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Highlight

- Original Article
- Case Report
- Technical Innovation
- ASEAN Movement in Radiology
- Common Artifacts in Southeast Asia

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CONTENTS

From The Editor

I'm pleased to introduce the next remarkable step of **The ASEAN Journal of Radiology.** From now, all issues of the journal will be fully online published in which all the editorial workflows including submission, reviewing, editing and production will be digitally traceable and recorded. I am certain that this progress will allow an innovative platform for any professions in radiology in ASEAN countries to exchange the academic information which will be easily accessible and credible. At the same time, this fully online publication also helps to reduce maintenance cost and storage space. I would like to invite radiologists, radiologic technologists, radiation physicists, nurses as well as radiological computer scientists to use **The ASEAN Journal of Radiology** as a channel to exchange academic knowledge. Finally, I hope that **The ASEAN Journal of Radiology** will serve as a prominent database about all aspects of radiology in ASEAN.

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Original Article

Appropriateness of pediatric CT utilization in clinical practice

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Abstract

Background: Justification of imaging investigations is important, particularly in pediatrics which underwent investigation using a relatively higher radiation such as CT, due to the higher radiation sensitivity in children.

Objective: To assess the difference of viewpoints between pediatric physicians and pediatric radiologists on the appropriateness of pediatric CT utilization in a tertiary-care university hospital with limited MR capacity.

Methods: Pediatric medical records of head CT, chest CT, and abdominal CT were retrospectively reviewed in consecutive date of the examination until having 100 head CTs and 100 body CTs with complete clinical and imaging information. The physicians and the radiologists were asked to suggest the imaging modality of choice for each patient according to the given data, regardless of the hospital's limitation. If the suggested modality of choice was not CT, the CT request would be considered as "inappropriate". They additionally scored the CT appropriateness, firstly using individual judgment, and secondly using the American College of Radiology Appropriateness Criteria (ACR AC). Both scoring methods used the same rating scale from 1 to 9; scores 1-3 were considered "inappropriate".

Results: From the viewpoint of the physicians and radiologists, the number of inappropriate CT requests was 20% and 54% according to "the modality of choice", 2.5% and 17% according to "individual judgment", 12% and 22% according to the ACR AC. The main difference was not from no indication for imaging but from the selected modality of imaging. The radiologists suggested 52% of head CTs and 64% of abdominal CTs could have been replaced by MRI if available.

Conclusion: There is a ten-percent disagreement on appropriateness of pediatric CT request between the physicians and the radiologists when using the same guidelines and considering the hospital limitations.

Key words: ACR appropriateness criteria, appropriateness, computed tomography, justification, pediatrics

Introduction

Exposure to ionizing radiation, including X-ray, increases the risk of developing of fatal cancer in the future with a much higher risk in pediatrics than adults [1-5]. CT is one of the major concerns because it gives a relatively higher radiation dose in diagnostic imaging; additionally, there has been a continuous increase of CT examinations in many countries [6-10]. Adjusted to the 1997 European Commission's directive, CT should be performed only when a patient's benefit is foreseen and no other available imaging modalities without or with a lower radiation dose could provide the same information [11]. In the United States, there is the ACR Appropriateness Criteria (ACR AC) as a guideline for indicating imaging investigation which includes radiation concerns as a part of appropriateness [12]. For the countries with limited resources such as in South East Asian countries, there is a significant challenge in providing MRI with enough capacity.

The number of unnecessary imaging incidents was estimated at 10% - 30% [13], and the number of inappropriate CT examinations was reported at 27% - 30% [14-15].

In this article, the appropriateness of CT request in pediatrics was studied from the viewpoints of the referring physicians and the radiologists in a tertiary-care hospital with limited MRI capacity.

Materials and methods

The authors' institution review board approved the study protocol. The informed consent was waived and the patient confidentiality was protected.

Medical records of pediatric patients under 15 years old having head CT, chest CT, and abdominal CT in a single institution since January 1st, 2012 were retrospectively reviewed in consecutive date of the examination until having 100 head CTs and 100 body CTs with complete clinical and imaging information. The review was done in 2014. The exclusion criteria were insufficient clinical information for evaluation of justification of a CT examination. PET-CT and CT scanning as a part of treatment purpose, such as CT for guiding intervention, CT navigation for operation, and CT simulation for radiation therapy were excluded.

CT examinations were done in a single hospital. It was a 1325-bed, tertiary-care university hospital for both adult and pediatric patients. There were 170 beds for pediatric in-patients and approximately 57,000 pediatric OPD viits per year. In the year 2012, there were 2 MR machines and 3 CT scanners (Somatom Sensation 4 and Somatom Sensation 16, both from Siemens Healthcare, Erlangen, Germany; and Aquilion One, Toshiba Medical Systems, Otawara, Japan).

Patients' history of illnesses, physical examinations, laboratory results, prior imaging results, responses to prior treatments, and reasons for CT requests were retrospectively reviewed.

The appropriateness of CT requests was assessed by both physicians and radiologists (a neuroradiologist with four years of experience and a pediatric body radiologist with fifteen-years of experience) who worked in pediatric subspecialties, including neurology, neurosurgery, neuroradiology, pulmonology, oncology, general surgery, and body imaging.

Each CT request would be assessed by one physician and one radiologist according to his or her subspecialty. They were asked to suggest the most appropriate imaging modality for each patient without consideration of hospital limitations. If the suggested modality was not CT and would deliver less or no radiation, the CT request would be considered "inappropriate" according to the "imaging modality of choice" criteria.

The specialists were then asked to score the appropriateness for each CT request by using their individual judgment in their usual environments, and then by using the ACR AC 2012 [12] for the cases who matched the specific clinical conditions of the criteria. Both scoring methods used the same ordinal scale from one to nine: scores 1-3 for "inappropriate", scores 4-6 for "may be appropriate", and scores 7-9 for "appropriate".

The considered inappropriateness of a CT request by the physicians and the radiologists, respectively, using the three different criteria - (a) CT not the modality of choice, (b) scores 1-3 from individual judgment, and (c) scores 1-3 from the ACR AC - were compared and analyzed.

In terms of the statistical analysis, demographic data of the patients were shown as mean (±SD) and percentage. The appropriateness of the CT examination was presented as mean (±SD) score and percentage of each categorized group. The difference between ACR rating score and appropriateness rating score was calculated by pair t-test. Statistical significance was defined as p-value less than 0.05. Cohen's kappa coefficient analysis and Spearman rank correlation coefficient were used for measurement of the inter-rater agreement and the correlation between pediatric radiologists and pediatric specialists, respectively. All statistical analyses were computed using SPSS version 20.

Results

Two-hundred CT examinations in 136 patients (67 boys and 69 girls) were enrolled. The patients' ages ranged from 1 month to 15 years with the mean age of 8.35 ± 4.86 years.

There were 100 head CTs and 100 body CTs (44 CT of the chest, and 56 CT of the abdomen). Indications for CT are shown in Table 1.

Table 1. Indications for CT examination according to CT areas.

100 head CTs		44 chest CTs		56 abdominal CTs	
Indication	**%**	**Indication**	**%**	**Indication**	**%**
Head injury	34	Follow-up*	48	Follow-up*	55
Seizure	19	Tumor staging	32	Tumor staging	14
Follow-up*	14	Others**	20	"Rule out" a surgical condition	13
Headache	12				
Conscious change	6			Trauma	9
Tumor staging	5			Others **	9
Others **	10				

* The "follow-up" CT indications were mostly for tumors after treatment.
** The others were miscellaneous other conditions such as inflammation.

