



Image-Guided Percutaneous Cryoablation of Lung Cancer Using a C-Arm: A Case Report

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Abstract

Computed tomography (CT)-guided percutaneous cryoablation can be used as an alternative for patients with primary or metastatic lung cancer who are unable to undergo surgery [1]. Studies have reported that CT-guided percutaneous cryoablation has low surgery-related mortality (1%) [2] and can be performed with ideal visualization via CT or magnetic resonance imaging (MRI). However, this procedure has a high level of technical difficulty and a high complication rate (70.5%) [1]. Studies have reported that C-arm image-guided video-assisted thoracoscopic surgery can be employed to locate pulmonary nodules with a high level of accuracy and patient satisfaction, and a low complication rate. This study presents the case of a female patient with a 1.9-cm residual nodule in the right lower lobe of the lung who received underwent C-arm-based image-guided percutaneous cryoablation in our institution's hybrid operation room (HOR).

Keywords: Percutaneous cryoablation; Lung cancer; Image-guided; Hybrid operation room; ARTIS Pheno

Case Report

The patient was 69 years old and had received a right thyroidectomy and hysterectomy. In 2019, she was given a diagnosis of adenocarcinoma in the right lung, stage IVA (T4N1M1a), and received targeted therapy with Afatinib. Her chest CT results obtained in chest outpatient department tracking in 2021 revealed a 1.9-cm residual nodule in her right lower lobe (Figure 1a). Which was verified to be adenocarcinoma through chest CT-guided biopsy. A clinical assessment revealed the patient to be unsuitable for surgery because of her physical status, and after a discussion with the patient, she was administered cryoablation.

Percutaneous Cryoablation Procedure

There is only one case in the study, so my institution IRB gave up the review. The patient underwent image-guided percutaneous cryoablation with helium-based and argon-based refrigerants in

an HOR with CBCT (ARTIS Pheno system; Siemens Healthcare GmbH, Forchheim, Germany). A double lumen tube was applied to administer general anesthesia, and the patient was fixed in a prone position. A ventilator was used to condition both lungs to end-inspiratory breath holding before the CBCT scans and cryoprobe puncture. A first CBCT scan was performed to obtain a CT image, which was required to plan the puncture path of the syngo Needle Guidance (Siemens Healthcare, VE10; (Figure 1b). The number of puncture paths was determined by whether the edges of the frozen puck (-20°C , 30 mm \times 48 mm per puck) covered the entire nodule. Under the guidance of a laser pointer, a No. 11 scalpel was used to create a wound on the skin (Figure 2a); a cryoprobe (IceRod PLUS 90° Cryoablation Needle; Galil technology, Galil Medical, Israel) was inserted to the target depth (Figure 2b). These steps were repeated until all puncture paths were completed (Figure 2c). A second CBCT scan was then completed to verify the accuracy of the punctures (Figure 1c). Each cryoablation was conducted at -20°C . **Cycle 1:** freeze 3

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min, thaw 3 min. **Cycle 2:** freeze 7 min, thaw 7 min. **Cycle 3:** freeze 10 min, thaw 10 min. A total of three cycles, takes 40 minutes. The cryoprobes were removed after the cryoablation was complete. A third CBCT scan was performed to verify the treatment effectiveness and identify potential complications (Figure 1d). After the cryoablation, the patient was transferred to a ward for observation.

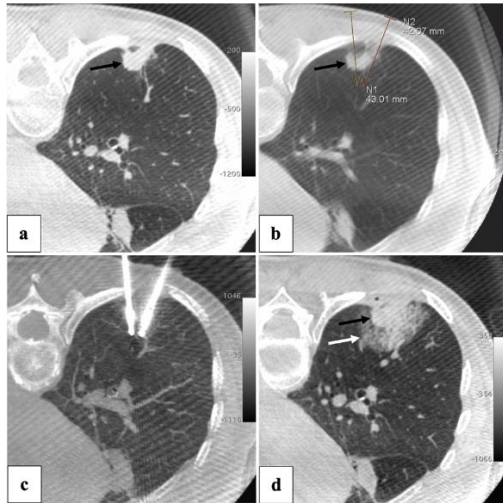


Figure 1: (a) Chest CT revealed one 1.9-cm residual nodule in the right lower lobe of the 69-year-old female patient. The nodule was identified as adenocarcinoma through CT-guided biopsy.

- (b) Puncture paths must be planned in advance to prevent damage to vital blood vessels and organs. The number of puncture paths is determined based on the edge of the frozen puck.
- (c) Instant CT imaging was used to verify whether the cryoprobes had been placed with the target accuracy.
- (d) After the cryoablation, the frozen puck coverage and potential complications were monitored.

