

Journal Pre-proof

DIAGNOSIS AND MANAGEMENT OF EXERCISE-INDUCED LARYNGEAL OBSTRUCTION (EILO): INITIAL RESULTS OF A MULTIDISCIPLINARY TEAM

Diego A. Rodríguez-Chiaradía Anna Rodó-Pin Clara Espina María Araceli Caballero-Rabasco Pilar Ausin Antonio Sancho Muñoz Julia Preckler Mireia Admetlló Ester Marco Navarro Jacinto García-Lorenzo



PII: S0300-2896(24)00361-2

DOI: <https://doi.org/doi:10.1016/j.arbres.2024.08.007>

Reference: ARBRES 3650

To appear in: *Archivos de Bronconeumología*

Received Date: 27 May 2024

Accepted Date: 30 August 2024

Please cite this article as: Rodríguez-Chiaradía DA, Rodó-Pin A, Espina C, Caballero-Rabasco MA, Ausin P, Muñoz AS, Preckler J, Admetlló M, Navarro EM, García-Lorenzo J, DIAGNOSIS AND MANAGEMENT OF EXERCISE-INDUCED LARYNGEAL OBSTRUCTION (EILO): INITIAL RESULTS OF A MULTIDISCIPLINARY TEAM, *Archivos de Bronconeumología* (2024), doi: <https://doi.org/10.1016/j.arbres.2024.08.007>

This is a PDF file of an article that has undergone enhancements after acceptance, such as the addition of a cover page and metadata, and formatting for readability, but it is not yet the definitive version of record. This version will undergo additional copyediting, typesetting and review before it is published in its final form, but we are providing this version to give early visibility of the article. Please note that, during the production process, errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

© 2024 Published by Elsevier España, S.L.U. on behalf of SEPAR.

DIAGNOSIS AND MANAGEMENT OF EXERCISE-INDUCED LARYNGEAL
OBSTRUCTION (EILO): INITIAL RESULTS OF A MULTIDISCIPLINARY TEAM

Diego A. Rodríguez-Chiaradía¹⁻⁴, Anna Rodó-Pin¹⁻³, Clara Espina^{6,2,3}, María Araceli Caballero-Rabasco^{7,3}, Pilar Ausin^{5,2,3}, Antonio Sancho Muñoz^{5,2,3}, Julia Preckler⁸⁻⁹, Mireia Admetlló^{5,2}, Ester Marco Navarro⁸⁻⁹, Jacinto García-Lorenzo^{6,2,3}

¹ Cardiopulmonary Exercise Testing Laboratory, Pulmonology Department, Hospital del Mar- Barcelona, Spain.

² Hospital del Mar Research Institute, Barcelona, Spain.

³ Department of Medicine and Life Sciences (MELIS), Universitat Pompeu Fabra (UPF), Barcelona, Spain.

⁴ Centro de Investigación en Red de Enfermedades Respiratorias, (CIBERES), Instituto de Salud Carlos III (ISCIII), Barcelona, Spain.

⁵ Specialized Asthma Unit, Pulmonology Department, Hospital del Mar, Barcelona, Spain.

⁶ Otorhinolaryngology Department, Hospital del Mar, Barcelona, Spain.

⁷ Pediatric Allergy and Pulmonology Unit, Pediatric Service, Hospital del Mar, Barcelona, Spain.

⁸ Department of Physical Medicine and Rehabilitation, Hospital del Mar, Hospital de l'Esperança, Barcelona, Spain.

⁹ Rehabilitation Research Group, Hospital del Mar Research Institute, Barcelona, Spain.

Dr. Diego A. Rodríguez-Chiaradía

Head of Pulmonology Department

Hospital del Mar, Passeig Maritim 25-29 08003 Barcelona, Spain

Phone: +34 93 2483584 Email: darodriguez@psmar.cat

Keywords: Exertional dyspnea; laryngeal dysfunction, complex asthma, pediatric asthma.

Due to the nature of the approach and services involved in the diagnosis and management of these patients we exceptionally included 10 authors.

