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Dynamic 320-slice CT larynx for detection and management of idiopathic bilateral vocal cord paralysis

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Abstract

Idiopathic bilateral vocal cord paralysis (VCP) is a rare and difficult condition often undiagnosed and frequently confused with asthma and other respiratory conditions. Accurate diagnosis is crucial since 80% of cases patients require surgical intervention, such as tracheostomy or laser surgery, to relieve symptoms. The "gold standard" for diagnosing VCP has been laryngoscopy. In this case study, we demonstrate for the first time that idiopathic bilateral VCP can be accurately diagnosed by means of a novel noninvasive methodology: dynamic volume 320-slice computed tomography larynx. Three-dimensional reconstruction of laryngeal motion during the breathing cycle permitted functional assessment of the larynx showing absence of vocal cord movements. The new methodology may be valuable for noninvasive diagnosis of vocal cord movement disorders before and for follow-up after surgery.

Introduction

Idiopathic bilateral vocal cord paralysis (VCP) is a rare and difficult condition to diagnose. Patients with the condition often complain of symptoms such as breathlessness, difficulty with swallow and stridor. Surgical intervention, such as tracheostomy, is needed in up to 80% of cases to relieve symptoms [1]. VCP can result from many causes, including surgery, trauma and viral infections but 50% of cases are of unknown origin [2].

The "gold standard" for diagnosing VCP is laryngoscopy. This procedure needs to be conducted by a skilled operator, requires specialized equipment and is often not done due to a lack of access to specialized services. 320-slice computed tomography (CT) larynx is a recent technological development that produces a dynamic "cine" view of the upper airway. It is possible to obtain dynamic images at a rate of 3/second that can be reconstructed as movement of the anatomical structure. The test does not require contrast and lasts less than a minute. Recent application in the upper airway has made it possible to detect movement abnormalities, such as in vocal cord dysfunction [3], and to demonstrate excessive dynamic upper airway collapse [1]. In this case report, we describe the first case of idiopathic bilateral VCP diagnosed using 320-slice CT larynx. The methodology was also useful to track progress after laser surgery.

Case Report

A 50-year-old previously healthy man presented with dyspnea on exertion over the preceding 5 years. The resulting dyspnea left the patient with a sensation of choking during mild or moderate exercise. The patient was a fit, nonsmoker, on no medication and had no known history of environmental or industrial exposures. He was initially diagnosed with asthma; however, symptoms were not alleviated by standard treatments. Physical examination was normal.

Spirometry was performed and inspiratory stridor was observed during the forced vital capacity maneuvre. The inspiratory limb of the flow volume loop appeared flattened and fixed extrathoracic obstruction was suspected.

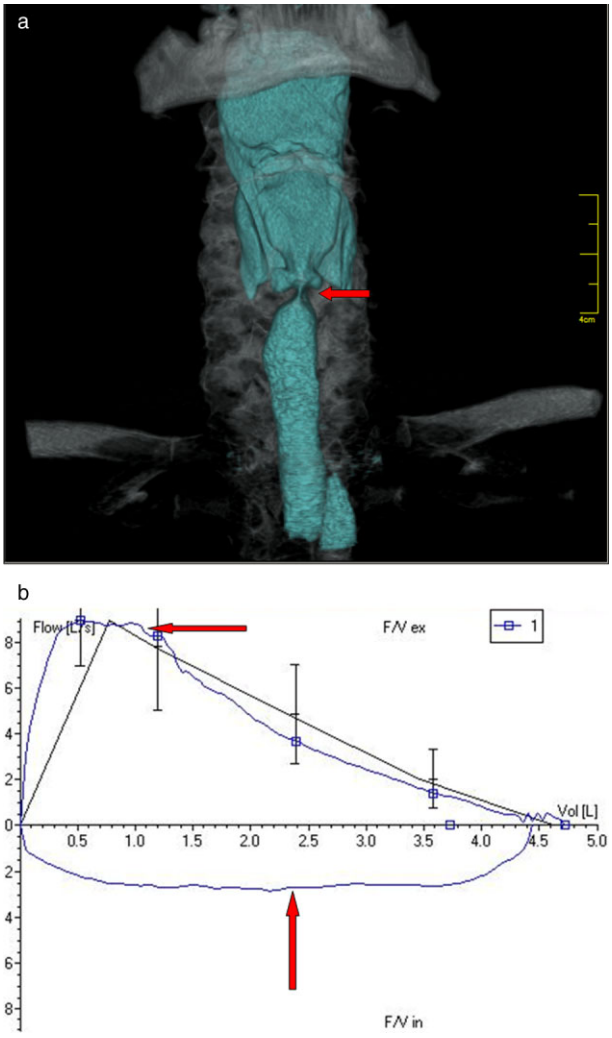

Figure 1. (a) Maximal intensity images reconstructed from the 320-slice CT image dataset displaying laryngeal airway in blue color showed persistent marked laryngeal narrowing due to adduction of the vocal cords throughout the breathing cycle. (b) Flow volume loop from the spirometry demonstrated flattening of the inspiratory and expiratory limbs, consistent with fixed upper airway obstruction.

