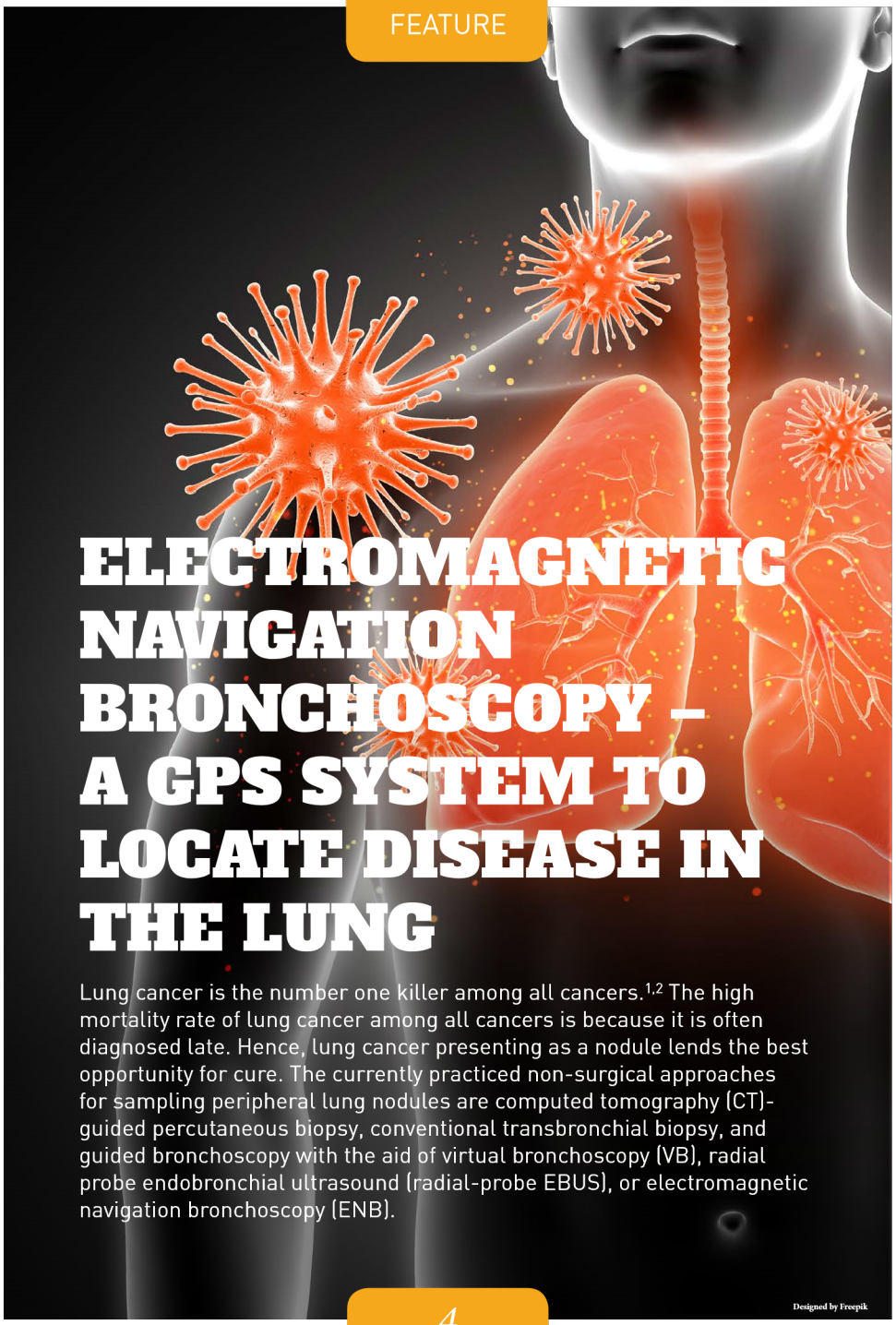

ELECTROMAGNETIC NAVIGATION BRONCHOSCOPY – A GPS SYSTEM TO LOCATE DISEASE IN THE LUNG

Lung cancer is the number one killer among all cancers.[1,2] The high mortality rate of lung cancer among all cancers is because it is often diagnosed late. Hence, lung cancer presenting as a nodule lends the best opportunity for cure. The currently practiced non-surgical approaches for sampling peripheral lung nodules are computed tomography (CT)-guided percutaneous biopsy, conventional transbronchial biopsy, and guided bronchoscopy with the aid of virtual bronchoscopy (VB), radial probe endobronchial ultrasound (radial-probe EBUS), or electromagnetic navigation bronchoscopy (ENB).

The diagnostic yield of CT-guided biopsy is as high as 90% (range, 76–90%).[3] The pooled sensitivity, specificity, diagnostic odds ratio, positive likelihood ratio, and negative likelihood ratio in a meta-analysis of 21 studies are reported as 0.95, 0.99, 54.72, 0.06, and 821.90 respectively.[4] The pneumothorax rate and bleeding rate ranges from 14.8–50%, and 4.1–18%, respectively.[5-7]

The diagnostic yield (sensitivity) of conventional transbronchial biopsy for peripheral lesions is 53%. When stratified by size, the sensitivity of this diagnostic procedure for nodules smaller than 2 cm is 34% and larger than 2 cm is 63%.[8] Based on distance from the hilum by lesion size, lesions ≤2 cm have a diagnostic yield of 14% when located in the peripheral third versus 31% when located in the inner two-thirds of the lung.[9]

The pooled diagnostic yield of guided bronchoscopy (virtual bronchoscopy, radial-probe EBUS, and ENB) in a meta-analysis of 39 studies is reported as 70%, much higher than yields reported using conventional bronchoscopy.[3] When stratified based on the individual technique, the diagnostic yields for VB and radial-probe EBUS are 72.0% and 71.1% respectively.[3]

