patient also developed an episode of acute cellular rejection A1 and renal failure, but both situations had been resolved by the time of discharge.

In short, lobar transplantation is a valuable option to optimize lung donation and to adapt the graft size in special situations, such as pediatric cases or small chest cavities. Usually these recipients cannot wait for a perfect sized donor. However, it is important to consider some type of cardiorespiratory assistance to protect lobar grafts during both the intraoperative (cardiopulmonary bypass or ECMO) and postoperative period (mainly ECMO), depending on the clinical scenario and preferences of the surgical group. In this particular case, lobar transplantation was combined with an unusual approach, a posterolateral thoracotomy. For that reason, until central ECMO was established, we decided to maintain the lobar graft without blood flow and without ventilation.

Other alternative surgical strategies for this transplant were considered, but ruled out. The possibility of right pneumonectomy, with the implantation of a single left lung, was rejected due to problems that might occur in association with the healing of the bronchial stump and pneumonectomy cavity. Performing the transplant using peripheral veno-arterial ECMO was also ruled out due to the risk of cannulas displacement during intraoperative positional changes.

In conclusion, given that the patient's right cavity could only accommodate 2 lobes, and that the best approach for this procedure was posterolateral thoracotomy, we believe that maintaining the bilobar graft without blood flow or ventilation until the establishment of cardiorespiratory assistance was a valid strategy.

Acknowledgements

We thank the Departments of Respiratory Medicine, Anesthesiology and Transplant Coordination of the Hospital Universitario Puerta de Hierro-Majadahonda.

References

1. Inci I, Schuurmans MM, Kestenholz P, Schneiter D, Hillinger S, Opitz I, et al. Long-term outcomes of bilateral lobar lung transplantation. Eur J Cardiothorac Surg. 2013;43:1220–5.
2. Stanzi A, Decaluwe H, Coosemans W, de Leyn P, Nafteus P, van Veer H, et al. Lobar lung transplantation from decesased donors: a valid option for small-sized patients with cystic fibrosis. Transplant Proc. 2014;46:3154–9.
3. Snell GI, Yusen RD, Weill D, Strueber M, Garrity E, Reed A, et al., Report of the ISHLT Working Group on Primary Lung Graft Dysfunction, part I: definition and grading – a 2016 Consensous Group statement of the International Society for Heart and Lung Transplantation. J Heart Lung Transplant. 2017;36:1097–103.

José Luis Campo-Cañaveral de la Cruz,* David Gómez de Antonio, Álvaro Sánchez Calle, Alejandra Romero Román

Servicio de Cirugía Torácica y Trasplante Pulmonar, Hospital Universitario Puerta de Hierro-Majadahonda, Madrid, Spain

* Corresponding author.
E-mail address: jluiscampo82@gmail.com
(J.L. Campo-Cañaveral de la Cruz).

1579-2129/

Graphical Analysis Methods in Obstructive Spirometry: Does a Picture Speak More Than a Thousand Words?☆

Métodos de análisis gráfico de obstrucción espirométrica: ¿una imagen vale más que mil palabras?

To the Editor,

The evaluation of airway obstruction is fundamental in the management of asthma and COPD. Obstruction is usually quantified by spirometry, comparing FEV1 and FEV1/FVC with reference values.[1] A reduced expiratory flow caused by obstruction of the small airways produces a concave pattern on the expiratory flow–volume curve (EFVC) in forced exhalation.[2] The standard practice of direct observation is subject to a certain degree of variability. As an alternative, if high quality maneuvers are obtained,[1] the graphic properties of this curve can be measured objectively, although this method is relatively unknown in the literature and standard practice.[3] The additional information provided by this method should increase the sensitivity of the diagnosis of obstruction, especially in patients with normal values on standard spirometry.

In this study, we describe the different techniques for measuring bronchial obstruction using curvilinear graphical analysis.

