Heart, Lung and Circulation (2015) **24,** 1020–1026
1443-9506/04/$36.00
http://dx.doi.org/10.1016/j.hlc.2015.03.018

ORIGINAL ARTICLE

Accuracy of Transthoracic Ultrasound for the Prediction of Chest Wall Infiltration by Lung Cancer and of Lung Infiltration by Chest Wall Tumours

Guido Caroli, MD [a*], Andrea Dell'Amore, MD [a], Nicola Cassanelli, MD [b], Giampiero Dolci, MD [a], Emanuela Pipitone [c], Nizar Asadi, MD [b], Franco Stella, MD PhD [a], Alessandro Bini, MD PhD [a]

[a]Thoracic Surgery Unit, S.Orsola – Malpighi Hospital, Bologna, Italy
[b]Thoracic Surgery Unit, AOUI - Verona, Italy
[c]Local Health Authority, Public Health Department, San Lazzaro di Savena, Bologna, Italy

Received 25 January 2015; received in revised form 15 March 2015; accepted 24 March 2015; online published-ahead-of-print 3 April 2015

Background We wanted to determine the accuracy of transthoracic ultrasound in the prediction of chest wall infiltration by lung cancer or lung infiltration by chest wall tumours.

Methods Patients having preoperative CT-scan suspect for lung/chest wall infiltration were prospectively enrolled. Inclusion criteria for lung cancer were: obliteration of extrapleural fat, obtuse angle between tumour and chest wall, associated pleural thickening. The criteria for chest wall tumours were: rib destruction and intercostal muscles infiltration with extrapleural fat obliteration and intrathoracic extension. Lung cancer patients with evident chest wall infiltration were excluded.
Transthoracic ultrasound was preoperatively performed. Predictions were checked during surgical intervention.

Results Twenty-three patients were preoperatively examined.
Sensitivity, specificity, positive and negative predictive values of transthoracic ultrasound were 88.89%, 100%, 100% and 93.3%, respectively. Youden index was used to determine the best cut-off for tumour size in predicting lung/chest wall infiltration: 4.5 cm.
At univariate logistic regression, tumour size (<4.5 vs ≥ 4.5 cm) ($p=0.0072$) was significantly associated with infiltration.

Conclusions Transthoracic ultrasound is a useful instrument for predicting neoplastic lung or chest wall infiltration in cases of suspect CT-scans and could be used as part of the preoperative workup to assess tumour staging and to plan the best surgical approach.

Keywords Lung cancer diagnosis • Chest wall • Ultrasound • Computed Tomography • Lung cancer surgery • Chest wall surgery

*Corresponding author at: S.Orsola-Malpighi Hospital – Thoracic Surgery Unit, v. Massarenti, 9 - 40100, Bologna, Italy. Tel.: +39 0516364206; fax: +39 0516364259, Email: caroli.guido@gmail.com

Introduction

Lung cancer is the leading cause of cancer-related mortality worldwide, accounting for more than 1.5 million deaths each year [1]. Thirty-three per cent of patients have locally advanced disease at the time of diagnosis, with chest wall infiltration occurring in 5% [2].

Chest wall invasion by lung cancer does not currently exclude surgery although it has an important impact on prognosis. In fact, a visceral pleura infiltration alone constitutes a T2-tumour with a five-year survival rate of 58% while a parietal pleura or chest wall infiltration implies a T3-tumour and a five-year survival rate of 41% [3].

Furthermore, preoperative prediction of chest wall invasion is important both for surgeons and for patients because unexpected intraoperative detection of chest wall invasion requires a change in surgical strategy, prolongs operative time, is more painful and has a higher morbidity than standard resections [4].

In a small subgroup of patients with peripheral pleural-based lung cancer, preoperative distinction between T2 and T3-lesion is often difficult [4–8].

Chest wall tumours are a very heterogeneous group of diseases, with primary and secondary lesions accounting for 50%.

Primary tumours are 5% of all thoracic neoplasms and can arise from both the most external anatomical plane of the chest and from the inner plane [9]. They may infiltrate the lung requiring an associated lung resection in about 34% of cases [10].

In a specular way, lung infiltration by chest wall tumours may be very difficult to detect in the absence of rib-cage infiltration and parietal pleural involvement.

Therefore, preoperative prediction of lung or chest wall infiltration from a tumour mass is very important in planning the surgical approach.

However, both computed tomographic scan (CT-scan) and static magnetic resonance imaging (MRI) have a low sensitivity value in the case of lack of soft tissue involvement or extensive lung infiltration [4–8].

As a result, there are many cases in which these two examinations are doubtful as regards infiltration, and the real surgical strategy cannot be predicted with high accuracy.

Considering our previous study on the accuracy of transthoracic ultrasound (TUS) in the prediction of pleural adhesions [11], we wanted to evaluate its accuracy in predicting chest wall infiltration by lung cancer and lung infiltration by chest wall tumours, because they represent two specular situations sharing the same echographic aspect: the sliding sign.

Patients and Methods

From January 2012 to February 2014 we prospectively enrolled consecutive patients scheduled for surgical intervention at the Thoracic Surgery Department of the S.Orsola-Malpighi Hospital of Bologna because they were affected by chest wall tumour or peripherally-located non-small cell lung cancer (NSCLC) or lung metastasis.

All patients underwent contrast-enhanced whole body CT scan with high resolution CT of the chest as part of the preoperative staging workup.

All CT scans were evaluated by the Cardio-Thoracic Radiology team of our Hospital.

Specific radiologic signs defined the study inclusion and exclusion criteria.

In the case of peripheral lung cancer, study inclusion criteria were: a) obliteration of extrapleural fat; b) obtuse angle between the mass and the chest wall; c) associated pleural thickening.

Lung cancers matching one or more of these criteria were defined as suspect for chest wall infiltration [5] and included in the study.

For chest wall tumours, CT scan inclusion criteria were: a) rib destruction and intercostal muscle infiltration with extrapleural fat obliteration; b) intrathoracic extension.

Chest wall tumours meeting one or both of these criteria were considered as suspect for lung infiltration and included in the study.

Study exclusion criteria were: a) lung cancer evidence of tumour growth into the chest wall and/or rib destruction; b) Pancoast tumours; c) tumours with paravertebral or infrascapular location.

In the first case, in fact, clear CT scan evidence of chest wall invasion was present, and no further examination was necessary.

In Pancoast tumours and tumours with paravertebral or infrascapular location, acoustic window is very small due to the presence of bone, and it does not permit a precise ultrasound evaluation of the tumor lesion.

All the patients meeting the abovementioned inclusion criteria underwent preoperative TUS the day before surgery.

Surgical interventions were all performed within three weeks of the CT-scan.

Examinations were all performed by the same operator (G.C.), blinded to clinical information, and conducted with a 5 MHz convex transducer probe with the patient in sitting position, to maximise lung respiratory excursion. When major soft tissue definition was needed, especially with chest wall tumours, an 8-10 MHz linear probe with virtual convex setting was used.

In each patient we detected the presence or the absence of the sliding sign underlying or overlying the tumour, in the case of chest wall tumour or NSCLC respectively, and around it.

In patients with NSCLC, the area overlying the tumour was inspected for chest wall infiltration. The absence of the pleural artefact over the mass was noted, due to the absence of aerated lung between the chest wall and the mass. In this case, the direct sliding of the mass under the parietal pleural surface was used to evaluate infiltration (Fig. 1).

The sliding sign of the pleura immediately adjacent to the mass was evaluated in the case of unclear mass sliding.

In patients with chest wall tumour, the absence of the sliding sign underlying the mass was considered a sign of