Using contemporary imaging techniques to improve quality of care for patients with coronary artery disease

Coronary artery disease (CAD) has been the third leading cause of death in Hong Kong since 1960s. One of the common treatment options for this condition includes percutaneous coronary intervention (PCI). Approximately 10–20% of Hong Kong patients with CAD who undergo PCI require re-stenting, which often happens in patients who experienced inadequate stent deployment. Apart from enhancing patient education to achieve a better control of risk factors, using an appropriate imaging technique during PCI also contributes to optimizing treatment strategy and improving clinical outcomes.

In this issue of Heart Talk, Dr Lam Yat Yin, Specialist in Cardiology, elaborates on the treatment options available for patients with CAD; he highlights the benefits of PCI and the advantages of using contemporary imaging techniques, such as optical coherence tomography (OCT)-guided PCI.

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Q: What is CAD?
A: CAD refers to the build-up of plaque in the lumen of coronary arteries. These arteries are responsible for supplying sufficient blood and oxygen for the heart muscles to function properly. Plaque is made up of fat, cholesterol, calcium and other substances. Building up of plaques on the artery walls would eventually cause narrowing and hardening of arteries, limiting the nutrients that the heart muscles require. Risk factors of CAD include high blood pressure, high sugar, high cholesterol and smoking. Individuals with CAD may experience chest pain when they participate in activities that require efficient blood and oxygen supply to the heart muscles, for example, exercising.

Q: What are the treatment options available for patients with CAD?
A: Treatment often begins with medications that aim to address the risk factors for CAD. Medications to slow down the heart rate and dilate the coronary arteries also help to relieve symptoms. However, treatment approaches in addition to medications, such as angioplasty and stenting, are recommended for individuals who have artery narrowing of more than 70%. PCI is a minimally-invasive procedure performed using a balloon catheter that is passed into a narrowed vessel – visualized using a contrast agent – where the balloon is inflated to the required width. Expanding the artery and surrounding muscular wall can restore adequate arterial blood flow. A stent is often inserted after ballooning to
help keep the artery open. In more severe cases, a more invasive option, the coronary artery bypass surgery may be a better option than angioplasty, which the blocked artery is bypassed using a blood vessel from another part of the body.

Q: What types of stents are available for PCI?

A: In general, there are three types of stents available, including bare metal stents, which are mesh-like metallic tubes used for supporting the expansion of arteries by forcefully pushing the plaques against the arterial wall. However, 20–30% of patients experience restenosis due to the re-accumulation of plaques inside the bare metal stents, these patients may require re-stenting to help keep the artery open again. Other options include drug-eluting stents, which slowly release drugs to inhibit the re-growth of plaques and reduce the chance of re-narrowing of arteries. Bioresorbable stents are a more recent advance; these are biodegradable stents that can be dissolved inside the arteries over 2–3 years, leaving no implant behind, and can minimise the chance of long term complications.

Q: What are the imaging techniques available for PCI?

A: Conventional coronary angiogram is a standard procedure that uses X-ray and contrast agent to visualize arteries. However, this technique is insufficient for reaching an objective diagnosis and choosing a suitable stent for patients. Limitations of angiography include difficulties in presenting a three-dimensional projection for asymmetric obstructive lesions, as well as assessing plaque compositions. This prompted the development of other imaging techniques, such as intravascular ultrasound (IVUS) and OCT, to help physicians make better clinical judgements.

Q: What are the benefits of choosing OCT-guided PCI?

A: Compared with IVUS, which uses ultrasound, OCT relies on near-infrared light, which produces high-resolution imaging of the structure of the arteries. Accurate three-dimensional measurements allow optimization of intervention strategies and help physicians to choose a stent of optimal size and length. Furthermore, this imaging technique also facilitates detailed plaque morphology assessment, such as, to determine whether the plaque is fibrous-, lipid- or calcium-rich (Figure 1). Additionally, it avoids incomplete stent apposition, defined as the absence of contact between stent struts and vessel walls (Figure 2). This valuable information can be used as a predictor for acute blood clot formation within the stent which can lead to sudden death. Once detected, incomplete stent apposition can be treated with ease during PCI by adequate balloon inflation within the implanted stent.

OCT-guided PCI is also helpful for precise stent deployment and determining the device landing zone, especially in complex lesions (Figure 3). In terms of post-procedural assessments, OCT adds value in detecting complications, by helping physicians identify edge dissections, which are defined as the disruption caused by implanted stents to the artery lumen. This in turn helps to minimise the chance of acute occlusion of the artery at the edge of the stents.
Q: Do these advantages translate into improvements in patients’ clinical outcome?