We performed a non-systematic review of the literature in the Pubmed database using the terms "concavity", "curvilinearity" and "spirometry". Prospective and retrospective search techniques were then applied. Studies were selected that assessed the diagnostic and prognostic capacity of curvilinear analytical methods.

We retrieved 13 articles describing 4 methods of evaluating obstruction using EFVC analysis.

The angle beta (Aβ) was created[3] in order to quantify the level of concavity of the EFVC. To this end, two straight lines were plotted: one from the point of residual volume to the EFVC at 50% of expiratory volume and one from 50% expiratory volume to the extrapolation of the peak expiratory flow on the vertical axis, corresponding to total lung capacity (Fig. 1a). Aβ is measured at the point where these two straight lines intersect.

In adult patients, Aβ has been used to quantify obstruction in patients with asthma[4] and COPD.[3,5] Reference values for pediatric patients have been described.[6] One study showed a 91% specificity for distinguishing patients with atopic asthma from healthy controls.[7] A lower Aβ measured by *z*-score was observed in patients with wheezing and spirometric obstruction than in healthy patients.[8]

An improvement in the Aβ in adults with asthma was recorded after treatment with inhaled corticosteroids[9] and bronchodilators.[4] A study in pediatric and adult patients[10] showed a significant correlation ($r=-0.959$) with the visual estimation of concavity by experts.

The degree of obstruction can be estimated by the area under the curve (AUC).[11,12] To achieve this, the area of a right-angled triangle (At) with one cathetus originating from the extrapolation of the peak expiratory flow (PEF) at the level of the abscissa (Xp) and the other running from this point to the point of residual volume, with the hypotenuse connecting both ends is calculated (Fig. 1b). Specific software is used to determine expiratory AUC, which, when subtracted from the At can be used to quantify the area Au (between

☆ Please cite this article as: Maritano Furcada J, Rodríguez CI, Wainstein EJ, Benito HJ. Métodos de análisis gráfico de obstrucción espirométrica: ¿una imagen vale más que mil palabras?. Arch Bronconeumol. 2019;55:272–274.