ENB-guided biopsies have been shown to have a higher diagnostic yield in the evaluation of peripheral lung nodules than flexible bronchoscopy alone, with diagnostic yields ranging from 62–85% compared with 36–86%, respectively.[8,9] Recently the American College of Chest Physicians (ACCP) guidelines concerning the diagnosis and management of lung cancer recommended ENB for the evaluation of peripheral lung lesions that cannot be reached by conventional bronchoscopy.[10]

What is ENB? As an analogy, when we arrive in an unfamiliar foreign country, we could rent a car and drive to the hotel. But what do we do if there is no one to offer directions, and we have no city map or GPS? The drive to the hotel will be challenging. Respiratory physicians face the same problem every day when they perform bronchoscopic biopsies to diagnose lung diseases. It is even more challenging when the diseased area is smaller than 2 cm or located in the periphery of the lungs.

The airways are the roads to the diseased area. But like the roads, different bronchioles lead to different areas of the lungs. Following a certain path at the outset does not guarantee that it will lead to the area of interest. Correspondingly, the diagnostic accuracy of bronchoscopy for peripheral lesions has traditionally been no better than 30–50%. Due to this, many respiratory physicians choose the alternative methods of CT-guided biopsy or surgery. The physicians and patients who agree on bronchoscopy to evaluate such lesions have to be prepared for an inconclusive result and a repeat procedure.

Although CT-guided biopsy has high detection rates, it carries high risk (25–50%) of complications such as pneumothorax. This increases the hospital resource utilisation by adding to the cost of diagnosis. Surgery, on the other hand, is invasive.

