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Highlight

- Original Article
- Case Report
- Pictorial Essay
- ASEAN Movement in Radiology
- Acknowledgement of Reviewers

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From The Editor

Water, mosquitoes, and sugar

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The Asian Oceanian Congress of Radiology (AOCR) 2024 was held in Taipei by the Taiwan Radiological Society (TRS) during 23-25 March. Out of 2,978 registrations, participants from ASEAN countries ranked the second place after East Asian countries and those from South Asia took the third place. This is not a surprise as these three regions have more than 2,000 years of sea trading history with a very short interruption during the colonial time which took place for only a few decades. Geographically, the culture and the wealth of ASEAN countries, as they are located in Southeast Asia, should be closely related to those of the South and East Asian countries.

The editor with AOCR faculty in AOCR 2024, Chinese Taipei.

Songkran Festival in April is the traditional new year occasion in Thailand, Laos, Myanmar, and Cambodia as well as among minorities in Vietnam, China's Yunnan province and Sri Lanka. In Thailand, Songkran is marked as a family moment when young people express their gratitude to their parents and seniors by pouring fragrant water on their hands or parts of the body. This is the occasion that young people who work in cities travel across the countries to their hometowns to cerebrate and spend the special time with their families. Unfortunately, it is also the peak of road accidents in Thailand which now ranks number one in the world. The government, to promote safer road practices to reduce accidents, continues the 7-day road safety campaign, which covers the Songkran Festival period from 11 April to 17 April, for many years. This year, on the final day of the campaign, there were 2,044 mishaps leading to 2,060 injuries and a tragic losses of 287 lives [1]. Speeding was identified as the leading cause of these accidents, accounting for 37.6%, while drink-driving (23.9%) and reckless lane-switching (21%) followed closely [2]. Thailand post-Songkran period has also seen a rise in COVID-19 infection, as well as Influenza which is also widespread with 128,156 cases reported since the start of the year [3].

After Songkran was the World Malaria Day on 25 April. In 2022, the World Health Organization (WHO) reported 608,000 deaths from 249 million cases of malaria, a mosquito-borne infectious disease, across 85 countries. Accordingly, Thailand is striving to eliminate malaria from 2017 to 2026. Currently, 49 out of 76 provinces in Thailand are malaria-free. Since January, 2,913 infections have been identified, largely among foreign residents living at the border of the country accounting for 60% of the cases [4].

Dengue fever and Zika virus, also transmitted by mosquitoes, were on the rise. Dengue fever in Thailand showed a 2.2-fold increase over the same period last year, according to the Disease Control Department [5]. Of the total of 24,108 cases, the primary sufferers are children aged 5 to 14 and of the 22 fatalities, people over 65 years old were the most major group [3]. Noted with deepest condolences, among 22 deaths is a female doctor in Songklanagarind Hospital with which I am affiliated, Songkhla Province. The Zika virus affected at least 758 individuals in 36 provinces across the country [6].

On March 4, three cases of anthrax were identified in the Champasak, a Laos province which shares a border with northeastern Thailand, raising concerns for potential cross-border transmission [7]. Transmission to humans is by consumption of uncooked meat from contaminated animals. Surveillance measures and checks for smuggled livestock along the Thai-Lao border were ordered while reports any sudden animal deaths from farmers were requested, and vaccines were prepared.

As excessive sugar consumption is one of the risks in developing non-communicable diseases such as heart attack, strokes, cancer and diabetes, a collaboration among organizations including the Thai Health Promotion Foundation, the Excise Department, Ministry of Finance and Ministry of Public Health imposed a sugar tax under the Excise Act 2017, targeting drinks with high sugar content. The result was a 35% surge in sales of beverages with lower sugar content and a significant decrease in the overall sugar consumption. However, Thai citizens still consume on average 23 teaspoons of sugar per day, almost quadruple the daily limit of six spoons per day recommended by the WHO [8].

Lured by the appealing designs of the devices and the extensive range of flavours, rapid popularity of e-cigarettes among Thai youths, despite their illegality under Thai law, was generally witnessed. Online marketing strategies, advertisement methods, lower prices and being able to be used repeatedly had also contributed to the surge [9]. Because the level of awareness about the real health impact of e-cigarette use remains relatively low, the Medical Association of Thailand with the Royal Colleges of physicians will officially state their concerns on the spread of use, harms of use to health, and support the government to ban the sales according to WHO's call to action [10].

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References

1. ASEAN NOW. c.2002-2024 [cited 2024 Apr 20]. Songkran ends with 243 deaths in traffic accident. Available from: https://aseannow.com/topic/1325346-songkran-festival-sees-surge-in-road-accidents-across-thailand/

2. ASEAN NOW. c2002-2024 [cited 2024 Apr 20]. Songkran festival sees surge in road accidents across Thailand. Available from: https://aseannow.com/topic/1325172-songkran-festival-ends-with-243-deaths-in-traffic-accidents/

3. ASEAN NOW. c2002-2024 [cited 2024 Apr 20]. 30 deaths from heatwave in Thailand. Available from: https://aseannow.com/topic/1325872-30-deaths-from-heatwaves-in-thailand/

4. ASEAN NOW. c2002-2024 [cited 2024 Apr 20]. Rise in malaria cases spurs action in Thailand. Available from: https://aseannow.com/topic/1325958-rise-in-malaria-cases-spurs-action-in-thailand/

5. Thai PBS World. c2018 [cited 2024 Apr 20]. Dengue fever cases in Thailand on the rise. Available from: https://www.thaipbsworld.com/dengue-fever-cases-in-thailand-on-the-rise/

6. nnt.thainews. c2022 [cited 2024 Apr 20]. Zika virus cases rise in Northeast Thailand. Available from: https://thainews.prd.go.th/nbtworld/news/view/31937/?bid=1

7. The Thaiger. 2024 [cited 2024 Apr 20]. Anthrax outbreak in Laos prompts raw meat warning in Thailand. Available from: https://thethaiger.com/news/national/anthrax-outbreak-in-laos-prompts-raw-meat-warning-in-thailand

8. The Thaiger. 2024 [cited 2024 Apr 20]. Anthrax outbreak in Laos prompts raw meat warning in Thailand. Available from: https://thethaiger.com/news/national/thailands-sugar-intake-quadruples-who-daily-limit-causing-health-concerns

9. The Thaiger. 2024 [cited 2024 Apr 20]. Thailand's CPPD calls for collective action against youth vaping. Available from: https://thethaiger.com/news/national/thailands-cppd-calls-for-collective-action-against-youth-vaping

10. World Health Organization. 2024 [cited 2024 Apr 20]. Electronic cigarettes: call to action. Available from: https://www.who.int/publications/m/item/electronic-cigarettes---call-to-action

Original Article

Radiographic features and molecular subtypes association of breast cancer in women younger than 40 years old

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Abstract

Background: Breast cancer is the most commonly diagnosed cancer and the leading cause of cancer death among females, particularly in women under the age of 40 years. However, early detection of breast cancer in this population remains challenging and it tends to present at a later stage with poorer prognosis.

Objective: To review mammographic and ultrasonographic findings, pathological features and molecular subtypes of breast cancer in younger than 40-year-old patients diagnosed in King Chulalongkorn Memorial Hospital and to determine which radiological characteristics are associated with molecular subtypes.

Materials and Methods: The study included 278 patients aged under 40 years who were diagnosed with breast cancer and underwent mammographic and ultrasonographic studies between January 2009 and December 2019. A retrospective review of mammographic and ultrasonographic findings, histopathological reports as well as biological markers were made. The association of radiological characteristics and molecular subtypes was analyzed by SPSS.

Results: In the 278 patients, the most common clinical presentation was palpable mass (268, 96.4%). The common mammographic findings were irregular shape mass (196, 77.8%) with hyperdensity (114, 45.2%) and an obscured margin (99, 39.3%). Presenting of microcalcification is not frequent (122, 48.4%). We found 27 patients with normal mammograms which were later detected in ultrasounds as 25 masses, 1 intraductal lesion and 1 focal duct change. The predominant ultrasonographic features were irregular shape mass (257, 91.5%), an angular margin (89, 31.7%), hypoechogenicity (198, 70.5%), no posterior feature (210, 74.7%) and internal vascularity (170, 60.5%). These radiological characteristics were classified as BI-RADS 5 in 194 lesions (69%). The most common histopathological type was mixed-type carcinoma (143, 50.9%), followed by invasive ductal carcinoma (114, 40.6%). Luminal B was the mostly found in this study (86, 30.6%). The patients frequently presented with stage IIA (91, 32.7%) while 15 patients were detected with an advanced stage at the first presentation. We found that triple negative, HER 2 overexpression and luminal B subtypes were associated with an obscured mass on mammography (p 0.048). Luminal B and HER 2 overexpression subtypes were also associated with the presence of fine pleomorphic microcalcification (p <0.001).

Conclusion: In this study, we found an association of the mass margin and suspicious calcification morphology on mammography with molecular subtypes. It would be helpful for further clinical management in young patients. The knowledge can be used for planning appropriate treatments according to molecular subtypes which are associated with these characteristics. However, the precision of cancer treatment is still based on the tissue diagnosis.

Keywords: Breast cancer, Breast imaging, Histopathological type, Molecular subtype, Young women.

Introduction

Among females, breast cancer is the most commonly diagnosed cancer and the leading cause of cancer death [1-2]. Around 6.6% of all breast cancer cases are diagnosed in women less than 40 of age [3-5]. Although the diagnosis of breast cancer is much less common among young women, it can have a greater impact than in older counterparts, as it tends to present at a later stage, being more aggressive and having a poorer prognosis [3].

Screening recommendations for women younger than 40 years old are less clearly defined. In addition, younger women tend to have dense breasts and early detection of breast cancer in this population remains a challenge [6]. The radiological characteristics of breast cancer in young women can vary and there are different imaging findings according to the histopathological types. The prior studies also found a high frequency of young breast cancer with biologically more aggressive tumors, a negative hormone receptor, HER 2 overexpression, a late diagnosis and an unfavorable prognosis. However, the precise distribution of poor prognosis features in this population remains unclear.

Therefore, the purpose of this study is to review the radiological characteristics, pathological features and molecular subtypes of breast cancer in patients younger than 40 years old diagnosed in King Chulalongkorn Memorial Hospital and to evaluate the radiological characteristics associated with molecular subtypes.

Materials and methods

Population

This retrospective study was approved by the institutional review board. We collected data from 591 female patients younger than 40 years old who were newly diagnosed with breast cancer (ICD-10 code C50) at King Chulalongkorn Memorial Hospital between January 2009 and December 2019. After excluding patients that had previously undergone a breast surgery or post neoadjuvant chemotherapy, had had imaging as well as lacked radiological and pathological data, a total of 278 patients who were first diagnosed with breast cancer were available and fit the characterestics needed.

Diagnostic Imaging

A whole breast ultrasonography was performed in all cases by on-site breast radiology specialists using a high-resolution linear-array transducer with a maximum frequency of at least 12-15MHz (GE Medical Systems, Philips, or Supersonic imagine). Mammograms were performed with routinely standard craniocaudal (CC) and mediolateral oblique (MLO) views (Hologic 3Dimension).

Radiographic and histopathological data analysis

A retrospective review of the patients' data including patient characteristics, clinical presentations, risk factors according to the American Cancer Society in 2019 [7], histopathology and staging according to the American Joint Committee on Cancer (AJCC) cancer staging manual 8th edition in 2017 [8] and the World Health Organization (WHO) classification of breast cancer 2012 [9], an estrogen receptor (ER), a progesterone receptor (PR), the HER2 status from histopathological reports, and molecular subtypes, were collected and categorized.

The mammogram and ultrasound were retrospectively reviewed together by an in-training diagnostic radiology resident and a radiologist with 12 years of experience in breast imaging with blind histopathology. The radiographic features including breast density, characteristics of masses, microcalcifications and associated findings (e.g., asymmetries, axillary lymphadenopathy, architectural distortion, skin thickening, nipple or skin retraction) were recorded according to American College Radiology (ACR) BI-RADS Atlas, 5th edition in 2013 [10]. A consensus was made in case of disagreement.

Statistical analysis

The radiographic data, histopathological and molecular subtype data were categorized and calculated in terms of the association between the radiographic group and the molecular subtype group. The significant association was examined using Fisher's exact test by SPSS version 28 (Statistical Package for the Social Sciences, IBM Corporation, United States). A value of $p<0.05$ is accepted as statistically significant. Continuous variables were summarized as mean with standard deviation, while categorical variables were performed as counts and percentages.

Results

Patient data

There were 278 patients ranging who were 18 to 39 years old with the mean age of about 34.9 years old (SD 3.64). The clinical presentations were palpable breast masses in 268 (96.4%) patients, nipple discharge in 7 patients (2.5%) and 3 patients remained asymptomatic (1.1%). In the 278 patients, 3 (1.1%) patients presented with bilateral breast masses which later were proven as cancer, bilaterally. Furthermore, six patients had risk factors of breast cancer including three patients who had genetic predisposition (BRCA1 gene and Li-Fraumeni syndrome), one patient with a history of contralateral breast cancer, one patient with a history of hormonal use and one patient with a history of chest wall radiation. We also found 4 patients, who had undergone breast augmentation.

In our study, a mammogram and an ultrasound were performed with 250 (89.9%) patients, while 28 (10.1%) patients only had an ultrasound. Lastly, there were a total of 281 proven cancerous lesions in the 278 patients. We found 252 lesions on the mammogram results in 250 patients who underwent mammograms with ultrasounds. Also, there were 27 (10.7%) in 252 lesions that had a negative mammogram, but the abnormalities were detected by an ultrasound. Most of the lesions were BI-RADS 5 (194, 69%). The most common stage of breast cancer at first presentation was IIA at about 91 (32.7%) patients. Moreover, 15 patients had the advanced stage at presentation with 2 liver, 1 lung, 1 nodal, 3 bone and 8 multi-organ metastases. Regarding histopathology, mixed-type carcinoma (e.g., IDC with DCIS, IDC with papillary carcinoma or IDC with mucinous carcinoma) in 143 (50.9%) lesions and luminal B subtype in 86 (30.6%) lesions were mostly found. The details of demographic data are shown in Table 1 and details of histopathology, molecular subtypes and the stage of cancer are shown in Table 2.

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Table 1. *Demographic data.*

Characteristics (Total = 278 patients)	Number (%)
Mean age (years ± SD)	34.9 ± 3.64
Clinical presentation	
- Palpable mass	268 (96.4%)
- Nipple discharge	7 (2.5%)
- Asymptomatic/Screening	3 (1.1%)
Risk factors	
- Family history of breast cancer/genetic predisposition	3
- History of contralateral breast cancer	1
- History of hormonal used	1
- History of chest wall radiation	1
Breast side	
- Right	143 (51.4%)
- Left	132 (47.5%)
- Bilateral	3 (1.1%)
Imaging modality	
- Ultrasound only	28 (10.1%)
- Mammogram with ultrasound	250 (89.9%)
BI-RADS assessment (Total = 281 lesions)	
- category 4A	11 (3.9%)
- category 4B	30 (10.7%)
- category 4C	46 (16.4%)
- category 5	194 (69%)

Table 2. *Histopathology, molecular subtypes, and stages of breast cancer.*

Characteristics	Number (%)
Histopathological types (Total = 281 lesions)	
- DCIS	11 (3.9%)
- invasive ductal carcinoma (IDC)	114 (40.6%)
- invasive lobular carcinoma (ILC)	2 (0.7%)
- Mixed-type carcinoma	143 (50.9%)
- Mucinous type	7 (2.5%)
- Papillary type	3 (1.1%)
- Other	1 (0.4%)
Molecular subtypes (Total = 281 lesions)	
- Luminal A	62 (22.1%)
- Luminal B	86 (30.6%)
- Luminal B/HER 2 positive	29 (10.3%)
- HER 2 overexpression	58 (20.6%)
- Triple negative	46 (16.4%)
Stage of breast cancer at presentation (Total = 278 patients)	
- stage 0	11 (4.0%)
- stage IA	68 (24.5%)
- stage IB	1 (0.4%)
- stage IIA	91 (32.7%)
- stage IIB	43 (15.5%)
- stage IIIA	28 (10.1%)
- stage IIIB	8 (2.9%)
- stage IIIC	13 (4.7%)
- stage IV	15 (5.4%)

Mammographic findings
225 proven cancerous lesions were detected from 252 lesions on mammograms. The detail of mammographic findings is summarized in Table 3. The breast composition in mammographic studies was mostly heterogeneously dense and extremely dense breasts in which about 183 (65.1%) and 68 (24.2%) patients were found with the conditions, respectively.

The most common abnormality, which was seen on mammography was masses in 200 (79.4%) lesions, followed by suspicious calcifications in 122 (48.4%) lesions. Most of the masses in mammographic findings were irregular shapes at about 196 (77.8%) lesions and the rest were an oval shape in 4 (1.6%) lesions, while 52 (20.6%) studies were non-visualized masses. The density of masses included 114 (45.2%) hyperdensity (as compared to the density of the fibroglandular tissue) and 86 (34.1%) isodensities. The margins of these masses were obscured margins in 99 (39.3%) masses, spiculated margins in 45 (17.9%), indistinct margins in 30 (11.9%), microlobulated margins in 25 (9.9%) and the least commonly found was circumscribed margins, found in 1 (0.4%) mass.

Table 3. *Mammographic findings.*

Characteristics (Total = 252 lesions)	Number (%)
Normal	27 (10.7%)
Breast composition	
- scattered areas of the fibroglandular tissue	1 (0.4%)
- extremely dense	68 (27%)
- heterogeneously dense	183 (72.6%)
Mass	200 (79.4%)
Mass shape	
- oval	4 (1.6%)
- irregular	196 (77.8%)

Characteristics (Total = 252 lesions)	Number (%)
Mass margin	
- circumscribed	1 (0.4%)
- obscured	99 (39.3%)
- microlobulated	25 (9.9%)
- indistinct	30 (11.9%)
- spiculated	45 (17.9%)
Mass density	
- high	114 (45.2%)
- equal	86 (34.1%)
Suspicious calcification morphology	
- amorphous	19 (7.5%)
- coarse heterogeneous	11 (4.4%)
- fine pleomorphic	87 (34.5%)
- fine linear or branching	5 (2%)
- no suspicious calcification	130 (51.6%)
Distribution of calcifications	
- diffuse	1 (0.4%)
- regional	5 (2.0%)
- grouped	80 (31.7%)
- linear	2 (0.8%)
- segmental	34 (13.5%)
Asymmetries	
- focal asymmetry	4 (1.6%)
- global asymmetry	1 (0.4%)
Skin thickening/retraction	30 (11.9%)
Architectural distortion	61 (24.2%)
Nipple retraction	16 (6.3%)
Axillary lymphadenopathy	79 (31.3%)

Regarding the association between the mass margin on mammography and molecular subtypes, triple negative, HER 2 overexpression and luminal B subtypes were associated with the obscured mass on mammography with the p-value of 0.048 (22 lesions [52.4%], 23 lesions [46%] and 30 lesions [37.5%], respectively) as demonstrated in Table 4. We also found irregular masses were frequently in luminal B subtype (62 lesions, 77.5%). However, the mass shapes on mammograms did not show a statistically significant association with the molecular subtype (p-value 0.216).

