2016

Journal of JART

—English edition—

2016

The Japan Association of Radiological Technologists

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Note: The contents of this magazine are those that have been published in JART magazine.

Overview of the Japan Association of Radiological Technologists

The Japan Association of Radiological Technologists, a public interest incorporated association under the jurisdiction of the Ministry of Health, Labour and Welfare, was established in 1947 with the purpose of contributing to the health of citizens through raising the professional ethics of members, improving and furthering the study of medical radiology and medical radiological technology, and enhancing public health.

In light of the startling progress being made in the fields of image diagnostics and radiation therapy where radiological technologists work, it is necessary to stay constantly aware of the latest know-how and technology. JART collaborates with other certification agencies to enhance the capacity of all radiological technologists in general through providing lifelong learning seminars, short courses, academic conferences and numerous other learning opportunities. We believe that such activities constitute our obligation as medical professionals to the general public.

As the only medical profession that has "radiological" in its name, we strive to limit medical exposure, to raise the standing of our profession, and to realize a profession of specialist technologists that can be advertised. And we are committed to promoting services with you all for the provision of safe and secure medical care.

general principles

We will render our services to those in need of health care.

We will act as individual members of a health care team.

We will perform our duties in our field of specialty.

We will continue to study for the benefit of mankind.

We will respect and practice the policy of informed consent.

The Role of Our English Language Journal

Yasuo Nakazawa (President)

It is very exciting for the Japan Association of Radiological Technologists to publish its second English edition "Journal of JART (JJART)". Through introducing the clinical, education, and research achievements of radiological technologists in Japan every month, the JART serves to standardize and enhance the work capability of radiological technologists and improve safety in medical institutions.

The English language edition features selected articles that have appeared in the journal over the past year and are thought will prove useful for radiological technologists throughout the world. Highlights in the second English edition include an introduction to the education system for radiological technologists in Thailand by Dr. Sala, who is the association president in that country, and an introduction to the educational system of radiological technology in Taiwan by the Taiwan society president Dr. Kuo. Understanding the education system for radiological technologists in different countries is useful for furthering the education system in one's own country. In Japan, education of radiological technologists is mainly conducted by 29 universities throughout the country. Moreover, each university has established a graduate school, where Master's Courses and Doctoral Courses are conducted with the aim of educating future leaders. In particular, because radiological technologists are required to produce clinical, education, and research achievements, it is essential that they acquire Master's and Doctoral qualifications.

The Japan Association of Radiological Technologists conducts modality-separate basic education geared to nurturing excellent human resources, while also working on developing certified technologists in cooperation with other relevant academic societies. In future, we intend to expand the work area of radiological technologists based on scientifically established materials in the Team Medicine Promotion Meeting of the Ministry of Health, Labour and Welfare. We will continue to introduce the clinical, education, and research achievements of radiological technologists in the JART and strive to enhance its contents. I hope that this English language journal will be a useful resource for radiological technologists throughout the world.

Introduction to National X-ray Week Events

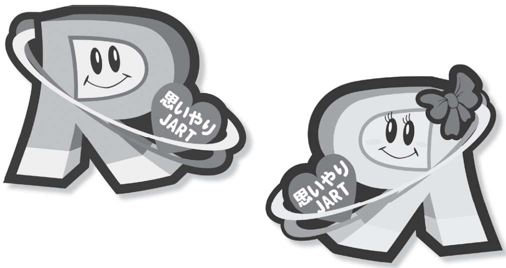
To commemorate the discovery of X-rays by W.C. Röntgen on November 8, 1895, the Japan Association of Radiological Technologists has designated the week from November 2 through 8 each year as Röntgen Week. For us radiological technologists, the discovery of X-ray by Doctor Röntgen not only has historical importance, but it is a memorable day that marks the beginning of our profession. Radiation, of which X-rays are the representative example, has made an immense contribution to the development of medical care and science; particularly in the field of medicine, and it is no exaggeration to say that medical care could not exist without utilization of radiation.

However, due to the negative image created by the nuclear power station accident that ensued the Great East Japan Earthquake, a feeling of unease regarding radiation has pervaded the general public. In these circumstances, radiological technologists, who are radiation experts, have planned events aimed at conveying correct knowledge and advertising our work as managers of radiation in medical care settings. Various events are being staged all over the country.

Yokohama

Röntgen Week was staged at Queen's Square in Yokohama on Sunday the 8th of November. The venue featured a corner where people could experience image processing using CT images, a natural radioactivity measurement corner, a corner for introducing the work of radiological technologists, and a corner containing panels explaining radiation. In the CT image processing corner, a work station was established so that people could perform three-dimensional image processing using actual CT images. In the natural radioactivity measurement corner, visitors could conduct actual measurements of fertilizer, hot spring water, flowers and so forth using a survey meter. In the corner for introducing the work of radiological technologists, Z cards giving brief explanations of the different types of work we do were distributed. On the stage, the event director hosted a talk show and, as a new feature to mark the 120th anniversary of the discovery of X-ray, explanations were given on radiation including the "Life of Röntgen" and the contents of examinations conducted by radiological

technologists were demonstrated, with the hoped effect of promoting greater understanding among onlookers. Participants explored the different corners and gifts were offered in exchange for stamps received from the characters “Rönt-kun” and “Ray-chan”. In spite of the rainy weather, the event attracted a greater turnout from the general public than expected and was a success.



“Rönt-kun” and “Ray-chan”

Z card

Kochi

“Relay for Life Japan 2015 Kochi” was staged on the grounds of Kochi University Faculty of Agriculture (Monobe Campus) on October 10 and 11 (Saturday and Sunday), and attracted approximately 500 participants. The Kochi Prefecture Association of Radiological Technologists set up a Radiation Advice Corner as a public service and offered information and advice on the role of radiological technologists, medical exposure, the importance of breast cancer examinations and so on for surviving cancer patients and family members, families of bereaved patients, care givers and visitors to the event.

Gifu

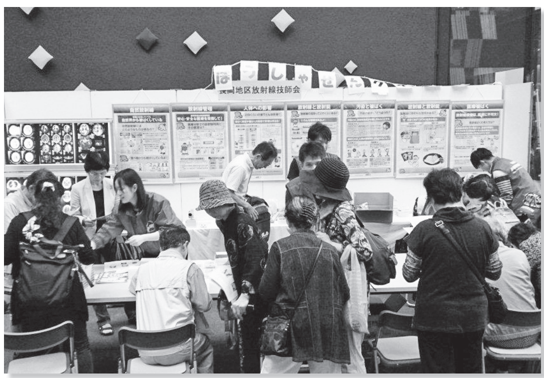
On Sunday the 8th of November, the 36th Gifu Citizens' Health Festival was staged at Gifu City Culture Center and attracted a total of 14,449 participants. The Gifu Prefecture Association of Radiological Technologists advertised radiation affairs in general and the work of radiological technologists to citizens in a bone density measurement corner, a radiation advice corner, a hands-on radiation measurement corner, and a panel display on radiation exposure and radiological examinations.

Yamanashi

On Sunday the 1st of November, a radiation festival was staged in the Aeon Hall on the third floor of the Kofu Showa branch of Aeon Mall and attracted approximately 120 participants. Staged in cooperation with Yamanashi Association of Medical Technologists, the event featured panel displays aimed at spreading knowledge about ultrasound bone density examinations and breast cancer examinations.

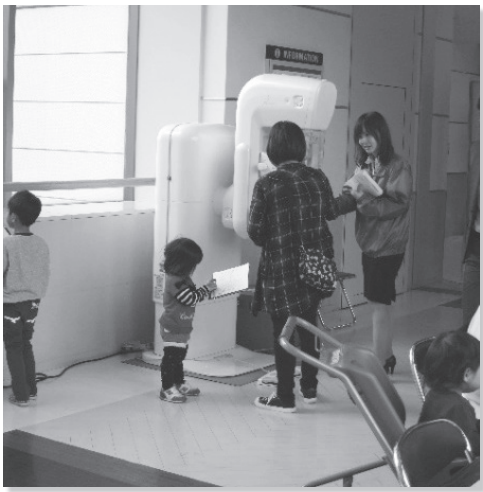
Niigata

The 18th Niigata Citizens' Health and Welfare Festival, which was held in the area around Bandai City Park in Niigata City on Sunday the 18th of October, attracted a great turnout of approximately 60,000 citizens. At the booth run by Niigata Prefecture Association of Radiological Technologists in the "Health Plaza" zone, on the theme of "Medical radiation in everyday life" panels were used to show how we radiological technologists utilize radiation in medical care and to demonstrate the safety of medical radiation in light of various recent issues in the field. In addition, a radiation quiz was conducted with a view to promoting greater understanding of the subject.



Shimane

On Tuesday the 3rd of November, at Yume Town Izumo, the "Radiation Exhibit for You" - Pink Ribbon Festival was staged with attendance by approximately 200 people. Through conducting hands-on bone density measurements and responding to questions about radiological examinations, some contribution was made towards resolving the doubts and questions that people have about examinations. Moreover, a quiz rally was held for the first time and proved popular with children, attracting far more participants than expected. The rally helped educate many people from children to the elderly about the work of radiological technologists.



The 31st Japan Conference of Radiological Technologists (31JCRT) —Reports

The 31st Japan Conference of Radiological Technologists (31JCRT) was held from November 21st (Saturday) to 23th (Monday) in 2015, at the Kyoto International Conference Center (Takaragaike, Sakyo-ku, Kyoto).

We introduce the chairman aggregation of the International session and hospital visits.

We have held an annual scientific conference of Radiological Technologists every year in Japan. The 32rd JCRT will be held in 2016 at Gifu prefecture. Everyone eager to please join us.

Hospital visits report

Akihiro Kasuya (Kariya Toyota General Hospital)

I will report here on a tour of Kyoto University Hospital and Shimadzu Foundation Memorial Hall by visitors from abroad, which took place during the 31st Japan Conference of Radiological Technologists.

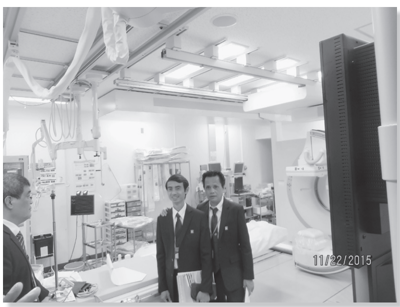
Following the conclusion of the international session on the second day of the conference, approximately 40 participants from abroad and 5 members of the international department of the Japan Association of Radiological Technologists took a tour of the two sites mentioned above.

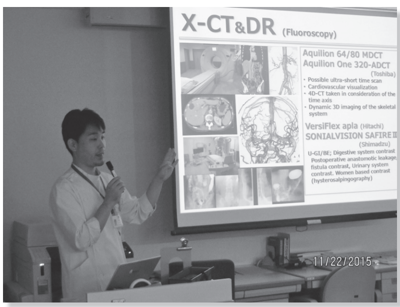
At Kyoto University Hospital, 5 staff members, including the chief radiological technologist Mr. Higashimura, guided the tour of the Diagnostic Radiation department and Radiation Oncology and Image-Applied Therapy department, despite the clinic was closed on that day.

Visitors were first led to the technologist room. After an introductory remark by the chief Mr. Higashimura, a staff technologist, Mr. Koizumi, provided an overview of the hospital and the radiation department. Informational handouts in English were available, and the participants appeared to be listening with interest.

Then the visitors were divided into 4 small groups and participated in the guided tour of related divisions within the facility, including radiography, fluoroscopy, angiography, x-ray computed tomography (x-ray CT), magnetic resonance imaging (MRI), radioisotope (RI), and radiation therapy.

The interior designs and displays that reflected the traditional architecture and gardens of Kyoto caught the attention of the visitors especially in the rooms for x-ray CT, radiation therapy, and mammography. Questions that were raised by the visitors included topics such as 3-dimentional image





processing and imaging procedures used by the nurses and the doctors of x-ray CT, image inspection system of radiography, and disposal of radiopharmaceuticals.

The participants then visited the Shimadzu Foundation Memorial Hall, where they were welcomed by Global Marketing Department manager, Mr. Aoyama, and many staff members.

Historical documents and materials on scientific instruments and medical x-ray apparatus that Shimadzu Corporation manufactured since their formation were on display, and it provided an overview of the developmental process of science and technology in Japan. With the help of detailed guide in English by the staff, the participants listened with enthusiasm.

The building of this hall was once used as the head office of Shimadzu Corporation when it was founded. It served as a space where visitors could feel the atmosphere of the time and the history.

International Session 1

Takaki Takeshi
(Hospital of the University of Occupational and Environmental Health)

This session included reports that were centered around the CT and MRI, and the content of the presentations ranged widely from basic science to clinical application studies.

I-001 was a report by the University Medical Center of Ho Chi Minh city on a triple rule-out with CT. By using 128-row-detector CT, an ECG-gated triple rule-out becomes easy, which leads to many benefits in the emergency room including cost reductions and quick treatment initiation.

I-002 was a report on radiation dose reduction in multi-detector CT. A 56% reduction in radiation is possible when the patient was centered in the scanner isocenter, and recent development in CT technologies enables radiation reductions while improving the image quality. The current study reported on a novel detector that is capable of reducing radiation by 30%. The study also indicated an additional radiation reduction by using reconstruction methods such as SAFIRE, IRIS, AsiR, and AIDR 3D.

I-004 was an investigation on the value of multi-detector row CT in the diagnosis of ureteral rupture caused by urolithiasis. This study reported that plain CT was useful in diagnosing urolithiasis, and that it was extremely effective to perform delayed imaging in diagnosing ureteral rupture.

I-005 reported on the utility of “Magic-Gips TM” that enabled MRI examinations on infants without sedation. The infant’s body temperature was measured at the forehead, chest, and back before and after a scan. There was no statistically significant difference before and after the scan, and examination was possible in 95% of the cases. Therefore the authors concluded that “Magic-Gips TM” was a useful tool in MRI.

I-006 analyzed cases in which side effects by MRI contrast agents were reported, which led to a revision of the MRI procedure manual. Twenty out of 6993 cases reported mild side effects, and there were no serious side effects. Then, the authors created a flow chart based on the symptoms and the degree of side effects. Then a team of radiological technologists, nurses, and radiologists revised the procedure manual, which they reported would result in safer MRI examinations.

I-007 examined the effects of radio frequency (RF) pulse on the slice profile in biomedical MRI, and analysis was conducted quantitatively with the Bloch equation. The study reported that the slice profile was improved by changing the shape of RF pulse.

I-009 examined the relationship between T2 values and the duration from the onset of an acute stroke. The authors reported correlations between T2 values and the duration from the stroke onset, and therefore prediction of the time of stroke was possible. This finding would be useful for thrombolytic therapy.

I-010 reported on the effects of RF transmission systems with B0 Filter on B1 inhomogeneity. The results indicated that dual RF was better than single RF at improving B1 inhomogeneity and thus led to improved image quality. In particular, this finding would be useful for imaging of the breast region in which fat suppression is necessary.

I wish continued success of the presenters, and I conclude my chairperson's summary of this session.

International Session 2

Kojiro Yamaguchi (Fujita Health University)

Yasuo Takatsu (Japan)'s presentation was titled "Simulation to Investigate Image Quality Dependent on the Partial Fourier Fraction in Dynamic Contrast-Enhanced Magnetic Resonance Imaging," in which data were rearranged in k-space and then evaluated by modulation transfer function (MTF).

Lam Io Pong (Macao)'s presentation was titled "MRI T2 Mapping Study on Knee Joint Cartilage." This study used T2 mapping at pre and post an exercise load of 20 minutes in order to evaluate its effect on the knee.

Yu Sau Yee Wendy (Hong Kong)'s presentation was titled "Quantitative evaluation of a quiet MRI sequence PETRA versus MPRAGE in Brain imaging at 1.5Tesla MRI scanner" which reported that the PETRA sequence was able to reduce the noise from 85 dB to 58 dB without jeopardizing the image quality.

Chia Hung Tu (Taiwan)'s presentation was titled "3D MRCP Image Quality: Comparison between Respiratory Triggered Technique and Navigator Triggered Technique," and made a comparison of respiratory gating methods for magnetic resonance Cholangiopancreatography (MRCP).

Chia-Peng Chung (Taiwan)'s presentation was titled "Using T2 imaging to evaluate susceptibility artifacts impact in TOF-MRA," which evaluated the effect of susceptibility artifacts when imaging internal carotid arterial (ICA) with time-of-flight MR angiography (TOF-MRA).

Chia-Tsung Lin (Taiwan)'s presentation was titled "Relation between Liver Function and Cirrhotic Liver Parenchymal Enhancement in Dynamic Contrast-Enhanced MR using Gd-EOB-DTPA" which evaluated MR hepatocyte-specific contrast agents, and concluded that Gd-EOB-DTPA provided better contrast than Gd-DTPA.

The following 4 presentations were by 4th year students at Fujita Health University Faculty of Radiological Technology.

Akari Kayukawa (Japan)'s presentation was titled "A study on the optimal contrast for Hahn echo typed RARE - A study of signal intensity for White and Grey Matter." This study evaluated a Hahn fast spin echo (FSE) method where the pulse flip angles were modified from the rapid imaging with refocused echoes (RARE) FSE (90° -180°- 180°) angles. This investigation was performed with white and grey matter that had similar T1 and T2.

Mayu Yamada's presentation was titled "A study on the optimal contrast for Hahn echo typed RARE - A study on phase angle dispersion for White and Grey Matter-" in which she examined phase angle dispersion. She studied white and grey matter for this investigation.

Ayako Shoji's presentation was titled "A study on the optimal contrast for Hahn echo typed RARE - A study of signal intensity for Fat and CSF" in which she evaluated a Hahn FSE method where the pulse flip angles were modified from those of the RARE FSE (90° -180°- 180°). This investigation was performed with fat, which has short T1 and T2, and cerebrospinal fluid (CSF), which has long T1

and T2.
Ayano Ito's presentation was titled "A study on the optimal contrast for Hahn echo typed RARE - A study on phase angle dispersion for Fat and CSF-," in which she investigated phase angle dispersion with fat and CSF.

International Session 3

Akihiro Kasuya (Kariya Toyota General Hospital)

The current session included a total of 7 presentations from India, Australia, Korea, Taiwan, and Japan and it covered a wide range of topics including radiological technologist education, clinical pediatric care, radiation exposure, general radiography, and X-ray fluoroscopy. Below is a summary of these presentations.

Bansal Chand Subhash reported the current status of radiological technologist training in India. He reported that radiological technologists have become important in India in a manner similar to Japan, as they manage radiology diagnosis and therapy that became increasingly diversified in the clinical setting, and that the curriculum for technologist training is being revised with the government's initiative.

Brady Akemi reported on skeletal survey for non-accidental injury cases in children in Australia. The insight from the study was that skeletal survey is necessary in cases where abuse is suspected on a child under 5 years old.

Kim Tae Hyoung from Korea investigated a method of radiation exposure reduction in medical personnel when using multi-detector computed tomography (MDCT), and Tang Ting Kuo from Taiwan measured changes in radiation exposure by different patient's positioning during percutaneous angioplasty. These studies reminded us that it is our responsibility to disseminate accurate knowledge on medical radiation exposure to doctors and nurses.

Three participants from Japan presented in the current session. Naoki Shimada of the National Cancer Center Hospital compared lesion visibility based on image processing parameters in bronchoscopy using fluoroscopy. Yoshiaki Miyazaki of Kyushu Cancer Center reported on the utility of computer-aided detection (CAD) system in lesion analysis using dynamic breast MRI. Shigeji Ichikawa of Fussa Hospital reported on quantitative evaluation in slot-scanning technology with fluoroscope.

This session provided information on the current status of radiological technologists in various foreign countries, while making us appreciate the high quality treatment and diagnostic support that radiological technologists provide in Japan, and reminding us of the necessity for more active international interaction in the future.

International Session 4

Seiji Nishio (Komazawa University)

I-030 The Development of Radiation Oncology in Vietnam.

Mr. Huynh Anh Vu reported on the current status of radiation therapy in Vietnam. In Vietnam, there are only 30 radiation therapy equipment despite its number is increasing. He also reported on difficulties that radiological technologists face, such as working during the night time in order to meet the demands of the increasing number of patients.

I-031 Effectiveness of iterative reconstruction of X-ray computed tomography for radiation treatment planning.

Ms. Satomi Nakahara of Hiroshima University Hospital reported on the effectiveness of iterative reconstruction of X-ray CT for radiation treatment planning. Iterative reconstruction is effective for radiation treatment as it helps us obtain stable CT values, which leads to improved noise-power spectrum (NPS) and contrast-to-noise ratio (CNR).

I-032 Extended versus Standard Skin Marking: Toward improving reproducibility among pelvic VMRT cases.

Ms. Stephanie Loo from Malaysia investigated whether extended skin marking would reduce errors such as rotational error in pelvic volumetric modulated arc therapy (VMAT) cases when compared to the current standard skin marking. She concluded that extended skin marking was a novel marking method that reduces translational and rotational errors.

I-033 A study of setup deviations of head and neck patients undergoing VMAT using kilo-voltage Cone Beam CT at Pantai Hospital Ayer Keroh.

Ms. Stephanie Loo reported on setup deviations of head and neck patients who undergo VMAT using cone beam CT.

I-034 Using Artificial Neural Network to Predict Correlation of Pre-mammography Questionnaire with Breast Cancer.

Ms. Hsiao-Ping Wu from Taiwan performed analyses using artificial neural network to predict correlation between pre-mammography questionnaire responses and breast cancer. She reported that a better model for early detection and prevention of breast cancer would be possible by improving the questionnaire and increasing the number of cases.

I-035 The Research of Receiving Factor of Mammography Screening in Taiwan

Mr. Jui-Hsiang Chou evaluated the mammography use by factors such as age group, education level, and ethnicity. He found that the rate of usage went up when the hospital staff conveyed the screening information via e-mail and phone, and reported that it was important to create a system that would encourage women to consider coming in for an examination.

I-036 The risk factors for development of coronary artery calcification in menopausal women

Mr. Ho-Huu Hung from Taiwan reported on the risk factors for coronary artery calcification in menopausal women. In addition to age, he reported that coronary artery calcification in menopausal women was related to lipoprotein, cholesterol and creatinine, and that it was not related to bone density.

The level of radiological technologists in Asia is advancing year by year, and the number of research presentations is increasing, with rich content. In addition, desire for improvement among young technologists is remarkable, and not only do they have longer years of education but also more technologists hold higher-education degrees. Also, many people speak English fluently despite the fact that English is not the official language. There are not many technologists in Japan who can handle question-and-answer sessions in English, and additional international academic exchange is desirable.

The Educational System for Radiological Technologists in Overseas

special feature

The Thai Society of Radiological Technologists and Radiological Technologists License System in Thailand.

Sala Ubolchai,
President of
The Thai Society of Radiological Technologists

contribution

The Educational System of Radiological Technology in Taiwan

Chiung-Wen Kuo,
President of Taiwan Society of Radiological Technologists, Taipei, Taiwan /
Department of Medical Imaging and Radiological Technology, Yuanpei University, Hsin Chu, Taiwan

contribution

International Fellowship at National Cancer Center (NCC)

Tomohiko Aso,
Manager Radiological Technologist,
Department of Radiological Diagnosis National Cancer Center Hospital

The Thai Society of Radiological Technologists and Radiological Technologists License System in Thailand.

Sala Ubolchai
President of The Thai Society of Radiological Technologists

Today, I would like to talk about Thai Society Radiological Technologists (TSRT) and about the license system and education in Thailand to check whether the thing all of you maybe know. I maybe make two more time you to make to talk about the history of TSRT and we talk about the Thai education system and role development in radiological technology in Thailand. And I would like to talk about the license, and competency in radiological technology in Thailand too, and future trend of radiological technology in Thailand.

Also the history of TSRT, we had established on 19th January, 1973. At the start, we have only 30 members to start the society that time. And now, we have the member 1,858 members, and now they send to my email to me now around more than 2000, around 2300 something now. Also the members have to make a membership of TSRT. The member open to any Thai society, because we have too many societies in Thailand also, but not as much as Japan, we have only five groups in Thailand, almost that come to the member-

ship with TSRT. At the start, we have showed you 31 founder members and now the Koreans we have, I can say to change now 2,300. Also we have a Japan member for the TSRT, we had three Japanese members.

Each year, we have the new member to join TSRT around 150 new, but this year, I think there are about, we have this year the 50-year anniversary for the Thai RT, not the society. We have a new member start this month. We have around 400 members that come to join, while we keep to 2,300.

So the TSRT, now I am the president, we found in 1973 and we have Rama Radiographers Association found in 1990 and Medical Radiographers Association founded in 1995 and Chulalongkorn Radiographers Association found in 2000. And now also we have the Songkhla University, the Songkhla Group, they have a new association also. We have you can say in Thailand we have now five group together (Fig.1).

So for the presidency in TSRT, each year, we have two-year for each presidency, maybe the same in Japan, two-year for the president or so. For the first president in Thailand, Mr. Chutchavarn, I think Mr. Chutchavarn also when they start a society, they come to Japan to join to meeting, I think the former president met him and maybe the former member maybe know him before, but they have tried to start in Japan.

The second president is Dr. Paladej, so my friend, the Thai, the same faculty and the same class together, Dr. Paladej. After that we have a president, Mr.Chalerm, the third president and fourth president Mrs. Vanee and fifth president Mrs.Rachanee and the sixth president is Mr. Jitchai maybe some of them know him also. Seventh president, Mr. Pichit and eighth president Mrs. Sirilux and for ninth president maybe to almost know her so Ms.Ampai and now she is doing the member also. Tenth president, me, because the TSRT now we have almost 10 presidents. For me, the president number 10 and I work for the society too long time, almost until now – I passed president 2003 and until now 2015 and next month, we will have an election again, so each two year we have the election (Fig.2).

