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香 港 醫 訊

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Radiology

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LORVIQUA®
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LORVIQUA®

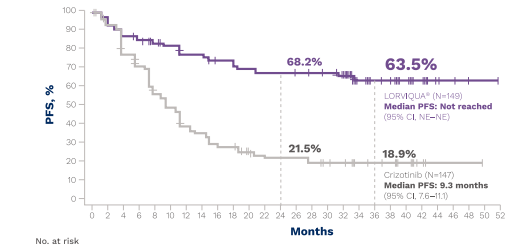
is now approved in HK for FIRST LINE use[1]

LORVIQUA® is indicated for the treatment of adult patients with metastaic non-small cell lung cancer (NSCLC) whose tumors are anaplastic lymphoma kinase (ALK)-positive.[1]

PROGRESSION-FREE SURVIVAL[2]

The **3-year PFS rate for LORVIQUA® was 63.5%** vs 18.9% with crizotinib

PFS by BICR in the ITT population



73% REDUCTION in the risk of progression or death vs crizotinib (BICR-assessed)

HR, 0.27 (95% CI, 0.19–0.388)

Adapted from Solomon et al. 2022
Data cut off date: 20 September 2021

SAFEGUARD patients WITH and WITHOUT brain metastasis[2]

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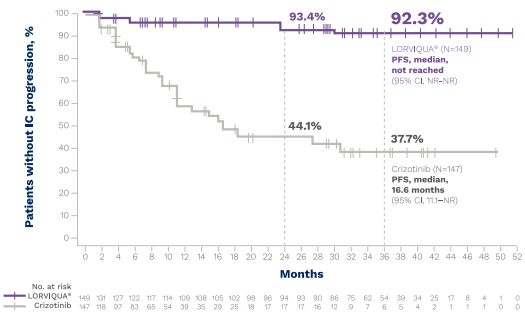
Rx LORVIQUA® 100mg OD[1]

TIME TO IC PROGRESSION BY BICR[2]

LORVIQUA® demonstrated **unprecedented IC efficacy**

Time to IC progression by BICR in the ITT population



92.3% of patients treated with LORVIQUA® were **free of CNS progression** at 36 months

HR, 0.08 (95% CI, 0.40–0.174)

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ALK, anaplastic lymphoma kinase; BICR, blinded independent central review; CI, confidence interval; CNS, central nervous system; HR, hazard ratio; IC, intracranial; ITT, intention-to-treat; NSCLC, non-small cell lung cancer; OD, once daily; PFS, progression-free survival; Rx, prescribe; TKI, tyrosine kinase inhibitor.

References: 1. LORVIQUA® Prescribing Information. Pfizer Corporation Hong Kong Limited: Version February 2022. **2.** Solomon BJ, *et al*. Updated efficacy and Safety From the Phase 3 CROWN Study of First-Line Lorlatinib vs Crizotinib in Advanced Anaplastic Lymphoma Kinase (ALK)-Positive Non-Small Cell Lung Cancer (NSCLC). Presented at: AACR Annual Meeting 2022; 8-13 April 2022; New Orleans, Louisiana, USA. Abstract #CT223.

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The Cover Shot

This oil painting is a copy of Irene Cahen D'anvers' portrait by Pierre Auguste Renoir. He was a French artist, and a leading painter of the impressionist style. I picked up oil painting as a hobby nine months ago, and this painting took me 6 - 8 hours.

I chose oil painting as my hobby to relieve stress.

One advantage of oil paintings over watercolours is that we can enhance them with finishing touches and highlights hours or even days later.

You are welcome to read my book《幸福人生》or scan the QR code of my Wordpress Website to view more articles on my experiences with different hobbies. Life is short. Let's live in the present and enjoy life!

Dr LAI Bing-man
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A Gentle Start to the Year of the Rabbit

Prof Bernard MY CHEUNG

President
The Federation of Medical Societies of Hong Kong

Prof Bernard MY CHEUNG

虎年已去春風暖，兔歲乍來喜氣濃

The year 2022 was a fearsome year, as befits the year of the tiger. The roar of the tiger was felt in the surge in COVID-19 cases in the Chinese Mainland and in the Hong Kong SAR. Would the year of the rabbit bring a change of fortune? I sincerely hope so.

Despite the gloom and doom of the faltering economy and the grief of those whose loved ones succumbed to COVID, there is cause for optimism. First, the proportion of the people in Hong Kong who have been vaccinated has kept rising. The development of herd immunity should not be far off. Second, we now have a choice of three types of vaccines, including the new bivalent mRNA vaccine. Third, we now have molnupirovir and Paxlovid, as well as convalescent plasma and immunomodulators to treat high risk COVID patients. Finally, for those who are fully vaccinated, COVID has become a mild illness, akin to flu.

Last year, we were hoping that borders would open soon and travelling would be resumed. This dream has come true, albeit later than anticipated. I am among the fortunate few who have travelled to Europe and Japan in recent months. Never has the ability to travel freely seemed so precious and joyful!

As the number of daily COVID infections has remained high, the Federation continues to organise and support hybrid and online meetings. Our conference services have been conspicuously successful and popular. We had a record number of registrants in our Annual Scientific Meeting in 2022. We have expanded our event management team and look forward to an exciting schedule of continuous professional educational events in 2023.

Our Hong Kong Medical Diary continues to offer an authoritative account of the latest developments in medical and dental topics. The beauty of the Medical Diary is that we commission local experts to write succinct reviews on diseases relevant to the Hong Kong population, and the state-of-the-art treatments that are available in Hong Kong. We also collaborate with the popular live phone-in radio programme, Healthpedia (精靈一點), on the themes of the Medical Diary.

COVID, being a multisystem disease affecting people of all ages, has brought together doctors of western medicine and Chinese medicine, nurses, pharmacists and allied health professionals to treat and rehabilitate patients, and to prevent the disease. Since its foundation in 1965, the Federation has always upheld the multidisciplinary nature of medicine and healthcare. The Federation believes in professionalism in every aspect of healthcare and promotes the highest standards of practice and integrity.

The rabbit is agile and quick, but also gentle and lovable. These attributes are very much what we need in the new year. On behalf of the Federation, may I wish all of our readers a happy, healthy and prosperous Year of the Rabbit!

玉兔迎春添新象，人逢泰世隨兔躍

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Date	Topics	Speakers
23 Feb 2023	Cataract and Cataract Surgery Update	Dr. CHAN Chung Yan, Tommy *FHKAM (Ophthalmology)*
	Refractive Errors, Presbyopia and Refractive Surgeries	Dr. WONG Ka Wai, Jasper *FHKAM (Ophthalmology)*
2 Mar 2023	Corneal and External Eye Diseases	Dr. WAN HO Nam, Kelvin *FHKAM (Ophthalmology)*
	Glaucoma and Glaucoma Surgery Update	Prof. Clement THAM *FHKAM (Ophthalmology)*
9 Mar 2023	Neuro-Ophthalmology	Dr. HO Wing Lau *FHKAM (Ophthalmology)*
	Squint, Paediatric Ophthalmology	
16 Mar 2023	Update in Orbital Diseases and Oculoplastic Surgery	Dr. AU Ka Hong, Alvin *FHKAM (Ophthalmology)*
	Red Eyes, Ocular Trauma and Emergencies	Dr. LIU Chi Han, Candice *FHKAM (Ophthalmology)*
23 Mar 2023	Retinal Detachment and Diabetic Retinopathy	Dr. LAI Hiu Ping, Frank *FHKAM (Ophthalmology)*
	Common Macular Diseases and Treatment	Dr. Danny NG *FHKAM (Ophthalmology)*
30 Mar 2023	Ophthalmic Imaging	Dr. MOHAMED Shaheeda *FHKAM (Ophthalmology)*
	Use of Laser in Ophthalmology	Dr. YUEN Shi Yin, Nancy *FHKAM (Ophthalmology)*

Date : 23 February & 2, 9, 16, 23, 30 March 2023 (Thursday)
Time : 7:00 pm – 8:30 pm
Course Feature: Video lectures (with Q&A platform for participants to post the questions)
Language Media : Cantonese (Supplemented with English)
Course Fee : HK$1,000
Certificate : Awarded to participants with a minimum attendance of 70% (4 out of 6 sessions)
Deadline: 16 February 2023
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OG = Obstetricians & Gynecologists.
*According to 2021 survey by Kantar HK. Respondents are doctors (Specialist in Obstetrics & Gynaecology). Sample size N=51.

References: 1. Chin Chua M, et al. JPGN 2017;65:102-6. 2. Phavichitr et al. Scientific Reports, 2021; 11:3534. 3. Martin R et al. Appl Environ Microbiol 2009;75:965-969. 4. Wong C. B et al. Nutrients 2019. 5. Coulier L et al. 2009; J. Aagric. Food Chem.;57, 8488- 8495. 6. Boehm G, et al. (2003) Acta Paediatr Suppl. 91(441):64-7. 7. Stahl B et al. Anal Biochem 1994; 223,218-226.

Important Notice: Breast-feeding is the best form of nutrition for babies and provides many benefits to babies and mothers. It is important that, in preparation for and during breast-feeding,pregnant and lactating women eat a healthy, balanced diet. Combined breast and bottle-feeding in the first weeks of life may reduce the supply of their own breast-milk, and reversing the decision not to breast-feed is difficult. Always consult healthcare professional for advice about feeding baby. If infant formula is used, mothers / care givers should follow manufacturer's instructions for use carefully- failure to follow the instructions may make baby ill. The social and financial implications of using infant formula should be considered. Improper use of an infant formula or inappropriate foods or feeding methods may present a health hazard.

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Editorial

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Dr LAW Chun-key


Dr WONG Yiu-chung

Radiology has come a long way since the discovery of the mysterious X-ray beam by Wilhelm Conrad Röntgen just more than a century ago. A wide range of sophisticated imaging tools now plays a central role in diagnosis, cancer detection and functional evaluation in pathological processes. In addition, with the aid of image guidance and technological advancement, many disease processes can now be safely and effectively managed in a minimally invasive fashion by interventional radiology (IR). In this Issue of the Hong Kong Medical Diary, we are pleased to invite our subspecialty experts to highlight the recent advances in this diverse and fast-moving field.

Are newer imaging tools always better? Dr Eliza Fung's article on breast imaging has provided a comprehensive review of the evidence and role of digital breast tomosynthesis (DBT) and breast MRI in managing breast cancer, which is the most common malignancy in women in Hong Kong. She has also revisited the ongoing debate on population-based breast cancer screening in Hong Kong.

The Hong Kong Children's Hospital commenced service in 2018 as the territory-wide tertiary referral centre for complex paediatric conditions. The Radiology team there has offered a taste of what child-centred and family-friendly Radiology looks like. Paediatric Radiology subspecialties of neuroradiology, cardiac imaging, musculoskeletal imaging and IR are introduced. The tips and tricks for keeping children still (and happy!) during imaging are also discussed.

Endovascular therapy has become the standard treatment for a wide range of neurovascular pathologies. Often viewed as high-risk and complex procedures, the interventional neuroradiology team at Queen Elizabeth Hospital has given us a succinct overview of evidence-based rationales and principles underlying successful neuro-interventions.

In modern medicine, the term "PET-CT" is often synonymous with cancer imaging and staging. The team at the Nuclear Medicine unit at Queen Elizabeth Hospital aims to show us that the application of this hybrid anatomical and molecular imaging modality is far more wide-reaching beyond the realm of oncology. They also highlighted the therapeutic potential and future developments of PET in the paradigm of personalised medicine. Radiologists are trained to have an eagle eye when reading imaging studies, not dissimilar to bird watchers! In the lifestyle section of this Issue, Dr Koel Ko will share with the readers his experience of spotting these wonderful critters in the urban jungle of Hong Kong.

Radiology is a specialty which has been constantly reshaped by advancements in technology. With the accelerating pace of technological development, the clinical role of Radiology is expected to expand continuously in the future. The mission of this Issue is to highlight some of the Radiology developments which are impactful in the caring of patients in Hong Kong.

Current Trend of Breast Imaging in Hong Kong

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Dr Eliza PY FUNG

INTRODUCTION

Since the early 1990s, breast cancer (BC) has become the commonest women's cancer in Hong Kong. According to the Hong Kong Cancer Registry[1], the number of newly diagnosed invasive female breast cancer cases was 4,761 in 2019, accounting for 27.4% of all female cancer. The median age at diagnosis was 58 years, and the lifetime risk of women before the age of 75 was 1 in 14. The age-standardised incidence rate of female breast cancer was 65.5 per 100,000. There were 852 registered death in women due to breast cancer in 2019, making it the third leading cause of female cancer deaths in Hong Kong.

For healthcare providers, conventional breast imaging modalities such as mammography and sonography are standard. With the development of personalised medicine, Digital Breast Tomosynthesis (DBT) and Magnetic Resonance Imaging (MRI) have emerging roles not only limited to the diagnosis of breast cancers but also in guiding the choice of drug treatment and mode of surgery.

The Hong Kong SAR Government launched a Breast Cancer Screening Pilot Programme in September 2021, providing screening services for eligible women aged between 44 and 69 at increased risk of breast cancer. This programme has raised the awareness of early breast cancer detection resulting in a surge in enquiries and demand for breast imaging services in both public and private sectors.

THE USE OF DIGITAL BREAST TOMOSYNTHESIS

Conventional mammography is performed by using a fixed low energy radiation source to penetrate the compressed breast tissue and to generate a summated image. Over the past decade, mammography, aided by the use of digital detectors, has transitioned from Screen-film systems to Full-field digital mammography (FFDM). Digital images allow room for post processing which can improve film resolution and contrast.

However, FFDM does not solve the problem of overlapping breast tissue. The development of Digital Breast Tomosynthesis (DBT) has enabled the acquisiton of multiple projection views while the x-ray source traverses along an arc; the acquired projection views are then reconstructed into a series of stacked images. This new tool is particularly useful for Hong Kong women, in whom dense breasts are common.

The use of DBT is becoming popular in Hong Kong as most of the mammographic machines in the Hospital Authority and in the private sector have been upgraded with the Tomosynthesis function. Radiologists may also modify the mammographic findings by adding the number of slices in certain projections where the target lesion is best seen. As lesions detected by Tomosynthesis only are often subtle, stating the lesion location clearly in the report is crucial for communication with clinicians and radiologists to follow up or perform a biopsy of the target lesion.

The common name of DBT is 3D mammogram, while FFDM is 2D mammogram. At the start of DBT in clinical practice, it was combined with FFDM. There was concern over the increased radiation dose, which was approximately double the mean glandular dose with FFDM alone.[2] This was alleviated with the development of synthetic mammography (SM), commonly called synthetic 2D, in which two-dimensional images are reconstructed from the raw tomosynthesis data to replace the FFDM.[3] More and more studies have shown comparable diagnostic accuracy in using DBT with SM vis-a-vis DBT with FFDM.[4] (Fig. 1)

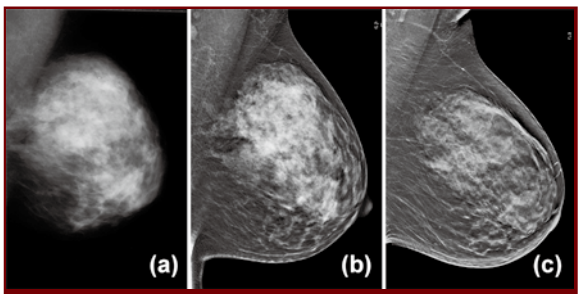

Fig. 1. Left MLO view of (a) Film Screen mammography, (b) Full Field Digital Mammography and (c) Synthetic View of a woman with heterogeneous dense breast tissue (Personal collection)

DBT improves the detection of a lesion in overlapping breast tissues. Studies have shown reduced call back rate and increased cancer detection rate, especially in invasive cancers with detection of smaller, more often node-negative cancers in screening when using DBT.[5-8]

However, some studies have shown an increase in recall rates after using DBT[9-10], and we share a similar experience in our hospital. Our hospital provides an opportunistic breast screening service, and we have been using Tomosynthesis with synthetic views as a screening tool since 2016. Since then, the call back rate

increased as more low density lesions are detected in Tomosynthesis, which lead to supplementary ultrasound in our setting. Many a time, the lesions are cysts or benign solid masses, which remain stable after sonographic follow up for two years though occasionally, we can detect cancers by this means.

Another reason for the increased callback rate was the increased detection of architectural distortion (AD) secondary to Tomosynthesis.[11] In our hospital, supplementary USG will be performed, and if there is no sonographic correlation, the lesion would be biopsied under tomosynthesis guidance. We have published our findings of 38 tomosynthesis-guided vacuum-assisted biopsies performed for DBT-detected sonographically occult AD. Three of them were malignant (7.9%), and 14 (36.8%) were high-risk lesions such as a radial scar. As a result, a biopsy should be performed rather than watchful waiting when such lesions are detected.[12] (Fig. 2)

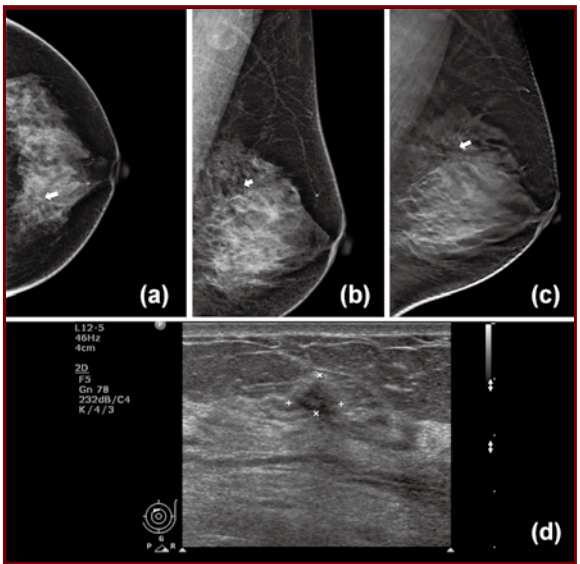

Fig. 2. Subtle architectural distortion (AD) in (a) CC (arrow) and (b) MLO (arrow) view of Digital Mammography, which was much enhanced in Tomosynthesis. (c) Selected tomosynthesis slice where the AD (arrow) was best seen. (d) Supplementary USG showed a corresponding irregular hypoechoic mass (cross) with angular margin, and subsequent biopsy was proven to be invasive carcinoma. (Personal collection)

There have been diverse comments regarding the detection of calcifications by using DBT.[13-14] The resolution of calcifications can be compromised in DBT due to image acquisition and motion. On the other hand, some "pseudocalcifications" detected in SM are artefactual due to the attenuating speckle or quantum/structural noise, which are enhanced in the reconstruction process.