Dear editor:

Exercise-Induced Laryngeal Obstruction (EILO) indicates an inappropriate, transient, reversible narrowing of the larynx in response to exercise¹. EILO is an important cause of a variety of respiratory symptoms that frequently mimic asthma and/or dysfunctional breathing, with a prevalence in general populations of older children and adolescents between 7% and 16%¹. Although the European Respiratory Society and the European Laryngological Society established the basis for the current diagnosis and management of EILO on 2017, most aspects of this condition are still not fully understood¹. Diagnosis of EILO requires a high degree of clinical suspicion and confirmation by visualization of the larynx during exercise by the gold standard test, known as Continuous Laryngoscopy during Exercise (CLE). CLE is a complex diagnostic test that requires the participation of pneumologists and otolaryngologist to record the movements of the larynx during an exercise test. This complexity is a major barrier due to the limited access to the test for the general population². In addition, the subsequent management and treatment require a multidisciplinary team to ensure a proper approach³. Particularly in Spain, there are very few reports of this disease⁴ and, to the best of our knowledge, there is no multidisciplinary team dedicated to EILO throughout the country. In 2021, we established a multi-disciplinary EILO team consisting of specialists in otorhinolaryngology, pulmonary medicine, rehabilitation medicine, speech language pathologist, physiotherapy and pediatric medicine in our tertiary hospital. The main objective of this study is to describe the initial results on the diagnosis and treatment of EILO in a cohort of patients referred to our multidisciplinary team.

The protocol (ID 2024-11454) was initiated by clinical suspicion raised by the pulmonologist or pediatrician. Subsequently, the otolaryngologist scheduled a

fiber optic laryngoscopy at rest. After confirming a correct larynx evaluation at rest, the patient was scheduled for CLE¹. Patients signed the informed consent before CLE. The patients underwent a CLE on a cycle ergometer following an incremental protocol, which consists on a progressively increasing load (watts) every minute until the patient reaches exhaustion, and maximum values. It was performed on a cycle ergometer (Ergoline Ergometrix 900, Überprüfung, Germany), with the patient monitored using a 12-lead electrocardiogram, oxygen saturation measured with a pulse oximeter (Wirstox2, Model 3150, Nonin, Plymouth, USA), and a gas analyzer (Medisoft Ergocard ® CPX clinical, Ergometrix). Objective variables such as oxygen consumption (VO_2), minute ventilation (VE), respiratory quotient, heart rate, blood pressure, and oxygen saturation were recorded, along with subjective variables obtained using the Borg scale (visual analog scale) to assess the level of dyspnea and leg discomfort perceived by the patient (before and after exercise). Laryngeal exploration was conducted using video nasopharyngoscopy introduced through the effort mask, following prior intranasal application of 2% lidocaine, which allows to visualize the airway during the test. Before starting the exercise, resting values were recorded, baseline spirometry was performed, and the maximum inspiratory capacity value was measured. Informed consent was obtained beforehand. With the laryngoscopy, we visualized the upper airway in order to look for abnormal adduction or collapse in both glottic and supraglottic space. Once the diagnosis of EILO was confirmed⁵, the patient was referred to the rehabilitation department, where the speech pathologist initiated individualized treatment. The treatment program comprised five 45-minute face-to-face sessions supervised by a speech therapist. Before beginning therapy, an interview took place involving the patient

and one family member (in the case of minors) along with the therapist. We aimed to understand the specific situations in which the obstruction occurred, including the type of physical activity, its intensity, frequency, duration, and the strategies of the patients response to the obstruction. Additionally, it was valuable to identify if laryngeal obstruction occurred in contexts unrelated to physical exercise. The therapist's examination involved both an interview and a functional assessment of posture at rest and in motion, as well as an evaluation of breathing (including type, mode, and respiratory rate). During the initial sessions, patients were instructed in biphasic inspiration and expiration lengthening, focusing on 1/4 cycles. The recommendation was to begin practicing these techniques at rest, gradually increasing exercise intensity. In the second session, the focus shifted to postural and breathing modifications, along with the introduction of laryngeal relaxation techniques. By the third session, we commenced, Inspiratory Muscle Training (IMT) using the Orygen Insp Valve (Forumed SL, Girona, Spain) for cases of glottic EILO. Subsequent sessions were dedicated to consolidating these techniques and determining the most effective way to generalize the appropriate breathing pattern for each patient.