So here actually we have to join all, the first time we have to join to ISRRT, we start join October in the same year, 1973. So about the activity, we had to pay attention to the TSRT activity, we had annual meeting and conference on the last week of April every year. We start to long time for every year and we have the member to participate meeting, about 300 to 400 persons every year. We have activity, the conference and education activity with the medical school, the radiological technol-

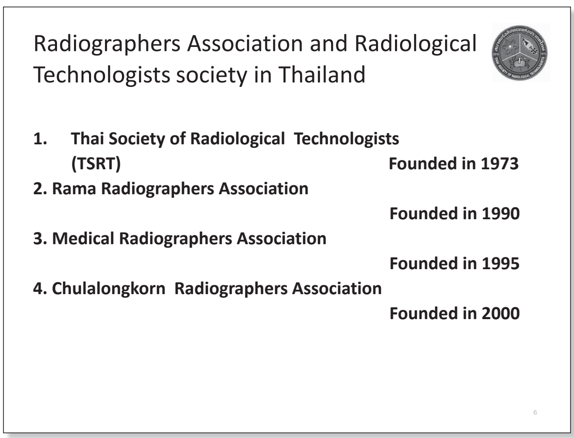


Fig.1

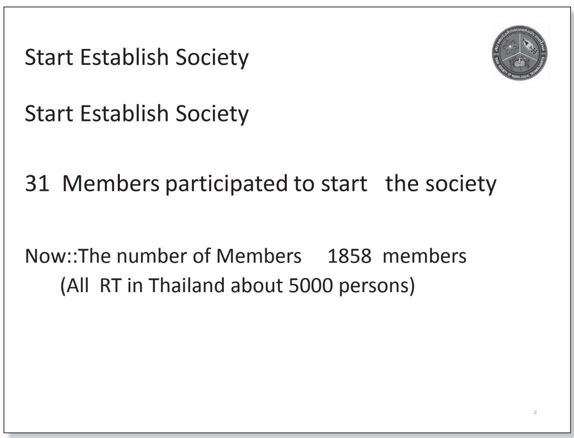


Fig.2

ogy school. In Thai, when the society people to the activity with the every university had school of radiological technology school. And also we have the activity with RT consortium how to make a good platform for the education to them.

So the education first, we have the activity, also we have to make the professional tracts for the RT, the CT, MRI, US, MIIA and for all the members we have to make call for it. Also, we have to pay to visit all of the world, I think we visit all (Fig.3). We have some member go to abroad to try and to cooperation look like ISRRT, ACRT, AOCR and JART, Hong Kong and Korea and China and Malaysia, Singapore, India, and Macau also. Now I can say, I go to every country, when they have to – when we have time, we have a chance, but we try to join and cooperate to the overseas.

So the second, I would like to say about RT education system and role of developmental project in Thailand. With the history, the RT programs, we were adopted from two-year certificate from the England and USA. We had two country to make for the period for the bachelor of science in Thailand. We make for the two-year certificate for the England and USA to change to the four-year bachelor degree.

So the credential requirement, complete

study required by the not less than four academic years of eight semesters and not more than eight economic year or 16 semesters. The study cost required for curriculum structure, general education, basic and professional education, and fee and again cost for all centers, not less than 145 credit with cumulative Thai average of not less than two, I think the same this developed (Fig.4).

The component structure, bachelor degree in RT programs, based on standard set by the RT Professional Committee, Ministry of Public Health, Kingdom of Thailand, also they had a registration body. Also now have committee for Ministry of Public Health also. The committee require bachelor degree level period to be eligible to take national professional license exam. When we have to study four year, after that we have to go through the ex-

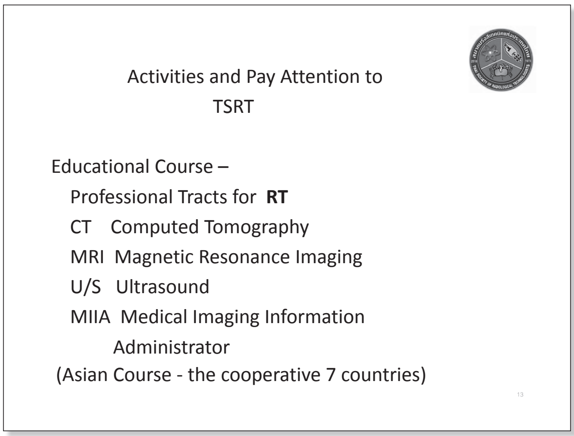


Fig.3

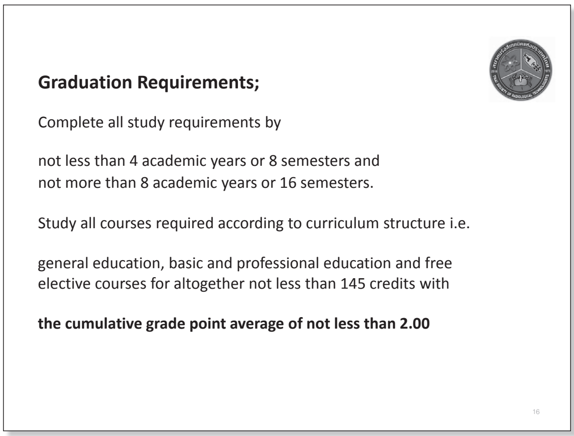


Fig.4

amination license again. If you after RT are required in curriculum including diagnostic radiography, radiation therapy and nuclear medicine, in Thai, we have the four year but we include all. When the RT period, they can go to the three Thai like diagnostic, therapy, and nuclear medicine.

For the first two year, we are required for the basic science, we take about 75 credit at the faculty of science. And the last two years for professional radiological technology including diagnostic radiotherapy, nuclear medicine, we take about 70 credit at the faculty of medical technology. All include all 145 credits.

For a person, a second year basic science, we have to study physics, chemistry, biology, mathematics, and social science. We study English, economics, biomedical science, anatomy, physiology, biochemistry, and pathology. For the third year and fourth year, we have to take for the professional subject for the RT for the practice work. The students were also required to complete the internship for all three disciplines, namely, diagnostic, radiotherapy, and nuclear medicine.

Curriculum design, curriculum is most program designed to fit the professional competency required by the Ministry, first I told you. However, each school can decide the extra content that fit their need or their expertise because they can more the modern 145 credit. Look like one of the university, Mahidol, they are more than 145.

The academic radiological technology in Thailand, now we have three to complete it and for the fourth university, sometime open for the student to go to the bachelor degree, sometime they open, sometime they close and this year they try to open all, meaning Mahidol University found in 1965 in Bangkok and Chiang Mai University found in 1974, Naresuan found in 1997 in Pitsanuloke. These are three universities that completed for the medical, for the radiological technology.

For Ramkhamhaeng University, for Khon Kaen University, Prince of Songklha University, Chulalongkorn University sometime open for the student, because in Thailand we have two case, when we start the first time we started four year for the bachelor degree and that time, not enough for the service the medical field for the hospital, they make a two-year curriculum and that we called the assistant, radiologic technology and after that we had to adapt by the four university to study two year again, input, almost four year to get a headway.

So bachelor and master degree in radiolog-

Table1 Degree offered by RT schools

University	Bachelor Degree	Master Degree	Doctoral Degree
1. Mahidol	Radiological Technology	Radiological Technology	Medical Technology
2. Chiang Mai	Radiological Technology	Medical Radiation Science	Biomedical Science
3. Naresuan	Radiological Technology	Medical Physics	
4. Ramkhamhaeng	Radiological Technology		
5. Khon Kaen	Radiological Technology		
6. Prince of Songkhla	Radiological Technology		
7. Chulalongkorn	Radiological Technology		

ical technology only had in Mahidol University. They had education about bachelor and master degree in radiological technology. For bachelor degree in radiological technology, we have at Chiang Mai University in Chiang Mai, Naresuan University in Phitsanuloke, Khon Kaen in Khon Kaen, Prince of Songklha in Hadyai, Songkhla, Ramkhamhaeng in Bangkok.

For the degree offered by the RT school, I put in the two universities, the Mahidol University. They have the offer radiological technology, master degree in radiological technology and doctoral degree medical technology in Mahidol. At Chiang Mai University, they have offer bachelor degree in radiological technology. For the master degree, they have the medical radiation science. For the doctoral, they have the offer biomedical science.

Naresuan, bachelor degree radiological technology, for the master degree they have offer to medical physics. But for Ramkhamhaeng, Khon Kaen, Prince of Songklha, Chulalongkorn University offer in radiological technology only (Table1).

So the number enrolled at the academy in Mahidol, every year we have around 60, in Chiang Mai every year we have 40, in Khon Kaen every year sometime year they have only 30, Prince of Songklha also 75, Naresuan is 50 every year and Ramkhamhaeng but this year they have around 90 (Fig.5).

Anyway, credit for segregating Thailand, until now we have around 5,000 student un-

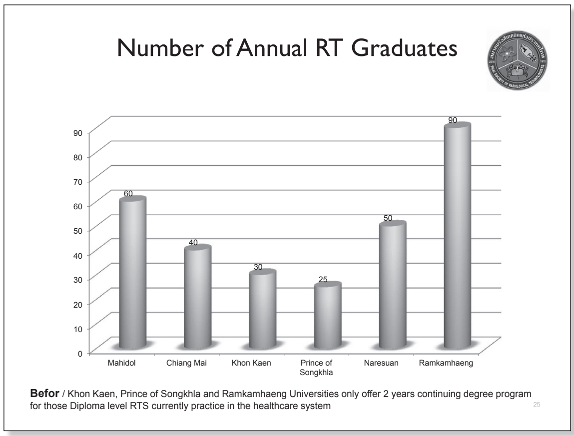


Fig.5

dergraduate in radiological technology. The period of study in four year for a B.Sc. First schedule education, the radiological technology mostly future they are educated in scientific field, in the medical, in medicine and especially master of science and PhD study. Master of science and at professional practice, the radiological technology which we process in the three main (medical physics, radiation science, medical imaging) for the master degree.

PhD study, up to now the number of radiological technologists, which I think for the PhD program has been increased in both professional field such as medical physics, biomedical engineering, radiation biology, computer science, basic science, and applied science.

About the license, license and competencies radiological technologists in Thailand. The license to practice medicine for the radiological technologists was approved in June, in July 2002. In Thailand, we start to have the license in 2002. For me, I had a license in number two, my friend is number one. But we started the modern graduate after I finished that got the license. And now license, we have almost the number of the license is 3,978 licenses in Thailand. We have 5,000 members, but almost they have to do have license only 3,978. And as maybe they don't need a license, they go to work some job, to work at companies something like that.

National license exam, we have consists of two parts examination. The professional RT, we have the exam about physics and dosimetry, anatomy and pathology for RT. Radiation protection, radiation biology, technique in diagnostic radiotherapy and nuclear medicine. And we have the exam of other law and professional teaching (Fig.6).

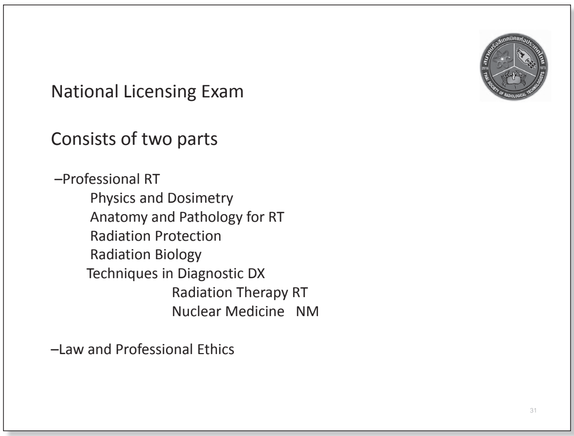


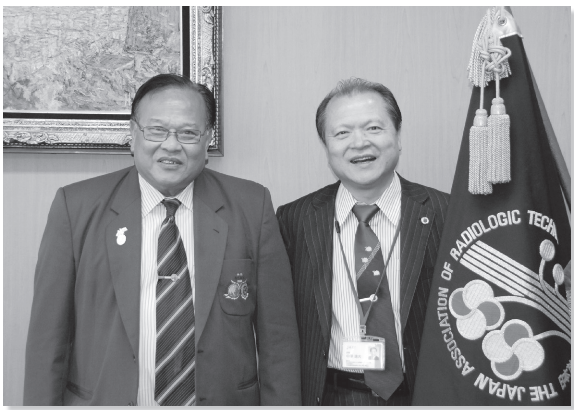
Fig.6

Competencies, we required to be the registered as license RT. The RT Professional Committee issue RT professional competency requirement for those who take the national license exam. This is regulated by law and public in the Royal gazette. This requirement are used by the educator to ensure the student competency before taking the exam. Basic competency, they have basic and professional science in radiological technology subject. They apply knowledge to professional, the professional skill in three major fields, in radiological technology, when they have the exam they must know skill three major, it means the diagnostic, nuclear medicine, and radiotherapy.

Practical skills; diagnostic radiology, ability to perform all plain field exam, ability to perform all fluoroscopic exam, ability to perform CT brain and trauma, and other exam, mammogram, MRI and additional training required. Professional skill radiotherapy, ability to deliver radiation treatment using cobalt-60 achieved, ability to give radiation treatment using LINAC in all basic treatment, ability to perform simulation procedure at one treatment such as IMRT, IGRT, additional training required. Providing skill for nuclear medicine, ability to perform standard nuclear medicine imaging, exam using gamma camera and SPECT, ability to perform basic quantitative analysis in nuclear medicine. PET and PET-CT additional training required.

Thai RT professional committee is now looking at how to set up continuing education credit. For renewal of license and also add one license for the specialized areas.

The future trend in radiological technology in Thailand, to access RT in their research, cooperative research network in radiological technology has been set up especially for RT in the future plan.



We hope for the future Thai RT professional international benchmark, RT and radiography practitioner especially practice with qualification accepted by government body. Professional with research potentials, strong collaboration with international counterparts. But we have today I think, in Thai, we have to need to try to cooperate to continue to long time because we know from the first president. Then the first time they have start to the ISRRT they have – also they have started to join to the meeting with Chuchawal. And until now, they have to – I think I tried to charge more than 12 years, I enjoyed the charge.

So I would like to say thank you very much, but also from my opinion, I hope I can come to see you to every year and something and also I invite you to Thailand every year too. I hope that Society of the Radiological Technologists of Japan and Thai we will have a good relationship. I think for me the first time I come to Japan around 20 years ago after training in Japan. And after that, I go back, I work in the hospital, after that I come to the society to work and had to join in Japan again. I hope to can cooperation together to long. Thank you.

The Educational System of Radiological Technology in Taiwan

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Introduction

Radiological technologist is a medical professional after the German professor Wilhelm Röntgen's discovery of x-rays on November 8, 1895. Radiological technologists use their expertise and knowledge of diagnostic imaging, radiotherapy, nuclear medicine, radiation safety and medical imaging to perform diagnostic imaging or therapeutic procedures.

In Taiwan, the academic radiologic technologist education were initialed 50 years ago. Currently there are nine universities with four-year bachelor degree and one college with five-year junior college for training radiological technologist. This paper presents the current state of educational system in Taiwan medical institutions.

Background of Radiological Technology Education

Between 1945 and 1964, the radiological technicians had trained at the National Taiwan University Hospital. However, the Ministry of Education which is the ministry responsible for incorporating educational policies considered the importance of radiological technology education. The vocational education (five-year junior college) began from 1964 for students graduated from junior high school. Yuanpei Junior College is the first institution to cultivate the radiological technology in Taiwan. Mr. Tsai Pin-Kung, the school founder, was a specialist in radiology and graduated from Kyoto College of Medical Science in 1937. This college was upgraded to offer undergraduate course in 1999 and renamed to Yuanpei University of Medical Technology in 2015.

The second vocational institute namely Chungtai Junior College was established in 1966. The college offered undergraduate course in 1998 and officially changed its name to the Central Taiwan University of Science and Technology in 2005. By 1990, there were only two junior colleges which provided 5-year courses to foster a great number of outstanding radiological technologists both in Taiwan and abroad. Students who complete at least 220 credits of study at a junior college were awarded to an associate degree.

In order to cultivate the professional medical talents, National Yang-Ming University offered an undergraduate degree in this subject in 1990. At present, there are nine universities and one junior college to foster the over 700 radiological students per year. Table 1

Table 1 Educational institutions that offer radiological technology program in Taiwan.

Institute	Year of the program	Location	Program Duration	Degree	Graduate Credits	Postgraduate program
Yuanpei University of Medical Technology	1964	Hsin Chu	4 year	Bachelor	142	Master
Central Taiwan University of Science and Technology	1966	Taichung	4 year	Bachelor	128	Master and Doctoral
National Yang Ming University	1990	Taipei	4 year	Bachelor	140	Master and Doctoral
Kaohsiung Medical University	1994	Kaohsiung	4 year	Bachelor	149	Master
Tzu-Chi University of Science and Technology	1996	Hualian	4 year	Bachelor	132	Master
Chang Gung University	1996	Taoyuan	4 year	Bachelor	141	Master
I-Shou University	2001	Kaohsiung	4 year	Bachelor	142	Master
Chung-Shan Medical University	2002	Taichung	4 year	Bachelor	128	Master and Doctoral
China Medical University	2003	Taichung	4 year	Bachelor	141	Master
Shu-Zen Junior College of Medicine and Management	2004	Kaohsiung	5 year	Diploma	220	

indicates the institutions that run radiological technology programs.

The master program was established in 1998 at the National Yang-Ming University. Similarly, the National Yang-Ming University offered the doctoral program from 2002 to promote advanced researches on medical imaging and radiological science.

Radiological Technology Curriculum

The program of radiological technology in Taiwan is designed to provide the general practice of medical imaging and radiotherapy as well as nuclear medicine. The undergraduate curricula at different universities are quite similar. Basically, the undergraduate program can be divided into four parts: (1) general education and humanities course, (2) fundamental core course, (3) professional core course, and (4) clinical practicum. General education and humanities course such as literature, social science, ethics, basic science and physical education should be taken during the freshman and sophomore years. Fundamental core course including anatomy, physiology, pathology, physics of radiology, radiobiology, radiochemistry etc. should be completed within the first three years. Professional core courses are composed of three major disciplines: diagnostic radiology, radiation therapy and nuclear medicine. These courses should be taken during the sophomore and junior years. After three years education, students are required to participate in clinical internship for at least 7 months in three department in medical centers of Taiwan. Students should practice at least 12 weeks at department of medical imaging; at least 4 weeks at department of radiotherapy; at least 4 weeks at department of nuclear medicine.

Even though a majority of clinical practicum including clinical observation takes place in Taiwan, students can choose to join the overseas clinical training. The pilot overseas internships, sponsored by the Ministry of Education Taiwan, is intended to subsidize those students to gain experiences in an overseas enterprise or professional institute[1]. Those students are selected by their university. The goal of the program is to give recipients

Fig.1 Five students from Yuanpei University of Medical Technology participated in clinical internship at National Cancer Center (Tsukiji Campus) in 2014.

opportunities to conduct practical training in an overseas enterprise or institute and extend their vision. Fig.1 shows the students join the overseas internship in Japan.

Qualification and continuing medical education

Upon satisfactory completion of the course, the students are eligible to take the qualification examination. The Professional Regulation Commission held by Ministry of Examination started in 1976. At initial stage, qualification for the radiological technologist exam was subdivided into three subjects: diagnostic imaging, radiation therapy and nuclear medicine. However, the certification exam was amended as senior professional and technical examinations for medical personnel after "Radiologic Technologists Acts" which was legislated in 2000 [2]. Base on the "Radiologic Technologists Acts", only qualified radiological technologists are eligible to work in the clinics, hospital or health care center.

The qualification exam take place twice per year. The examination paper consists of six subjects (basic medical science, radiological physics and radiation safety, radiological modalities, diagnostic imaging, radiotherapy technology, nuclear medicine technology). Totally 80 questions of single choice at each examination paper should be completed with 60 minutes. From July 2010, the written examination paper has been replaced by computerized tests owing to the importance of understanding about medical imaging. Although the qualification exam takes pace every January and July, the average pass rate is relative lower when compare with Japan. According to the statistic from the Ministry of Examination, the pass rate in recent five years is from 8.27% to 45.15% (Table 2) [3].

Table 2 The pass rate in the recent 5 years.

Year	Examinee	Pass	Pass rate (%)
2010 (1)	428	25	5.84
2010 (2)	849	337	39.69
2011 (1)	451	71	15.74
2011 (2)	828	397	47.95
2012 (1)	485	50	9.69
2012 (2)	830	293	35.3
2013 (1)	470	66	14.04
2013 (2)	868	305	35.14
2014 (1)	516	50	9.69
2014 (2)	976	370	42.77
2015 (1)	540	53	11.8
2015 (2)	766	323	42.17
Total	12,209	3,575	28.42

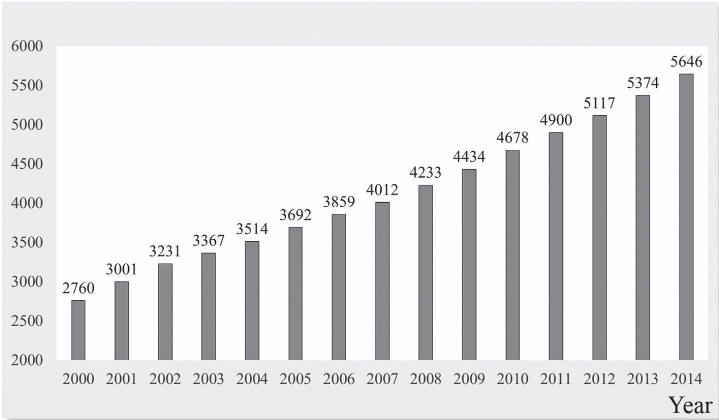


Fig.2 The registered radiological technologists from 2000 to 2014.

All radiological technologists who practice their professional work in the clinical, hospital or health care center should be registered with the Taiwan Association of Medical Radiologic Technologists. According to the Ministry of Health and welfare, there are 5,646 registered radiological technologists in 2014 (Fig.2)[4].

Until last year, qualified radiologic technologists should maintain records of 150 continuing medical education (CME) credits within the sexennial renewal cycle. However, the requirement for renewal license is reform for reducing CME credits to 120 from this year. There are four aspects of CME course: professional courses, professional quality, ethics, and regulations. The ways to earn CME credits include the attendance at radiological courses from the professional authority, internet CME course, participation conference, or publish the research paper.

Post Graduate Year Program

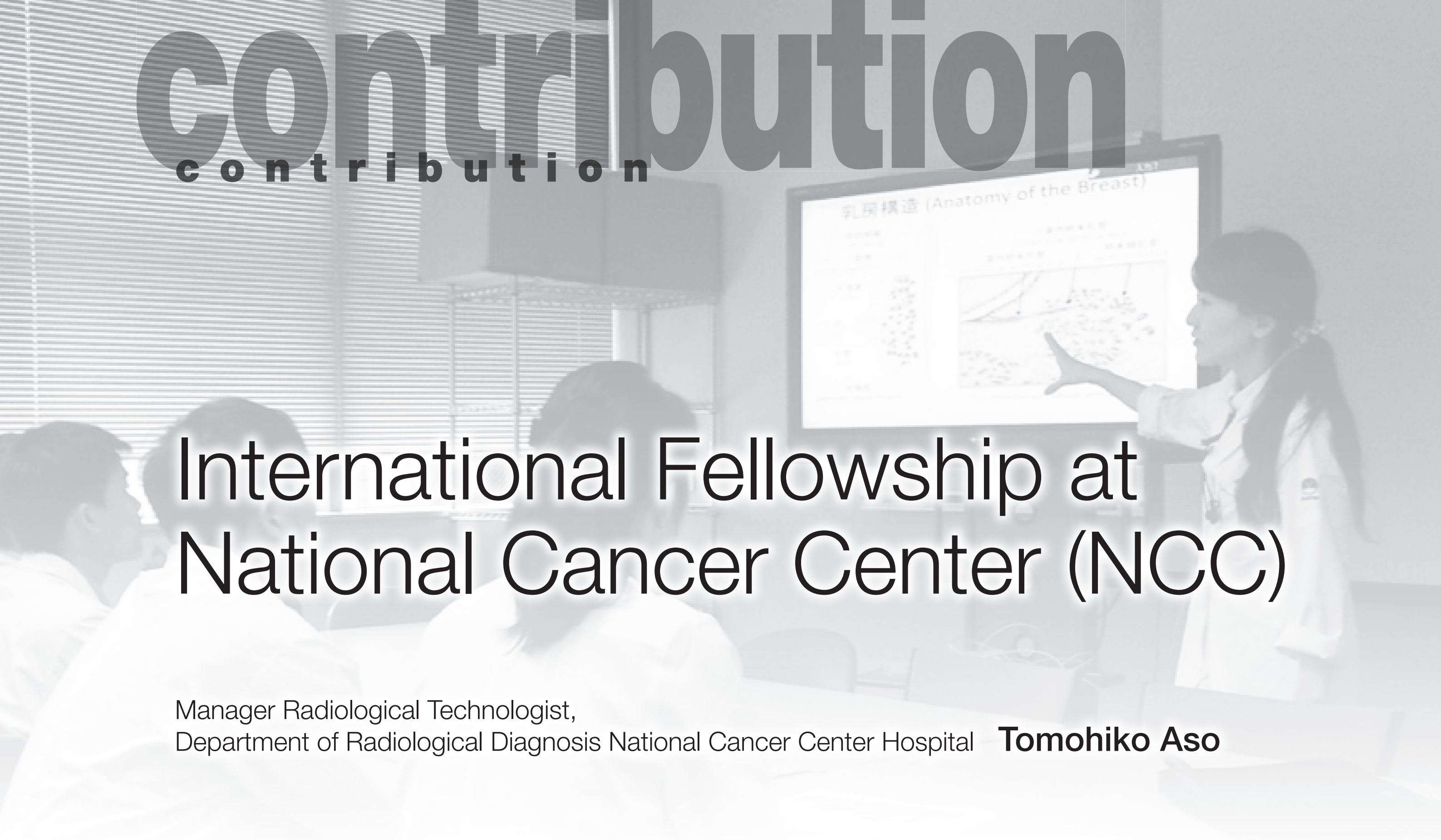
This program launched in August 2003 after SARS outbreak. As the result of over-emphasis on specialty training, most of the residency training program neglected general medicine education. To rectify this drawback, the Ministry of Health and Welfare (former name for the Department of Health) decided to sponsor a national project known as "The Postgraduate General Medicine Training Program" in 2003. Radiological Technologist's training program was concurrent and persisted two years namely postgraduate year (PGY) 1 and PGY2. The education goals of PGY are to accumulate experiences for taking care of patients, to enhance the acquisition of detailed factual knowledge, and to develop the professional competence in radiology, radiotherapy, nuclear medicine.