There are other issues with DBT as a tool in population screening, such as the doubling of reading time when compared with FFDM, and the additional requirement of data storage, connectivity and viewing facilities. There are also potential problems of increased false positive cases and overdiagnosis. Feasibility and cost-effectiveness trials on breast cancer mortality reduction are needed for further evaluation of the efficacy of DBT.

THE USE OF MAGNETIC RESONANCE IMAGING

Compared with mammography, which is a structural imaging limited by the breast tissue density and complexity, Magnetic resonance Imaging (MRI) can provide functional information on top of morphological characterisation of lesions. Mammography depicts calcifications and spiculated masses well, hence highlighting ductal carcinoma in situ and lower-grade invasive cancers.[15] MRI with contrast enhancement highlights tumour angiogenesis and hence preferentially identifies invasive and high-grade disease compared to mammography, which merely relies on structural depiction.

The high soft tissue contrast with the multiplanar reconstruction of MRI provides a high sensitivity for detecting breast cancer (~ 90%) with a high negative predictive value. However, the specificity still remains moderate (~ 80%).[16-17]

The cost of MRI is high when compared to mammograms and ultrasounds. The time for examination is also much longer. Nevertheless, the indications for the use of MRI are expanding. While the clinical benefits of the use of pre-operative MRI in women with newly diagnosed breast cancer are still debatable, it is a well-accepted means for staging invasive lobular carcinoma, which tends to be multifocal, multicentric yet mammographically occult disease with contralateral involvement. The use of MRI is also proven to be useful in assessing the response to neoadjuvant chemotherapy (NAC) and in detecting residual disease so as to determine the feasibility of breast conservation surgery. It is also useful in detecting occult primary breast cancer in patients presenting with metastatic axillary lymph nodes.

A full diagnostic protocol for contrast-enhanced MRI usually includes T1/T2-weighted sequence with or without fat saturation, T1-weighted precontrast sequence, and three or more T1-weighted dynamic postcontrast sequences. Post-processing usually includes subtraction and maximum intensity projection (MIP) images. This protocol provides morphological features and quantitative assessment of the lesion derived from enhancement kinetics over time. Typically, breast cancers will show a fast rise at the initial phase (first 2 mins) with a washout in the delayed phase. (Fig. 3)

Diffusion Weighted Images (DWI) are optional but of increasing importance. The use of DWI to measure the mobility of water molecules in tissue can differentiate tissue types based on the use of apparent diffusion coefficient (ADC). Malignant tumours tend to have higher cellularity with restricted diffusion and a lower ADC value. The cut off ADC value for benign and malignant lesions was approximately 1.22×10^{-3} mm $^2/_s$ for b = 1,000 s/mm^2.[18] As no contrast is needed for the DWI, it is usually incorporated into MRI study to improve the sensitivity and specificity of the exam. DWI/ ADC value is also useful for predicting tumour response in patients treated with NAC. The ADC increase in responder is higher, and the lesion will be brighter in ADC upon response to NAC.

Apart from imaging of breast cancers, MRI is the best imaging modality for the evaluation of the integrity of silicone breast implants due to the high soft tissue contrast. (Fig. 4) In addition, it is useful to evaluate the disease extent in the chest or even abdominal wall in cases of injectional mammoplasty such as Polyacrylamide hydrogel (PAAG). (Fig. 5) Very often, the mammographic and sonographic diagnostic accuracy are reduced due to the presence of implants and the leakage of implant contents.

In order to increase the throughput and accessibility of MRI, Kuhl et al. initially introduced an abbreviated breast MRI protocol for screening that substantially shortened examination and reading times, while maintaining a diagnostic accuracy equivalent to a full diagnostic protocol.[19-20] Abbreviated Breast MRI consists of an unenhanced T1-weighted and first contrast-enhanced T1-weighted sequence, subtraction imaging, and a single MIP image, while some of them also include a T2-weighted, STIR sequence. The acquisition time was reduced from 17 minutes to 3 minutes.

Another novel Ultrafast dynamic sequence is also being developed to reduce the time and cost of MRI breast imaging. It captures the rapid initial contrast material inflow into breast lesions within the first 2 minutes with a temporal resolution that is typically below 5 seconds, which means images are acquired every 5 seconds, skipping the rest of the delayed post-contrast images. So far, the use of Ultrafast imaging protocol is not yet standardised and is uncommon in Hong Kong as specific MRI coils and sequences are required for this technique. Few private centres in Hong Kong have started using Ultrafast dynamic sequences for breast imaging. The potential role for ultrafast MRI as a stand-alone test is currently limited by low spatial resolution as a trade-off for high temporal resolution, but the definitive role of this evolving technique is yet to refine.[15]

The interpretation of findings of Ultrafast dynamic sequences is different from the conventional protocol producing dynamic curve and delayed phases. Early wash-in quantitative lesion characteristics such as time to enhancement (TTE), maximum slope of time-intensity curve, initial enhancement rate (IER) and arterial-venous interval (AVI) are used instead. Malignant breast lesions usually show early avid enhancement. Therefore, they are associated with significantly shorter TTE, steeper maximum slope, and higher IER than benign lesions.[15] Shorter AVI is associated with vascular shunting, which is seen in cases with tumour angiogenesis.

Using MRI as an adjunct to mammography for screening high risk women has been adopted in the guidelines of the American College of Radiology. The Department of Health in Hong Kong has also issued a similar recommendation, and the details will be discussed in the latter part of this article.

As the use of MRI for breast imaging is getting common in Hong Kong, it is essential for imaging facilities to have tools or proper referrals for biopsy the lesions detected only in MRI. Specific MRI biopsy coil, immobilisation device for the breasts and making available MR-compatible apparatus are all required to perform intervention under MRI guidance.

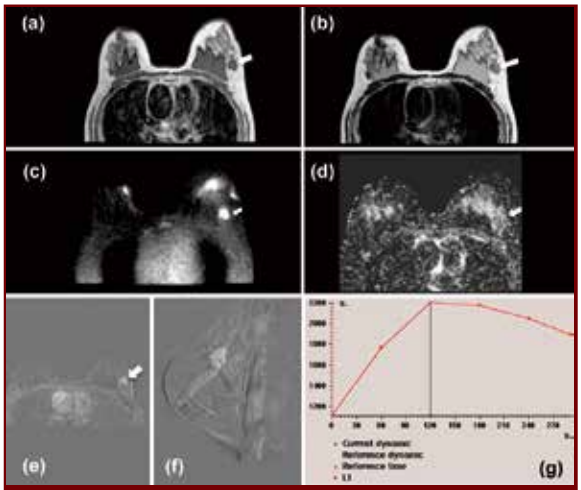

Fig. 3. Typical MR findings of an invasive ductal carcinoma in the left breast of women with bilateral pre-pectoral silicone implants. An irregular non-circumscribed mass was (a) hypointense in T1W image and isointense mass in (b) T2W image. The mass appeared bright in (c) DWI image with diffusion restriction, which was hypointense in (d) ADC image. (e, f) Heterogenous internal enhancement in axial and sagittal views of post-contrast images. (g) Dynamic Kinetic Curve is showing a FAST initial phase (> 100% increase in pixel intensity within the first 2 mins) and a Type III washout in the delayed phase (signal intensity decreased > 10 % after its highest point from initial rise). (Personal collection)

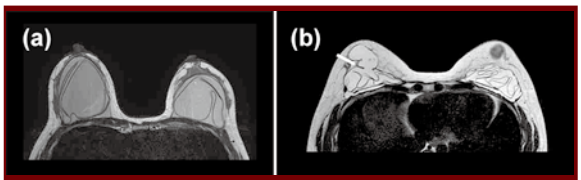

Fig. 4. MRI without contrast is considered the gold standard in the evaluation of the integrity of silicone implants. (a) Typical "Linguine Sign" in intracapsular rupture of bilateral breast implants represents the collapsed shell floating in silicone gel with the intact fibrous capsule maintaining the shape of implants. (b) Extracapsular rupture with defects (arrow in the right breast) in both the implant shell and fibrous capsule, leading to silicone leakage beyond into the surrounding tissue. (Personal collection)

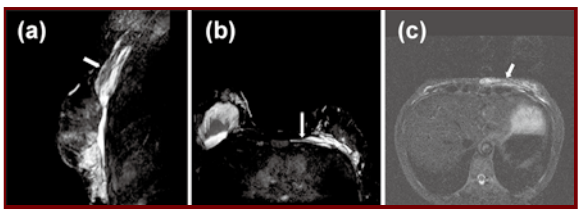

Fig. 5. Breast MRI is a useful tool to detect the extent of PAAG distant migration.
(a) Tracted along pectoralis muscle fascial planes. (b) Extended into intrathoracic and extrapleural spaces. (c) Down to abdominal wall (Personal collection)

BREAST CANCER SCREENING PILOT PROGRAMME IN HONG KONG

There has been a long debate on whether or not population breast screening should be implemented in

Hong Kong. Based on the revised recommendations of the Cancer Expert Working Group on Cancer Prevention and Screening (CEWG) of the Cancer Coordinating Committee, a risk-based approach for breast cancer screening has been recommended for women aged 44 to 69 in Hong Kong.[21] The Government rolled out a Breast Cancer Screening Pilot Programme in Hong Kong in September 2021.

At the initial stage, the Department of Health uses a personalised breast cancer risk assessment tool developed by the University of Hong Kong to assess the risk of developing breast cancer in local Chinese women in the general population.[22] Interested individuals need to pay and get enrolled in the Women Health Service (WHS); breast cancer screening will be provided at one of the three Women Health Centres as appropriate. Supplementary ultrasound will be arranged if necessary.

Carriers of BRCA1/2 deleterious mutations, those with a significant family history of breast cancer/ovarian cancer (please refer to the government website www.cancer.gov.hk for details) or personal risk factors such as radiation therapy to the chest at a young age, history of breast cancer (including DCIS and lobular carcinoma) as well as high risk lesions (such as atypical ductal hyperplasia or atypical lobular hyperplasia) are considered at high risk of developing breast cancer. The recommendation is for these high-risk groups to undergo mammography screening every year. For confirmed carriers of BRCA1/2 deleterious mutations or women who had radiation therapy to the chest for treatment between age 10 and 30 years such as radiation therapy for Hodgkin's disease, additional annual screening by MRI should be considered.[23]

For women at moderate risk (i.e. family history of only one first-degree female relative with breast cancer diagnosed at ≤ 50 years of age; or two first-degree female relatives diagnosed with breast cancer after the age of 50 years), mammography every two years is recommended. MRI is not recommended.[23]

Women should discuss with their doctors and understand the potential benefits and harms before the start of breast cancer screening. The potential benefits of screening include the detection of smaller breast cancers at earlier stages. The patients can benefit from less extensive surgery. Evidence from western countries revealed the reduction of breast cancer mortality in their populations. Nevertheless, the potential harms of screening include overdiagnosis and overtreatment of ductal carcinoma in situ (DCIS). The false positive cases lead to unnecessary biopsies/treatment and patient anxiety. The estimated risk of death from mammography-related radiation induced BC ranged from 1-11 per 100,000 women, depending on age and screening interval, though such risk is outweighed by the ability of mammography to reduce death from BC.[24] Women who have undergone screening should be well aware of the possibility of false negativity. A normal screening mammography should not deter women from seeking medical consultation when signs or symptoms of breast cancer arise.

CONCLUSION

Advances in Breast Imaging have been achieved rapidly in recent decades. Tomosynthesis is getting popular, and there is a trend towards replacing Full Field Digital Mammography with Tomosynthesis with Synthetic View in both diagnostic and screening settings. The use of Magnetic Resonance Imaging is no longer limited to the initial diagnosis and staging of breast cancer but is also useful to guide neoadjuvant chemotherapy. MRI is the best imaging modality for the assessment of implant integrity and is widely accepted as a screening tool in high-risk women. The launch by the Hong Kong SAR Government of a Breast Cancer Screening Pilot Programme in September 2021 has led to a surge in breast imaging demand in both the public and private sectors. Of note, the targeted women should be well informed of the pros and cons of screening before screening starts.

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基層醫療指南
Primary Care Directory

Primary Care Directory (PCD) is a web-based database set up to facilitate the public to search for suitable primary care service providers according to their practice information.

- **All registered doctors in Hong Kong are eligible** for enrolment.
- Shall accumulate the **required CME/CPD points for maintaining listing** in the directory.
- **Pre-requisite** for joining District Health Centre (DHC) Initiative, Vaccination Subsidy Scheme (VSS) and Residential Care Home Vaccination Programme (RVP).
- More than 2,600 doctors have enrolled and more than 70,000 public searches made in 2022.

The Primary Healthcare Blueprint redefines the role of the PCD into a Primary Care Register (PCR) which serves as a central register for all primary healthcare (PHC) professionals under one umbrella for better monitoring, co-ordination and quality assurance.

Key features of the Primary Care Register are,

Requiring all healthcare professionals to be enlisted in the PCD or PCR for all **Government-subsidised programmes**.

All PCD and PCR enrollees will be subject to **quality assurance**.

The use of Electronic Health Record Sharing System **(eHRSS)** for documentation of patients' records will become mandatory for healthcare providers on the PCR.

Health Bureau
The Government of the
Hong Kong Special Administrative Region
of the People's Republic of China

If interested in joining the PCD, please visit our home page via the following link or scan the QR Code

www.pcdirectory.gov.hk

Imaging Children - Embracing Technology, Innovation and Collaboration

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The establishment of the Hong Kong Children's Hospital (HKCH) is a dream coming true for many paediatric caregivers. Having a dedicated environment and dedicated teams caring for the sick children means we are able to specifically tailor to their needs in a manner like never before in Hong Kong. In this issue, we will dive deep into how the radiology needs of paediatric patients are served at the Department of Radiology at HKCH. (Fig. 1)

Fig. 1. Hong Kong Children's Hospital is located in the historical site of Kai Tak Airport in Kowloon Bay. (Courtesy of Dr Wendy Lam)

CHILD-CENTRED CARE

As a 'child-centred family-friendly' hospital, our goal is to transform radiological examinations at the Department of Radiology into a fun experience. Our team of radiologists, radiographers and nurses gathered up our creativity and converted the original "plain, white and cold" department into a 'theme park' that is unlike any conventional hospital. The general X-ray room is decorated like a spaceship (Fig. 2), the ultrasound room is a 'night safari' covered with glow-in-the-dark stars, the computer tomography (CT) suite (Fig. 3) has a circus theme and the magnetic resonance imaging (MRI) scan room is decorated as an ocean.

Fig. 2. General radiography room (HKCH Collection)

Fig. 3. CT scan suite (HKCH collection)

Our team of radiologists, radiographers, radiology nurses, anaesthetists, perioperative nurses and anaesthesia assistants work closely to provide a child-centred family-friendly service. As a team, we take up the challenge to innovate new processes and workflow, in addition to acquisition of new technology and equipment. In this article, paediatric radiology subspecialties of neuroradiology, cardiac imaging, musculoskeletal imaging and interventional radiology

(IR) will be introduced. We will also discuss various techniques used to keep children motionless for imaging procedures.

PAEDIATRIC NEURORADIOLOGY

Paediatric neuroradiology includes imaging of a variety of diseases such as tumours, metabolic disease, infection/inflammation, neurovascular disease, epilepsy and malformation. It is similar to adult neuroradiology in many ways. However, the brain is still undergoing development throughout childhood till early adulthood. All these make paediatric neuroradiology one of the most challenging subspecialties in the field of Radiology.

Paediatric Neuroradiology at HKCH

At HKCH, we aim to deliver patient-centred neuroradiology services to meet personalised needs of each individual child. The disease spectrum of paediatric central nervous system disorders differs the significantly from the adult counterpart. For example, primary brain tumours are common in the paediatric population and many metabolic brain disorders first present in childhood and even during neonatal period. High-quality clinical practice, research and education in paediatric neuroradiology as an area of sub-specialization in Paediatric Radiology are of utmost importance to provide the best care for children in Hong Kong. At HKCH, the neuroradiologists maintain truly rewarding collaborations with neonatologists, paediatric oncologists, clinical oncologists, anesthetists, neurosurgeons, and paediatric neurologists to deliver best case for the children.

Neuro-metabolic Imaging

High-quality MRI of brain and spine allows us to detect, diagnose and monitor patients with metabolic diseases. Some specific imaging patterns on MRI of brain can suggest the diagnosis even before genetic confirmation in appropriate clinical context. Presence of the "eye of the tiger sign" in MRI will raise suspicion of pantothenate kinase-associated neurodegeneration (PKAN)[1]. Further information may be obtained with MR spectroscopy as an advanced MR technique. In mitochondrial diseases, MR spectroscopy may demonstrate lactate peak in basal ganglia and cerebral white matter[2].

Neuro-oncology Imaging

Neuro-imaging is involved throughout the journey of brain tumour management from detection of a tumour to surveillance after remission. MRI gives information on location and extent of a tumour and allows tissue characterisation. Advanced imaging techniques are frequently used in imaging brain tumours such as diffusion weighted imaging (DWI), MR perfusion imaging, MR spectroscopy and diffusion tensor imaging (DTI)[3]. DWI, MR perfusion and MR spectroscopy can give information on tumour grading. DWI is also used to detect region of higher cellularity that may represent the tumour burden to facilitate targeted biopsy. DTI can be used for pre-operative planning to avoid injury to vital structures such as language centre and motor centre. MR perfusion and MR spectroscopy may allow differentiation of viable tumour and post-treatment changes during response assessment. In the Neuro-Oncology Multidisciplinary Meeting, imaging findings are discussed together with clinical information from paediatric oncologists, operative findings from neurosurgeons, and genetic and pathological results from pathologists to decide the best next step of management of individual patients.

