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Case Report

CT-guided harpoon marking a ground-glass infiltrate: A case report ☆,☆☆

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ABSTRACT

Physicians are facing a growing challenge in characterizing suspicious pulmonary lesions through biopsy. Video thoracoscopic surgery is crucial for conducting surgical biopsies of these nodules. However, accurately identifying small pulmonary nodules, tiny, subsolid, and deep ones, remains a significant challenge due to the absence of digital palpation. One proposed technique for localization involves using a harpoon, initially designed for mammary nodules but also applied to pulmonary nodules. In cases involving solitary pulmonary nodules, histologic characterization is often necessary also accurate descriptions through computed tomography and the patient's clinical and epidemiologic context allow for a presumptive diagnosis. In this case, during an abdominal CT scan, a 49-year-old female patient was serendipitously found to have a ground-glass infiltrate in the anteromedial segment of the lower lobe of her left lung. Despite presenting with normal lung auscultation on physical examination, the increasing prevalence of subsolid lung nodules, combined with the contemporary era of minimally invasive surgery, prompted the medical team to employ CT-guided harpoon marking for precise lesion localization. Subsequent pathology analysis confirmed the presence of lepidic pattern adenocarcinoma. This case underscores the efficacy of the CT-guided harpoon marking approach, which significantly enhances surgical precision. Such precision is paramount in formulating individualized treatment strategies and follow-up plans for patients with similar clinical presentations.

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Background

Physicians are confronted with an increasing number of suspicious pulmonary lesions that must be characterized by biopsy. Today, video thoracoscopic surgery (VATS) plays a central role in the surgical biopsy of suspicious pulmonary nodules [1]. However, the lack of digital palpation in small, subsolid, and deep nodules may make it impossible to identify small pulmonary nodules accurately. When lung nodules are not identified intraoperatively on VATS, the procedure should be converted to an open thoracotomy; therefore, there is an indication to preoperatively locate small nodules that are distant from the pleural surface [2,3].

One of the first localization techniques described suggested using a harpoon for mammary nodules [4]. Still, they have also been described in pulmonary (PN) using percutaneous placement [5–9], either fiber- or platinum-coated [10,11]. Possible complications include bleeding with hematoma formation, pneumothorax, hemothorax, and harpoon dislodgement, which may occur before surgery or during intraoperative placement [5,8,10]. Another localization technique involves a percutaneous injection of different substances, radiotracer [12], or intraoperative localization of nodules under ultrasound guidance.

In most cases of patients with solitary PN, histologic characterization is necessary; the behavior over time is an essential factor in predicting the etiology of the nodule; most benign processes resolve spontaneously or within weeks or months after adequate treatment. Malignant nodules may remain unchanged for a long time (2-3 years) until they present an increase in size or density, and during this period, they are usually entirely asymptomatic [13]. Initial evaluation and follow-up depends on 2 essential characteristics: size and tomographic density [14]. PNs are classified as solid or subsolid; the latter may correspond to pulmonary adenocarcinoma but have a good prognosis in noninvasive or minimally invasive lesions. This case report highlights a 49-year-old female patient with an incidental subsolid PN marked with a harpoon. The histopathologic diagnosis revealed mucinous adenocarcinoma with a "lepidic" growth pattern, exemplifying the significance of precise characterization in determining patient management.

Case report

A 49-year-old female patient with a medical history of obesity, hashimoto's thyroiditis, low risk nonalcoholic fatty liver disease, and chronic undertreated sinusitis with an incidental finding in abdominal CT of a ground-glass infiltrate in the anteromedial segment of the lower lobe of the left lung. One year later, she was redirected to thoracic surgery and pulmonology, who found the patient with an intermittent clinical presentation of nasal congestion, dysphonia, and cough with mobilization of secretions; physical examination with normal pulmonary auscultation and extension imaging studies were performed:

- Chest computed tomography (CT), 2018: In the anterior region of the apical segment of the left lower lobe, there is an area with increased density in ground-glass of 20 × 18 mm with a central cavitation with no continuity with a structure of the airway. A comparison with a prior extra-institutional study conducted in 2017 reveals an enlargement in the size of the ground-glass component along with an elevated density. It is worth noting that the entire previous study was not encompassed in this evaluation (Fig. 1A).
- Fibrobronchoscopy: Negative for malignancy and microorganisms in bronchioalveolar lavage.
- Chest computed tomography (CT), 2021: Ground-glass lesion located in the anteromedial basal segment of the left lower lobe, which has increased in size compared with previous studies, probable neoplastic etiology (adenocarcinoma with lepidic pattern). A histopathologic study is recommended. Subcentimeter nodule in the right lower lobe, possible intrapulmonary lymph node (Fig. 1B).