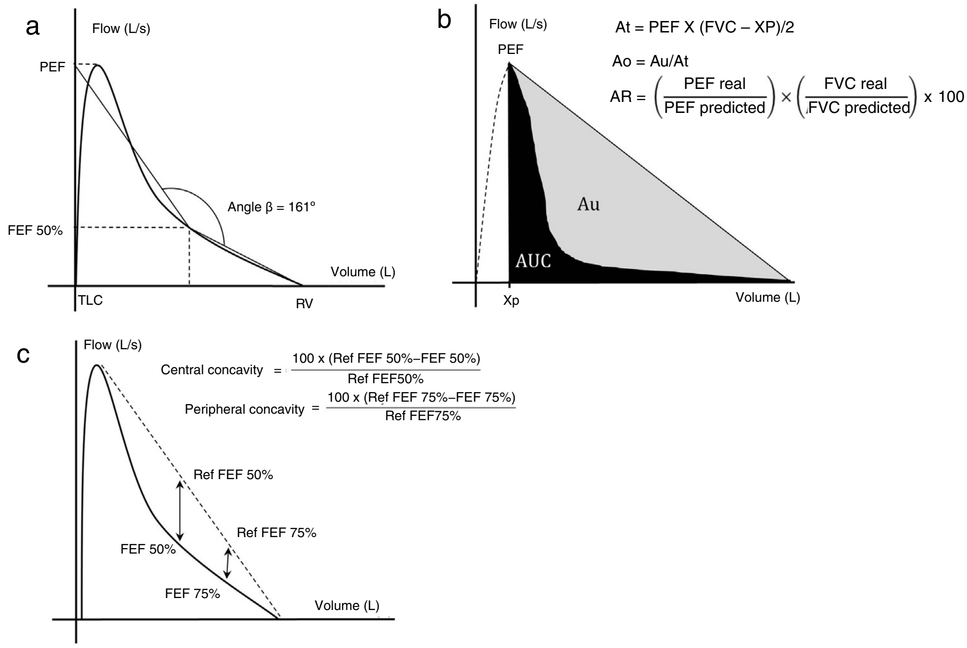

Fig. 1. (a) Measuring angle β. (b) Area under the curve method. (c) Central and peripheral concavity. Each method is described in the text.
Ao: obstructive area; AR area: area of the rectangle; At: area of the triangle; Au: area between the hypotenuse of the triangle and the expiratory forced expiration curve; AUC: area under the curve; FEF50%: forced expiratory flow at 50% of vital capacity; FEF75%: forced expiratory flow at 75% of vital capacity; L/s: liters per second; PEF: peak expiratory flow; Ref: reference; RV: residual volume; TLC: total lung capacity; Xp: extrapolation of PEF in the abscissa.
Graphics adapted from Dominelli et al.,[5] Lee et al.,[11] and Johns et al.[15]

the hypotenuse of the triangle and the EFVC). Given that this area depends on the degree of concavity and the anthropometric characteristics of the subject, the obstructive area (Ao=Au/At), which is proportional to the degree of obstruction, is used.

Using the same catheti mentioned above, the area of the rectangle (AR) can be calculated from the ratio between a real and a predicted rectangle.

By studying these variables and their ratios, both Ao/AR and Ao/PEF were found to correlate closely with RV/TLC (r=0.718 and r=0.780, respectively; P=.001 for both) and distance walked on a 6-minute walk test (r=−0.618 and r=−0.581, respectively; P<.01 both).[11] Furthermore, in a study of AUC/At in the first 3 s of expiration,[12] a strong correlation (r=0.88; P<.001) was observed with obstruction measured by FEV1/FVC and a kappa of 0.72 for the diagnosis of COPD according to Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria.

EFVC concavity can be quantified using mathematical models. Hyperbolic[13] and quadratic[14] functions have been used to estimate the curve. The greatest difference between functions is that in one, maximum curvature (Kmax) is estimated while in the other, the average curvature index (ACI) is determined.

A negative exponential relationship between Kmax and FEV1 has been found in a heterogeneous population of adults.[13] In pediatric patients with asthma, moreover, a regular correlation (r=0.53; P<.001) was observed between ACI and symptoms that was higher than that of the traditional spirometric variables (r=−0.22 for FEV1; P=.14).[14]

Concavity indices are calculated by comparing forced expiratory flows (FEF50% and 75%) with the reference values (estimated by extrapolation of their points toward a straight line that joins PEF with the point of residual volume) (Fig. 1c).

A study of non-smokers[15] showed a higher prevalence of obstruction according to central (12%–14.6%) and peripheral (14.6%–17.9%) concavity compared with FEV1 (6.2%–8.0%), and FEV1/FVC (5.6%–8.3%) that was not associated with clinical outcomes, suggesting possible overdiagnosis. There was a high correlation (between r=−0.710 and −0.789) for concavity indices and FEV1/FVC.

Curvilinear analysis techniques showed variable usefulness in the diagnosis of obstruction, association with therapeutic response, and the presence of symptoms. The populations evaluated were heterogeneous in terms of etiology and age range. No comparisons were made between methods, and the methods for demonstrating diagnostic utility vary among the studies. The methods involve a risk of overdiagnosing obstruction, and standardized limits are not available for some. The pediatric population may benefit from the use of these techniques, since their standards of obstruction are less sensitive.

The wider dissemination of these methods could lead to new applications in medical practice. However, there is not enough evidence to recommend any method in a systematic way. It would be useful to evaluate these methods in symptomatic patients without spirometric obstruction with the aim of detecting a population who might benefit from treatment.