A: Although there is currently a paucity of data from large clinical trials, studies have demonstrated that OCT-guided PCI resulted in a lower incidence of post-operative complications. The prospective pilot study, OPTICO-Integration, investigated the benefits of real-time OCT co-registration with angiography (ACR) in the pre- and post-procedural settings. Results showed that pre-procedural OCT changed physician decision-making in 71.4% of cases compared with angiographic-guided PCI decision-making. Additionally, post-procedural OCT imaging revealed the need for PCI optimisation in 52.2% of lesions. Data suggested that, as it gains popularity, this imaging technique will help guide younger physicians in reaching an objective clinical judgement, standardising treatment strategy and detecting complications for patients with CAD who require PCI.

Q: What is the best follow-up strategy for patients undergoing PCI?

A: The most challenging aspect in treating patients with CAD is the misconceptions that most patients have; PCI should not be regarded as a cure for the disease but a solution to tackle a focal obstructive lesion. Post-procedural care is as equally important and should be promoted, which includes risk factor management and adherence to prescribed medication regimens. Therefore, patient education is essential for those with CAD to prevent thrombus formation within the stent and the development of new complications in other segments of the artery.

The ongoing large, multicentre, randomized ILUMIEN IV trial aims to recruit more than 2,500 patients who are at high risk of acute coronary syndrome and address whether OCT-guided PCI improves clinical outcomes compared with angiographic guidance alone; results are expected in the near future.²

Summary points

- Choosing an appropriate imaging technique for patients who require PCI is essential
- OCT-guided PCI is an imaging technique that provides precise three-dimensional measurements and plaque morphology assessment
- Using OCT can help physicians optimize treatment strategy pre-PCI and reduce the chance of complications post-PCI
- Enhanced patient education on post-PCI care, such as risk factor management and medication adherence, is critical for long-term management of patients with CAD
References:

Figures

**Figure 1:**
OCT scans of an artery with a (A) fibrous-rich plaque, (B) lipid-rich plaque and (C) calcium-rich plaque

**Figure 2:**
Three-dimensional OCT imaging in PCI, guiding the positioning of the wire to one of the side branch of the stented artery

**Figure 3:**
Stent roadmap with (A) co-registered angiography frames. OCT-imaging allows accurate lumen profile measurement representing the locations of the appropriate (B) distal and (C) proximal landing site for coronary stenting as markers within the co-registered angiography frames
問：甚麼是冠狀動脈疾病？

答：冠狀動脈疾病是指冠狀動脈內积聚斑塊所引起的心血管疾病。冠狀動脈負貴為心臟肌肉提供足夠的血液和氧分來維持正常運作，而積聚的斑塊是由脂肪、膽固醇、鈣質和其他物質所組成。在動脈壁內積聚斑塊最終會令動脈收窄和硬化，以致供應至心臟肌肉的養分減少。冠狀動脈疾病的風險因素包括高血壓、高血糖、高膽固醇和吸煙。當患者進行需要足夠血液和氧分輸送至心臟肌肉的運動或活動時，便會出現胸痛的情況。

問：有哪些治療方案可供冠狀動脈疾病患者選擇？

答：治療大多以針對冠狀動脈疾病風險因素的藥物為主，這包括減慢心跳率和擴展冠狀動脈以紓緩症狀的藥物。然而，對於動脈收窄超過七成的患者，除了服用藥物外，醫生還會建議使用「通波仔」和植入支架等治療方法。冠狀動脈介入手術（PCI）是一種微創手術，透過注入顯影劑來清楚看見動脈內腔的情況，然後把設有用球囊的導管置入收窄的血管內，並把球囊擴張至合適的闊度。由於擴張動脈和周邊肌肉壁有助恢復動脈的血流，因此在球囊擴張後，醫生通常會為病人置入支架以保持動脈暢通。在一些較嚴重的個案，冠狀動脈搭橋

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自60年代起，冠狀動脈疾病已成為香港的第三號殺手疾病，而其中一種常見的治療方案為冠狀動脈介入手術（PCI）。全港約有10%至20%接受PCI的冠狀動脈疾病患者需要再次植入支架，而此情況經常發生於支架擴張不全的患者身上。除了加強患者在控制風險因素方面的教育外，在PCI過程中使用適當的影像技術亦有助強化治療策略和改善臨床效果。