Neonatal Neuro-Imaging

Endowed with an outstanding neonatal intensive care unit at HKCH, paediatric neuroradiologists can play an important role in the care of premature infants, neonates with hypoxic ischaemic injury and brain malformation. Brain ultrasonography service is regularly provided by Department of Radiology at HKCH. It is usually used to detect intraventricular haemorrhage, periventricular leukomalacia and hydrocephalus. In addition, MRI of the brain is used for assessment of neonates with hypoxic ischaemic injury requiring therapeutic cooling.

PAEDIATRIC CARDIAC IMAGING

Traditionally echocardiogram and cardiac catheterisation have been the backbone in imaging congenital heart disease. With technical advances in CT and MRI, the role of these modalities has grown exponentially in recent years.[4] Imaging paediatric hearts pose a very unique set of challenges as children's hearts are usually of small size yet beating at fast heart rates. Furthermore, managing structural heart diseases require much understanding of the challenging anatomy as well as their altered haemodynamics, which echoes what we often say in the congenital heart community, 'every congenital heart is unique'. Thus imaging of each and every one of these patients require dedicated effort of the cardiac imaging team to tailor-make the imaging protocols specific for the indications of the particular patient.

Joint-care Model

Our paediatric cardiac imaging service for CT and MRI is based on a joint-care model where the radiology team and cardiology team work hand-in-hand together. With our different training backgrounds, cardiologists and radiologists bring different skill sets to the table. Many of our cardiac MRIs are co-read by a cardiologist and a radiologist. Our cardiac MRI stress studies are performed with supervision by both our cardiologist and radiologist to ensure the quality and safety of this study for our children. We are also able to delineate the anatomy of the coronaries of small neonates and infants with our state-of-the-art single heart beat CT scanner, together with general anaesthesia support from our anaesthetists and heart-rate control with beta-blockers by our cardiologists. In our joint cardiac surgical meetings, we would sit down and pool the findings of all our echocardiograms, cardiac catheterisations, CTs and MRIs together for discussion of the management plan for a patient with complex congenital hearts. It is through this joint-care model that our HKCH team has been able to perform technically demanding exams such as neonatal cardiac MRIs or neonatal cardiac CTs.

This joint-care model will no doubt continue to be the cornerstone of the future development of our cardiac imaging service.

New Techniques

Our team performs hundreds of paediatric cardiac MRIs a year, 10% of which are done under sedation or general anaesthesia. We are well versed in our technique in applying basic cardiac MRI techniques in the paediatric population including volumetry, phase-contrast flow-studies, late-gadolinium enhancement, MR angiograms, anatomical imaging, etc. We are the only institution in Hong Kong that has developed our local paediatric reference data ranges for T1, T2 parametric mapping, which was very useful in characterising the myocardium especially when we had a surge of teenagers with vaccine-induced myocarditis in 2021 during the pandemic[5,6]. We have also scanned and segmented several complex congenital hearts for 3D-printing to facilitate our cardiac interventionist and surgeons for pre-treatment planning. 4D-flow is a new MR technique allowing insights into the flow patterns within the abnormal hearts and vessels. HKCH has performed 4D flow on some selected patients to further our understanding on the haemodynamic consequences of the complex congenital hearts such as coarctation of aorta and Fontan circuits.

PAEDIATRIC MUSCULOSKELETAL IMAGING

The growing skeleton and the unique set of pathologies that affect children make paediatric musculoskeletal imaging different from imaging in adults and pose its own challenges. HKCH radiology provides a children-based centre for concentration and development of expertise to yield better imaging outcomes in this special field.

Musculoskeletal Imaging in Oncology

Bone tumours including osteosarcoma and Ewing's sarcoma account for a significant proportion of paediatric malignancy. Optimal MRI provides accurate assessment of disease extent for staging and surgical planning. This is particularly challenging in paediatric population where the background bone marrow signal can be heterogeneous in the presence of hematopoietic marrow. When in doubt, our centre utilises multi-parametric MRI techniques to yield more diagnostic information. Dynamic contrast enhanced MR imaging helps to differentiate between viable tumour and other lesions[7]. Rapid sequential imaging at an area of interest following contrast administration enables assessment of temporal enhancement property. Related to angiogenesis, viable tumours tend to show rapid early enhancement followed by washout. Analysis of time-intensity-curve helps to identify viable tumour for accurate determination of disease extent.

Diffusion weighted MRI is a quantitative analysis of diffusion which reflects cellularity[8]. Restricted diffusion is seen in viable tumour densely packed with cells while increased diffusion is seen in necrosis. This is useful in the assessment of chemotherapy response, particularly for inoperable cases where histological assessment of tumour necrosis is not feasible. Whole body MR imaging is also emerging as a modality for staging and assessment of overall tumour burden[9].

Imaging of Skeletal Maturity

Assessment of skeletal maturity is an important facet of paediatric musculoskeletal imaging for children suffering from disorders of growth & puberty. Traditionally it is assessed by obtaining hand & wrist radiograph and manually comparing the skeletal maturity against atlases to assign a bone age according to the closest matching reference radiograph. This process is subjective and biased by intra- and inter-rater variability. HKCH radiology is the first centre in Hong Kong to employ the artificial intelligent(AI) software for automated bone age assessment. This provides an accurate and almost immediate assessment of bone age, streamlining and increasing the efficiency of the workflow[10].

Skeletal Dysplasia Imaging

Next generation gene sequencing developed in the recent decades shifted the paradigm in the diagnosis and understanding of skeletal dysplasia. Prognosis and living quality of patients are greatly improved from earlier diagnoses and rapidly developing treatment options. To optimise management for each of these unique disorders, close collaboration between radiologists, paediatric endocrinologists, orthopedic surgeons and geneticists is crucial[11]. At HKCH, these specialists assess these patients in a combined skeletal dysplasia clinic, deriving imaging plan and medical and orthopedic management tailored for each patient.

Taking mucopolysaccharidosis as an example, close monitoring for cervical stenosis/subluxation and early orthopedic intervention before myelopathy occurs is crucial to maintain quality of life[12]. Selected patients undergo carefully planned dynamic cervical spine MRI at our centre. Dynamic imaging in children is difficult due to their limited cooperation in flexion and extension of the neck. This is especially difficult for MR imaging, which requires the child to stay still for a long time. We work closely with occupational therapists who provide pre-imaging assessment to accurately estimate their tolerated range of movement of the neck. Tailored neck support are then designed to keep patient's neck stable during scanning. Anesthesiologists also support by providing the right level of sedation. Optimal cervical spine imaging is crucial for surgical planning in patients with cervical subluxation or stenosis.

Short stature homeobox-containing gene (SHOX) deficiency is another example of skeletal dysplasia in which timely imaging can greatly improve clinical outcome. Patients with this condition suffer from Madelung deformity which is an abnormal curvature of the forearm bones as a result of distal radial growth disturbance. This was traditionally treated by combined corrective radioulnar osteotomy. Modern understanding of the pathology has identified abnormal Vickers' ligament tethering the lunate to the radius as the cause of the deformity in the majority of these patients[13]. Early high resolution MRI of the wrist

identifies and localises these ligaments, allowing for planning of surgical release. Patients thus benefit from a much less invasive procedure which prevents the development of the disabling deformity.

PAEDIATRIC IR

Paediatric IR encompasses a range of image-guided minimally invasive procedures which can be used for diagnostic or therapeutic purposes. While many of the IR procedures and skills commonly performed on adult patients are transferable to children, the old adage "children are not small adults" remains true. The different spectrum of diseases in paediatric population, the limitation of adult-sized equipment in small children, the need of sedation and radiation dose optimisation highlight some of aspects unique to paediatric IR. However, with a good dose of innovation and adaptation, most interventions can be modified for small patients. (Fig. 4)

Fig. 4. Team of radiologists, anaesthetists, radiographers and nurses preparing a patient for interventional procedure (HKCH Collection)

How Can Paediatric IR Help?

Oncology

At HKCH where there is a high volume of oncology patients, central venous access and image-guided biopsy are bread-and-butter of our daily work. Innovative line insertions techniques may be used for very small-sized children, such as adopting a 4 French adult peripherally inserted central catheter (PICC) as a tunnelled central venous catheter (CVC).[14] For children with mediastinal mass precluding jugular venous access, a tunnelled femoral CVC can be inserted under ultrasound guidance for long-term use. Coaxial method for image-guided biopsy is often used to obtain adequate tissue sample while minimising haemorrhagic complications. This is particularly important in patients with solid tumour where up to 10-15 cores of tissue are needed for histopathology and genetic profiling.[15] (Fig. 5)

In oncology patients with high surgical risks, percutaneous ablative therapies or transarterial chemo-embolisation (TACE) can be offered. Thermal ablation using radiofrequency or microwave can be used as an alternative to hepatic surgery to treat hepatic adenoma or hepatocellular carcinoma.[16] Use of cryoablation has been well documented in the literature for treating desmoid fibromatosis.[17] At HKCH, we have also used TACE to manage patients with desmoid which are not amenable to surgery or ablation.[18]

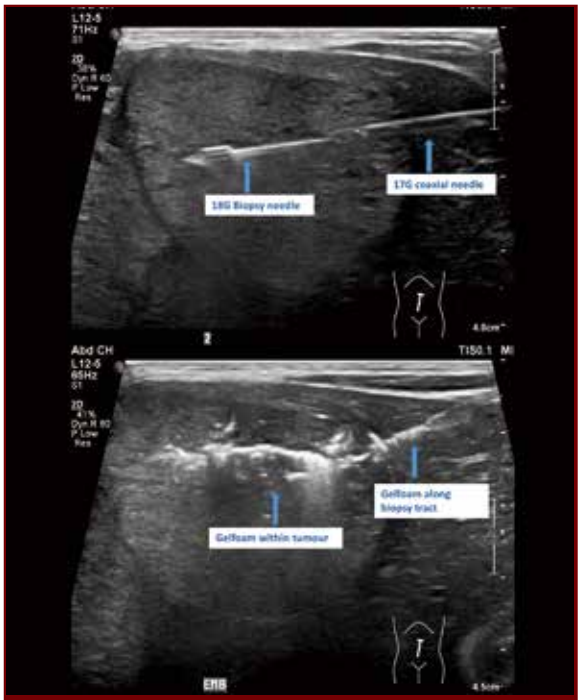

Fig. 5. Ultrasound-guided biopsy of a liver tumour in a 2-year-old child. (a) A coaxial needle was placed into the tumour to allow multiple cores to be obtained; (b) The biopsy tract was embolised by gelfoam to prevent haemorrhagic complications. (Dr K Fung's personal collection)

Nephrology

IR also plays an important role in treatment of renovascular hypertension, where in children fibromuscular dysplasia is the leading cause. In cases refractory or intolerant to medical treatment, balloon angioplasty can often reduce or eliminate need of anti-hypertensive medications.[19] Gaining arterial access can be challenging in neonate or infants, the use of axillary access has been reported in patients whose femoral arteries are too small to accommodate the vascular sheaths.[20] In young children, we often adapt low-profile adult coronary balloon catheters for treating renal artery stenosis.

Paediatric Surgery

Vascular anomalies, including vascular tumours and malformations, is a unique group of conditions which are commonly seen in children.[21] Due to discrepancies in nomenclature, these pathologies are frequently misunderstood by clinicians and parents, leading to delay in diagnosis and treatment. At HKCH, interventional radiologists collaborate with paediatric surgery and other paediatric disciplines including oncology and genetic service as a dedicated vascular anomaly team to evaluate and manage these patients.

Cardiology

The lymphatic system is often referred to as a "forgotten circulation", while in fact it plays a major role in tissue fluid homeostasis, immune function as well as absorption of dietary lipid. Abnormalities in conducting central lymphatics such as the thoracic duct can result in devastating consequence such as chylothorax, chylous ascites, protein losing enteropathy and malnutrition.[22] The lymphatic system is traditionally imaged using lymphoscintigraphy or pedal lymphangiography with oil-based contrast, which gives limited spatial and temporal resolution. HKCH is the first centre in the territory to perform dynamic contrast-enhanced MR lymphangiography (DCMRL) using inguinal nodal and intrahepatic lymphatic access. DCMRL enables us to visualise the real-time flow of central conducting lymphatics and accurately identify the site of chyle leak, which is essential for determining subsequent management. In selected patients, especially those with traumatic chylous leak, lymphatic interventions such as thoracic duct embolisation can be performed. (Fig. 6)

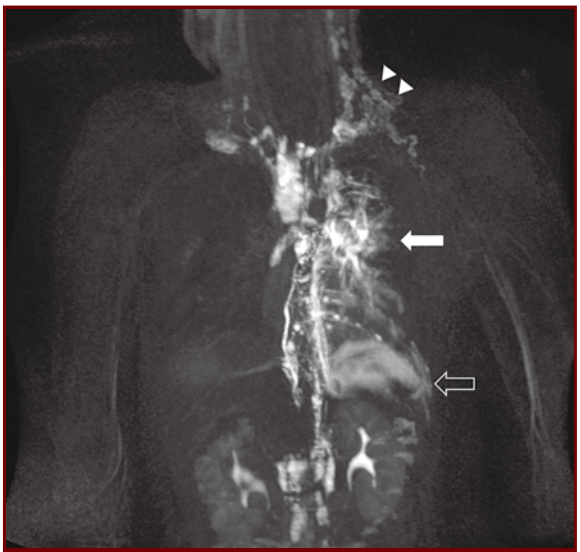

Fig. 6. Selected maximum intensity projection (MIP) image of dynamic contrast enhanced MR performed in a 13-year-old girl presenting with non-traumatic left chylothorax. Gadolinum based contrast agent was injected into bilateral inguinal nodes. Contrast leakage was demonstrated in mediastinum, left hilar region into the left lung (white arrow) and left pleural cavity (hollow arrow). Lymphatic reflux also demonstrated at left supraclavicular region (white arrowheads). Imaging features are supportive of pulmonary lymphatic perfusion syndrome. (Dr K Fung's personal collection)

KEEPING CHILDREN STILL FOR IMAGING AND PROCEDURES

At HKCH, the Department of Radiology and Department of Anesthesiology & Peri-operative Medicine work hand in hand as a pioneer in providing safe, quality care to our young patients, at the same time making their experience at the Department of Radiology enjoyable.

Anaesthesia-led One-Stop Sedation Service: Smart and Lean Management

In many institutions in HK, sedation for radiological procedures is conducted by clinical teams. Patients are often required to be admitted for securing an intravenous access, and sedation is given orally or intravenously by clinicians. Failed sedation is not uncommon, resulting in cancellation and rescheduling of procedures. Not only does failed sedation pose stress on the tight radiological resources, the patient also has to bear the unwanted side effects of sedation drugs. For patients with airway and cardiovascular comorbidities, safe sedation can be technically challenging as well. At HKCH, anaesthesia-led sedation team is responsible for the majority of sedation service for children undergoing radiological procedures. Clinicians can refer their patients to anaesthetists at our pre-sedation clinics for pre-sedation assessment. Anaesthetists will then assess patient's fitness for sedation and explain the details, risks and fasting instructions to parents. For those whom sedation is not indicated, anaesthetists will refer patients back to the radiology team for feed-and-sleep, mock scans or non-sedation as appropriate.

On the examination day, patients come to the Department of Radiology directly without admission. Intravenous access will then be established after the sedative effect kicks off, minimising psychological stress of needle insertion. Patients are monitored closely by anaesthetists throughout procedure. The careful choice and titration of sedation medication allows early recovery with time of stay less than half a day. After completion of the procedure, patients are monitored by the perioperative nurse in the recovery room in our Department.

"Feed and Sleep" Programme: Imaging While Baby is Asleep

The need for pharmacological sedation in babies between ages of 0 to 6 months can be reduced through the "Feed and Sleep" programme. "Feed & Sleep" is a collaborative programme with the Department of Anesthesiology & Peri-operative Medicine. With careful selection of patients by the anaesthesiologist, we make use of patients' daily feed and natural sleep pattern to let the baby falls asleep before start scanning.

"Mock MRI Scan" Programme: Empowering Children Through Simulation

Older children from 3 to 6 years old can avoid pharmacological sedation with the "Mock Scan MRI" programme, which was created in collaboration with play specialists. Our mock scanner, the only one in Asia, simulates the MRI experience including the noises the scanner makes. (Fig. 7) Selected patients are individually invited to a mock scan, during which education and training are provided to the child and parents/guardians, while at same go the compliance level of the child is also assessed.

In conclusion, the Department of Radiology at HKCH will continue to strive and persevere to serve the medical needs of sick children and their families. Our team of radiologists, radiographers and radiology nurses will continue to endeavour in innovation and collaboration, in addition to adoption of new technology. We hope to provide some respite during our patients' difficult times by making the visits to our Department as fun as possible.

Fig. 7. A play therapist with a young patient at our Mock MRI scanner (HKCH Collection)

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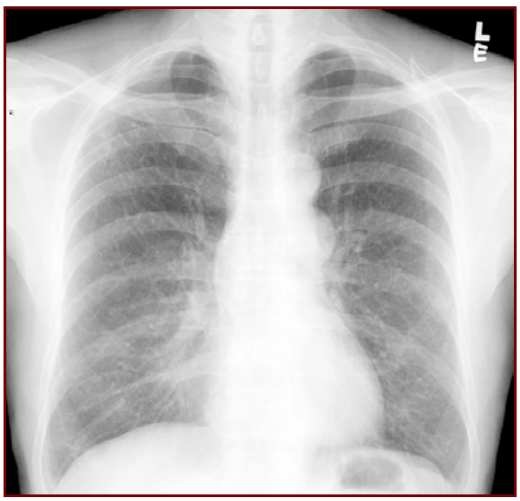
Radiology Quiz

Dr John YH MAK
MBBS, FRCR



A 60-year-old male presented with incidental CXR findings.

Questions

1. What is the abnormality on the radiograph?
2. What are the most likely differential diagnoses?
3. What is the next step of the investigation?

(See P.40 for answers)

Neuro-intervention at Queen Elizabeth Hospital

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INTRODUCTION

Neuro-intervention has become the standard treatment for a wide range of elective and emergency neurovascular conditions[1]. In this article, we aim to share our experience of endovascular treatment for a comprehensive range of neurovascular pathologies, including intracranial aneurysms, arterial dissections, arteriovenous malformations, dural arteriovenous fistulas, spinal vascular malformations, acute stroke with large vessel occlusions, carotid stenosis, carotid blowout, and pre-operative embolisation for head and neck tumours.