References

1. Pellegrino R, Viegi G, Brusasco V, Crapo RO, Burgos F, Casaburi R, et al. Interpretative strategies for lung function tests. Eur Respir J. 2005;26:948–68.
2. Hogg JC, Macklem PT, Thurlbeck WM. Site and nature of airway obstruction in chronic obstructive lung disease. N Engl J Med. 1968;278:1355–60.
3. Kapp MC, Schachter EN, Beck GJ, Maunder LR, Witek TJ Jr. The shape of the maximum expiratory flow volume curve. Chest. 1988;94:799–806.
4. Ohwada A, Takahashi K. Concave pattern of a maximal expiratory flow–volume curve: a sign of airflow limitation in adult bronchial asthma. Pulm Med. 2012;2012:797495.
5. Dominelli PB, Foster GE, Guenette JA, Haverkamp HC, Eves ND, Dominelli GS, et al. Quantifying the shape of the maximal expiratory flow–volume curve in mild COPD. Respir Physiol Neurobiol. 2015;219:30–5.
6. Nève V, Edmé J-L, Baquet G, Matran R. Reference ranges for shape indices of the flow–volume loop of healthy children. Pediatr Pulmonol. 2015;50:1017–24.
7. Park SH, Im MJ, Eom S-Y, Hahn Y-S. Accuracy of maximal expiratory flow–volume curve curvilinearity and fractional exhaled nitric oxide for detection of children with atopic asthma. Korean J Pediatr. 2017;60:290–5.
8. Nève V, Matran R, Baquet G, Methlin C-M, Delille C, Boulenguez C, et al. Quantification of shape of flow–volume loop of healthy preschool children

and preschool children with wheezing disorders. Pediatr Pulmonol. 2012;47:884–94.
9. Kraan J, van der Mark TW, Koëter GH. Changes in maximum expiratory flow–volume curve configuration after treatment with inhaled corticosteroids. Thorax. 1989;44:1015–21.
10. Weiner DJ, Forno E, Sullivan L, Weiner GA, Kurland G. Subjective and objective assessments of flow–volume curve configuration in children and young adults. Ann Am Thorac Soc. 2016;13:1089–95.
11. Lee J, Lee C-T, Lee JH, Cho Y-J, Park JS, Oh YM, et al., KOLD Study Group. Graphic analysis of flow–volume curves: a pilot study. BMC Pulm Med. 2016;16:18, http://dx.doi.org/10.1186/s12890-016-0182-8.
12. Li H, Liu C, Zhang Y, Xiao W. The Concave shape of the forced expiratory flow–volume curve in 3 seconds is a practical surrogate of FEV1/FVC for the diagnosis of airway limitation in inadequate spirometry. Respir Care. 2016;62:363–9.
13. Zheng C-J, Adams AB, McGrail MP, Marini JJ, Greaves IA. A proposed curvilinearity index for quantifying airflow obstruction. Respir Care. 2006;51:40–5.
14. Wildhaber JH, Sznitman J, Harpes P, Straub D, Möller A, Basek P, et al. Correlation of spirometry and symptom scores in childhood asthma and the usefulness of curvature assessment in expiratory flow–volume curves. Respir Care. 2007;52:1744–52.
15. Johns DP, Das A, Toelle BG, Abramson MJ, Marks GB, Wood-Baker R, et al. Improved spirometric detection of small airway narrowing: concavity in the expiratory flow–volume curve in people aged over 40 years. Int J Chron Obstruct Pulmon Dis. 2017;12:3567–77.

Joaquín Maritano Furcada,* César Ignacio Rodríguez, Esteban Javier Wainstein, Hernán Javier Benito

Servicio de Neumonología, Hospital Italiano de Buenos Aires, Buenos Aires, Argentina

* Corresponding author.
E-mail address: joaquin.maritano@hospitalitaliano.org.ar (J. Maritano Furcada).