Table 4. *Association between radiographic findings and molecular subtypes.*

Characteristics	Molecular subtypes				
	Luminal A	Luminal B	Luminal B / HER 2	HER 2 overexpression	Triple negative
Mass shape on mammography					
- oval	2 (3.6%)	2 (2.5%)	-	-	-
- irregular	37 (67.3%)	62 (77.5%)	21 (84%)	38 (76%)	38 (90.5%)
- no	16 (29.1%)	16 (20%)	4 (16%)	12 (24%)	4 (9.5%)
	P = 0.216				
Mass margin on mammography					
- circumscribed	1 (1.8%)	-	-	-	-
- obscured	19 (34.5%)	30 (37.5%)	5 (20%)	23 (46%)	22 (52.4%)
- microlobulated	3 (5.5%)	11 (13.8%)	3 (12%)	2 (4%)	6 (14.3%)
- indistinct	5 (9.1%)	6 (7.5%)	6 (24%)	6 (12%)	7 (16.7%)
- spiculated	11 (20%)	17 (21.3%)	7 (28%)	7 (14%)	3 (7.1%)
- no	16 (29.1%)	16 (20%)	4 (16%)	12 (24%)	4 (9.5%)
	P = 0.048				
Suspicious calcification morphology on mammography					
- amorphous	5 (9.1%)	6 (7.5%)	2 (8%)	5 (10%)	1 (2.4%)
- coarse heterogeneous	2 (3.6%)	4 (5%)	1 (4%)	3 (6%)	1 (2.4%)
- fine pleomorphic	12 (21.8%)	36 (45%)	14 (56%)	20 (40%)	5 (11.9%)
- fine linear or branching	1 (1.8%)	1 (1.3%)	1 (4%)	2 (4%)	-
- no suspicious calcification	35 (63.6%)	33 (41.3%)	7 (28%)	20 (40%)	35 (83.3%)
	P = <0.001				

Characteristics	Molecular subtypes				
	Luminal A	Luminal B	Luminal B / HER 2	HER 2 overexpression	Triple negative
Mass shape on ultrasonography					
– oval	3 (4.8%)	1 (1.2%)	-	1 (1.7%)	3 (6.5%)
- irregular	56 (90.3%)	77 (89.5%)	26 (89.7%)	55 (94.8%)	43 (93.5%)
- intraductal lesion	2 (3.2%)	3 (3.5%)	3 (10.3%)	1 (1.7%)	-
- no	1 (1.6%)	5 (5.8%)	-	1 (1.7%)	-
			P = 0.217		
Mass margin on ultrasonography					
- circumscribed	2 (3.2%)	1 (1.2%)	-	-	2 (4.3%)
- indistinct	17 (27.4%)	21 (24.4%)	5 (17.2%)	13 (22.4%)	15 (32.6%)
- angular	18 (29%)	25 (29.1%)	10 (34.5%)	24 (41.4%)	12 (26.1%)
- microlobulated	9 (14.5%)	16 (18.6%)	4 (13.8%)	10 (17.2%)	15 (32.6%)
- spiculated	13 (21%)	15 (17.4%)	7 (24.1%)	9 (15.5%)	2 (4.3%)
- no	3 (4.8%)	8 (9.3%)	3 (10.3%)	2 (3.4%)	-
			P = 0.116		
Mass echogenicity on ultrasonography					
- complex cystic/solid	1 (1.6%)	-	-	-	1 (2.2%)
- hypoechoic	43 (69.4%)	61 (70.9%)	24 (82.8%)	39 (67.2%)	31 (67.4%)
- isoechoic	3 (4.8%)	-	1 (3.4%)	-	1 (2.2%)
- heterogeneous	14 (22.6%)	20 (23.3%)	4 (13.8%)	18 (31%)	13 (28.3%)
- no	1 (1.6%)	5 (5.8%)	-	1 (1.7%)	-
			P = 0.232		
Mass posterior features on ultrasonography					
- enhancement	4 (33.3%)	3 (25%)	-	1 (8.3%)	4 (33.3%)
- shadowing	8 (19%)	13 (31%)	1 (2.4%)	13 (31%)	7 (16.7%)
- combined	2 (11.8%)	7 (41.2%)	-	3 (17.6%)	5 (29.4%)
- no posterior feature	48 (22.9%)	63 (30%)	28 (13.3%)	41 (19.5%)	30 (14.3%)
			P = 0.144		

Furthermore, suspicious calcifications were found in 122 (48.4%) lesions, including fine pleomorphic microcalcification in 87 (34.5%) lesions, amorphous microcalcification in 19 (7.5%) lesions, coarse heterogeneous microcalcification in 11 (4.4%) lesions and fine linear microcalcification in 5 (2.0%) lesions. The most major distribution of calcification was grouped, which was seen in 80 (31.7%) lesions. There was a statistically significant association between suspicious calcification morphology on mammography and molecular subtypes with a p-value of <0.001, as shown in Table 4. The presence of fine pleomorphic microcalcification was associated with luminal B and HER 2 overexpression subtypes (36 lesions [45%] and 20 lesions [40%], respectively). The majority of triple negative and luminal A lesions were associated with masses without calcification (35 lesions [83.3%] and 35 lesions [63.6%], respectively).

Asymmetries were not frequently discovered in this study. Only 4 (1.6%) lesions detected focal asymmetry and 1 (0.4%) global asymmetry were observed. The other associated findings included skin thickening or retraction in 30 (11.9%) lesions, architectural distortion in 61 (24.2%) lesions and nipple retraction in 16 (6.3%) lesions. Axillary node enlargement on mammograms was seen in 79 (31.3%) lesions. In some mammographic studies showed benign appearing axillary nodes, but ultrasonography could detect the abnormalities as enlarged nodes, loss of fatty hilum, a thickened cortex or a rounded shape.

In this study, there were 27 negative mammographic findings and abnormalities were later detected by ultrasonography, which included 25 masses, 1 intraductal mass and 1 focal duct change. All lesions were proven as cancer. Among these negative mammograms, extremely dense breast tissues were seen in 16 lesions (59.3%).

Ultrasonographic findings

There were 281 proven cancerous lesions in 278 patients who underwent an ultrasound. Ultrasonographic findings are depicted in Table 5. In 265 (94.3%) masses on the ultrasonography were 257 (91.5%) an irregular shape and 8 (2.8%) an oval shape. We also found 9 (3.2%) intraductal lesions. The most common characteristics of masses were angular margins in 89 (31.7%) masses, followed by indistinct margins in 71 (25.3%) masses. Most of the masses were non-parallel orientations (253, 90%). The echogenicity of masses was hypoechogenicity in 198 (70.5%) masses, heterogeneous echogenicity in 69 (24.6%) masses, isoechogenicity in 5 (1.8%) masses and complex cystic/solid in 2 (0.7%) masses.

Table 5. *Ultrasonographic findings.*

Characteristics (Total = 281 lesions)	Number (%)
Mass	265 (94.3%)
Intraductal lesion	9 (3.2%)
No mass	7 (2.5%)
Mass shape	
- oval	8 (2.8%)
- irregular	257 (91.5%)
Mass orientation	
- parallel	12 (4.3%)
- not parallel	253 (90%)
Mass margin	
- circumscribed	5 (1.8%)
- indistinct	71 (25.3%)
- angular	89 (31.7%)
- microlobulated	54 (19.2%)
- spiculated	46 (16.4%)
Mass echogenicity	
- complex cystic/solid	2 (0.7%)
- hypoechoic	198 (70.5%)
- isoechoic	5 (1.8%)
- heterogeneous	69 (24.6%)

Characteristics (Total = 281 lesions)	Number (%)
Mass posterior feature	
- no posterior feature	210 (74.7%)
- enhancement	12 (4.3%)
- shadowing	42 (14.9%)
- combined	17 (6%)
Vascularity	
- absent	76 (27%)
- internal vascularity	170 (60.5%)
- vessels in rim	35 (12.5%)
Calcification	
- in mass	108 (38.4%)
- outside of mass	8 (2.8%)
- intraductal calcifications	16 (5.7%)
Axillary lymphadenopathy	92 (32.7%)
Duct changes	74 (26.3%)
Architectural distortion	29 (10.3%)
Skin thickening/retraction	18 (6.4%)
Edema	3 (1.1%)

Almost all of the masses were no posterior features, which were found in 210 (74.7%) masses, followed by posterior shadowing (42, 14.9%). The mass with internal vascularity was the most frequently observed, at about 170 (60.5%) lesions, followed by masses with vessels in the rim (35, 12.5%) and absent vascularity (76, 27%). There were 108 (38.4%) masses with internal calcification, 16 (5.7%) intraductal calcification and the others were calcification outside of the masses (8, 2.8%). Ultrasound was a useful modality to detect lesions, especially in young patients with dense breasts, whose masses could be occulted on mammograms (Figure 1 and Figure 2).

In this study, there was no statistically significant association between ultrasonographic findings and molecular subtypes as demonstrated in Table 4.

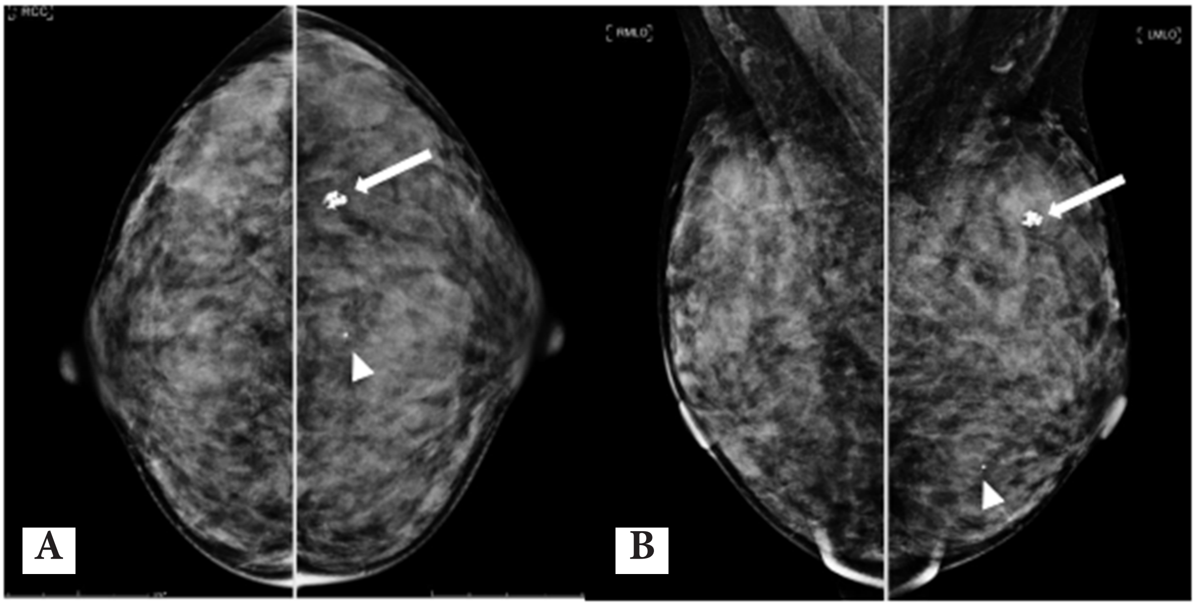

Figure 1. *Mammography of bilateral CC (A) and MLO (B) views of a 36-year-old female presented with palpable multiple bilateral breast masses revealed extreme density in both breasts, which may obscure small masses. There were a popcorn calcification at LUOQ (white arrow) and a group of coarse heterogeneous calcifications at the left lower mid part (arrowhead).*

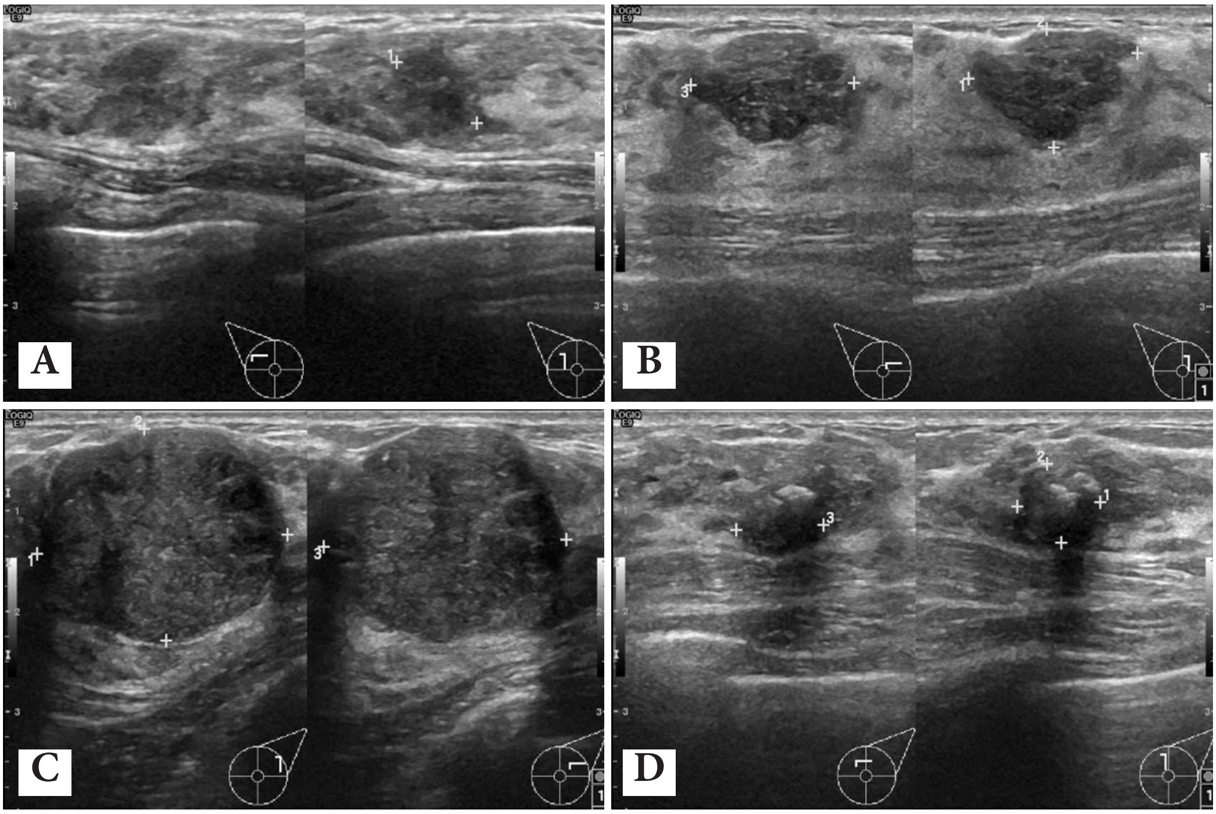

Figure 2. *Ultrasonography of both breasts of the same patient in Figure 1 showed multiple varying sized masses in both breasts. Two irregular hypoechoic masses with an angular margin at RUOQ and RUIQ, (A and B), respectively, high suspicion for malignancy (BI-RADS 4C). A well-circumscribed round-shape hypoechoic mass at LUOQ (C) and a well-circumscribed hypoechoic mass with internal macrocalcification at the left upper mid part (D), likely degenerating fibroadenoma. Histopathology at RUOQ and RUIQ masses revealed invasive ductal carcinoma with DCIS (luminal A) (A and B).*

Discussion

Breast cancer in younger women or younger than 40 years old is challenging in diagnosis and treatment. In this age group, there tends to be a late diagnosis, a more aggressive tumor and a poor prognosis [3, 11-15]. The high percentage of these patients presented with advanced stage breast cancer perhaps due to the absence of a screening protocol for patients under the age of 40 years old. Moreover, the diagnosis is challenging because of relatively denser breast parenchyma on mammograms which could obscure the lesions [16].

The most common presentation in women under 40 years old in this study was palpable masses (96.4%), which was similar to many previous studies. Mammographic findings frequently found in our study were irregular masses (77.8%), obscured margins (39.3%), followed by spiculated margins (17.9%), and fine pleomorphic microcalcification (34.5%), were consistent with the findings of previous studies [5, 14]. The most common ultrasonographic findings were irregular shape masses (91.5%), angular margins (31.7%), hypoechogenicity (70.5%), no posterior feature (74.7%) and internal vascularity (60.5%), which also resemble prior studies [5, 13, 17]. Radiographic data was assessed according to ACR BI-RADS 5th edition [10]. We found a majority of lesions (194, 69%) were categorized as highly suggestive for malignancy (BI-RADS 5) in line with the results of previous studies [11]. These radiographic findings of suggestive malignant lesions were similar findings in older women.

Additionally, we found these patients were more likely to be diagnosed with stage IIA (32.7%), similar to a prior study [6]. Nevertheless, 15 patients presented with advanced stage cancer and 8 of them had multi-organ metastases (e.g., liver, lung, bone, brain or lymph node). These patients represented a late diagnosis and a more aggressive tumor in young women; thus, early detection and increase awareness of breast cancer in this age group could be the principal management.

According to association between mammographic findings and molecular subtypes, in previous studies reported that significantly more spiculated masses found in the luminal subtype and HER 2 overexpression subtype tumors significantly correlated with the presence of calcifications [17]. Our study also showed a statistically significant association between the presence of fine pleomorphic microcalcification with luminal B and HER 2 overexpression subtypes (p <0.01) in the agreement with the prior study [17]. We also found triple negative and luminal A subtypes lesions were associated with masses without calcification, similar to the previous study [13].

Additionally, the present study showed that triple negative, HER 2 overexpression and luminal B subtypes were associated with obscured masses on mammography (p 0.048), which was inconsistent with the previous study [17]. Irregular masses were frequently in luminal B subtypes in this study, but did not show a statistically significant association with molecular subtypes.