Conclusion

Radiological technologists play an important role in helping illness diagnosis or cure the disease. The rapid development in Radiological Technology produces a continuous stream of new knowledge about disease processes. Nevertheless the education system of radiological science is complete in Taiwan, the training system should focus on not only good at their specialty but also hardworking and devoted to research. We will continue to contribute our effort to improve the quality of health care in our country.

Reference

1) https://www.studyabroad.moe.gov.tw/
2) Radiologic Technologists Acts. The Legislative Yuan, 2000.
3) http://wwwc.moex.gov.tw/main/ExamReport/wFrmExamStatistics.aspx
4) http://mohw.gov.tw/CHT/DOS/Statistic.aspx



International Fellowship at National Cancer Center (NCC)

Manager Radiological Technologist,
Department of Radiological Diagnosis National Cancer Center Hospital **Tomohiko Aso**

Introduction

It was spring in 2014 when I first received an inquiry about international fellowship. It was just a phone call from Professor Nishio of Komazawa University. The conversation did not go into the detail. I answered it affirmatively under the wrong interpretation that it was just an observation tour. Although our institution is a teaching hospital accepting many local and international 'visitors', however it was quite a new to us accepting 5 Taiwanese trainees over 6 weeks. I had to confess that I was irresolute for some time, but finally I made up mind to accept them supported by following two ideas. One is this would be a good opportunity of 'human resource development' in both of us. The other is friendly relations that Yuanpei university assistant professor Kuo and I maintain for a long time. We occasionally meet in international meetings starting from an international JART meeting in Nagasaki. The most impressive event was dinner held in Yuanpei University in 2012. The students' smiles registered with me quite well.

In the following, I would like to mention how we carried out this fellowship program successfully.

Accepting international trainees

Following four problems came to my mind in accepting international trainees,

1. Language barrier
2. Curriculum difference
3. Monetary burden
4. Responsibility

1. Language barrier

Language barrier is a big problem. The number of staffers who speak English is limited, let alone Taiwanese. Our division has a Chinese radiological technologist (RT), which was a great help to us. But she cannot train as many as 5 students at one time.

In spite of my worries, this fellowship turned out be a good opportunity of 'human resource development' and broadened our knowledge and horizons.

The staff communicated with trainees better than I expected using language aid applications installed in smartphones.

2. Curriculum difference

Another thing to be mentioned is difference in the college education curriculum between Taiwan and Japan.

We have a clinical teaching guide of our own for domestic trainees (Fig.1). To overcome this problem, we prepared a simplified version in English and provide international trainees for their effective learning (Fig.2).

We gave them lectures covering all the field of diagnostic radiology. Each 30 minute lecture was performed in English by a chief RT of his

1　臨床実習指導の基本

1-1　臨床実習における指導の進め方

この臨床実習指導ガイドラインは、実習の指導が円滑にできる点において配慮して作成してあります。しかし、実際の臨床実習では、検査内容や指導者、実習期間が異なるため、臨床実習指導ガイドラインの内容すべてを取り上げることが困難な場合があります。実習指導者の判断で実習項目や詳細項目を決めて指導をすることとします。また、実習の進度は、各部署で実習期間において設定していただいて構いません。

目標の設定は、学生が工夫することによって到達できるレベルとして下さい。

実習項目の表に履修必要度を記号A，B，Cの３段階で示しております。履修必要度:

A:十分な指導を行い、学生に習得、理解させる項目

B:十分な説明を行い、学生に理解させる項目

C:経験しておくと良い項目(特殊検査，特殊装置など)

1-2　評価方 法 につ いて

臨床実習期間中の評価は、各担当の実習責任者・実習指導者でお願いいたします。

一般撮影・造影透視検査(消化管検査)・CT 検査・MRI 検査・血管撮影・RI 検査の部門毎に評価をお願いいたします。

評価項目については以下の項目とします。

⟨学習評価⟩

理解力、学習意欲(向上心・探究心)、接遇、記録について評価をお願いいたします。

各評価は、5 段階（5:大変良い、4:良い、3:普通、2:努力を要する、1:かなり努力を要する）とします。

⟨注意項目評価⟩

礼儀・服装、言動、責任感、協調性、適正、について評価をお願いいたします。

各評価は、5 段階(5:大変良い、4:良い、3:普通、2:努力を要する、1:かなり努力を要する)とします。

2　放射線診断部における学生実習教育目標

2-1　総合般目標（GIO：General Instructional Objective）

臨床実習で放射線技師として必要な基礎知識や技術を習得するとともに、専門分野での専門的知識および技術を修得する。

2-2　行動目標（SBOs：Specific Behavioral Objectives）

（１）　共通項目

（２）　一般撮影に関する項目

（３）　乳房撮影に関する項目

（４）　ポータブル撮影に関する項目

（５）　造影、透視検査(消化管検査)に関する項目

（６）　CT 検査に関する項目

（７）　MRI 検査に関する項目

（８）　血管撮影に関する項目

（９）　RI 検査に関する項目

（１０）放射線管理に関する項目

（１１）品質管理(QC)・品質保証(QA)に関する項目

（１２）病院情報システムに関する項目

（１３）勤務態度、その他

(1)　共通項目

1　検査の内容、必要性について理解させる。

2　患者様の状態に合わせた検査法を選択、実施することを理解させる。

3　放射線による被曝低減を目的とした設定を理解させる。

4　フィルム撮影とデジタル撮影の違いを説明させる。
デジタル画像の有用性について理解させる。

5　デジタルシステムの基本構成について説明させる。

6　ＣＲおよびＦＰＤ撮影の原理を説明させる。

7　画像処理に関して理解させる。

8　階調処理、周波数処理、サブトラクション処理などの処理効果について理解させる。

9　デジタル画像の圧縮法について理解させる。

10　撮影条件（管電圧、撮影時間、距離、焦点サイズ）の違いによる画像効果について説明させる。

11　造影剤の薬理動態を理解させる。

12　造影剤による副作用および禁忌について理解させる。

13　造影剤による副作用発生時に適切な対処を理解させる。

14　検査に使用する薬剤について理解させる。

15　装置の構造、性能を理解させる。

16　装置の特性を理解し安全な操作を理解させる。

17　周辺機器の構造、性能を理解させる。

18　周辺機器の特性を理解し安全な操作を理解させる。

19　装置の基本性能について理解させる。

20　測定の容易な基本性能については測定させる。

21　始業点検、日常点検、引取り検査の必要性を理解させる。

Fig.1

or her own specialty (Fig.3). The trainees were deeply grateful for our efforts (Fig.4). So we basically followed the domestic clinical teaching system.

3. Monetary burden

Although the government of Taiwan granted a subsidy to this fellowship, it did not cover the whole expenses of their stay and travel. I

Xray General	To know the standard positioning during the X-ray.	
	To know the anatomical planes for the x-ray	
	To understand the right positioning according to the purpose of X-ray.	
	To know the appropriate use of instruments.	
	To understand the right radiograohing condition.	
	To understand chest X-ray.	
	To understand abdominal X-ray.	
	To understand the other general X-rays.	
	To understand how to determine bone mineral quantity	
	To understand panoramic radiography	
Mammography	To understand the significance of mammography	
	To understand how to treat the patients	
	To know the breast anatomy.	
	To understand the physiology and the right time for mammography	
	To understand the basics and the blind area of mammography	
	To understand the checkpoints of the mammography	
	To understand how to add mammography and its checkpoints	
	To understand special and magnification radiography	
	To understand characteristics and right radiographing conditions.	
	To understand the QA and QC of mammographing devices	
	To understand the difference between analog and digital imaging	
Portable radiography	To understand the significance of portable radiography	
	To understand how to use the device in a hospital room	
	To understand the importance of cooperation with nurses and doctors	
	To understand radiation control of those nearby the examinee.	
Fluoroscopy	To understand the significance of fluoroscopy	
	To understand the kinds and contents of fluoroscopy	
	To understand side effcets and contraindication of the contrast enhancement.	
	To understand how to asses image quality.	
	To understand direct and indirect radiography.	
	To understand I.I, DR and FPD.	
	To understand how to proceed the fluoroscopy.	
	To understand the physiology and anatomy of GI tract.	
	To understand the basic of GI tract examinations.	
	To understand the examination ,anatomy and physiology of urinary system	
	To understand how to deal with digital image.	
Computed Tomography (CT)	To understand the basics, characetristics and significance of CT	
	To understand the procedure of CT imaging	
	To understand pretreatment and precaution of CT imaging.	
	To understand how to use contarst enhancement and its side effects	
	To understand the patient treatment and the importance of explanation to and monitoring over the patient.	
	To understand the anatomical structure of human body.	
	To understand image enhancement processing method in ecah function.	
	To understand the property and the setting of contarst enhancement	
	To understand the relation between W/W, W/L and CT value and image quality	
	To understand the principle and application of 3D,MPR amd MIP processing.	
	To understand how the artifact ocures and how to prevent it.	
Magentic Resonace Imaging (MRI)	To understand the basics, characetristics and significance of MRI	
	To understand admition instructions and patient treatment.	
	To understand basic system and RF coil characteristics.	
	To understand how to use contarst enhancement and its side effects	
	To understand the patient treatment and the importance of explanation to and monitoring over the patient.	
	To understand equip management and quenching.	
	To understand the anatomical structure of human body.	
	To understand basic image acquisition (pulse sequence).	
	To understand how sequence affect MR imaging.	
	To understand artifacts.	
	To understand the relationship between RF power and SAR.	
	To understand the diference between oral and IV contarst enhancement	
	To understand the characteristics of contrast enhancement of Gd.	
	To understand the diffrence between MRI and CT	

Fig.2

worked hard to hold down the teaching fee.

4. Responsibility

Two kinds of responsibility came to my mind, one is for causing damage to the institution and the other is for medical expenses. Former one should be dealt with making a contract, and the latter should be with carrying medical insurance.

I'd like to mention again that we did not find any major problems accepting international trainees including immunization and epidemic procedures.

Closing remark

Smart phone has been widely spread and provided us uncountable things such as scheduling, internet access besides telephone function. However how to handle Social Networking Services (SNSs) using this device is a very sensitive issue. In my personal view, it is essential to get the trainees to fully understand the significance of keeping safe of personal information of patients and confidential information of any kind that belong to the teaching hospital.

Environments around the RT have been changed gradually. Image reading assistance, examination explanations, consultation on radiation exposure, expansion of the work should be included in the teaching program. I hope what the trainees learned would bring

Fig.3

National Cancer Center Visiting Fellowship Program July,27,2015 ～ September,4,2015 Ver.2
Division of Diagnosic Radiology and Radiation Oncology

	July					August																															September			
	27日	28日	29日	30日	31日	1日	2日	3日	4日	5日	6日	7日	8日	9日	10日	11日	12日	13日	14日	15日	16日	17日	18日	19日	20日	21日	22日	23日	24日	25日	26日	27日	28日	29日	30日	31日	1日	2日	3日	4日
	Mo	Tu	We	Th	Fr	Sa	Su	Mo	Tu	We	Th	Fr	Sa	Su	Mo	Tu	We	Th	Fr	Sa	Su	Mo	Tu	We	Th	Fr	Sa	Su	Mo	Tu	We	Th	Fr	Sa	Su	Mo	Tu	We	Th	Fr
student 1	*	XP	NM					9	10	13	14	CK TB			XP			IR				IR		Fluoro		MMG			MRI		CT					National Center for Global Health and Medicine		MRI	FLU	†
student 2	*	CT	NM					CK TB	9	10	13	14			CT			XP				XP		IR		MMG			Fluoro		MRI							FLU	IR	†
studet 3	*	MRI	NM					14	CK TB	9	10	13			MRI			CT				CT		XP					IR		Fluoro					IR	IR FL	National Center for Global Health and Medicine		†
Student 4	*	FLU	NM					13	14	CK TB	9	10			Fluoro			MRI				MRI		CT					XP		IR					XP	CT IR			†
Student 5	*	IR	NM					10	13	14	CK TB	9			IR			Fluoro				Fluoro		MRI					CT		XP					CT	MR CT			†
Lectures				NM														XP	CT				MRI		IR	MMG				Flu 1		Flu 2								

* Orientation and Welcome party
† No specific schedules

XP:X-ray General　Fluoro:Fluoroscopy　MMG:Mamaography
Numerical number of 9.10.13.and 14 represent radiation treatment room number .
CK:Cyberknife　TB:TureBeam

Notes
○Diagnosic Radiology
・This program starts at eight thirty.
・Lectures begins at three pm.
・Follow mild dress code.
・Keep the patients' personal information to be safe.
・In case of being late or absent, be sure to contact us through the following number.
(Tel :03-3547-5201 ex3551,7728)

○Radiation Oncorogy
・There are six linacs in room .9,10,13,14, TB.

Fig.4　National Cancer Center Visiting Fellowship Program 2015

Photography with Dr. Kuo and students in Taiwan.

positive effects on the working environment of the RT in their own country.

In the end, I would like to conclude that international fellowship has helped our human resources to develop to a level that nothing can be compared to. I am determined to continue to develop our human resources through international fellowship.

Arts and Sciences

contribution

Activities of the Japan Disaster Relief Medical Team (First Group) Following the Massive Earthquake in Federal Democratic Republic of Nepal

Kazuyoshi Yamano

special feature

Mastering 3D for Medical Applications
Basis of Medical 3D-CT Image

Hironobu Tomita

the original work

Radiation Exposure of Sonogaraphers After Administering Radiopharmaceuticals

Emi Kinoshita, Isao Komiya, Yoshiyuki Umezu, Noriko Mizoguchi,
Kouji Kobayashi, Tatsuyuki Senjyu, Yasuhiko Nakamura

the original work

Optimal Bladder Volume in IMRT Planning for Prostate Cancer

Yoshiyuki Kawasaki, Yoshitaka Nemoto, Hisanori Aoki,
Mayumi Kuronuma, Yoshiyuki Seya, Norio Mitsuhashi

the original work

Optimization for Q-Space Imaging in a Clinical Setting: Setting of MPG Direction Number

Nozomi Hamasaki, Masaaki Hori, Yuriko Suzuki, Haruyoshi Houshito, Shigeki Aoki

material

A Survey Regarding Acceptance and Awareness of Autopsy imaging (Ai) among Radiological Technologists in Our Institution: Comparison with Those of Two Other Institutions

Kazuya Tashiro, Tomoya Kobayashi, Satoka Someya, Katsumi Miyamoto,
Hiroyuki Takei, Seiji Shiotani, Hideyuki Hayakawa

Activities of the Japan Disaster Relief Medical Team (First Group) Following the Massive Earthquake in Federal Democratic Republic of Nepal

Kazuyoshi Yamano

Department of Diagnostic Radiology, National Cancer Center Hospital East

A 7.8-magnitude earthquake occurred in the mid-west region of Nepal on April 25, 2015 at 11:56 am (local time), inflicting immense damage on Nepal and the surrounding countries. At the request of the Government of Nepal for medical assistance, the Government of Japan decided to dispatch a broad-based medical team based on the framework of the Japan Disaster Relief Team (JDR).

In contrast to the previous JDR medial teams, of which activities had been limited to outpatient care, this team was organized for the first time as a broad-based medical team that was capable of providing comprehensive medical support, including not only outpatient care, but also surgery, dialysis, and ward-based treatment, in order to respond to hyperacute medical needs.

The author participated in the broad-based medical team from April 28 to May 11, 2015. This paper describes our medical assistance activities in Bahrabise Village, Sindhupalchok District (Fig.1).

Damage to life and property

On Saturday, April 25, at 11:56 a.m. (3:11 p.m. in Japan), a 7.8-magnitude earthquake occurred with the epicenter located in Saurpani, Gorkha District, 77 km northwest of the Nepalese capital of Kathmandu, at a focal depth of 15 km, which was followed by a 7.3-magnitude aftershock on Tuesday, May 12, with the epicenter in Kodari, 76 km east-northeast of Kathmandu. This has affected 8 million people in Nepal, resulting in more than 8,600 deaths and more than 21,000 injuries (as of May 27, 2015).

Fig.1 Federal Democratic Republic of Nepal

In Kathmandu, most collapsed buildings were of older construction, such as ancient temples. The majority of buildings in the city were saved from collapsing, although we noticed that there were several tilted constructs being propped up with timber supports. Utility services were mostly resumed. At our hotel, water and electricity were available without restriction, along with a sufficient connection to the Internet. We also perceived that there was no shortage of daily commodities and that there was heavy vehicular traffic in the city.


Fig.2 Buildings in Kathmandu city


Fig.3 Kathmandu city


Fig.4 Collapsed temples


Fig.5 Traffic conditions in the city


Fig.6 Life in a cargo container


Fig.7 Collapsed constructs in Bahrabise

However, the environments remained stressful, with people rushing out of doors after every aftershock (Fig.2-5).

In Bahrabise, the majority of collapsed constructs had been made of layers of bricks or stone. Some families evacuated their damaged houses to cargo containers of their trucks parking on the road (Fig.6, 7). Food had been transported by helicopter to this landslide-hit isolated village inaccessible by road.

Broad-based JDR medical team

< Background of the establishment and deployment of a broad-based medical team >

The JDR medial teams had provided medical assistance for disaster victims on an outpatient basis. There was a growing expectation that such medical assistance focusing merely on outpatient care should be improved to a level that would match the resources of Japan, so that medical teams could provide sufficient support in the case of a devastating disaster in the Asian-Pacific region. In light of this, a panel on a broad-based medical team was established, in which “the need to expand the capability of JDR medical teams to respond to a major disaster in neighboring Asian countries during its acute phase” was recognized. The availability of charter planes increased the potential of a medical team to provide a neighboring country with critical care during the hyperacute phase of a disaster. Efforts were made to improve the capability of JDR medical teams in order to provide not only, as in their previous deployments, outpatient services addressing acute and subacute medical needs, but also hyperacute critical care. The present team was deployed for the first time as a broad-based JDR medical team.

Table 1 Types and numbers of previous and present (broad-based) medical team members

Type/Title	Previous team	Present broad-based team
Principal	1	1
Subprincipal	2	2 (1 physician)
Physician	3	7
Nurse	7	16
Pharmacist	1	2
Clinical radiologist	1	2
Laboratory technician	1	2
Clinical engineer	0	2
Medical coordinator	3	2
Project coordinator	4	8
Total	23	44

< Members of the broad-based medical team (Table 1) >

In addition to the conventional sections of outpatient services (reception, clinic, pharmacy, and examination/laboratory), surgery, dialysis, and inpatient care sections are to be incorporated into a team, according to the needs of the affected region it is deployed.

The present team included emergency medicine physicians specializing in orthopedic surgery, general surgery, pediatrics, and anesthesiology. Nurses were allocated to three sections (outpatient clinic, ward, and surgical care).

< Available surgical care >

The broad-based JDR medical team was capable of providing medical and surgical care for the following disorders:

1. Crush syndrome

Conditions: Metabolic acidosis, hyperkalemia, acute renal failure, frequent episodes of ventricular arrhythmia, and a widened QRS complex

2. Limb and soft-tissue injuries

Conditions: Open fractures of the limbs and pelvis, and severe, extensive soft-tissue injuries

3. Thoracoabdominal trauma

Conditions: Hemopneumothorax, lung injuries, abdominal parenchymal organ injuries, gastrointestinal injuries, and others

4. Medical conditions requiring inpatient treatment (up to approximately 24 hr of hospitalization followed by transfer), except for the following cases:
   1) Extremely poor prognostic features
      High risk of death despite surgical treatment
      Requiring transfusion
   2) High risk of treatment discontinuation due to the limited availability of medical resources in the deployed area
      Having required prolonged cardiopulmonary resuscitation
      Impaired consciousness with a Japan Coma Scale (JCS) of ≥100
      Requiring long-term artificial ventilation
      Others

Activity report

On April 27 (Monday), I had a talk with my supervisor about the possibility of JDR deployment to Nepal and my willingness to participate in the team, to which he readily agreed. In the case of a possible deployment of the JDR, I always talk to my supervisor in advance for his approval for my JDR participation and inform my colleagues accordingly. At 8 p.m., I received a notification letter from the JDR secretariat by fax and email indicating that the deployment of a broad-based JDR medical team to Nepal had been authorized and that they were assembling team members. I immediately informed my supervisor accordingly, and received his final approval. I was notified of my acceptance to the team at 11:30 p.m., then attended an initiation ceremony at Narita Airport at 2 p.m. on April 28 (Tuesday), and left at 5 p.m. for Nepal via Bangkok, Thailand, where the team stayed at a hotel overnight.

On April 29 (Wednesday), we left our hotel, departed from Bangkok at 10:15 a.m., and arrived at Kathmandu Airport, Nepal, at 4:20 p.m. After checking in a hotel, I attended a Foreign Medical Teams (FMT) meeting together with the principal and subprincipal of the medical team, personnel from the Japanese Ministry of Foreign Affairs, and staff members of JICA Nepal Office. The members of the JDR search and rescue team stayed at the same hotel.

On April 30 (Thursday), in the wake of a proposal from the Nepalese Government for the provision of medical services in Bahrabise Village, Sindhupalchok District, 13 members, including interpreters, were flown into the village by military helicopter in the evening (Fig.8). While in Kathmandu, at Annapurna Hospital, two physician and two nurse members assisted surgical procedures from 4 to 10 p.m. (Fig.9).

On May 1 (Friday), members in Kathmandu made a round trip to Bahrabise by car to assess the conditions of trafficability and the situation in the area, and some of the members remained in Bahrabise to join the advance members. From this assessment, we knew that overland transport was possible, although some parts of the road was half-blocked by earthquake-related landslides. Members in Bahrabise started to provide medical services from noon in the premises of a junior high school, and we transported a patient with a femoral fracture to Annapurna Hospital in Kathmandu by land. The patient said a word of thanks to us after emergence from surgical anesthesia. A part of medical equipment and supplies arrived from Japan, including an X-ray apparatus and all related supplies.

On May 2 (Saturday), some members in Kathmandu left for Bahrabise with some of the equipment and supplies, including the X-ray apparatus, while some advance members in the village returned to Kathmandu. Clinic hours in Bahrabise were set from 8:30 a.m. to around 3:30 p.m. (reception closing time).

Fig.8 Military helicopter cabin


Fig.9 Surgery at Annapurna Hospital

On May 3 (Sunday), the rest of the equipment and supplies arrived in Kathmandu from Japan. Since the members located there were scheduled to leave for Bahrabise the next day, they prepared for relocation by organizing the equipment and supplies. In Bahrabise, we started to perform X-ray examinations.

On May 4 (Monday), all members in Kathmandu moved to Bahrabise and set up a cross-shaped tent, in which broad-based medical care was provided.

On May 5 (Tuesday), we started to work as a broad-based medical team and provided surgical care in the cross-shaped tent. Three patients received surgical treatment (two of whom were hospitalized) on the day, followed by two patients (both were hospitalized) on May 6 (Wednesday). On May 7 (Thursday), one patient underwent surgical treatment, one received inpatient care for a non-surgical condition, and one inpatient was transferred.

On May 8 (Friday), shortly after noon, half of the members of the subsequent JDR medical team (second group), who had arrived in Kathmandu, were deployed in Bahrabise to replace half of the first group who left the village on the day. The other half of the first group transferred relevant information to their successors.

On May 9 (Saturday), the other half of the second group left Kathmandu for Bahrabise, where the members of the first group provided medical care with their successors before they left the village in the afternoon.

Site of medical care

Conventional tents (used for the reception) and a part of cross-shaped tent for surgical care) were set up on the schoolyard of a local junior high school. This site was too narrow to pitch all tents the team brought, and the school allowed us to use their vacant facilities. We lo-


Fig.10 Cross-shaped tent


Fig.11 Medical activities in the treatment room

Fig.12 Patient briefing with an iPad

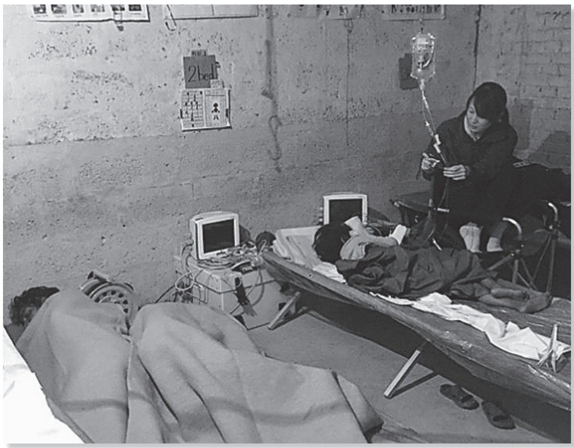


Fig.13 Night-shift work in the ward

Fig.14 X-ray examination room

cated the X-ray examination room and clinical laboratory in the same facility, and the examination room, treatment room, and ward in separate facilities. The temperature inside the cross-shaped tent rose above 40°C, and the use of electric fans was poorly effective in cooling, making the mission demanding for surgical members (Fig.10-14).

