



# Optimizing Patent Foramen Ovale Detection Through a Multimodal Approach

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## INTRODUCTION

Patent foramen ovale: a small opening in the heart that allows the flow of blood between the right and left atrium.

This heart condition is present at birth in all infants and closes shortly after birth, however, in about 25% of the population, this hole remains open through adulthood (Gonzales-Alujas et al. 2011).

Most remain asymptomatic, however, events such as strokes and embolisms, migraines with aura, and sometimes decompression sickness occurs (Gonzales-Alujas et al. 2011).

Most PFOs are detected through traditional imaging methods such as transesophageal echocardiography (TEE), transthoracic echocardiography (TTE), and transcranial doppler (TCD)

However, these methods can present limitations when used alone, therefore, it is important to create a multifaceted approach to enhance existing techniques, integrate multiple methods, and explore new methods to effectively detect and diagnose PFO Detection

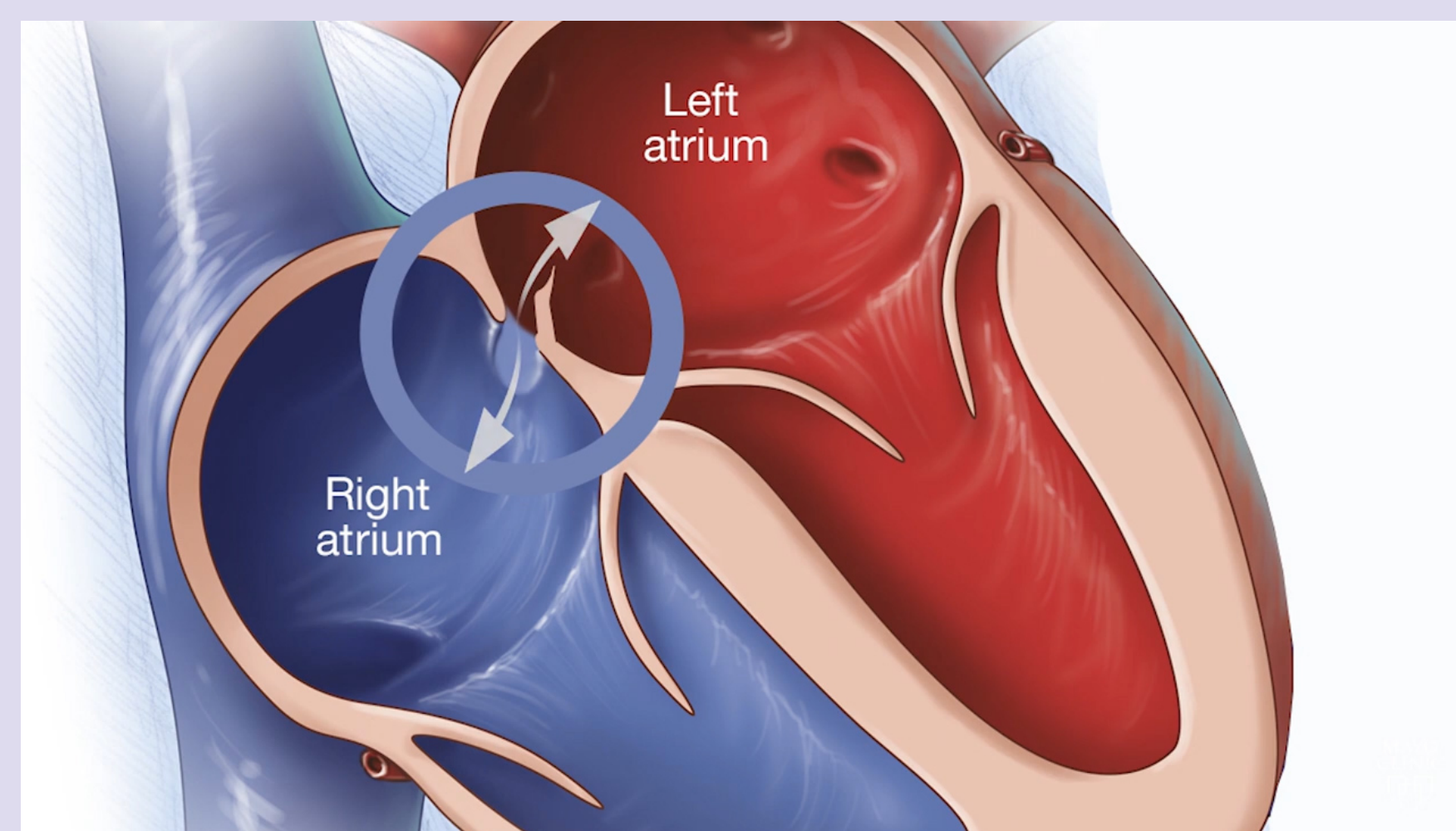


Figure 1: A visual representation of the patent foramen ovale, illustrating the small opening that is present between the right and left atrium.