According to the association between ultrasonographic features and molecular subtypes, Junwoo Kim et al. [13] revealed triple negative subtypes were significantly found with a posterior enhancement compared with the other molecular subtypes. Bullier B et al. [17] reported that triple negative cancers significantly more often had a round-oval shape compared to other phenotypes that were irregular and had circumscribed-microlobulated-indistinct margins compared to luminal phenotypes that were angular or spiculated. In our study, triple negative subtypes were predominant in masses with indistinct margins (32.6%) which were the same as ones with microlubulated margins (32.6%). This finding was similar to the prior study [17], but did not show a statistical significance in association. Furthermore, we found most of all molecular subtype lesions showed no posterior feature which disagrees with the previous study [13]. However, the molecular subtypes did not show a significant association with any ultrasonographic findings in our study.

Collins et al. [15] showed no significant differences in the molecular phenotype, the tumor stage or the grade among the different age groups of young women. Similarly, Erić et al. [8] found no difference in cancer laterality in both younger and older groups. In our study, the most common histological type was mixed-type carcinoma (50.9%) and no-special type invasive ductal carcinoma (40.6%), which resemble many prior studies [11, 14, 17-18]. Regarding the molecular subtype, luminal B was the most common (30.6%), followed by luminal A (22.1%) and HER 2 overexpression (20.6%), similar to Collins et al. reporting in their large cohort study that luminal B type is the most prevalent (35%) in young breast cancer patients compared to the general population. On the other hand, some previous studies showed more prevalence of triple negative subtypes [4, 11-12].

Mammography sensitivity is decreased in young women because of the higher breast tissue density, which can obscure breast masses [5, 19]. Therefore, ultrasonography is a useful initial modality for the diagnosis of breast cancer in young age group because with more sensitivity [15] and reduced accumulation of radiation in young women. In the current study, ultrasonography could detect abnormalities in all patients, while we found mammographically missed lesions in 27 patients (10.7%). Thus, we also agree with many studies before that recommended ultrasonography as the primary diagnostic tool for young patients.

There were some limitations of this study because it had a retrospective design and was a single center study. Further data collection should be taken into consideration for further research.

Conclusion

In this study, we found that the mass margins and suspicious calcification morphology on mammography were significantly associated with molecular subtypes, so it would be helpful for further clinical management in young patients. For example, if mammographic findings of young patients with palpable breast masses, showing irregular masses with obscured margins and internal fine pleomorphic microcalcification, clinician could be planning the treatment for the luminal B or HER 2-overexpression tumor which was associated with these characteristics. However, the precision of cancer treatment was still based on tissue diagnosis.

Conflicts of Interest

The authors declare that there is no conflict of interest.

References

1. Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin 2018;68:394-424. doi: 10.3322/caac.21492.

2. Paluch-Shimon S, Pagani O, Partridge AH, Bar-Meir E, Fallowfield L, Fenlon D, et al. Second international consensus guidelines for breast cancer in young women (BCY2). Breast 2016;26:87-99. doi: 10.1016/j.breast.2015.12.010.

3. Assi HA, Khoury KE, Dbouk H, Khalil LE, Mouhieddine TH, El Saghir NS. Epidemiology and prognosis of breast cancer in young women. J Thorac Dis 2013;5 Suppl 1:S2-8. doi: 10.3978/j.issn.2072-1439.2013.05.24.

4. Anders CK, Johnson R, Litton J, Phillips M, Bleyer A. Breast cancer before age 40 years. Semin Oncol 2009;36:237-49. doi: 10.1053/j.seminoncol.2009.03.001.

5. Durhan G, Azizova A, Önder Ö, Kösemehmetoğlu K, Karakaya J, Akpınar MG, et al. Imaging Findings and Clinicopathological Correlation of Breast Cancer in Women under 40 Years Old. Eur J Breast Health 2019;15:147-52. doi: 10.5152/ejbh.2019.4606.

6. Gillman J, Batel J, Chun J, Schwartz S, Moy L, Schnabel F. Imaging and clinicopathologic characteristics in a contemporary cohort of younger women with newly diagnosed breast cancer. Cancer Treat Res Commun 2016;9:35-40.

7. American Cancer Society. Cancer facts and figures 2019. Atlanta: American Cancer Society; 2019.

8. Hortobagyi GN, Connolly JL, D'Orsi CJ, Edge SB, Mittendorf EA, Hope S, et al. Breast. In: Amin MB, Edge S, Greene F, Byrd DR, Brookland RK, Washington MK, et al, editors. 8th ed. New York: Springer; 2017. p. 589-628.

9. Lakhani SR, Ellis IO, Schnitt SJ, Tan PH, van de Vijver MJ, editors. WHO classification of tumours of the breast: WHO Classification of Tumours, 4th ed. Volume 4. Lyon: IARC Press; 2012.

10. D'Orsi CJ, Sickles EA, Mendelson EB, Morris EA. ACR BI-RADS® Atlas, Breast Imaging Reporting and Data System. Reston(VA): American College of Radiology; 2013.

11. Davey MG, Brennan M, Ryan ÉJ, Corbett M, Abd Elwahab S, Walsh S, et al. Defining clinicopathological and radiological features of breast cancer in women under the age of 35: an epidemiological study. Ir J Med Sci 2020; 189:1195-202. doi: 10.1007/s11845-020-02229-z.

12. Shoemaker ML, White MC, Wu M, Weir HK, Romieu I. Differences in breast cancer incidence among young women aged 20-49 years by stage and tumor characteristics, age, race, and ethnicity, 2004-2013. Breast Cancer Res Treat 2018;169:595-606. doi: 10.1007/s10549-018-4699-9.

13. Kim, J, Jang M, Kim SM, Yun BL, Lee JY, Kim EK, et al. Clinicopathological and imaging features of breast cancer in Korean women under 40 years of age. J Korean Soc Radiol 2017;76:375-85.

14. Eugênio DSG, Souza JA, Chojniak R, Bitencourt AGV, Graziano L, Marques EF. Breast cancer diagnosed before the 40 years: imaging findings and correlation with histology and molecular subtype. Appl Cancer Res [Internet]. 2017 [cited 2024 Feb 19];37(16). Available from: https://appliedcr.biomedcentral.com/articles/10.1186/s41241-017-0019-7#article-info

15. Collins LC, Marotti JD, Gelber S, Cole K, Ruddy K, Kereakoglow S, et al. Pathologic features and molecular phenotype by patient age in a large cohort of young women with breast cancer. Breast Cancer Res Treat 2012;131:1061-6. doi: 10.1007/s10549-011-1872-9.

16. Tirada N, Aujero M, Khorjekar G, Richards S, Chopra J, Dromi S, et al. Breast cancer tissue markers, genomic profiling, and other prognostic factors: A primer for radiologists. RadioGraphics 2018;38:1902-20. doi: 10.1148/rg.2018180047.

17. Bullier B, MacGrogan G, Bonnefoi H, Hurtevent-Labrot G, Lhomme E, Brouste V, et al. Imaging features of sporadic breast cancer in women under 40 years old: 97 cases. Eur Radiol 2013;23:3237-45. doi: 10.1007/s00330-013-2966-z.

18. Erić I, Petek Erić A, Kristek J, Koprivčić I, Babić M. Breast cancer in young women: Pathologic and immunohistochemical features. Acta Clin Croat 2018; 57:497-502. doi: 10.20471/acc.2018.57.03.13.

19. Expert Panel on Breast Imaging; Mainiero MB, Moy L, Baron P, Didwania AD, diFlorio RM, , et al. ACR Appropriateness Criteria® Breast Cancer Screening. J Am Coll Radiol 2017;14(11 Suppl):S383-90. doi: 10.1016/j.jacr.2017.08.044.

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Case Report

Camper's and Scarpa's fasciae: Anatomic landmark to differentiate between lymph node and abdominal wall involvement in a case of lymphoma

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Abstract

Cutaneous involvement of MALT lymphoma can either be primary or secondary, Secondary spread to the skin is considered disseminated extra-nodal disease involvement, which is classifies as a stage IV disease.

We described a case of a 44-year-old woman with MALT lymphoma of the lacrimal glands with biopsy-proven lymphoma involvement in the subcutaneous tissue of the anterior abdominal wall. This involvement is manifested as multiple small discrete solid enhancing subcutaneous nodules. Although such findings on conventional CT scans are usually non-specific and may present in various systemic conditions, the knowledge of the patient's prior clinical history should alert interpreting radiologists to be aware of cutaneous and subcutaneous involvement of lymphoma. This awareness can help plan the use of imaging-guided tissue biopsy for a minimally-invasive and safe acquisition of tissue specimen for histopathological diagnosis.

Keywords: Cutaneous involvement, Extra-nodal lymphoma, Fascia, MALT lymphoma.

Introduction

The extranodal lymphoma occurred more frequently for non-Hodgkin lymphoma than Hodgkin lymphomas [1]. The most common types of extranodal lymphoma (ENL) are diffuse large B-cell lymphoma (DLBCL) and mucosa associated lymphoid tissue (MALT) lymphoma.

The extranodal involvement is commonly localized in the gastrointestinal tract, followed by head and neck, lung, skin, bone, and brain. Extra-nodal marginal zone lymphoma of mucosa associated lymphoid tissue (MALT lymphoma) is a relatively rare subset of non-Hodgkin lymphoma, a cancer of the lymphatic system which arises from the B-cell lineage of lymphocytes. It involves the mucosal epithelium of various organs, such as the stomach, salivary glands, lungs, small bowel, thyroid, ocular, adnexa, and skin. The stomach is the most frequent site of involvement with a strong correlation with Helicobacter pylori infection [2].

As part of initial staging of MALT lymphoma, conventional computed tomography (CT) scan or magnetic resonance imaging (MRI) and imaging of the orbits and salivary glands is acquired. Initial staging is primarily based on Lugano classification [2, 3]. Positron emission tomography (PET) scans in cases of marginal zone lymphoma have been shown to be useful only when localized treatment is planned [2]. This differs from recommendation for primary nodal lymphoma, where the use of PET-CT is considered the gold standard for staging of fluorodeoxyglucose (FDG)-avid nodal lymphoma which includes all histology except chronic lymphocytic leukemia/small lymphocytic lymphoma, lymphoplasmacytic lymphoma/Waldenström macroglobulinemia, mycosis fungoides, and marginal zone NHLs, unless there is a suspicion of aggressive transformation [3].

Cutaneous involvement of MALT lymphoma can either be primary or secondary, where secondary spread to the skin is considered disseminated extra-nodal disease involvement which classifies as a stage IV disease [3]. The primary cutaneous marginal zone lymphoma (PCMZL) presented with multifocal plaques or nodules localized on the trunk and arms [4]. The age of patients with PCMZL is younger than those with secondary cutaneous marginal zone lymphoma (SCMZL). The average age is being 50 years in PCMZL and 57 years in SCMZL [5]. Imaging findings of cutaneous lymphoma of T-cell lineage are typically described as panniculitis-like, seen as a subcutaneous nodule or thickening, whereas a cutaneous lymphoma of B-cell lineage usually presents with enhancing nodules and infiltrative cutaneous and subcutaneous masses [6]. Bone marrow biopsy and excisional biopsy of three subcutaneous lesions verified DLBCL, stage IV [7].

In this article, we present a classic case of lacrimal gland MALT lymphoma with multiple abdominal subcutaneous enhancing nodules located below Camper's fascia and Scarpa's fascia. This patient was diagnosed with lymphoma stage IV. The whole abdominal CT of this patient showed multiple enhancing nodules beneath Scarpa's fascia and Camper's fascia, which could be misled, as these might be mistaken for lymph node metastasis and determined incorrect staging. Owing to the detection of multiple nodules in CT scans for initial disease staging, the nodules were biopsied and proven to be lymphoma involvement on histopathology. Subsequent resolution on imaging occurred following treatment with chemotherapy.

Case Summary

A 44-year-old woman without an underlying disease or a history of trauma, presented with swelling of both eyelids. She reported no palpable abdominal mass or skin lesions elsewhere. The initial physical examination showed movable rubbery consistency masses at the lateral aspect of both eyelids without any other palpable masses.

Her initial complete blood count (CBC) showed mild anemia with elevated LDH, and blood chemistry was within normal limits. Further CT scan of both orbits was performed which revealed enhancing masses at both lacrimal glands (Figure 1). The patient was then referred to our institution for a right lacrimal gland biopsy, which showed extra-nodal marginal zone lymphoma of the mucosa-associated lymphoid tissue (MALT lymphoma).

Figure 1. *Conventional CT of the orbit in axial (A) and coronal (B) views show multiple enhancing masses involving both lacrimal glands (*), upper eyelids (arrow), and the intra/extra-conal spaces of both orbits. Pathology proven is extranodal marginal zone lymphoma of the mucosa-associated lymphoid tissue (MALT lymphoma).*

Additional bone marrow biopsy, and conventional CT scans of the neck, chest, and abdomen were carried out as part of her initial staging. The bone marrow biopsy revealed 60% cellularity with presence of all the cell lineages with maturation. A few scattered small B-cells (CD20+) and T-cells (CD3+) were detected without presence of malignant cells. In our institute, PET scan was not performed.

Her abdominal CT scan revealed borderline hepatosplenomegaly and multiple well-defined enhancing nodules along the subcutaneous layer of the abdominal wall (Figure 2). No other significant lymphadenopathy was detected in the neck, chest, or abdomen.

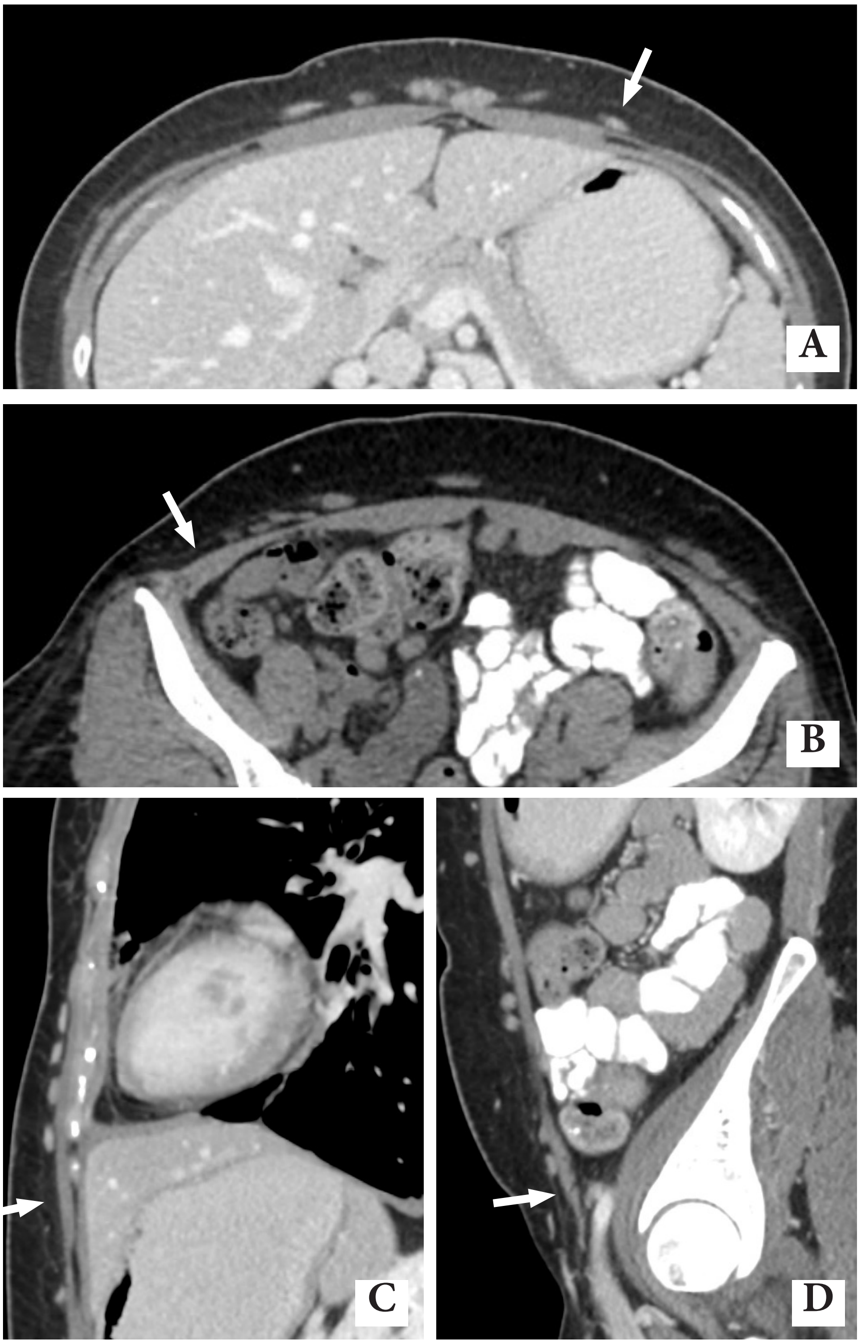


Figure 2. *Conventional CT of the whole abdomen axial upper level (A), axial lower level (B), sagittal (C, D) show multiple well-defined enhancing nodules along the subcutaneous layer of the abdominal wall located beneath Camper's and Scarpa's fasciae (arrow).*

Due to the patient's underlying MALT lymphoma, cutaneous involvement of lymphoma was suspected. An ultrasound-guided biopsy of the abdominal wall nodule was performed. Ultrasonography revealed an ill-defined subcutaneous hypoechoic lesion at the anterior abdominal wall. The lesion was biopsied, and histopathological results showed a small B-cell neoplasm (CD20+, CD79a+, Bel2+, CD5-, CD23-, CD10-, cyclinD1-, CD3-, CD138+ few plasma cells with kappa light chain restriction (Figure 3).