Neuro-intervention must be personalised for each patient. We cannot emphasise enough the importance of diligent treatment planning with pre-procedural imaging, which may include computer tomography (CT) or magnetic resonance (MR) angiograms, and especially for vascular malformations, digital subtraction angiograms (DSA) of the head, neck, or spine. Other general considerations essential for a safe and effective procedure include the following:

1. ***Contrast agent***
   The dosage of iodinated contrast varies according to the patient's age and co-morbidities and must be limited by minimising the number and amount of contrast injections.

2. ***Periprocedural anticoagulation***
   To reduce the risk of thromboembolic complications, the patient undergoing neuro-intervention procedures should receive systemic heparin infusion unless contraindicated.

3. ***Anti-platelet use***
   To reduce the risk of stent thrombosis, periprocedural anti-platelet is essential when stent or flow diverter placement is being planned. Dual anti-platelet for 6-12 months, followed by a defined period of aspirin is commonly adopted after the procedure.

4. ***Instruments***
   Guide catheters, microcatheters, guidewires, adjunct devices and embolic agents must be carefully chosen to minimise procedure risk.

5. ***Access route***
   A combination of the femoral artery, femoral vein, and transradial approach may be considered on a case-by-case basis.

INTRACRANIAL ANEURYSMS

Intracranial aneurysms are common in the adult population, with a prevalence of 3.2%[2] and a lifetime rupture risk of around 0.5%[3-5]. Case fatality of rupture used to reach a staggering 27-44%, but this figure has dropped in recent decades due to improved neurological care[6]. The International Subarachnoid Aneurysm Trial (ISAT) has demonstrated superiority of coiling over surgery for ruptured aneurysms, and endovascular treatment has become the treatment of choice for both ruptured and unruptured aneurysms due to its minimal invasiveness and high efficacy.

For ruptured intracranial aneurysms, emergency management, via aneurysm protection to prevent re-bleeding and to avert worsening subarachnoid haemorrhage and neurological function, is essential to improve patient outcome. The decision and timing of elective embolisation for unruptured aneurysms is based on multiple factors, including size, rate of growth, location, and morphology of aneurysm, and is hence made on a case-by-case basis [7].

While simple coil embolisation is the method of choice for smaller aneurysms with favourable anatomical geometry, including a small neck-to-dome ratio (Fig. 1, Fig. 2), aneurysms that demonstrate complex geometry against parent vessels, large neck-to-dome ratio, and large size may require the use of adjuncts for successful embolisation with adequate protection of the parent vessel.

Adjuncts commonly used to assist aneurysm coiling are compliant balloons, open-cell stents, and flow diverters (Fig. 3). Balloon-assisted coiling (BAC) refers to temporary inflation of a compliant balloon over the neck of an aneurysm during coil placement[8]. This approach is often used for sidewall aneurysms with wide necks (Fig. 4, Fig. 5). For bifurcation aneurysms with wide necks, stent-assisted coiling (SAC) is often the method of choice, whereby two stents are placed from each of the distal branches into the proximal common branch in a Y-shaped configuration to protect these vessels (Fig. 6).

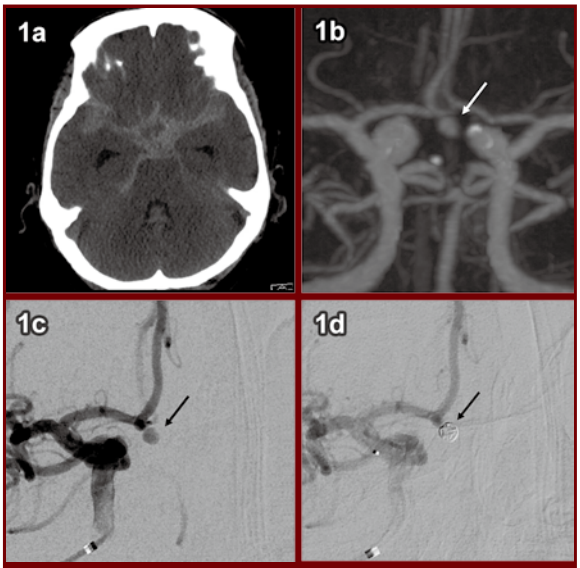

Fig. 1. A 63-year-old male with ruptured anterior communicating artery aneurysm. a) axial CT brain shows diffuse subarachnoid haemorrhage involving interhemispheric fissure; b) coronal CT angiogram reformatted image shows a 3.7mm anterior communicating artery aneurysm (white arrow). On c) pre-embolisation and d) post-embolisation right internal carotid artery (ICA) frontal angiograms, complete embolisation of the aneurysm (black arrow) using four coils is demonstrated. (Clinical collection)

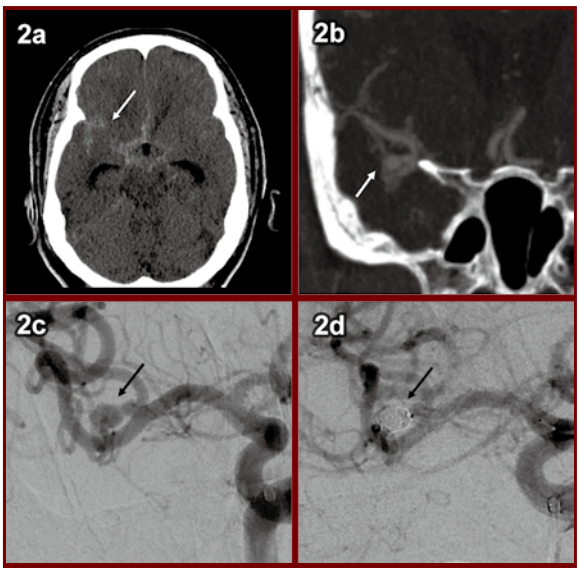

Fig. 2. A 60-year-old male with ruptured right middle cerebral artery (MCA) bifurcation aneurysm. a) axial CT brain shows subarachnoid haemorrhage over right Sylvian fissure (white arrow); b) coronal reformatted CT angiogram demonstrates a 6.1 mm aneurysm (white arrow) at right MCA bifurcation. Comparing c) pre-embolisation and d) post-embolisation right ICA angiograms, successful occlusion of aneurysm (black arrows) is seen using four coils. (Clinical collection)

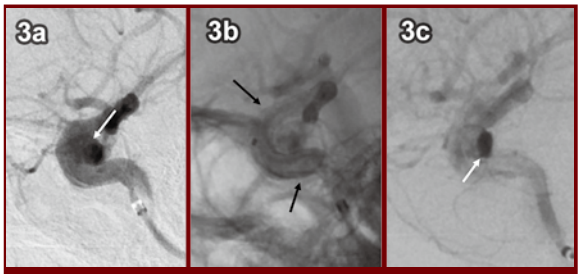

Fig. 3. A 53-year-old female with a) right internal carotid artery (ICA) ophthalmic segment posterior pointing 4 mm aneurysm (white arrow) seen on pre-embolisation right ICA angiogram lateral projection. After flow diverter stent placement, post-embolisation angiograms demonstrate b) patent stent (black arrows) and c) contrast stasis in the aneurysm (white arrow), indicating successful embolisation. (Clinical collection)

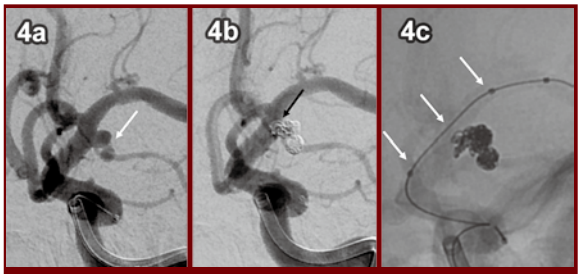

Fig. 4. A 66-year-old female with ruptured left terminal ICA aneurysm a) measuring 5 mm x 2.5 mm in size with lobulated outline (white arrow) on pre-embolisation angiogram. b) Due to slight prolapse of coils into the parent artery (black arrow), c) a compliant balloon is placed over the neck of the aneurysm (white arrows) to facilitate complete coil embolisation of the aneurysm. (Clinical collection)

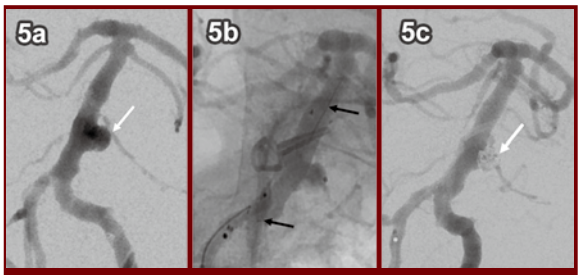

Fig. 5. A 69-year-old female with a) leftward pointing mid-basilar artery wide-neck aneurysm (white arrow) measuring 4.5 mm x 3 mm seen on a right vertebral angiogram. b) after placing a catheter into the aneurysm, a flow diverter stent is placed across the neck (black arrow). c) stent-assisted coil embolisation of the aneurysm is then performed with five coils (white arrow), resulting in complete embolisation. (Clinical collection)

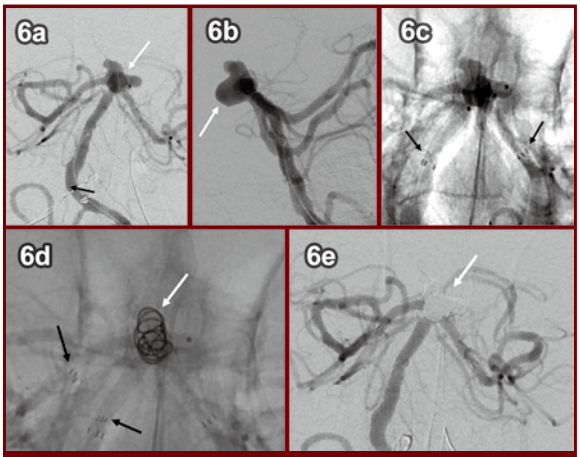

Fig. 6. An 81-year-old female with basilar tip aneurysm. Vertebral artery (VA) angiograms with frontal a) and lateral b) views demonstrate a complex tri-lobed wide-neck aneurysm arising from the basilar tip (white arrow). This complex aneurysm requires a Y-stenting technique to protect the basilar and bilateral posterior cerebral arteries (PCA). c) To accomplish this, an open-cell stent is placed from proximal left PCA to mid basilar artery (black arrows), then d) another stent is placed from right PCA to mild basilar artery (black arrows) before embolisation with coils (white arrow). e) Post-embolisation VA angiogram shows successful occlusion of aneurysm (white arrow). (Clinical collection)

For aneurysms close to a small vessel that cannot be sacrificed, or blister aneurysms that essentially cannot be treated by coils alone, flow diverter (FD) placement is often the treatment of choice. This can be combined with coil embolisation to achieve FD-assisted coiling, a common approach to managing aneurysms along the carotid siphon.

The choice between endovascular coiling/flow-diversion and surgical clipping for the treatment of intracranial aneurysms depends on the angioarchitecture of aneurysms, urgency for treatment, the expertise of the Neurovascular centre and the preference of the patients and their relatives. More than 90% of intracranial aneurysms are treated by endovascular approach in our institution, and this is also the current trend of treatment choice.

INTRACRANIAL DISSECTING ANEURYSMS

Ruptured intracranial dissecting aneurysms, primarily involving the posterior circulation, particularly the vertebral artery, are associated with high morbidity and mortality[9-12]. Due to the high rate of re-bleeding and consequent dismal neurological outcomes, early treatment is imperative[13]. There are two main options for the treatment of ruptured intracranial dissecting aneurysms; both are endovascular strategies: endovascular trapping with parent artery occlusion and flow diverter stenting.

For ruptured vertebral dissection, the choice between these modalities depends on multiple factors, including vertebral artery dominance, anatomical relationship with the posterior inferior cerebellar artery (PICA), and extent of involvement of vertebrobasilar junction. Similar considerations exist for ruptured intracranial dissecting aneurysms involving other locations.

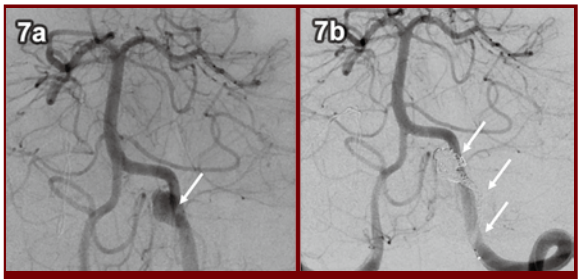

Fig. 7. A 40-year-old male with left PICA dissecting aneurysm. a) Pre-embolisation left VA angiogram demonstrates dissecting aneurysm measuring 7 mm at proximal left PICA involving its origin (white arrow). b) Post-embolisation angiogram showing successful trapping of the diseased segment of left PICA with 13 coils (white arrows). (Clinical collection)

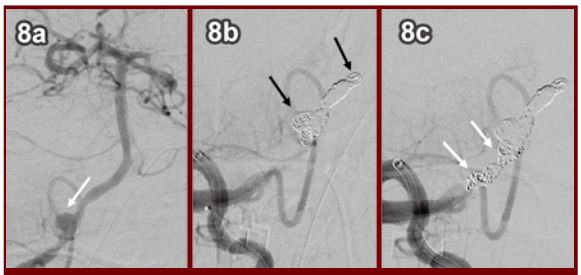

Fig. 8. A 50-year-old female with right VA dissecting aneurysm presenting with subarachnoid haemorrhage. a) Right VA angiogram demonstrates the irregular calibre of right VA distal to right posterior inferior cerebellar artery (PICA) origin extending to the VBJ with a 5.5mm dissecting aneurysm (white arrow). b, c) Endovascular trapping is performed with nine coils in total, from distal right VA including the aneurysm (black arrows) to proximal right VA (white arrows). (Clinical collection)

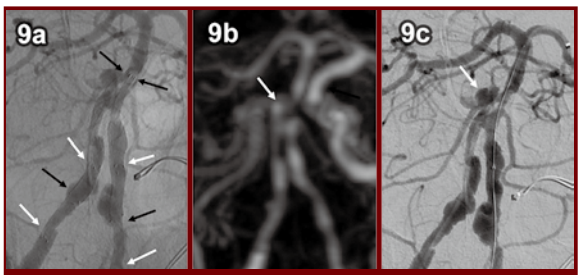

Fig. 9. A 77-year-old female with a) bilateral intradural VA dissections and a 3 mm rightward pointing aneurysm (white arrow) at the vertebrobasilar junction (VBJ). b) to exclude the aneurysm, two flow diverters are placed simultaneously with distal ends flush at the VBJ (black arrows); to completely protect the diseased VA, two more flow diverters are placed proximally (white arrows). c) Follow up MR angiogram demonstrates obliteration of the previously noted dissecting aneurysm (white arrow). (Clinical collection)

In general, endovascular trapping is the treatment of choice (Fig. 7, 8) unless the diseased arterial segment gives off perforating vessels that supply blood to critical regions of the brain or when the collateral flow is deemed inadequate to a significant portion of the brain

after the sacrifice of the parent artery. Flow diverter deployment requires the administration of dual anti-platelet, which is associated with an increased risk of re-bleeding since flow diverters do not provide immediate full protection of the dissection and are thus reserved for cases where endovascular trapping is considered not feasible (Fig. 9).

ARTERIOVENOUS MALFORMATIONS

Intracerebral arteriovenous malformations (AVM) are uncommon congenital vascular lesions with a prevalence of 0.05%[14]. AVMs originate from abnormal connections between arteries and veins without intervening capillary bed[15], through an abnormal tangle of vessels known as the nidus. The shunt can give rise to high risk angioarchitectural features in multiple ways: on the arterial side, intra-nidal aneurysms or flow-related aneurysms along supplying arteries may arise[16]; on the venous side, long-standing increased flow can lead to outflow venous steno-occlusion; these are associated with a higher risk of haemorrhage of the AVM. In addition, the AVM causes chronic arterial steal phenomenon[17], jeopardising flow to normal brain parenchyma. The details of AVM classification are beyond the scope of this article, and we will focus on the management paradigm.

Whilst some AVMs remain asymptomatic, the annual rate of ICH from AVM is reported at 2.3% annually, according to a meta-analysis, with annual risk rising, reaching 4.8% in previously ruptured AVMs[16]. Apart from ICH, some AVMs present signs of vascular steal, focal ischaemia, and intracranial venous hypertension, including epileptic seizures and other progressive focal neurological deficits[18].

Although a multi-modality approach is necessary when considering treatment for cerebral AVMs, endovascular embolisation is considered the mainstay of treatment nowadays[19]. Embolisation can be performed as stand-alone curative procedure or staged procedure for pre-operative devascularisation, followed by surgery or stereotactic radiosurgery.

Two important recent technical developments facilitate drastic improvement of complete endovascular embolisation of AVMs (Fig. 10,11). Firstly, non-adhesive liquid embolic agents such as ethyl vinyl alcohol copolymers (e.g. Onyx) and precipitable hydrophobic injectable liquid (PHIL) allow prolonged infusion of embolic agents, thereby increasing the likelihood of complete embolisation[20]. Secondly, detachable tip microcatheters (e.g. Apollo) reduce the risk of catheter adhesion and retention during withdrawal from super-selective catheter positions close to the nidus of AVMs being treated[21].

As a result of these advances, the complete occlusion rate of AVM by endovascular treatment can reach up to 96% for AVMs with favourable angioarchitectural features[22,23]. In AVMs with more complex anatomy, targeted embolisation of high-risk angioarchitectural features such as peri-nidal or flow-related aneurysms in a single or staged manner also serves to reduce the risk of haemorrhage and facilitate further surgical or radiation treatment[24].

To optimise the result of embolisation, the transarterial pressure cooker technique is often adopted[25]. This technique involves navigating two into the desired feeding artery of the AVM. The proximal microcatheter is used to place an anti-reflux using coils. After placing this plug, the distal microcatheter is used to deliver liquid embolic agent at high forward pressure into the AVM nidus, hence achieving complete embolisation[26].