X-ray examinations

The radiographic system used in the present operation was the one that had been introduced into the JDR since its medical missions in the Philippines. This system was equipped with a flat panel detector (FPD), from which registered X-ray images were transferred to an iPad so that they could be viewed from a remote location. The facility of the X-ray examination room and clinical laboratory had a sufficient height and width to perform examinations. A camping mattress placed on top of two benches firmly connected to each other was used as an examination table. Perioperative radiography involved a time-consuming transfer of the apparatus. Additionally, the low height

Fig.15 Radiography in the X-ray examination room

Fig.16 Intraoperative radiography

of the tent and the use of a fixed-height stretcher as the operating table (of which the height could not be lowered) interfered with the conventional placement of the apparatus for its safe use; therefore, the X-ray apparatus was securely tied to a supporting pole with a rope in order to maintain the highest possible distance between the X-ray tube and the patient.

Due to the earthquake disaster, there were a higher percentage of trauma patients. We performed radiography not only for routine examinations, but also for the evaluation of reduction provided in the X-ray examination room and intraoperative confirmation to serve as a replacement for surgical imaging (Fig.15, 16). Since we had only one X-ray apparatus, radiography was unavailable for outpatients during surgery, which needs to be addressed in the future.

We often had problems in printing radiographic images and sometime in loading them to a database on an iPad, and, thereby, physicians needed to visit the X-ray examination room to view these images.

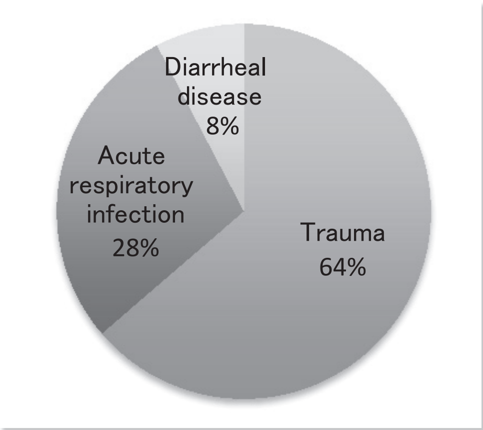


Fig.17 Disease categories

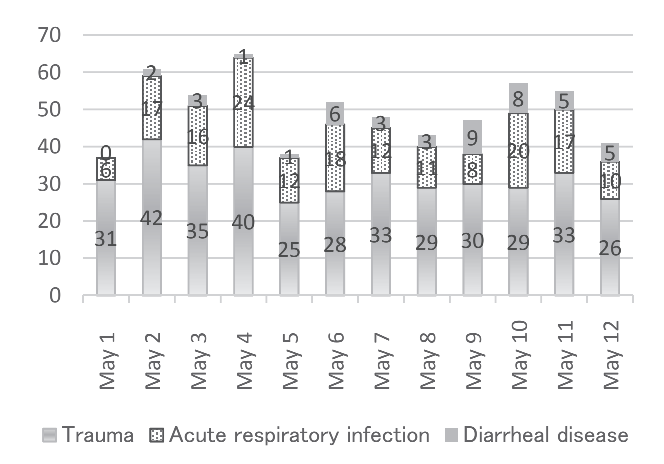


Fig.18 Changes in the number of patients by disease

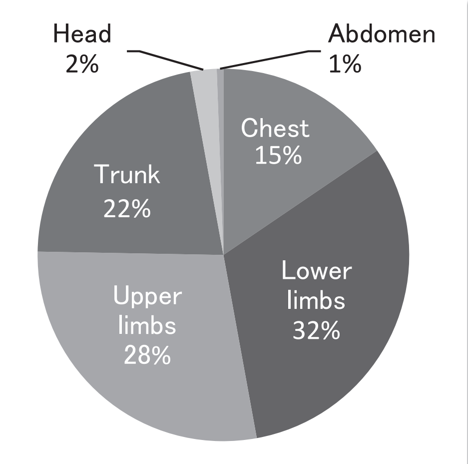


Fig.20 Sites of X-ray examinations

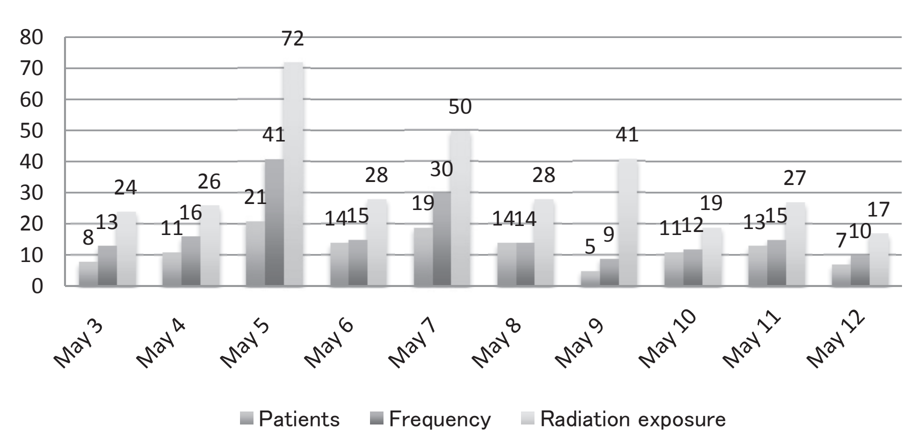


Fig.19 Changes in the frequency of radiography

Fig.17-20, respectively, show the disease categories and changes in the number of outpatients, changes in the frequency of radiography, and the sites of radiographic examination in patients treated by the first and second groups.

Treatment was provided to 987 individuals, including return patients, of whom 64% were trauma patients due to earthquake disaster. There were no marked inter-day variations in the types of disease treated in the Bahrabise site.

The number of radiation exposures increased on the three days when radiography was performed for the confirmation of reduction and surgical procedures. In terms of the sites of examination, chest X-ray was ordered for a rib fracture rather than for acute respiratory infection.

Conclusion

Since the present mission was undertaken for the first time as a broad-based JDR medical team that was capable of providing surgical and inpatient care, much time and effort was devoted to on-site preparation after arriving in Nepal, as well as to the transport of a large amount of equipment and supplies. A team of this kind may need at least two clinical radiologists, when the team is deployed to an area where radiology members are to perform intra-operative radiography as well as conventional X-ray examinations and where there may be a large number of trauma patients.

A surgically capable medical team should take the management of the postoperative follow-up system into account, in contrast to its limited role in providing follow-up care to their patients until full recovery. The present mission demonstrated that such a team needs to build a firm relationship with local healthcare institutes when providing surgical care in order to develop a trusting relationship with patients, their families, and local healthcare providers and share detailed postoperative follow-up plans with them for successful surgical care.

Acknowledgments

I am grateful to the staff members of National Cancer Center Hospital East for allowing me to participate in the medical activities, despite short notice. Also, I am grateful to the members of the first group of the JDR medical team (Fig.21).

Fig.21 JDR medical team members (first group) and local staff members

Mastering 3D for Medical Applications
Basis of Medical 3D-CT Image

Hironobu Tomita

Saiseikai Kawaguchi General Hospital

The '3D PACS Study Group' was established in December 2008 for promoting research and improving knowledge on image processing technologies and clinical applications. It is targeted at medical science technicians who use 3D PACS products and their peripheral equipment as well as at contributing to medical sites.

This article features the details of a lecture given at the Seventh Session of the 3D PACS Study Group, which was held in Nagoya City in December 2014.

○**Moderator**: I would now like to ask Tomita from Kawaguchi General Hospital of Saiseikai Medical Association to give us a presentation on the topic titled 'Fundamentals of 3D Display You've Been Embarrassed to Ask About.'

Introduction

First, I would like to briefly talk about some fundamental issues and then, move onto the subject of subtraction, which is performed at almost every facility. There are a variety of subtractions with a variety of set characteristics; therefore, I would like to talk about these aspects. Furthermore, what is referred to as 'Dual Energy CT' is currently gradually being implemented in clinical applications; therefore, I would like to mention some of the relevant applications as well.

I believe that everyone here is aware of how three-dimensional images are formed, that is by the stacking of two-dimensional images. An interpolation technology is generally used for smoothing out surfaces, and the interpolation calculation at the most fundamental level is referred to as linear interpolation. Nowadays, such applications are performed mostly by using 'multi-slice CT' but require an enormous amount of information.

Portraying three-dimensional images. We then have the intended CT value and refer to it as the threshold value. How we set this threshold value determines how an image with the intended CT value is rendered and is a commonly used method that we refer to as volume rendering.

The term 'MIP' is an abbreviation for maximum intensity projection. As the name implies, this is a method for projecting only the volume data with the largest voxel value in a specific direction, features favourable characteristics for body parts that are susceptible to noise, and offers good renditions for the continuity of blood vessels with the overlapping of images that are difficult to discern. I believe that this method is often used for displaying images of the blood circulatory system.

The term 'Multi Planer Reconstruction' is a function available as a feature with some of the existing equipment and makes it possible to render arbitrary cross-sectional images.

Various processes related to 3D images

The important aspects of volume rendering are that it involves a shading process, which is performed using the two parameters of threshold value and transmittance. Further, it is a method for showing an actual 3D image.

This method is ordinarily most often used in clinical applications. This is an extremely popular method, which allows us to set the thickness to an arbitrary value. Then, we have the 'curved multi planer reconstruction', which is used for displaying a cross-section along a hypothetical centre line assigned to blood vessels as well as other thin and long structures. This is extremely useful, particularly in viewing the blood vessels of the heart or thin blood vessels, as well as the associated plaque.

'Virtual endoscopy' is a method that is often used as an endoscopic mode. It provides views of the interior of the blood vessels. The observation of objects with an infinite perspective provides a view from the inside, as if the observers entered into a human body.

This may still be rarely used, but the method of display by using the integrated values of the projected CT value is a method known as the 'Ray Sum'. Simply put, this method provides images that resemble X-ray images. This is a minimum intensity projection, which is the reverse of the maximum intensity projection discussed earlier. This is a minimum value projection method and is used for projecting the minimum value for a voxel value. The method features characteristics similar to those of the MIP. The 'shaded surface display' (SSD) method goes back to the time when the available CPUs were lacking in power, volume rendering was not possible, and retention of the data of blood vessel interiors was not possible; thus, images had to be sort of pasted on, as in paper mache. This is the best description that I could come up with for this concept. However, it would suffice to remember that SSD is a method for displaying images under a paper mache condition. This one here is the MAR for the workstation supplied by TeraRecon, and this is an image of the superior mesenteric artery; SMA.

There is also a method that allows for a display of a single cross-section of the SMA, namely a result of tracing a single image (Fig.1).

◈VR (volume rendering)
◈MIP (maximum intensity projection)
◈MPR (multi planer reconstruction)
◈CPR (Curved planer reformation)
◈VE (Virtual Endoscopy)
◈SSD (Shaded surface display)
◈MinIP (minimum intensity projection)
◈Ray Sum

Fig.1 Various processes related to images, including original 3D image

Nowadays, isotropic imaging features three-dimensional spatial resolution for the X, Y, and Z-axes with an extremely high level of spatial resolution for CT images, referred to as the isotropic voxel. It is sufficient for you to just remember the name.

Relationship between reconstruction Kernel and spatial resolution

The configuration for the matrix of CT images is more or less 512 × 512 pixels. This implies that in a case where the FOV is 200, a single pixel will be 0.39 mm. Spatial resolutions of the equipment in the direction of the body axis may be 1 mm, 0.6 mm, or even 0.5 mm, while in the Z-direction, there may be substantial resolution, which is referred to as the effective resolution. The spatial resolution varies in the X–Y direction, depending on the relevant reconstruction function. Improving the resolving power improves the expressive power of images, such as the 3D MPR to levels with higher definition.

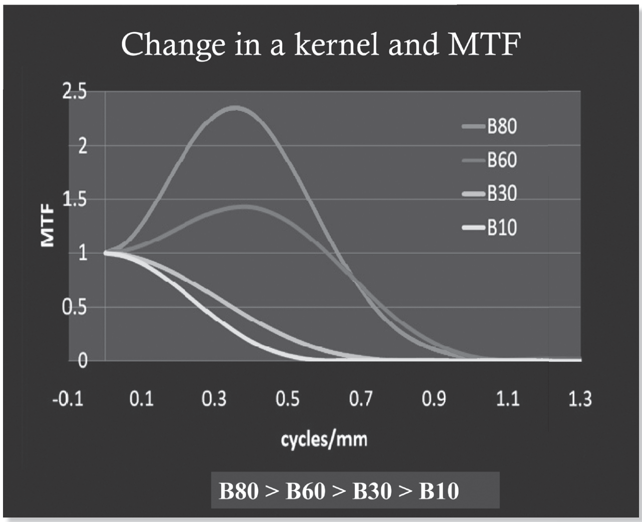


Fig.2 Difference between reconstruction kernel and MTF

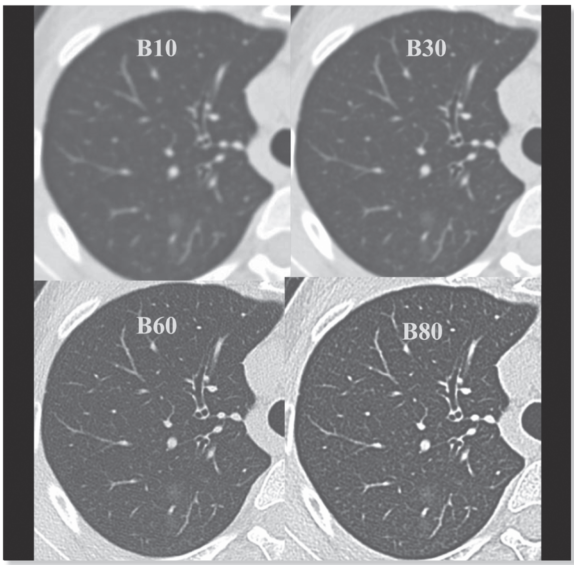


Fig.3 Clinical image

The terms B80 or B60 relevant to this kernel of lungs relate to sections for viewing the lungs or bones. Soft-tissue kernel include B30 and B10. This curve of the MTF makes evident the spatial resolution that offers a more detailed resolution (Fig.2). An actual clinical image is like this and its appearance may vary significantly, depending on the reconstruction kernel (Fig.3).

This slide shows what a 3D image looks like. As you can see, the spatial resolution and noise vary between B10 and B30, as well as B60 (Fig.4), and I am sure that you make appropriate adjustments at your work sites.

Speaking a bit more in terms of physics, let me show you this curve of the MTF (Fig.5). Let us assume that such a curve exists. Now, when the FOV on the left is 350 mm, the pixel size is 0.68 mm. The formula for deriving the frequency is shown here, but when we consider this

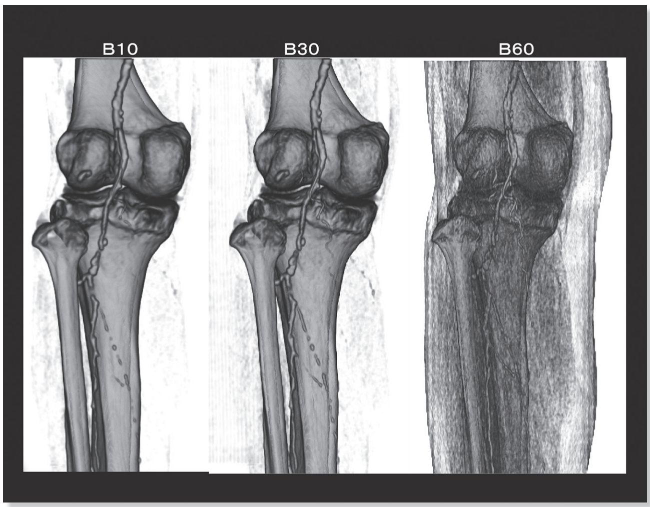


Fig.4 Difference between reconstruction functions and relationship with rendering performance

frequency, the limit of resolution is the MTF. This implies that in the case of this kernel, the limit would be just about here. As the limit value approaches the actual limit, for this case, the FOV value of about 220 mm, expanding the reconstruction further would not provide more details.

Further, the original image does not have a spatial resolution for it. It would also be physically useful to prepare an image, while considering an expansion from the curve of the MTF, and then, perform the reconstruction to some extent. I hope that this serves as a reference to your work.

Incidentally, the original position for capturing images should not be from the side or on an edge but right in the centre. This is the difference between centring and off-centring. The image on the right is an image captured off centre, while the one on the left is an image captured in the centre (Fig.6). It may appear as if the selection was made on the basis of how well the subject appears, but what you need to understand is that it would give you a much better view of the subject when the view is brought to the centre.

A variety of time intervals, such as 1 s or 0.5 s, are also available for capturing images, but these depend on the amount of projection data to be captured. Therefore, I hope that you can use this as your reference.

These also depending on the equipment used. Therefore, it is essential that you have a good understanding of the characteristics of the individual equipment. Images are categorised by time and off-centre capturing at this instance. The data indicate that a short time duration for capturing images results in a poor resolution.

These are images for which the resolution in the body axis direction increases when the thickness of the slices is decreased. Since these are images, I shall not provide the detailed descriptions, but your ordinary concept absolutely applies for these (Fig.7).

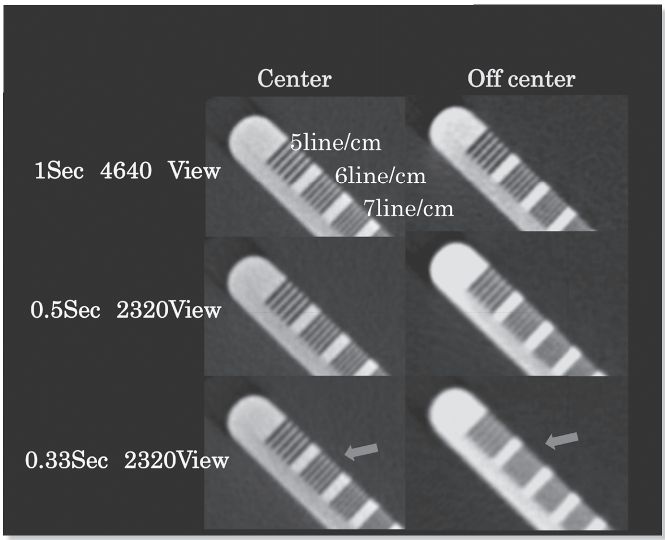


Fig.6 on-center VS off center

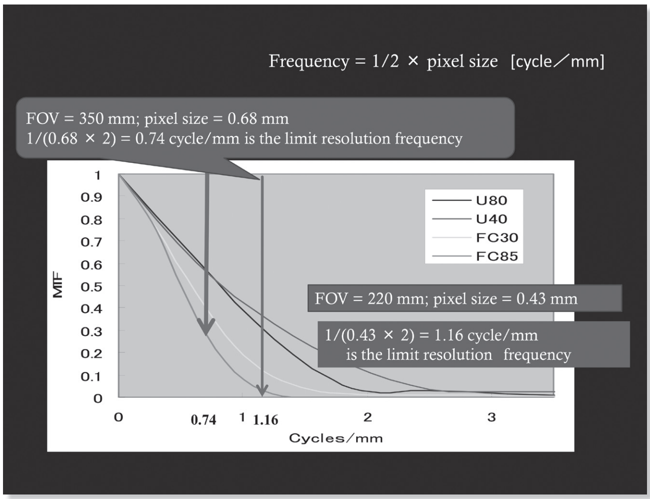


Fig.5 pixel size and limit resolution

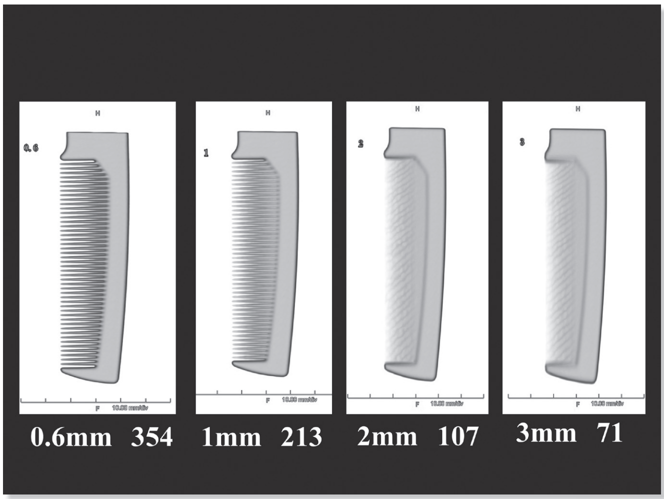


Fig.7 Difference in reconstruction thickness for comb phantoms and images (reconstruction interval = 1/2 slice thickness)

In terms of images, decreasing the thickness of the slices results in sharper images. This is clearly visible with the images of the lung.

This is an image of a comb with teeth measuring 1 mm. Finer details are revealed with 3D images, when the slice thickness decreases. However,

If, for instance, it is sufficient to show only the external shape of the comb and it is not necessary to show an image that includes the tips of the comb, then it may be sufficient to use a thickness of 1 mm. Otherwise, it may not be necessary to use a narrow thickness such as 0.6 mm. Therefore, it is a good idea to change such settings, depending on what is desired and where the emphasis is placed, when taking into consideration different aspects about the image server, different aspects of thin slices, and other such details. Minimizing the measurement obviously means that you get to see more detailed pictures.

Improving resolution (spatial resolution)

Further, equipment of various mechanisms is available. I would like you to just remember the term here, but the spatial resolution improves with the QQ reconstruction or at a place called the 'frying focal spot'. In some equipment, there are detailed matrices and it may be better to vary them slightly, particularly when displaying the MPR of bones, to evaluate the images and use the ones that are suitable.

This is an image of my foot and was taken after I had a surgery for a tibial plateau fracture. The images were captured as a part of my follow-up observation, but the right side was taken with the UHR, which is a high-resolution image capturing method, while the left side was taken with an ordinary method. As you can see, the image quality is completely different. Therefore, it is a good idea to try different equipment to evaluate images that can be captured (Fig.8).

Fundamental examination of CT image characteristics based on differences in radiographic dosage and subtraction method

There are a variety of problems with subtraction. However, it is easier now since we can perform a nonrigid process and a positional correction process (Fig.9), but in the past, we used to perform subtraction, where 512 matrices are subtracted from 512 matrices. Many 3D images that are available currently involve the application of subtraction on voxels. Further, increasing pitch causes a windmill artefact to

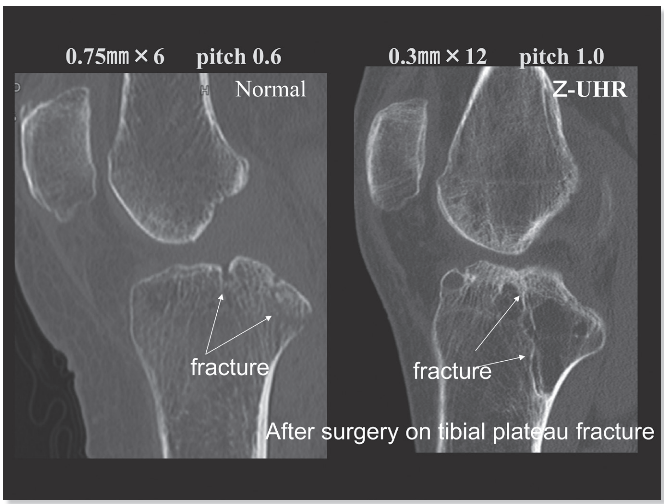


Fig.8 UHR Technology

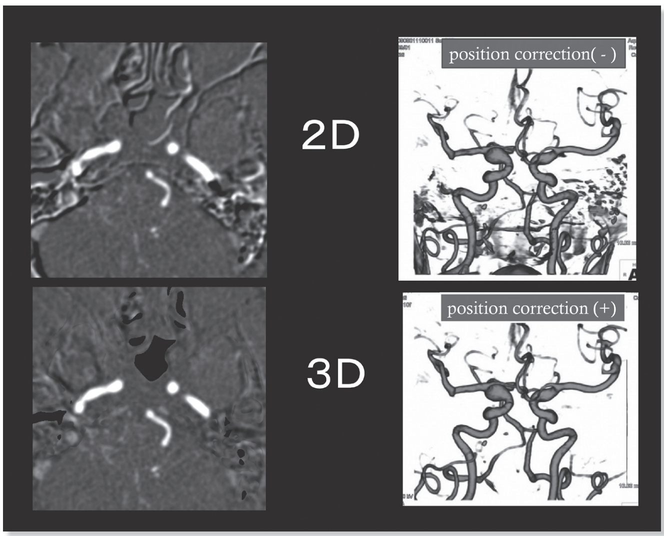


Fig.9 Clinical image

emerge, which is a problem. It is essential that the pitch be adjusted on the equipment to ensure that such problems do not occur.There is equipment with very few windmill artefacts. Therefore,it is necessary to consider original data, taking into account the characteristics of the equipment. In reality, if position matching is not conducted appropriately in 2D, there will be image residues, but we can still obtain clear 3D images (Fig.10).

Actual clinical images with 3D subtraction

I am sure that in your experiences, all of you have noticed that the SD is better with actual images with 3D subtraction. The CT value changes slightly if the mask image is drawn in contrast imaging. The arrows indicate 'All' and the CT value of the mask. The value of 180 HU is used here. However, when we ensure that the setting does not exceed this value in the drawing, then the original value of 366 HU is maintained as the CT value of the blood vessels (Fig.11). Therefore, we need to keep in mind such settings to prevent the CT value from decreasing and can then obtain a good subtraction.