Five pediatric physicians and two pediatric radiologists evaluated CT requests according to their expertise with the distribution of the requests shown in Table 2.

Table 2. Number and area of CT requests distributing to pediatric physicians and pediatric radiologists for assessment.

Number and area of CT requests	5 pediatric physicians and number of CT requests assessed		2 pediatric radiologists and number of CT requests assessed
100 head CTs	Neurosurgeon Neurologist Oncologist	44 requests 43 requests 13 requests	Neuroradiologist 100 requests
44 chest CTs	Oncologist Pulmonologist	32 requests 12 requests	Body imaging radiologist 44 requests
56 abdominal CTs	Oncologist Surgeon	44 requests 12 requests	Body imaging radiologist 56 requests

From 100 head CTs, there were 64 requests meeting the specific clinical conditions of the ACR AC, with the indications of trauma, headache, and seizure. From 100 body CTs, only 4 abdominal CTs met the clinical conditions of the ACR AC, with the indication of right lower quadrant pain.

When using the "imaging modality of choice" as the criteria for CT justification, the number of inappropriate CT utilizations in the studied hospital was 20% by the opinion of the physicians and 54% by the opinion of the radiologists. The radiologists suggested 52% of head CTs and 64% of abdominal CTs could have been replaced by MRI if available, while the physicians suggested 27% and 3%, respectively. The modality of choice was plain radiograph or not necessary in 4%-5% of the requests.

When the "individual judgment" was used as the criteria for CT justification, the number of inappropriate CT requests (scores 1-3) was 2.5% and 17% by the physicians and by the radiologists, respectively. The mean score of appropriateness from the physicians and the radiologists was 7.63 and 6.28, consecutively.

When the ACR AC was used in 68 criteria-matched cases, the number of inappropriate CT requests (scores 1-3) were 12% and 22% by the physicians and by the radiologists, respectively. The mean score of appropriateness from the physicians and the radiologists was 6.57 and 5.85, respectively. The correlation of scoring and the agreement of grouping between the physicians and radiologists were strongest when using the ACR AC.

The percentage of inappropriate CT requests according to each criterion assessed by the physicians and the radiologists, respectively, is shown in Table 3.

Table 3. The percentage of inappropriate CT requests according to scanning areas, criteria of assessment and assessors.

CT area	Number	Criteria for assessment			
	Assessor	Modality of choice	Individual judgment	Individual judgment*	ACR AC
Brain	Number	100	100	64	64
	Physician	33%	5%	6%	12%
	Radiologist	53%	27%	23%	23%
Chest	Number	44	44	-	-
	Physician	W0%	0%		
	Radiologist	30%	11%		
Abdomen	Number	56	56	4	4
	Physician	11%	0%	0%	0%
	Radiologist	75%	3.5%	0%	0%
Total	Number	200	200	68	68
	Physician	20%	2.5%	6%	12%
	Radiologist	54%	17%	22%	22%

Individual judgment* was for the assessment of the 68 CT requests that matched the specific clinical conditions of the ACR AC for comparison with the scores by the ACR AC.

The scores from "individual judgment" by the physicians and the radiologists are shown in Table 4. The highest score belonged to the chest CT request, followed by the abdominal CT, and then the head CT. The physicians gave higher scores than the radiologists for all of the CT areas.

Table 4. Scores for CT requests by "individual judgment" of the physicians and the radiologists.

CT area	Assessors	Mean score (SD)	Score 1-3	Score 4-6	Score 7-9	Total
Head	Physicians	7.23 (1.88)	5 (5%)	27 (27%)	68 (68%)	100 (100%)
	Radiologist	5.48 (2.43)	27 (27%)	29 (29%)	44 (44%)	100 (100%)
Chest	Physicians	8.27 (0.5)	0	0	44 (100%)	44 (100%)
	Radiologist	7.18 (1.96)	5 (11%)	4 (9%)	35 (80%)	44 (100%)
Abdomen	Physicians	7.84 (0.18)	0	6 (11%)	50 (89%)	56 (100%)
	Radiologist	7.02 (0.96)	2 (3.5%)	2 (3.5%)	52 (93%)	56 (100%)

The scores of 64 head CTs that met the specific clinical conditions of the ACR AC are shown in Table 5. The physicians gave lower scores when using the ACR AC than when using "individual judgment" with statistical significance, while the radiologist gave the same scores.

Table 5. Scores of 64 head CT requests from "individual judgment" and from the "ACR AC" by the physicians and the radiologist.

Assessors	Scoring method	Mean score (SD)	Score 1-3	Score 4-6	Score 7-9	Total	Scoring difference by pair t-test
Physicians	Individual*	7.13 (2.02)	4	20	40	64	Significance
	ACR AC	6.55 (2.42	8	23	33	64	$p < 0.05$
Radiologist	Individual*	5.78 (2.56)	15	14	35	64	No significance
	ACR AC	5.78 (2.56)	15	14	35	64	$p = 1$

Individual* = Individual judgment

The correlation of scoring between the physicians and the radiologists by Spearman rank correlation coefficient and the agreement of grouping by Cohen's kappa coefficient analysis are shown in Table 6. The correlation and the agreement for the same group of 64 head CTs were moderate and fair when "individual judgment" was used, but were very strong and moderate when the ACR AC was used. The correlation and the agreement for chest CT and abdominal CT using "individual judgment" were very poor.

Table 6. The correlation of scoring and the agreement of grouping of CT requests between the physicians and the radiologists by using "individual judgment" and the "ACR AC".

CT area	Scoring method	Number	Inter-rater correlation of scoring			Inter-rater agreement of grouping		
			Level	Spearman correlation	p-value	Level	Kappa agreement	p-value
Head	Individual*	100	Moderate	0.549	<0.0001	Poor	0.179	0.007
	Individual**	64	Moderate	0.653	<0.0001	Fair	0.291	0.001
	ACR AC	64	Very strong	0.857	<0.0001	Moderate	0.565	<0.0001
Chest	Individual*	44	Weak	0.211	0.17	N/A	N/A	N/A
Abdomen	Individual*	56	Very weak	0.172	0.205	No	-0.69	0.497

Individual* = Individual judgment
Individual** = Individual judgment for the requests that met the specific clinical conditions of the ACR AC
N/A = Not assessed. No statistics were computed because the score group by the physicians was a constant for chest CT.

Discussion

This study was conducted in a university hospital that had pediatric subspecialties. In the year 2012 with limited MR capacity (i.e., 2 MR machines for 1325-bed hospital and 1.4 million OPD visits per year), most of the MRI slots were reserved for studies that CT could not confidently give important information about. Besides, there was a shortage of anesthesiologists. The waiting time for pediatric MRI was quite long, particularly for the ones that need sedation; thus, many pediatric patients had to undergo CT instead.

The number of pediatric CTs in 2012 was 811 examinations, and nearly 80% of them were head CTs, chest CTs, and abdominal CTs, with the ratio of the head CT to the body CT around 1:0.9. Therefore, the authors studied the equal numbers of head CT and body CT to represent pediatric CT in the hospital.

From 200 CT requests, the radiologists suggested 52% of head CTs and 64% of abdominal CTs could have been replaced by MRI if available, while the physicians suggested a much lower the number, i.e., 27% of head CT and 3% of abdominal CT for MR preference. This information shows the demand for more pediatric MR capacity in the hospital. It also revealed a remarkable difference in the opinions on appropriateness between physicians and radiologists. Two examples of one head CTs and one abdominal CTs that the physicians considered appropriate, but radiologist suggested MR were - a teenage boy with Hodgkin disease developed the first episode of generalized tonic clonic seizure 3 weeks after chemotherapy, and the indication for urgent imaging was to rule out CNS lymphoma or posterior reversible encephalopathy syndrome, and – the 9th follow-up imaging of immature teratoma after treatment for a 12-year–old girl.