Recently, a technological advance in miniaturisation has adapted the GPS technology of terrestrial navigation to help physicians find their way to abnormal areas in the lungs. This is called Electromagnetic Navigation Bronchoscopy. It uses virtual reality and a GPS-guided system to locate and obtain suspected diseased cells in the lungs. In the procedure, a 3D 'road map' is created in which the physician has a choice of a number of bronchioles to approach the target site with the suspected diseased or cancerous cells. The onscreen map guides the procedure, showing the proximity of the instrument – in centimetres – to the site. Once the target is reached, tissue samples can be obtained using biopsy forceps or a triple needle brush. The map makes the bronchoscopy safer and more precise. If the area is shown to be cancerous, a dye can be injected to mark the site, making it easy for the surgeon to remove the cancer subsequently.

This technology has improved the reach and accuracy of bronchoscopy over the conventional approach, favourably impacting patient care. This procedure has been performed on 35 patients with no complications in Tan Tock Seng Hospital so far. For ENB, the pooled sensitivity, specificity, positive likelihood ratio, negative likelihood ratio, and diagnostic odds ratio in a meta-analysis of 17 studies have been reported as 82%, 100%, 18.75, 0.22 and 97.36%, respectively.[11] ENB has been used in the US and Europe for more than 10 years. Elsewhere in Asia, it is also available in Hong Kong and Malaysia.

There are several factors that affect the success of ENB-guided biopsy. This success correlates positively with the size of the lesion, the use of needle for collecting the specimen, availability of rapid onsite evaluation (ROSE) of the specimen to ascertain tissue quality and adequacy, radial-probe EBUS to locate the lesion, and thinner CT slice for constructing virtual pathways to the lesion.

Some investigators have reported diagnostic yield of 89% for nodules >3 cm compared to 61% for nodules <2 cm (p=0.03) with ENB.[12] Despite making sense intuitively, several other studies have paradoxically reported lack of association between the yield and the size of the lesion.[13-16]

The use of needle for obtaining tissue has been reported to give better yield than with forceps as the former penetrates the tissue deeply whereas the latter may only sample the surface of the nodule.[17] Correspondingly, some investigators reported the yield with ENB of 70% with needle technique.[18] However, in Singapore we only use forceps or brush biopsy, followed by bronchoalveolar lavage. The practice of using the needle for bronchoscopic biopsy of parenchymal lesions is underutilised globally. This is because the small nodules are not visible on fluoroscopy, making real time visualisation of the lesion and needle position difficult thereby increasing the risk of pneumothorax.

The use of ROSE with ENB has been consistently shown by several investigators to improve the yield. Twenty-five of 36 patients were diagnosed with malignancy by ENB, yielding a sensitivity for malignancy of 69.4% when ROSE was used in one study.[19] Another study reported improved yields when ENB was combined with ROSE.[18] This could be one reason for the lower yield in our hands as we did not use ROSE for the bronchoscopic biopsy.

In a randomised controlled trial of 118 patients, the investigators reported an improvement in overall yield and yield for malignancy, from 59% to 88% and 55% to 90% respectively, by addition of radial-probe EBUS to ENB.[20]

The success of ENB is inversely related to the thickness of the slice of the CT scan used for constructing virtual pathways to the lesion. Planning and pathway construction using 1-mm slices is associated with better yield. Investigators in the past have reported better yield with slices of 1 mm thickness compared to those of 3 or 5 mm.[21]

Despite the above factors associated with the success of ENB-guided biopsy, we have experienced encouraging yields for diagnosing lung cancer with ENB alone under fluoroscopy, without thin CT slice, needle technique, ROSE, or radial-probe EBUS, compared to conventional bronchoscopy. The addition of the above techniques will improve the diagnostic yield of ENB with reduced risk of complications.

Tan Tock Seng Hospital is the first and, up to now, the only hospital to offer this service Singapore.