I noticed that the SD fluctuated slightly at this instance, and thus, decided to perform this experiment. The method was as described here, but as you all probably know, SD generally increases with a decrease in the dosage. A comparison of the 2D subtraction method (hereinafter referred to as the '2D method') and the 3D subtraction method (hereinafter referred to as the '3D method') revealed that the SD deteriorated as the gap in the mask and live dosages worsened with the 2D method, the dosage was reduced, and the things were slightly better with the 3D method (Fig.12). The NPS of the images of subtraction should exhibit a similar trend for both the 2D and the 3D methods, but the NPS dropped in the low-frequency areas of the subtraction images of the 3D method, while the high-frequency wave was a

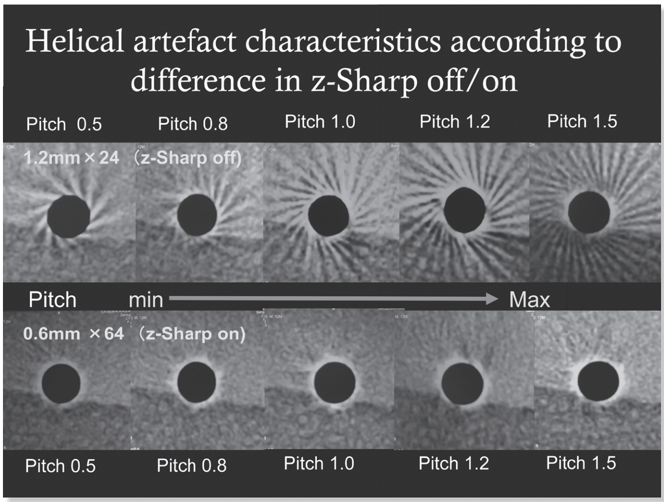


Fig.10

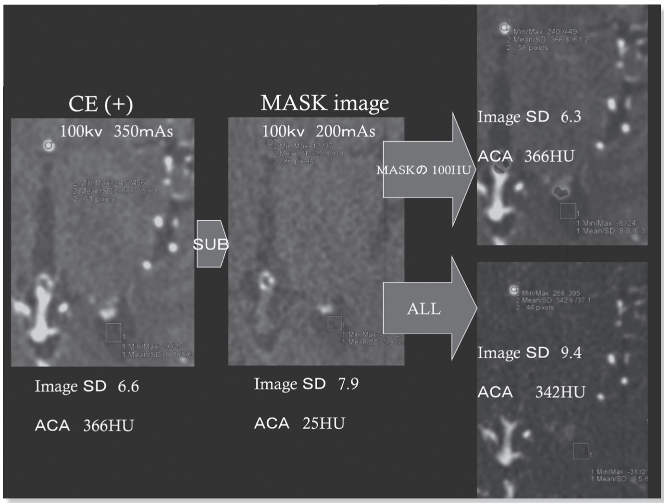


Fig.11

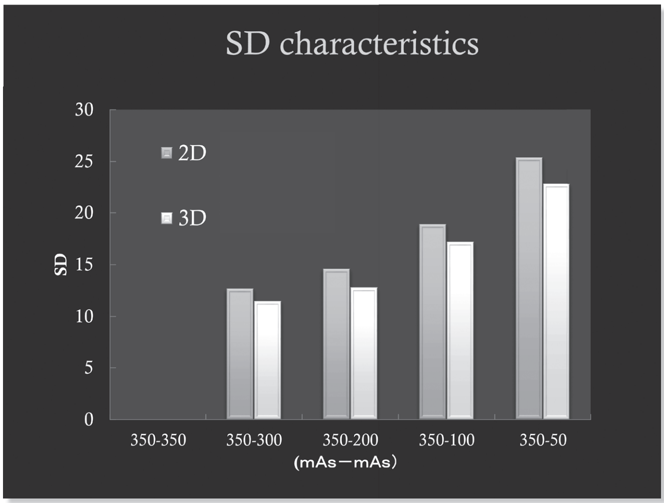


Fig.12

straight line. This indicated that the quality of these images was considerably different from that of the original. Since the NPS characteristics differ in such a manner, it is necessary to evaluate the final image. Further, it is evident that much the image was processed with the 3D method.

When subtraction is performed, the image is pulled in the less desirable direction with the 2D method. The image deteriorates slightly with the 3D method, but the SD improves over that of the original image. Therefore, it improves or rather does not deteriorate much, even when the dosage is pulled towards a lower figure. Therefore, this should be considered when adjusting images and image qualities for clinical applications. This alone will remove the roughness of the image. Therefore, when creating an image in an ordinary manner, slightly reducing the mask dosage would generate such an effect (Fig.13). This is done by the workstations supplied by TeraRecon, and although the behaviour may differ slightly with other workstations, this should be a reference for you when you use your own workstations.

Performing subtraction results in such outcomes, and it is evident that the image is improved on the left side with the 2D method and on the right side with the 3D method. Reducing the dosage further improves the image quality slightly in terms of SD, and since, in the end, the image quality does not deteriorate with strong signals, and the use of a system that allows for a sufficient reduction of the dosage will be suitable for clinical applications (Fig.14).

The upper level is 320 of 100 and 260 of 100, while the lower level is 100 kV of 320 mAs. Forgive me for using the unit of milliampere-seconds, but the image would be good with a workstation supplied by TeraRecon, even with a dosage that is only about one-tenth of this (Fig.15 and 16). I would imagine after this subtraction ordinarily involves extracting bones, and an image without the bones to an image with bones can be added consid-

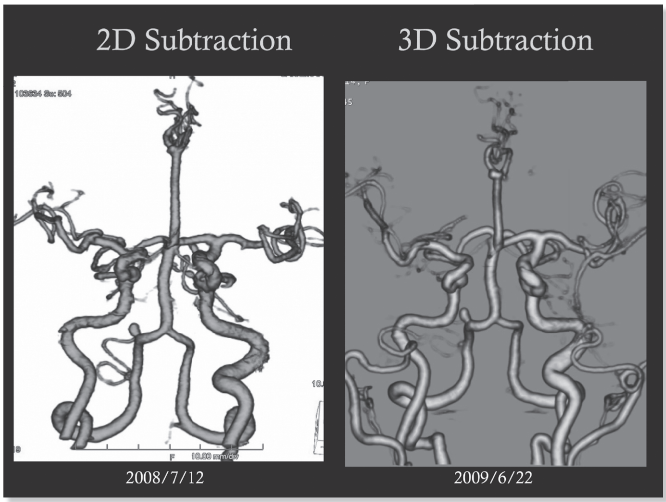


Fig.14

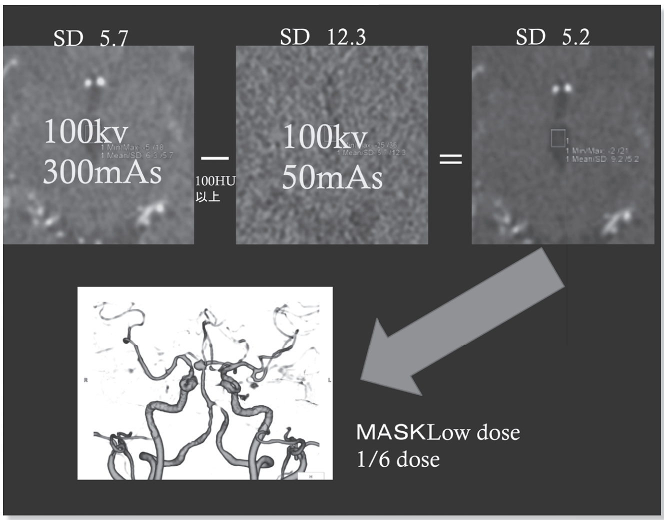


Fig.13

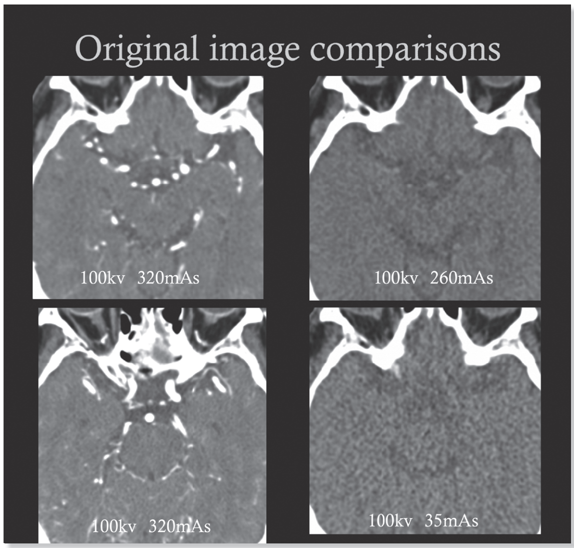


Fig.15

erably easily (Fig.17).

About dual energy

I am sure that everyone here has been performing the dual energy function, but I am currently performing virtual/virtual subtraction, based on various considerations of our facility. This is a method for drawing a virtual simplified image based on a contrast image of a single virtual colour, using a subtraction method for drawing only blood vessels by taking a single image with dual energy and without capturing any simplified image. Equipment supplied by Siemens was used in this case. Further, you can see that the axial image on the right side is considerably jagged. Performing volume rendering with this will result in a jagged image and will not be very good. Therefore, I wondered what was going on and had a look at the original image. The pixels of the image were jagged, while once the subtraction process was performed with the workstation, the interpolation of the image was smoothed out and the lower image actually ended up looking considerably smooth. This implies that the use of a workstation provides a relatively better image than the use of the existing equipment (Fig.18).

The problem is the phantom image seen in the dual energy image. The CT value was measured at this instance, and the blue portions are the bones. The various figures shown here were obtained when the image was cap-

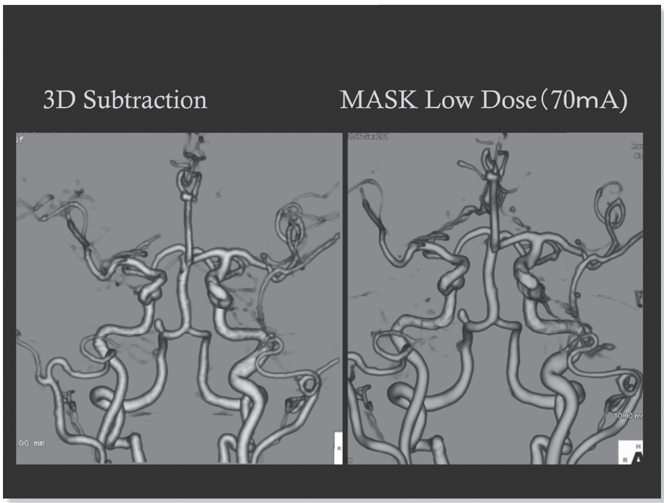


Fig.16

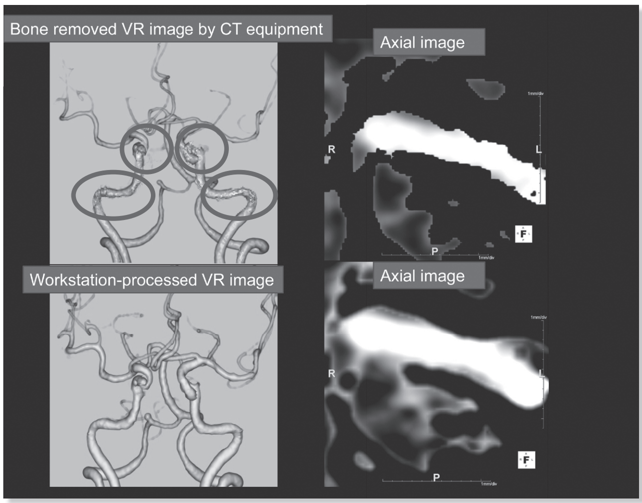


Fig.18

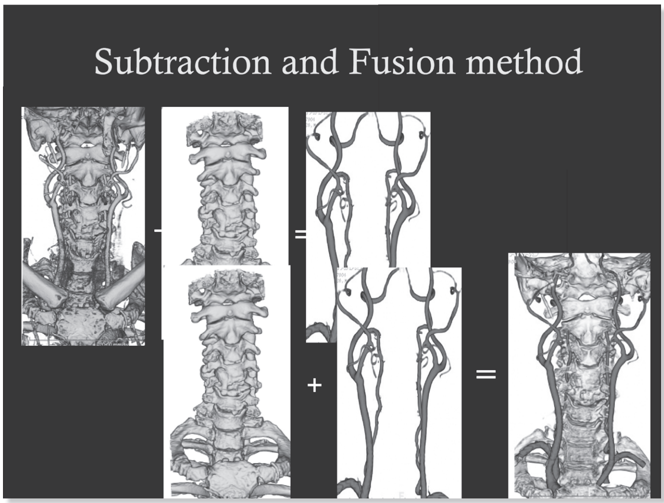
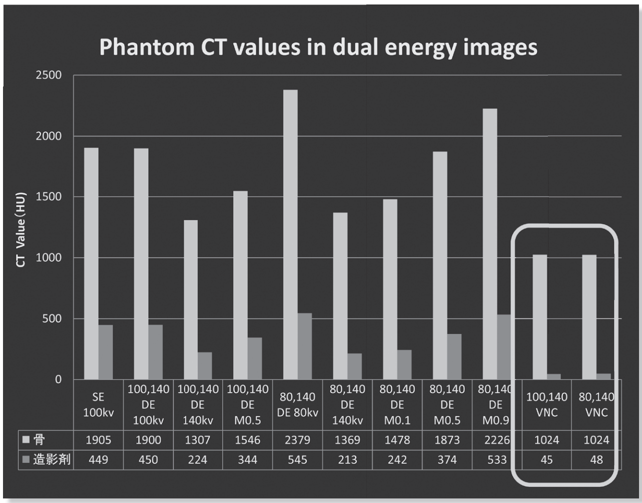


Fig.17



	SE 100kv	100,140 DE 100kv	100,140 DE 140kv	100,140 DE M0.5	80,140 DE 80kv	80,140 DE 140kv	80,140 DE M0.1	80,140 DE M0.5	80,140 DE M0.9	100,140 VNC	80,140 VNC
■ 骨	1905	1900	1307	1546	2379	1369	1478	1873	2226	1024	1024
■ 造影剤	449	450	224	344	545	213	242	374	533	45	48

Fig.19

tured with the dual energy feature, and the red portion denotes the contrast agent. When the energy level increases or decreases, the CT value of the contrast agent is elevated and the portion surrounded with red is the VNC, a CT value for the virtual non-contrast bones. The CT value is the X-ray CT, and therefore, it changes when the energy is changed. The CT value of the bones decreases with the virtual contrast; however, the problem is that the bones remain even when the CT value of the bones is subtracted from the contrast image (Fig.19). Therefore, is this technology useless for our purpose? Well no, as the equipment supplied by TeraRecon that I am currently using allows me to do this. A contrast image series is selected, and a virtual single colour image is selected below. The threshold process is then set, and the threshold in the range is drawn, only for the portion that I have set. The portions where the original CT value was low are irrelevant, and only the bones are extracted so that subtraction can still be performed (Fig.20). Capturing the contrast image CT by using this dual energy feature is considerably useful. Irradiation only needs to be done once, and even when there are a large number of patients, single contrast imaging is sufficient, with the rest all taken care of with subtraction.

Therefore, I would like to do a bit more with

this feature.

This is an image of a patient with an aneurysm on the IC-PC. This is an image from his follow-up session; the right side represents the aneurysm, while the left side represents the image captured by the virtual/virtual subtraction of dual energy feature (Fig.21).

I believe that we can expect progress with the non-rigid process as TeraRecon continues with its considerations for a commercially implemented product. I am expecting some additional functions that will be suitable for the equipment. I also believe that the ideas of clinical technicians regarding the virtual/virtual subtraction method that we have been discussing can be very useful, even if they do not end up changing the world to any substantial de-

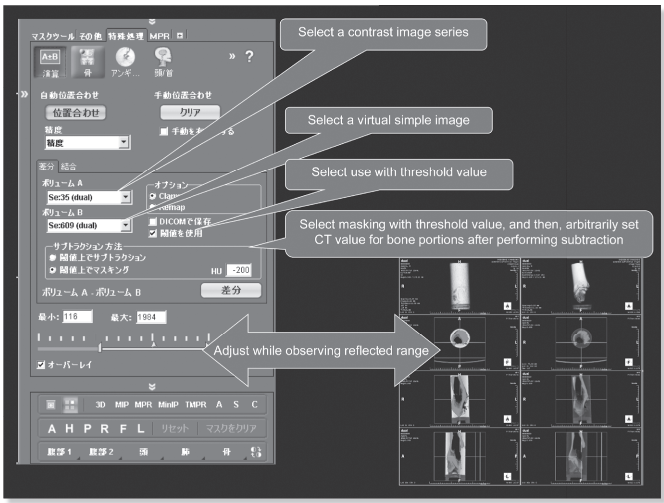


Fig.20

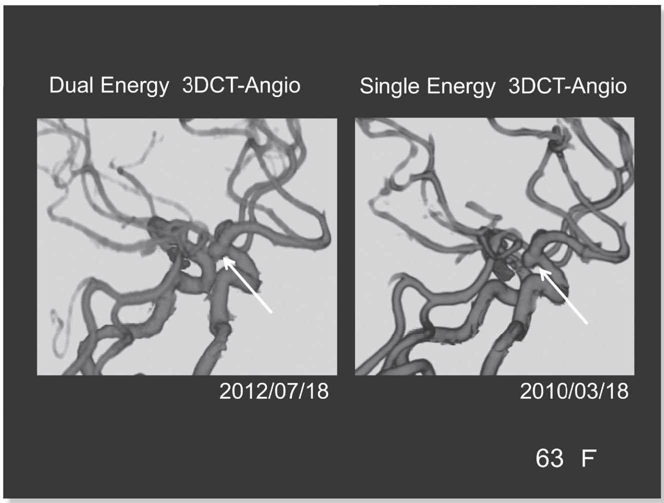


Fig.21

gree. It is important to understand individual characteristics of the equipment well and clarify what we are seeking and then, perform the work properly, starting from the original 3D image. I think the rest depends on the application of sequential approximation, which is ordinarily dealt with by equipment, particularly that which will be introduced in the future as a feature sequential approximation function. Therefore, we at our association believe that there will be a reduction of 20% or 25%, or at least 15% or thereabouts, even though this depends on the targeted part of the body. Such sequential approximation is not featured at all with older equipment, but there is no need to completely give up on the idea, since noise reduction can be performed using a workstation, even after a process has already been completed. Further, there are good that can provide the outcomes of good quality. I am hopeful that such technologies that can be implemented after a process has been completed, when used in combination on a workstation would reduce the number of irradiations.

○**Moderator**: Mr. Tomita, thank you very much. I believe that he explained to us the fundamental details that we have been 'embarrassed to ask about'. Are there any questions anyone would like to ask, now that you have a chance?

○**Auditor**: Thank you very much for the lecture. While we had no discussion on these subjects, I would like to consider the intensity of the light source or its position that may cause variance in the images or turn them into images with an extremely metallic impression or images with a matt texture. I also believe that most of our audience uses systems that are preset and the specifications of such preset values may be poorly defined. If the presetting is quite extensive, extremely dark edging would appear when the blood circulatory system is searched and I find this undesirable. Could you tell us how you ordinarily instruct people to deal with such situations and how your instructions might vary, depending on the symptoms?


Left: Chairperson Ushio;
Right: Chairperson Kobayashi

○**Mr. Tomita**: When we enter specifications for default values at our facility, we reconsider the overall framework, according to how we perceive things, such as changing settings for heads to suit the way we perceive how heads should be imaged. As you mentioned, in the end, what we have is a shadow picture and as such, we obtain dark appearances for the objects in the distance. The nearby objects tend to get brighter, and therefore, we need to make adjustments so that the nearby objects are not whitewashed.

We then repeat this process. We also have a button for improving the quality with all of our workstations. When we use these to improve the image quality, the enhancement of shadows becomes extremely highly defined and shiny objects remain shiny but appear clearly when we use the mode available with this button.

Therefore, we perform our adjustments, which include adjustments using such modes.

Radiation Exposure of Sonographers After Administering Radiopharmaceuticals

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Key words: Ultrasound examination, Radiation exposure, Radiopharmaceutical, Shielding effect

【Abstract】
An effective dose was sometimes detected by the personal dosimeter (glass badge) worn by the radiological technologist in an ultrasound examination. The maximum effective dose detected was 0.2 mSv per month and 1.1 mSv per year. An investigation suggested that the source of the radiation exposure was the administration of radiopharmaceuticals before ultrasound examination. We evaluated 921 cases in which radiopharmaceuticals had been administered before an ultrasound examination between April 2010 and March 2012. The effective dose was higher when more ultrasound examinations were carried out subsequent to the administration of radiopharmaceuticals. The shielding ratio for a 4-mm lead sheet was approximately 95% for Tc-99m and approximately 79% for I-131, suggesting that a lead sheet (masking shield) may be effective.

Introduction

Given the increased interest in radiation exposure in recent years, new issues are arising in the clinical settings in which radiological technologists work[1)]. The glass badges issued as dosimeters to radiological technologists who carry out ultrasound examinations to measure individual exposure to radiation have detected effective doses of 0.2 mSv per month and 1.1 mSv per year. These figures are less than 50 mSv per year and 100 mSv per five years, and within the maximum permitted effective doses[2, 3)], but although the risk of carcinogenesis or genetic effects due to this level of radiation exposure is low, this still represents unnecessary radiation exposure that must be avoided.

An investigation of the cause of radiation exposure during ultrasound examinations found that it lay in the performance of ultrasound examinations subsequent to the administration of radiopharmaceuticals for nuclear medicine tests. We therefore investigated the association between the radiation exposure experienced by radiological technologists during ultrasound examinations and the administration of radiopharmaceuticals to the patients undergoing ultrasound examinations as well as methods of preventing such exposure.

1. Methodss

1-1 Analysis of radiation dose experienced by radiological technologists carrying out ultrasound examinations

The subjects were two radiological technologists (Technologists A and B) engaged in performing ultrasound examinations, whose dosimeters had detected radiation exposure. Both were women who wore their glass badges in the right abdominal region. During ultrasound examinations, the right abdominal region is on the side of the patient undergoing the examination. The survey covered a 2-year period from April 2010 to March 2012.

1-2 Association between ultrasound examinations and nuclear medicine scans

A total of 921 cases in which radiopharmaceuticals were administered before an ultrasound examination between April 2010 and March 2012 were identified by our hospital's Radiology Information System (RIS) and analysed. The parameters investigated comprised the type of radiopharmaceutical, time of administration, dose, time from radiopharmaceutical administration to the start of the ultrasound investigation, and time taken by the ultrasound examination. The radioactivity concentration of the radiopharmaceutical was calculated as the internal radioactivity concentration at the start of the ultrasound examination on the basis of the dose administered and the half-life of the radionuclide[3]. Although excretion from the body should also be taken into consideration, given the impossibility of additional investigation, only the physical half-life was calculated.

1-3 Shielding effect of radiation-protective clothing

The shielding effect of radiation-protective clothing against the γ-rays emitted by radiopharmaceuticals was measured for the radioisotopes Tc-99m and I-131, both of which contribute to radiation exposure. Their respective radioactive concentrations were 297.0 MBq for Tc-99m and 105.8 MBq for I-131. They were chosen on the assumption that Tc-99m reflects the radioactivity concentration inside the body of a patient undergoing bone scintigraphy scanning and I-131 reflects that during an ultrasound examination. A point 30 cm from the radiation source was used as the reference point (0 cm). This distance was chosen on the assumption that it reflects the distance between the technologist and the patient undergoing the ultrasound examination with a radiopharmaceutical having accumulated inside his or her body. A TCS-161 scintillation detector (Hitachi-Aloka Medical Corporation, Tokyo, Japan) was used to take measurements at distances in 10-cm increments from the reference point, both with and without radiation-protective clothing containing 0.25 mm lead equivalent (Fig.1). Measurements were made three times at each location.

1-4 Shielding effect of a lead sheet during ultrasound examination

To reduce the radiation dose during ultrasound examinations, a masking shield consisting of an L-shaped 4-mm-thick lead sheet was produced that could be placed between the patient and the technologist and behind the patient's back. The effective dose transmission factor[4] for γ-rays of a 4-mm-thick lead sheet is 1.23 10^{-4} for Tc-99m and 4.2 10^{-1} for I-131. A PDM-111 pocket dosimeter (Hitachi-Aloka Medical Corporation, Tokyo, Japan) was used to take measurements when this sheet was used. When carrying out an abdominal ultrasound examination, the technologist stands near the patient's pelvis, and the sites of measurement used were therefore the patient's lower abdomen and chest. When carrying out a thyroid ultrasound examination, the technologist stands near the patient's chest, and measurements were therefore carried out at the patient's neck and chest. The pocket dosimeter

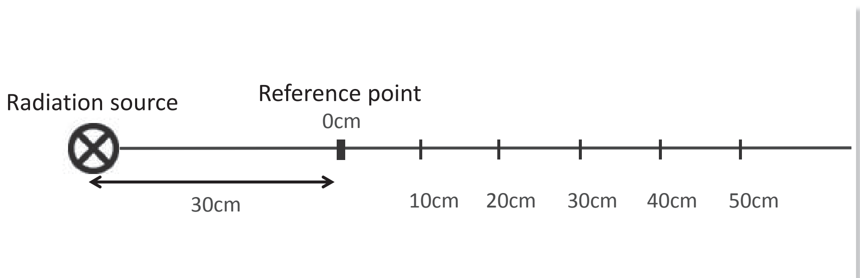

Fig.1 Layout diagram for measuring the shielding effects from the radiation source

was used to take measurements on the surface of the lead sheet on the patient's side and the technologist's side as well as at five different points on the technologist (Fig.2).