A previous study from Olkarinen et al in 2009 [14] reported 36% of head CTs and 37% of abdominal CTs in patients under 35 years old were unjustified and most of these could have been replaced by MRI, based on the guideline recommended by the European Commission. The study of appropriateness of outpatient adult CTs referred from primary care clinics by Lehnert et al in

2010 [15] revealed 65% of head CTs and 18% of abdomen/pelvis CTs were not considered appropriate according to proprietary evidence-based appropriateness criteria used by a national RBM program. Both studies were from the radiologists' opinions.

The score of CT appropriateness by individual judgment was based on the knowledge and experience of each specialist, the hospital resources, and the healthcare coverage. From the long waiting time of MRI in the authors' hospitals, both physicians and radiologists agreed that most of the 200 CT requests were appropriate. The number of inappropriateness was 2.5% from the opinion of the physicians and 17% from the radiologists. Most of the inappropriate requests considered by the radiologists were from head CT with clinical conditions of seizure, headache, and follow-up of the tumor which were elective cases and should have MRI.

From the subgroup consisting of 64 brain CTs that had been scored for appropriateness by both "individual judgment" and by the ACR AC, there was a better inter-rater correlation of scoring and a better inter-rater agreement of grouping when using the ACR AC. This reflected the usefulness of the guideline in making similar judgment in clinical practice. This finding also correlated with previous meta-analyses that the clinical practice can be improved by providing accurate medical guidelines [16]. However, many clinical problems were not addressed in the ACR AC [17], as shown in our study in which 96 from 100 pediatric body CTs did not fit in the criteria. With "individual judgment", even the appropriateness scores of chest CTs and abdominal CT were higher than for head CTs, the inter-rater correlation and the inter-rater agreement were poorer.

In this study, three criteria were chosen to determine inappropriate CT requests. The first criteria, "imaging modality of choice", was rather ideal, regardless of hospital limitations. The second criteria, "individual judgment" allowed flexibility of judgment in the practice with limited resources, but it could easily be biased. The third criteria, the ACR AC, was evidence-based, regularly updated, and easily accessible, but not including many clinical conditions. Despite using the same criteria, the physicians and the radiologists had certain different opinions in identifying inappropriate CT requests. In the cases that CT and MRI might provide the same important information, the physicians preferred CT as the modality of choice while the radiologists preferred MRI. From the physicians' viewpoint, CT quickly and noninvasively provided important information that they could treat their patients early, and MRI should be for the patients whose diseases were not easily detected by CTs, because the study took much longer time and was relatively expensive which might not be affordable. From the radiologists' viewpoint, MRI, most of the time, provided more information, particularly, in neurology and abdomen, and without radiation.

A round-table discussion with evidence-based information in which their opinions could be tuned in the same way might be a solution. Any request doubtful of appropriateness in terms of modality of choice should not be proceeded unless there is a thorough communication and a proper discussion. It is important to improve the imaging facilities and the system to get to a better situation to provide a safe imaging service to the patients.

This study was a retrospective review, therefore having a limitation of data collection. The reason for a CT request might not be completely written down, such as the waiting time for MRI or the parent's affordability for the cost of MRI, which would affect the scoring of appropriateness. The second limitation was the determination of appropriateness by using the evidence-base guidelines. The ACR AC in 2012 was very good; however, the criteria covered only 34% of the CT requests in this study. The third limitation was from a small sample size with the analysis of data in the subgroups.

Conclusion

The number of inappropriate CT requests in the opinion of the physicians was much less than the radiologists' opinions. Although the same guideline was adopted, there were a ten-percent disagreement on the appropriateness of pediatric CT requests between them. The main difference was not from no indication for imaging but from the selected modality of imaging. The radiologists suggested MRI as modality of choice in much higher number than the physicians.

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Case Report

Barium granuloma in peritoneal cavity and right scrotal sac mimicking a germ cell tumor

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Abstract

Colonic perforation after barium enema is rare. We present a case of a 6-month-old boy with a palpable mass at the left sided abdomen and the right sided scrotum. Ultrasound and computed tomography (CT) showed calcified masses at Cul de sac and right scrotum with intraperitoneal fat infiltration mimicking germ cell tumor. Preexisting colonic wall injury or trauma and exposed to barium enema procedure can help to correct diagnosis and obviate unnecessary surgery.

Introduction

Barium enema is a safe diagnostic procedure to detect colonic lesions. Although on rare occasions, colonic perforation may transpire. Not only excessive intraluminal pressure, but usually also preexisting weakened colonic wall by iatrogenic trauma or colonic disease can break the colonic wall. Completely disrupted colonic wall produces intra/ extraperitoneal perforation which is clinically more severe. When barium perforation occurs, granulomatous reaction around barium forms the so called “barium (sulfate) granuloma”. We present a case of barium granuloma occurring after colonic biopsy and mimicking germ cell tumor.

Case Summary

A 6-month-old infant was presented with palpable mass at the left sided abdomen and the right scrotum. Ultrasound and CT showed circumferential calcification along the descending colonic wall with intraperitoneal fat infiltration, and calcified masses at Cul de sac and right scrotum (Fig. 1a, 1b, Fig. 2a, 2b). Alpha-fetoprotein was normal based on the patient's age (93ng/ml). Germ cell tumor was presumptively diagnosed. Subsequently exploration of laparotomy found colonic fistula at splenic flexure with chronic thick walled abscess connecting through umbilicus. Histology of abscess wall and the right scrotum demonstrated fibrosis, granulation tissue, dystrophic calcification and granulomatous formation (Fig. 3a, 3b). Retrospective review of medical history discovered that colonic biopsy was done at the first day of life because of clinical gut obstruction and the patient underwent ileostomy. Then barium enema was performed at the age of 3 months evaluated before ileostomy closure. Barium granuloma within the peritoneal cavity and the right scrotum via patent processus vaginalis was finally diagnosed.

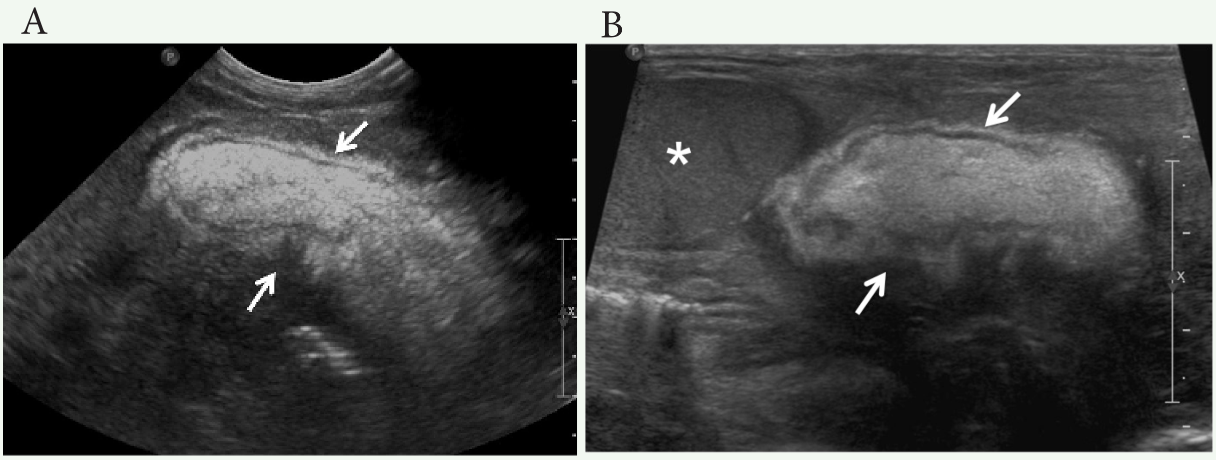

Figure 1. (A) Ultrasound at left sided abdomen shows hyperechoic mass - like lesion (arrows). (B) Ultrasound at the right scrotal sac demonstrates a normal right testis (*) which is superiorly displaced by a hyperechoic mass like lesion (arrows) with the same characteristics as the lesion in the left sided abdomen.

