

## ***What we expected from a 1.5T MRI system with the latest specifications and what achievements we obtained.***

***-Including the significance of community shared use of brain checkups, etc. -***



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**Summary:** Tano Hospital aims to further improve clinical usefulness, high quality patient service, and contribute to community healthcare. Last year, the hospital replaced its MRI system. In this article, the role and usefulness of the latest 1.5T MRI system installed at this time and the spillover effect to the hospital and region are reported.

chronic phase medical care, and as a convalescent phase rehabilitation hospital to support patients until they return home.

Departments at the hospital include surgery, gastroenterological surgery, proctology, general practice, neurosurgery, orthopedics, internal medicine, cardiovascular, pediatrics, dermatology, ophthalmology, otorhinolaryngology, radiology, rehabilitation, pediatric neurology. In addition, epilepsy outpatient, sleep apnea, smoking cessation, memory loss are addressed in order to enhance and develop of community healthcare and nursing care. There are 84 beds in the general ward (including 42 beds in maintenance phase rehabilitation ward). A wide range of patients are accepted, including patients referred by neighboring doctors, patients requiring acute phase rehabilitation and are sent to emergency department, patients requiring convalescent phase rehabilitation such as through a community medical cooperation network for stroke patients, and patients discharged to their home but require maintenance phase rehabilitation. In addition, 365-day rehabilitation is provided so that patients who are stable in the acute phase as well as in the convalescent phase can immediately start rehabilitation.

### ***Introduction to Tano Hospital***

Tano Hospital (Fig.1) opened on April 1, 1986 in an effort to develop community healthcare and nursing care, contribute to the security and happiness of the local residents, and with the idea of pursuit of happiness of the entire staff and family. In order to carry out emergency care in consideration of regionality, strong support from the time of emergency patient acceptance, hospitalization, discharge, until home care in coordination with staff from multiple departments is considered important. Furthermore, this is the only hospital in the region which has functioned up to now as a facility for



Fig. 1 Exterior of Tano Hospital

### ***Operating system of the Radiology Department***

At this hospital, radiology technologists retain their own duties as co-medicals, and rapidly provide data to physicians for use in diagnosis. They work as a team with the staff from other departments, and seek to respond in consideration of the feelings of the patients in their daily activities. The staff consists of 3 full-time radiology technologists and 3 part-time radiology technologists (three times a week, one person each day), who can handle MRI, CT,

DR, general radiography, portable X-ray fluoroscopy, and imaging. The average number of exams per month for main modalities in the most recent five months was 401 cases for general radiography, 297 cases for CT, 182 cases for MRI (135 cases for the previous year, examination by category: brain 70%, orthopedic regions 25%, abdomen 5%).

Initially, our CT system was 16 rows and an X-ray tube heat capacity of 2 MHU. HU increased if the contrast examination continued, increasing waiting time. By upgrading to a 64 row CT system ("Supria Grande" Hitachi, Ltd.) in March last year, imaging with high-speed, low-noise and high image quality became possible. These features helped to reduce patient burden due to a low radiation dose and shorter waiting time. Since there are many elderly people in the region, few patients can raise both arms while scanning, and as a result, artifacts due to lowering arms was a problem. However, images with low-noise and high image quality can now be obtained. Image quality clearly improved even in cases when breath-holding was difficult.

Hitachi Ltd.'s "VersiFlex VISTA" is used for DR in procedures such as PTCO and ERCP, and although simple, angiographs such as TAE and PSE are also carried out. In addition, a wide range of requests, such as portable and scanning at the orthopedic operation room, as well as general radiography, are handled.

Furthermore, the radiology department works 24 hours a day, so even the night shift staff is ready to handle various examinations for all modalities. Since the staff is limited, information is shared daily in order to respond to the various above-mentioned examinations from the radiology department, promote standardization and ensure reproducibility.

On the other hand, we do not have nurses dedicated to the radiology department at this hospital. Therefore, training about risks when entering or leaving the MRI room, needs for medical interviews, and precautions in contrast examinations are our current issues. Consequently, workshops for magnetic field experience and examination are carried out for staff members from other departments from time to time in an effort to prevent an incident before it happens.