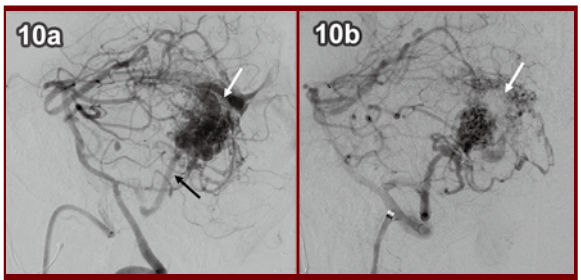

Fig. 10. A 43-year-old female with left cerebellar arteriovenous malformation (AVM) (white arrow) shown in a) pre-embolisation angiogram, mainly supplied by distal branches of the hypertrophic left PICA (black arrow). b) Post liquid embolisation angiogram demonstrates successful devascularisation of the AVM (white arrow) with a significant reduction in the size of nidus. (Clinical collection)

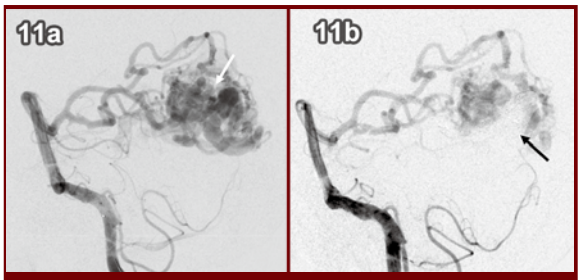

Fig. 11. A 48-year-old male with left occipital AVM (white arrow) shown in a) pre-operative left VA angiograms in lateral projection. On post-embolisation angiogram b) from the same projection, successful devascularisation of the AVM using a liquid embolic agent is noted with the PHIL cast as illustrated (black arrow). (Clinical collection)

INTRACRANIAL DURAL ARTERIOVENOUS FISTULAS

Intracranial dural arteriovenous fistulas (dAVFs) are pathological anastomoses between meningeal arteries and dural venous sinuses[27], frequently associated with major dural venous sinuses including transverse-sigmoid, superior sagittal and cavernous sinuses. These lesions are rare, accounting for up to 10 - 15% of intracranial vascular malformations[28]. These lesions are believed to result from chronic venous sinus stenosis related to previous trauma, operation, or infection, leading to the development of arteriovenous fistulae[29,30]. Cortical venous drainage on angiographic examination, and presentation with ICH or non-haemorrhagic neurological deficits (NHND) are factors predictive of high morbidity and mortality[31-33], and dAVFs with these features warrant early endovascular treatment.

Embolisation is now the treatment of choice for dAVFs (Fig. 12,13). Planning of digital subtraction angiograms is imperative for assessing the feasibility of endovascular treatment, which is highly individualised. In a typical case of dAVF, the favoured approach involves the introduction of a guide catheter to the involved dural venous sinus and access to the major draining vein with double microcatheters. A reverse pressure-cooker technique like that described for AVM is then employed, with an anti-reflux plug deployed from the microcatheter placed closer to the outflow veins, while the delivery of a liquid embolic agent into the dAVF is performed via the one placed closer to the shunting zone.

SPINAL VASCULAR MALFORMATIONS

Spinal vascular malformations are a heterogeneous group comprising 5 - 9% of vascular lesions of the central nervous system[34]. There are three major entities: dural AVFs are most common and account for 50 - 85% of spinal vascular malformations[35], most often affecting middle-aged males and occurring between T4 and L3 spinal levels[36,37]; intradural perimedullary AVFs are exceedingly rare, favour lower thoracic levels and present in young patients[38,39]; spinal cord AVMs occur in paediatric population up to the third decade of life, and is characterised by the presence of an intramedullary nidus[40].

Clinical presentation of spinal vascular malformations is also variable. Most spinal vascular malformations present insidiously with lower limb neurological deficits (including numbness, weakness, bowel and bladder dysfunction) associated with spinal cord oedema[41]. Acute neurological deterioration associated with cord or subarachnoid haemorrhage is less frequent, and often associated with spinal cord AVMs more so than other types of spinal vascular malformations[42].

The role of endovascular treatment for spinal vascular malformations has indeed been expanding in recent years with the advent of microcatheters with improved navigability and liquid embolic agents with improved penetrability[43]. However, for vascular malformations closely associated with arteries supplying the spinal cord, namely the anterior spinal artery, posterior spinal artery and Artery of Adamkiewicz, the risk of cord ischaemia and irreversible neurological deficits associated with embolisation can be prohibitive[44]. Successful endovascular treatment, therefore, hinges upon careful analysis of diagnostic spinal angiograms.

ACUTE STROKE WITH LARGE VESSEL OCCLUSION

In 2015, five randomised controlled trials were published reporting the superiority of endovascular management for selected acute stroke patients over medical treatment with intravenous thrombolytics[45-49]. In general, patients with intracranial large vessel occlusions presenting within 6 hours of onset may be good candidates for endovascular thrombectomy. Two primary methods of clot retrieval are employed: suction thrombectomy using reperfusion catheters, and stentriever thrombectomy using retrievable stent devices.

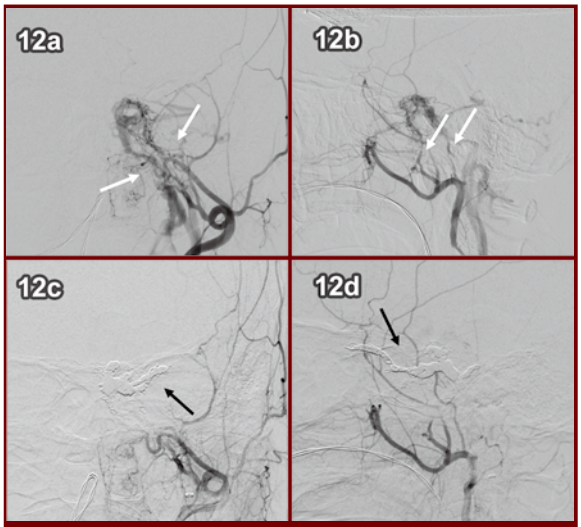

Fig. 12. A 58-year-old female with left carotid-cavernous fistula (CCF) presenting with left eye chemosis and proptosis. a) Frontal and b) lateral left ECA angiograms demonstrate the CCF with major arterial supply from left middle and accessory meningeal branches (white arrows). Transvenous liquid and coil embolisation are performed subsequently. Post-embolisation c) frontal and d) lateral left ECA angiograms to illustrate complete obliteration of the CCF with the coil mass / PHIL cast seen at the location of prior shunting (black arrows). (Clinical collection)

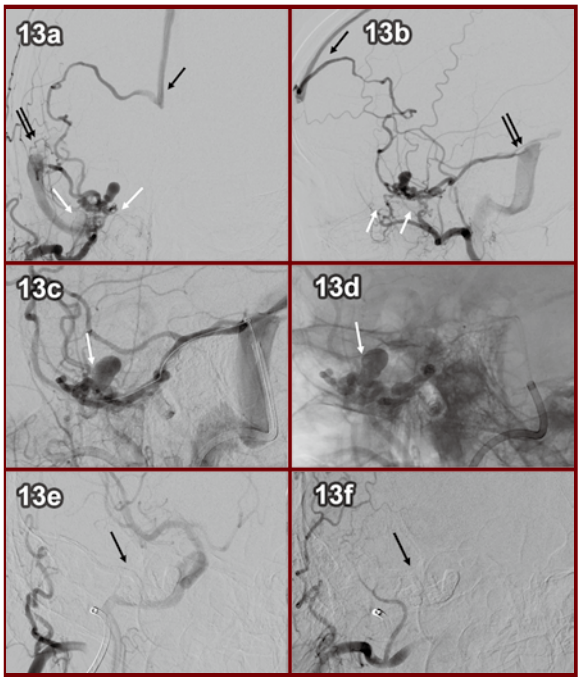

Fig. 13. A 71-year-old female with a complex right temporal dural arteriovenous fistula (dAVF). On pre-embolisation a) frontal and b) lateral right ECA angiograms, the dAVF is seen supplied from deep temporal branches of the right internal maxillary artery (white arrows) with venous drainage into the superior sagittal sinus (black arrow) and right sigmoid sinus (double black arrows). Transvenous embolisation is performed with PHIL cast (white arrows) seen on c, d) lateral right ECA angiograms. Complete obliteration of the dAVF with PHIL cast in its position (black arrows) is seen on post-embolisation e) frontal and f) lateral right ECA angiograms. (Clinical collection)

Since the landmark trials in 2015, there has been explosive development of endovascular devices as well as further research into expanding the indication of patients eligible for intra-arterial thrombectomy. With these incoming advancements, selected patients with basilar artery or other posterior circulation artery occlusions, distal anterior circulation artery occlusions, or extended time window presenting beyond 6 hours may be feasible for mechanical thrombectomy[50].

The HERMES metanalysis showed that endovascular thrombectomy led to significantly reduced disability at 90 days compared with medical treatment alone (adjusted cOR 2.49, 95% CI 1.76 - 3.53; $p < 0.0001$). The number needed to treat with endovascular thrombectomy to reduce disability by at least one level on mRS for one patient was as low as 2.6[51].

CAROTID STENOSIS

Carotid artery stenting for internal and common carotid artery stenosis is a well-known and established alternative to carotid endarterectomy. In general, symptomatic patients with moderate to severe carotid stenosis are eligible for carotid stenting[52]. In this procedure, an embolic protection device is carefully navigated across the targeted stenotic site before deployment of a self-expanding bare metal stent across the stenosis, with additional post-stenting angioplasty to ensure smooth apposition of the carotid stent to the vessel wall[53].

Although carotid stenting has not consistently achieved non-inferiority to open surgery in most trials[54-56], most of the morbidity and mortality appear to be related to periprocedural stroke in elderly patients over 70 years old. Peri-operative stroke is likely related to embolic phenomenon during manipulation across anatomically challenging aortic arches[57]. With good use of embolic protection devices, and appropriate patient selection, carotid stenting may well supersede endarterectomy as the treatment of choice for patients with symptomatic extracranial carotid stenosis.

CAROTID BLOWOUT

Carotid blowout syndrome refers to the rupture of the common carotid artery branches with life-threatening exsanguination, which commonly occurs as a delayed complication of radiotherapy for head and neck malignancies, particularly nasopharyngeal carcinoma (NPC). Endovascular treatment has been shown to carry a better prognosis than surgical ligation[58], but the mortality rate remains high despite treatment[59].

Two approaches for endovascular treatment of carotid blowout are generally considered when the perforation site occurs at the internal or common carotid artery, most commonly the cervical or petrous segment of the internal carotid artery. Reconstructive treatment with a covered stent graft or flow diverter is favoured to artificially reinforce the vessel wall while maintaining distal flow. The risk of acute thromboembolism is still present and reduced with the administration of dual anti-platelet.

The second approach is vessel sacrifice with coil embolisation, also called "trapping" of the pseudoaneurysm. For internal carotid artery blowout, in patients with poor collateral supply, incomplete Circle of Willis or patients who fail the balloon occlusion test, endovascular trapping carries high risk of irreversible neurological deficits. Stenting would be the treatment of choice in these cases. On the other hand, endovascular trapping is the treatment of choice when the bleeding site occurs in external carotid artery branches, as vessel sacrifice is associated with minimal neurological morbidity for these patients.

PRE-OPERATIVE EMBOLISATION FOR HEAD AND NECK TUMOURS

Surgical management of hypervascular head and neck tumours can be risky due to the anatomical complexity of this region. Pre-operative embolisation is hence increasingly favoured by surgeons to reduce intra-operative blood loss and ensure a clean operative field during surgery[60]. A wide range of tumours is amenable to embolisation, including sinonasal carcinomas, juvenile nasopharyngeal angiofibromas, paragangliomas and intracranial meningiomas[61].

Principles of endovascular embolisation of supplying arteries for head and neck tumours include a careful analysis of angiograms to identify major tumour supply, usually from external carotid artery branches. Embolic particles of the size range 150 - 250 um are used, and the best time for embolization is 3 - 7 days before surgery for optimal devascularisation[62].

CONCLUSION

In this article, we have illustrated a range of neurovascular pathologies that can be tackled by endovascular treatment. For these pathologies, we reviewed clinical and technical details regarding the respective intervention procedures. With the advent of better technological and theoretical support behind these procedures, neuro-intervention will increasingly become the treatment of choice for vascular pathologies, and we can expect to see more innovations and paradigm shifts in the future.

Take Home Messages

1. Endovascular coiling, alone or with adjuncts such as stents or balloons, can be used to manage complex wide-neck aneurysms (be it ruptured or unruptured).
2. Ruptured intracranial dissections can be managed by endovascular trapping or stenting.
3. Embolisation is currently the treatment of choice for dural AVF.
4. Embolisation can be the sole or adjunctive treatment for brain or spinal AVM.
5. The NNT for mechanical thrombectomy to reduce disability in acute ischaemic stroke patients is as low as 2.6.
6. Endovascular treatment can be used to salvage cases of a carotid blowout.

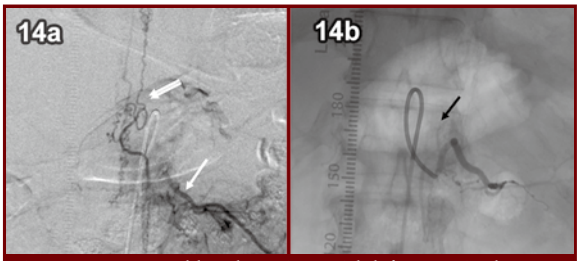

Fig. 14. A 62-year-old male patient with left T12 spinal dural AVF. On a) frontal view selected left T12 segmental artery angiogram, abnormal trans-dural shunting between the radicular artery and vein (white arrow) is noted, with venous drainage into engorged perimedullary veins (double white arrows). b) Post-embolisation angiogram demonstrates complete resolution of the spinal dural AVF at the site of previous shunting (black arrow). (Clinical collection)

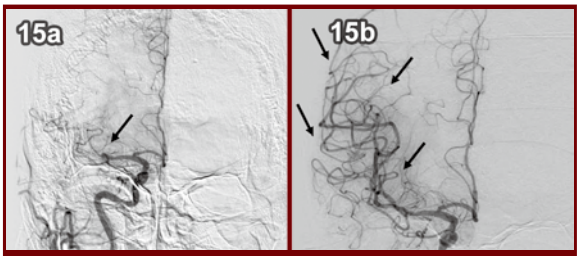

Fig. 15. A 70-year-old male patient presenting with left dense hemiplegia, with acute large vessel occlusion at right MCA M1 segment detected on CT angiogram. Urgent mechanical thrombectomy is arranged. a) Pre-thrombectomy right ICA angiogram frontal view demonstrates the acute occlusion at the right MCA M1 segment (black arrow). After one cycle of mechanical suction thrombectomy with reperfusion catheter, b) frontal view right ICA angiogram demonstrates complete opening up of right MCA and distal branches (black arrows) with TICI3 reperfusion achieved. (Clinical collection)

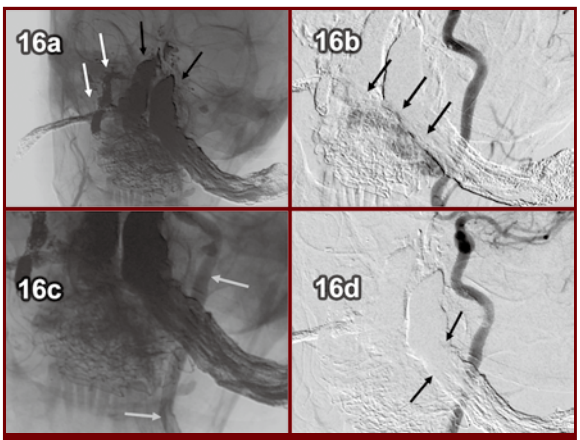

Fig. 16. A 59-year-old female with a history of recurrent nasopharyngeal carcinoma (NPC) post nasopharyngectomy. This was followed by an episode of a carotid blowout with right ICA pseudoaneurysm and trapping of cervico-petrous segments of the right ICA. She presented with the second episode of a blowout while recovering in the ward and an urgent diagnostic angiogram is arranged. a) Fluoroscopic image from frontal view right common carotid artery (CCA) angiogram demonstrates metallic coils from prior trapping (white arrows) and nasal packing (black arrows), with no recanalisation of right ICA. b) However, the left CCA angiogram frontal view demonstrates active extravasation from the cervical segment of left ICA (black arrows) instead. c) Cover stent placement over the left ICA blowout site (white arrows) is performed with d) subsequent repeat angiogram demonstrating successful haemostasis (black arrows). (Clinical collection)

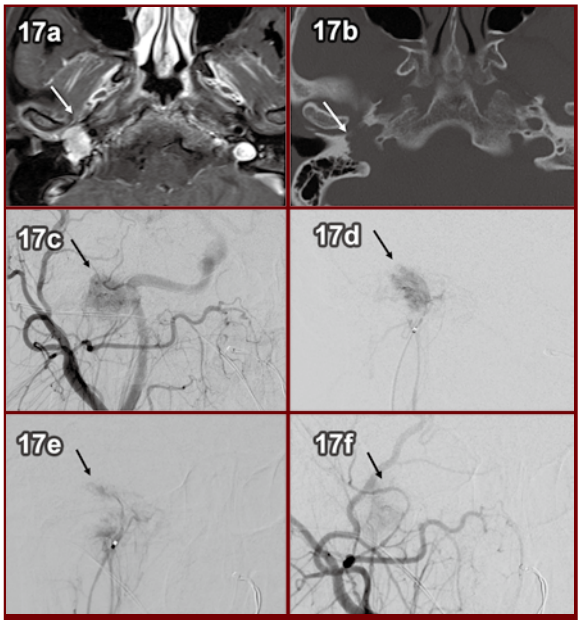

Fig. 17. A 36-year-old female patient with right glomus jugulotympanicum tumour. a) Axial MRI T1-weighted post-contrast fat-saturated image demonstrates a 1.3cm enhancing tumour (white arrow) at right jugular fossa, with b) corresponding axial CT demonstrating permeative bone destruction (white arrow) in keeping with known glomus tumour. c) Right ECA angiogram and subsequent d) super-selective right occipital artery angiogram demonstrates tumour blush (black arrows) with supply from right occipital artery stylomastoid branch. Tumour embolisation is performed with particles of size range 255 - 350 um. Post-embolisation e) right occipital artery and f) right ECA angiograms demonstrate successful devascularisation of the tumour (black arrows). (Clinical collection)

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Hybrid Functional Positron Emission Tomography and Computed Tomography Imaging: Now and the Future

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This article has been selected by the Editorial Board of the Hong Kong Medical Diary for participants in the CME programme of the Medical Council of Hong Kong (MCHK) to complete the following self-assessment questions in order to be awarded 1 CME credit under the programme upon returning the completed answer sheet to the Federation Secretariat on or before 28 February 2023.