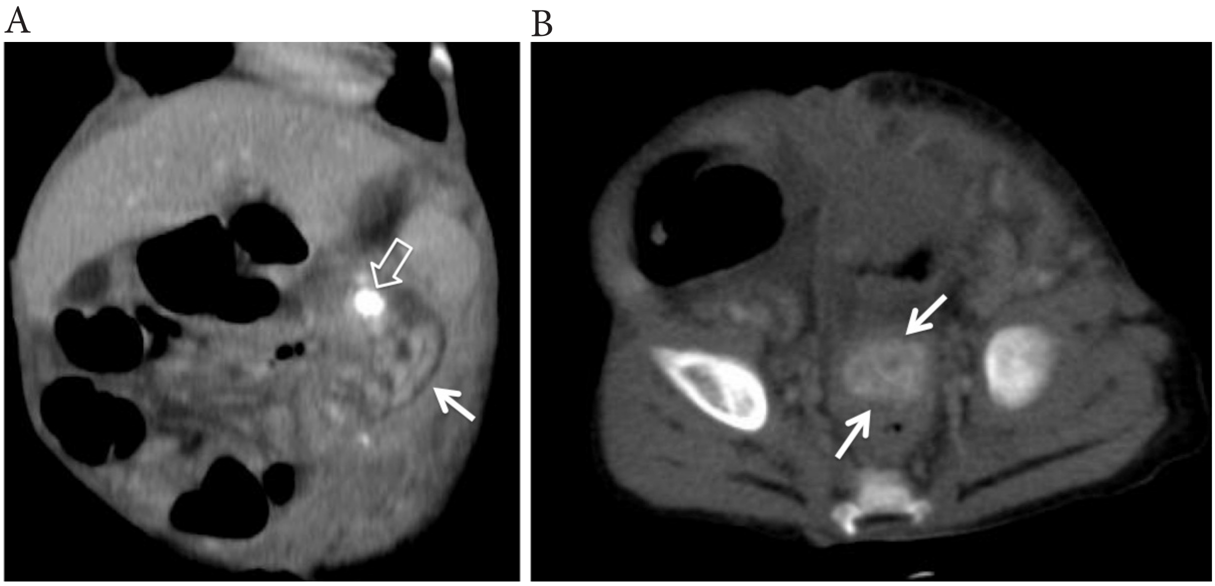

Figure 2. (A) Coronal multiplanar reconstruction image of enhanced CT reveals a dense calcification (open arrow) at splenic flexure and dense calcified wall along descending colon (arrow) with surrounding fat infiltration. (B)Axial enhanced CT at pelvis shows a calcified mass (arrow) at Cul de sac between the urinary bladder and the rectum.

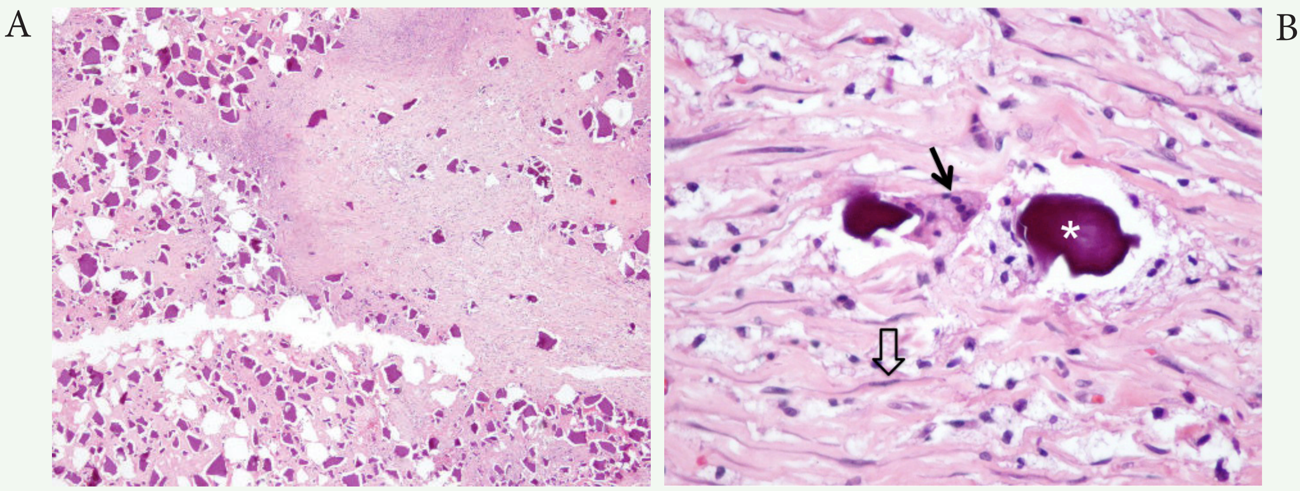

Figure 3. (A) Histological slide shows diffuse calcification with fibrosis and foreign body granuloma. (H&E) (B) High magnification shows dystrophic calcify (*) with foreign body type giant cell (arrow) with fibroblastic cell proliferation (open arrow).

Discussion

Barium sulfate granuloma is a rare complication after barium contrast study. It was first described in 1954 as a pedunculated rectal mass [1, 2]. Most of the previous reported cases had a history of barium enema. A recent reported case by Kim et al, however, diagnosed a barium granuloma of the rectum in a patient with no history of barium enema but the patient underwent upper gastrointestinal series and colonoscopy was performed nine months later [1]. Colonic perforation after barium enema can occur at any level from dentate line up to cecum and it can be complete entire thickness of colonic wall or incomplete with intact colonic serosa [3, 4]. Incomplete dissection of barium can either fill intestinal glands, so called " peculation" which is of no clinical significance or penetrate intramural deposition that may be asymptomatic or develop pain and tenderness in minutes or hours later [5, 6]. It is usually seen in a post evacuation film and has to be differentiated from true pathologic colitis [5]. If the barium is trapped in the submucosa and lamina propria and localized in the anastomotic site, it can cause fibrosis and anastomotic stricture [7]. A pre-existing disease of the colon or an underlying disease of the patient has increased risk for colonic perforation than those with normal intestines. The previous rectal biopsy, the recent colonic operation, bowel wall diseases: - such as ulcerative colitis, diverticulitis, carcinoma, and parasite manifestation - or rare excessive intraluminal pressure, infants or debilitated patients are also the predisposing factors [2-4].

Barium within peritoneal cavity can create severe inflammatory reaction encountering fibroblasts, multinucleated cells, macrophages and lymphocytes which are the characteristics of a granulomatous reaction surrounding the barium sulfate crystal [1, 8]. Later on, it can produce a fibrotic change resulting in colonic stricture or intraperitoneal adhesion/fibrosis. Furthermore, intraperitoneal colonic perforation has more serious complications than extraperitoneal perforation or below pouch of Douglas. Sometimes the barium granuloma can mimic a tumorous mass and give incorrect presumptive diagnosis. Kim et al reported a barium granuloma of the rectum whose preoperative diagnosis was calcified submucosal tumor such as gastrointestinal stromal tumor [1]. Our case had the previous colonic biopsy at splenic flexure and then the patient developed a post-operative intra-abdominal collection that were the predisposing factors for colonic perforation during barium enema procedure. The barium leaked along the fistulous tract at the biopsy site into the peritoneal cavity and extended to the right scrotum via patent processus vaginalis. This misled the diagnosis of a germ cell tumor in the scrotum with intraabdominal nodal metastasis.