### **Process of upgrading the MRI system and superiority of the new system**

For MRI examinations, in addition to high quality images, systems with excellent operability, an acoustic noise reduction function, and energy-saving function have recently appeared. Since the introduction of such a system at this hospital was considered to promote further improvement in clinical usability, high quality patient service, and contribute to



Fig. 2 ECHELON Smart Plus (Hitachi, Ltd.) is used by this hospital

community healthcare, upgrading the MRI equipment was planned. From our consideration, Hitachi Ltd.'s 1.5T system "ECHELON Smart Plus," (Fig. 2) which upgrades Hitachi Ltd.'s 1.5T system "ECHELON Vega", was installed last July. Main areas of superiority are described below.

#### **① "IP-RAPID", the next-generation high-speed scanning technology that achieves high quality and high-speed scanning**

Since around 2008, in addition to advanced image qualities and functions, demands on an acoustic noise reduction and energy-saving functions have increased for 1.5T MRI systems. In other words, demands for "ease in performing an examination" and "easy to introduce functions" are increasing. ECHELON Smart Plus (launched in April 2019) is a model that includes IP-RAPID, new high-speed imaging technology, built into ECHELON Smart (launched in April 2017) and was developed to meet these needs.

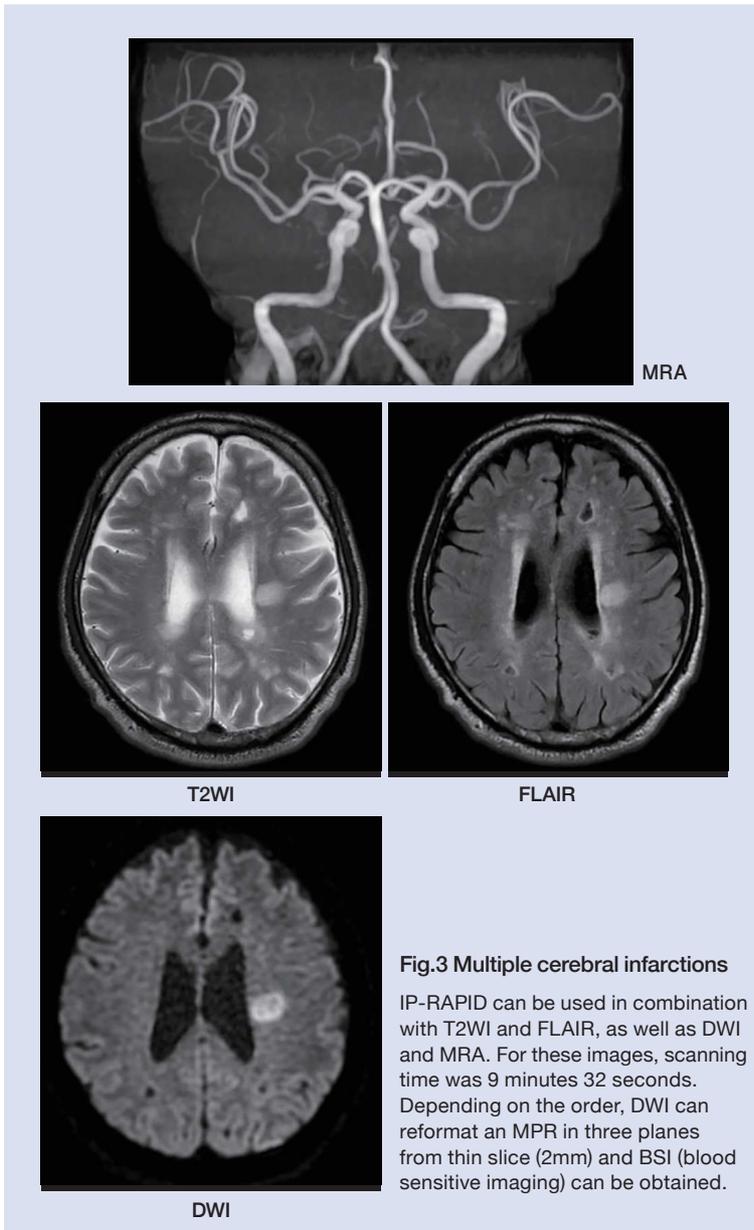
Features of the system will be described later, but IP-RAPID is based on technology that utilizes under-sampling and iterative processing to achieve high image quality and high-speed scanning, and has attracted attention in recent years.

After system installation and before starting practical use, the radiology technologist in the radiology department, the head of the neurosurgery department which requests the most orders for MRI, and the manufacturer's application specialist reviewed the parameters including IP-RAPID, and optimized image quality and scanning time in accordance with hospital demand. While imaging parameters should be regularly updated, scanning by the new model provides satisfactory image quality in a shorter time than the previous model

which had excellent performance (Fig. 3). Even from viewpoint of patients, we are frequently asked by the local residents who visit each year for follow-up, "did it become faster than before?"