INTRODUCTION

Positron emission tomography (PET) is a nuclear molecular and functional imaging technique introduced in the 1970s.[1] PET can elucidate a wide variety of physiological and biochemical processes at molecular levels by visualising and quantifying the distribution of positron-emitting radionuclides injected into the body. The anatomical localisation of the functional abnormalities was once a challenge due to the limited spatial resolution of PET imaging. Since early 2000s, PET machines have been combined with high resolution anatomical imaging, such as computed tomography (CT) to provide both functional information as well as anatomical details.[2,3] Currently, anatomic and functional images can be simultaneously acquired for patients from a single scanning session. While fluorine-18 (F) fluorodeoxyglucose (FDG) is the most commonly used radionuclide for PET, many other positron-emitting radionuclides have now been developed for use in different clinical applications. In addition to oncological diseases, PET can also be utilised in the management of neurological, cardiac, infective and inflammatory diseases. This article will review PET technology, introduce selected positron-emitting radionuclides, discuss the current application in a variety of diseases, and lastly, provide some perspectives for the future.

PET TECHNOLOGY

Once a positron-emitting radionuclide (radiotracer) is intravenously injected into the body, the radiotracer is distributed following the normal biodistribution of the tagged molecule. As the radionuclide possesses a proton-rich unstable nucleus, it undergoes a decay process that emits positrons, which travel a short distance before annihilating with an electron. Two 511-keV photons are emitted back-to-back as a result of the annihilation (see Fig. 1).[4] PET detectors are arranged in a ring-like configuration embracing the patient. During the scan, annihilating photon pairs that strike opposing detectors at approximately the same time, known as coincidence events, are recorded through projections at different angles. These projections are then used to reconstruct a three-dimensional representation of in-vivo radiotracer distribution.

Only a tiny amount of radiotracer has to be injected because of the high sensitivity of PET scanners. In general, radiotracer uptake on PET images is assessed by the visual search for abnormal distribution of the radiotracer that may represent pathological processes such as malignancy in the appropriate clinical context. The intensity of radiotracer uptake can be semi-quantified by standardised uptake value (SUV = ratio of image-derived radioactivity concentration in the region of interest to the whole body concentration of the injected radioactivity). The measurements can be used for diagnosis and follow up of the disease process.[5] Some other functional parameters such as metabolic tumour volume may also be used.

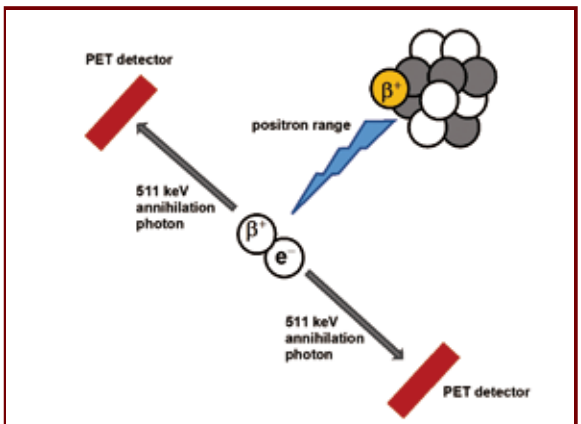

Fig. 1. Back-to-back emission of two 511-keV photons following annihilation (Developed by the authors)

FDG PET AND APPLICATION

FDG - Oncology

The most widely used radiotracer is FDG. As a radiolabelled analogue of glucose, FDG uptake intensity

on PET reflects regional tissue glucose consumption. As a way to harness aerobic glycolysis to fuel cell growth[6], many cancer cells have increased cellular glucose transporters and hexokinase activity compared with normal cells. Being able to demonstrate the contrast of added glucose consumption by tumour cells, FDG PET has become the non-invasive imaging of choice for detection, staging, restaging and therapy response assessment in many oncological diseases (see Fig. 2, 3). National Comprehensive Cancer Network® (NCCN) Imaging Appropriate Use Criteria™ recommends the use of FDG PET/CT for a large number of oncological indications, as shown in Table 1.[7]

Table 1. Examples of clinical indications for FDG PET/CT recommended by the National Comprehensive Cancer Network® (NCCN) Imaging Appropriate Use Criteria™[7] (Excerpted from reference 7)

Examples of diseases	Examples of clinical indications
Colorectal carcinoma	Diagnosis for potentially surgically curable suspected or known metastases; OR Restaging for recurrence
Gastrointestinal stromal tumour	Post-treatment follow-up reassessment
Head and neck cancer – including nasopharynx, oral cavity, oropharynx, hypopharynx, larynx	Diagnosis and post-treatment follow-up reassessment
Lung cancer – non-small cell (see Fig. 2)	Diagnosis
Lymphoma – including diffuse B-cell lymphoma, extra-nodal NK/T cell lymphoma, follicular lymphoma, Hodgkin lymphoma) (See Fig. 3)	Diagnosis and post-treatment follow-up reassessment
Melanoma	Diagnosis and post-treatment follow-up reassessment
Occult primary	Diagnosis for neck mass with no primary found
Sarcoma – including Ewing sarcoma, osteosarcoma	Diagnosis and post-treatment follow-up reassessment

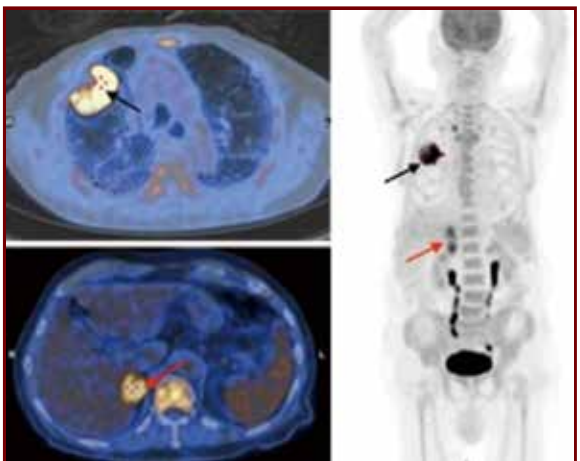

Fig. 2. FDG PET staging for an 83-year-old male with biopsy proven right upper lobe lung cancer (black arrow): the hypermetabolic right adrenal mass is worrisome of metastasis (red arrow). (Collection from the authors' institution)

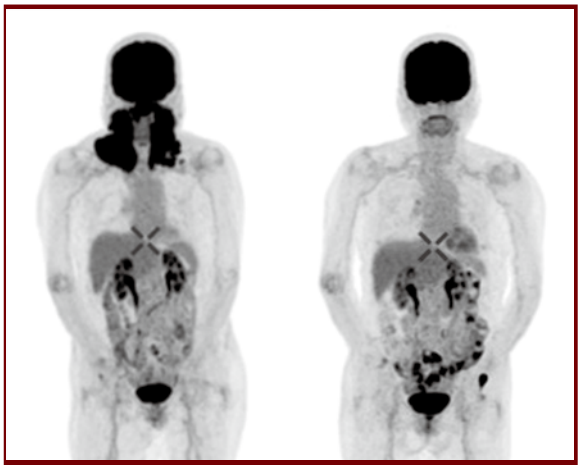

Fig. 3. Pre-treatment FDG PET on the left shows diffuse large B-cell lymphoma disease involving the nasopharynx and bilateral cervical regions. Post-treatment FDG PET on the right shows a complete metabolic response. (Collection from the authors' institution)

FDG - Neurology

The energy required for brain function is largely provided by glucose. In certain pathological brain conditions, neuronal and synaptic changes lead to changes in regional glucose metabolism.[8] In particular, Alzheimer's disease (AD), dementia with Lewy bodies (DLB), and frontotemporal lobe dementia (FTLD) show different characteristic patterns of regional hypometabolism in the brain (see Fig. 4).[9] FDG PET can be utilised to support differential diagnosis between AD and FTLD; AD and DLB; FTLD and DLB (see Table 2); and different parkinsonian syndromes.[9] Secondly, FDG PET can offer a pre-surgical evaluation to detect the epileptogenic zone using an interictal injection in drug-resistant epilepsy patients. FDG PET may also have a role in managing encephalitis, other neurodegenerative diseases (such as amyotrophic lateral sclerosis), and neuro-oncological diseases.[9]

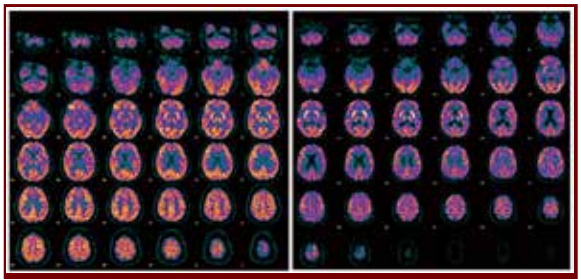

Fig. 4. Normal FDG PET of the brain on the left. FDG PET on the right shows bilateral temporoparietal hypometabolism, including posterior cingulate gyrus and precuneus, compatible with the metabolic pattern of Alzheimer's disease. Less prominent hypometabolism is also shown in bilateral frontal lobes. (Collection from the authors' institution)

Table 2. Typical cerebral region of hypometabolism in AD, FTD and DLB (Excerpted from reference 9)

Brain region	AD (see Fig. 4)	FTD	DLB
Frontal lobe	possible in advanced state/ frontal variant	√	possible
Anterior cingulate gyrus		√	
Temporal lobe	√	√	√
Parietal lobe	√		√
Posterior cingulate gyrus	√	possible	
Precuneus	√		
Occipital lobe	possible in posterior variant		√

FDG - Cardiology

The STICH trial (Surgical Treatment for Ischemic Heart Failure) showed no significant survival benefit among patients with ischaemic cardiomyopathy randomised to revascularisation compared with optimal medical therapy.[10] Given the difficulty in the process of decision making, multiple imaging modalities have been used to differentiate between viable myocardium, which may recover function following revascularisation, and scars, which will not.[11,12] Under fasting and aerobic conditions, fatty acids are the preferred source of energy for the heart, whereas, in post-prandial conditions, glucose becomes the preferred substrate.[13] Therefore, with adequate glucose loading, viable myocardium shows preservation of regional myocardial glucose consumption on FDG PET whereas scars do not (see Fig. 5). In short, regional higher FDG myocardial uptake relative to regional myocardial blood flow (perfusion-metabolism mismatch) signifies hibernating but viable myocardium.[14] Long-term follow-up for the PARR-2 trial (Positron Emission Tomography and Recovery Following Revascularisation) showed significant outcome benefits for those using FDG PET-assisted strategies of revascularisation and adhering to the recommendations.[15]

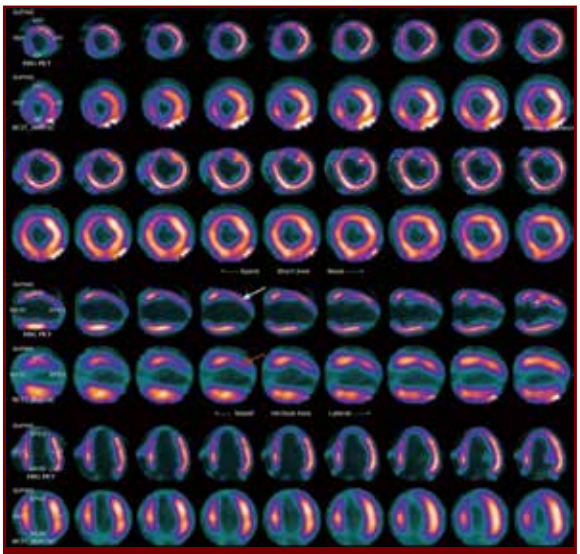

Fig. 5. Matched regional reduction in metabolism on FDG PET (upper row, white arrow) and perfusion in rest myocardial perfusion SPECT (lower row, red arrow) in the apical segment, anterior wall, and septum of left ventricle suggests scars. (Collection from the authors' institution)

FDG – Inflammation and Infection

The use of FDG PET in inflammation and infectious diseases has been rapidly evolving. It has been shown that neutrophils and monocytes/macrophages, which are involved in inflammation and infection, express increased glucose transporters and hexokinase activity.[16] In addition, increased glucose consumption can also be attributed to a stress reaction in inflamed or infected cells.[17] Currently, criteria for the appropriate use of FDG PET in inflammatory/infective diseases have been developed only for musculoskeletal conditions in the United States.[18] The use in some other inflammatory/ infective diseases endorsed by relevant international guidelines is shown in Table 3 (see also Fig. 6).

Table 3. The roles of FDG PET in some inflammatory/ infective conditions endorsed by international guidelines (Summarised from the references by authors)

System	Specific indications
Musculoskeletal[18]	Diagnosing spondylodiscitis in patients with or without spinal hardware Diagnosing uncomplicated peripheral osteomyelitis Diagnosing complicated peripheral osteomyelitis with or without hardware Diagnosing foot osteomyelitis in diabetic patients
Cardiovascular	Diagnosing cardiac sarcoidosis (together with myocardial perfusion study) and may be of value in monitoring treatment response[19] Diagnosing large vessels vasculitis and may be of value in monitoring treatment response[20] High negative predictive value in diagnosing vascular graft/endograft infection (at least four months after surgery)[21] Diagnosing infective endocarditis with a prosthetic valve or cardiac implantable electronic device (at least three months after implantation)[22]
Other possible major applications[23]	Fever of unknown origin (see Fig. 6), extracardiac sarcoidosis, evaluation for metastatic infection

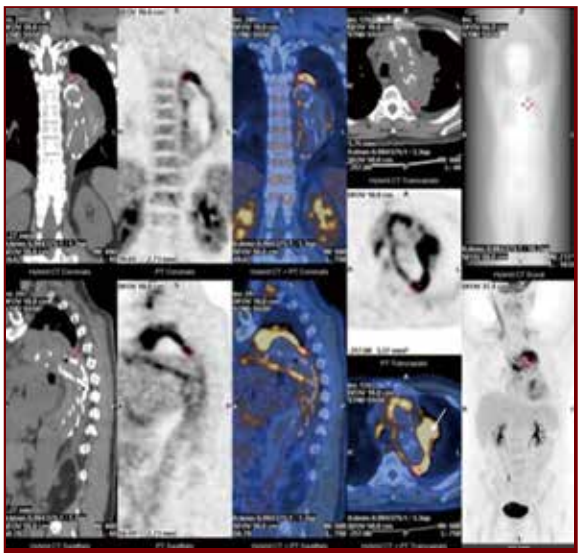

Fig. 6. FDG PET for fever of unknown origin in a 55-year-old male: hypermetabolism along the aortic arch and ascending thoracic aorta graft and in a saccular density arising from the aortic arch (white arrow), in keeping with graft infection complicated with the mycotic aneurysm. (Collection from the authors' institution)

FDG – Radiation Safety

The effective radiation dose from FDG PET in adults is 3.5 millisievert (mSv) for an administered activity of 185 megabecquerel (MBq), according to International Commission on Radiological Protection (ICRP).[24] In general, this radiation dose is considered to be safe (with less than 0.02% added lifetime chance of fatal cancer).[25] The radiation exposure of the CT scan as part of an FDG PET/CT study can range from 1 to 20 mSv, depending on its intended use.[26] Most commonly, it is low-dose when performed for attenuation correction and localisation of PET lesions. Sometimes, the dose can be higher if high-resolution diagnostic CT is performed, in particular when intravenous contrast is injected.[26]

OTHER RADIOTRACERS

Somatostatin Receptor PET

Somatostatin receptors (SSTR) are, in general, overexpressed in well differentiated neuroendocrine tumours (NET), which can therefore be imaged using radiolabelled somatostatin analogues.[27,28] Clinical indications for the use of SSTR PET include the initial staging of NET at diagnosis, localisation of the primary tumour, and selection of patients for peptide receptor radionuclide therapy (PRRT) and post-PRRT study to serve as a new baseline 9-12 months after the completion of treatment for future comparison.[29,30] Three SSTR PET radiotracers are currently approved for use by the Food and Drug Administration of the United States (FDA): gallium-68-DOTATATE, gallium-68-DOTATOC and copper-64-DOTATATE.[28]

Prostate-specific Membrane Antigen PET

In 2019, prostate cancer was the third commonest cancer in men in Hong Kong.[31] Imaging plays an important role in the management of prostate cancer, the assessment of which is traditionally by technetium-99m-methylene diphosphate bone scan and/or CT in high-risk patients.[32] Recently, there has been significant advance towards detecting the extent of prostate cancer, including using PET imaging. Although FDG PET has wide applicability in oncology, it has limited applicability in prostate cancer staging. Prostate-specific membrane antigen (PSMA) is a transmembrane protein primarily present in all prostatic tissues.[33] Since most adenocarcinomas of the prostate show increased PSMA expression in primary tumours and metastatic lesions, the use of PSMA PET in the management of prostate cancer has rapidly developed in the last decade.[34] The FDA-approved PSMA PET radiotracers are F-DCFPyL and Gallium-68-PSMA-11. Clinical scenarios considered appropriate for using PSMA PET in the United States are shown in Table 4.[35]

Myocardial Perfusion PET

Myocardial perfusion scintigraphy (MPS) is an important diagnostic, and prognostic tool for the management of epicardial coronary artery disease (CAD).[36,37,38] The goal of evaluating myocardial perfusion is to detect haemodynamically significant coronary artery stenosis to guide clinical management of patients with known/suspected CAD or cardiovascular risk factors.[39] Interpretation of conventional single-photon emission computed tomography (SPECT) MPS studies is primarily qualitative or semi-quantitative in nature, assessing regional perfusion in relative terms.[40] PET MPS was later performed with selected positron-emitting radionuclides that can be used to reflect perfusion to the myocardium.

