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Chest ultrasonography in health surveillance of asbestos related pleural disease

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ABSTRACT

High resolution computed tomography, (HRCT), is currently considered the diagnostic gold standard to diagnose early stage malignant pleural mesothelioma and other non-malignant pleural conditions, but it is expensive and exposes the patient to radiation dose. In a screening and population medicine perspective, Thoracic Ultrasounds may become a valuable alternative because it can detect minimal changes in pleural surface, is widely available and safe.

On these bases, we therefore validated thoracic US in subjects with history of exposure to asbestos, having HRCT as the reference standard.

One hundred-fifty subjects were screened and 117 were recruited. Pleural abnormalities at US and/or HRCT were detected in 66 out of 117 subjects (prevalence = 57%), and their prevalence was unrelated to both mansion and smoking habit, while mean age and mean length of exposure were higher in those having pleural abnormalities (age = 47 ± 5 vs 44 ± 6 years, $p < 0.05$; years of exposure = 20 ± 7 vs 17 ± 5, $p < 0.05$). Thirteen out of 19 subjects with pleural abnormalities at HRCT were also identified by thoracic US, whereas 47 participants had lesions seen at US, but not at the HRCT scan. Positive and negative percent agreement were 66.6% and 51.8%, respectively; the McNemar's test for equality showed a p-value < 0.001.

In conclusion, chest US might complement HRCT in the health surveillance of asbestos exposed population to detect earlier lesions or to follow up US approachable lesions. Further research is needed to clarify whether this approach may enhance early recognition of pleural mesothelioma and ameliorate prognosis.

1. Introduction

Malignant pleural mesothelioma and other non-malignant pleural conditions such as pleural thickening, rounded atelectasis and pleural plaques may develop 20–50 years after the first exposure to high concentrations of asbestos dusts and, less commonly, also after a shorter exposure [1]. Small irregular opacities in the lower lung and irregular pleural thickening at chest x-ray are the most common key to the diagnosis. High resolution computed tomography, (HRCT), is currently considered the diagnostic gold standard [2]. On the other hand, restrictive lung function impairment is related more to parenchymal than to pleural abnormalities and, therefore, cannot qualify as a proxy for early detection of pleural abnormalities [3–6].

Unfortunately, HRCT scan is expensive, exposes the patient to high radiation dose and might cause psychological distress [7]. Thoracic Ultrasounds (US) is a valuable alternative because it can detect minimal changes in pleural surface, is widely available, and safe. However, its diagnostic accuracy vs early pleural changes is unclear. In a recent study, US yielded a 90,9% sensitivity and 85.7% specificity in diagnosing chest wall invasion in subjects with non small cell lung cancer versus a 61.5% and 84.6%, respectively, provided by CT scan [8]. Similarly, in 52 consecutive patients with suspected malignant pleural effusion, US had a sensitivity for the diagnosis of malignancy of 73%, a specificity of 100%, a positive predictive value of 100%, and a negative predictive value of 79% vs a contrast-enhanced HRCT and hystology based diagnosis [9]; in the same study, parietal pleural thickening was identified with a sensitivity of 42% (95% CI:26–61), specificity of 95% (95% CI: 74–99) positive and negative predictive value of 93% and 49%, respectively. Unfortunately, a standard US cannot explore the whole pleural surface. Indeed, it cannot image the mediastinal pleura, whereas the sternum, clavicles, scapulas and vertebras limit pleural visualization to about 70% of the total. Furthermore, US are thought to

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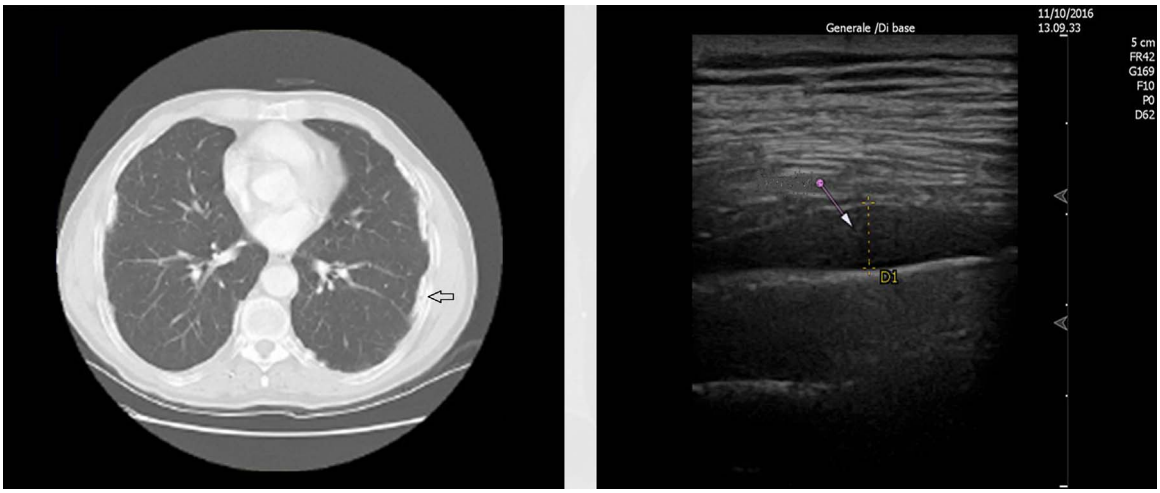

