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Editorial

# Functional Respiratory Assessment Before Lung Volume Reduction in Patients With Emphysema☆

## Valoración funcional respiratoria previa a la reducción de volumen pulmonar en pacientes con enfisema

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Severe pulmonary emphysema is characterized by a reduction in the elasticity of the lung that limits airflow and increases airway resistance, resulting in functional problems such as air trapping and pulmonary hyperinflation.[1] Hyperinflation has been associated with loss of exercise capacity and quality of life, worsening respiratory muscle function and chest mechanics, and increased mortality.[2] The main objective of volume reduction treatment in these patients is to reduce the excess dead space that cannot be reached with bronchodilator therapy. This can be done in 2 ways: with lung volume reduction surgery (LVRS) or using bronchoscopy techniques (bronchoscopic lung volume reduction (BLVR)).

The first randomized controlled clinical trial of LVRS in patients with severe pulmonary emphysema, the NETT study, was published in 2003.[3] Patients were included if they had $FEV_1 \geq 15\%$ and $\leq 45\%$, total lung capacity (TLC)$\geq$100%, residual volume (RV)$\geq$150%, $PaO_2 \geq 45$ mmHg, $PaCO_2 \leq 60$ mmHg, and 6-min walk test (6MWT)>140 m. These values were based on previous studies that demonstrated the beneficial effects of this technique.[4] The NETT study showed the superiority of LVRS over conventional treatment in quality of life, lung function, and survival, but only in patients with poorer exercise capacity (maximum work load <25 watts in women and <40 watts in men) and heterogeneous emphysema, predominantly in the upper lobes. Emphysema is defined as heterogeneous when the difference in lung density between the lobe to be treated and the ipsilateral contiguous lobe is greater than or equal to 15%, measured by high-resolution computed tomography (CT).[5] Morbidity and mortality were very high, especially in the patient subgroup with worse lung function ($FEV_1$ and/or DLCO<20%), so the intervention is not recommended in these patients. Subsequent studies showed similar results.[6] Volume reduction in the NETT study improved exercise capacity and $CO_2$ elimination, reduced dead space ventilation, improved breathing patterns, and reduced dyspnea.[7]

Some years later, inspired by the effectiveness of LVRS, BLVR was developed as a strategy that would avoid the risks of surgery.[8] Several techniques are now available, including endobronchial valves, endobronchial coils, foam sealants, and thermal vapor ablation.[8]

Lung function is a basic consideration when selecting patients who may benefit from this approach. Recommended values are $FEV_1$ 15%–50%, RV$\geq$150%, TLC>100%, DLCO>20%, and $PaCO_2$<50 mmHg. All these parameters indicate a patient with severe or very severe obstruction, air trapping, and hyperinflation, who would be an ideal candidate to benefit from BLVR.[6] To undergo this procedure, the patient must also be symptomatic, be receiving optimal medical treatment (including respiratory rehabilitation), and have dyspnea$\geq$mMRC grade 2.[8] A distance of >140 m on the 6MWT[8] and DLCO>20% are recommended[8] Lung function values to select candidates for BLVR are arbitrary figures that have been extracted from studies carried out with LVRS. Other lung function parameters have also been found to predict a better response, including lung compliance, airway resistance, respiratory muscle function, and most importantly, an RV/TLC ratio greater than 0.67.[1] New functional studies are available, such as optoelectronic plethysmography, used to assess the degree of asynchrony between the compartments of the abdomen and the rib cage, and to identify patients who might benefit most from volume reduction.[9]

Volume reduction is generally inadvisable in patients with $FEV_1$ and DLCO<20%, since these subjects have shown a poorer prognosis. Nevertheless, there is no contraindication for the use of valves and coils in a subgroup of patients with values close to these who are candidates for lung transplantation: in these subjects, the procedure increases the possibility of accessing transplantation in better conditions. Surgical reduction, on the contrary, may complicate a possible dissection procedure during lung transplantation.[10]

BLVR in patients with severe pulmonary emphysema with the characteristics mentioned above has been shown to improve lung function (increased $FEV_1$ and reduced RV and TLC), quality of life, and exercise tolerance, irrespective of the device used,[8] although