1579-2129/

Current Management of Pleural Effusion: Results of a National Survey☆

Resultados de una encuesta nacional sobre la situación actual del manejo del derrame pleural

To the Editor,

Between 4% and 10% of respiratory problems in pulmonology departments involve pleural effusion (PE), and more than 3000 individuals per million inhabitants are affected.[1] In the last decade, there has been a significant advance in diagnostic and therapeutic techniques in this disease that have led to modifications in management algorithms.[2–5] However, the management of PE in our setting has not been fully characterized. Surveys or clinical audits are evaluation strategies aimed at improving the quality of the processes and outcomes of a clinical service. In other countries, such as the United Kingdom, some scientific societies have conducted audits focused on collecting data in clinical practice, which has allowed them to define and assess areas for improvement.[6–8]

An understanding of the organization and specific aspects of care in this disease could help us develop recommendations to try to achieve quality care. For this reason, and with the aim of assessing the current state of affairs, we conducted this study. The main objective was to describe clinical care and to collect data on patient management, safety aspects, ethical and legal considerations, and on teaching and research activity in PE.

Between July and October 2016, we carried out a multicenter cross-sectional study in Spain, with a survey that was sent to pulmonology department heads, managers, and physicians specializing in pleural diseases in public sector hospitals of different levels of complexity. Hospital complexity was classified according to criteria used in other studies performed in Spain.[9] Study sites were selected randomly, and 129 hospitals were included. The respondents were contacted by email, and invited to complete the survey on an online platform. This survey included 22 items on different organizational, care, teaching and research aspects.

The survey was completed by 48 (37%) professionals, 24 (50%) heads of department, 11 (23%) heads of unit, and 13 specialists in PE; 23 (48%) hospitals were centers of medium complexity (between 200 and 500 beds and more than 50 interns) and 25 (52%) were high complexity (ample technological resources, more than 500 beds and between 160 and 300 interns). The survey was not completed by any low complexity center. Table 1 shows the results of the analysis of the different items by complexity of the center.

Significant differences can be observed among Spanish hospitals in terms of organization of the care of pleural disease, associated mainly with the complexity of the centers. According to data from the White Paper on Respiratory Medicine,[10] which surveyed nearly 500 pneumologists in 2014, there were only specific pleura clinics in 12% of the centers with less than 750 beds and in 20% of those with more than 750 beds. Although in our survey, 52% and 72% of the hospitals of medium and high complexity, respectively, claimed to have a pleura unit, this was integrated into the bronchoscopy unit in 83% and 66% of the sites, respectively. Only 13% of hospitals of medium complexity and 36% of high complexity had dedicated pleura clinics: these results are similar to those published in the White Paper.[10] In 96% of the centers, PE is studied on an outpatient basis, with no differences between centers. In a previous study, we found that ambulatory care can be delivered with a high level of efficiency and equal level of safety.[11]

The number of centers that perform advanced procedures such as thoracoscopy or tunneled drainage is limited, especially in hospitals of medium complexity. However, the percentage of hospitals that include conventional chest tubes or talc slurry pleurodesis in their portfolio of services is higher, and both procedures are therapeutic alternatives in infectious or malignant PE.[4,5] The White Paper found that 35% of pulmonologists do not perform ultrasound, tube placement, pleurodesis, or fibrinolysis.[10] The results for some of these procedures were different in this survey, but this may be because some were inappropriately recorded. It would appear necessary that all pleural techniques be centralized, thus justifying the creation and development of specific units to which value may be added by incorporating more advanced procedures.

In 2015, the British Thoracic Society published the details of their second audit.[8] They found a greater use of informed consent and an increase in the use of ultrasound guidance for chest tube insertion, from 52% to 69%. Ultrasound was available in 82%

☆ Please cite this article as: Botana-Rial M, Núñez-Delgado M, Leiro-Fernández V, Fernández-Villar A. Resultados de una encuesta nacional sobre la situación actual del manejo del derrame pleural. Arch Bronconeumol. 2019;55:274–276.