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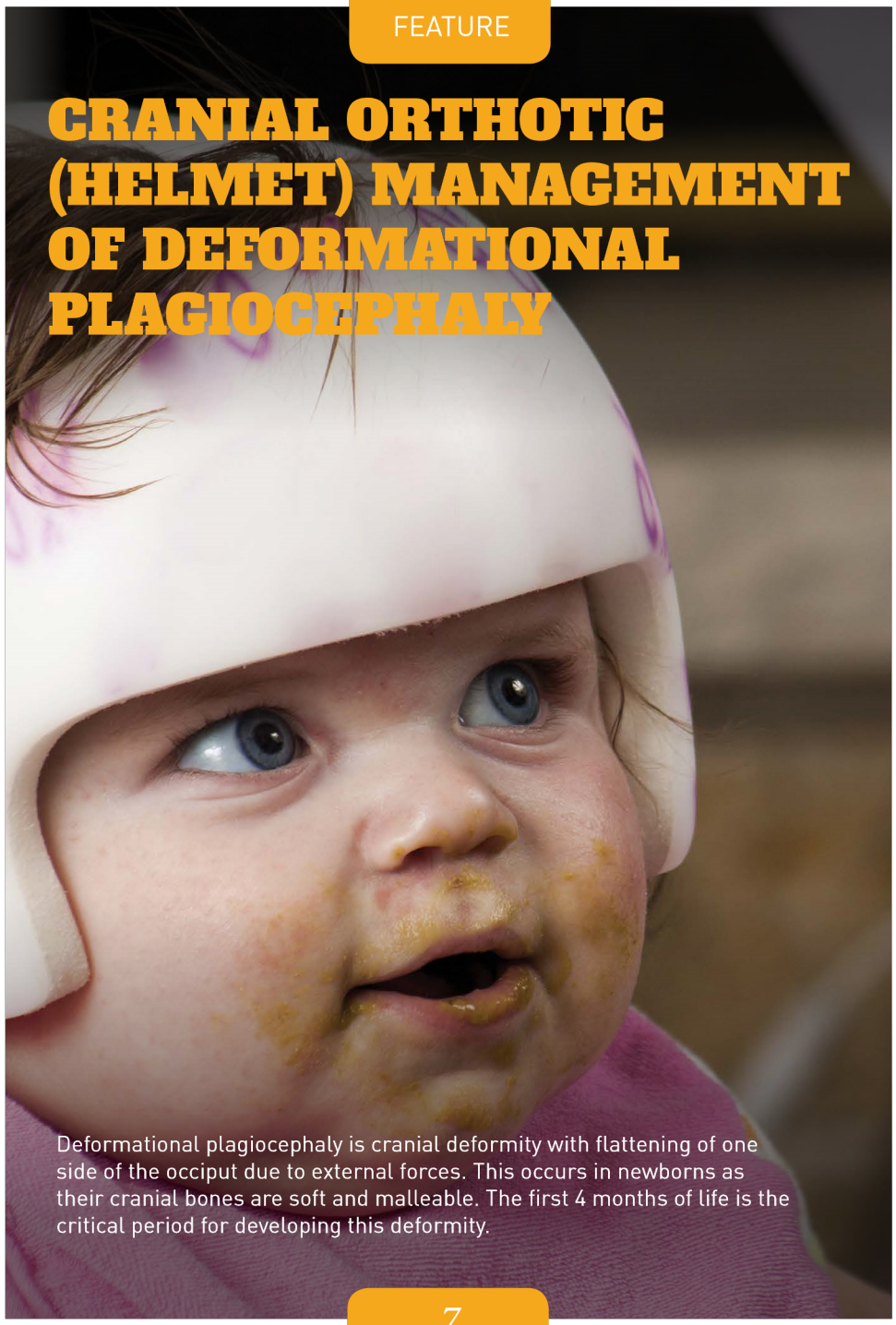
CRANIAL ORTHOTIC (HELMET) MANAGEMENT OF DEFORMATIONAL PLAGIOCEPHALY



Deformational plagiocephaly is cranial deformity with flattening of one side of the occiput due to external forces. This occurs in newborns as their cranial bones are soft and malleable. The first 4 months of life is the critical period for developing this deformity.