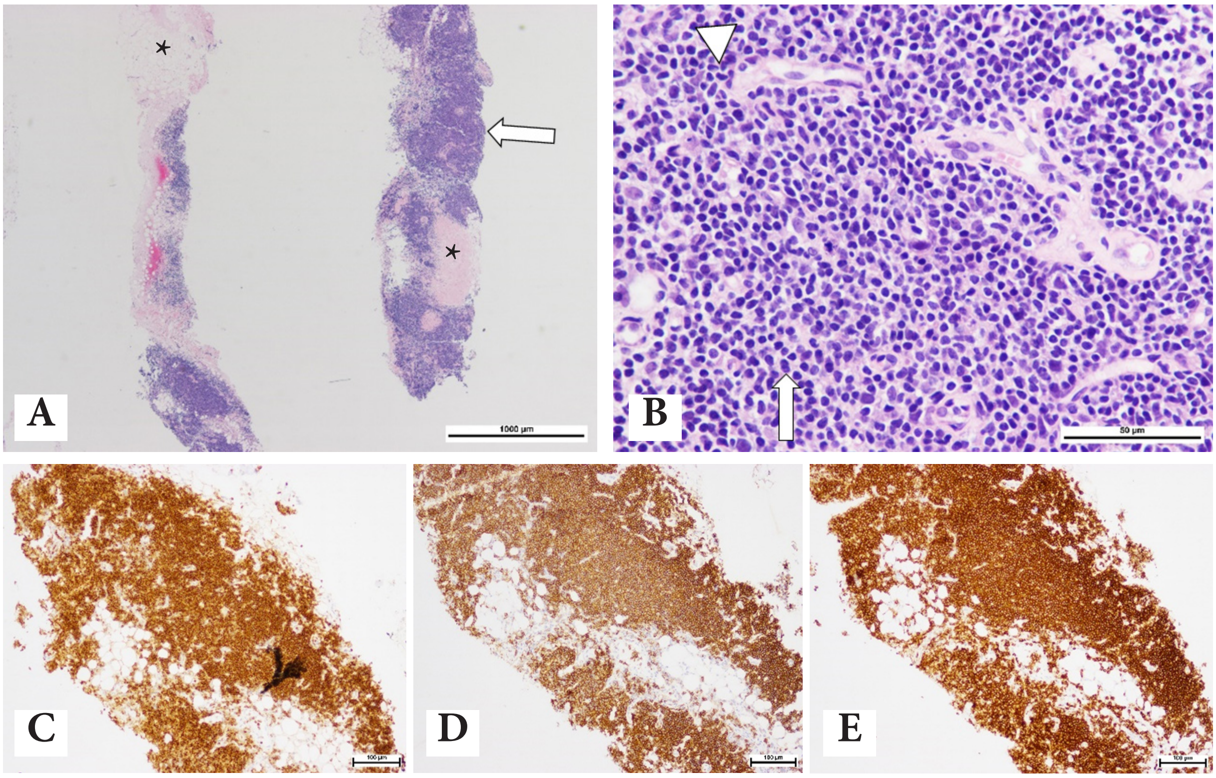


Figure 3. *Core tissue needle biopsy of the abdominal wall (A, B) shows atypical lymphoid cells (arrow) with small to medium sizes, infiltrating in fibroadipose tissue (*). Small vessel (arrowhead), lined by normal endothelial cells are noted. (Hematoxylin-eosin stain; original magnification, x20 and x400). Atypical lymphoid cells are highlighted with immunohistochemical stain for BCL2 (C), CD20 (D), and CD79a (E). The most likely diagnosis of this case is MALT lymphoma.*

The patient was diagnosed with stage IV MALT lymphoma with abdominal wall and liver involvement, and was treated with chemotherapy (CHOP). An interim follow-up CT after three cycles of chemotherapy showed disappearance of the lacrimal gland masses and almost complete disappearance of the subcutaneous abdominal wall nodules (Figure 4).

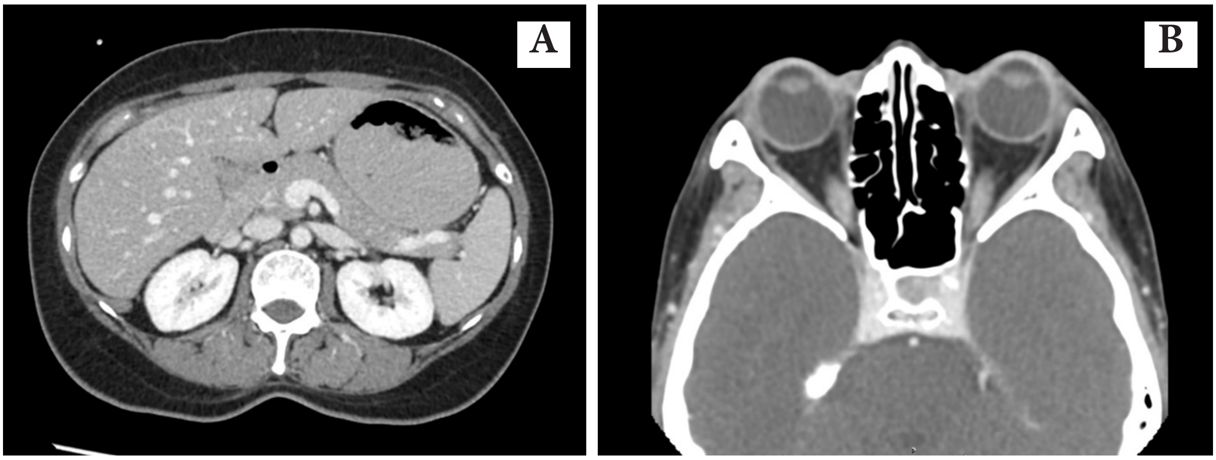


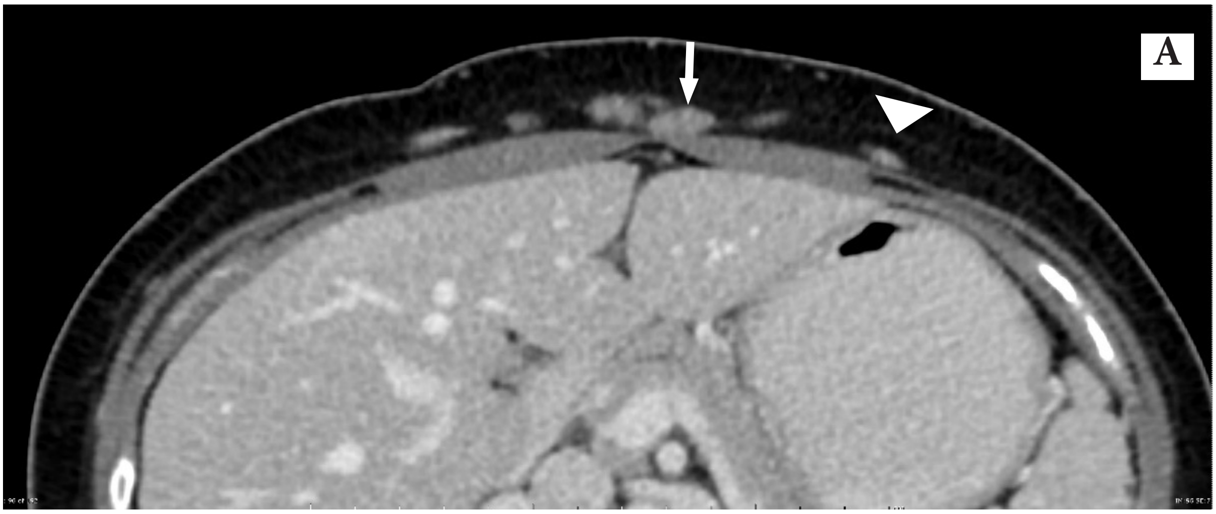
Figure 4. *After three cycles of chemotherapy (CHOP regimen) in a case of MALT lymphoma. Conventional CT of the whole abdomen axial (A) shows disappearance of multiple well-defined enhancing nodules along the subcutaneous layer of the abdominal wall. Conventional CT of the orbit in axial (B) shows disappearance of multiple enhancing masses involving both lacrimal glands, upper eyelids, and the intra/extra-conal spaces of both orbits.*

Discussion

In our case, the abdominal CT showed multiple small, discrete, solid enhancing subcutaneous nodules without internal calcification or fat density. These enhancing nodules were located beneath Scarpa's fascia and Camper's fascia (Figure 5), which could be misleading as these may metastasize to lymph nodes. According to anatomy of superficial lymphatic drainage of the abdominal wall, lymphovenous anastomosis (LVA) were found originating from the umbilical cord, a midline watershed area, with small diameters (<0.1cm), and above Scarpa's fascia (Figure 5), immediately deep to subdermal venules [8]. Hence, from CT imaging, these nodules located below the Scarpa's fascia and Camper's fascia, suggest secondary subcutaneous involvement. These findings are non-specific, and can be found in various systemic diseases such as post-transplant lymphoproliferative disorders, soft tissue sarcoma, metastasis, or even from subcutaneous injections, resulting in the formation of injection granuloma. Differentiation of these conditions based on imaging findings alone is difficult, and the key to interpreting a diffuse abdominal wall process is knowledge of the patient's clinical history [9]. Nonetheless, histopathology remains the reference standard for the diagnosis of skin pathology, and the role of cross-sectional imaging is primarily for baseline tumor staging in the case of suspected malignancy, preoperative planning, and assessment of treatment response.

Due to our patient's known underlying MALT lymphoma of the lacrimal gland and absence of a prior history of subcutaneous injections, cutaneous involvement of lymphoma was, therefore, suspected. Ultrasound-guided biopsy was chosen due to the superficial location of the subcutaneous nodule and was successfully performed without post-procedural complications.

Interim follow-up CT after three cycles of chemotherapy showed almost complete disappearance of the subcutaneous abdominal wall nodules with a slightly smaller size of the borderline hepatosplenomegaly (Figure 5), suggesting a good response to treatment. In the patient's latest documented follow-up, the fourth cycle of CHOP was administered and the patient will continue to be followed at our institution.



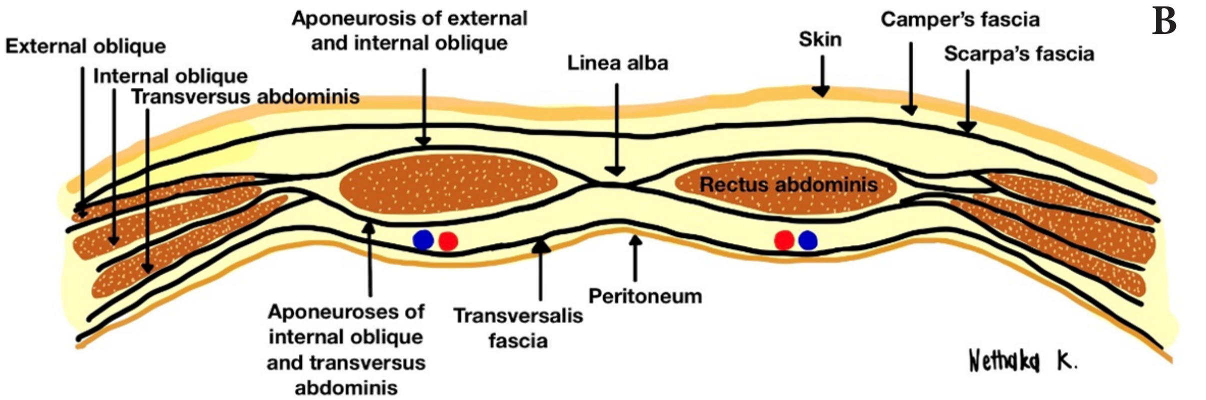


Figure 5. *CT abdomen (A) shows multiple small solid enhancing subcutaneous nodules (arrow) located beneath Camper's and Scarpa's fasciae (arrowhead). The drawing (B) demonstrates anatomy of anterior abdominal wall including Camper's and Scarpa's fasciae [10].*

References

1. Reginelli A, Urraro F, Sangiovanni A, Russo GM, Russo C, Grassi R, et al. Extranodal Lymphomas: a pictorial review for CT and MRI classification. Acta Biomed [Internet]. 2020 [cited 2024 Feb 26];91 Supp 8 :34–42. Available from: http://dx.doi.org/10.23750/abm.v91i8-S.9971

2. Zucca E, Arcaini L, Buske C, Johnson PW, Ponzoni M, Raderer M, et al. Marginal zone lymphomas: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. Ann Oncol [Internet]. 2020 [cited 2024 Feb 26];31(1):17–29. Available from: http://dx.doi.org/10.1016/j.annonc.2019.10.010

3. Cheson BD, Fisher RI, Barrington SF, Cavalli F, Schwartz LH, Zucca E, et al. Recommendations for initial evaluation, staging, and response assessment of Hodgkin and non-Hodgkin lymphoma: the Lugano classification. J Clin Oncol [Internet]. 2014 [cited 2024 Feb 26];32(27):3059–68. Available from: http://dx.doi.org/10.1200/JCO.2013.54.8800

4. Willemze R, Cerroni L, Kempf W, Berti E, Facchetti F, Swerdlow SH, et al. The 2018 update of the WHO-EORTC classification for primary cutaneous lymphomas. Blood [Internet]. 2019 [cited 2024 Feb 26];133(16):1703–14. Available from: http://dx.doi.org/10.1182/blood-2018-11-881268

5. Gerami P, Wickless SC, Querfeld C, Rosen ST, Kuzel TM, Guitart J. Cutaneous involvement with marginal zone lymphoma. J Am Acad Dermatol [Internet]. 2010 [cited 2024 Feb 26];63(1):142–5. Available from: http://dx.doi.org/10.1016/j.jaad.2009.07.047

6. Juan YH, Saboo SS, Tirumani SH, Khandelwal A, Shinagare AB, Ramaiya N, et al. Malignant skin and subcutaneous neoplasms in adults: multimodality imaging with CT, MRI, and 18F-FDG PET/CT. AJR Am J Roentgenol [Internet]. 2014 [cited 2024 Feb 26];202(5):W422-38. Available from: http://dx.doi.org/10.2214/AJR.13.11424

7. eurorad.org [Internet]. ESR; c2024 [cited 2024 Feb 28]. Case 16418. Imaging of a rare location, extra nodal lymphoma lesions. Available from: https://www.eurorad.org/case/16418

8. Tourani SS, Taylor GI, Ashton MW. Anatomy of the superficial lymphatics of the abdominal wall and the upper thigh and its implications in lymphatic microsurgery. J Plast Reconstr Aesthet Surg [Internet]. 2013 [cited 2024 Feb 26]; 66(10):1390–5. Available from: http://dx.doi.org/10.1016/j.bjps.2013.05.030

9. Ballard DH, Mazaheri P, Oppenheimer DC, Lubner MG, Menias CO, Pickhardt PJ, et al. Imaging of abdominal wall masses, masslike lesions, and diffuse processes. Radiographics [Internet]. 2020 [cited 2024 Feb 26];40(3):684–706. Available from: http://dx.doi.org/10.1148/rg.2020190170

10. Matalon SA, Askari R, Gates JD, Patel K, Sodickson AD, Khurana B. Don’t forget the abdominal wall: Imaging spectrum of abdominal wall injuries after nonpenetrating trauma. Radiographics [Internet]. 2017 [cited 2024 Feb 26]; 37(4):1218–35. Available from: http://dx.doi.org/10.1148/rg.2017160098

Pictorial Essay

Imaging findings of the infective endocarditis with neurological complications

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Abstract

Neurological complications are the most serious extracardiac complications of infective endocarditis. They can be manifested as ischemic stroke, intracranial hemorrhage, mycotic aneurysms, meningitis, cerebritis and abscesses. Avoidance of anticoagulants and antiplatelet agents with early intravenous antibiotic administration is crucial in the management of this condition. MRI of the brain is an important tool for early diagnosis and guiding the treatment decision. The purpose of this article is to review the imaging appearances and the possible mechanisms of the intracranial findings in the patients with neurological complications of infective endocarditis.

Keywords: Cerebral infection, Infective endocarditis, Intracranial hemorrhage, Mycotic aneurysm, Stroke.

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Introduction

Infective endocarditis is an infectious disease that causes vegetations along the cardiac valves or endocardium, involving both native and prosthetic valves, and implanted cardiac devices. The incidence of infective endocarditis has increased in the past few decades due to the frequent use of long-term intravenous lines and cardiac devices [1, 2]. Patients who present with a valvular or structural cardiac abnormality are at significantly increased risk of this disease. The most common pathogen is Staphylococcus aureus, the microbiota of the skin and upper respiratory tract, found in about 40% of the patients. The second common pathogen, Streptococcus viridans, has been reported in about 17% of the patients, followed by enterococci in about 11% [3].

Neurological sequelae are the most severe extracardiac complications related to high rates of death and disability. Approximately 80% of the patients with infective endocarditis have abnormalities detected on magnetic resonance imaging (MRI) of the brain, and most of them are asymptomatic embolic events [4]. Stroke is the most common neurological complication, either ischemic infarction or hemorrhage. The mycotic aneurysm and cerebral infection have been described as the second and third manifestations, respectively [5].

The risks of neurological complications in infective endocarditis depend on the characteristic of vegetation and the duration of the antibiotic treatment [6]. Neurological presentations can be non-specific and diverse ranging from silent events to lethality. Moreover, physical examination can be clouded over when it comes to dealing with impairment of the consciousness resulting from severe cardiac failure or sepsis-related encephalopathy. Therefore, MRI of the brain is crucial for detection of the CNS complications. Various MRI abnormalities have been found related to different manifestations.

Ischemic stroke

Ischemic stroke is the most common neurological complication of infective endocarditis, which has been reported in up to 50% [6]. Almost all ischemic events are presented as cardioembolic patterns (Figure 1 and 2), and these embolic materials are composed of mixed fibrin-platelet clots and microorganisms [1].

The previous studies reveal high rates of post-thrombolytic intracranial hemorrhage with low rates of favorable outcomes in ischemic stroke associated with infective endocarditis [5, 7]. Hence, anticoagulation and antiplatelet agents should be avoided in this form of stroke, conversely to the non-infectious embolic events.

Doubtless, left-sided infective endocarditis has been more relevant to ischemic stroke than right-sided infective endocarditis. In addition, some studies found increased risk of cerebral ischemia in the cases with mitral valve vegetations compared to the aortic valve [3, 8]. MCA territory is the most affected part of the brain due to the high demand of cerebral blood supply; likewise, more than one territorial combination will probably be seen [8].