Compared with SPECT MPS, not only does PET MPS provide better diagnostic accuracy, but it also allows quantitative measurements of myocardial blood flow (MBF), offering a paradigm shift of the gold standard from an anatomical to a functional one.[41,42] The quantification of MBF in PET MPS extends the scope of SPECT MPS from the detection of advanced epicardial CAD to early disease or microvascular dysfunction, as well as allowing assessment of multi-vessel CAD (i.e. balanced reduction of MBF in all three major coronary territories).[42] Currently, FDA-approved PET MPS radiotracers are rubidium-82 and nitrogen-13-ammonia.

Table 4. Clinical scenarios considered appropriate for using PSMA PET in the United States (Adopted from reference 35)

	Specific indications
New diagnoses	Unfavourable intermediate, high-risk, or very high-risk prostate cancer Unfavourable intermediate, high-risk, or very high-risk prostate cancer with negative/equivocal or oligometastatic disease on conventional imaging
Post-treatment	Persistent or rising prostate-specific antigen (PSA) from undetectable level after radical prostatectomy Rising PSA above nadir after definitive radiotherapy Non-metastatic castration-resistant prostate cancer on conventional imaging

Table 5. Examples of other PET radiotracers available for clinical use (Summarised from the references by authors)

PET radiotracers	Clinical use(s)
F-DOPA	Differentiating essential tremor from neurodegenerative parkinsonian syndromes[43] Differentiating parkinsonism due to presynaptic degenerative dopamine deficiency from other forms of parkinsonism, e.g., between IPD and drug-induced, psychogenic, or vascular parkinsonism[43] Differentiating DLB from other dementias[43] Detecting early presynaptic parkinsonian syndromes[43] Staging and restaging for medullary thyroid carcinoma[44] Staging and restaging for sporadic pheochromocytoma and inherited pheochromocytoma/paraganglioma (except succinate dehydrogenase mutation)[45]
Radiolabelled amyloid[46]	Supporting diagnosis of AD when a patient has persistent or progressive unexplained mild cognitive impairment; satisfying the core clinical criteria for possible AD with unclear clinical presentation—either an atypical clinical course or an etiologically mixed presentation; or the patient has progressive dementia with early age of onset was atypically early
Radiolabelled amino acids[47]	Differentiating grade III and IV gliomas from non-neoplastic lesions or grade I and II gliomas Differentiating glioma recurrence from treatment-induced changes Disease and therapy monitoring for gliomas

Others

Last but not least, examples of some other PET radiotracers available for clinical use are shown in Table 5.[43-47]

BEYOND DIAGNOSES

Theranostics

Personalised medicine entails tailoring preventive and therapeutic strategies by means of assessing biomarkers at the level of molecular disease pathways.[49] Theranostics in nuclear medicine pertains to identifying the most appropriate molecular targets in tumour diseases so as to allow selection of the optimal radioligands for subsequent disease management.[50,51] PET has since been playing an important role in decision making and therapeutic monitoring in patients who may benefit from radionuclide therapies.

For instance, randomised controlled NETTER-1 trial revealed a five-fold improvement in response to lutetium-177-DOTATATE radionuclide therapy compared with conventional treatment of gastro-entero-pancreatic neuroendocrine tumours.[52] SSTR PET can be used to select patients with metastatic or inoperable neuroendocrine tumours suitable for SSTR radionuclide therapy as well as monitoring treatment response. More recently, another randomised controlled VISION trial showed significant improvement in the overall and progressive survivals in progressive metastatic castration-resistant prostate cancer patients who received Lutetium-177-PSMA-617 radionuclide therapy and standard care compared to standard care alone.[53] PSMA PET can now be used to select appropriate prostate cancer patients to undergo PSMA radionuclide therapy and monitor treatment response. These two important clinical trials have paved the way for more theranostics in future management of oncological diseases.

Radiotherapy Planning

FDG PET plays an important role in the radiotherapy (RT) planning of lung cancer.[54,55] FDG PET can be helpful in delineating tumour boundaries in case of extra-thoracic or mediastinal tumour extension, when the tumour and normal tissue have a similar appearance on CT, or when there is atelectatic change adjacent to the tumour.[56] FDG PET also can be used in advanced uterine cervical cancer for RT planning with emphases on staging and target definition.[57]

FUTURE PERSPECTIVES

Radiomics

Radiomics is a term recently introduced, conceptualised as workflow-based machine learning to generate automatic high throughput of quantitative metrics from imaging (including shape, intensity and/or textural features) for different clinical applications.[58] For instance, Arshad et al. evaluated FDG PET radiomics for overall survival prediction after radiotherapy or chemoradiotherapy for lung cancer patients. Histogram, shape, and texture features were incorporated in addition to traditional PET metrics. The combined radiomic feature vector correctly predicted a 14-month survival difference in the validation cohort.[59] With a long tradition of generating quantitative data, nuclear medicine has huge potential to bring in radiomics in the next phase of its evolution. We are just at the crossroads though. In particular, the limitation is that there is a need to develop and strictly adhere to harmonised image acquisition and other protocols.[60]

Total Body PET

Conventional PET machines have detector units covering only one bodily region, so images have to be sequentially captured by regions. Now there is an instrumental total body PET machine where there are detection units spanning the entire axial direction so that images can be simultaneously acquired for the entire body.[61] The advantages provided by this technology include decreased acquisition time, patient motion mitigation, anaesthesia avoidance, improved diagnostic accuracy, dose reduction, and also allowing dynamic or multiple time-point scans for improved lesion detection.[62]

CONCLUSION

Since using radioiodine compounds in the management of thyroid diseases in the mid-twentieth century,[63] nuclear medicine has to date evolved to visualising many other molecular functions through the development of PET technology and new radiotracers. The technology not only allows improved lesion detection, disease characterisation, accurate quantitation, and quicker and safer scans but also drives personalised medicine with individualised treatment planning and post-treatment evaluation. With further expanding clinical applications of PET technology within sight, nuclear medicine physicians are thrilled to work hand-in-hand with clinicians to better patient care in a wide spectrum of diseases.

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MCHK CME Programme Self-assessment Questions

Please read the article entitled "Hybrid Functional Positron Emission Tomography and Computed Tomography Imaging: Now and the Future" by Dr CHAN Tak-kwong, Dr KUNG Boom-ting and Dr AU YONG Ting-kun and complete the following self-assessment questions. Participants in the MCHK CME Programme will be awarded CME credit under the Programme for returning completed answer sheets via fax (2865 0345) or by mail to the Federation Secretariat on or before 28 February 2023. Answers to questions will be provided in the next issue of The Hong Kong Medical Diary.

Questions 1-10: Please answer T (true) or F (false)

1. **Two 511-keV photons are emitted towards each other during annihilation.**
2. **A large dose of radiotracer must be injected to achieve high sensitivity of PET scanners.**
3. **SUV = ratio of image-derived radioactivity concentration in the region of interest to the whole-body concentration of the injected radioactivity.**
4. **Under fasting and aerobic conditions, glucose is the preferred source of energy for the myocardium.**
5. **The effective radiation dose from FDG PET in adults is 3.5 microsievert for an administered activity of 185 megabecquerel.**
6. **In general, somatostatin receptors (SSTR) are overexpressed in poorly differentiated neuroendocrine tumours (NET).**
7. **Most adenocarcinomas of the prostate show increased PSMA expression in primary tumours and metastatic lesions.**
8. **PET myocardial perfusion scintigraphy allows quantitative measurements of myocardial blood flow (MBF).**
9. **Radiomics is conceptualised as workflow-based machine learning to generate automatic high throughput of quantitative metrics from imaging for different clinical applications.**
10. **Conventional PET machines have detector units spanning the entire axial direction so that images can be simultaneously acquired for the entire body.**

ANSWER SHEET FOR FEBRUARY 2023

Please return the completed answer sheet to the Federation Secretariat on or before 28 February 2023 for documentation. 1 CME point will be awarded for answering the MCHK CME programme (for non-specialists) self-assessment questions.

Hybrid Functional Positron Emission Tomography and Computed Tomography Imaging: Now and the Future

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1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

Name (block letters):_____ HKMA No.: _____ CDSHK No.: _____

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Contact Tel No.:_____ MCHK No. / DCHK No.: _____(must fill in)

Answers to January 2023 Issue

Approach to Adult Scoliosis

1. T 2. F 3. T 4. T 5. F 6. T 7. F 8. T 9. T 10. T

Verzenio: The first and only CDK4 & 6 inhibitor to significantly reduce risk of recurrence in combination with ET[1,3]

In patients with HR+, HER2-, node-positive EBC at high risk of recurrence

monarchE enrolled 5,637 node-positive patients with a range of familiar high-risk disease characteristics[1,2]

KEY INCLUSION CRITERIA[1,2]

1 TO 3 POSITIVE NODES

AND

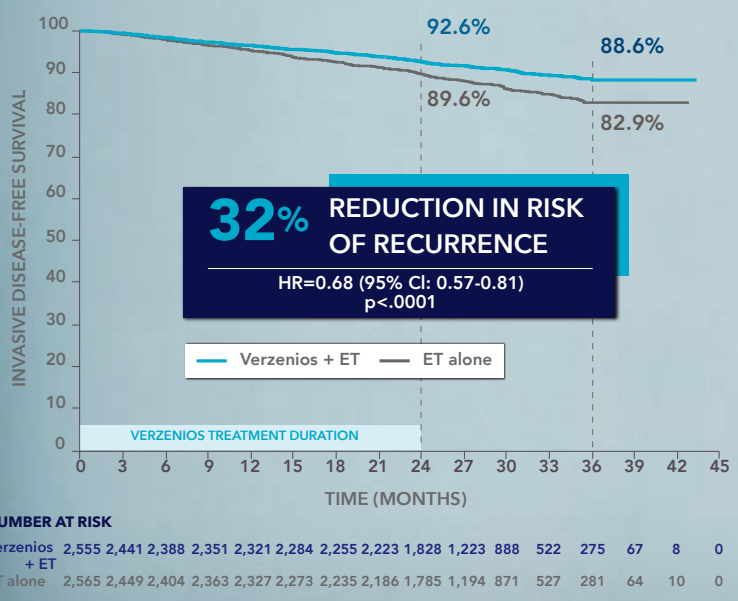
At least one of the following characteristics associated with high risk of recurrence:

- Tumor size ≥5 cm
- Histologic Grade 3

OR

4+ POSITIVE NODES

IDFS IN COHORT 1 POPULATION[1,4]



NUMBER AT RISK

Verzenios + ET	2,555	2,441	2,388	2,351	2,321	2,284	2,255	2,223	1,828	1,223	888	522	275	67	8	0
ET alone	2,565	2,449	2,404	2,363	2,327	2,273	2,235	2,186	1,785	1,194	871	527	281	64	10	0

CDK4 & 6=cyclin-dependent kinases 4 and 6; EBC=early breast cancer; ET=endocrine therapy; HR=hazard ratio; HER2-=human epidermal growth factor receptor 2-negative; HR+=hormone receptor-positive; IDFS=invasive disease-free survival.

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A Case Series on Urban Birdwatching in Hong Kong

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INTRODUCTION

Under the constrictive ordeal of quarantine mandated by the unfortunate COVID pandemic during the past two years, many denizens in Hong Kong are desperate to explore new pastimes. As a birdwatcher, I sometimes get asked where to find birdlife in this densely populated city. Fortunately, there are plenty of opportunities to do just that for both birders and non-birders alike. In this article, I will illustrate a case series on where to start birding in urban Hong Kong for natural lovers interested in acquiring this hobby.

CASE 1 - URBAN OASES

Small migrating birds tend to travel during nighttime to avoid being harassed by hawks. For hungry, weary migrant birds traversing a city such as the Kowloon peninsula, the few sizeable urban parks are literally oases that glitter like fireflies against the dark background of the concrete jungle and often attract them like magnets.

One such oasis well-known amongst local residents is the service reservoir playground in Ho Man Tin, a small forested hill nestled in central Kowloon. It merely takes a ten-minute walk to get there from the Hospital Authority Head Office. At the hilltop, one can enjoy a panoramic view of East Kowloon featuring Kai Tak, Whampoa, the Lion Rock, and Kowloon Peak (Fig. 1a). This playground is a favourite haunt of morning joggers, recreational tennis players, and school children from various baseball teams around the area; this might not sound like a place for birds.

Fig. 1a. View from the hilltop of the service reservoir playground in Ho Man Tin, with Lion Rock, Kowloon Peak, Kai Tak and the rest of central and east Kowloon visible. The elevation of this site may be one of the reasons why migrant birds tend to end up here. (Personal collection)

However, every spring and autumn, an unbelievable plethora of migrants grace this tiny urban oasis in Ho Man Tin with their presence. Early April is the best time to connect with these travellers as they race back from Southeast to Northern Asia to breed in temperate and boreal forests. On the best of days, the hills may be abound with Narcissus Flycatcher, a stunning black-and-white bird with bright tangerine yellow chest and brow; Blue-and-white Flycatcher, a smart bird with metallic cobalt-coloured plumage; and the Japanese Paradise Flycatcher, a regal-looking bird with sleek physique, purplish glossy plumage and cyan-blue eye-rings (Fig. 1b). Up to 20 species of migrants could appear in one hill on the same day!

Fig. 1b. Stunning migratory birds photographed in Ho Man Tin, clockwise from bottom right hand corner: Narcissus Flycatcher (male), Blue-and-white Flycatcher (male), Japanese Paradise Flycatcher (male, post-breeding), and Fairy Pitta (adult in spring) on passage. The first two are frequently present in early April, while the latter two are more challenging to encounter. (Personal collection)

The miracle of Ho Man Tin does not end here. In the last few years, birders have discovered that an incredibly beautiful and endangered bird passes through parks in Kowloon on their journey to forests in Taiwan, Japan and South China. This is the gorgeous Fairy Pitta (Fig. 1b), aptly named the "bird of eight colours" in Chinese. Observing this elusive, ground-loving bird hunting for earthworms along the shrubby slopes in Ho Man Tin can be quite a life-changing experience indeed!

Ho Man Tin is by no means the only urban site capable of attracting exhausted migrants in this metropolis: Kowloon Park, King's Park, as well as urban parks from

other districts such as Tsing Yi Park, Sha Tin Central Park, and Quarry Bay Park, have all received their share of avian visitors over the years. Some of these parks even boast more obscure guests certainly not expected around sky-scraping residential blocks.

CASE 2 - PHANTOMS OF THE NIGHT

Nocturnal birds are notoriously secretive with keen, supernatural senses, more often detected via their eerie calls than seen by human observers. Their usual haunts are in the deep forests away from human disturbance. In rare circumstances, however, travelling or even resident nocturnal birds have found their way into human habitation wherever appropriate environments and food sources exist.

Lai Chi Kok Park (LCKP) is one such site, familiar to locals for its ancient Chinese style pagodas, artificial rugged stone statues and ornamental ponds; it even served as a filming venue for a variety of television programmes (Fig. 2a). Yet with its close proximity to a row of residential blocks, the park has successfully attracted many species of nocturnal birds likely due to an abundance of flowering plants nurturing large populations of moths and other large nocturnal insects.

Fig. 2a. Lai Chi Kok Park from the eyes of a casual visitor, with Chinese-style gardens, turtle ponds and stone ornaments, belying an environment with potentially rich pickings for migratory birds (Personal collection)

Fig. 2b. Nocturnal birds photographed by day in the city centre, clockwise from the right side: Northern Boobook, Slaty-legged Crake, and Grey Nightjar. In urban parks, all three species have been recorded multiple times in both spring and autumn passage periods. (Personal collection)

The first star bird that turned up in LCKP was the Northern Boobook, one of the few species of Owls practising long distance migration. This Owl is the size of a large Pigeon, chocolate-coloured all over, with bold teardrop-patterned feathers along its white belly; its huge glaring yellow eyes impart a penetrating gaze (Fig. 2b). While it is rarely encountered elsewhere in Hong Kong, individuals have been found roosting in the trees in this park by day and feeding actively on flying insects by night for a few consecutive years.

Another night bird finding its way into LCKP is a cryptic bird shaped and patterned like a piece of a wooden log, the expertly camouflaged Grey Nightjar. Inclement foggy or rainy weather sometimes grounds migrating Nightjars, which are left with little choice but to temporarily rest and feed in urban parks. On a similar note, the stunning Slaty-legged Crake, a reddish bird that looks like a chicken (Fig. 2b), has been found multiple times in LCKP, Kowloon Park, Whampoa Park and inside a residential complex in Chai Wan, hiding in dense shrubbery by day and sometimes seen strolling in planters looking for small invertebrates to feed on during dawn and dusk.

CASE 3 - PIERS OF PASSAGE

Just as many forest-dwelling birds can be found in pockets of greenery in the city centre, a collection of waterbirds may be observed along the meandering coastline of Hong Kong, not only in remote sections of the coast but also along those stretches frequently used by humans as well. Many of these waterbirds feed on small fish and other aquatic creatures, and as fishermen and anglers may attest, these waterbirds are often concentrated along the piers due to the presence of food and shelter (Fig. 3a).

Fig. 3a. Panoramic view of the Sai Kung Pier from the adjacent promenade, where the pier can be seen packed with holiday goers, fishermen, and bird photographers. Numerous Terns often station on the distant rocky islets and buoys dotting the bay, visiting the Pier area to feed many times throughout the day. (Personal collection)

As a result, piers attract the large number of elegant, fish-eating birds called Terns. Some of these are particularly abundant during passage, while others breed in the summer on rocky islands along the coastline and visit piers to feed. The Sai Kung pier is probably the prime site for viewing Terns performing acrobatic fishing, with as many as five species possible in peak migration season (Fig. 3b). Sometimes even resident Sea Eagles and Black Kites may join in the fishing foray, and the result is a wildlife spectacle just outside the famous seafood restaurants of Sai Kung.

Incidentally, just outside another congregation of populous seafood restaurants in Hong Kong, adjacent to the main pier of Cheung Chau, lies the favourite fishing ground of another awe-inspiring bird. It is only after sunset when customers of seafood restaurants may notice a two-foot-tall figurine perched on one of the fishing boats in the bay, and on closer inspection, they would realise that it is a real owl pondering where to find its next meal. This is one of the resident Brown Fish Owls (Fig. 3b), widespread in Hong Kong but perhaps most readily seen on Cheung Chau out of everywhere else.