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Technical Innovation

'X-ray gun' identifies sources of Song Dynasty porcelains from a shipwreck in the Java Sea

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The 'Silk Road', often thought of as a network of land routes across Central Asia, was complemented by a 'Maritime Silk Road' which passed through Southeast (SE) Asian waters as it connected China with South Asia and East Africa. During the Song Dynasty, China exported large quantities of ceramics to generate income used to pay for its imports. Interestingly, the ships which carried this trade were mostly of non-Chinese origin with Indonesians being the master sailors.

The sea floors of the Maritime Silk Road became the final resting place of many ships due to storms and fighting. One such unlucky ship sunk in the Java Sea in the 12th century on its way to Java to offload a large cargo. Discovered by fishermen in the 1980s, the wreck lay in 27 m of water and was excavated in 1996 by Pacific Sea Resources under a license from the Indonesian government. The evidence at the site suggested that the ship was an Indonesian lashed-lug vessel, about 28 m in length [1]. A model thought to replicate the ship is shown in Figure 1.

Figure 1. Replica of the Java Sea shipwreck vessel, built by Nicholas Burningham. Image credit: The Field Museum, cat. no. 357835; photo ID no. A114245d_001d. Photographer John Weinstein.

The excavation team estimated that the ship's cargo included 200 tons of cast iron pans and wrought iron bars, over which lay some 100,000 pieces of Song Dynasty ceramics [2]. About 12,000 intact pieces were excavated from where they lay on and under the seabed (Figure 2). Half of the ceramic findings went to the Indonesian government (consistent with the license) and half were donated to the Field Museum in Chicago for continued archeological study. The donated collection included stoneware, earthenware and porcelain (Figure 3).

Figure 2. Chinese ceramics on the bottom of the Java Sea around a 12th century shipwreck which were excavated for conservation in 1996.
Image credit: Pacific Sea Resources, Inc.

Figure 3. Chinese ceramic bowls from the Java Sea Shipwreck.
Image credit: The Field Museum, Anthropology. Photo ID no. A115095d _025. Photographer Karen Bean.

Chinese ceramics from this era came largely from the Southeast, specifically Fujian and Jiangxi. The finest porcelain, including qingbai, came from kiln complexes in Jingdezhen with copies and more common forms from kilns in Fujian. But this localization is known only in general. Archeologists and anthropologists in the Field Museum team have been studying the composition of the clays and glazes of the porcelains to identify specific 'signatures' which could allow identification of the actual source kilns.

X-ray fluorescence analysis has provided the tool for determining these signatures. As reported earlier this year [3], the team used a portable X-ray fluorescence detector (pXRF; called by the lay press, an'X-ray gun') to analyze the composition of the clays and glazes both of shards found near kiln complexes and of 60 samples from the shipwreck ceramic collection. The technique works by bombarding the sample with high-energy X-rays, exciting elements in the surface clay and glaze, and results in photon/fluorescence emissions. The pXRF analyzes these element-specific energy 'signatures'. This paper was a proof-of-concept that pXRF could be used to distinguish pieces and associate them with materials from specific locales and kiln complexes in SE China. The pXRF is rapid, non-destructive (of the object analyzed) and of moderate cost.

The use of pXRF with Chinese porcelains found in East Africa was reported in 2016 [4]. In the report from the Chicago team, glazes were distinguished based on the quantitation of fluorescent signatures from 10 elements [3]. The 60 shipwreck samples clustered with glazes on shards from four kiln complexes in SE China. The highest quality qingbai correlated with clays and glazes from a complex in Jingdezhen (Jiangxi), while pieces of lesser quality were shown to be consistent with clays and glazes from kilns in Fujian.

This study showed that a pXRF could be used to rather easily distinguish the kiln sources of glazed ceramics, even after the pieces had been underwater for centuries. In the case of the Java Sea shipwreck and its large porcelain cargo, the source kiln complexes were located and led to a rethinking of the ship's route. Now researchers suggest that it most likely started in Fuzhou, then going to Quanzhou before embarking for SE Asia and the Indonesian islands.

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Technical Innovation

MR lymphangiography in lymphedema

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Lymphedema is a chronic disorder, defined as a progressive and excessive accumulation of protein-rich fluid, inflammation, adipose tissue hypertrophy, and fibrosis in the interstitial space, which results from impaired lymphatic drainage. Regardless of the etiology, it is clinically characterized by chronic swelling, localized pain, atrophic skin changes and secondary infections. However, the main devastating aspect of lymphedema is the appearance of the affected limb that causes psychological morbidity.

Lymphedema is classified as primary or secondary depending on etiology and presentation. The primary lymphedema is a form of lymphedema without an inciting factor, generally due to a congenital condition associated with pathologic development of the lymphatic vessels. It can be divided into three forms, classified by the age at the onset: congenital lymphedema, lymphedema praecox, and lymphedema tarda. Congenital lymphedema presents at birth or up to two years postnatally. Lymphedema praecox typically arises during puberty or pregnancy with the onset prior to age 35 years, which accounts for 77–94% of all cases of primary lymphedema, and lymphedema tarda presents with an onset after age 35.[1,2] The secondary lymphedema occurs as a result of other conditions or treatments, usually resulting from injury of the lymphatic vessels from infection, trauma, or tumors but it may also be iatrogenic following surgical interventions or radiotherapies. In developing countries, secondary lymphedema is mainly caused by infections-infestations influencing lymphatic channels, primarily the result of filarial infections (Wuscheria banrofti).[1] On the other hand, in developed countries, secondary lymphedema occurs most commonly after the surgical removal of lymph nodes for cancer treatment.

Despite being a common problem, it is vulnerable to misdiagnosis and has been badly reputed as an incurable disease. There are conservative and operative treatment options for lymphedema. Unfortunately, the efficacy of conservative treatment is highly variable between patients and is not curative. Nowadays, the microsurgical treatment for bypassing the obstructed segment of the lymphatic pathway into the venous system, also known as lymphovenous anastomosis (LVA) is preferred in lymphedema cases. However, a preoperative imaging technique is needed to assess the soft tissues of the entire limb, determining whether suitable lymphatic channels are present, and defining the location of the lymphatics relative to anatomic landmarks that the surgeon can use in the operation.[3]

There are several imaging modalities which aid in the diagnosis of lymphedema and define the location of obstruction such as lymphoscintigraphy, Near Infra-Red Fluorescence Imaging (NIRF), conventional lymphangiography, CT lymphangiography and MR lymphangiography.