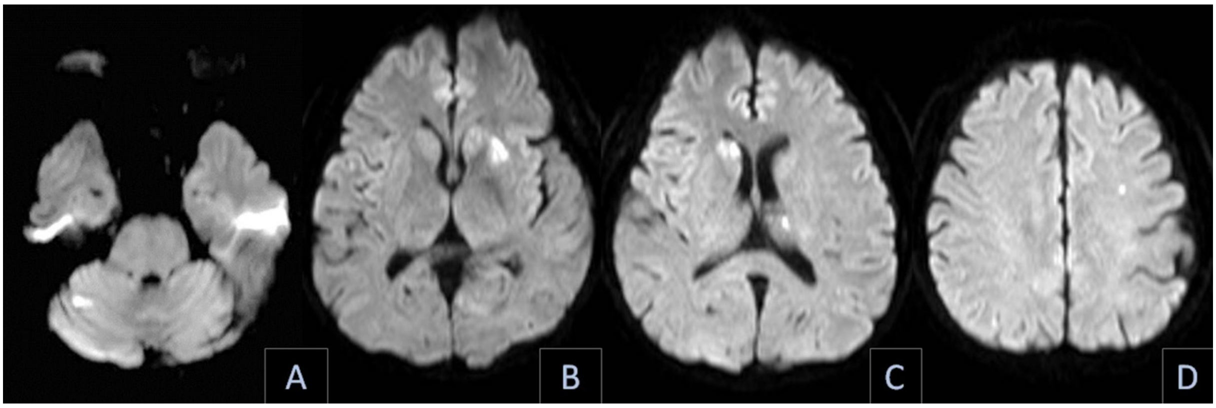

Figure 1. *A 73-year-old female underlying type A aortic intramural hematoma and calcified bicuspid aortic valve underwent Bentall procedure and developed S. epidermidis septicemia. Diffusion-weighted imaging (A-D) shows multiple small acute infarctions in the right cerebellum, bilateral basal ganglia, left thalamus and left centrum semiovale, which are in different arterial territories suggesting embolic insults.*

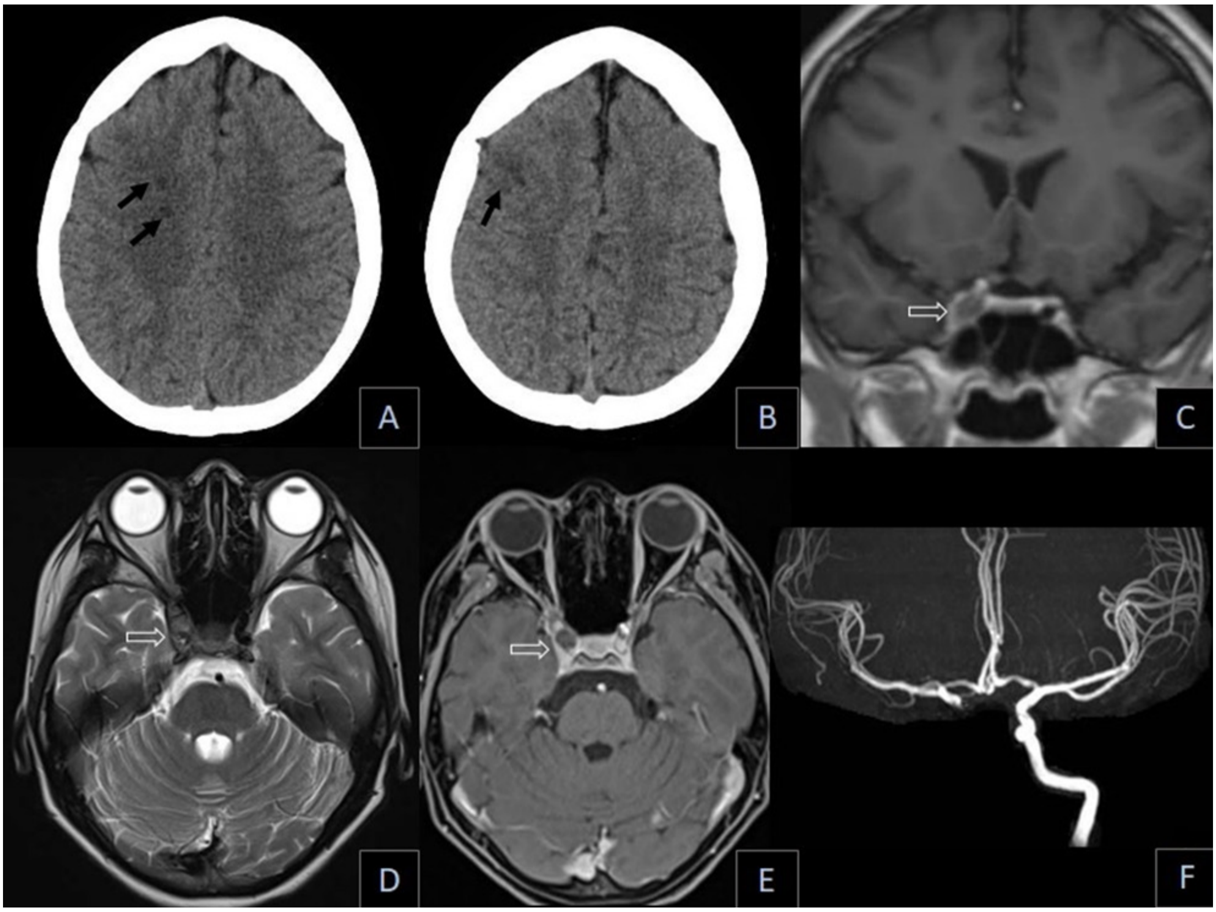

Figure 2. *A 15-year-old female underlying severe AR and moderate to severe MR presenting with acute limb ischemia and acute left hemiparesis. The immediate CT scan of the brain (A and B) shows a few small acute infarctions in the right centrum semiovale and a small wedge-shaped acute infarction in the right frontal lobe (black arrows). The follow-up MRI performed 18 days later; axial T2-weighted image (D), axial post contrast T1-weighted image with fat suppression (E) and coronal post contrast T1-weighted image (C) reveal heterogeneous signal intensity and an abnormal bulging contour of the right cavernous sinus with an absent flow void in the cavernous segment of the right ICA (open white arrows). 3D time of flight MR angiography on the same date (F) confirms the absent flow in the right ICA from the distal extracranial segment up to the cavernous segment. Findings are suggestive of right cavernous ICA occlusion concomitant with ipsilateral cavernous sinus thrombosis.*

Intracranial hemorrhage

Intracranial hemorrhage is the second most common CNS complication, found in 30% of the patients with infective endocarditis [5]. The hemorrhagic lesion can manifest as subarachnoid hemorrhage or lobar parenchymal hemorrhage, which may be caused by hemorrhagic transformation of prior ischemic infarction, progression, or growth of the microbleeds and ruptured aneurysm (Figures 3 and 4) [5].

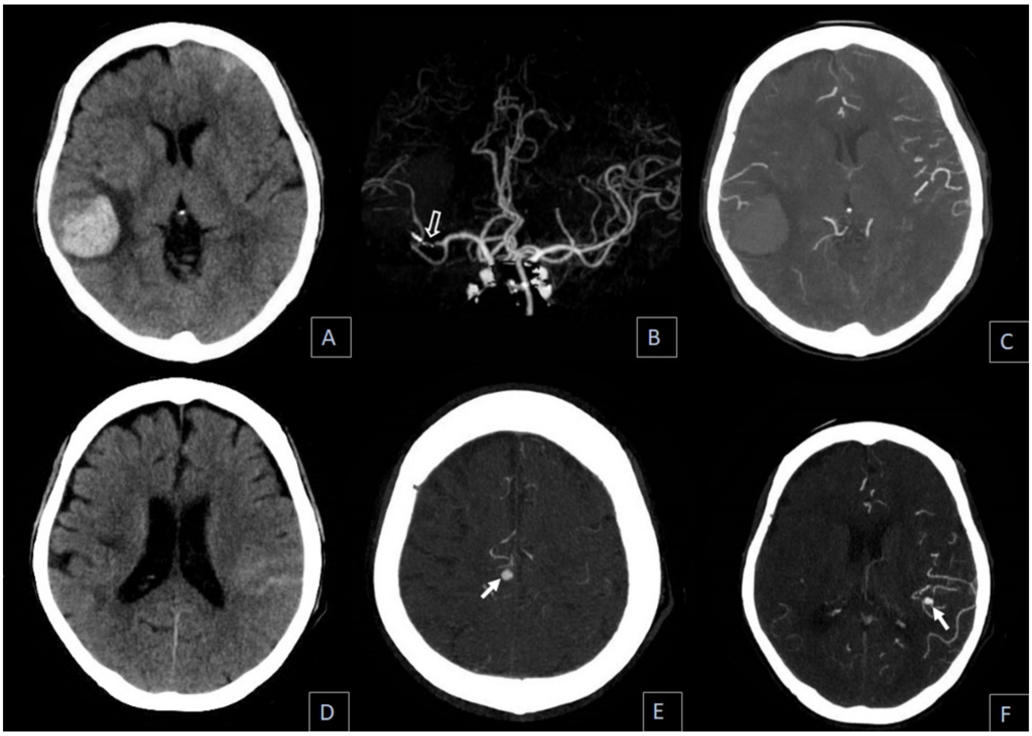

Figure 3. *A 51-year-old female underlying SLE and AIHA, post aortic valve replacement, and LV-RA fistula repair, developed candida septicemia and infective endocarditis of the prosthetic heart valve. Axial CT brain (A) reveals acute intraparenchymal hematoma in the right temporal lobe and acute subarachnoid hemorrhage in the left frontal sulci. 3D MIP (B) and axial MIP CT angiography (C) show severe stenosis of the proximal M2 segment of right MCA (open arrow) and no evidence of aneurysm. The follow-up CT 4 days later (D) reveals new acute subarachnoid hemorrhage in the left fronto-parietal sulci and axial MIP CTA (E and F) shows two new aneurysms arising from the cortical branch of the right ACA and the opercular segment of the left MCA (solid arrows).*

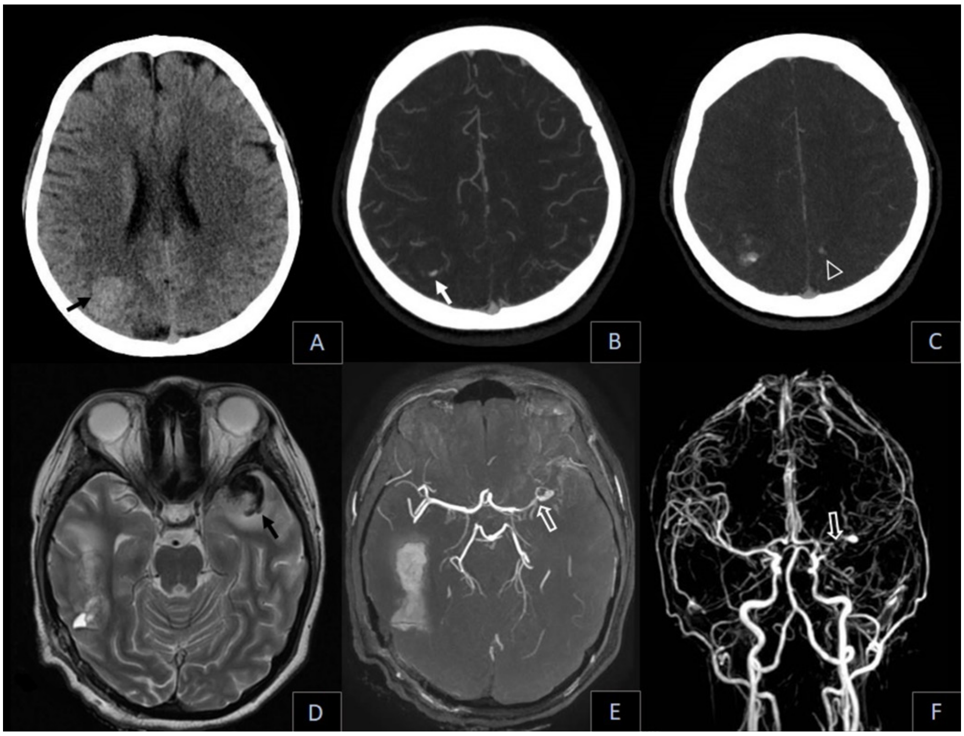

Figure 4. *A 20-year-old-female with moderate to severe mitral regurgitation and a 0.8x0.3-cm oscillating mass at the posterior mitral valve leaflet. Axial CT brain (A) demonstrates subacute intraparenchymal hematoma in the right parietal lobe (black arrow). Further CT angiography (B) shows a small aneurysm in the right parietal area (solid white arrow). Axial delayed phase CT angiography (C) shows increased contrast accumulation surrounding the right parietal aneurysm and a new small nodular contrast pooling in left parietal lobe (open white arrowhead), suspicious of mycotic aneurysms with hemorrhage and contrast extravasation. The patient underwent follow-up MRI after craniotomy and hematoma removal ten days afterward. The axial T2-weigted image (D) shows new intraparenchymal hematoma in the left anterior temporal lobe (black arrow). Axial MIP time-of-flight MRA (E) and contrast enhanced MRA (F) demonstrate new severe stenosis of the proximal M1 segment of the left MCA and a saccular aneurysm distal to the luminal stenosis (open white arrows).*

Generally, cerebral microbleeds can be found in those with old age, Alzheimer's disease, and small vessel diseases, such as hypertension, cerebral amyloid angiopathy, and atherosclerosis. Increased incidence of cerebral microbleeds has been documented in the patients with infective endocarditis [9]. Microbleeds are the insults of subacute microvascular inflammation from immunologic vasculitis and/or embolism in the vasa vasorum [6]. These microhemorrhages tend to present in cortical distribution, found in about 85% of the patients [9]. The rest have been seen in the subcortical area, basal ganglia, and posterior fossa.

The previous study described the characteristics of microbleeds from infective endocarditis as a small Bull's eye-liked lesion on T2WI/GRE T2*WI, which appears to be round/oval-shaped lesion measured less than 10 mm with central T2 hypointensity surrounded by the faint T2 hyperintense area [10]. Enhancement on the T1W post-gadolinium image is often seen. The central T2 hypointensity area represents microhemorrhage, tiny, infected aneurysms, or bacterial clots, while the peripheral hypersignal intensity reflects a parenchymal reaction or edema due to rapid regression of the lesion on serial follow-up imaging after an antibiotic treatment [10].

Intracranial mycotic aneurysm

Intracranial mycotic aneurysm has been found in less than 10% of neurological complications associated with infective endocarditis. 'Infectious intracranial aneurysm' has been proposed as the preferred term by some authors because the term ‘mycotic’ may represent the fungal etiology [5].

The explanation of infectious intracranial aneurysm is septic emboli in the vasa vasorum or due to intraluminal embolism to the distal vasculature. These septic emboli cause inflammation from the interaction between microorganisms and the host's immune response resulting in destruction of the vascular wall [5].

Unlike the fungal intracranial aneurysms, those mostly found in the proximal intracranial vessels, the bacterial mycotic aneurysms tend to affect the distal vessels [5]. Furthermore, they can be multiple, bilateral, and cortical locations, as well as saccular or fusiform shapes (Figures 3, 4 and 5).

MR angiography and CT angiography provides high sensitivity in diagnosis of mycotic aneurysm in up to 95% of the cases, despite increased challenge in the aneurysms smaller than 5 mm [6, 11]. Vascular occlusion or stenosis can co-exist with mycotic aneurysm (Figures 4 and 5).

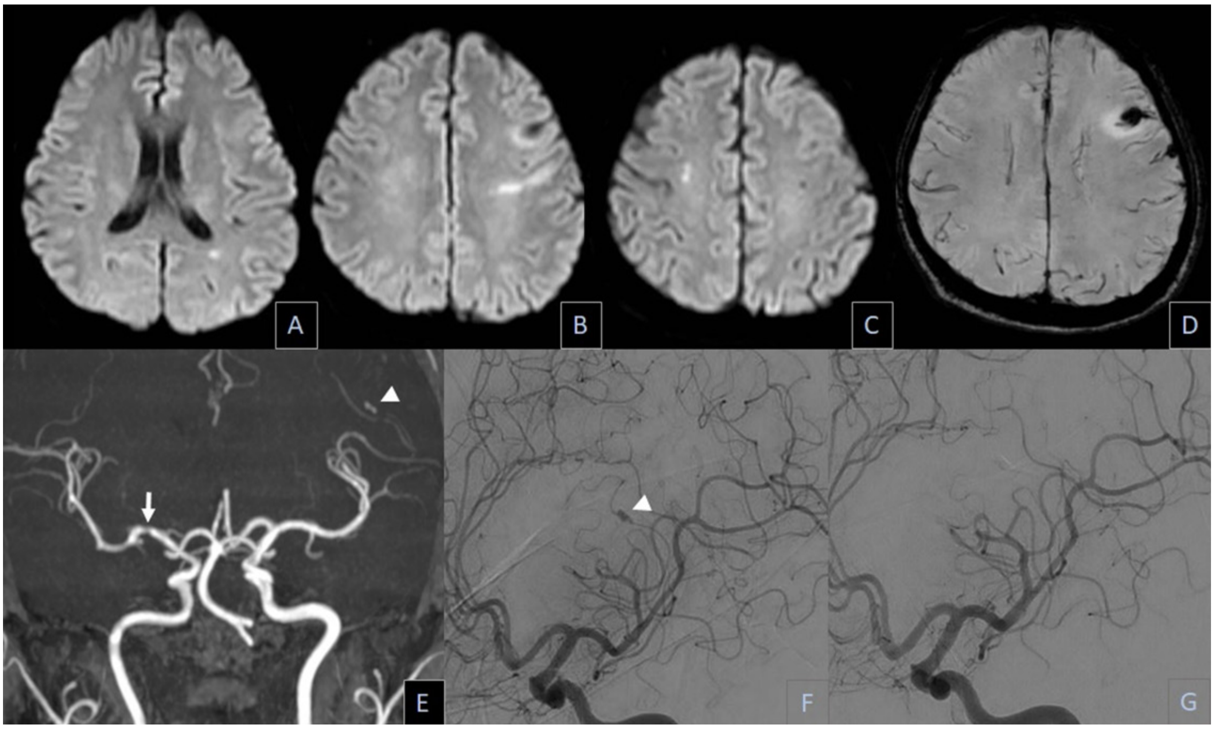

Figure 5. *A 54-year-old male with severe prolapsed posterior mitral leaflet and Streptococcus gordonii septicemia, was discovered with two oscillating masses at the aortomitral continuity fibrosa. Axial diffusion-weighted images (A-C) reveal a few small acute infarctions in deep white matter of the left parietal lobe and the bilateral centrum semiovale. Axial susceptibility-weighted image (D) shows small intraparenchymal hematoma in the left frontal lobe with adjacent sulcal subarachnoid hemorrhage. Coronal MIP time of flight MRA (E) demonstrates a small aneurysm arising from the cortical branch of the left MCA (arrowhead) and focal moderate stenosis of the M1 segment of the right MCA (arrow). Digital subtraction angiography (F) confirms a 4x4-mm fusiform aneurysm arising from the frontal branch of the left M4 MCA (arrowhead), representing ruptured mycotic aneurysm. There is complete obliteration of the aneurysm after NBCA glue embolization (G).*

CNS infection

Intracranial infection can be manifested as cerebritis, cerebral abscess, and meningitis. The proposed mechanism of cerebral infection refers to bacterial hematogenous spread similar to an infectious intracranial aneurysm, in which the septic emboli invade the vascular walls and then spread into the brain parenchyma and meninges, resulting in cerebritis, intraparenchymal abscess, and meningitis [2].