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each device has its particular characteristics. The most widely used devices are endobronchial valves and coils. For the valves to function correctly and achieve lobar exclusion, there must be no collateral ventilation. To ensure this, the integrity of the fissures must first be assessed with CT or by bronchoscopy with a catheter that can measure pressures after occluding the target areas with a balloon.[11] Integrity of the fissure is not required for coils, since they can work in patients with collateral ventilation, although they do require the presence of residual parenchyma in the area of insertion so they can be retracted, thus reducing the volume.[12]

In summary, the use of BLVR has greatly improved the treatment of emphysema, since the patient is better characterized, and a choice of several devices is available. It is essential that candidates for lung volume reduction are correctly selected in order to ensure the success of the procedure. In this respect, we must be very careful to include patients with the required lung function parameters ($FEV_1$ above 15%–50%, RV>150%, TLC>100%, 6MWT>140 m, PaCO<50 mmHg and DLCO>20%), and we must also confirm the absence of collateral ventilation (endobronchial valves). These parameters are also applicable to LVRS, but this procedure has been overtaken by BLVR, and we are in no doubt that we are moving in the right direction. Volume reduction remains a field where there is much room for improvement but one which has great potential for the future.

## References

1. Fessler HE, Scharf SM, Ingenito EP, McKenna RJ, Sharafkhaneh A. Physiologic basis for improved pulmonary function after lung volume reduction. Proc Am Thorac Soc. 2008;5:416–20.
2. Criner GJ. Lung volume reduction as an alternative to transplantation for COPD. Clin Chest Med. 2011;32:379–97, http://dx.doi.org/10.1016/j.ccm.02.014.
3. Fishman A, Martinez F, Naunheim K, Piantadosi S, Wise R, Ries A, et al. A randomized trial comparing lung-volume-reduction surgery with medical therapy for severe emphysema. N Engl J Med. 2003;348:2059–73.
4. Geddes D, Davies M, Koyama H, Hansell D, Pastorino U, Pepper J, et al. Effect of lung-volume-reduction surgery in patients with severe emphysema. N Engl J Med. 2000;343:239–45.
5. Valipour A, Shah PL, Gesierich W, Eberhardt R, Snell G, Strange C, et al. Patterns of emphysema heterogeneity. Respiration. 2015;90:402–11, http://dx.doi.org/10.1159/400043954.
6. Hillerdal G, Löfdahl C, Ström K, Skoogh B, Jorfeldt L, Nilsson F, et al. Comparison of lung volume reduction surgery and physical training on health status and physiologic outcomes. A randomized controlled clinical trial. Chest. 2005;128:3489–99.
7. Criner GJ, Belt P, Sternberg AL, Mosenifar Z, Make BJ, Utz JP, et al. Effects of lung volume reduction surgery on gas exchange and breathing pattern during maximum exercise. Chest. 2009;135:1268–79.
8. van Agteren JE, Hnin K, Grosser D, Carson KV, Smith BJ. Bronchoscopic lung volume reduction procedures for chronic obstructive pulmonary disease. Cochrane Database Syst Rev. 2017;2:CD012158.
9. Zoumot Z, LoMauro A, Aliverti A, Nelson C, Ward S, Jordan S, et al. Lung volume reduction in emphysema improves chest wall asynchrony. Chest. 2015;148:185–95.
10. Shigemura N, Gilbert S, Bhama JK, Crespo MM, Zaldonis D, Pilewski JM, et al. Lung transplantation after lung volume reduction surgery. Transplantation. 2013;96:421–5.
11. Shah PL, Herth FJ, van Geffen WH, Deslee G, Slebos D. Lung volume reduction for emphysema. Lancet Respir Med. 2017;5:147–56.
12. Hartman JE, Klooster K, Gortzak K, ten hacken NHT, Slebos D. Long-term follow-up after bronchoscopic lung volume reduction treatment with coils in patients with severe emphysema. Respirology. 2015;20:319–26, http://dx.doi.org/10.1111/resp.12435.