Lymphoscintigraphy is a nuclear medicine study and demonstrates a slow or absent lymph flow usually in later stages of lymphedema. Technetium 99m sulfur colloid is injected intradermally and the transit time to lymph node basins can be measured; however, subdermal lymphatics cannot be assessed. While radionuclide lymphoscintigraphy has been considered the primary clinical imaging modality to diagnose lymphedema, its limited temporal and spatial resolution does not allow the identification and localization of individual lymphatic channels. NIRF is a dynamic test done by using indocyanine green, allowing visualization of the superficial lymphatic flow and functioning lymphatic vessels, thus, discovering abnormalities at early stages. It can be used to stage the severity of the disease and for preoperative-intraoperative planning. Conventional lymphangiography is another entity where radio-opaque material is directly injected into peripheral lymph vessels, but the number of studies declined markedly since the introduction of cross-sectional imaging techniques. Therefore, levels of expertise in both performing lymphography and interpreting lymphograms are declining. This technique is rarely adopted due to the risk of damaging lymph vessels.[4]

MR lymphangiography (MRL) is an advanced imaging technique using 3D volumetric contrast-enhanced MR angiography with high temporal and spatial resolution, by injection of Gadolinium into the hand or foot to clarify the course of lymphatics, which can be used to evaluate both anatomy and function of the lymphatic system in a single examination. It is a quick and less invasive imaging technique for evaluation in a case of lymphedema or suspected lymphatic injury, and useful for preoperative planning of LVA microsurgery. MRL could also be useful for evaluating changes in the lymphatic circulation postoperatively or in the event of surgical complications. However, there are also limitations despite Gadolinium, which can also get into the venous system making the interpretation of lymphatic channels difficult.

The indication of MRL is for diagnosis and preoperative planning for the case of primary lymphedema. The contraindication of MRL is the same as general contraindication for MRI such as patients who have a metallic device or a metallic foreign body.

Our experience of MRL in Prince of Songkla University (PSU) hospital will be described from this point on. All the cases were referred from MRL of the lower extremities, to rule out lymphedema and evaluate the causes of lymphedema in affected limbs.

Equipment and imaging techniques

Equipment: MRL can be performed at either 1.5 tesla or 3.0 tesla. In our experience, a 3.0-tesla MRI was preferred and most of the cases were performed by a Philips Achieva 3.0T dStream, with a maximum gradient strength value of 40 mT/m and a slew rate of 200 mT/m/ms.

Coils: a multielement body coil is fundamental for this type of examination. Based on our purposes, we used a phased-array coil for the study of the lower extremities (SENSE XL Torso coil, Philips Medical Systems), which has a large anatomical coverage and a good signal-to-noise ratio.

Patient position: patients were placed supine and feet-first on the scanner table. The multielement coils were positioned to cover both lower extremities from both feet to the groin. Then, a two-station exam was performed.

Contrast medium: based on our purposes, the water soluble extracellular Gd-based MR contrast agent used was gadoterate meglumine (Gd-DOTA, Dotarem) with concentration of 0.5 mmol/mL. A mixture of a standard dose (0.1 mmol/kg body weight) contrast medium and 2-4 mL of 2% lidocaine (Xylocaine) without adrenaline for local anesthesia is injected subcutaneously/intradermally.

Insertion of the needle: a 24–28-Gauge thin needle is generally preferred. Ideally, the tip of the needle should gently be inserted subcutaneously into the dorsal aspect of each foot in the region of the four interdigital web spaces. The injection is limited to a maximum volume of 2 mL (generally 1 mL) for each interdigital web space.

Imaging techniques:

- Short-tau inversion recovery (STIR) sequences in coronal view of both lower extremities before the contrast medium injection.

- 3D Spoiled gradient echo (3D GRE) of both lower extremities; dynamic at 0, 5, 15, 25, 35, 45, 55 and 90 minutes (min), respectively.

Each sequence parameter for the 3.0-T MRL is shown as follows:

Parameter	STIR	3D GRE
FOV	400 x 500 x 258 mm^3	340 x 499 x 260 mm^3
Matrix	525x277	228 x 332
TR (ms)	14499 ms	3.4 ms
TE (ms)	70 ms	1.32/2.2 ms
TI (ms)	230 ms	-
FA	90°	10°

Case study

A 48-year-old female presented with progressive, having a swelling left leg for 1 month. She had been diagnosed with a left popliteal injury after a motorcycle accident for 10 months and post repair with PTFE graft.

Doppler study for both thighs showed a patent left popliteal artery graft without significant stenosis and patent left DPA and distal PTA. Deep vein ultrasound study also showed a normal venous system.

MRL of the left leg was performed on a 3.0-T machine after obtaining an informed consent. Following painting and draping of her left foot, 14 mL of Dotarem and 2% Xylocain was injected subcutaneously into all the interdigital web spaces and between the first and second proximal metatarsal spaces of both feet. The injected sites were massaged for 1 min. Imaging was performed using a STIR 3D-DRIVE and dynamic 3D GRE. The acquisition of dynamic 3D-GRE was done at 0, 5, 15, 25, 35, 45, 55 and 90 min after injection. A dilated epifascial lymphatic system with an extensive reticular pattern were first visualized in 5 min (Figure 1-B) followed by 15 min (Figure 1-C), 35 min (Figure 1-D) and by 55 min, lymphatics up to the groin could be seen (Figure 1-E). There was an excellent visualization of multiple lymphatic channels on the medial aspect of the left leg and dorsum of the left foot. In addition, there was also normal contrast filling of the venous systems. No abnormal tortuous dilated lymphatic vessels or an obvious dermal back flow of right lower extremity was noted. The patient was kept on antibiotics after the procedure. There was no pain at the puncture site and no other complications were noted.

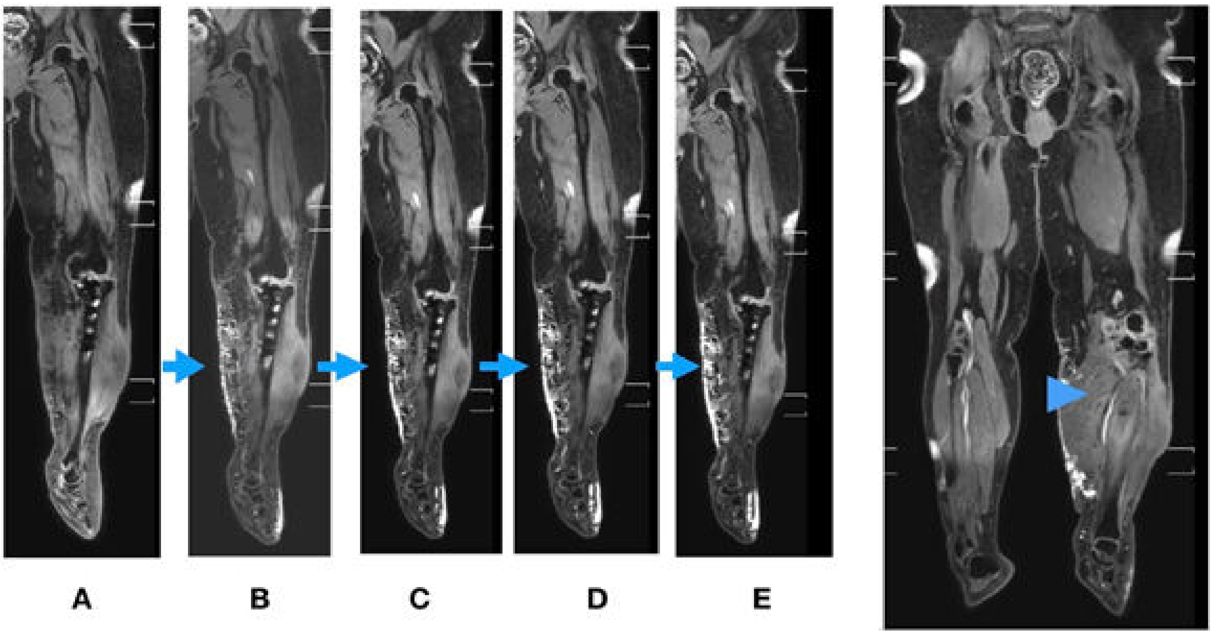

Figure 1. 3D MRI images obtained at 0 min (A) , 5 min (B), 15 min (C) 35 min (D) and 55 min (E) shows the dilated epifascial lymphatics (arrows) and a normal visualization of the veins (arrow head).