2. Results

2-1 Radiation dose experienced by radiological technologists carrying out ultrasound examinations

A high effective dose of 0.2 mSv was detected by Technologist A in August 2010 and by Technologist B in April and June 2011. An effective dose exceeding 0.1 mSv per month was detected during nine and eight different months for Technologist A and Technologist B, respectively, during the 2-year period. The effective dose for Technologist B during the 2011 academic year was 1.1 mSv (Table 1).

2-2 Association between ultrasound examinations and nuclear medicine scans

2-2-1 Association between time of ultrasound examination and effective dose

For both Technologists A and B, a trend was seen in that the longer the examination, the higher the effective dose. The effective dose was over 0.1 mSv per month almost every month in which the time spent carrying out ultrasound examinations exceeded 100 hours for both technologists (Figs.3 and 4).

2-2-2 Association with type of nuclear medicine scan

For both Technologists A and B, the greater the number of examinations carried out after

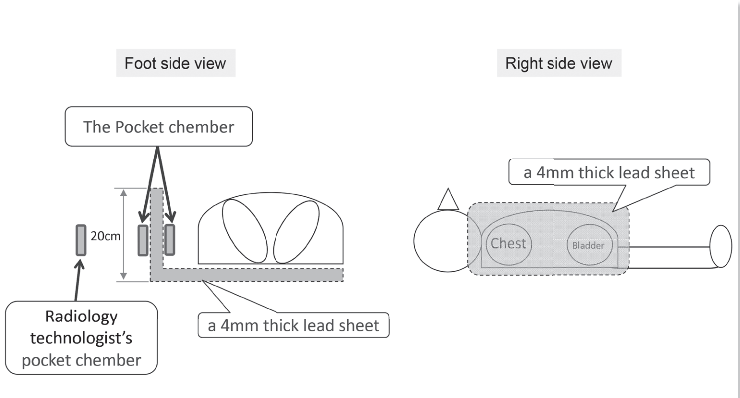

Fig.2 Layout diagram for measuring during clinical practice

Table1 Personal dosimeter (glass badge) results

Radiological Technologist A (Female・Abdominal pocket of Right side) [mSv]

year		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total year
2010	Effective dose	0.1				0.2	0.1							0.4
2011	Effective dose	0.1				0.1		0.1	0.1	0.1	0.1		0.1	0.7

Ragiological Technologist B (Female・Abdominal pocket of Right side) [mSv]

year		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total year
2010	Effective dose												0.1	0.1
2011	Effective dose	0.2	0.1	0.2	0.1				0.1	0.1	0.1	0.1	0.1	1.1

radiopharmaceutical administration, the higher was the effective dose (Figs.5 and 7).

Bone scintigraphy made the greatest contribution, and in months in which five or more patients were administered radioisotopes for bone scintigraphy, the effective dose was 0.1 mSv per month or higher. The effective dose was also 0.1 mSv per month or higher in months in which a patient was examined on the same day as undergoing treatment with radioactive iodine for thyroid cancer (Figs.6 and 8).

2-3 Shielding effect of radiation-protective clothing

Measurements taken at increasing distances from a reference point 30 cm from the radiation source, determined in light of the relative

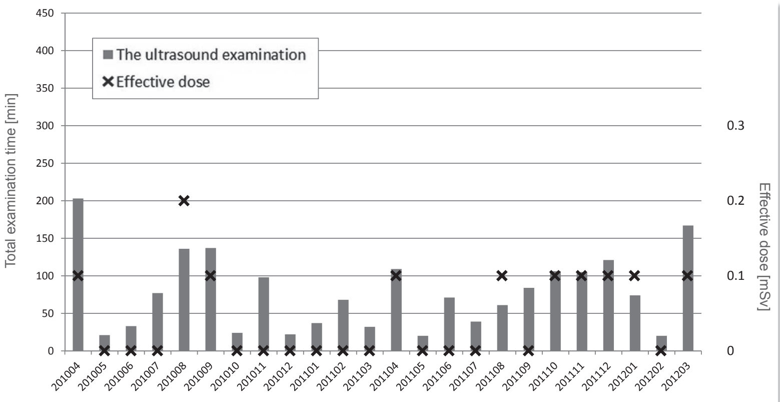

Fig.3 Relationship between the total examination time of the ultrasound examination and the radiation exposure dose (Radiological Technologist A)

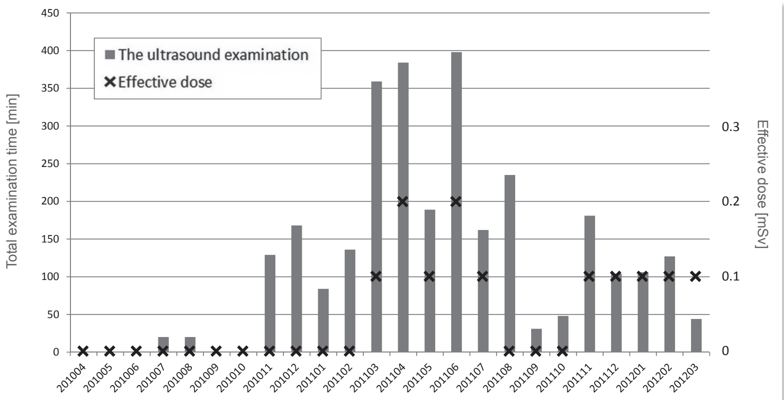

Fig.4 Relationship between the total examination time of the ultrasound examination and the radiation exposure dose (Radiological Technologist B)

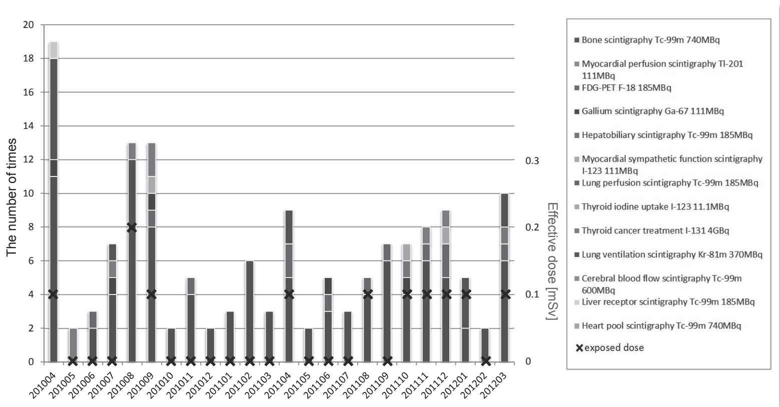

Fig.5 Relationship between the number of times the ultrasound examination is conducted and the radiation exposure dose (Radiological Technologist A)

positions of the patient and technologist during ultrasound examinations, revealed that the further the distance, the lower the radiation dose, whether or not radiation-protective clothing was used for shielding (Fig.9).

The shielding ratio of 0.25-mm lead-equivalent radiation-protective clothing was 47.7% at 0 cm and 43.9% at 50 cm for Tc-99m, with a mean value of 43.9%. For I-131, it was 5.7% at 0 cm and 5.9% at 50 cm, with a mean value of 6.4%. The shielding effect was thus 6.9 times greater for Tc-99m than for I-131 (Fig.10).

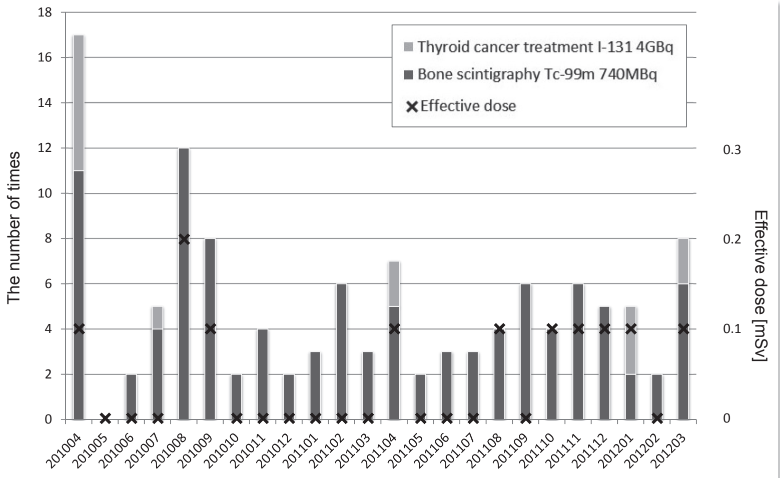

Fig.6 The relationship between the number of times the ultrasound examination is conducted and the radiation exposure dose after bone scintigraphy administration and after the oral administration of radioactive iodine to treat thyroid cancer (Radiological Technologist A)

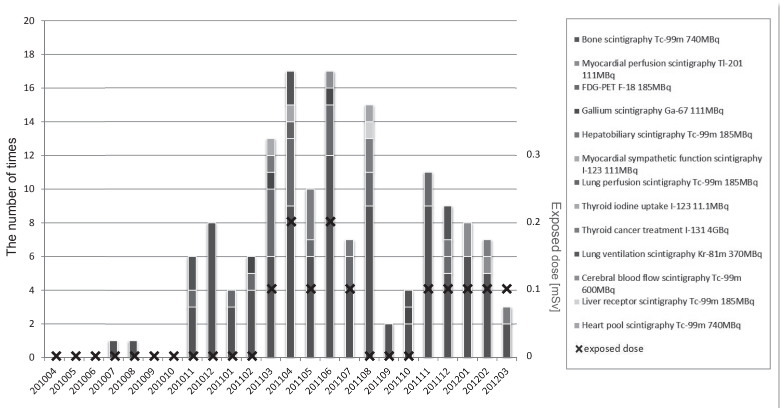

Fig.7 Relationship between the number of times the ultrasound examination is conducted and the radiation exposure dose (Radiological Technologist B)

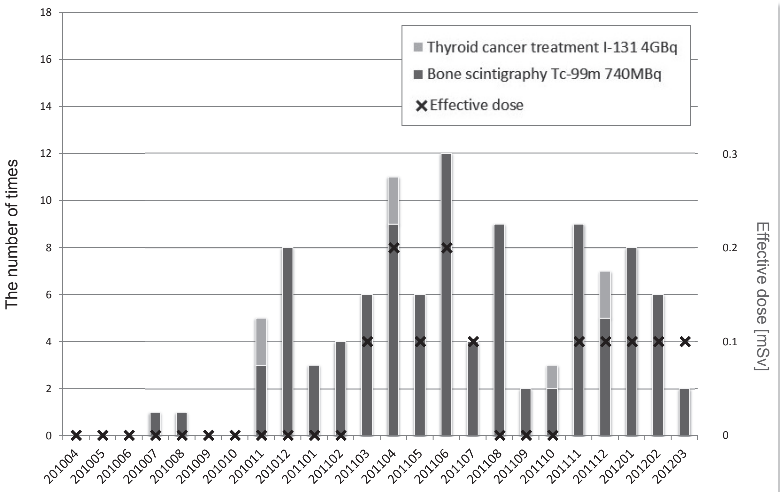

Fig.8 The relationship between the number of times the ultrasound examination is conducted and the radiation exposure dose after bone scintigraphy administration and after the oral administration of radioactive iodine to treat thyroid cancer (Radiological Technologist B)

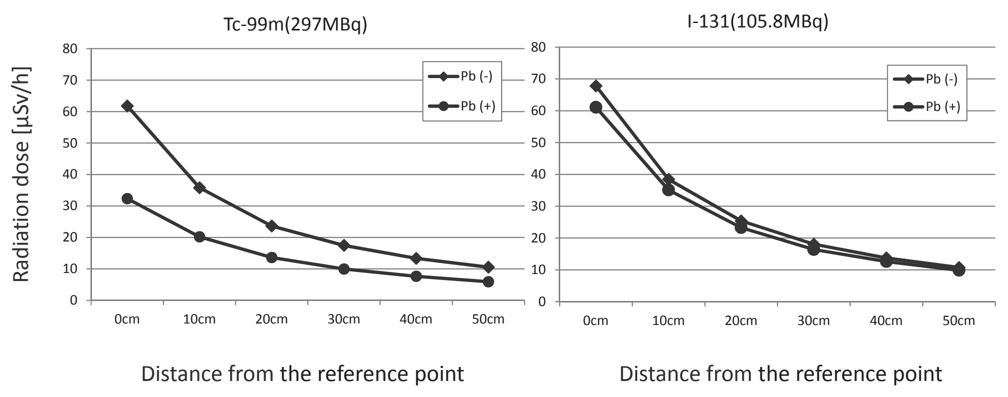

Fig.9 The shielding effects of Tc-99m and I-131 in radioactive protective clothing (the Lead equivalent 0.25mm Aprons)

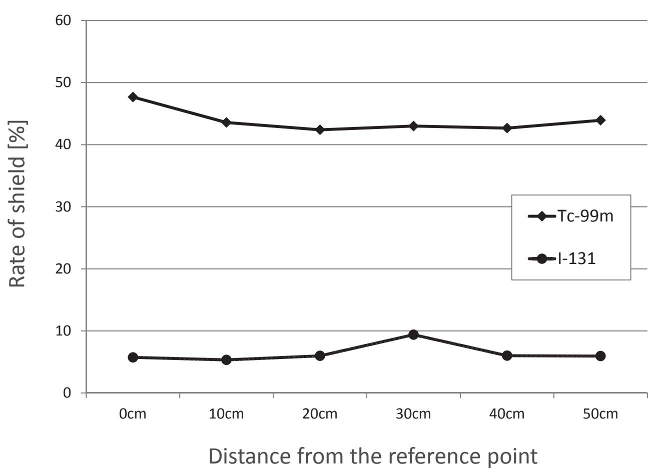

Fig.10 The shielding rate of radioactive protective clothing (the Lead equivalent 0.25mm Aprons)

Table 2 The shielding effect of a 4mm thick lead sheet in clinical practice

	Patient's point	Radiological Technologist's point
Tc-99m（Abdomen）	95.9	93.5
I-131（Abdomen）	78.0	79.6
I-131（Thyroid）	78.0	79.9

[%]

2-4 Shielding effect of a lead sheet during clinical examinations

The radioactivity shielding ratio of a 4-mm-thick lead sheet in clinical practice was 95.9% in the patient's lower abdominal area and 93.5% at the technologist's position for Tc-99m. For I-131, it was 78.0% at the patient's chest and thyroid and an average of 79.7% at the technologist's position (Table 2).

3. Discussion

Radiation exposure of 0.1–0.2 mSv per month was detected in technologists responsible for performing ultrasound examinations, and an investigation of its cause revealed that it was associated with the administration of radiopharmaceuticals. The present study showed that it was associated with the type of radiopharmaceutical, time of administration, dose, time from radiopharmaceutical administration to the start of the ultrasound investigation, and time taken by the ultrasound examination. The months in which radiation exposure was detected were those in which a large number of patients had undergone radiopharmaceutical administration before their ultrasound examination, and among them, a trend was seen in that the greater the number of ultrasound examinations of patients who had undergone bone scintigraphy or treatment with radioactive iodine for thyroid cancer, the higher was the effective dose. For Tc-99m, which is used in bone scintigraphy, the mean time between administration and the start of ultrasound examination was only 64 minutes, and the radioactivity concentration was therefore high. For I-131, which is used in radioactive iodine treatment for thyroid cancer, not only is its radioactivity concentration high but its half-life is also long, which has a major effect on the effective dose even when patients met the conditions for discharge from inpatient wards.

No radiation exposure was detected for Technologist B during the 2010 academic year. This may have been because she had frequently been engaged in x-ray scanning other than ultrasound examinations, and had therefore taken the appropriate measures for protection against x-rays. Radiation-protective clothing was effective for shielding against both Tc-99m and I-131, and the reason for its lower shielding effect against I-131 compared with Tc-99m was considered to be their different nuclide energies[3], with the main radiation energy for Tc-99m being 141 keV and for I-131 being 364 keV. The dose decreased with increasing distance for both Tc-99m and I-131, but as it is difficult for a technologist to maintain a safe distance from the patient during an ultrasound examination, we designed a lead shielding sheet, confirmed its effect, and found the anticipated shielding effect of the 4-mm-thick lead sheet was approximately 95% for Tc-99m and approximately 70% for I-131. The thicker the lead sheet, the greater the shielding effect, but as the increased lead also increases the sheet's weight, any shield must be placed with due regard to ensuring the safety of both patient and technologist in order to reduce radiation exposure.

4. Conclusions

In this study, we identified an association between the administration of radiopharmaceuticals and radiation exposure during ultrasound examinations. Although the effective dose per month and per year was below the radiation exposure limit, it still represents unnecessary exposure, and in future, it will be necessary to consider reviewing examination procedures, changing the date of examinations, and using shielding devices such as lead sheets in an attempt to reduce the amount of exposure. Part of the content of this paper was presented at the Seventh Annual Meeting of the Kyushu Radiological Medical Technology, the Kyushu Radiological Medical Technology Organization.

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Optimal Bladder Volume in IMRT Planning for Prostate Cancer

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Key words: Prostate cancer, IMRT, 3D-CRT, Treatment planning, Bladder volume

【Summary】
Prostate cancer has traditionally been treated with surgery and hormone therapy, but radiotherapy has attracted attention in recent years as an additional treatment option. A number of studies have been conducted on treatment by using external irradiation, and highly precise radiation therapy such as three-dimensional conformal radiotherapy and intensity-modulated radiotherapy has enabled safe and effective treatment. Meanwhile, the reality is that no examination of the bladder volume is conducted during treatment planning. At our institution, 53 prostate cancer patients treated with IMRT were designated as the subjects of a study in which we retrospectively analyzed the results of DVH and urination frequency to determine the optimal bladder volume. The results indicated that the optimal bladder volume was 200 mL or larger.

Introduction

Prostate cancer has seen a rapid increase in its incidence among the male cancers[1-3]. The principal conventional treatment methods for prostate cancer are surgery and hormone therapy, but radiotherapy has recently attracted attention as an additional treatment option. Prostate cancer can be treated with external beam irradiation using a linear accelerator, interstitial brachytherapy or particle radiation therapy.

However, external radiation therapy with high energy X rays is a most common choice of radiation therapy[1-3]. Recent technological innovations have led to the clinical applications of highly precise treatment techniques including 3D conformal radiotherapy and intensity-modulated radiation therapy (IMRT), which concentrate radiation on the prostate gland and minimize radiation exposure to the surrounding normal tissues including the rectum and the bladder, enabling the treatment to be conducted safely and effectively. Compared with surgery, the main superiority of radiotherapy is the high post-treatment quality of life (QOL) in regards to the urinary and sexual functions[1-3]. Meanwhile, the principal disadvantage is development of rectal complications. Therefore, number of institutions which introduce IMRT for minimizing adverse reactions is increasing rapidly[1-3].

In the treatment planning of IMRT for prostate cancer, a dose limitation for each organ at risk (OAR) and a planning method based on an optimization algorithm, known as inverse planning (IP), should be established. An evaluation standard of the treatment plan should be cleared before a start of IMRT. Dose limitations are generally set for the prostate gland, rectum, bladder, and femoral head, and a decrease in position repeatability of OARs does not guarantee the dose volume histogram (DVH) of the treatment plan. Bone structure can keep immobility by using various immobilizing devices and the rectum can preserve repeatability by defecation, suction of gas in the rectum, and/or administration of laxatives.

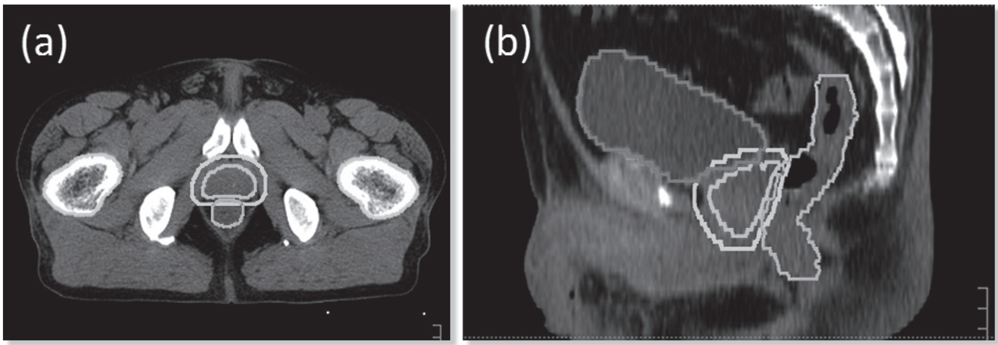

Fig. 1 Definition of a target and organs at risk (a) Axial view (b) Sagittal view.

However, it is not easy to control the urine collection volume in the bladder[4]. To make and maintain a bladder with constant volume, an ultrasound image diagnosis device for the bladder is used during both treatment planning and radiotherapy to ensure that treatment is performed under the same conditions as when formulating the plan. However, there is no current consensus regarding optimal bladder volumes and protocol for preparing optimal bladder volume when planning IMRT and carrying out daily IMRT. Therefore, we conducted a retrospective analysis to determine the optimal bladder volume for prostatic cancer patients treated with IMRT.

Table 1 Dose assessment standard of our facility.

Structure	Constrain
CTV	$D_{99\%} > 74.0$ (100% dose) Gy
	$D_{max} < 79.9$ (108% dose) Gy
PTV	$D_{95\%} > 74.0$ (100% dose) Gy
	$D_{max} < 79.9$ (108% dose) Gy
Rectum wall (RW)	$D_{max} < 74.0$ (108% dose) Gy
	$V_{25.2Gy} < 60\%$ volume
	$V_{42.0Gy} < 40\%$ volume
	$V_{67.1Gy} < 25\%$ volume
Bladder wall (BW)	$D_{max} < 75.5$ (102% dose) Gy
	$V_{13.4Gy} < 80\%$ volume
	$V_{26.9Gy} < 60\%$ volume
	$V_{36.3Gy} < 55\%$ volume
	$V_{45.7Gy} < 40\%$ volume
	$V_{66.6Gy} < 30\%$ volume
Femoral head	$D_{max} < 50.0$ Gy

1. Method

Because a detailed understanding of the anatomy of the prostate gland is necessary for formulating an IMRT treatment plan, both computed tomography (CT) and magnetic resonance (MR) images were acquired for all patients, and these both images were superimposed to conduct the planning process.

During treatment planning, a region of interest (ROI) for the target site (clinical target volume (CTV)/planning target volume:((PTV)) and the OARs (rectum/bladder/femoral head) are delineated (Fig. 1). The CTV of T1c to T3a tumor was contoured as the prostate gland plus the proximal portion of the seminal vesicles, and the CTV of T3b tumor was contoured as the prostate gland plus the entire seminal vesicles. The PTV included the CTV with a margin of 0.8 cm except at the postrectal interface, where a margin of 0.5 cm was used. All patients with localized prostate cancer were treated by IMRT (10 MV photons, VMAT technique) consisting of a total dose of 74 Gy in 37 fractions of 2Gy per fraction administered 5 times a week over 7.5 weeks, taking into consideration the radiobiological characteristics of the prostate gland and the rectum. An IMRT treatment plan is formulated by using IP up to meet the evaluation standards by our institution. Plans that do not meet the standards are rearranged. The assessment standards on the treatment plan that were decided in reference to some reports [5-12] are listed in Table 1.

In this study, bladder volumes were measured by using previously formulated treatment plans and classified into seven groups: 0–49 mL, 50–99 mL, 100–149 mL, 150–199 mL, 200–249 mL, 250–299 mL, and 300 mL or larger. Following this classification, the relationship between the bladder volume and the bladder DVH, the success rates against bladder treatment plan assessment standards, and the urination frequency were examined.

1-1 Subjects

Fifty three consecutive patients with a median age of 69 years (range: 59 to 77 years) who received IMRT radiotherapy for prostate cancer between November 2011 and April 2012 were enrolled to this study. All patients provided written informed consent before study-related procedures.

The number of patients in each bladder volume group; 0–49 mL, 50–99 mL, 100–149 mL, 150–199 mL, 200–249 mL, 250–299 mL, and 300 mL or larger were 5, 7, 9, 9, 8, 8 and 9, respectively.

1-2 Devices

The devices used in the study were a Synergy linear accelerator by Elekta, a Pinnacle^3 (Ver. 9.0) radiation treatment planning system by Philips, a SOMATOM Definition AS+ CT scanner for treatment planning by Siemens, and a MT-VL-B40 immobilizing device by Civco Medical Solutions.

1-3 Bladder volume and bladder DVH

A report by Nishimura et al. was used as a reference for recording the bladder wall ROI (BW) as the area up to 4 mm into the bladder ROI and for assessing the bladder DVH[5-10]. V_{20}, V_{40}, V_{50}, V_{60}, and V_{70} assessments were compared for each bladder volume, and the achievement rate for the bladder treatment plan assessment standards was evaluated.

1-4 Bladder volume and urination frequency

An international prostate system score (IPSS) is recorded prior to treatment, and on the final day of treatment. In addition, urination frequencies in daytime and night-time were recorded by the nursing staff in interviews during treatment. These records were then used for this study to compare the changes in the urination frequency before and after the treatment. 40 patients who were not administered α-blockers such as tamsulosin hydrochloride during their treatment were enrolled to this study. Generally, daytime urination frequency of eight times or more is diagnosed as pollakiuria. The recorded daytime urination frequencies before and after the treatment were used for comparing the ratio of the patients exhibiting pollakiuria.

Comparison of the bladder volumes, DVH Normalized Volume, and urination frequency scores obtained in this study was conducted by using the Mann-Whitney U-test for statistical analysis. P values of less than 0.05 were considered to denote statistically significant difference.

2. Results

2-1 Bladder volume and bladder DVH

Fig. 2 indicates the relationship between the bladder volume and bladder DVH. A summary of V20, V40, V50, V60, and V70 assessments for each bladder volume is shown in Table 2. These data in Fig. 2 and Table 2 demonstrate the average values for the 53 patients.