During the imaging follow-up, lesion growth was detected, so it was presented to the medical board with radiology and pathology, and a pulmonary wedge resection was indicated by left thoracoscopy with previous CT-guided marking of the

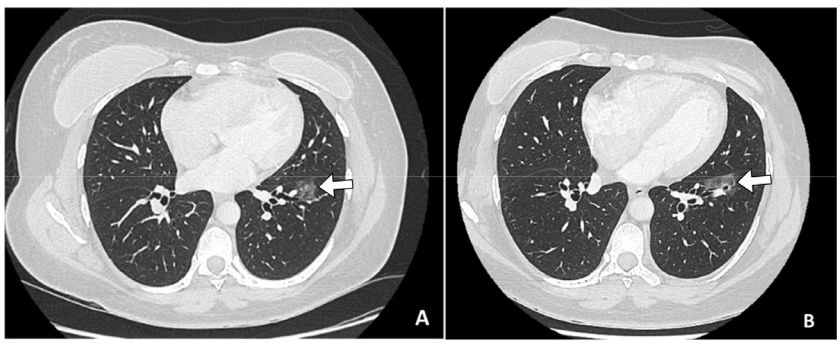

Fig. 1 – Lung computed tomography of (A) 2018: In the anterior region of the apical segment of the left lower lobe area with increased density in ground-glass of 20 × 18 mm with a central cavitation with no continuity with a structure of the airway and (B) 2021: Ground-glass lesion located in the anteromedial basal segment of the left lower lobe, which has increased in size compared with previous studies, probable neoplastic etiology (adenocarcinoma with lepidic pattern).

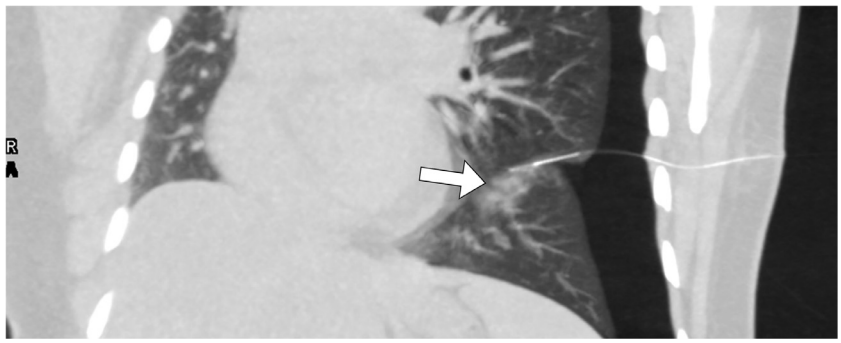

Fig. 2 – Chest CT scan in sagittal section showing pneumothorax after placement of the harpoon in the pulmonary nodule described.