When the abscesses are large enough, they can present as high T2W lesions with central restricted diffusion and rim enhancement (Figures 6 and 7). Nevertheless, the microabscesses, defined as the enhancing lesion measured less than 10 mm, are more common in infective endocarditis (Figure 8) [11].

Occasionally, the dirty CSF sign seen as sulcal FLAIR/DWI hyperintensity in the cerebral sulci adjacent to the Bull's eye-liked lesion may be seen, which represents the presence of pus or blood from meningitis and vasculitis [10].

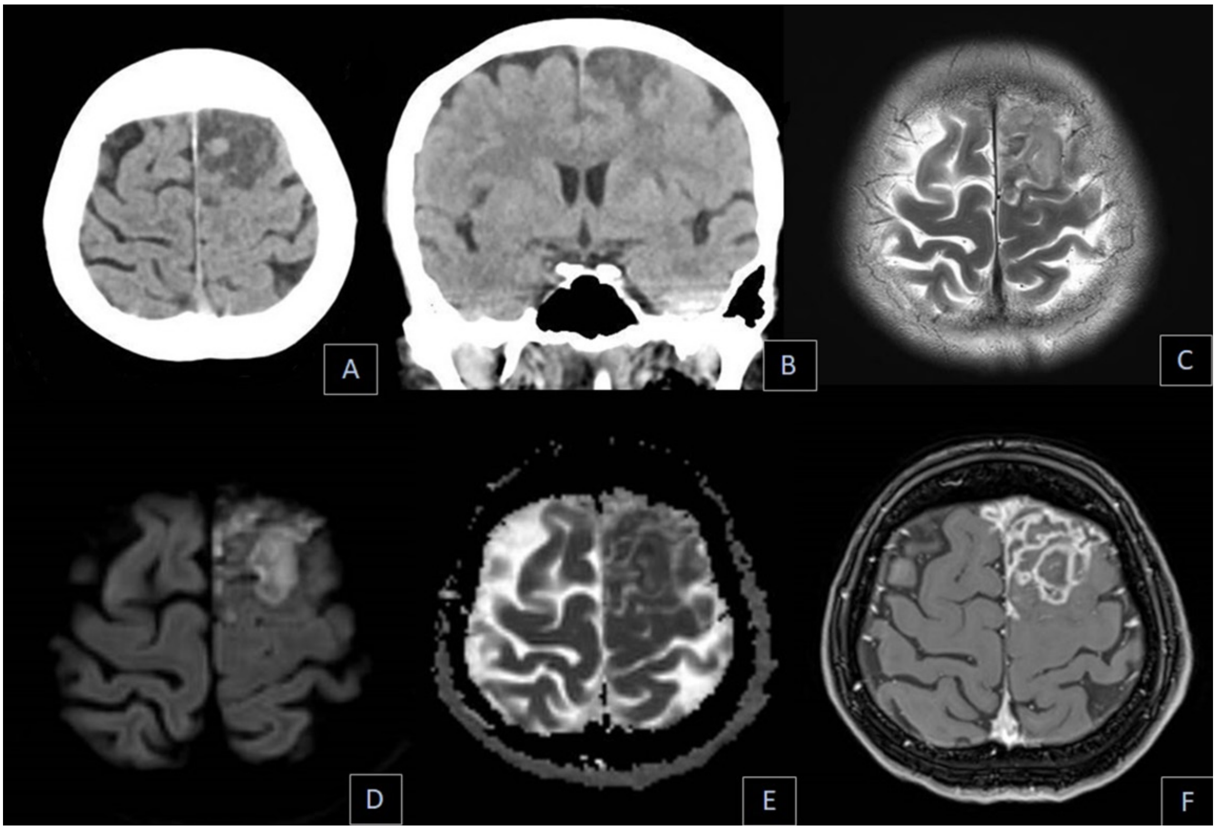

Figure 6. *A 60-year-old female was shown with severe MR and infective mitral endocarditis. Axial and Coronal CT brain (A and B) demonstrates a well-demarcated hypodense lesion involving the parasagittal left frontal lobe. The patient underwent MRI two weeks afterward. Axial T2 weighted image (C), DWI (D), ADC (E) and post-contrast T1 weighted image (F) show persistent heterogeneous T2 hyperintensity of the left frontal lobe lesion with restricted diffusion and layering rim enhancement, likely representing cerebritis and abscess.*

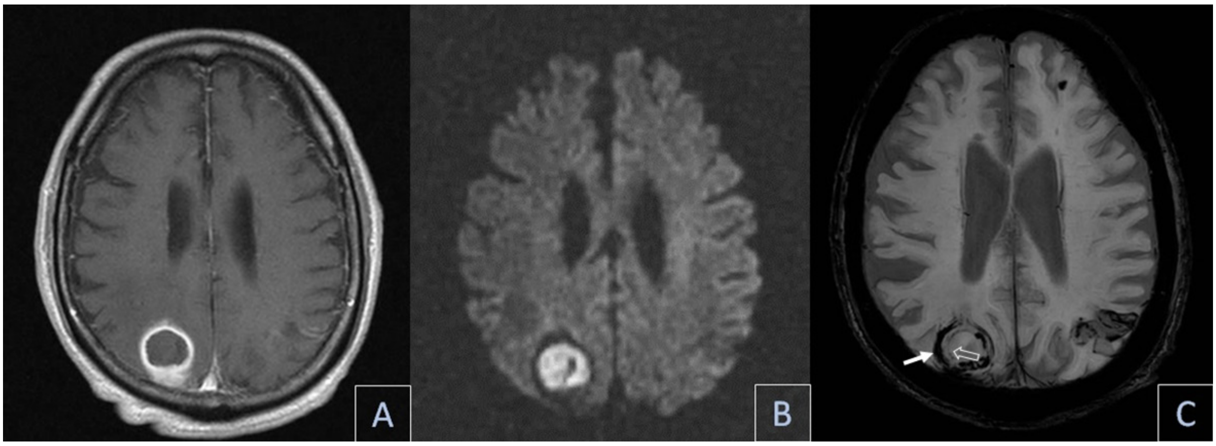

Figure 7. *An 80-year-old male was presented with severe AR post bioprosthetic valve replacement with infective endocarditis caused by Streptococcus gallolyticus and Enterococcus faecalis. Axial MRI post-contrast T1 weighted image (A) reveals smooth rim enhancing abscess in the right parietal lobe with internal restricted diffusion on DWI (B). SWI of the same patient (C) shows a smooth complete outer dark rim (solid arrow) and an immediate internal bright line (open arrow), representing a dual rim sign. Subarachnoid hemorrhage in the left parietal region and a microbleed in the left frontal lobe are also noted.*

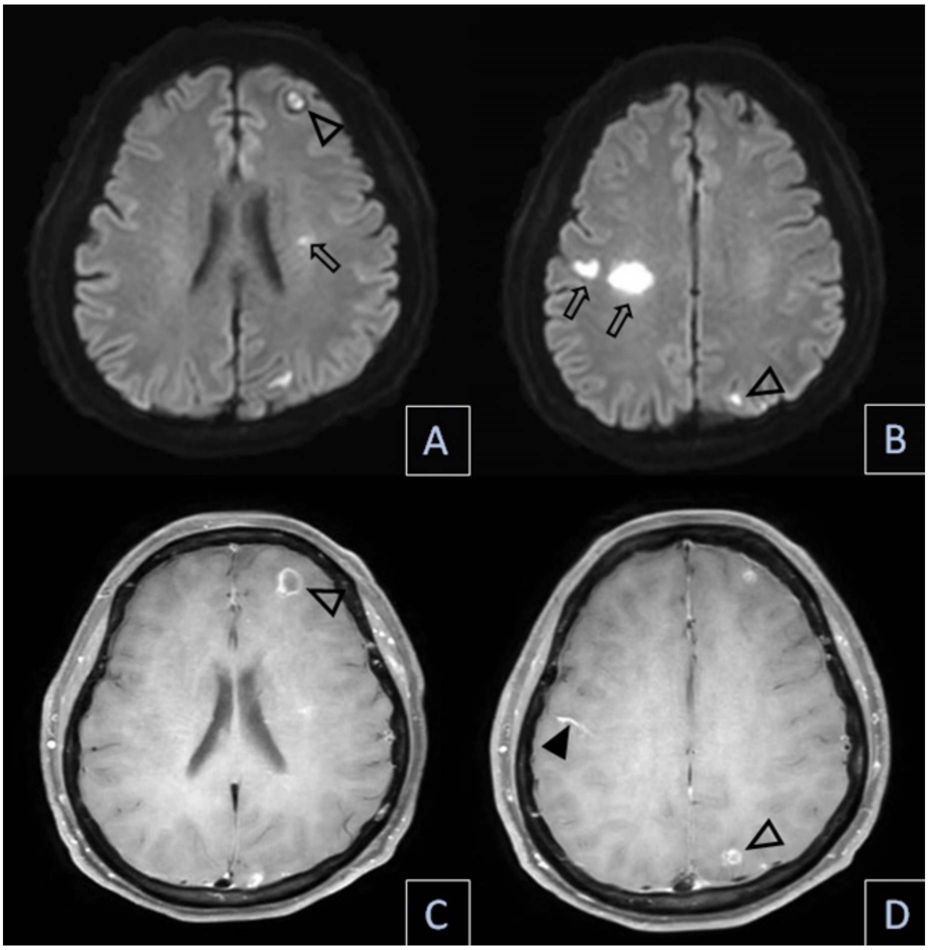

Figure 8. *A 54-year-old-female underlied moderate to severe MR with infective mitral endocarditis. Axial MRI diffusion-weighted images (A and B) and post-contrast T1 weighted images (C and D) show two small rim enhancing microabscesses in the left frontal lobe and the left parietal lobe (open black arrowheads), a few small acute infarctions in the left corona radiata and the right centrum semiovale (open black arrow), and meningeal enhancement in the right frontal sulci (solid black arrowhead).*

Conclusion

Intracranial complications of the patients with infective endocarditis have been described in the pieces of literature, including embolic infarction, intracranial hemorrhage, mycotic aneurysm and CNS infection. More than one combination is frequently encountered in an individual patient. A wide range of CNS symptoms can be accompanied by an alteration of the mental status, which raises a challenge in clinical diagnosis alone. Imaging evaluation with MRI and radiologists' awareness of the wide range of possible abnormal MRI findings would help in the early diagnosis and timely initiation of the proper management.

References

1. Hu W, Wang X, Su G. Infective endocarditis complicated by embolic events: Pathogenesis and predictors. Clin Cardiol 2021;44:307-15. doi: 10.1002/clc.23554.

2. Ferro JM, Fonseca AC. Infective endocarditis. In: Biller J, Ferro JM, editors. Handbook of Clinical Neurology. Amsterdam: Elsevier; 2014. p. 75-91.

3. Chakraborty T, Rabinstein A, Wijdicks E. Neurologic complications of infective endocarditis. Handb Clin Neurol 2021;177:125-34. doi: 10.1016/B978-0-12-819814-8.00008-1.

4. Duval X, Iung B, Klein I, Brochet E, Thabut G, Arnoult F, et al. Effect of Early Cerebral Magnetic Resonance Imaging on Clinical Decisions in Infective Endocarditis. Ann Intern Med 2010;152:497-504. doi: 10.7326/0003-4819-152-8-201004200-00006.

5. Morris NA, Matiello M, Lyons JL, Samuels MA. Neurologic complications in infective endocarditis: identification, management, and impact on cardiac surgery. Neurohospitalist 2014;4:213-22. doi: 10.1177/1941874414537077.

6. Novy E, Sonneville R, Mazighi M, Klein IF, Mariotte E, Mourvillier B, et al. Neurological complications of infective endocarditis: new breakthroughs in diagnosis and management. Med Mal Infect 2013;43:443-50. doi: 10.1016/j.medmal.2013.09.010.

7. Asaithambi G, Adil MM, Qureshi AI. Thrombolysis for ischemic stroke associated with infective endocarditis: results from the nationwide inpatient sample. Stroke 2013;44:2917-9. doi: 10.1161/STROKEAHA.113.001602.

8. Derex L, Bonnefoy E, Delahaye F. Impact of stroke on therapeutic decision making in infective endocarditis. J Neurol 2010;257:315-21. doi: 10.1007/s00415-009-5364-3.

9. Hess A, Klein I, Iung B, Lavallee P, Ilic-Habensus E, Dornic Q, et al. Brain MRI findings in neurologically asymptomatic patients with infective endocarditis. AJNR Am J Neuroradiol 2013;34:1579-84. doi: 10.3174/ajnr.A3582.

10. Azuma A, Toyoda K, O'Uchi T. Brain magnetic resonance findings in infective endocarditis with neurological complications. Jpn J Radiol 2009;27:123-30. doi: 10.1007/s11604-008-0308-x.

11. Champey J, Pavese P, Bouvaist H, Kastler A, Krainik A, Francois P. Value of brain MRI in infective endocarditis: a narrative literature review. Eur J Clin Microbiol Infect Dis 2016;35:159-68. doi: 10.1007/s10096-015-2523-6.

ASEAN Movement in Radiology

Radiology in Central Asia (Kazakhstan) after independency

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The Radiological Society of Thailand (RST) and the Royal College of Radiologists of Thailand (RCRT) invited the Radiological Society of Kazakhstan (RSK) to introduce to their members the Radiology in Central Asia in their annual meeting during 8-10 February 2005 in Bangkok, Thailand. It was an honor and a privilege to the author (DTK) to be the representative of RSK to give a speech on the issue in Binbakya Bidyabhed Lecture, the honorary lecture named after the first radiologist of Thailand and first president of RST (Figure 1).

Figure 1. *The author (DTK) gives a speach in Binbakya Bidyabhed Lecture at the RCRT-RST annual meeting, 8th-10th February 2024, Bangkok, Thailand.*

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On 18th of February in 1977 at the First Republican Congress of Radiologists of Kazakhstan the statute of the Kazakh Republican Scientific Society of Radiologists was adopted (Figure 2).

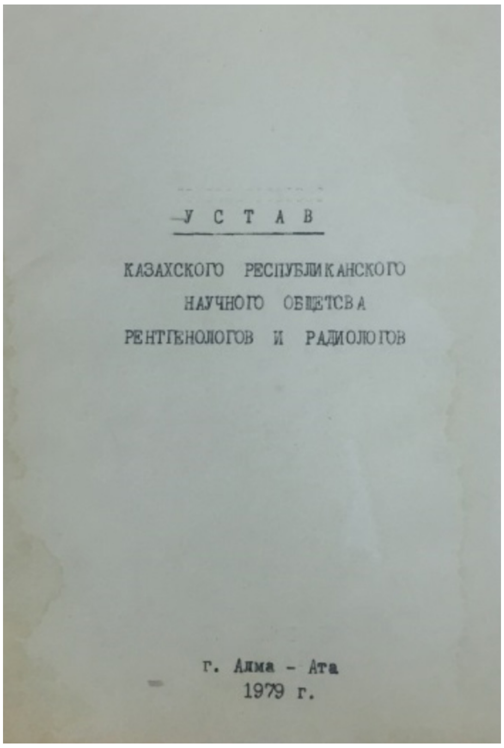
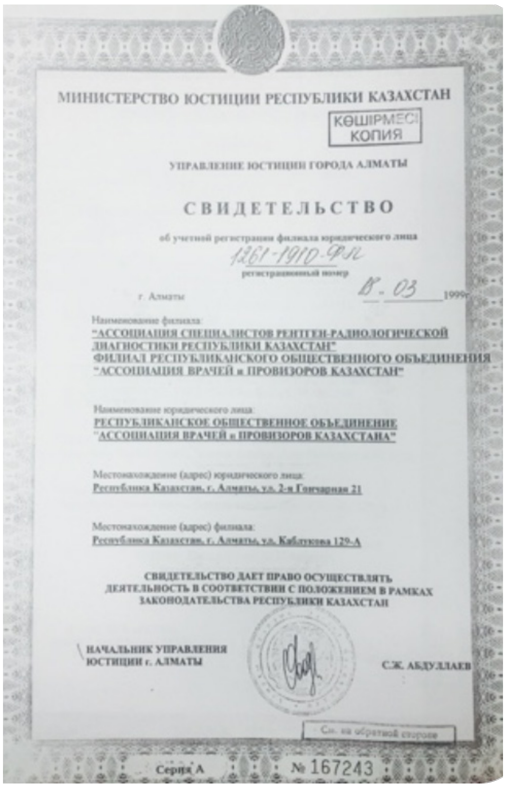


Figure 2. *Statute of the Kazakh Republican Scientific Society of Radiologists.*

The Kazakh Republican Scientific Society of Radiologists and Radiologists was part of the All-Union Scientific Society of Radiologists until 1991 (before the collapse of the USSR). The primary goals and objectives of the Kazakh Republican Scientific Society of Radiologists were the development and improvement of radiology in Kazakhstan, the education and training of their members and young radiologists in close relationship with other radiological societies. The first symposium on vascular and X-ray endovascular surgery was held in 1992 with the participation of foreign experts.

After the independency, the Kazakh Republican Scientific Society of Radiologists was reorganized into the Association of X-ray Radiological Diagnostics Specialists of the Republic of Kazakhstan in the year 1999 (Figure 3).



МИНИСТЕРСТВО ЮСТИЦИИ РЕСПУБЛИКИ КАЗАХСТАН

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СВИДЕТЕЛЬСТВО ДАЕТ ПРАВО ОСУЩЕСТВЛЯТЬ ДЕЯТЕЛЬНОСТЬ В СООТВЕТСТВИИ С ПОЛОЖЕНИЕМ В РАМКАХ ЗАКОНОДАТЕЛЬСТВА РЕСПУБЛИКИ КАЗАХСТАН

НАЧАЛЬНИК УПРАВЛЕНИЯ ЮСТИЦИИ г. АЛМАТЫ С.Ж. АБДУЛЛАЕВ

См. на обратной стороне

Серия А № 167243

Figure 3. *X-ray Radiological Diagnostics of the Republic of Kazakhstan Association's Registration Certificate.*

In 1997 in Almaty, Kazakhstan, a meeting between the President of the Association of X-ray Radiological Diagnostics of the Republic of Kazakhstan, Zhangali Khamzabayevich, and the President of the European Association of Radiologists, Professor Hans Ringerz happened during the International Congress of Radiologists (Figure 4). The issue of incorporating the Association of Radiologists of Kazakhstan into the European Association of Radiologists was discussed, and in the 1999, it was accepted as an associate member of the European Association of Radiologists (EAR).