Fig. 1. Chest CT scan showing a pleural plaque (large arrow) and ultrasonographic picture of the same lesion (thin arrow).

be associated with variable inter-observer agreement making the reproducibility of the method object of debate [10]. However, US technique is amenable to standardization according to a consensus statement recently elaborated by a multidisciplinary panel of 28 experts from eight countries [11]. On the other hand, pleural abnormalities, regardless of their nature, usually involve the parietal pleura of the lateral thoracic wall between the 6th and 9th ribs, the posterolateral chest wall between the 7th and the 10th ribs and, more rarely, the dome of the diaphragm, the mediastinum and the fissures [12]. Thus, it is unclear whether US may qualify as an autonomous diagnostic technique or should only complement HRCT in the screening of asbestos associated pleural changes.

In this proof of concept study, we aimed at validating thoracic US as a diagnostic tool in the management of pleural changes in subjects with a history of occupational exposure to asbestos and to compare its diagnostic accuracy with that of HRCT scan of the chest.

2. Materials and methods

Subjects with documented (workplace description, cohort demographics, time period of exposure and follow up) occupational exposure to crysothile asbestos were referred to a tertiary care teaching hospital, the Campus Bio Medico University, in Rome-Italy, for screening and early recognition of asbestos related pleural diseases. The only inclusion criteria for screening were: prolonged and continuative (over 15 years) exposure to crysotile asbestos; ability to perform pulmonary function tests, CT scan and chest ultrasound within a 3 week long time-laps. Excluded were subjects refusing to sign in the informed consent form. Findings pertaining to the first 150, enrolled from January 2016 to February 2017, are the object of the present report.

Local Ethical Committee approval was obtained (Prot. 56/16 ComEt CBM) and all patients signed an informed consent for this study.

All participants were males serving in aircraft and automotive industry with documented long lasting exposure to crysothile asbestos fibers.

Smoke history and other relevant environmental exposure were also collected. The conventional screening panel included HRCT, a complete spirometry and DlCO measurement.

Chest USs were performed by a single operator blinded to both CT scan and spirometry reports. US assessment was performed using an Exagyne™ machine (Echo Control Medical-ECM, Angoulème − France) equipped with linear (7–13 mHz) and convex (2 5 mHz) probes. Chest wall was systematically explored with the dorsal and lateral images obtained with the patient sitting, whereas the supine position was used for visualizing the ventral side. Raising the arms and crossing them behind the head causes intercostal spaces to be extended and facilitated access. The examiner was able to visualize the region behind the shoulder blade, if the patient put his/her hand on the contralateral shoulder. The transducer was moved along the intercostal space from dorsal to ventral in longitudinal and transversal positions. Turning the probe in different positions provides the examiner with a three-dimensional image. Every accessible segment of the pleural space was systematically evaluated [11].

The followings were considered pathologic US findings: diffuse pleural thickening, defined as a smooth, well demarcated and hypoechogenic pleural tissue that displaces the lung from chest wall, but does not infiltrates the chest wall; focal pleural thickening or pleural plaques defined as smooth, elliptical, hypoechoic pleural thickenings, sometimes with inner calcifications; pleural tumors defined as diffuse pleural thickening, nodular and/or irregular, eventually associated with calcifications, focal pleural masses and pleural effusion [13].

Chest US was performed within three weeks after HRCT scan. As recommended, thin-section CT acquisition in full inspiration with a volume CT dose index of around 3–7 mGy were obtained for scanning the thorax [14]. US and HRCT findings were compared with regard to location, size and width of the lesions (Fig. 1).

Data are expressed as means (± standard deviation, SD) for continuous variables or as a percentage for categorical variables. Comparison between groups was made by non parametric Wilcoxon test for continuous variables and Chi-square for categorical ones (statistical software: R version 3.3.0, Wien − Austria). Inter measurement agreement between HRCT and Chest ultrasound pleural abnormalities size was evaluated by Cohen's k determination. Agreement between tests was determined by overall, positive and negative agreement calculation and McNemar's test.

3. Results

One hundred-fifty subjects were consecutively screened. Among these, 117 were effectively recruited, having performed a HRCT in the past 3 weeks and lung function tests within the past 6 weeks. Mean age was 46.8 years (± 6.0) and the mean length of asbestos exposure was 20 years (± 7); eighty-three (71%) served as aircraft and automotive maintenance operator, 12 (10%) were pilots, 6 (5%) were on-board system operators, and 15 (13%) were in charge of other mansions. Of the 117 participants, 16 (14%) were current smokers, 40 (34%) were former smokers with a mean pack/year of 11.9 (± 9.2) and 15.4 (± 13.0), respectively. A normal spirometry was observed in 108 subjects (93%), a mild obstructive pattern in 4 (4%), a mild restriction in 3 (3%) and a mixed pattern spirometry in 1 (1%).