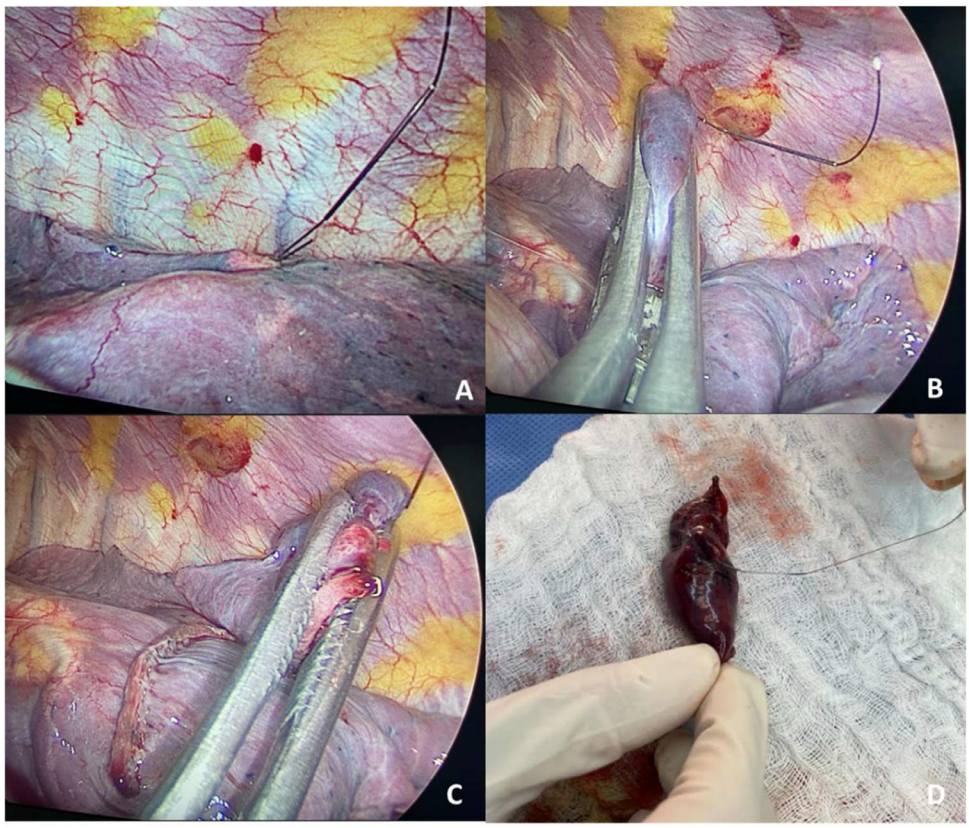

Fig. 3. (– A-C) Intraoperative thoracoscopic image of the harpoon and lung parenchyma; (D) resected lung segment with the harpoon anchored in the non-nodular lesion.

lesion (Fig. 2). The patient was taken under general anesthesia, and the marking harpoon was found on the junction of the apical segment with the anteromedial (Fig. 3); without palpable lesions, the procedure was performed, and the samples were analyzed intraoperatively.

- Pathology report: Microinfiltrating lepidic pattern adenocarcinoma, with mucinous differentiation, tumor size 0.5 × 0.5 × 0.5 cm, well-differentiated (G1). Resection margin of the negative parenchyma and pleura. Lymphovascular invasion was not observed.

The surgical procedure was carried out without any complications, and the patient was subsequently discharged in an asymptomatic condition, displaying normal lung auscultation, and the absence of dyspnea. Following discharge, the patient continued to receive outpatient follow-up care under the supervision of the thoracic surgery and pulmonology department. During the follow-up, the thoracic surgery team requested a control chest X-ray and CT scan, both of which revealed no evidence of consolidation or infiltrative-type lesions. Additionally, the pulmonology department recommended conducting a positron emission tomography (PET-CT)

6 months after the surgery. This PET-CT was aimed at assessing the potential presence of lymph node involvement that might necessitate further management by the oncology team.

- PET-CT, 2023: There was no evidence of hypermetabolic lesions indicative of a neoplastic process.

As of the latest update, the patient remains asymptomatic, with no evidence of new lesions detected during the ongoing check-ups.

Discussion

With the increasing availability and accessibility of radiological diagnostic techniques, coupled with the emergence of lung screening programs and the rising incidence of incidental findings of pulmonary nodules across various imaging modalities, the prevalence of pulmonary nodules (PN) detected via CT scans has surged to 31%, further escalating to 50% among patients with identifiable risk factors [15]. This phenomenon has driven an augmented demand for diagnostic and therapeutic thoracic procedures [16]. Consequently, it is imperative to offer image-guided biopsies or surgical interventions to obtain histologic information from these suspicious nodules and determine the appropriate course of action. In this context, the preoperative assessment of pulmonary lesions through thoracic tomography assumes a crucial role in defining the indication for surgical resection, in addition to facilitating the selection of patients who may benefit from preoperative localization techniques. These techniques encompass the use of metallic harpoons [17,18], methylene blue [19], injection of high-intensity substances such as lipiodol or barium [20], or colored collagen [21], along with other approaches like intraoperative detection with ultrasound [22,23]. Despite inherent limitations, these methods have proven to be highly beneficial in planning and treating patients with small pulmonary nodules [24]. In specific clinical scenarios, precise lesion marking is imperative to ensure successful targeting while preventing either inadequate excision/treatment or excessive removal of healthy tissue. In 1993, Kanazawa et al. [25] pioneered the development of a hook-wire/suture system designed to streamline the localization of lung lesions for subsequent thoracoscopy. Since then, various targeting systems have been developed, and the role of interventional radiology procedures within the treatment strategy algorithm has evolved significantly [26].