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手術或許較「通波仔」具有更好的療效。冠狀動脈搭橋手術屬人侵性治療，利用身體另一部位的血管繞過栓塞的動脈來維持血流。

問：在進行PCI時可使用哪些支架類型？

答：一般來說共有三種支架可供選擇，包括裸金屬支架，是一種網狀金屬管，可將斑塊擠壓至動脈壁來支撐已擴張的動脈。然而，約20％至30％的患者因裸金屬支架內聚集著斑塊而出現再次栓塞的情況；這些患者可能需要再植入支架來重新保持動脈擴張。其他方案還包括藥物塗層金屬支架，這種支架會慢慢釋出藥物來抑制斑塊再度生長，並減低動脈再次收窄的機會。全吸收式生物可吸收模架屬較為嶄新的技術，這種模架可在植入動脈後的2至3年內慢慢溶解，因而不會殘留在血管內，長遠來說有助減低出現併發症的機會。

問：哪些影像技術可供進行PCI時使用？

答：在進行PCI時，一般會使用傳統的冠狀動脈造影術，利用X光和顯影劑來清楚檢查動脈內腔的情況。然而這種技術卻不足以為患者作客觀的診斷和選擇合適的支架。此外，動脈造影術的局限性還包括難以對稱的阻塞性病變塑造3D影像，以及難以評估斑塊的成分。這促使血管內超聲波(IVUS)和光學相干斷層掃描(OCT)等其他影像技術的發展，以助醫生作出更準確的臨床決定。

問：使用OCT引導的PCI有甚麼好處？

答：與使用超聲波的IVUS相比，OCT使用近紅外線光塑造動脈結構的高清影像。精準的3D度數除可大大提升介入技術的效果，也有助醫生為病人選擇合適的支架大小和長度。此外，這種影像技術亦有助於斑塊作出詳細的評估，如確定斑塊屬纖維性、脂肪性或鈣性（見圖一）。這也可防止出現支架貼壁不良的情況。即支架螺桿與血管壁未能接合（見圖二）。這些有用的資訊有助預知出現可引致突然死亡的急性支架血栓。一旦發現此情況，醫生可在進行PCI期間，透過在植入的支架內擴張球囊來處理支架貼壁不良的情況。

問：這些好處能否改善患者的臨床效果？

答：雖然現時缺乏大型臨床實驗的數據，但多項研究卻能證實OCT引導的PCI可減低術後出現併發症的情況。
在一項稱為OPTICO-integration的前瞻性研究中，研究了在術前和術後使用實時OCT與血管造影術共同對位的好處。研究結果顯示，相比血管造影術引導PCI所作的醫療決定而言，術前OCT能在71.4%的個案中改變醫生的決定。此外，術後OCT影像技術有助發現52.2%的病變需要提升PCI。數據顯示，隨著此影像技術愈趨流行，的確有助年青醫生作出客觀的臨床判斷，為治療技術標準化，以及為需要進行PCI的冠狀動脈疾病患者檢測併發症。

問：對於接受PCI的患者，甚麼是最理想的跟進策略？
答：治療冠狀動脈疾病患者的最大挑戰，莫過於在大部分患者對治療的誤解：PCI不應當作治療疾病的方法，而應當是解決急性栓塞病變的方案。術後護理同樣重要，也應加以強調，這包括風險因素管理，以及遵從處方的藥物療程。因此，對於冠狀動脈疾病患者來說，病人教育是預防支架血栓形成，以及動脈其他部位出現新併發症的關鍵。

總結要點

• 為需要進行PCI的患者選擇合適的影像技術十分重要
• OCT引導的PCI是一種影像技術，可提供精確3D測量和斑塊形態評估
• 使用OCT有助醫生提升PCI的術前治療策略，並減低PCI術後出現併發症的機會
• 加強患者對於PCI術後護理的教育，例如風險因素管理和遵從藥物治療，這對於冠狀動脈疾病的長遠治療尤為重要
參考資料:

圖表

圖一：
(A) 纖維斑塊、(B) 脂肪斑塊及 (C) 鈣斑塊的 OCT動脈掃描

圖二：
PCI 中的 OCT 3D 影像，引導導線進入已植入支架動脈的另一旁支

圖三：
(A) 血管造影框架共同對位的支架路線圖。OCT 影像可帶來準確的血管內腔測量，確定合適的 (B) 遠端和 (C) 近端置入部位，以進行冠狀動脈支架植入，並作為血管造影框架共同對位的標記