#### **② High-speed scanning for the spine and extremities**

ECHELON Smart Plus includes another technology to reduce scanning time. It is the FatSep method, that uses the DIXON method, a fat suppression technology. This technology obtains in-phase and out of phase signals by multi echo and



**Fig.3 Multiple cerebral infarctions**  
IP-RAPID can be used in combination with T2WI and FLAIR, as well as DWI and MRA. For these images, scanning time was 9 minutes 32 seconds. Depending on the order, DWI can reformat an MPR in three planes from thin slice (2mm) and BSI (blood sensitive imaging) can be obtained.

then calculates the fat suppressed image. However, since this system can be combined with IP-RAPID for this imaging method, examination time can be greatly reduced.

In addition, unlike fat suppression by the CHES method which is conventionally used in high magnetic fields, with which inhomogeneous fat suppression sometimes occurs depending on the anatomical region and/or inhomogeneous areas of the magnetic field, FatSep can obtain uniform and stable images with fat suppression, even in such areas. This hospital has handled orders of the spine or extremities using the FatSep method which can provide both high image quality and high-speed scanning for images including fat suppressed images (Fig.4).

#### ③RADAR method (a scanning method for motion artifact reduction)

As previously mentioned, many examination patients at this hospital are elderly. Artifacts due to movement, breathing,

and involuntary motions occur, but the RADAR method is effective in such cases. Furthermore, it can be used for MRA examinations and T2\*WI, so it is also effective for diagnosis of cerebrovascular diseases and micro bleeds.

#### ④AutoExam (a scanning assist function)

The AutoExam function executes slice positioning, image processing, image display, image storage and image transfer in one step, using image processing technology such as MRA automatic clipping (AutoClip) during brain examinations. As an example of its contribution, a new radiology technologist joined the radiology department in February. The radiology technologist could smoothly start operations using AutoExam's scanning assist, along with the easy to follow, intuitive operations on the operations screen, and could achieve highly-repeatable output. In addition, AutoExam has shown its effect during examinations at this hospital, where three full-time and three part-time radiology technologists operate each modality in rotation, as well as handle emergency brain examinations which require both speed and accuracy.

### Overview of the Neurosurgery Department of this Hospital

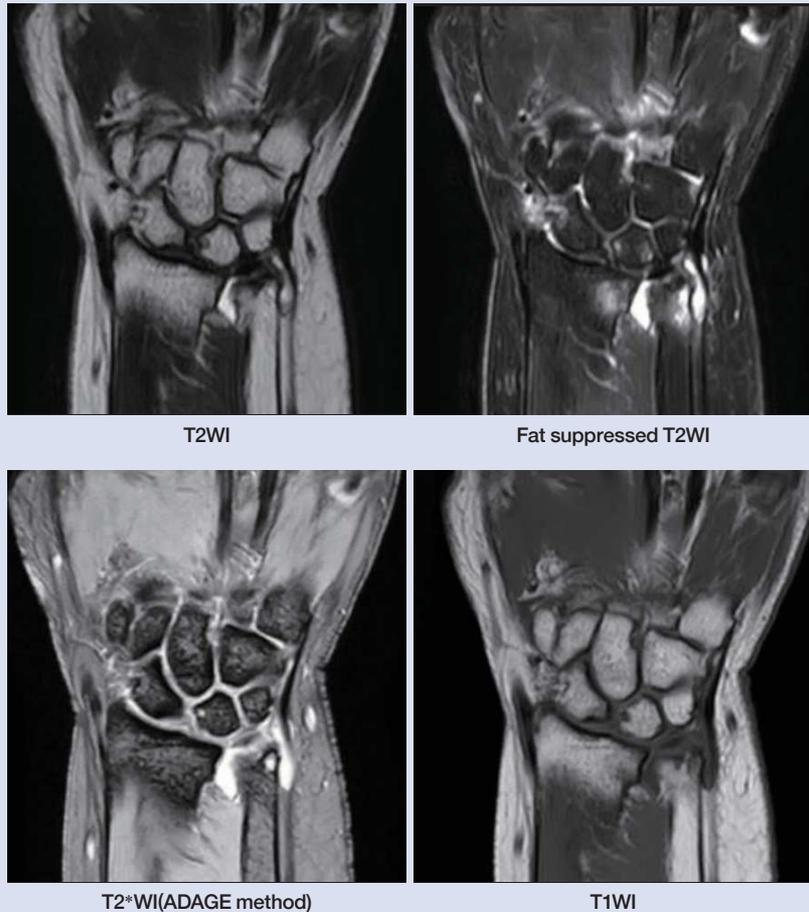
Current conditions of the neurosurgery department, which orders the most MRI examinations, are described as follows. According to data from January to December 2019, 144 patients were hospitalized in the year, 6,474 patients visited as outpatients (an average of 500-600 patients a month), the number of cases of surgery at this hospital was 15 cases. Medical examinations by disease type performed by the neurosurgery department are

shown in Fig. 5.