It is noteworthy that techniques for marking suspicious lesions with metallic harpoons have found successful application in breast cancer [27], soft tissue masses, and other oncologic lesions, including pulmonary metastases [28]. These minimally invasive surgical procedures enable less aggressive approaches [28], resulting in shorter hospital stays and expedited postoperative recovery. One of the minimally invasive surgical procedures is VATS, which has become a fundamental tool in the diagnosis and treatment of pulmonary nodules [2,29]; however, in some cases, it is impossible to locate them correctly at the time of the procedure, which, according to the authors, occurs in 7.5%-11% of cases [26,30] and on such occasions preoperative marking is necessary to perform complete and safe resection using VATS [31,32].

In cases involving lung lesions, sublobar lung resection is recommended for early-stage primary lung cancer and small size metastases. However, localizing these lesions can pose challenges, either due to their deep-seated location or their presentation as nonsolid opacities, such as ground-glass opacity [26]. Potential complications of the procedure encompass bleeding leading to hematoma formation, pneumothorax, hemothorax, and harpoon dislodgement, which may manifest either before surgery or during intraoperative placement [5,8,10]. To overcome these challenges, multiple localization techniques have been proposed: percutaneous hook-wire placement [8,33–35]; localization with injection of dyes, ethiodized oil, or radioisotopes [36]; and lung nodule marking before stereotactic-body-radiotherapy (SBRT) [37].

This case report focuses on a female patient with intermittent upper respiratory symptoms and normal pulmonary auscultation with an incidental ground-glass lung lesion on chest CT, which had increased in size during her imaging follow-up. Depending on the tomographic density, such lung lesions can be classified as solid or subsolid [38]. The morphology of a solid PN refers to an area of increased attenuation due to airspace collapse, as opposed to subsolid PNs, which in turn include pure ground-glass opacity (GGO) and mixed nodules [38]. Our patient had a nodule in pure GGO.

Although CT cannot confirm the benign or malignant etiology of the lesion, it can make an approximation considering some characteristics of the lesion. For pure GGO nodules, a size >8 mm and the presence of lobulated borders are alarm factors, while if it measures <4 mm, it is considered benign. A pure GGO nodule can be malignant in up to 20%-40%, while the rest is due to fibrotic processes or inflammatory, hemorrhagic, or infectious foci [13]; in the case of our patient, the lesion was more prominent than 8 mm [14].

While CT-guided harpoon marking has been previously described for PN lesions with a placement success rate of up to 100% [18], we emphasize that every suspicious lesion, regardless of its size, warrants meticulous evaluation. This approach ensures accurate assessment, especially when considering thoracoscopic procedures with prior marking, which enhances control and facilitates precise adjustments in treatment strategies.

In the case of the patient's pathology, lepidic pattern adenocarcinoma is an infrequent entity that can present in the fifth decade of life, tends to be multifocal, and predominates in women, nonsmokers of Asian descent [39,40]. Adopting this diagnostic technique for non-nodular pulmonary lesions is necessary since pulmonary carcinoma remains one of the neoplastic lesions with the highest morbimortality worldwide.

Therefore, in the era of minimally invasive surgery, interventional radiology assumes a pivotal role in the localization and marking of diverse pathologies. With the rising incidence of subsolid lung nodules, CT-guided harpoon marking proves to be an effective method for guiding the resection of ground-glass nodules, offering superior surgical precision. This precision holds significant relevance in determining appropriate therapeutic strategies and follow-up plans for individual cases and future research should prioritize long-term follow-

up studies to assess durability, including ground glass nodule recurrence rates and impact on patient quality of life.

Ethics approval and consent to participate

The reported case was reviewed and approved, and individual patient consent was obtained following institutional guidelines. Following our institutional policies, all protected health information was removed.

Availability of data and materials

Not applicable.

Authors' contributions

Daniela Nasner: Project administration, Original draft, Writing – review & editing; Valentina Mejía-Quiñones: Conceptualization, Writing – review & editing; Mauricio Velásquez-Galvis: Writing – review & editing; Juan Sebastián Toro-Gutiérrez: Writing – review & editing.

Data sharing statement

The relevant anonymized patient-level data are available via request from the authors.

Patient consent

Written informed consent for the publication of this case report was obtained from the patient.

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