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Early View

Research letter

Is it feasible to perform Continuous Laryngoscopy Exercise (CLE) test with a cold air inhalate: a case report

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Title: Is it feasible to perform Continuous Laryngoscopy Exercise (CLE) test with a cold air inhalate: a case report.

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Take home message:

•The continuous laryngeal exercise (CLE) test can be combined with breathing cold air.

•Combining the CLE test and cold air did not cause excessive discomfort.

•The indicated laryngeal responses with cold air support the need for more research.

INTRODUCTION

Exercise induced laryngeal obstruction (EILO) describes laryngeal airflow obstruction during increased exercise (1), and is an important differential diagnosis for a variety of respiratory diseases, exercise-induced bronchoconstriction (EIB) being the most common (2). The EILO prevalence is reported as high as 27 percent among cross-country skiers (3), compared to five to seven percent in the general young population (4,5). Breathing cold air may trigger airway obstruction in patients with EIB, and increase the test sensitivity (7).

The continuous laryngoscopy during exercise test (CLE test) is the gold standard for diagnosing EILO (9), without additional triggers other than exercise. Studies have discussed whether breathing cold air might induce EILO (10-12). However, this has not been investigated systematically. We therefore aimed to see whether the CLE test is feasible to perform with cold air, in two patients with suspected EILO.

METHODS

Study subjects

Two female participants (age 27 and 28 years), otherwise healthy, with respiratory symptoms indicating EILO were recruited from a specialist clinic for pulmonary diseases. They had been tested to rule out EIB prior to inclusion.

The regional ethics committee granted ethical approval (REK 109946), and informed written consent was obtained from the participants.

Continuous laryngoscopy exercise test

The two participants each completed two CLE tests with one week apart, one while breathing room air (20 - 22°C) and one while breathing cold air (minus 15 °C). Spirometry was performed before and five minutes after CLE tests, measuring maximal expiratory flow volume curves (13).

The CLE test follows the setup described by Heimdal et al (9). A solution of 0.5 ml Lidocaine Hydrochloride (40 mg/mL) was applied in one of the nostrils. A flexible fiberoptic laryngoscope (Olympus ENF-V2, Tokyo, Japan), diameter 3.4 mm, was inserted via the nostril, to a position giving an optimal view of the larynx. The scope

was attached to a custom-made headgear and fixed to the nose using a plug in the nasal opening, taped externally on the wings of the nose. A nose clip closed the nasal opening. The laryngoscope allowed for video recording of the laryngeal inlet during the test.

The test protocol consisted of an eight-minute running test on a treadmill with a 5.5 percent incline (Woodway PPS 55 Med, Weil am Rheid, Germany). The participants were asked to maintain a steady heart rate of 90-95 percent of estimated maximum heartrate (220 beats per minute minus age) for the last six minutes. If the participants reached volitional exhaustion, they could stop earlier. Heart rate was measured using a heart rate monitor band (Polar H10, Kempele, Finland). The protocol was identical for both tests.

Breathing cold air

The TurboAire Challenger^{TM} (Equilibrated Bio Systems, Ind., Melvillle, NY) makes it possible to test ventilatory responses when breathing cold and dry air. The device is connected with medical air, and a pressure around 6.8 bar provides an airflow of 240 L/min, creating an air temperature of approximately minus 15°C (confirmed by a digital thermometer measuring at the outlet). The unit hung from the ceiling and was adjusted to the subject's height. Figure 1 illustrates the complete setup.

The CLE-score

CLE-score was graded according to Maat et al (14). The scoring system contains four sub-groups, each graded from 0 to 3 at glottic and supraglottic level at moderate and maximal effort. Higher scores indicate more laryngeal closure.

Borg scale (CR10)

Borg Scale (CR10) was used to estimate perceived breathlessness immediately after exercise (15). The scale goes from 0 (no breathlessness) to 10 (maximal breathlessness).