Twenty CLE tests were performed in patients with suspected EILO from January 2022 to February 2024. Table 1 describes the clinical characteristics of the patients. Eight patients (40%) were under 15 years old; only six patients (30%) were older than 45 years old. Nine patients (45%) were referred from multidisciplinary asthma unit and three patients (15%) from outpatient respiratory clinics. All patients were referred due to inspiratory symptoms mainly at high-intensity level of exercise, with or without a combination of other symptoms including throat tightness (85%), dizziness (10%), upper chest tightness (15%),

noisy breathing (5%), stridor (5%), hoarseness (5%), cough (30%) changes of the voice (5%) and panic reaction (15%). On CLE, eight (40%) patients had EILO (4 of which presented glottic obstruction and the other 4 presented supraglottic obstruction, one of that patient was combined with a glottic obstruction) and thirteen (65%) patients showed dysfunctional breathing ⁶. We did not find any complication during CLE. Figure 1 shows the prevalence and coexistence of asthma, EILO, and dysfunctional breathing patterns. Of the five patients who started treatment, an average of 5 therapy sessions were required before discharge. Four patients reported more frequent and complete physical activity participation immediately post-therapy as well as reduced inhaler use in asthmatic patients.

According to our understanding, this is the first report of the approach to diagnosis and management of EILO implemented by a multidisciplinary team in Spain. The diagnosis of EILO is difficult to make based on clinical assessment because many potential confounding factors may be present². In this line, our results are similar to other series particularly in children and young adults under assessment by CLE ⁷. However, it has been recognized that self-reported symptoms are poor predictors of EILO, in which a high index of suspicion remains the key factor for diagnosis¹. There are some symptom questionnaires that attempt to detect EILO ⁸ in the context of inspiratory breathing difficulties in typical athletic children or young adults but none of them are validated in Spanish so far. Current analyses indicate that the multidisciplinary approach is the best option to achieve an adequate response to treatment. Our results, with up to 80% of patients experiencing symptom improvement, are similar to the few previous reports⁹⁻¹⁰. Although the analyses has limitations due to its small size and retrospective

nature, the work sets the scene for future multidisciplinary teams approaches for patients with suspected EILO. Pulmonologists are usually the first line providers, and they must be an essential part of these teams to detect symptoms and clinical presentation and to rule out other respiratory conditions, especially asthma².

In conclusion, the diagnosis of EILO is frequently delayed by the belief to be a rare disease and the nonspecific clinical presentation. Also, access to CLE test for diagnosis is limited to expert centers. Early diagnosis and specific treatment based on speech therapy and rescue breathing exercises decrease symptoms.

Legend of figure

Figure 1. Asthma, dysfunctional breathing and exercise-induced laryngeal obstruction (EILO) in subjects reporting exercise-induced dyspnea.

Conflict of Interest Statement

There are no conflicts of interest to report.

Funding Sources

No funding was used for this study.

BIBLIOGRAPHY

1. Halvorsen T, Walsted ES, Bucca C, Bush A, Cantarella G, Friedrich G, et al. Inducible laryngeal obstruction: an official joint European Respiratory Society and European Laryngological Society statement. *Eur Respir J*. 2017;50(3):1602221. <https://doi.org/10.1183/13993003.02221-2016>
2. Giraud L, Destors M, Clin R, Fabre C, Doutreleau S, Atallah I. Diagnostic work-up of exercise-induced laryngeal obstruction. *Eur Arch Otorhinolaryngol*. 2023;280(3):1273-81. <https://doi.org/10.1007/s00405-022-07654-7>
3. Ludlow S, Daly R, Elsey L, Hope H, Sheehan R, Fowler SJ. Multidisciplinary management of inducible laryngeal obstruction and breathing pattern disorder *Breathe (Sheff)*. 2023;19(3):230088. <https://doi.org/10.1183/20734735.0088-2023>
4. Ajami RIP, Arribas MB, Santiago VS, Gómez CM, Gil EA, Andújar FR, García PF, et al. Adaptation in Pediatric Population of the Continuous Laryngoscopy Exercise Test for Diagnosis of Exercise-inducible Laryngeal

