Ultrasound-guided thoracenthesis: the V-point as a site for optimal drainage positioning

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Abstract. – INTRODUCTION: In the latest years the use of lung ultrasound is increasing in the evaluation of pleural effusions, because it makes follow-up easier and drainage more efficient by providing guidance on the most appropriate sampling site. However, no standardized approach for ultrasound-guided thoracenthesis is actually available.

AIM: To evaluate our usual ultrasonographic landmark as a possible standard site to perform thoracenthesis by assessing its value in terms of safety and efficiency (success at first attempt, drainage as complete as possible).

MATERIALS AND METHODS: Hospitalized patients with non organized pleural effusion underwent thoracenthesis after ultrasound evaluation. The point showing on ultrasound the maximum thickness of the effusion ("V-point") was chosen for drainage.

RESULTS: 45 ultrasound guided thoracenthesis were performed in 12 months. In 22 cases there were no complications; 16 cases of cough, 2 cases of mild dyspnea without desaturation, 4 cases of mild pain; 2 cases of complications requiring medical intervention occurred. No case of pneumothorax related to the procedure was detected. In all cases drainage was successful on the first attempt. The collected values of maximum thickness at V-point (min 3.4 cm – max 15.3 cm) and drained fluid volume (min 70 ml – max 2000 ml) showed a significative correlation (*p* < 0.0001). When the thickness was greater or equal to 9.9 cm, drained volume was always more than 1000 ml.

CONCLUSIONS: The measure of the maximum thickness at V-point provides high efficiency to ultrasound guided thoracentesis and allows to estimate the amount of fluid in the pleural cavity. It is also an easy parameter that makes the proposed method quick to learn and apply.

Key Words:
Lung ultrasound, Pleural effusion, Thoracenthesis.

Introduction

In the latest years the role of ultrasound in respiratory medicine is increasing, although the physical features of the lung are a limit for the use of this imaging thechnique. In fact, the physiological alveolar ventilation is a barrier to ultrasound, so that lung parenchyma is represented by a composition of artifacts: horizontal lines (known as A-lines), vertical lines (B-lines or comet-tail artifacts), sliding (gliding sign)[1]. Even the slightest interposition of air (few millimeters) between the probe and any intra pulmonary target hinders a comprehensive study of the lung, making the technique a second level exam, being limited to the study of the disease that "reaveals the organ"[2]. For this reason ultrasound can be a great ally for pulmonologist in the evaluation of pleural effusions: it allows a real time study at the bedside and makes follow-up easier and drainage more efficient by providing guidance on the most appropriate sampling site[1-7].

Other studies have already highlighted the safety of the technique[4-7]. However, actually no standardized approach for ultrasound-guided thoracenthesis is available.

The aim of our study was to evaluate the ultrasonographic landmark that we choose in our clinical practice as the best site to perform thoracenthesis and assess its value in terms of safety and efficiency (success at first attempt, drainage as complete as possible).

Materials and Methods

Patients hospitalized in our Internal Medicine Department from April 2009 to March 2010 (12 months) were included in the study when showing: non organized effusion requiring thoracenthesis for diagnostic and/or therapeutic purposes, prothrombin time < 1.5 INR, platelets count > 50.000/ml. Patients with either localized or multilocular or organized effusions were not included, because in these cases sampling is focused in the effusion site.

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Patients meeting inclusion criteria underwent thoracenthesis with ultrasound guidance (Philips iE33, ultrasound probe S5-1 MHz).

We chose to perform thoracenthesis in the site showing in ultrasound the maximum thickness of the pleural effusion (i.e. the maximum distance between surface and organs like lungs, diaphragm, blood vessels, etc.): a thickness greater than the length of the needle could guarantee a safe procedure.

With patient in sitting position, the maximum thickness site was always located over the diaphragm, where hyperechoic lines indentifying diaphragm and the contour of collapsed lung converged, often forming a "V". For this reason we will identify the point of maximum thickness as "V-point" (Figure 1).

In all patients, a venous access was available to treat any complication that could arise during and after the procedure. Thoracenthesis was performed with the patient in sitting position, after local disinfection and local anesthesia with lidocaine. We used Abbocath 16G (maximum draining speed 180 ml/min) by removing the spindle when entered the pleural cavity. The criteria for discontinuation of drainage were: 2000 ml drained, flow interruption with ultrasonographic evidence of complete drainage, occurrence of any complication. After the procedure the chest X-ray was always performed as daily clinical practice (usually 6 hours later).

The data we collected were: distance at V-point (cm), success at first attempt, amount of drained fluid (ml), complications classified in mild (complications that did not require any intervention) and severe (wich required medical intervention), including occurence of pneumothorax (any thickness) at chest x-ray performed in inspiration.

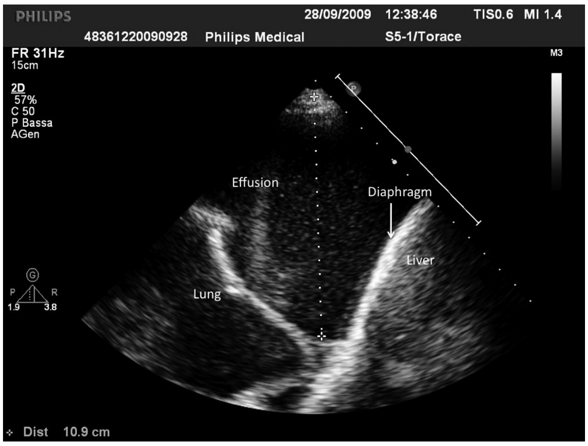

Figure 1. The lines represented by collapsed lung border and diaphragm create a "V" sign. In this point (called "V-point") we often detected the maximum thickness of pleural effusion.