Accumulation of lifestyle habits is one cause of strokes, and is connected to adult diseases such as high blood pressure, diabetes, and hyperlipidemia. These risk factors are often the trigger of stroke occurrence. Consequently, medical treatment addressing adult diseases as outpatient care in order to prevent strokes occupies a large part of the work of this department.

On the other hand, while 24-hour emergency care should be mentioned, if a disease is detected and treated early, the possibility of recovery increases. This hospital has a full-time brain surgeon who is on call even at night, and radiology technologist also perform MRI and CT examinations in a shift system 24 hours a day.

This hospital is located in the east district of Kochi Prefecture. Here, local hospitals have closed one after another, so this hospital accepts emergency patients over a very wide



**Fig. 4 Suspected ulnar/distal radius fracture**

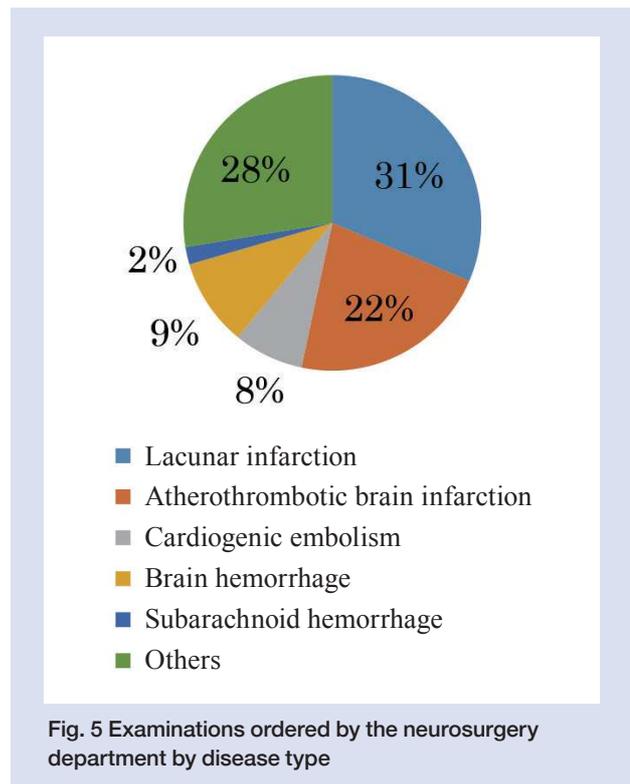
T2WI and fat suppressed T2WI were scanned at the same time by the FatSep method (3 minutes 28 seconds). Even for regions which are difficult to set in the center of the magnetic field, good SNR and fat suppression effect can be obtained.

\*ADAGE method: Multi echo synthesis Gradient Echo method

area. When I am on duty, it is not uncommon to receive a call like “a patient is suspected of having a brain infarction and this emergency will arrive in 40 minutes.” At such times, if detection is early, we can be ready to perform rt-PA therapy in time. Actually, this happened last year, and as soon as the emergency patient arrived, a head CT and MRI were taken and brain infarction was determined, and Grtpa (Alteplase) was administrated.

Furthermore, we have been carrying out memory loss outpatient care since 2014. In addition to evaluation for dementia by the Hasegawa Dementia Scale, MMSE, CDR, FAST, image diagnosis by MRI has been important. The number of cases of MRI examinations started at 57 cases, but now this has increased to 143 cases. It has become difficult to maintain the MRI examination framework. Regarding items performed for dementia, evaluation by T2WI, FLAIR in two planes, axial and coronal, DWI in three planes, evaluation for microbleeds by BSI (blood sensitive imaging), evaluation of vascular lesions by MRA (brain, neck), and VSRAD analysis. Scanning used to take more than 40 minutes with the previous system, but can now be done in less than 30 minutes by ECHELON Smart Plus. The problem of the examination framework has been resolving.

