Influence of the Method Used to Obtain Pleural Fluid on the Determination of the Acid-Base Balance

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OBJECTIVE: To analyze the methods used in our hospital for obtaining pleural fluid to determine the acid-base balance and to evaluate the clinical repercussions of each method.

METHODS: Initially we studied the methods used by physicians in our hospital to collect pleural fluid for determination of the acid-base balance. In a second phase, we performed a prospective, descriptive, comparative study with the participation of 71 patients with pleural effusions in order to compare the acid-base balance according to the technique used to obtain the fluid.

RESULTS: Pleural fluid was obtained using 3 methods: a) direct extraction using a heparinized syringe (group 1); b) extraction using a 20-mL syringe with subsequent aspiration from this syringe into a heparinized syringe (group 2); and c) filling a heparinized syringe from the 20-mL syringe (group 3). The only significant differences between group 1 and groups 2 and 3 were an increase in the mL syringe (group 3). The only significant differences (group 2); and aspiration from this syringe into a heparinized syringe extraction using a 20-mL syringe with subsequent direct extraction using a heparinized syringe (group 1);

PCO2 obtained in the different groups were statistically significant, with values superior to .95 in the last 2 variables.

CONCLUSIONS: Physicians who perform thoracentesis in our hospital use different methods for obtaining fluid to determine the pleural acid-base balance. The 3 methods analyzed show no significant differences with regard to pH or PCO2. Pleural fluid may be obtained by a single puncture with a large-volume syringe, subsequently transferring the fluid to a heparinized syringe without this significantly affecting the pH or PCO2, thus reducing the number of manipulations and the risk of complications.

Key words: Pleural effusion. pH. Thoracentesis.

Importancia de la forma de obtención del líquido en la determinación del equilibrio ácido-base pleural

OBJETIVO: Analizar las formas de obtención del líquido para determinar el equilibrio ácido-base pleural en nuestro medio y su influencia o relevancia clínica.

MÉTODOS: En una primera fase se describieron las formas en que los médicos de nuestro hospital obtenían el líquido para determinar el equilibrio ácido-base pleural. En una segunda fase se realizó un estudio prospectivo, descriptivo y comparativo de 71 pacientes con derrame para comparar el equilibrio ácido-base pleural según las formas de obtención.

RESULTADOS: El líquido pleural se obtenía de 3 formas distintas: a) extracción directa con jeringa heparinizada (grupo I); b) extracción con jeringa de 20 ml, aspirando de esta jeringa con la jeringa heparinizada (grupo II), o c) llenando la jeringa heparinizada con la jeringa de 20 ml (grupo III). Se observó un aumento significativo sólo en los valores de la presión parcial (PO2) y saturación de oxígeno entre el grupo I y los grupos II o III. La diferencia de las medias del pH entre los grupos I y II fue de 0,009 (intervalo de confianza del 95 %, –0,039 a 0,02; P = .5) y entre los grupos I y III, de 0,007 (intervalo de confianza del 95 %, –0,038 a 0,023; P = .6). Las correlaciones entre los distintos grupos de la PO2, pH y presión parcial de anhídrido carbónico (PCO2) fueron estadísticamente significativas y con valores superiores a 0,95 en las 2 últimas.

CONCLUSIONES: Los médicos que realizan las toracocentesis en nuestro hospital procesan de formas distintas el líquido para determinar el equilibrio ácido-base pleural. Las 3 formas analizadas no mostraron diferencias significativas en cuanto al pH y la PCO2. La obtención del líquido puede realizarse con una única punción con jeringas de mayor capacidad, para posteriormente llenar la jeringa heparinizada, sin que se modifiquen de forma significativa los valores del pH y la PCO2, y con una disminución del número de manipulaciones y el riesgo de complicaciones.

Palabras clave: Derrame pleural. pH. Toracocentesis.

Introduction

Consideration of the general characteristics of pleural fluid and its analysis are essential in the management of pleural effusions.1,3 In the analysis of the acid-base balance, pleural pH is the most widely used parameter because of
Determination of the Acid-Base Balance in the Pleural Fluid

Two-to-three mL of pleural fluid were passed slowly into each heparinized syringe (3-mL syringe for arterial blood samples with 200 units of heparin and a 22F needle, Quick ABG, Marquest, Englewood, Colorado, USA; ref. 4022) taking care to avoid the presence of residual air bubbles by elimination of part of the fluid loaded into the syringe before its subsequent closure. The syringes were opened and used once only at the time of processing the samples. The syringes loaded from each patient using the various techniques for obtaining the fluid were transported to the laboratory to determine the acid-base balance within 10 minutes of having performed the thoracentesis. The order in which the different syringes from a single patient were tested was altered each time (the first syringe tested from a patient became the last one tested in the following patient).

The acid-base balance was determined throughout the study using the same machine (model 248 gas analyzer, Ciba Corning Diagnostics, Medfield, Massachusetts, USA) with hourly calibration of the system. The determinations were performed using samples of 60 to 85 µL at 37°C ± 0.15°C in less than 60 seconds, with a wash out every 30 minutes to prevent obstruction. The pH, PO₂, and PCO₂ were measured and the system calculated the base excess, true or plasma bicarbonate, standard bicarbonate, estimated oxygen saturation, and total carbon dioxide.