Fig. 3b. Birdlife of urban piers, clockwise from the right side: Brown Fish Owl found along Cheung Chau Pier, and four species of Terns common along Sai Kung Pier: White-winged Black Tern, Whiskered Tern, Roseate Tern, and Black-naped Tern (Personal collection)

CASE 4 - THE TELFORD MIRACLE

The three cases above illustrate well the potential of urban birding in Hong Kong, but the interesting occurrences in Telford Gardens surmount them all as an exemplary case of how miraculously close to home serious birdwatching may be.

Birds are known to navigate by multiple environmental cues, some of which are well-known and utilised by human explorers. Some migrating birds have been shown to follow major rivers and other landmarks visible from an altitude. It is, therefore, within reason that urban parks attract a selection of migrants, while most housing complexes with only a few small isolated planters do not usually receive exciting migrants.

This observation was controverted a few years back by a phenomenon occurring in Telford Gardens since a few years back. A private housing estate above the Kowloon Bay MTR station complete with local banks, clinics, a shopping plaza and 41 residential blocks, Telford boasts a modest podium consisting of a concrete-paved resting area with several small pesticide-free planters, as well as a fountain and small turtle ponds. Telford is hardly where one would expect to go for birdwatching.

However, multiple members of a bush-loving, otherwise extremely elusive family of small birds called Grasshopper Warblers (and their friends) have gone out of their way to visit the planters in Telford every autumn and winter (Fig. 4a). The phenomenal congregations of bird photographers every time a rare bird turns up in Telford has generated massive positive interest in tenants, gardeners and security guards, with multiple sign boards put up to educate local residents of the cast of birds involved (Fig. 4b). The scurrying little birds were even construed as a sign of auspiciousness for the estate!

Fig. 4a. Telford Plaza planters have been attracting huge flocks of bird watchers, bird photographers, and curious residents over the past few autumns. The presence of multiple rare migrant birds has prompted security guards to put up signage on the property to explain the phenomenon, as well as make it into the local news. (Excerpted from Sing Tao Daily)

Fig. 4b. Part of a stellar cast of migrants photographed in Telford Gardens, clockwise from bottom right hand corner: Middendorff's Grasshopper Warbler, Lanceolated Warbler, Pallas's Grasshopper Warbler, and Baikal Bush Warbler. These birds are known for their reclusiveness and for their propensity to scutter around like little mice, much to the amusement of residents in the estate. (Personal collection)

CONCLUSION

The bustling city centre of Hong Kong is by no means a desert to wildlife. Rather, this article has showcased hotspots in town where both humans and birds congregate and coincide, offering unique opportunities for city-dwelling birders to connect with weird and wonderful birds without having to venture into the wilderness. Hopefully my dear readers may discover for themselves some of the birds featured in this article next time they go for a jog or family outing in a local park, as they stroll by the seaside promenade, or even within their own residential complex as they get home from work!

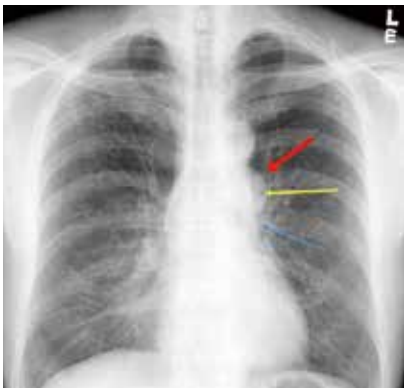
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1	★Zoom Brain Health and Dementia Prevention - Online ★Certificate Course on Common Diseases in Otorhinolaryngology, Head & Neck Surgery 2023 (Video Lectures) 2	3	★CME - Webinar: New Advance In Salivary Gland Surgery - Sialendoscopy 4
5	★Zoom Acute diarrhea Management in Pediatric Patients - Online 6	★In-person / Zoom HKMA-HKSH CME Programme 2022-2023 (Physical Lecture + Online) 7	★The Hong Kong Neurosurgical Society Monthly Academic Meeting - No-Reflow Phenomenon in Ischemic Stroke: Controversies and Potential for A New Therapeutic Target ★Zoom Approach to Ankle Sprain Injuries - Online 8	★Zoom Update on Diagnosis and Management of Tuberculosis - Online ★Certificate Course on Common Diseases in Otorhinolaryngology, Head & Neck Surgery 2023 (Video Lectures) 9	10	11
12	13	★Certificate Course on Complaint Management 2023 (Video Lectures) 14	15	★Zoom Updates on LDL-C Management: Applying New Guidelines to Clinical Practice - Online ★FMSHK Executive Committee Meeting ★FMSHK Council Meeting 16	17	18
19	20	★In-person / Zoom HKMA-GHK CME Programme 2023 (Physical Lecture + Online) - Herpes Zoster ★Certificate Course on Complaint Management 2023 (Video Lectures) 21	★Zoom Contemporary Physiotherapy Practice in Hong Kong - Online 22	23	24	25
26	27	★Zoom Doctor, I want to get pregnant - Online ★Certificate Course on Complaint Management 2023 (Video Lectures) 28				

Date / Time	Function	Enquiry / Remarks
2 THU 2:00 PM	**Zoom** **Brain Health and Dementia Prevention - Online** Organiser: HKMA-Kowloon East Community Network Speaker: Dr Charles Fei CHAN	Mr Peter HO 3108 2514 1 CME Point
7:00 PM	**Certificate Course on Common Diseases in Otorhinolaryngology, Head & Neck Surgery 2023 (Video Lectures)** Organiser: The Federation of Medical Societies of Hong Kong Speaker: Dr Eric TANG	Ms Vienna LAM Tel: 2527 8898
4 SAT 4:00 PM	**CME - Webinar: New Advance In Salivary Gland Surgery - Sialendoscopy** Organisers: Multidisciplinary Salivary Gland Society & Hong Kong Chinese Medical Association Ltd. Speakesr: Dr Robert IRVINE, Dr Siu-kwan NG, Dr Jean-Michel LOPEZ Moderator: Dr Zahoor AHMAD	
6 MON 2:00 PM	**Zoom** **Acute diarrhea Management in Pediatric Patients - Online** Organiser: The Hong Kong Medical Association Speaker: Dr TAM Yat-cheung	HKMA CME Dept. 3108 2507 1 CME Point
7 TUE 1:00 PM	**In-person / Zoom** **HKMA-HKSH CME Programme 2022-2023 (Physical Lecture + Online)** **Topic: Updates on Total Hip and Knee Replacement - Robotics and Design** Organiser: The Hong Kong Medical Association and the Hong Kong Sanatorium & Hospital Speaker: Dr KOU Sio-kei Venue: HKMA Dr. Li Shu Pui Professional Education Centre, 2/F, Chinese Club Building, 21-22 Connaught Road, Central, Hong Kong	HKMA CME Dept. 3108 2507 1 CME Point
8 WED 7:30 AM	**The Hong Kong Neurosurgical Society Monthly Academic Meeting - No-Reflow Phenomenon in Ischemic Stroke: Controversies and Potential for A New Therapeutic Target** Organiser: Hong Kong Neurosurgical Society Speaker: Dr Christopher Hiu-fung SUM Chairman: Dr James Tin-fong ZHUANG Venue: Conference Room, F2, Department of Neurosurgery, Queen Elizabeth Hospital; or via Zoom meeting	CME Accreditation College:1.5 points College of Surgeons of Hong Kong Dr Calvin MAK Tel: 2595 6456 Fax: 2965 4061
2:00 PM	**Zoom** **Approach to Ankle Sprain Injuries - Online** Organiser: HKMA-Shatin Community Network Speaker: Dr Cherry Wai-chung CHAN	Ms Candice Tong 3108 2513 1 CME Point
9 THU 2:00 PM	**Zoom** **Update on Diagnosis and Management of Tuberculosis - Online** Organiser: HKMA-Central, Western & Southern Community Network Speaker: Dr WONG Chi-fong	Ms Candice Tong 3108 2513 1 CME Point
7:00 PM	**Certificate Course on Common Diseases in Otorhinolaryngology, Head & Neck Surgery 2023 (Video Lectures)** Organiser: The Federation of Medical Societies of Hong Kong Speaker: Dr Fiona Chui-yan WONG	Ms Vienna LAM Tel: 2527 8898
14 TUE 7:00 PM	**Certificate Course on Complaint Management 2023 (Video Lectures)** Organiser: The Federation of Medical Societies of Hong Kong Speaker: Dr Ludwig TSOI	Ms Vienna LAM Tel: 2527 8898
16 THU 2:00 PM	**Zoom** **Updates on LDL-C Management: Applying New Guidelines to Clinical Practice - Online** Organiser: HKMA-Hong Kong East Community Network Speaker: Dr Duncan Hung-kwong HO	Ms Candice TONG 3108 2513 1 CME Point
7:00 PM	**FMSHK Executive Committee Meeting** Organiser: The Federation of Medical Societies of Hong Kong; Venue: Council Chamber, 4/F, Duke of Windor Social Service Building, 15 Hennessy Road, Wanchai, Hong Kong	Ms Nancy CHAN Tel: 2527 8898
8:00 PM	**FMSHK Council Meeting** Organiser: The Federation of Medical Societies of Hong Kong; Venue: Council Chamber, 4/F, Duke of Windor Social Service Building, 15 Hennessy Road, Wanchai, Hong Kong	Ms Nancy CHAN Tel: 2527 8898
21 TUE 2:00 PM	**In-person / Zoom** **HKMA-GHK CME Programme 2023 (Physical Lecture + Online) - Herpes Zoster** Organiser: The Hong Kong Medical Association and the Gleneagles Hong Kong Hospital Speaker: Dr HO King-yip Venue: HKMA Dr. Li Shu Pui Professional Education Centre, 2/F, Chinese Club Building, 21-22 Connaught Road, Central, Hong Kong	HKMA CME Dept 3108 2507 1 CME Point
7:00 PM	**Certificate Course on Complaint Management 2023 (Video Lectures)** Organiser: The Federation of Medical Societies of Hong Kong Speaker: Dr Robert LAW	Ms Vienna LAM Tel: 2527 8898
22 WED 2:00 PM	**Zoom** **Contemporary Physiotherapy Practice in Hong Kong - Online** Organiser: HKMA-New Territories West Community Network Speaker: Mr Samson KWONG	Mr Peter HO 3108 2514 1 CME Point
28 TUE 2:00 PM	**Zoom** **Doctor, I want to get pregnant - Online** Organiser: The Hong Kong Medical Association Speaker: Dr Sofie Shuk-fei YUNG	HKMA CME Dept. 3108 2507 1 CME Point
7:00 PM	**Certificate Course on Complaint Management 2023 (Video Lectures)** Organiser: The Federation of Medical Societies of Hong Kong Speaker: Dr Carl LEUNG	Ms Vienna LAM Tel: 2527 8898

Answers to Radiology Quiz

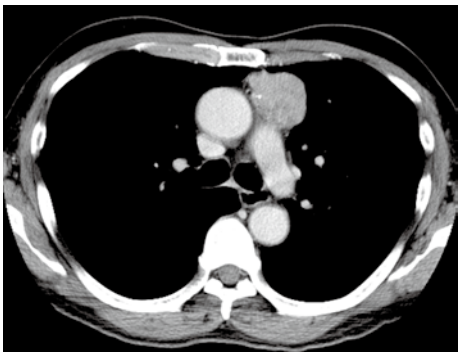
Answers:

1. An abnormal left peri-hilar opacity with a smooth lateral border - red arrow. Medial border is not discernable from the mediastinum. Silhouettes of the normal left pulmonary vessels (middle mediastinum; hilum overlay sign - yellow arrow) and the descending thoracic aorta (posterior mediastinum - blue arrow) are preserved.



2. The radiographic features are most compatible with an anterior mediastinal mass. Common differential diagnoses for this radiographic abnormality include thymic neoplasm, germ cell tumour, and lymphoma.

3. CT thorax with contrast. There is a well-defined left anterior mediastinal mass with internal calcification. Differential diagnosis includes germ cell tumour, lymphoma and thymic lesion. The presence of fat can be a feature of germ cell tumour. Extensive lymphadenopathy would be more in favour of underlying lymphoma. The purely cystic lesion may point towards a thymic cyst. Suspicious concomitant lung/pleural lesions would suggest malignancy. Definitive diagnosis may require a biopsy.



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1. Molnupiravir is authorized for use under an Emergency Use Authorization (EUA) for the treatment of mild-to-moderate coronavirus disease 2019 (COVID-19) in adults:
   - with positive results of direct SARS-CoV-2 viral testing, and
   - who are at high risk for progression to severe COVID-19, including hospitalization or death, and
   - for whom alternative COVID-19 treatment options approved or authorized by FDA are not accessible or clinically appropriate
2. Molnupiravir is not approved for any use, including the treatment of COVID-19, but is authorized for emergency use by the FDA under an Emergency Use Authorization (EUA).
3. The emergency use of molnupiravir is only authorized for the duration of the declaration that circumstances exist justifying the authorization of the emergency use of drugs and biological products during the COVID-19 pandemic under Section 564(b)(1) of the Federal Food, Drug, and Cosmetic Act, 21 U.S.C. § 360bbb-3(b)(1) unless the declaration is terminated or authorization revoked sooner.

Limitations of Authorized Use

4. Molnupiravir is not authorized:
   - for use in patients who are less than 18 years of age
   - for initiation of treatment in patients hospitalized due to COVID-19. Benefit of treatment with molnupiravir has not been observed in subjects when treatment was initiated after hospitalization due to COVID-19
   - for use for longer than 5 consecutive days
   - or pre-exposure or post-exposure prophylaxis for prevention of COVID-19
5. Molnupiravir may only be prescribed for an individual patient by physicians, advanced practice registered nurses, and physician assistants that are licensed or authorized under state law to prescribe drugs in the therapeutic class to which molnupiravir belongs (i.e., anti-infectives).

Contraindications

6. No contraindications have been identified based on the limited available data on the emergency use of molnupiravir authorized under this EUA.

Warnings and Precautions

7. There are limited clinical data available for molnupiravir. Serious and unexpected adverse events may occur that have not been previously reported with molnupiravir use.
8. Molnupiravir is not recommended for use during pregnancy. Based on findings from animal reproduction studies, molnupiravir may cause fetal harm when administered to pregnant individuals. There are no available human data on the use of molnupiravir in pregnant individuals to evaluate the risk of major birth defects, miscarriage or adverse maternal or fetal outcomes.
9. Molnupiravir is authorized to be prescribed to a pregnant individual only after the healthcare provider has determined that the benefits would outweigh the risks for that individual patient. If the decision is made to use molnupiravir during pregnancy, the prescribing healthcare provider must document that the known and potential benefits and the potential risks of using molnupiravir during pregnancy were communicated to the pregnant individual.
10. Advise individuals of childbearing potential of the potential risk to a fetus and to use an effective method of contraception correctly and consistently during treatment with molnupiravir and for 4 days after the final dose.
11. Prior to initiating treatment with molnupiravir, assess whether an individual of childbearing potential is pregnant or not, if clinically indicated.
12. Hypersensitivity reactions, including anaphylaxis, have been reported with molnupiravir. If signs and symptoms of a clinically significant hypersensitivity reaction or anaphylaxis occur, immediately discontinue molnupiravir and initiate appropriate medications and/or supportive care.
13. Molnupiravir is not authorized for use in patients less than 18 years of age because it may affect bone and cartilage growth. The safety and efficacy of molnupiravir have not been established in pediatric patients.

Adverse Reactions

14. The most common adverse reactions occurring in ≥1% of subjects in the molnupiravir treatment group in the Phase 3 double-blind MOVe-OUT study were diarrhea (2% versus placebo at 2%),nausea (1% versus placebo at 1%), and dizziness (1% versus placebo at 1%) all of which were Grade 1 (mild) or Grade 2 (moderate).
    Serious adverse events occurred in 7% of subjects receiving molnupiravir and 10% receiving placebo; most serious adverse events were COVID-19 related. Adverse events leading to death occurred in 2 (<1%) of the subjects receiving molnupiravir and 12 (2%) of subjects receiving placebo.

Drug Interactions

15. No drug interactions have been identified based on the limited available data on the emergency use of molnupiravir. No clinical drug-drug interaction trials of molnupiravir with concomitant medications, including other treatments for mild to moderate COVID-19, have been conducted.

Breastfeeding

16. There are no data on the presence of molnupiravir or its metabolites in human milk. It is unknown whether molnupiravir has an effect on the breastfed infant or effects on milk production. Based on the potential for adverse reactions in the infant from molnupiravir, breastfeeding is not recommended during treatment with molnupiravir and for 4 days after the final dose. A lactating individual may consider interrupting breastfeeding and may consider pumping and discarding breast milk during treatment and for 4 days after the last dose of molnupiravir.

Males of Reproductive Potential

17. Nonclinical studies to fully assess the potential for molnupiravir to affect offspring of treated males have not been completed. Advise sexually active individuals with partners of childbearing potential to use a reliable method of contraception correctly and consistently during treatment and for at least 3 months after the last dose of molnupiravir. The risk beyond three months after the last dose of molnupiravir is unknown.

Before prescribing, please consult the full prescribing information.

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CI=confidence interval; CR=complete response; FDA=Food and Drug Administration; HER2=human epidermal growth factor receptor 2; ICR=independent central review; ITT=intent-to-treat; IV=intravenously; mBC=metastatic breast cancer; mPFS=median progression-free survival; NE=not evaluable; ORR=objective response rate; PR=partial response; Q3W=every 3 weeks; RECIST=Response Evaluation Criteria in Solid Tumors.

References: 1. ENHERTU Hong Kong Prescribing Information. (August 2021 version); **2.** Modi S, et al. Cancer Res 2021;81(4 Suppl). Abstract no. PD3-06; **3.** Modi S, et al. N Engl J Med. 2020;382(7):610-62; **4.** The U.S Food and Drug Administration. FDA approves fam-trastuzumab deruxtecan-nxki for unresectable or metastatic HER2-positive breast cancer. Available at: https://www.fda.gov/drugs/resources-information-approved-drugs/fda-approves-fam-trastuzumab-deruxtecan-nxki-unresectable-or-metastatic-her2-positive-breast-cancer.Accessed on January 28, 2022.

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