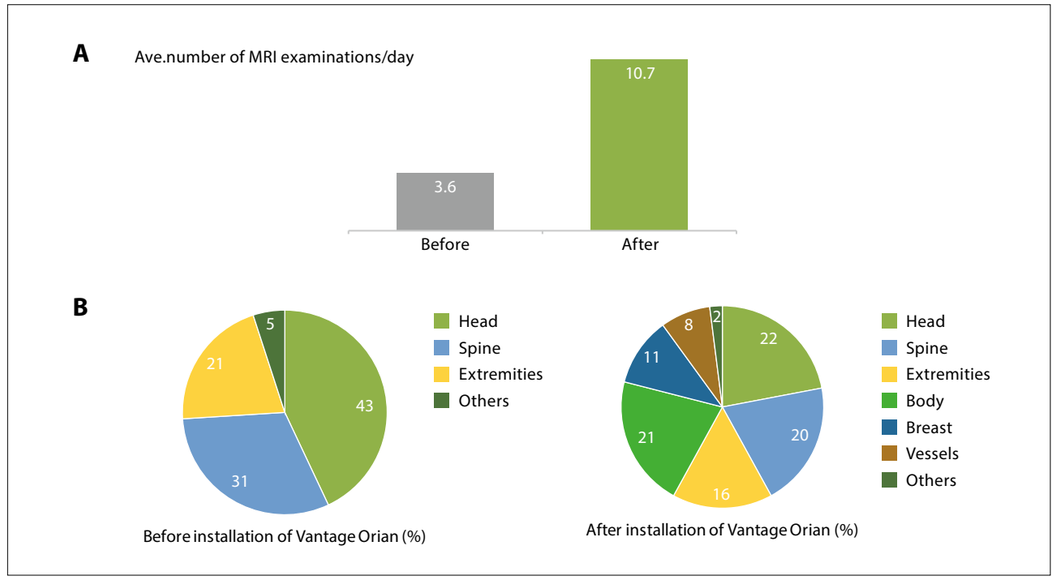

Figure 2 Changes in status of our MRI examinations before and after installation of Vantage Orian
A. Average number of MRI examinations per day. Compared the number of cases in the month before and after installation.
B. Percentage of MRI examinations by body region. Compared in the month before and after installation.

can be created not only by reducing the scan time but also by conducting the examination as efficiently as possible so as to minimize the overall examination time while ensuring that accurate diagnostic information is obtained.

In order to minimize the overall examination time, various operations in Vantage Orian have been automated. For example, the SpineLine+ feature automatically analyzes the patient's anatomy to identify and properly position the scan plans for the intervertebral discs. This eliminates the need for a skilled operator to perform complicated procedures, thus substantially reducing the overall examination time and improving consistency of planning from one exam to the next. In addition, image stitching can be performed automatically for acquisition techniques that require multiple steps, such as DWIBS, even when the images are at different angles or the resolution varies. This eliminates the need to perform complicated and time-consuming post-processing.

The motion correction method and high-precision fat suppression method (DIXON method) are incorporated into the system, helping to ensure that examinations are performed accurately. With regard to the MRI examinations performed at our hospital, body motion and nonuniform fat suppression are two of the main challenges that may make it necessary to perform repeat scanning. With Vantage Orian, when the Quick Star technique incorporating a new 3D motion correction method is employed, abdominal images with minimal blurring can be obtained even in patients who have difficulty holding their breath. In addition, with regard to nonuniform fat suppression, the DIXON method can be used to obtain images with minimal nonuniformity even in regions that are particularly susceptible to the effects of magnetic field inhomogeneity. Errors in water-fat separation are rarely encountered, even with the two-point method, and the system is effective for the examination of a wide range of anatomical regions. Thanks to these features, examinations can be completed accurately, which eliminates the need to perform repeat scanning thus creating additional time savings and increased patient and physician satisfaction.

Facilities which have decided to update their MRI systems naturally expect that improvements in image quality will help them to increase the number of examinations they can perform. However, factors other than image quality are also important in maximizing the number of examinations. These factors include the ability of the system to perform a wide variety of examinations as well as the ability of the system to perform robust and consistent examinations, as discussed above.

In order to handle a larger number of examination requests, it is essential not only to reduce the overall examination time but also to increase productivity by efficiently utilizing any time savings that is created. Even when no emergency examination requests are received, this spare time can be used to perform other important tasks and to provide more personal care for patients undergoing examinations. This can be expected to improve the work efficiency of the entire radiology department and to promote greater customer (patient) satisfaction. Our goal is to contribute to efficient hospital management by ensuring smooth operational flow of our MRI systems in which not a single second is wasted.

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