In summary, the MRI lymphangiography is a modality for diagnosing peripheral lymphedema, which can be seen as stagnation of the contrast media at the level of pathology in the affected limb, or congestion of contrast media in dilated lymphatic systems distal to obstructive point. Furthermore, the venous system can also be evaluated at the same time. MRL is considered noninvasive and more helpful for diagnosis and preoperative evaluation in a case of lymphedema for its better spatial and temporal resolution.

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ASEAN Movement in Radiology

Standard national high-resolution computed tomography (HRCT) Protocol/

A recommendation by The Royal College of Radiologists of Thailand (RCRT) and Thoracic Society of Thailand under Royal Patronage (T.S.T.)

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Diffuse interstitial lung diseases (ILDs) include more than hundreds of diseases which have different causes or underlying, target groups, signs and symptoms, clinical courses, radiographic appearances, treatments, and prognoses. Among them, idiopathic pulmonary fibrosis (IPF) is the most fatal, with prognosis worse than many types of cancer. After decades of no specific treatment, new medications that may help slow down the progression of the fibrosis have been introduced and approved in some countries. Similar to corticosteroid, anti-inflammatory and immunosuppressive drugs which are used to treat some ILDs; these antifibrotic medications could cause certain side effects. In contrast, the cost of treatment is much higher.

To monitor ILDs in terms of incidence, demographic and geographic distributions, and life expectancy; T.S.T. is developing a national ILD database. To ensure that the particular database will provide the most accurate information, diagnosis should be as precise as possible.

However, the diagnoses of most ILDs are multidisciplinary. With the facts that surgical lung biopsies are available in lower than 20% of patients in most countries[1], HRCT plays an important role in showing disease characters and extension. Certain HRCT patterns are accepted to replace surgical lung biopsies (SLBs) in some diseases.

Unfortunately, typical diagnostic HRCT patterns to replace SLB are not possible in all case, for example, only about half of usual interstitial pneumonia[2]. Initially, a diagnosis could not be made in some cases whose HRCT patterns are not specific and other clinical information is not sufficient. A longitudinal study by following up HRCTs and adding subsequently exhibited clinical data, or even surgical lung biopsy, could eventually establish the diagnosis. These patients need a system that provides a regular clinical and HRCT follow-up as well as the multidisciplinary team to evaluate newly acquired clinical and radiographic information .

Playing a significant role in managing patients with ILDs, standard HRCT is required to ensure that the initial examination will provide sufficient radiographic information where both the initial and follow-up examinations could be compared and the interpretation of all examinations is reproducible, and it could be performed in most institutes.

To develop a typical HRCT protocol; the current situation of interstitial lung diseases in Thailand, the purpose to develop the protocol, and a probable draft of the standard protocol (made by the committee from RCRT) were presented to a panel consisting of thoracic radiologist experts from all parts of Thailand in a meeting held on 11 January 2019 by Foundation of Orphan and Rare Lung Disease (FORD) and Imaging Academic Outreach Center (iAOC). Knowledge sharing, benefits and disadvantages of the drafted protocol were discussed. Adjustment was done based on feasibility, coverage of all lung diseases, diagnostic accuracy, and radiation safety.

The panel provided a recommended protocol describing scan coverage, technique, collimation, rotation time, pitch, radiation dose, and reconstruction images. The typical protocol recommends a mandatory acquisition for the first HRCT and optional or additional ones for follow-up or particular cases.

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Recommended HRCT Protocol for ILD: Version.1/2019

	Supine/Inspiration (Mandatory in both initial and follow-up)	Supine/Expiration (Mandatory in initial and optional in follow-up)	Prone/inspiration (Optional)
Scan coverage	Whole chest[1]	Whole chest[1]	limited to region of interest[2] (eg. lower chest) or Whole chest[1]
Technique	Volumetric[3]	Recommended: sequential4 (every 10- 20 mm interval) at end expiration Optional: If breath holding is not adequate or tracheobronchomalacia is suspected, volumetric scan during forced expiration is recommended with ultralow radiation dose (*) and highest pitch[7]	Recommended: sequential[4] (every 10-20 mm interval) Optional: If breath holding is not adequate, volumetric scan at the region of interest[2] is recommended with lower radiation dose and highest pitch[7]
Collimation	Thinnest (<1.5 mm)[5]	Thinnest (<1.5 mm)[5]	Thinnest (<1.5 mm)[5]
Rotation time	Shortest (<0.5 s)[6]	Shortest (<0.5 s)[6]	Shortest (<0.5 s)[6]
Pitch	Highest (>1)[7]	-	-
Radiation dose	120 kVp, auto mAs[8] (1-3 mSv)	120 kVp, 20-60 mAs[8] *100 kVp, 40-60 mAs[8] (<1 mSv)	120 kVp, 40-80 mAs[8] (<1 mSv)
Reconstruction[12]	1. Axial, lung-window[9] (high-spatial algorithm) ≤1.5 mm thickness overlap (30-50%)[9] 2. Axial, mediastinal-window[10] (low-spatial algorithm) ≤1.5 mm thickness overlap (30-50%) 3. Coronal[11], mediastinal-window (low-spatial algorithm), ≤1.5 mm thickness contiguous	Axial, lung-window[9] (high-spatial algorithm), ≤1.5 mm thickness	Axial, lung-window[9] (high-spatial algorithm), ≤1.5 mm thickness

Note WL/WW for lung-window setting: -450 to -600 HU/1450 to 1600 HU
WL/WW for mediastinal-window setting: 30 to 50 HU/350 to 450 HU
TBM = tracheobronchomalacia

Appendix

1,3 In order to increase rate of detection of even a small focal lesion, and to reformat multiplanar images for study of vertical distribution
2 In order to decrease radiation dose
4 In female and/or age < 45 year
5 Thinner than 1 mm is possible with increased noise
6,7 In order that the images are motion-free (shortest rotation time and highest pitch result in scan time of the whole chest less than 5 seconds)
8 Automatic exposure control which is available in most CT machines will automatically adjust mA according to the thickness of the region/ Automatic exposure control with indicated maximal dose or fixed low mA could be used in follow up. However, ultralow dose is not recommended in supine inspiratory HRCT
9 For more sharpness
10 In order to demonstrate associated mediastinal or soft tissue findings.
11 In order to study vertical distribution
12 Iterative reconstruction (IR) is recommended to decrease noise

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Common Artifacts in Southeast Asia

Learning history through porcelains

Chinese porcelain bowl exports in the second half of the Ming Dynasty and the shift in domestic production of earthenware in Southeast Asia

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Figure 1. (A) Side view (B) Top view

The blue and white porcelain bowls patterned and decorated as in Figure 1 could be commonly seen in museums and antique shops in Southeast Asian countries. A common characteristic was the approximately 6 inched diameter with the narrow lower part and the slightly expanded rim, adorned with blue color under glaze. The decorative pattern might slightly vary from one piece to another. For example, the porcelain in Figure 1 was bought from an Indonesian antique seller who asserted that it was discovered in a river. The outer part was painted with flower scroll design, with the blue lines encircled the outer lower part and the rim of the bowl. The inner part of the bowl was adorned with Vajara pattern inside the circle at the base in which the inner rim was adorned with the alternating pattern of crosses and dots. The evenly spread and thin matte which revealed its milky white porcelain clearly indicated that it was sunken under in the river for hundreds of years. A bowl with the mentioned characteristics is believed to be a product in the Ming Dynasty during the reign of the Hongzhi Emperor (1487-1505AD).