RESULTS

The practical setup

It was possible to combine the CLE test with the setup for breathing cold air, and the combination was well tolerated. Fixation of the laryngoscope directly to the nose and

not through the facemask (as we normally do) gave a more unstable laryngoscope, and it was challenging to keep a steady videorecording. The part of the laryngoscope outside the nose tended to touch the TurboAire Challenger™ during vigorous running, causing additional disruption in the video-recordings.

Continuous laryngoscopy exercise test

At maximal effort, participant A had glottic obstruction grade 1 in room air and 3 in cold air. Participant B had no glottic obstruction in room air and grade 1 in cold air. Supraglottic scores did not differ. Participant A aborted the test after three minutes in cold air and five minutes in room air, with no Borg score difference. Participant B had Borg score 6 in room air and 7 in cold air.

There was no difference in spirometry pre and five minutes post exercise.

DISCUSSION

The CLE test is feasible to perform while simultaneously breathing cold air. Both participants ran to exhaustion on both tests and evaluated them as equal according to discomfort. The video recordings were more unstable during the cold air setup. Both participants had increased glottic obstruction when breathing cold and dry air.

Methodological considerations

Video recording

It was more challenging to get satisfying videorecording of the larynx when the participants were breathing cold air. We introduced the laryngoscope through a fitted plug in the nasal vestibule, and combined with nose clips and tape, but the laryngoscope was still not as steady as fixing it through a facemask.

Breathing sounds

During a standard CLE test, breathing sounds are registered. Noise from the TurboAire Challenger™ made it difficult to register respiratory sounds properly, and it was periodically challenging to differentiate between inspiration and expiration. The participants also had difficulty communicating verbally while breathing cold air, and hand-signs were necessary to agree on beforehand.

Breathing cold air

The measured temperature in the TurboAire Challenger^{TM} was at least minus 15°C, both pre- and post-test. However, it is challenging to predict the exact temperature of the air that passed through the larynx, as the inspired air heats when entering the mouth. However, this is not different from breathing cold air while exercising outside in the cold. Notably, we cannot separate the effect of dry versus cold air with this method.

Previous studies have reported that being surrounded by cold air might impact the lung capacity (16). Using the setup described, air is traveling directly into the airways, and we are not able to investigate if being surrounded by cold air impacts EILO.

Cold air breathing may elicit bronchoconstriction in patients with airway hypereactivity (17). Thus, spirometry pre- and post-CLE test were performed five minutes post exercise to ensure that differences in lung function did not affect the test result.

Feasibility

When already having a CLE setup, the method does not require extensive resources and equipment to be performed. Besides breathing cold air, the original CLE setup is no different. This makes it easy for professionals familiar with the original CLE setup to perform this test.

Laryngeal findings

The participants had a higher score on glottic obstruction when breathing cold air, and one participant quit the test earlier. The difference in performance between the tests corresponds with a more severe CLE score, underpinning the importance of investigating a potential connection between breathing cold air and EILO. To minimize the possible influence of a learning effect from one test to another, we randomized the order. The method in this study might be useful for future studies, to explore whether breathing cold air worsens or even causes EILO, and whether a certain subtype (glottic or supraglottic) is more affected with cold air.

Participant A aborted the test before planned due to volitional exhaustion. Using an EIB-protocol to diagnose EILO is not optimal, and a stepwise protocol to exhaustion

may be more suitable to explore obstructions at different exercise intensities and at termination.

Next step

EILO patients should be investigated under different climatic conditions, like temperature, humidity and altitude.

CONCLUSION

It is feasible to combine the CLE test with breathing cold air.

COMPETING INTEREST

The authors have no conflicts of interest relevant to this article to disclose.

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Figure 1. CLE-test with setup for breathing cold air. An experimental setup for a continuous laryngoscopy exercise test performed on a treadmill. The participant is breathing through a TurboAire Challenger^TM biting over a mouthpiece. A wire connected to the celling adjusts the TurboAire Challenger^TM. A gas glask with a bar approximately 6.8 bar give the air a temperature around minus 15°C.