Statistical Analysis

A descriptive analysis of the techniques used by the staff in our hospital to obtain the pleural fluid in order to determine the acid-base balance was performed for the overall sample of physicians and by specialty. For the second phase of the study, the descriptive data were compiled for the principal characteristics of the patients included in the study and the type of pleural effusion and its etiology. An independent analysis of the acid-base balance was performed for each of the techniques used to obtain the pleural fluid. These values were compared using as reference the values recorded after obtaining the fluid directly from the pleural space. Comparisons were performed using the t test and the Pearson correlation coefficient. All analyses were performed using the SPSS 11.0 program (SPSS Inc, Chicago, Illinois, USA). Statistical significance was taken as a P value less than or equal to .05.

Results

Table 1 shows the different methods used to obtain pleural fluid to determine the acid-base balance and the distribution of these methods among the staff in our hospital. The 3 forms used were a) direct aspiration from the pleural cavity using a heparinized syringe (group 1), b) aspiration of the sample using a 20-mL syringe, subsequently aspirating fluid from this syringe into a heparinized syringe (group 2), and c) using the fluid from the 20-mL syringe to fill the heparinized syringe (group 3).

Table 2 shows the principal characteristics of the patients studied in the second phase of the study. The group of patients with pleural tumors included 26 patients with...
adeno- or undifferentiated carcinomas (15 of pulmonary origin, 5 from the breast, 4 from the stomach, and 2 from the ovary), 4 malignant mesotheliomas, and 1 lymphoma. The important conditions among the nonneoplastic lesions were 7 parapneumonic effusions, 4 cases of tuberculous pleuritis, 6 cases of heart failure, 3 cases of chronic liver disease, 2 pulmonary emboli, and 2 postcardiac-surgery effusions; the remainder were nonspecific pleural effusions.

Table 3 shows the values of the pleural acid-base balance using the 3 different methods for obtaining this fluid. The results for groups 2 and 3 were compared with those of group 1. Only the PO2 and oxygen saturation were significantly higher in the patients from groups 2 and 3. The intergroup differences in the mean pH were 0.009 (95% confidence interval [CI], -0.039-0.02; P=.5) for groups 1 and 2, 0.007 (95% CI, -0.038-0.023; P=.6) for groups 1 and 3, and 0.001 (95% CI, -0.032-0.03; P=.9) for groups 2 and 3. The correlations between results from groups 1 and 2 for pH, PCO2, and PO2 were 0.98, 0.96, and 0.90, respectively; between results for groups 1 and 3, the correlations were 0.98, 0.97, and 0.85; and between groups 2 and 3 they were 0.98, 0.95, and 0.85. The level of significance for all these correlations was P<0.05. The correlations between the different methods used to determine the pH are shown graphically in the Figure.

Discussion

Our study shows that the physicians who perform thoracentesis in our hospital use different methods to obtain pleural fluid to determine the acid-base balance. Of the 3 methods studied, the majority of physicians avoided using the system considered to be the gold standard, namely direct aspiration of the fluid from the pleural space using a heparinized syringe.3 However, the pH and PCO2 did not vary significantly between the different methods of extraction. With the exception of the PO2 and oxygen saturation, the 3 methods used to extract the pleural fluid to determine the acid-base balance showed no significant or clinically relevant differences, and presented good correlations, particularly with respect to pH.

Only 1 previous study has evaluated differences in pH according to the method used to obtain the pleural fluid (MEDLINE search, 1996-2007). In that study, Goldstein et al10 analyzed 20 pleural effusions, mainly of lymphocytic exudates of nonspecific etiology, without observing significant differences in the pH values between the 2 methods used to extract the fluid. They included a smaller number of patients than we did, only compared direct extraction of the fluid from the pleural space with the filling of the heparinized syringe from the fluid obtained using the 20-mL syringe.
Better-known importance of the pH and PCO2; nevertheless, unknown clinical utility of pleural PO2 compared to the use of oxygen when the heparinized syringe is being filled.3,7,16 This technique does not prevent the entry of small bubbles of pleural fluid and the use of gas analyzers, indicate that following the current recommendations on the processing of the fluid samples.7,11-13 The higher PO2 and the stability of the other parameters analyzed in this study, despite the following the current recommendations on the processing of pleural fluid and the use of gas analyzers, indicate that this technique does not prevent the entry of small bubbles of oxygen when the heparinized syringe is being filled.7,16 However, this increase is of little importance given the better-known importance of the pH and PCO2; nevertheless, these results are sufficient to recommend against evaluation of the PO2 when the pleural fluid is not obtained by direct aspiration.

The absence of significant differences in the values of the pH and PCO2 confirms that the method used to obtain pleural fluid for study of the acid-base balance does not affect the management of these patients and provides clinically useful information for the general management of patients with pleural effusions.1,20-23 In daily practice, the use of a single syringe reduces the duration of thoracentesis and the risk associated with an increase in the number of manipulations or changes of syringe during the procedure. It is likely that this will reduce the risk of pneumothorax due to entry of air into the pleural space through the needles or to an accidental lesion to the lung parenchyma during the changes of syringe.7,10 Our study indicates that, in this type of patient, pleural fluid may be obtained with a single puncture using a larger syringe and that this fluid may be introduced into a heparinized syringe to determine the acid-base balance without risk that its values will be significantly affected.

REFERENCES