Appendix 1 How we do it: practical step-by-step considerations for new CBCT-AF users

Figure 3 represents the entire workflow of a patient undergoing a CBCT guided navigation bronchoscopy (CBCT-NB).

Step 1: preprocedural planning: *Figure 3A-3D* show a peripheral pulmonary nodule in the right upper lobe on a preprocedural CT and PET-CT scan. The first (preprocedural) step is to determine and memorize the optimal path through the airways towards the nodule based on the preprocedural CT, preferably on the axial slices. If no bronchus sign is present, it is advisable to try to determine your exit point for a trans-parenchymal approach as well. The eventual navigation path might differ from the preprocedural mental plan made, but a memorized preprocedural plan significantly helps navigating on 2D imaging (augmented fluoroscopy) in 3D lungs and decreases navigation time needed.

Step 2: General inspection: After the patient is sedated, the first step is a general inspection bronchoscopy with a normal flexible bronchoscope. Any endobronchial abnormalities can be sampled.

Step 3: Course navigation: After general inspection, the pre-angulated extended working channel (EWC) is inserted through the bronchoscope. The bronchoscope is wedged in the subsegment of the target nodule (predetermined on preprocedural CT) and the extended working channel is guided through as can be seen on *Figure 3E,3F*. Based on your predetermined memorized path initial course navigation in the direction of the nodule can be performed.

Step 4: CBCT spin and segmentation: After the EWC is inserted, the first CBCT spin is performed (*Figure 3G*) on (inspiratory) breath-hold. The target nodule and pathway are segmented on your workstation, where optimal viewing angles for fluoroscopy can be determined. When the extended working channel is in close proximity to the target nodule, mark the distal tip of the EWC. This mark helps correlate the projected image from the 3D CBCT with the real-life position on 2D fluoroscopy (*Figure 3H*) as there will be a discrepancy between a breath-hold scan, and fluoroscopy of the breathing patient. The mark can be correlated with the visible distal tip of the catheter and helps place the segmented nodule in perspective with the live imaging.

Step 5: When the catheter is at the target nodule, position confirmation is important for optimal sampling. rEBUS can provide confirmation; *Figure 3I* shows central positioning of the rEBUS probe in the lesion. In absence of rEBUS confirmation or when in doubt of positioning, an additional CBCT scan can help confirm the position and assist in repositioning if the extended working channel or sampling instrument need readjusting. *Figure 3L* shows a needle in the target lesion, confirming that the sample taken is from the lesion. The CBCT scan furthermore gives information on the optimal fluoroscopy angles for a progression and angulation view for optimal sampling.

Step 6: Tissue acquisition: After position confirmation sufficient samples need to be taken (*Figure 3J-3M*). Even when there is a clear rEBUS image, it is advisable to obtain multiple samples with both transbronchial needle and forceps biopsy device. Aim to sample in multiple sections of the nodule. When there is doubt of optimal positioning (both on rEBUS and CBCT) obtain multiple samples not only of the segmented lesion but also of the direct vicinity of the lesion to increase the chance of a diagnostic sample. Rapid OnSite Evaluation (ROSE) can help to determine if the target lesion is sampled successfully, especially when positioning of the sampling instrument has been confirmed with CBCT.

General considerations

Ventilation: An optimized ventilation protocol and collaboration with the anesthesia are important. CBCT scanning is performed under breath-hold and should only be performed 5–7 seconds after initiating breath-hold due to initial lung movement. See Bhadra *et al.* (2022) for a ventilation protocol that can help optimize the navigation bronchoscopy procedure. Especially obesity and lesions in the posterior lung fields might be troubled by atelectasis (42,46,47).

Learning curve: CBCT-NB is a navigation technique with a long learning curve. An additional navigation modality such as

 https://dx.doi.org/10.21037/atm-22-2845

EMN can help fasten this process.

Radiation: Monitor procedural radiation dose closely, collimate as much as possible and communicate with your radiology technician on when to radiate.

Interfering objects: Take care to place objects such as the metal components of a blood pressure cuff as far from the radiation field as possible. Even if not visible on the reconstructed slices of your 3D scan; CBCT scanning is based on a cone beam and as such they can negatively influence the image quality.

https://dx.doi.org/10.21037/atm-22-2845