- Obstruction. *Open Respir Arch.* 2021;3(2):100092.
<https://doi.org/10.1016/j.opresp.2021.100092>
5. Maat RC, Røksund OD, Halvorsen T, et al. Audiovisual assessment of exercise-induced laryngeal obstruction: reliability and validity of observations. *Eur Arch Otorhinolaryngol* 2009; 266: 1929–1936.
<https://doi.org/10.1007/s00405-009-1030-8>.
 6. Knöpfel G, Baty F, Uhl F, Kern L, Brutsche M. Quantification of breathing irregularity for the diagnosis of dysfunctional breathing using proportional tidal volume variation: a cross-sectional, retrospective real-world study. *BMJ Open.* 2024 Jun 16;14(6):e083401. <https://doi.org/10.1136/bmjopen-2023-083401>.
 7. Shay EO, Sayad E, Milstein CF. Exercise-induced laryngeal obstruction (EILO) in children and young adults: From referral to diagnosis. *Laryngoscope.*2020;130(6):E400-E406.
<https://doi.org/10.1002/lary.28276>
 8. Olin JT, Shaffer M, Nauman E, Durso CS, Fan EM, Staudenmayer H, et al. Development and validation of the Exercise-Induced Laryngeal Obstruction Dyspnea Index (EILODI). *J Allergy Clin Immunol.* 2022;149(4):1437-44. <https://doi.org/10.1016/j.jaci.2021.09.027>
 9. Fujiki RB, Olson-Greb B, Braden M, Thibeault SL. Therapy Outcomes for Teenage Athletes With Exercise-Induced Laryngeal Obstruction. *Am J Speech Lang Pathol.* 2023;32(4):1517-31.
https://doi.org/10.1044/2023_ajslp-22-00359
 10. Wells C, Makariou I, Barker N, Thevasagayam R, Sonnappa S. Paediatr *Respir Rev.* Exercise induced laryngeal obstruction (EILO) in children and

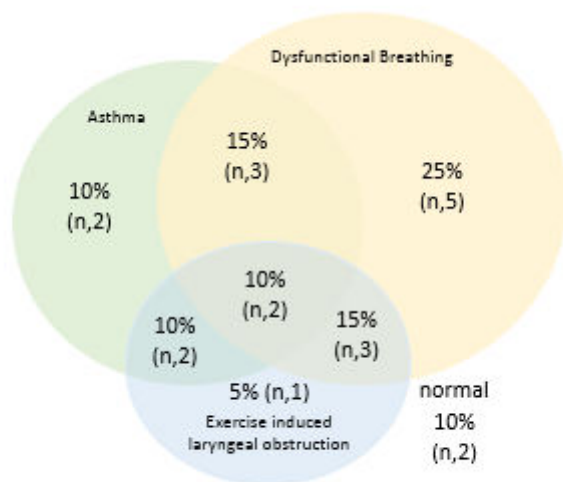
young people: Approaches to assessment and management 2023.

Paediatr Respir Rev. 2023;46:37-48.

<https://doi.org/10.1016/j.prrv.2023.04.003>

Journal Pre-proof

Fig.1



Journal Pre-proof

Table 1. General characteristics of the study population (n,20).

Clinical characteristics, median (P25-75)	
Age (years)	17 (13-47)
Female n, (%)	11, (55)
BMI (kg/m ²)	21 (19-27)
Current smokers n. (%)	8, (40)
Hemoglobin (g/l)	14 (13-15)
Hypertension n, (%)	2, (10)
Diabetes n, (%)	2, (10)
Dyslipidemia n, (%)	2, (10)
Pulmonary Function, median (P25-75)	
FEV ₁ (%)	100 (90-110)
FVC (%)	98 (91-107)
DLco (%)	101 (95-110)
Exercise Capacity median (P25-75)	
SpO ₂ final (%)	98 (96-100)
Workload (watts) peak	136 (114-156)
Heart rate peak beats per min	172 (159-181)
Heart rate peak (% predicted)	92 (88_96)
VO ₂ ml/kg/min peak	28 (21-34)
VO ₂ (% predicted)	74 (52-90)
V'E (l/min) peak	74 (63-88)

Abbreviations: BMI: Body Mass Index; FEV₁: Forced expiratory volume during first second; FVC: Forced Vital Capacity; DLco: Diffusing Capacity for Carbon Monoxide; SpO₂: Arterial Oxygen Ssaturation measured by Pulse Oximetry; VO₂: Oxygen Uptake; Max: Maximum; V'E: Minute Ventilation.