The larger the bladder volume, the lower the normalized volume value was. A significant difference in the value was observed up to 200 mL but no significant reduction in the values of 200 mL or larger. There was a remarkable improvement of the normalized volume values in the low-dose region. The achievement rates for the treatment plan assessment standards for each bladder volume are shown

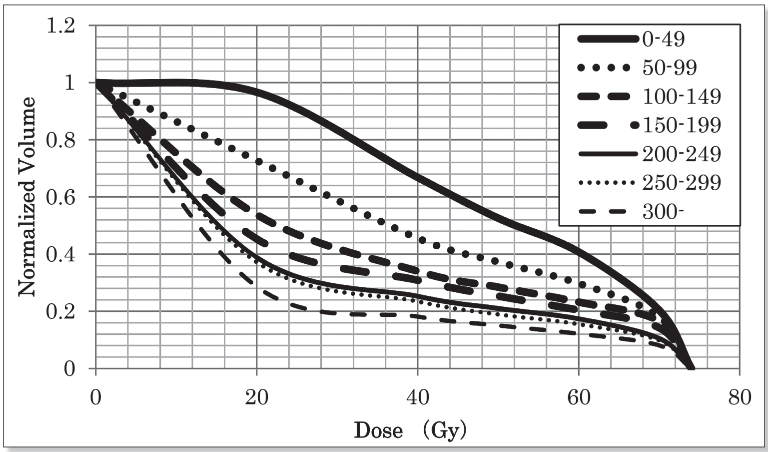

Fig. 2 DVH curves for different bladder volume groups.

Table 2 Average normalized volumes for different bladder volume groups.

Constrain	Bladder volume (ml)						
	0–49	50–99	100–149	150–199	200–249	250–299	300–
V20Gy	0.97±0.02	0.73±0.20	0.54±0.12	0.45±0.15	0.39±0.04	0.37±0.03	0.29±0.04
V40Gy	0.67±0.06	0.46±0.10	0.34±0.07	0.31±0.09	0.25±0.03	0.23±0.03	0.18±0.04
V50Gy	0.53±0.01	0.37±0.09	0.28±0.06	0.25±0.08	0.21±0.03	0.19±0.02	0.15±0.04
V60Gy	0.41±0.04	0.30±0.08	0.23±0.05	0.20±0.07	0.17±0.03	0.15±0.02	0.12±0.03
V70Gy	0.20±0.03	0.18±0.08	0.17±0.05	0.14±0.06	0.11±0.02	0.10±0.02	0.08±0.02

Table 3 Achievement ratios of dose assessment standard for different bladder volume groups.

Constrain	Bladder volume (ml)						
	0–49	50–99	100–149	150–199	200–249	250–299	300–
V13.4 < 80%	0.0	16.7	88.9	100.0	100.0	100.0	100.0
V26.9 < 60%	25.0	33.3	100.0	100.0	100.0	100.0	100.0
V36.3 < 50%	25.0	33.3	100.0	100.0	100.0	100.0	100.0
V45.7 < 40%	25.0	33.3	100.0	100.0	100.0	100.0	100.0
V66.6 < 30%	75.0	83.7	100.0	100.0	100.0	100.0	100.0

in Table 3. Although all patients with bladder volumes of 150 mL or larger achieved the treatment plan assessment standards, the patients with bladder volumes of less than 150 mL decreased in achievement rates as the bladder volume decreased and bladder dose became low.

2-2 Bladder volume and urination frequency

Fig. 3 shows the relationship between the bladder volumes and the daytime and nighttime urination frequencies. A significant difference was observed in the urination frequency for bladder volumes of up to 200 mL. An increase in the urination number of times was

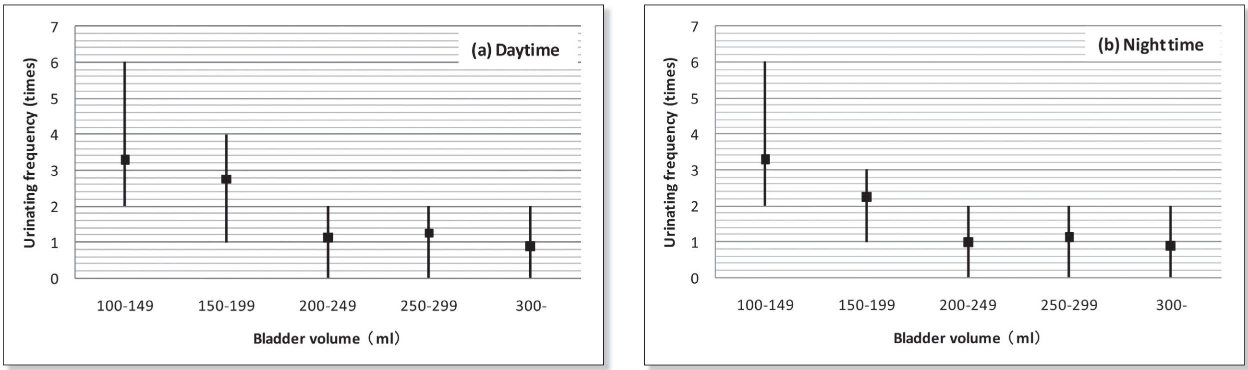

Fig. 3 Daytime (a) and night-time (b) urination frequency as a function of bladder volume.

Table 4 Diagnosis rate of frequent urination for different bladder volume groups.

	Befor radiation	After radiation	Rate of increase
100–149	42.9	85.7	42.9
150–199	22.2	55.6	33.3
200–249	25.0	25.0	0.0
250–299	25.0	37.5	12.5
300–	25.0	25.0	0.0

only up 2 times or less for the patients with a volume of 200 mL or larger. In particular, for the patients with bladder volumes smaller than 200 mL, a significant increase in both daytime and night-time urination frequency was observed with every bladder volumes group. Table 4 demonstrates changes in incidence of the patients who were diagnosed as having pollakiuria as a function of bladder volume. The proportion of pollakiuria decreased as bladder volume became larger.

3. Discussion

Optimal bladder volume for IMRT-based prostate cancer treatment was investigated by a retrospective analysis of 53 patients who had received IMRT. The results confirmed that bladder volumes of at least 200 mL are desirable owing to the bladder DVH and suppression effect of pollakiuria. As the reason, it is considered that a larger region of the bladder is irradiated when the bladder volume is smaller.

Acute adverse events of the urinary system by external radiation therapy for prostate cancer are pollakiuria, decreased urinary flow rate, and painful urination. Pollakiuria is observed in up to 80% of the patients. But most of them are Grade 2 or less and the incidence of Grade 3 or more is extremely rare. Chronic Grade 2 or more urinary adverse events develop up to 10% of the patients, and have been reported to be observed even 5 years after completing the external radiation treatment[3,13,14]. Therefore, it is very important to reduce the incident of chronic urinary adverse events by reducing the normalized volume value for the bladder DVH. As indicated in Fig. 4, bladder volumes with less than 100 mL result in the inclusion of almost the entire bladder in the irradiation field. As a result, it

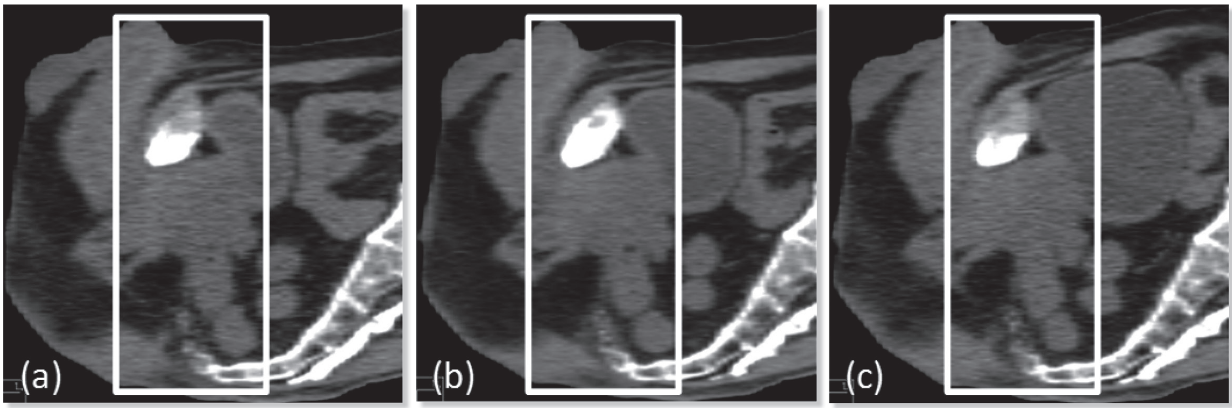

Fig. 4 Irradiation range as a function of bladder volume (a)100mL (b)200mL (c)300mL.

is difficult to restrict the normalized volume for DVH even by IMRT technology, and the incidence of urinary complications increases. Therefore, an increase of the urination number of times can be controlled during IMRT by keeping bladder volume more than 200mL throughout planning and treatment.

However, it is often difficult to accumulate urine more than 200 mL in a bladder as the prostate cancer is common in the elderly, and there are many patients complicated with benign prostatic hypertrophy. In such patients, an attempt should be kept bladder volume 150–199 mL, which can clear the treatment planning assessment standards in 100% of patients. If problems are still remained, the bladder volume and/or the prescribed dose should be re-evaluated for making a treatment plan.

Many efforts have been paid to improve a reproducibility of bladder during radiation therapy. However, there is no guideline regarding optimal bladder volumes and protocol for preparing optimal bladder volume during IMRT. In many institutes, IMRT is performed at 30 or 60 minutes after drinking 500 mL of water[4)]. But these methods do not make the stable bladder volume reproducibly [13-15)].

Recently, bladder ultrasound image diagnosis devices are introduced to confirm the appropriate bladder volume in some institutes[13-15)].

Facilities using simplified ultrasound image diagnosis devices may increase in the future. At the same time, it is hoped that a protocol for obtaining appropriate bladder volume is made and the efficient work processes flow is established.

4. Conclusion

This study revealed that the optimal bladder volume for IMRT-based prostate cancer treatment is 200 mL or larger by the DVH analysis.

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Optimization for Q-Space Imaging in a Clinical Setting: Setting of MPG Direction Number

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Key words: QSI, Clinical Setting of MPG, Scan time, MPG direction number

【Abstract】
Q-Space Imaging (QSI) is widely used to evaluate non-Gaussian, restricted diffusional changes of water molecules. We scanned the brains of volunteers to evaluate the optimal settings of Motion Probing Gradient (MPG) settings in clinical use. The settings of MPG direction were MPG1, MPG2, MPG3, MPG6, and MPG15. We evaluated analysis values of the Probability Density Function (PDF) of the cerebrospinal fluid (CSF), corpus callosum ampulla (white matter), posterior limb of internal capsule (white matter), and thalamus (gray matter). In the MPG3 or more axes, the comparable results were obtained at all measurement points. In addition, in the MPG2, it was equal to results of MPG15 by a setting direction. In conclusion, in the clinical use of QSI, the MPG3 or more settings are appropriate.

Introduction

Q-Space Imaging (QSI) was described in a 1991 report by Callaghan on the analysis of the structural mechanics of porous materials and has since been described in research on biological applications[1) 2) 3)]. QSI is a method to visualise, analyse, and evaluate the motion of water molecules in restricted diffusions of non-Gaussian distribution using diffusion-weighted imaging with multi-directional Motion Probing Gradient (MPG), multiple prepared q-values, Δ {Δ: Motion Probing Gradient interval (MPG)}, and δ {δ: the superimposition of MPG}.

MPG is important for diffusion measurements in Magnetic Resonance Imaging as well as QSI. The Stejskal-Tanner method, commonly used in diffusion-weighted imaging diffusion measurements, is also employed in this study[4)]. In the Stejskal-Tanner method, before and after a spin echo method 180° pulse, an MPG of the same size is applied for the same amount of time. Using the strength of the MPG and the changes in the signal strength produced according to its directionality, this method makes possible the analysis of anisotropy, the measurement of the size of the diffusion in the brain, and QSI analysis.

The q-space of QSI is expressed as a wavenumber space that requires as its object the displacement of the diffusion; the q-values express the size of the wavenumber vectors within the q-space. The q-value is defined as $q\ (cm^{-1}) = \gamma G \delta / 2\pi$ (γ: gyromagnetic ratio; G: MPG magnetic-field gradient; δ: MPG application time) and can be calculated from the parameters related to the b-values used in diffusion-weighted imaging, $b\ (s/mm^2) = \gamma^2 G^2 \delta^2 (\Delta - \delta/3)$ (γ: gyromagnetic ratio; G: MPG magnetic-field gradient; Δ: MPG interval; δ: MPG application time). Moreover, the inverse q-values indicate the displacement of water molecules in the diffusion. In clinical equipment, γ is constant and the q-values depend upon G and δ. QSI analysis first seeks a Probability Density Function (PDF) by applying a Fourier transform to the measurement signals from multiple q-values and then evaluates using the Mean Displacement as calculated from the

PDF half-width and Max Probability or the peak value. Of the many challenges in clinical QSI installations, one is the long imaging time[5]. QSI imaging time is proportional to the number of MPG application axes and the area of the configured q-values multiplied by Repetition Time (TR), as indicated in the following equation:

QSI imaging time ∝ No. of MPG application axes × No. of q-values × TR

Although it is possible to decrease the imaging time by reducing the number of MPG application axes, there are no reports on the recommended number of MPG application axes for QSI. Therefore, in this study we investigate how modifying the number of MPG application axes affects the analysis values and report on the configuration of MPG application axes appropriate for clinical QSI installations.

Subjects and Method

[Equipment used and Subjects] We employed a 3T MRI (Achieva, Philips Healthcare, Best, The Netherlands) with a 32ch head coil. Three male volunteers (average age 39.5 ± 0.5 years) agreed to participate in the study. After receiving approval from the Ethics Committee, the aim and contents of this study were carefully explained to the volunteers and their written consent was obtained.

[Imaging Conditions] With the condition that δ be at the lowest on the above equipment, we used an Spin Echo-type Echo Planar Imaging and the following imaging conditions: TR (repetation time)/TE (echo time) (ms): 4000/98, Field of view (mm): 256 × 256, Matrix: 64 × 64, Thickness (mm): 4, gap (mm): 0, slice: 10, voxel size (mm): 4 × 4 × 4, Δ/δ (ms): 47.3/37.8, and b-value (s/mm^2): 0, 150, 600, 1,350, 2,400, 3,750, 5,400, 7,350, 9,600, 11,250, and 15,000. Further, the imaging b-values were converted into q-values and the following q-values were set at equal intervals: 0 (cm^{-1}), 10.46, 20.93, 31.39, 41.86, 52.32, 62.78, 73.25, 83.71, 90.62, and 104.64. Single-axis MPG applications include the following three directions: vertical encoding on the slice in the SI direction (Slice: S), phase encoding on the AP direction (Phase: P), and frequency encoding on the RL direction (Frequency: F). Two-axis MPG applications consist of the following three directions: SP direction formed by the superimposition of the SI direction (Slice: S) and AP direction (Phase: P), SF direction from the SI direction (Slice: S) and RL direction (Frequency: F), and PF direction formed of the AP direction (Phase: P) and RL direction (Frequency: F). This study focused primarily on imaging the basal ganglia.

[Method 1] We conducted imaging with MPG application configurations of 1, 2, 3, 6, and 15 axes. Although settings of more than 15 axes are possible, they increase the imaging times to more than 15 minutes. Thus, in this study we considered a maximum of 15 axes. With 15 axes, the imaging time for one supplemental run was 10 min 12 s; considering changes in the SNR (signal to noise ratio) on other configuration axes, we attempted to use settings that would ensure that supplements would require the same amount of time. On a single axis, the imaging time for 12 supplements was 8 min 28 s; for two axes, the imaging time for six supplements was 8 min 28 s; for three axes, five supplements required 10 min 28 s; and for six axes, two supplements required 8 min 12 s.

[Method 2] Building on the results of Method 1, in this investigation, we used the configuration with the least axes that was not significantly different from the analysis values yielded by the maximum configuration of 15 axes. We modified the average number during imaging to determine if the average number had any influence on the imaging.

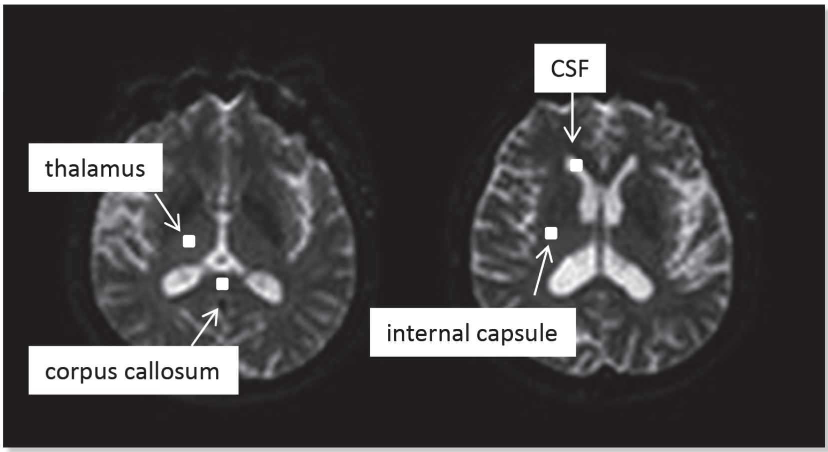

Fig. 1 Position of ROI

[Analysis and Testing] We used the free Diffusion Tensor Imaging analysis software dTV II FZR (University of Tokyo Department of Radiology Imaging Information Processing & Analysis Laboratory) to analyse the QSI data; this is an improvement upon the original dTV that incorporates the QSI analytics. The Region of Interest (ROI) was set to Image J using the Max Probability Image and Mean Displacement Image as calculated by dTV II FZR. As depicted in Fig. 1, an image with b-values at 0 s/mm^2, the ROI was set to the cerebrospinal fluid: CSF (right cerebral ventricle anterior horn), splenium of the corpus callosum, posterior limb of internal capsule, and thalamus. While the ROI was set on the splenium and posterior limb of the internal capsule, an MPG15 Fractional Anisotropy Image was consulted. The size of each section was identical, an 8 × 8 mm square. To ensure that each section was measureable even when the number of MPG axes changed, the ROI position was recorded in the software and the analysis was conducted on identical ROIs for all subjects.

To confirm the statistical significance, a Mann-Whitney U test was conducted on the analytic values of the Mean Displacement and Max Probability from the MPG15 application, which had the greatest amount of data, and on the values from MPG1, MPG2, MPG 3, and MPG6.

Results of Method 1

The average PDF of the three volunteers is illustrated in Fig. 2 and the analytic values are provided in Table 1. Because the PDF is a bell-shaped curve with bilateral symmetry, to best display the breadth of the curve, we display the right side instead of the centre.

The QSI analysis values under MPG applications of 1, 2, 3, 6, and 15 axes revealed no significant differences ($P > 0.05$) in the Max Probability and Mean Displacement under application configurations of 3, 6, and 15 axes; when the number of axes was increased, the standard deviation decreased.

The analysis results of the MPG2 application when two application directions included an axis equivalent to the direction of the white matter fibres (RL on the splenium, SI direction on the posterior limb of the inner capsule) and the analysis values from the MPG15 application were not significantly different ($P > 0.05$). However, when configured to two directions that did not include an axis aligned with the direction of the white matter fibres, the Max Probability increased and statistical significance was observed ($P < 0.05$).

In the cerebrospinal fluid and thalamus, de-

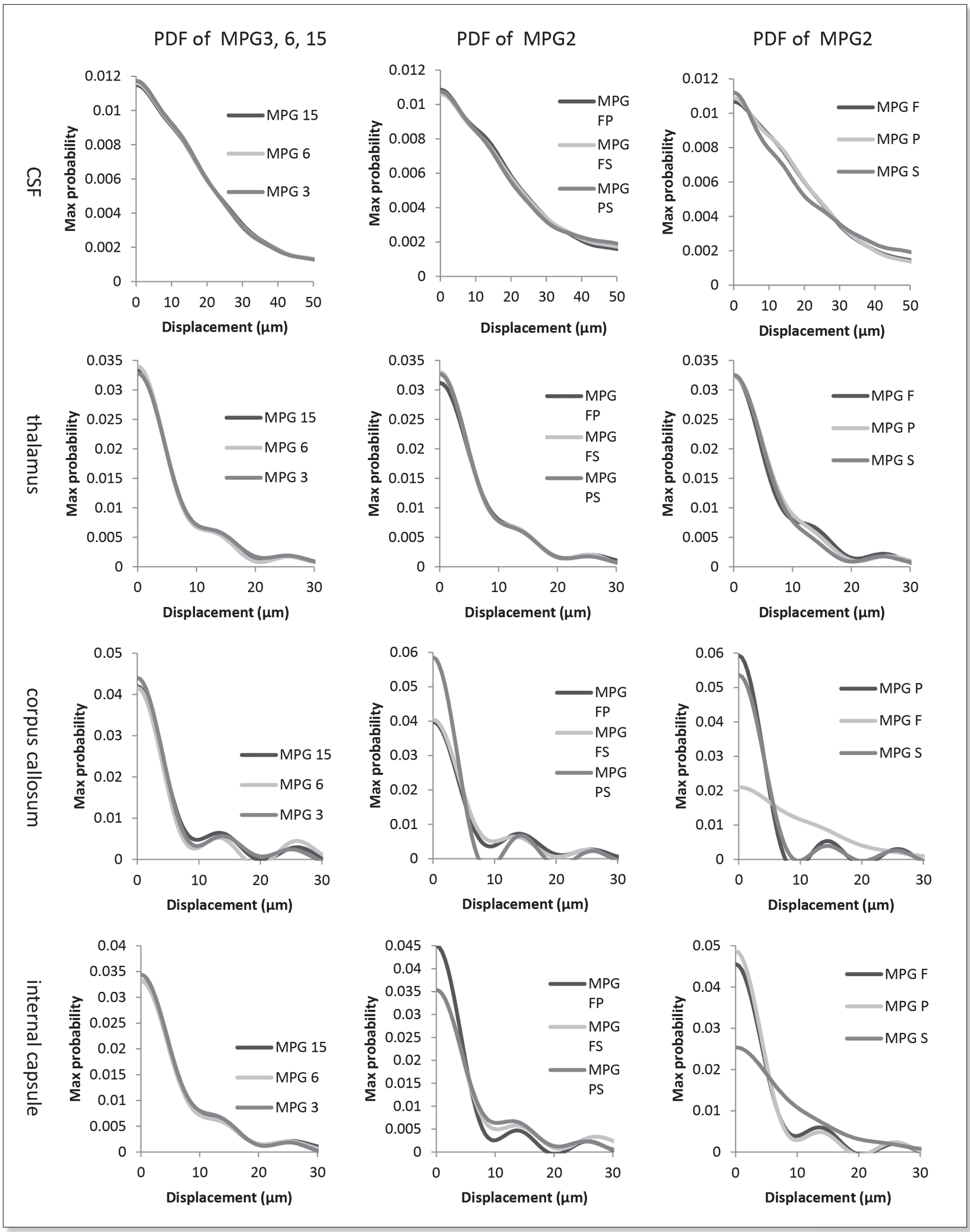

Fig. 2 PDF of MPG-directions

creasing the number of MPG application axes increased the standard deviation in comparison with the analytic values obtained with MPG15. However, configurations of more than two axes were not significantly different ($P > 0.05$).

The analytic results of MPG application on a single axis were statistically significant ($P < 0.05$), as in the splenium and posterior limb of the interior capsule areas, when the direction of the application axis aligned with the direction of the white matter fibres (RL direction in the cerebrospinal fluid area, SI direction in posterior limb of the interior capsule area), resulting in increased Mean Displacement and minimal Max Probability.

Table 1　QSI analysis value

MPG direction	Max Probability (%)				Mean Displacement (μm)			
	CSF	corpus callosum	internal capsule	thalamus	CSF	corpus callosum	internal capsule	thalamus
15	1.17±0.40	3.53±0.41	3.58±0.39	3.11±0.19	34.08±0.20	9.46±0.22	9.86±0.34	12.84±0.53
6	1.17±0.44	3.55±0.39	3.57±0.20	3.24±0.23	34.10±0.14	9.94±0.23	10.67±0.43	12.12±0.85
3	1.18±0.61	3.92±0.47	3.71±0.15	3.21±0.25	34.45±0.18	9.40±0.33	10.39±0.47	12.83±0.92
FP	1.14±0.84	4.01±0.32	4.50±0.62	3.09±0.32	36.45±0.28	9.36±0.33	10.85±0.69	13.42±0.82
FS	1.13±1.03	4.10±0.46	3.54±0.47	3.17±0.29	38.03±0.92	9.32±0.41	8.99±0.79	12.55±0.67
PS	1.14±0.66	5.87±0.52	3.55±0.63	2.97±0.63	36.52±0.31	7.85±0.38	9.80±0.71	13.60±0.53
F	1.14±0.98	2.07±0.12	4.52±0.85	3.22±0.81	36.66±0.42	22.23±1.44	9.27±0.80	12.67±1.06
P	1.15±1.44	5.96±0.74	4.87±0.45	2.83±0.99	36.09±0.52	8.52±0.53	8.60±0.72	14.25±1.76
S	1.16±1.21	5.45±0.49	2.53±0.36	3.17±0.56	35.92±0.69	8.64±0.65	17.9±1.90	12.36±0.84

Table 2　MPG3 fixed, average number 1, 3, and 5 of QSI analysis value

Average	Max Probability (%)				Mean Displacement (μm)			
	CSF	corpus callosum	internal capsule	thalamus	CSF	corpus callosum	internal capsule	thalamus
5	1.15±0.71	3.91±0.55	3.75±0.42	3.26±0.22	35.39±1.04	8.94±0.79	9.50±0.69	10.99±0.65
3	1.17±0.56	3.99±0.67	3.66±0.61	3.29±0.20	34.74±1.42	9.09±0.70	9.53±0.77	11.09±0.61
1	1.19±0.60	4.01±0.69	3.70±0.71	3.28±0.24	34.91±1.39	9.11±0.84	9.49±0.86	11.24±0.78

For all ROIs, the setting with the minimum number of application axes that did not differ significantly from the 15-axis setting was the 3-axis setting.