Figure 4. *Round table during the International Congress of Radiology (1997 year, Almaty).*

In 1998, under the leadership of Zhangali Khamzabaevich, the Association of Radiologists of Kazakhstan together with the IAEA conducted a two-week course on nuclear medicine for specialists from Central and West Asia, which was one of the first international collaborations of Kazakh radiologists with foreign radiological societies. This event gave impetus to the development and brought radiation protection measures in Kazakhstan to be in line with international standards.

During the period of the cooperation from 1998 to 2010 between the the Association of Radiologists of Kazakhstan and the European Association of Radiologists (EAR), 74 young radiologists from Kazakhstan were trained at the European School of Radiologists Graz Tutorial led by Professor Rainer Rienmueller on the basis of the radiology department of the Medical University Graz.

In 2005, the Radiological Society of Kazakhstan established a biannual Eurasian Radiological Forum for educational purposes in close collaboration with radiological societies from Europe and Asia (Figure 5).

Figure 5. *Emblem of the Second EARF.*

In 2006, under the initiative of Rozhkova N.I. and Rakhimzhanova R.I. the Eurasian Association of Mammologists was established jointly among Russia, Kazakhstan, Azerbaijan, Uzbekistan, Ukraine, and Japan.

In August 2012, the Association of Radiologists of Kazakhstan was transformed into the Radiological Society of Kazakhstan. In 2012, the Radiological Society of Kazakhstan became a national full member of the European Society of Radiology (ESR).

Since 2014 every year in Astana a two-week European School of Radiology (ESOR) Astana Tutorial has been held by the initiative of the European Society of Radiologists (Figure 6). During this period, 105 young radiologists from Kazakhstan, Uzbekistan, Kyrgyzstan, Turkmenistan and Tajikistan have the opportunity to refresh their knowledge from leading professors from Europe and Russia (Figure 7).

Figure 6. *Professor Nicholas Gourtsoyanis - Scientific and Educational Director of ESOR in Astana/ Kazakhstan (2016 year).*

Figure 7. *Third ESOR Astana Tutorial (2016 year, Astana).*

In 2016, the first Eurasian school of breast imaging was organized by the initiative of the Radiological Society of Kazakhstan by inviting lecturers from Canada, Russia, Uzbekistan and Dagestan (Figure 8).

Figure 8. *Eurasian Radiomammological School (2016 year, Astana).*

During June 29 - July 1, 2023, the 10th Eurasian Radiological Forum (10th EARF) was held in Astana, Kazakhstan, by the Radiological Society of Kazakhstan (RSK) in an in-person format (Figure 9). The program consisted of the Friendship Symposium on cardiovascular radiology between the Korean Society of Radiology and the Radiological Society of Kazakhstan, a sectional session of the World Federation of Emergency Radiology, a sectional session of the Asian-Oceanian School of Radiology on pediatric radiology, a meeting between RSK and Russian Society of Roentgen Radiologists, and a joint meeting with the IAEA "Quality and safety in diagnostic and interventional radiology. About 400 attendees from 34 countries around the world with 86 overseas participants and 314 local participants participated in the 10th EARF. The countries with the highest number of participants included Kazakhstan, Russia, Uzbekistan, and Belarus, respectively (Table 1).

Figure 9. *Participants of the first plenary session.*

Table 1. *Participants of the 10th EARF.*

NO.	Country	TOTAL
1	Austria	5
2	Azerbaijan	3
3	Armenia	1
4	Belarus	4
5	Bulgaria	2
6	China	1
7	Dagestan	1
8	England	1
9	Estonia	3
10	Finland	1
11	France	1
12	Georgia	2
13	Germany	1
14	Hong Kong	1
15	India	2
16	Kazakhstan	314
17	Kyrgyzstan	2

NO.	Country	TOTAL
18	Latvia	1
19	Lithuania	4
20	Malaysia	1
21	Mongolia	1
22	Republic of Moldova	2
23	Russia	23
24	Serbia	1
25	Singapore	2
26	South Korea	3
27	Tajikistan	1
28	Taiwan	2
29	Thailand	2
30	Turkey	2
31	Turkmenistan	1
32	Uzbekistan	7
33	Ukraine	1
34	USA	1

Fifty-seven eminent speakers who are experts in the concrete field of diagnostic and interventional radiology, medical physics and theranostic performed their reports during various sessions (Table 2).

Table 2. *The program of the 10th EARF.*

Forum program	
2 Plenary Sessions	1 Friendship Symposium
12 Sectional Sessions	1 Satellite Symposium
1 Conjoint Session	1 Master Class

Every month Astana branch of RSK carries out a one-hour meeting on actual issues of diagnostic and interventional radiology, management in radiology. During the meeting, topical issues, rare clinical cases, plans of future conferences and congresses are discussed (Figure 10). Furthermore, leaders and members of our society conduct educational seminars and thematic master classes in different regions of Kazakhstan.

Figure 10. *Regular meeting of the main specialists in radiology of the Health Ministry of the Republic of Kazakhstan, Astana/Kazakhstan (2023 year).*

In summary, it is necessary to note that our society has a tight collaboration with the European Society of Radiology, the Asian Oceanian Society of Radiology, the Korean Society of Radiology, the Russian Society of Roentgen Radiologists and the International Society of Radiology. Year after year, we are getting closer to international standards in radiology.

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ASEAN Movement in Radiology

DRL as a common language in patient dose reduction and optimization: A short note from AsiaSafe in 2024 RCRT-RST Annual Congress, Bangkok, Thailand

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Abstract

The AsiaSafe Asian Oceanian Symposium at the 2024 RCRT-RST Annual Congress discussed the situation and the role of radiology in patient dose reduction and optimization using Diagnostic Reference Levels (DRLs) as a common language. The scientific committee of the Royal College of Radiologists of Thailand (RCRT) and Radiological Society of Thailand (RST) established the Collaboration Symposia to discuss hot health-related topics with participating Asian Radiological societies. At the 2024 RCRT-RST Collaboration Symposia, different views, initiatives, and ideas were presented by representatives from societies.

Keywords: AsiaSafe, ALARA, Diagnostic Reference Levels (DRLs), Dose reduction, Medical physicist, Optimization, Radiation, Radiation safety, Radiologist, technologist.

Main messages

- Diagnostic reference levels (DRLs) can be adopted as a common language in promoting optimization as well as a practical tool and general guideline for clinical operations,
- DRLs was first proposed in 1990 by the International Commission on Radiological Protection (ICRP), typically set at the 75th percentile of the dose distribution from a survey conducted across a wide user base,
- DRLs is typically used for identifying situations where the levels of patient dose are unusually high,
- DRLs are not for regulatory or commercial purposes, not a dose restraint and not linked to limits or constrants,
- It is essential to ensure that the image quality appropirate for the diagnostic purpose is achieved when changing patient doses and the optimization must balance the image quality and the patient dose,
- Establishing the national DRL is somewhat chanllenging and needs to adapt to fit the situation in each country.
- Several countries in Asean Oceanian region have been embarking on various stages of DRLs development and implementation.

Introduction

The Asian Symposia were established by the Royal College of Radiologists of Thailand (RCRT) and Radiological Society of Thailand (RST) scientific committee with the aim to discuss currently hot health-related topics of Asian Oceanian countries. The symposia were held in the second day of 2024 RCRT-RST and participation was by invitation only (Figure 1). The proposed topics discussed in the 2024 RCRT-RST Asian Symposia were hepatocellular carcinoma, cholangiocarcinoma, prostate cancer, and diagnostic reference level (DRL).

The following societies delivered a presentation and subsequently submitted a written report summarizing the point of view of their respective country or region. The societies included the College of Radiology, Academy of Medicine of Malaysia (MCoR), the Korean Society of Radiology (KSR), the Taiwan Radiological Society (TRS), and the Royal College of Radiologists of Thailand (RCRT) – Radiological Society of Thailand (RST).

Figure 1. *The authors and some participants from organizations related to radiation safety in Asian Symposia during the RCRT-RST annual meeting on 9 February 2024 in Bangkok, Thailand.*

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The Situation in Malaysia

Emeritus Professor Kwan Hoong Ng, AsiaSafe chairman and representative of the College of Radiology, Academy of Medicine of Malaysia

With a recorded population of 34.3 million in 2023, Malaysia can be considered a relatively small country in Southeast Asia after Singapore with a middle- to high-income status. Its doctor to people ratio is 2.3 per 1,000 people (The World Bank, 2023) and the nation's healthcare system has been upgraded from Healthcare Level (HCL) 2 to HCL 1 by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) in 2022. In the field of radiology and nuclear medicine, the country has approximately 650 serving radiologists, or 0.01 radiologists for every 1,000 people, which is still a rather small figure compared with Australia and Europe (UNSCEAR 2022).

The Malaysian public healthcare system comprises a comprehensive network of clinics, hospitals and preventive health centres. According to the 2019 National Radiological Services Operational Policy published by the Medical Development

Division of the Health Ministry (MoH), radiological services have been made available at all general hospitals nationwide. Additionally, these services are also extended to 27 private specialist hospitals, 28 specialist clinics and 219 government health clinics (MoH, 2019).

As radiology grows and more patients are being subjected to procedures such as X-ray, computed tomography, positron emission tomography and magnetic resonance imaging, the MoH has commissioned three national medical radiation exposure surveys to determine patient dosimetry in hospitals nationwide. Although technology and equipment have evolved to become safer and more efficient, concerns have been raised on what constituted a safe quantity of radiation exposure, with calls for standards and guidelines to be introduced to ensure the safety of patients and medical staff.

Therefore, in the past 30 years, MoH has conducted three National Medical Radiation Exposure Surveys to monitor trends in radiological practises and to update guidelines and safety measures to suit current demands and technological advances.

1st National Medical Radiation Exposure Survey (1993-1995)

The initial national dose survey reports for diagnostic radiology practices in Malaysia spanning from 1990 to 1994 had been presented in three publications [1-3]. These findings were subsequently incorporated into the UNSCEAR 2000 report. The surveys served as foundational benchmarks, facilitating the assessment of usage patterns, trends, standards and the overall clinical service status of radiological treatments in Malaysia.

The survey results were also used to support improvements and updates in Malaysia's Quality Assurance Programme (QAP) in diagnostic radiology. The QAP in diagnostic radiology was first established in 1985, starting with 14 state hospitals and two district hospitals. By 1989, all government hospitals had implemented the QAP in their radiology departments. Subsequently, QAP was introduced to the private hospitals.

2nd National Medical Radiation Exposure Survey (2007-2009)
The MOH carried out a second medical radiation exposure survey involving both public and private healthcare institutions from 2007 to 2009 to develop diagnostic reference levels (DRLs) in diagnostic radiology, dental radiology and nuclear medicine. Data collected were also shared with UNSCEAR. The survey resulted in several publications to address quality and safety issues of radiological services in Malaysia within the period.

Additionally, guidelines for establishing national DRLs in both radiology and nuclear medicine were formulated in 2013. The 2nd National Dose Survey Report was published by MoH in 2008 (https://inis.iaea.org/collection/NCLCollectionStore/_Public/45/099/45099981.pdf). In May 2013, the national DRL on radiology and nuclear medicine was officially released by the ministry (URL).

3rd National Medical Radiation Exposure Survey (2022-2024)
The third survey is currently ongoing and has three objectives: (i) To conduct a more comprehensive national dose survey; (ii) to update DRLs in diagnostic radiology, dental radiology and diagnostic nuclear medicine; and, (iii) to include new modalities and hybrid modalities.

Research and Development in Medical Radiation Exposure/ Patient Dosimetry
There are studies carried out by local higher-learning institutions, notably Universiti Malaya(UM), Universiti Putra Malaysia (UPM), Universiti Kebangsaan Malaysia (UKM), Universiti Sains Malaysia (USM), etc. These public universities have the academic experts who have been actively collaborating with the MoH and various hospital managements, as well as related government agencies. Some recent publications include patient doses in mammography, CT, paediatric, etc. [4-9].

Additionally, two related edited books were published during this period: *"Subject Dose in Radiological Imaging."* Ed. K-H Ng, D A Bradley and H M Warren-Forward, Elsevier 1998, and “Radiological Safety and Quality: Paradigms in Leadership and Innovation” Ed. L Lau and K H Ng, Springer 2013. These books are the products of a unique collaboration by experts from leading international, regional and national agencies and professional organizations discussing radiation doses in imaging and promoting judicious uses to maximize the benefits and minimize the risks when using radiation in medicine.

Current and Planned Activities

Some 30 years ago, dose measurements were performed in common radiographic examinations and medical radiation exposure was surveyed only at selected radiology centres. Today, they have been expanded to include all imaging modalities and procedures at all healthcare institutions nationwide. Ongoing initiatives are conducted to raise awareness and encourage participation from multiple stakeholders. The objective is to integrate DRLs into the whole optimisation process.

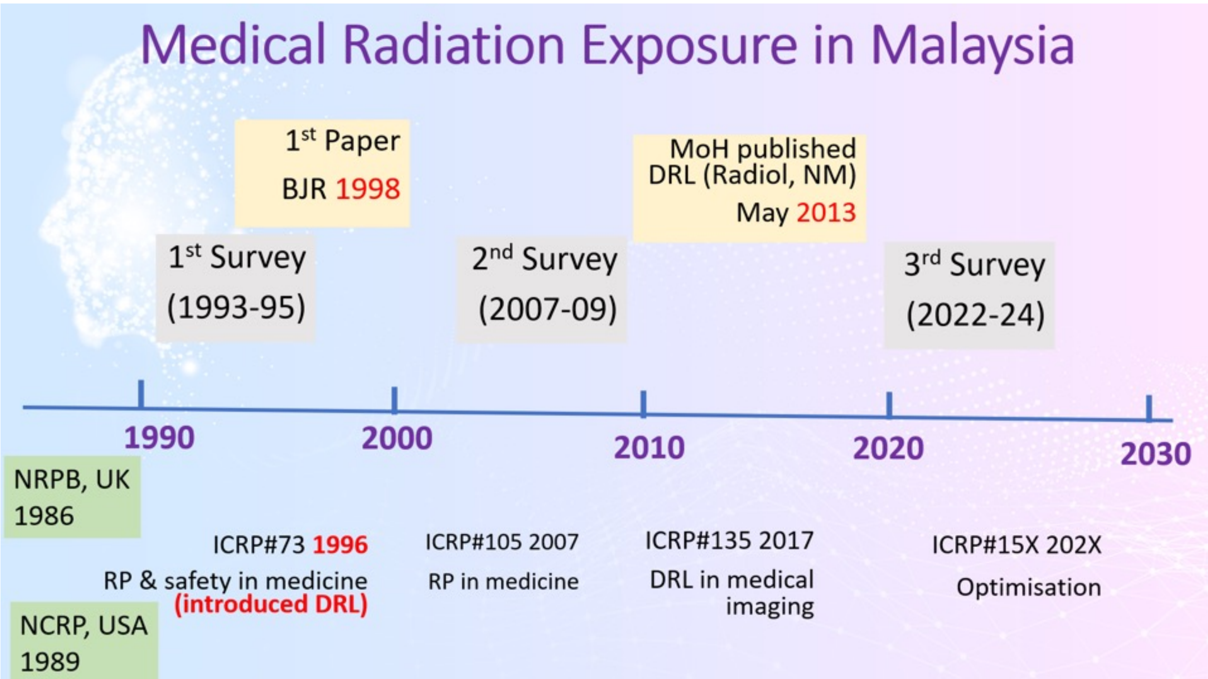

Figure 2. *Timeline of medical radiation exposure milestones in Malaysia, along with several international key developments.*

The Situation in South Korea

Professor Seung Eun Jung, representing the Korean Society of Radiology (KCR)

Since 2007, South Korea has embarked on a comprehensive initiative to establish and periodically update Diagnostic Reference Levels (DRLs) for radiographic procedures, a government-led project spearheaded by the Korean Society of Radiology (KSR). This project started with mammography and general radiography and expanded to include CT, fluoroscopy, and interventional procedures. DRLs were published for chest postero-anterior scanning and mammography in 2008, for CT scanning in 2009, for paediatric chest radiography in 2010, for general radiography in 2012, and for dental imaging in 2013 [10].

Regular updates to the DRLs were recognized as essential for reducing patient doses. These updates consider technological advancements and evolving clinical practices with a shift from initial phantom measurements to analyzing CT dose reports for contemporary data collection.

In mammography, for instance, the average glandular dose observed was 1.36 mGy in 2007, which slightly increased to 1.6 mGy in 2018 with the introduction of Digital Radiography (DR) and subsequently decreased to 1.56 mGy in 2022. Similar systematic updates to DRLs for general radiography were implemented in 2022, incorporating data from numerous medical institutions [11].

For CT scans, the methodology has been refined over the years, starting from measurements using phantoms on 2007 to including various protocols and dose report collection on 2017 and 2021. By 2021, a total of 7829 CT examinations from 225 CT scanners had been analyzed [12], providing benchmarks for patient safety and guiding dose optimization.

The 2021 survey revealed a slight increase in DRLs for some protocols compared to 2017, likely due to the inclusion of more institutions. This finding underscores the need for continued vigilance in monitoring DRLs.

In terms of interventional procedures, Korea's DRLs, based on data collection of DAP and fluoroscopic time for various procedures, were lower than the average and tended to be lower than those of other nations [13].

Emphasizing pediatric radiography, data from seven university hospitals were analyzed using automated dose management software to optimize radiation doses in pediatric CT scans. The importance of continuous updates to DRLs was underscored, advocating for further research and data collection to develop national DRLs [14].

Moving toward the future, Korea is integrating advanced electronic systems for better dose monitoring and management, such as the Korean National CT Dose Index Registry (KNCDR) (Fig 1), which is currently in the pilot phase [15]. This transition to automated recording and analysis aims to enhance the effectiveness of DRLs and expand their scope to include more imaging modalities and procedures, aligning with technological advancements.

Conclusion:

South Korea's commitment to updating DRLs and integrating advanced electronic systems for radiation dose management represents a significant step forward in promoting patient safety and adapting to technological advances in medical imaging. Sustained efforts and meticulous attention to systematic DRL updates are paramount to maintaining progress and effectiveness in optimizing radiographic practices.