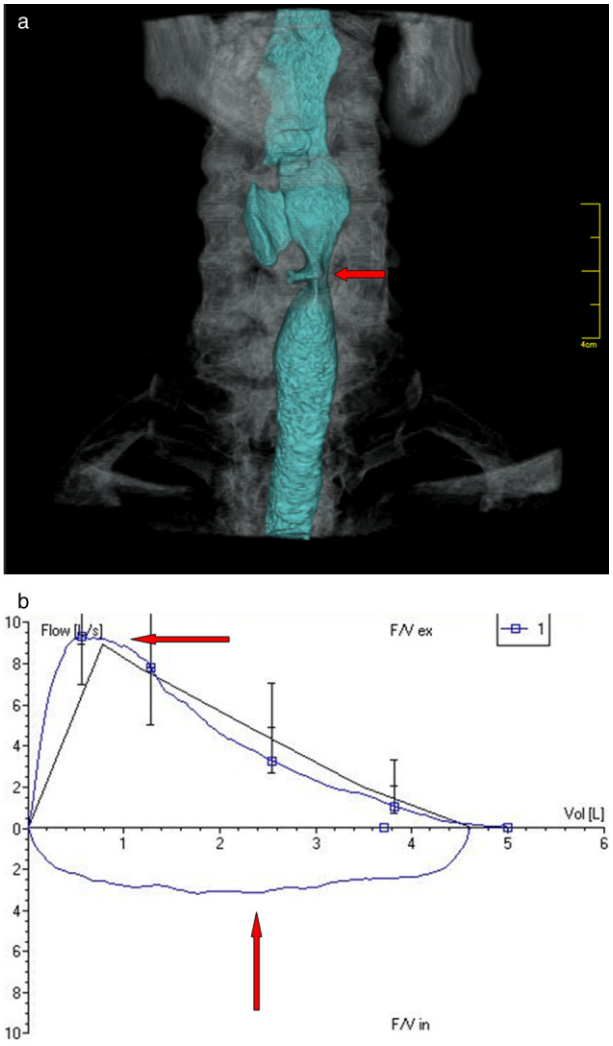

Figure 2. (a) Reconstructed maximal intensity images from the 320-slice CT image dataset on the same patient displaying laryngeal airway in blue color showed widened laryngeal lumen due to reduced adduction of vocal cords throughout the breathing cycle. (b) Flow volume loop from spirometry demonstrating an increased inspiratory flow and showed an improvement of expiratory loop.

320-slice dynamic CT scan larynx revealed bilateral vocal cord paralysis with persistent adduction of the vocal cords during the entire respiratory cycle (see Fig. 1a, b). Fiberoptic laryngoscopy confirmed these findings. Neurological assessment, including magnetic resonance imaging of the brain, revealed no neurological cause. After review of the history and test results, a diagnosis of idiopathic VCP was made.

The patient underwent endoscopic laser arytenoidectomy. This involved transecting the membranous vocal fold and resecting the vocal process of the arytenoid to open the glottic airway posteriorly. This procedure has been shown to have a minimal effect on speech since it preserves the membranous fold where voice is predominantly generated. Some contracture and airway restriction has been previously reported, but no evidence of this was found at follow-up reviews.

Postoperatively, the patient had repeat 320-slice CT larynx. This demonstrated significant improvement of laryngeal airway diameter (see Fig. 2a, b). Repeat endoscopy also confirmed marked improvement in glottic aperture. Respiratory function tests demonstrated increased inspiratory flow with normalization of the shape of the flattened expiratory loop. Stridor was notably absent during

testing. Dyspnea on exertion and the sensation of choking had resolved. Video files of the pre- and post-surgery CT larynx reconstruction are available in the online Supporting Information.

Discussion

Idiopathic bilateral vocal cord paralysis is traditionally diagnosed by laryngoscopy. However, this procedure is often not conducted by physicians who first evaluate the patient's complaints of breathlessness and a noninvasive test to image laryngeal motion would be a significant advance. High-resolution dynamic volume 320-slice CT was primarily used for cardiac imaging and to detect coronary artery disease [4], but recently, we have used this technique to assess upper airway function [1]. Imaging itself takes approximately 5–6 sec, the time taken while the neck is "scanned" every 0.3 sec during a breathing cycle, that is, inspiration and expiration. Images are then reconstructed to create a dynamic "cine" of laryngeal movement. Specific anatomical areas can be selected for detailed evaluation, for example, movement of the vocal cords during inspiration and expiration. Quantitative measurements may also be feasible using changes in lateral diameter of the trachea and vocal cords [1, 3].

Typical radiation doses delivered to the larynx are approximately 1–4 milliSievert (mSv) depending on the body habitus of the patient [3]. The radiation dose delivered in this study was 1.6 mSv, which is within acceptable annual radiation levels as defined by the Australian Radiation Protection and Nuclear Safety Agency [5]. In this context, it will be important to consider risk versus benefit for this new imaging modality. Considering that annual background radiation is 3–4 mSv, radiation associated with chest CT is in the range of 4–8 mSv and hip CT can be as high as 15 mSv [4], radiation doses associated with CT larynx appear to be reasonable.

In conclusion, we demonstrate that dynamic volume 320-slice CT larynx provides a simple and noninvasive method to diagnose abnormal vocal cord motion. Given that 320-slice CT is likely to become widely available, our observations suggest that CT larynx may become the preferred future option to exclude vocal cord movement abnormalities. Further studies to examine benefits versus fiberoptic laryngoscopy are merited.

Disclosure Statements

No conflict of interest declared.

Appropriate written informed consent was obtained for publication of this case report and accompanying images.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Video Clip S1. Pre-treatment coronal view from 320-slice CT larynx showing marked laryngeal narrowing due to adduction of the vocal cords throughout the breathing cycle.

Video Clip S2. Post-treatment coronal view from 320-slice CT larynx of the same patient displaying widened laryngeal lumen due to reduced adduction of vocal cords.