Results of Method 2

Method 2 employed a 3-axis setting drawn from the results of Method 1 and the results of setting the average number of QSI analysis values to one (imaging time: 2 min 12 s), three (imaging time: 6 min 20 s), and five (imaging time: 10 min 28 s) are presented in Table 2. Reducing the average number yielded no significant difference in analysis values (P > 0.05).

Discussion

For all ROIs, there was no significant difference in analysis values for uniform arrangements of 3, 6, and 15-axis MPG application configurations. The Max Probability and Mean Displacement values are displayed as average values because MPG configurations of uniform arrangements of greater than three axes yielded identical results. Moreover, increases in the number of axes tended to reduce fluctuations away from the standard deviation of the analysis values.

It can be assumed that the white matter fibres of the splenium run along the one frequency direction (RL); however, in the MPG2 configuration that includes the direction of the white matter fibres, we obtained the same values as when we applied MPG15. Furthermore, because Max Probability was assessed higher in configurations that did not include axes aligned with the direction of the white matter fibres than in 15-axis configurations, when evaluating white matter it seems that setting an axis to align with the direction of the white matter fibres is a necessity. Similarly, in the posterior limb of the interior capsule, the white matter fibres were extended along a direction close to the direction (SI) perpendicular to the slice plane and a 2-axis MPG setting that included the white matter fibre direction obtained values identical to MPG15. In cases where the target tissue is limited and the direction of the white matter fibres can be assumed, we believe the 2-axis setting to be effective.

For the non-restricted diffusion expected in the thalamus and cerebrospinal fluid, application configurations of greater than two axes yielded PDF, Mean Displacement, and Max Probability values identical to those obtained with MPG15. Imaging only non-restricted diffusion organisation configurations with more than two axes is possible, minimising imaging time and facilitating clinical introduction. However, because reducing the number of application axes produces variations in the standard deviation of the analysis values and even minimal changes in the ROI position causes significant changes in the analysis values, sufficient caution is warranted in cases where the ROI and imaging target tissue are small.

Lacking information from other axes, the arithmetic mean of the average number can be considered a statistically significant factor on a 1-axis configuration. Because multiple-axis MPG application synthesis is performed on the geometric mean, signal averaging has not confirmed the statistical significance of the analysis values. Further, the lack of image distortion correction was also a factor. Because the signal value of the images with b-values of 10,000 s/mm^2 or greater was weak, alignment with images of a b-value of 0 s/mm^2 was difficult. Moreover, because the corrective processing of the distorted images produced tiny blemishes, all of the images in this study were analysed without the use of corrective techniques. Correcting damaged images with high b-values is a challenge for the future.

In clinical settings where the target tissue cannot be determined, an MPG setting of greater than three axes is advisable.

On identical axis configurations, even if the average number changes, imaging is possible with an average number of one because the analysis values are not statistically significant. It is possible to achieve imaging times of approximately five minutes in clinical installations by setting the MPG application to three axes and the average number to one, even in QSIs using b-values on multiple images.

One of the problems facing the clinical introduction of QSI is the report that it only approaches true values as $\Delta \gg \delta$. However, δ cannot be extended beyond the biological safety restrictions in even the maximum gradient of the magnetic field strength of clinical equipment. In this study, we set δ to be as short as possible, however, with Δ : 47.3 ms and δ : 37.8 ms, we must admit that we have not satisfied the condition wherein $\Delta \gg \delta$.

Conclusion

It is possible to reduce imaging time in each of the tissue structures targeted for imaging by modifying the number and direction of the MPG application axes. Further, increasing the number of MPG application axes results in averaging of the QSI analysis values within the ROI. Clinical installations of cranial QSI require stable analysis values by increasing the number of MPG application axes; however, considerations of imaging time suggest that MPG application configurations of three axes will prove useful.

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A Survey Regarding Acceptance and Awareness of Autopsy imaging (Ai) among Radiological Technologists in Our Institution: Comparison with Those of Two Other Institutions

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Key words: Autopsy imaging (Ai), radiological-technologist, questionnaire survey, postmortem CT, postmortem MRI

【Abstract】
An anonymous questionnaire survey consisting of 8 questions was conducted to 35 radiological technologists in our institution regarding their feelings and awareness about autopsy imaging (Ai). Among them, 30 subjects (85%) responded, with approximately 60% of them indicating an interest in Ai, mainly for its potential contribution to society. And 90% of the respondents answered an absence of negative feelings associated with the imaging of unnaturally deceased bodies, as a matter of their routine work. However, only 30% of the respondents were aware of two recent Japanese laws regarding death-cause detection, while 70% of the respondents had awareness of a model project for pediatric Ai, suggesting insufficient knowledge of the background and reasoning behind the needs of Ai. Our survey results were compared with two other previously-published surveys. Our comparative investigation suggests necessity of more Ai-related education in training institutes, greater distribution of relevant information by the Japan Association of Radiological Technologists, and the sharing of experiences among hospital staffs, all of which will help meet the needs and social demands of Ai.

1. Introduction

Since the introduction of post-mortem examination scans (Autopsy imaging, hereafter referred to as "Ai") in 2000[1) 2)], Ai has come into widespread regular practice[10)] throughout the early adoption phase of the past 10 years[3)–9)]. In July 2012, two Japanese laws were introduced regarding the investigation of the cause of death: "Act on the Investigation into the Cause of Death or the Identity of Corpse by Police or Security Forces" (Act of Death Investigation and Identification)[11)] and "Policy on the Promotion of Corpse Examination" (Policy on Corpse Examination)[12)]. With the start of enforcement in April 2013, the Act Of Death Investigation And Identification establishes the "implementation of procedures when the police chief recognizes the need to perform internal bodily exams to determine the cause of death when handling corpses, to the extent required, in order to verify the state of bleeding via body fluid collection, exams to check for drugs and/or poisoning via the collection of body fluid or urine, autopsy imaging, and other examinations prescribed by law"[13)]. The Council for the Promotion of Policy on Corpse Examination, responsible for the implementation of the Policy on Corpse Examination, released its final report[14)] in April 2014, and made a cabinet decision, "Plan for Promotion of Corpse Examination" in June 2014. Ai is listed as one of those specific measures[15)]. The "Model Project of Post-Mortem Imaging for Pediatric Deaths" run by the Ministry of Health, Labor and Welfare began in September, 2014[16)].

Since our hospital first opened in February 1985, post-mortem computed tomography (CT) has been performed[17)–20)] to estimate and identify the cause of death in patients who died after being transported to our facility's emergency department for cardiopulmonary arrest. Among our radiological technologists, the daytime CT lead operator (8:30-17:30) and evening (17:30-22:00) and overnight (22:00-8:30am) on-duty operators perform these post-mortem CT scans. Our hospital is designated as an autopsy center (a facility commissioned by the prefecture to implement dissection with consent according to the administrative autopsy procedures) to perform post-mortem CT scans to guide and supplement dissection, and perform magnetic resonance imaging (MRI) when possible, for abnormal corpses sent by the police for autopsy[21)–23)]. These pre-dissection post-mortem CT and MRI scans are performed the evening before dissection by a rotation of 5 radiological technologists that have been doing Ai for over 10 years, and/or have received official certification from an Ai certification workshop. Our hospital radiology department is responsible for a wide variety of procedures like common x-rays, ultrasound scans, CT, MRI, nuclear medicine, radiation therapy, and other medical exams[24)], but the main responsibilities of each individual radiologist are fixed to an extent. That is to say, that we can expect differences between technicians regarding their degree of involvement with Ai, and their levels of interest and knowledge about Ai. Up until now, there have been a few investigations conducted concerning the realities of Ai[25)–28)], and the The Japan Association of Radiological Technologists (hereafter referred to as "JART") recently conducted a fact-finding survey about Ai[29)] that is still being analyzed (personal communication). However, although this Ai awareness survey of radiologists has been mentioned in a few conference presentation abstracts[30)–32)], very few reports have been published[33) 34)]. We conducted an Ai awareness survey among the radiological technologists at our hospital and are sharing the results here.

Table 1 Questionnaire sheet including 8 questions regarding Ai

Question 1	"Do you have an interest in Ai?" (Yes, I'm interested. / No, I'm not interested. / I don't know.)
Question 2	"What is the reason for your interest in Ai?" (select all that apply) (I want to assist in cause of death investigations. / It's relevant to recent events. / It's an unknown field for me. / Other (free response))
Question 3	"What is the reason for your disinterest in Ai?" (select all that apply) (It makes me uncomfortable. / I just can't handle it. / Other (free response.))
Question 4	"How do you feel about Ai as a routine part of work?" (I don't mind it as a routine part of work. / I don't want to do it as a routine part of work. / Other (free response.))
Question 5	"Are you willing to conduct Ai following a request from the police?" (I want to do it. / I don't mind doing it. / I don't want to do it.)
Question 6	"Do you know the two laws regarding death cause detection?" (I know them. / I've heard of them. / I don't know.)
Question 7	"Are you aware of the model project of pediatric Ai?" (I know it. / I've heard of it. / I don't know.)
Question 8	"Please write your thoughts about Ai."

2. Materials and Methods

The full staff of 35 radiological technologists (male-to-female ratio 24:11, ages 23-47, average age 34) were surveyed anonymously concerning their awareness and knowledge of Ai (survey period April 22-30, 2014). The 8 survey questions are listed in Table 1.

Questions 1 through 7 were multiple-choice. Radiological technologists who answered "I'm interested" to Question 1 also answered Question 2, and Questions 4-8. Radiological technologists who answered "I'm not interested" to Question 1 also answered Question 3, and Questions 4-8. Radiological technologists who answered "I don't know if I'm interested" to Question 1 also answered Questions 4-8. A blank writing space was provided for elaboration on answers of "Other" for Questions 2-4. For Question 4 "How do you feel about Ai as a routine part of work?" Ai was defined as post-mortem CT scans performed on patients whose deaths were confirmed at our hospital, either by the emergency department or an in-patient wing. For Question 5 "Are you willing to conduct Ai following a request from the police?" Ai was defined as post-mortem CT scans (or MRI, depending on the case) of abnormal corpses sent to the autopsy center by the police for autopsy and/or post-mortem exam.

The survey results were compared to the results of an Ai survey conducted in 2009 among 43 radiological technologists (citation #33 says 45 people, but it was actually 43) at the Department of Radiology at Gunma University Hospital (hereafter referred to as "Gunma University Survey")[33] which officially began doing Ai in 2008, and an Ai survey conducted in 2014 among 17 radiology staff members (16 radiological technologists and 1 radiologist) at the medical technology division of Koyama Memorial Hospital (hereafter referred to as "Koyama Memorial Hospital Survey")[34] which has been doing Ai since 2004 or earlier. The Gunma University Survey included questions that correspond to Question 1 and 4 of this survey. The Koyama Memorial Hospital Survey included questions that correspond to Question 1 and 4-7 of this survey. In Question 4 "How do you feel about Ai as a routine part of work?" the answer choices of "I don't mind it as a routine part of work" "I don't want to do it as a routine part of work" and "Other" were phrased as "I want to do it" "I don't mind doing it" and "I don't want to do it" in the Koyama Memorial Hospital Survey. In order to compare the results more easily, the "I want to do it" and "I don't mind doing it" responses were classified together as "I don't mind it as a routine part of work" for convenience in this survey.

3. Results

The survey was completed by 30 out of 35 people (86% completion rate).

Question 1 "Do you have an interest in Ai?"

Among the 30 survey responses, 18 people (60%) selected "Yes, I'm interested," 8 people (27%) selected "No, I'm not interested," and 4 people (13%) selected "I don't know" (Fig.1).

Question 2 "What is the reason for your interest in Ai?" (select all that apply)

Among the 18 people who responded "Yes, I'm interested" to Question 1, 14 people (78%) selected "I want to assist in cause of death investigations," 6 people (33%) selected "It's relevant to recent events," 5 people (28%) selected "It's an unknown field for me" and 1 person (6%) selected "Other." The person who selected "Other" wrote "I feel a societal obligation."

Question 3 "What is the reason for your disinterest in Ai?" (select all that apply)

Among the 8 people who responded "No, I'm not interested" to Question 1, nobody selected "It makes me uncomfortable" or "I just can't handle it." All 8 people selected "Other," and 7 of those people wrote a freestyle response. Among the "Other" written responses, 4 people (50%) wrote "No particular reason." 1 person (13%) wrote "It has nothing to do with my job," 1 person (13%) wrote "I don't feel familiar with Ai" and 1 person (13%) wrote "Unlike living bodies, I don't think it will provide any useful knowledge that can be used in future examinations."

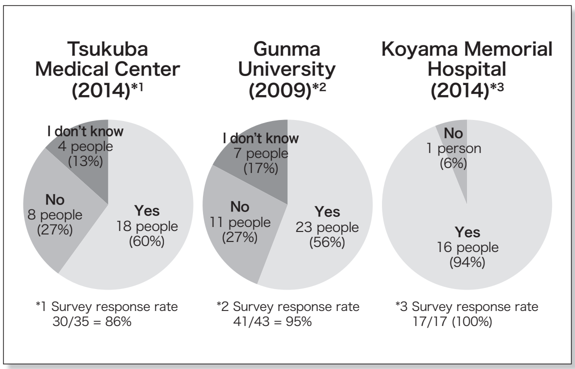

Fig.1 Ratio of respondents regarding the first question, "Do you have an interest in Ai?"

Question 4 "How do you feel about Ai as a routine part of work?"

Among the 30 survey responses, 27 people (90%) responded "I don't mind it as a routine part of work." Among their answers to Question 1, 16 out of 18 people (89%) selected "I'm interested." 7 out of 8 people (87%) responded "I'm not interested" and 4 out of 4 people (100%) selected "I don't know." On the other hand, there were no radiological technologists who selected "I don't want to do it as a routine part of work." The 3 remaining people selected "Other" (Fig.2a, b, c) and 2 of those people wrote a freestyle response. 1 person (33%) wrote "I don't think it's necessary for cases where the cause of death of obvious" and 1 person (33%) wrote "I hate that you can't read the date and time."

Question 5 "Are you willing to conduct Ai following a request from the police?"

Among the 30 survey responses, 6 people (20%) selected "I want to do it" regarding police requests, 16 people (54%) selected "I don't mind doing it" and 7 people (23%) selected "I don't want to do it." (Fig.3).

Question 6 "Do you know the two laws regarding death cause detection?"

Among the 30 survey responses, 9 people (30%) selected "I know them" regarding the two laws, 2 people (7%) selected "I've heard of them" and 19 people (63%) selected "I don't know." (Fig.4).

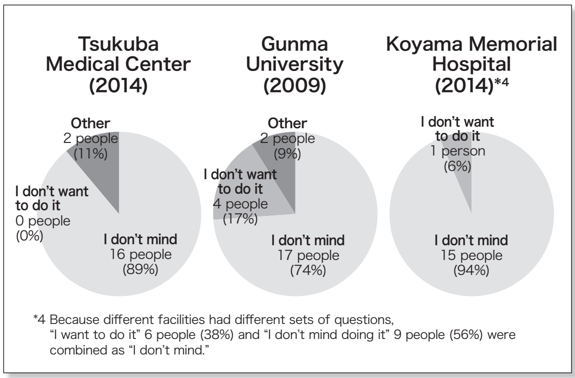

Fig.2 a Acceptance of Ai regarding the 4th question, "How do you feel about Ai as a routine part of work?" (to respondents who indicated an interest in Ai)

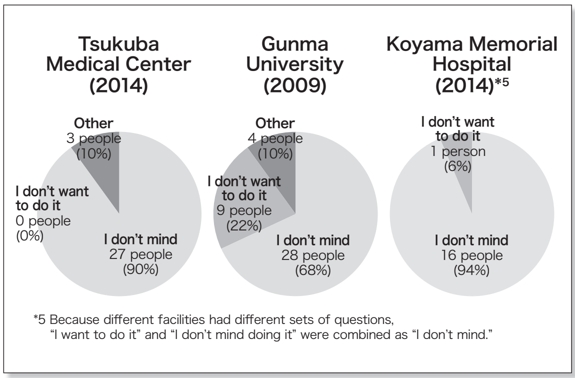

Fig.2 c Acceptance of Ai regarding the 4th question, "How do you feel about Ai as a routine part of work?" (to all respondents)

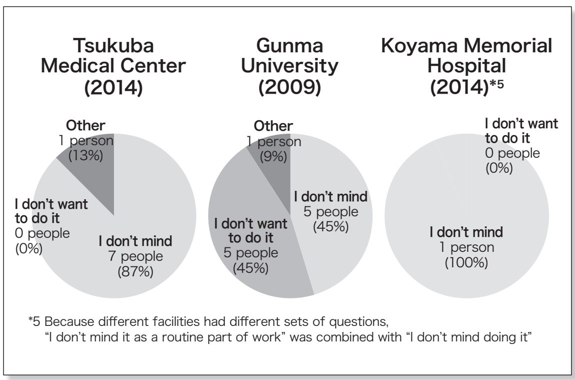

Fig.2 b Acceptance of Ai regarding the 4th question, "How do you feel about Ai as a routine part of work?" (to respondents who indicated no interested in Ai)

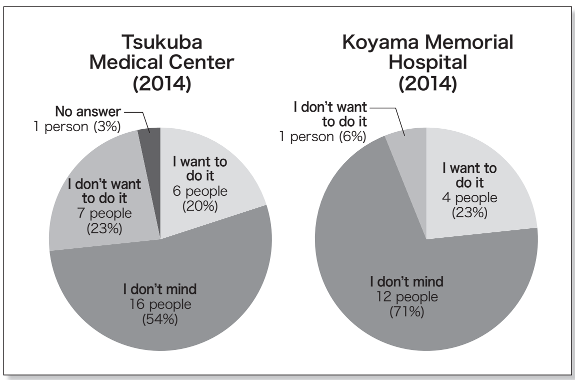

Fig.3 Acceptance regarding the 5th question, "Are you willing to conduct Ai following a request from the police?"

Question 7 "Are you aware of the model project of pediatric Ai?"

Among the 30 survey responses, 21 people (70%) selected "I know it" regarding the project, no one selected "I've heard of it" and 9 people (30%) selected "I don't know." (Fig.5).

Question 8 "Please write your thoughts about Ai."

Among the 30 survey responses, 5 people wrote the following freestyle comments: "I first heard about Ai back when I was a student, so I accept it as a part of work in this field." "Post-mortem MRI aren't usually done in other facilities so I'm interested in it, but I'm worried whether I can do it well." "I want to know the background that led to the creation of the pediatric Ai model project." "If radiological technologists can assist with identifying the cause of death, we should do it positively." "I think that performing Ai is an important opportunity for the radiology department (the radiological technologists doing the imaging and the radiologists that make the diagnosis) to view the whole body structure."

4. Discussion

The proportion of radiological technologists who said they have an interest in Ai was greater than half of the respondents at all 3 facilities. Only our hospital's survey asked for the reason why the respondents had an interest in Ai or not, and we found that the motivation for interested respondents was their contribution to society rather than their own personal interest. We also found that uninterested respondents were not motivated by feelings of discomfort, and that they might become interested in Ai if work related to Ai was to increase at their workplace.

The proportion of radiological technologists who said they don't mind it as a routine part of work was greater than two-thirds of the respondents at all 3 facilities. The freestyle comment "I first heard about Ai back when I was a student, so I accept it as a part of work in this field" leads us to believe that if a greater number of radiological technologist training facilities (universities and trade schools) included Ai in the course curriculum, we can predict that a greater proportion of radiological technologists would consider Ai to be a routine part of work. The percentage of radiological technologists who said "I want to do it" or "I don't mind doing it" regarding police request Ai was 74%, lower than the 90% of respondents who answered "I don't mind doing it as a routine part of work." While no radiological technologists at this hospital selected "I don't want to do it as a routine part of work," 7 people said that they don't want to do police request Ai. It is thought that they might be motivated by the following two reasons: First, because police request Ai at

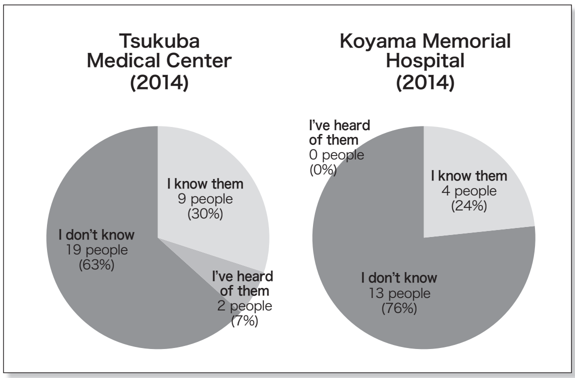

Fig.4 Awareness regarding the 6th question, "Do you know the two laws regarding death cause detection?"

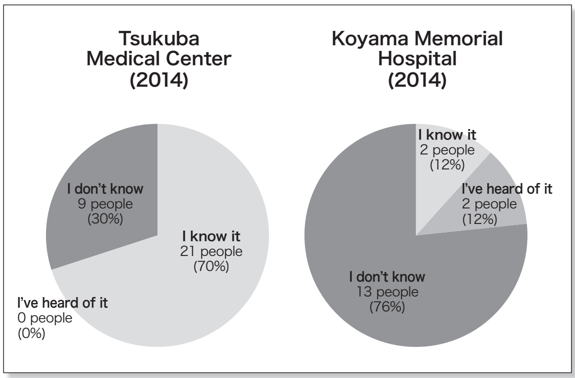

Fig.5 Awareness regarding the 7th question "Are you aware of the model project of pediatric Ai?"

our facility is restricted to only 5 members of our radiology staff, the remaining radiological technologists aren't as familiar with police request Ai compared to Ai as a routine part of work. Second, the freestyle comment "Post-mortem MRI aren't usually done in other facilities so I'm interested in it, but I'm worried whether I can do it well" leads us to believe that because police request Ai means post-mortem MRI, it involves a greater responsibility than work performing post-mortem CT scans. A study group report on the use of post-mortem examination scans says "Ideally, radiological technologists that completed training held by organizations like the JART should be performing post-mortem scans, and we ought to consider making this a certification subcategory inside JART's certification system"[8]. As of 2011, JART implemented a certification process for Ai-certified radiological technologists[35], according to the following criteria.

- Applicant has been granted a radiological technologist license and has 5 years or more work experience, including at least 2 years of CT scan experience.
- Applicant has taken JART's radiological technologist basic training "X-Ray CT Examination" and an Ai certification workshop.
- Applicant has previous experience inspecting post-mortem imaging.

These certification requirements show that in order to take CT scans that are useful in cause of death investigations, a radiological technologist needs a good command of the same technical skill and knowledge that is used in everyday clinical work with living bodies. It might be more difficult to perform post-mortem MRI than post-mortem CT scans.

The proportion of respondents that knew the two relevant laws was between one-fourth and one-third. Because an increase in police request Ai commissions is expected in the future[36], it would be ideal for the radiological technologists performing these scans to know the background of this work. Currently, the Ai certification workshop is held three times a year[37], but the number of students is limited to 100 people each time. The JART believes that it's necessary to convey the importance of performing Ai to more radiological technologists not only through certification workshops, but also by holding a symposium of the JART general members and by increasing the frequency of awareness measures[9] like publishing articles about Ai in the Journal of JART.

The proportion of respondents that knew about the pediatric Ai model project was higher at our hospital than in the Koyama Memorial Hospital Survey. It is thought that they might be motivated by the following two reasons: First, our hospital's radiology department held a study session about Ai just two weeks before this survey was done, and the pediatric Ai model project was also discussed, so it's expected that anyone who attended that session would select "I know it." Second, our hospital has a pediatrics department, but Koyama Memorial Hospital does not (note: there is a neonatology department.) One of the purposes of the pediatric Ai model project is to identify child abuse[16]. Every year, there are a few requests from our pediatrics department to take full-body x-rays[38] [39] to confirm the presence of physical abuse; this leads us to think that our radiological technologists can easily understand the purpose of the pediatric Ai model project, and have a greater interest in it. The freestyle comment "I want to know the background that led to the creation of the pediatric Ai model project" reflects this as well.

This paper's scope is limited because we could only compare the survey from our hospital with two other facilities. It's possible that completely different results could be obtained at other facilities with a different number of staff, range of ages, or male-to-female ratio. A nationwide survey with a greater number of questionnaires will be necessary for future research. This paper will also become comparison data for that project.

Japan is rapidly aging, and is entering a phase when death will be commonplace in society[40]. Even though Japan is often called a society that doesn't investigate the cause of death[1) 2)], there are great expectations for Ai as the rate of dissection fails to rise[41]. 90.4% of Ai practitioners are radiological technologists[6]. Just as the freestyle comment "If radiological technologists can assist with identifying the cause of death, we should do it positively" suggests, we radiological technologists need to respond to the societal demand for Ai. In order to achieve that, it is necessary to establish Ai as a field of study at radiological technologist training facilities[42) 43)] and continue the ongoing implementation of JART's Ai certification workshops and positive public relations work. Given that "performing Ai is an important opportunity for the radiology department... to view the whole body structure," results could be achieved through Ai study sessions held across a variety of hospital departments including general medicine, nursing, clinical laboratories, and administration, as well as an increase in communication between facilities[44], and active participation in Ai-related academic circles[45].

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