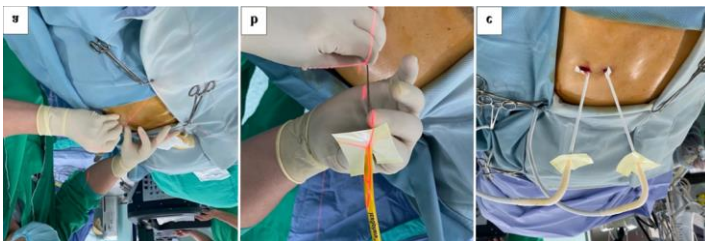


Figure 2: (a) Cryoprobes have large diameters and blunt tips. Wounds must be opened for cryoprobes to enter the skin.

- (b) Under the guidance of a laser pointer, a cryoprobe was inserted to the target depth in the lung.
- (c) Multiple cryoprobes were applied to increase the coverage of the frozen pucks and ensure the effectiveness of the treatment.

Follow up

The patient was discharged and was in a stable clinical condition before she returned to the outpatient department three months later. A chest CT revealed that the solid nodule had enlarged to

2.4 cm (Figure 3a). A chest CT-guided biopsy (Figure 3b,c) revealed the pathological condition to be fibrosis.

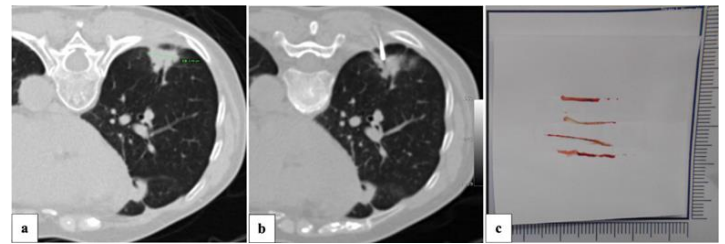


Figure 3: (a) A chest CT scan performed 3 months after the surgery revealed that the solid nodule had enlarged from 1.9 to 2.4 cm. (b, c) The chest CT-guided biopsy results revealed the pathological condition to be fibrosis.

Discussion

Conventional CT-guided percutaneous cryoablation requires patients to hold their breath at the end of an inspiratory cycle when they receive CT scans and cryoprobe punctures [1]. This can lead the total lung volume during each breath hold to be inconsistent. Even when local anesthesia has been administered, patients may cause cryoprobe displacement because they feel fear of or pain from the punctures [2]. Consequently, radiologists are required to confirm and adjust the directions of punctures through repeat CT scans until they achieve adequate puncture accuracy. Patients with nodules of larger size require numerous cryoprobes to ensure the nodules are fully covered with frozen pucks. However, each cryoprobe can be as large as 1.5 mm (17 G) in diameter. The increased number of cryoprobes prolongs the puncture time and repeat adjustment of the puncture direction increases the risk of complications [3]. In theory, using image-guided percutaneous cryoablation can rule out the negative consequences of CT-Guided percutaneous cryoablation. Under the control of general anesthesia and ventilator, it can reduce the positioning error caused by the difference between patient displacement and total breathing volume. Thoracic surgeons can plan the puncture path in advance to avoid important vessels or risk organs. The puncture of the cryoprobe is performed in an intuitive manner under the guidance of the laser pointer. These are well demonstrated in our treatment results this time. However, we need more research data to demonstrate the feasibility of this technology [4]. This treatment method has several limitations. First, the treatment used in this case cannot be repeated by medical institutions unless they have the required equipment [5]. Second, a small nodule that can be fully covered with only frozen puck can be treated with ARTIS zeego with equal effectiveness. ARTIS zeego may be less effective when applied to a nodule that requires or more frozen pucks for full coverage [6]. This is because ARTIS zeego does not enable users to simultaneously plan multiple puncture paths; one path must be completed before

another can be planned. ARTIS Pheno, which is a newer model, does not have this restriction; it enables thoracic surgeons to complete multiple puncture paths within the breath-holding period at the end of one inspiratory cycle, which lowers the risk of complications [7].

Conflicts of Interest

Jui-Pin Chao, BS, Ying-Chieh Su, MD, PhD Student, Chao-Kun Chen, MD, Yao Fong, MD have no conflict of interest or financial ties to disclose.

Author Contribution Statement

Jui-Pin Chao, BS: Conceptualization; Investigation; Methodology; Roles/Writing - original draft.

Ying-Chieh Su, MD, PhD Student: Investigation; Writing - review & editing.

Chao-Kun Chen, MD: Investigation; Writing - review & editing.

Yao Fong, MD: Conceptualization; Investigation; Methodology; Supervision; Writing - review & editing.

List of Abbreviations

CT: Computed Tomography; CBCT: Cone Beam Computed Tomography; HOR: Hybrid Operation Room

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