Statistical Analysis

Calculations were carried out with a statistical software package (Graphpad Prism 5, Graphpad Software, USA). Summary statistics of maximum thickness at V-point and drained fluid volume were expressed as the mean ±SD, and median. Linear regression analysis was used, and the Pearson test was used to investigate correlation between maximum thickness at V-point and drained fluid volume. The level of significance was set at $p \leq 0.05$.

Results

45 ultrasound guided thoracentheses were performed in 26 patients (21 male, 5 female) with non organized pleural effusion. In some patient it was not possible to place a drainage (because of age, medical conditions and social problems), so they underwent repeated thoracentheses in the same site after at least 2 days.

The range of collected values of maximum distance at V-point was from 3.4 cm up to 15.3 cm (mean 10.4 ± 2.73 cm, median 11 cm) and they were often obtained between mid-shoulder blade line and posterior axillary line.

In all cases drainage was successful on the first attempt. Drained fluid volume range was from 70 ml up to 2000 ml (mean 1307 ± 462 ml, median 1400 ml).

In 22 cases there were no complications, there were 16 cases of cough, 2 cases of mild dyspnea without desaturation, 4 cases of mild pain. 2 cases of major complications occurred: a case treated with oxygen desaturation, a case of pain that required treatment with intravenous analgesics .

Post-thoracentesis chest X-ray revealed pneumothorax in 2 cases out of 45 total, but pneumothorax were already existing before the procedure and did not require surgical treatment (these 2 cases coincided with the patients with major complications).

Discussion

By analyzing the obtained data on the safety, we noted that major complications occurred in

4% of procedures and no case of pneumothorax was related to the maneuver. In addition, thoracentesis was successful at first attempt in all cases, thus limiting the more as possible the discomfort for patients.

The data agree with previous studies showing the greater safety of US-guided thoracentesis in spite of the thoracenthesis based only on physical exam. In fact, the average incidence of pneumothorax after thoracentesis performed with the clinical method is 20 to 39% compared with 0-3% of US-guided procedures[8-13].

During data collection became evident a strong correlation between the thickness measures at V-point and amount of drained fluid, so we tested the linear correlation between the two data sets (Figure 2) that showed a statistically significant correlation ($p < 0.0001$). Thus, we can affirm that in not organized pleural effusions increasing values of the thickness measurement are related to increasing values of collected liquid volume.

In particular, when the measure at V-point was greater or equal to 9.9 cm, drained fluid volume was always superior to 1000 ml.

This finding may be of very useful for non-invasive estimation of a pleural effusion, because actually there is no technique available to calculate the exact volume of effusion using ultrasound. It could also be a simple and comparable benchmark for follow-up of chronic effusions that can not be treated with a surgical drainage or chemical pleurodesis in case of clinical or healthcare problems.

With the data available, it is not possible actually to obtain an accurate quantitative estimation of pleural effusion because in some cases the drainage was incomplete and the only measure of depth at V-point is insufficient to calculate a volume. In addition, during the ultrasound exam the calculation of pleural effusion volume is difficult from a technical point of view because it often occurs in an irregular shape so that can not be approximated and it is generally larger than the scan provided by the probe. Because of this significant correlation, however, we have a starting point to develop in the next future a method aimed at non invasive estimation of effusion volume.

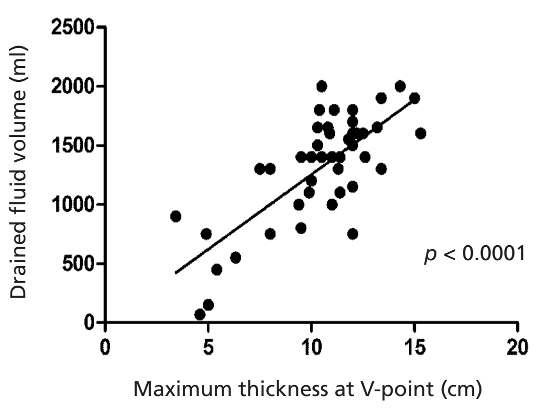

Figure 2. Increasing values of maximum thickness at V-point are significantly related to increasing values of drained fluid volume ($p < 0.0001$).

Conclusions

We have shown that the measure of the maximum depth at V-point provides high efficiency to ultrasound guided thoracentesis and also allows to estimate the amount of fluid in the pleural cavity.

By itself, the thickness measure does not allow an exact determination of the amount of pleural fluid. However, is an easy and quick-to-acquire parameter that makes the proposed method easy to learn and apply. In addition, it does not require complex software or packages of calculation, so that the procedure could be performed also with the easiest ultrasound machines available. In the future it could be a useful parameter in the hands of the clinician and could be a standardized procedure ultrasound-guided thoracentesis. Further studies are needed, possibly carried out on larger series, to confirm and enforce our results.

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