The number of brain checkups requested by the neighboring



**Fig. 5 Examinations ordered by the neurosurgery department by disease type**

Muroto City was originally about 200 cases a year. However, it may increase to 250 cases after this year since scanning time could be reduced as mentioned above. The contribution to the residents in many areas will connect to greater trust in the region as well as rewarding and motivating work.

Here, the “Survey study on a healthy brain and a driving brain in elderly drivers” in Tano Town, in which this hospital participated, is introduced.

This study project began in 2018, led by Visiting Professor Kaechang Park (Head of Regional Traffic Medicine and the Social Brain Laboratory) at Kochi University of Technology. The purpose of the study is to determine how the condition of the brain and health in elderly drivers influences their driving. Data on a total of 7 items, including brain MRI examination, questionnaire survey of the driver and his/her family, and a driving test on actual vehicle in Tano Town has been obtained by survey over the past three years.

The survey on elderly drivers is continually carried out in a limited area and is the first trial in Japan and this hospital’s MRI system is used to perform 100 examinations/year (T2WI, T1WI, axial plane of FLAIR, brain and neck MRA, thin slice T1WI) as a part of this study (quoted from the Kochi University of Technology website. <https://www.kochi-tech.ac.jp/news/2018/003879.html>).

### **Other effects due to the introduction of the new system**

#### **①“SmartCOMFORT”, an acoustic noise reduction function**

“SmartCOMFORT,” Hitachi’s latest acoustic noise reduction technology, is built into ECHELON Smart Plus. This function can be performed without greatly affecting image quality and time, by reformatting the gradient magnetic field pulse form and adjusting imaging parameters. In addition to this scan, SmartCOMFORT can be applied to scanograms, sensitivity maps, and shimming needed for an MRI examination, and is mainly used for brain examinations for children and brain checkups at this hospital.

In case of pediatric examinations performed while sleeping, the number of cases where the patient woke up decreased, and as a result, rescanning occurrences also decreased.

Moreover, the MRI room of this hospital is located close to the outpatient pediatrics clinic. Although silence is needed when operating the MRI system and during an MRI examination, medical care and examinations are carried out without problem since the system began operations last July.

In addition to the acoustic noise reduction function, ECHELON Smart Plus has other functions for the comfort and individual needs of various patients. For example, a brain MRI examination is usually performed using a receiver coil for the brain. However, if the patient is claustrophobic, or has a severely kyphosis or anterior bending, an MRI scan can still be taken without the upper attachment. Of course, sensitivity

is somewhat decreased in the regions without the attachment, but cases which used to require switching to CT are now possible by MRI, and the number of examinations has also increased. Furthermore, obtaining only a DWI is useful for diagnosis in neurosurgery.

#### **②“SmartECO”, an energy-saving function**

Regarding energy-saving, the previous machine, ECHELON Vega, used the zero boil-off system which does not consume liquid helium during operation. However, “SmartECO” is additionally built into ECHELON Smart Plus as a new function. Since SmartECO can temporarily turn off the cryocooler which consumes much electricity, it can also reduce the power consumption of the chiller equipment which dissipates heat, while maintaining zero boil-off, controlling the overall running cost.

### **Expectations regarding new imaging methods and future aspirations**

For patients targeted for an MRI examination on their initial medical examination by the neurosurgery department at this hospital, a carotid artery examination by ultrasound is performed as well. Since ECHELON Smart Plus has an application that uses the RADAR method which can evaluate carotid plaque characteristics, we would like to compare results with ultrasound examination and consider its usability in the future. In addition, since the CT was upgraded to 64 rows, contrast enhanced lower extremity CT angiography is performed. We would like to switch to non-contrast MRI examination as much as possible depending on the case and purpose, from the viewpoint of its low-invasiveness.

Currently, MRI has been the modality to satisfy both improvement in clinical usability by high image quality and superior functions, provision of a comfortable examination environment for the patient, improvement in throughput, and economic contribution by reduced running costs. This article has introduced some of the good effects and achievements by the latest 1.5T MRI.

The ratio of elderly people in the population in eastern Kochi Prefecture is much higher than the average in Japan. The population itself is also showing a decreasing trend. However, people will still need medical care, and the demand for medical care is expected to continue. In this situation, with limited resources, equipment, and personnel, providing a flexible response to the demands by the local residents for safe and good quality medical care is considered to still be needed in the future. ECHELON Smart Plus is an MRI system that can strongly support these demands.

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