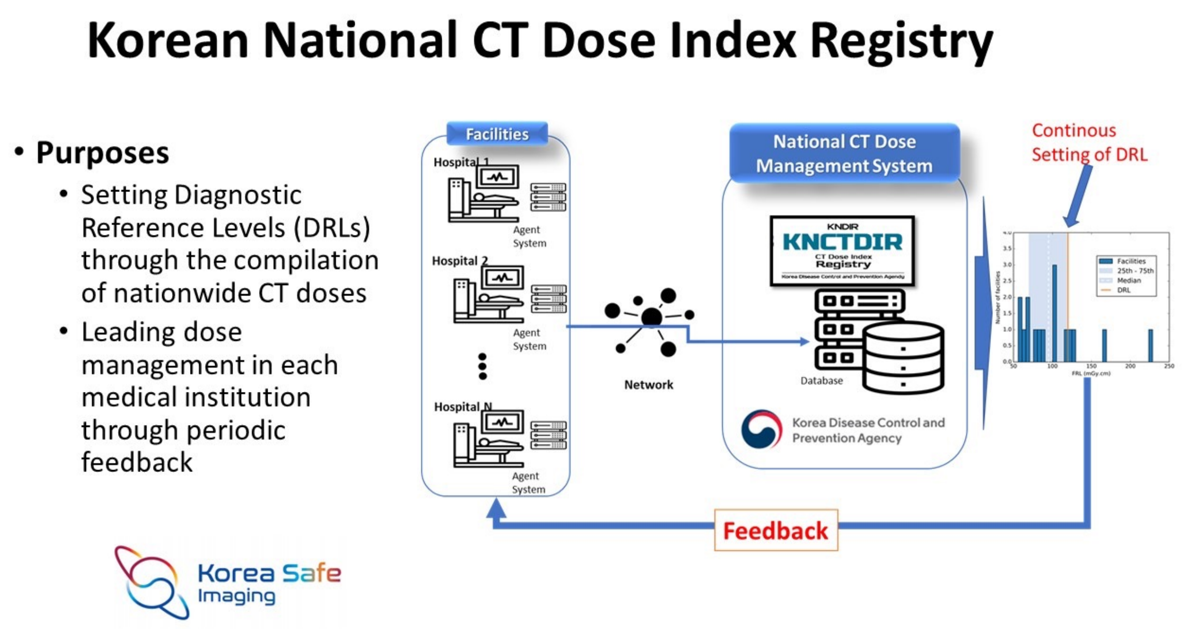

Figure 3. *An infographic showcasing the Korean National CT Dose Index Registry system: the flow diagram highlights the registry's purposes such as setting DRLs through the aggregation of nationwide CT dose data and enhancing dose management at medical institutions via regular feedback. The process involves data collection from various hospitals through an agent system, followed by analysis in a central database managed by the Korea Disease Control and Prevention Agency. The right side illustrates the continuous setting of DRL with a bar chart comparing individual facility doses against the 25th, 50th (median), and 75th percentiles, and the established DRL.*

The Situation in Taiwan

Professor Hui-Yu Tsai, representing Taiwan Radiological Society (TRS), Chinese Society of Medical Physics, Taipei

Taiwan's progressive approach in radiological safety and dose optimization through the adoption of Diagnostic Reference Levels (DRLs). This initiative represents a concerted effort between key regulatory bodies—specifically, the Nuclear Safety Commission and the Ministry of Health and Welfare—and professional organizations including the Taiwan Radiological Society (TRS), the Chinese Society of Medical Physicists in Taipei (CSMPT), and the Taiwan Society of Radiological Technologists (TWSRT). This collaboration underscores Taiwan's commitment to aligning with the recommendations offered by the International Commission on Radiological Protection (ICRP).

The path to improved radiation safety began with extensive quality assurance reviews across a spectrum of radiological modalities between 2008 and 2023. These efforts laid the groundwork for the creation of both local and national DRLs, marking a pivotal advancement in reducing patient exposure during mammography, computed tomography (CT), and angio-fluoroscopy. Central to this progress has been the meticulous collection of radiological data, which includes a broad range of dose metrics such as average glandular dose (AGD), volumetric CT dose index (CTDIvol), dose length product (DLP), and incident air kerma rate at the patient entrance reference point (Ka,r). This data compilation has been crucial in establishing National Diagnostic Reference Levels (NDRLs) [16-19], setting a new standard for radiological procedures throughout the country.

To facilitate the widespread adoption and effective implementation of DRLs, Taiwan has initiated several guidance [20-23] and education programs. These encompass developing standardized operating procedures, fostering hospital collaborations, and conducting expert-led seminars and workshops. Aimed at cultivating a culture of ongoing improvement, these initiatives strive to integrate DRL principles into the core practices of Taiwan's radiological sector, emphasizing their essential role in optimizing patient safety and enhancing the quality of medical imaging practices.

Looking forward, Taiwan is committed to expanding the scope of NDRLs to include a broader array of CT scans and mammography, adapting to diverse breast sizes and 3D scans. This diligent endeavor underscores the importance of regular data evaluations to align with evolving safety standards, thus emphasizing the universal significance of DRLs in advancing medical imaging safety and efficacy. Taiwan's proactive measures underscore a long-term commitment to elevating radiological standards, spotlighting the necessity of continuous education and quality enhancement in radiological safety.

Conclusion:

Taiwan's strategic deployment of DRLs represents a crucial step forward in enhancing radiological safety and optimizing dose management. Collaborative efforts among government regulators and professional organizations have cultivated a comprehensive framework for reducing radiation exposure in diagnostic procedures. The diligent gathering and analysis of radiological data have been instrumental in establishing National DRLs, guiding medical imaging practices toward heightened safety and efficiency. Through the ongoing expansion of these standards and a strong focus on education and quality improvement, Taiwan actively contributes to the global mission of improving radiological health and safety, highlighting the indispensable role of DRLs in fostering superior patient care and advocating for continuous progress in the radiological sciences.

The Situation in Thailand

Associate Professor Panruethai Trinavarat, representing the Royal College of Radiology of Thailand and Radiological Society of Thailand

The establishment of national DRLs in Thailand was first started by the Department of Medical Sciences, Ministry of Public Health (DMSc, MoPH) for general and dental radiographs in the fiscal year 2017. Before 2017, a patient dose in Thailand was already an issue of concern and had been surveyed in several medical schools, but mostly in a single center or in a small group of hospitals, for the high dose imaging - particular CT scanning and interventional radiology [24-30]. In the year 2018, there were two coincidental projects to survey patient doses in CT, one by the DMSc, and the other by a group of radiologists from medical schools under the country project THA 6043 supported by the International Atomic Energy Agency (IAEA). The ICRP publication 135 has been used as the guideline and there were renowned medical physicists from IAEA Expert Mission visiting Thailand to enlighten the DRL process and also dose management.

Since 2018, there has been a mutual agreement that the establishment of DRLs in Thailand would be mainly conducted by the DMSc with the collaboration of medical schools and/or professional organizations to have radiologists, radiologic technologists, and medical physicists involved in the DRL process, because some imaging procedures and/or patients are somehow complicated and clinical subspecialties can help clarify the imaging process and suggest how to fill the dose record forms.

Thai DRLs of mammography were established in 2019 and the DRLs of interventional neuroradiology and body interventional radiology procedures were established in 2020 with the collaboration between the DMSc, medical schools and the Thai Society of Vascular and Interventional Radiology (TSVIR). Since 2021, the DMSc started the second round of DRL process.

To broaden national and local DRLs to include more imaging modalities and more imaging procedures, several professional organizations created their own surveys on imaging not having been surveyed by the DMSc. These included DRLs in Nuclear Scintigraphs, Cardiac IR procedures, CT angiography in several areas, head CT in pediatrics, and more. The DRL results from these surveys have been collected and reported together in the published National Diagnostic Reference Levels in Thailand (updated 2023) by the DMSc, and can be accessed online from the website of the Royal College of Radiologists of Thailand (RCRT) [31], however, in a Thai version.

Besides the manual national and local surveys for DRL establishment, Thailand has started dose registry for CT by using dose monitoring software, initiated by the country project THA6043 supported by the IAEA. There was a meeting among (expecting) participating hospitals to set an agreement on which CT procedures were common and should have DRLs. This CT dose registry started its function on January 2022, collecting dose data of 14 CT protocol names from 9 participating hospitals with the central server at the Office of Atoms for Peace (OAP) who runs the project in collaboration with the RCRT. Each participating hospital has got feedback every trimester of the hospital's median CT dose compared to DRLs of the group. The hospital(s) using significantly a high CT dose was directedly contacted, and the expert team from the RCRT could provide the online consultance or even a site visit to help them in optimization. The local DRLs of Thai CT dose registry can also be accessed online from the website of the Royal College of Radiologists of Thailand (RCRT) in a Thai version [32]. The number of participating hospitals will expand from 9 hospitals to 17 hospitals in 2024, and 27 hospitals in 2025.

The establishment of pediatric DRLs in Thailand is a big challenge, as the number of examinations is quite small relative to the number of the exams in adults, and has to be further categorized with age bands. Although Thai local DRLs for pediatrics can be established in some modalities and some procedures, they are still incomplete and some are partly dominated by data from university hospitals.

The result of Thai DRLs shows that most of the imaging modalities and procedures providing a radiation dose not much different from those reported from other countries, but Thailand still has ample opportunities for improvement. There is evidence from the first and second rounds of DRL establishment for general radiographs that there has been obvious dose rising in chest X-ray from digital radiography. Other concerning findings are the relatively high Thai DRLs for adult chest CT and adult abdomen-pelvis CT from the national survey, and the high DRLs for pediatric head CT from Thai CT dose registry. Thailand has been trying to solve these problems through education- to both radiologic technologists and radiologists, both in the curriculum and in continuous medical education. Initiation of the audit system on patient dose has been raised, but not yet fixed.

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3. Professor Hui-Yu Tsai, representing the Taiwan Radiologicl Society,
4. Associate Professor Panruethai Trinavarat, representing the Royal College of Radiologists of Thailand and the Radiological Society of Thailand.

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References

1. Ng KH, Rassiah P, Wang HB, Hambali AS, Muthuvellu P, Lee HP. Doses to patients in routine X-ray examinations in Malaysia. Br J Radiol 1998;71:654-60. doi: 10.1259/bjr.71.846.9849390.

2. Ng KH, Abdullah BJ, Rassiah P, Sivalingam S. X-ray based radiological procedures in Malaysia: 1990-1994. Med J Malaysia 1999;54:185-91.

3. Ng KH, Abdullah BJ, Sivalingam S. Medical radiation exposures for diagnostic radiology in Malaysia. Health Phys 2000; 77:33-6. doi: 10.1097/00004032-199907000-00007.

4. Jamal N, Ng KH, McLean D. A study of mean glandular dose during diagnostic mammography in Malaysia and some of the factors affecting it. Br J Radiol 2003;76:238-45. doi: 10.1259/bjr/66428508.

5. Sabarudin A, Sun Z, Ng KH. Radiation dose associated with coronary CT angiography and invasive coronary angiography: an experimental study of the effect of dose-saving strategies. Radiat Prot Dosimetry 2012 ;150:180-7. doi: 10.1093/rpd/ncr377.

6. Muhammad NA, Karim MKA, Hassan HA, Kamarudin MA, Wong JHD, Ibahim MJ. Estimation of effective dose and organ cancer risk from paediatric computed tomography thorax–abdomen-Pelvis examinations. Radiat Phys Chem 2019;165:108438.

7. Abdulkadir MK, Shuaib IL, Achuthan A, Nasirudin RA, Samsudin AHZ, Osman ND. Estimation of pediatric dose descriptors adapted to individual specific size from CT examinations. Radiat Prot Dosimetry 2022;198:1292-302. doi: 10.1093/rpd/ncac163.

8. Muhammad NA, Karim MKA, Harun HH, Rahman MAA, Azlan RNRM, Sumardi NF. The impact of tube current and iterative reconstruction algorithm on dose and image quality of infant CT head examination. Radiat Phys Chem 2022;200:110272.

9. Jusoh II, Abdullah KA, Ali MH. Diagnostic reference levels for common CT examinations: results from a statewide dose survey. Radiat Prot Dosimetry 2022;198:1417-23. doi: 10.1093/rpd/ncac182.

10. Do KH, Jung SE. Current status of medical radiation exposure in Korea - recent efforts to develop a radiation exposure control system focussed on justification and optimisation. Ann ICRP 2016;45(1 Suppl):113-21. doi: 10.1177/0146645316637783.

11. Yoon Y, Park H, Won J, Song S, Gil, J, Lee BY. Korean diagnostic reference level for general radiography and mammography in 2022. Public Health Wkly Rep [Internet]. 2023 [cited 2024 Apr 14];16:1082-100. Available from: https://www.researchgate.net/publication/373019541_Korean_Diagnostic_Reference_Level_for_General_Radiography_and_Mammography_in_2022.

12. Nam S, Park H, Kwon S, Cho PK, Yoon Y, Yoon SW, et al. Updated national diagnostic reference levels and achievable doses for CT protocols: a national survey of Korean hospitals. Tomography 2022; 8: 2450–59. doi: 10.3390/tomography8050203.

13. Lee MY, Kwon J, Ryu GW, Kim KH, Nam HW, Kim KP. Review of National diagnostic reference levels for interventional procedures. Prog Med Phys 2019;30:75-88. doi.org/10.14316/pmp.2019.30.4.75

14. Hwang JY, Choi YH, Yoon HM, Ryu YJ, Shin HJ, Kim HG, et al. Establishment of local diagnostic reference levels of pediatric abdominopelvic and chest CT examinations based on the body weight and size in Korea. Korean J Radiol 2021;22:1172-84. doi: 10.3348/kjr.2020.0890.

15. Kim JS, Kwon SM, Cho PK, Yoon SW, Kim JH, Gil JW, et al. Policy planning for patient dose registry system for computed tomography examination. Public Health Wkly Report 2022;15(16):1057-68.

16. Lin YY, Tsai HY, Wu YE, Liao YL, Hwang YS. A nationwide survey on the dose of digital breast tomosynthesis. Formosan J Med 2019;23:289–309. doi: 10.6320/fjm.201905_23(3).0002.

17. Tung CJ, Tsai HY, Lo SH, Guan CN, Chen YB. Determination of guidance levels of dose for diagnostic radiography in Taiwan. Med Phys 2001;28:850–7. doi: 10.1118/1.1368126.

18. Hwang YS, Chen CC, Liao YP, Kuang WC, Tsai HY, Liu HL. Establishment and application of diagnostic reference levels of medical radiation exposures. Formosan J Med [Internet]. 2012 [cited 2024 Apr 14];16:518–28. Available from:https://www.airitilibrary.com/Article/Detail/10281916-201209-201210300009-201210300009-518-528.

19. Tsai HY, Tung CJ, Yu CC, Tyan YS. Survey of computed tomography scanners in Taiwan: dose descriptors, dose guidance levels, and effective doses. Med Phys 2007;34:1234–43. doi: 10.1118/1.2712412.

20. Hwang YS, Yeh MY, Chiang SW, Liu IC, Liao YL, Tsai HY, et al. Recommendations for physics testing of digital mammography systems. Formosan J Med [Internet]. 2018 [cited 2024 Apr 14];22:311–23. Available from: https://www.airitilibrary.com/Article/Detail?DocID=10281916-201805-201805310001-201805310001-311-323.

21. Hwang YS, Hsiao YH, Chiang SW, Yeh MY, Liu IC, Yan FX, et al. Recommendations for physics testing of fluoroscopic and interventional radiologic systems. Formosan J Med [Internet]. 2015 [cited 2024 Apr 14];19:517–27. Available from: https://www.airitilibrary.com/Article/Detail/10281916-201509-201510050023-201510050023-517-527.

22. Tsai HY, Chen CC, Hwang YS, Liu HL. Review and recommendations for physics testing of x-ray computed tomography: CSMPT CT task group report. Chin J Radiol [Internet]. 2009 [cited 2024 Apr 14];34:173–84. Available from: http://www.scopus.com/inward/record.url?eid=2-s2.0-76149086157&partnerID=40&md5=394ce7e889baa076403e41173bcf128d. Subscription required.

23. Hwang YS, Wang H, Chen C, Liu H, Tsai HY. Review and recommendations for physics testing of conventional and digital mammography: CSMPT mammography task group report. Chin J Radiol [Internet]. 2008 [cited 2024 Apr 14];33:153–79. Available from:https://www.airitilibrary.com/Article/Detail?DocID=10188940-200809-33-3-153-179-a

24. Wongsanon S, Witchathorntakun W, Wongsanon W. Patient radiation dose received from the body interventional radiology. Srinagarind Med J 2009; 24:339–43. Thai.

25. Trinavarat P, Kritsaneepaiboon S, Rongviriyapanich C, Visrutaratna P, Srinakarin J. Radiation dose from CT scanning: can it be reduced? Asian Biomed 2011;5 (: 13-21.

26. Trinavarat P, Manaphol S, Yimpraphan N, Assawakulkamnurd S. Cancer risk from pediatric diagnostic radiology; should we be concerned? Chula Med J 2011; 55: 621-32. Thai.

27. Urairat J, Asavaphatiboon S, Singhara Na Ayuthaya S, Pongnapang N. Evaluation of radiation dose to patients undergoing interventional radiology procedures at Ramathibodi Hospital, Thailand. Biomed Imaging Interv J 2011; 7:e22. doi: 10.2349/biij.7.3.e22.

28. Kritsaneepaiboon S, Trinavarat P, Visrutaratna P. Survey of pediatric MDCT radiation dose from university hospitals in Thailand: a preliminary for national dose survey. Acta Radiol 2012; 53:820-6. doi: 10.1258/ar.2012.110641.

29. Admontree S, Krisanchinda A, Laothamatas J, Trinavarat P. Radiation dose on whole brain computed tomography in comprehensive stroke imaging using axial volumetric 30-detector CT. Chula Med J 2015;59:1-11.

30. Sulagaesuan C, Saksobhavivat N, Asavaphatiboon S, Kaewlai R. Reducing emergency CT radiation doses with simple techniques: a quality initiative project. J Med Imaging Radiat Oncol 2016;60:23-34. doi: 10.1111/1754-9485.12410.

31. Department of Medical Sciences, Ministry of Public Health. National diagnostic reference levels in Thailand 2023. [Internet]. Nonthaburi: Ministry of Public Health; 2023 [cited 2024 Apr 14]. Availble from: https://www.rcrt.or.th/wp-content/uploads/2023/10/National-DRLs-in-Thailand-2023.pdf. Thai.

32. Office of Atoms for Peace, Royal College of Radiologists of Thailand. Thailand national CT dose registry, trimester report 2023 [Internet]. Bangkok: RCRT; 2023 [cited 2024 Apr 14]. Available from: https://www.rcrt.or.th/thailand-national-ct-dose-registry/. Thai.

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