According to the timeline in Figure 2, at the time, the present-day Vietnam was ruled by Champa and Dai Viet Empires. Khmer Empire under its dark age was invaded by flourishing Siamese Ayuthaya Kingdom. At the same time, it was the first half of Burmese Empire and latter half of Majapahit Empire that ruled over the land of present day Indonesia before she entered the period in which islands of Indonesia were overwhelmingly filled with fleets from Spain and Portugal for hundreds of years.

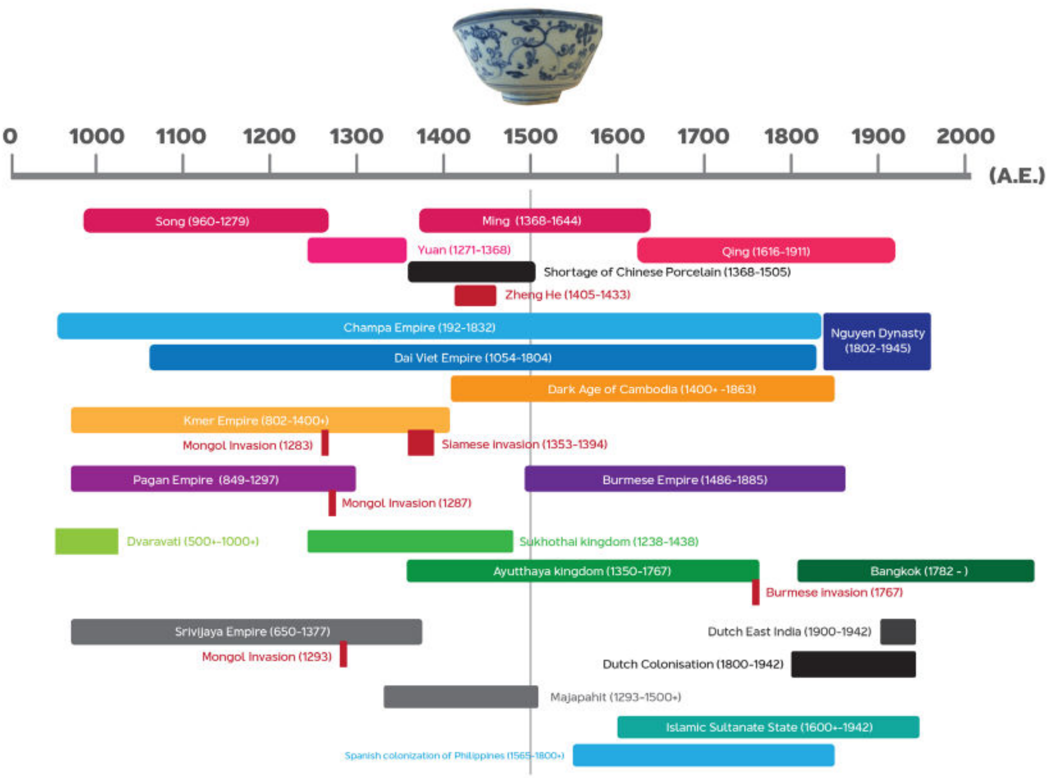

Figure 2: Timeline showing the dynastic rules In China and Southeast Asian empires.

The porcelain bowl market in Southeast Asia at that time was rapidly expanding and porcelain bowls along with the utensils were in a strong demand. They were mainly used as utensils for consumption by their virtue of being strong but light in weight while also not leaving undesirable smell and residue after the usage. Furthermore, the taste of food was not distorted by porcelain bowls. That is not all, some were even used in religious ceremonies as they were regarded as rare object owing to the improbability of being produced in Southeast Asia. For this reason, porcelain bowls also served as the status symbol of the affluent at that era as well as provided beauty with their intricately-shaped forms and luster coloration. The flourishing production, thriving trade and enormous demands can be apparently observed in the evidence of shipwreck and discovered kiln sites as shown in Figure 3.

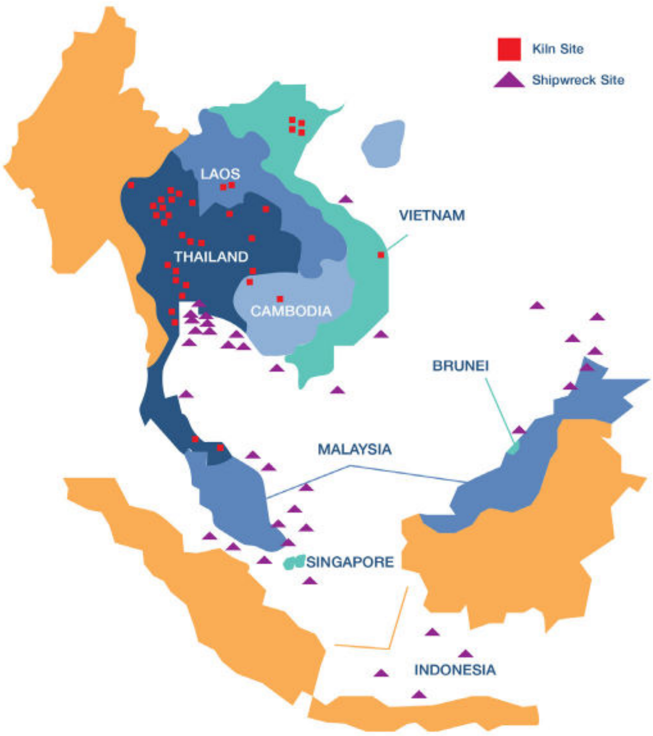

Figure 3. Kiln sites and shipwreck sites [1].

The Kiln sites could be found here and there in Southeast Asia with the highest numbers concentrated in the northern part, running down along the path of the river in the area of the modern day Thailand and sparsely distributed in the modern day Northern Laos and Vietnam. The shipwreck sites were highly concentrated in the Gulf of Thailand, the eastern part of The Malay Peninsula, Straits of Malacca, the Coast of the Philippines and the Southern Coast of Vietnam.

The prosperous domestic production of porcelain bowls in Southeast Asia as illustrated by the extensive numbers of shipwreck sites on the map which reached their peak during the beginning of the Ming Dynasty. The reason of the flourishing domestic production was due to stricter control of porcelain exports during the early Ming Dynasty due to the concern over its domestic security. (Porcelains were the largest exports of China which were among the other two most exported items including metal and silk.)

However, during the reign of the Hongzhi Emperor, the export rules of porcelain were no longer tightly regulated and the exports of Chinese porcelains became flourishing again. This caused the domestic production of porcelains in Southeast Asia to gradually close down and finally no longer operate in the reign of the Wanli Emperor (1572-1620 AD).

By carefully looking into porcelain bowls in Figure 1, we can conspicuously acknowledge the reason that this little bowl could led to the decline in domestic kiln sites. Looking in hindsight, around 500 years ago, kilns in Southeast Asia could only be used to produce heavy and thick earthenware which were mostly in a dull single color and lackluster glaze. The arrival of Chinese porcelain exports during the Hongzhi Emperor's reign with its "novelty" and "insurmountable beauty" made monumental changes in the market of bowls and utensils. Despite that, it was not only the novelty of the porcelain exports alone that marked the monumental changes in the market of bowls and utensils in Southeast Asia, but also improved transportation, lower cost and more convenient trading networks that performed as crucial catalyst to be taken into consideration regarding these changes as it's mentioned in the Chronicle of China that at the particular era, there was already a well-established network of Chinese merchants throughout Siam, Indonesia, and Malacca.

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