<https://newsnetwork.mayoclinic.org/discussion/mayo-clinic-q-and-a-treatment-for-patent-foramen-ovale/>

## METHODS

This literature review critically evaluates studies conducted to improve and enhance PFO detection.

Studies focused on investigating methods to improve testing, diagnosis, and availability.

20 primary sources were collected and reviewed to gather results.

## RESULTS

Traditional imaging methods present limitations in sensitivity, specificity, and availability.

Refinements to improve detection:

- Increasing contrast injections improves sensitivity of PFO detection (Johansson et al., 2008)
- Optimizing specific phases of Valsalva maneuver improves sensitivity (Rodriguez, 2013)
- Inferior Vena Cava compressions are an effective alternative to Valsalva maneuver (both aim to increase pressure in chest cavity) (Yamashita et al., 2017)

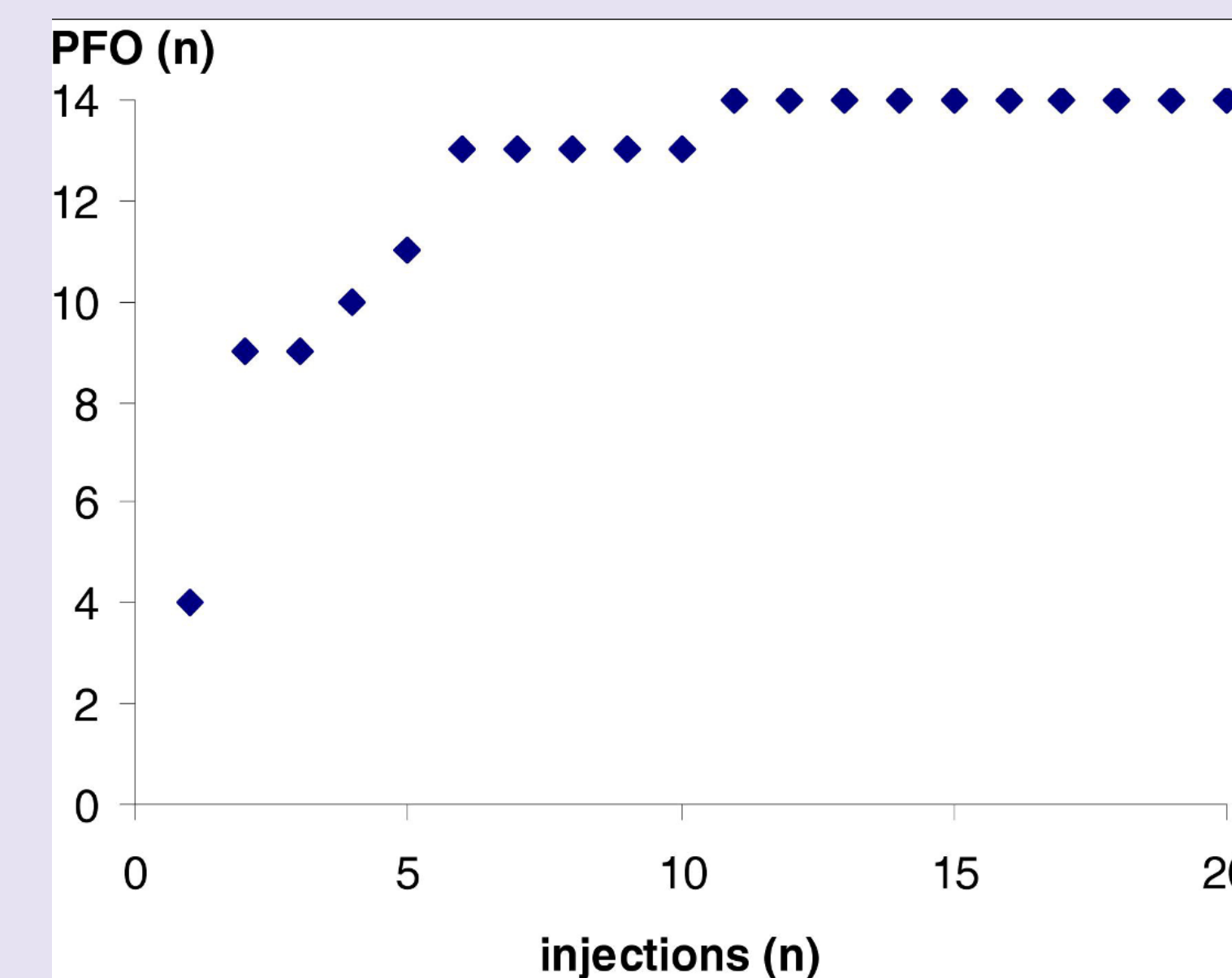


Figure 2: This graph represents the correlation of increased PFO detection with increased contrast injections. Eleven injections per patient were needed to detect all PFOs present in the study group. Few injections could miss PFOs, small or large, leading to false negatives. Five injections were sufficient to detect the large PFOs (Johansson et al., 2008).

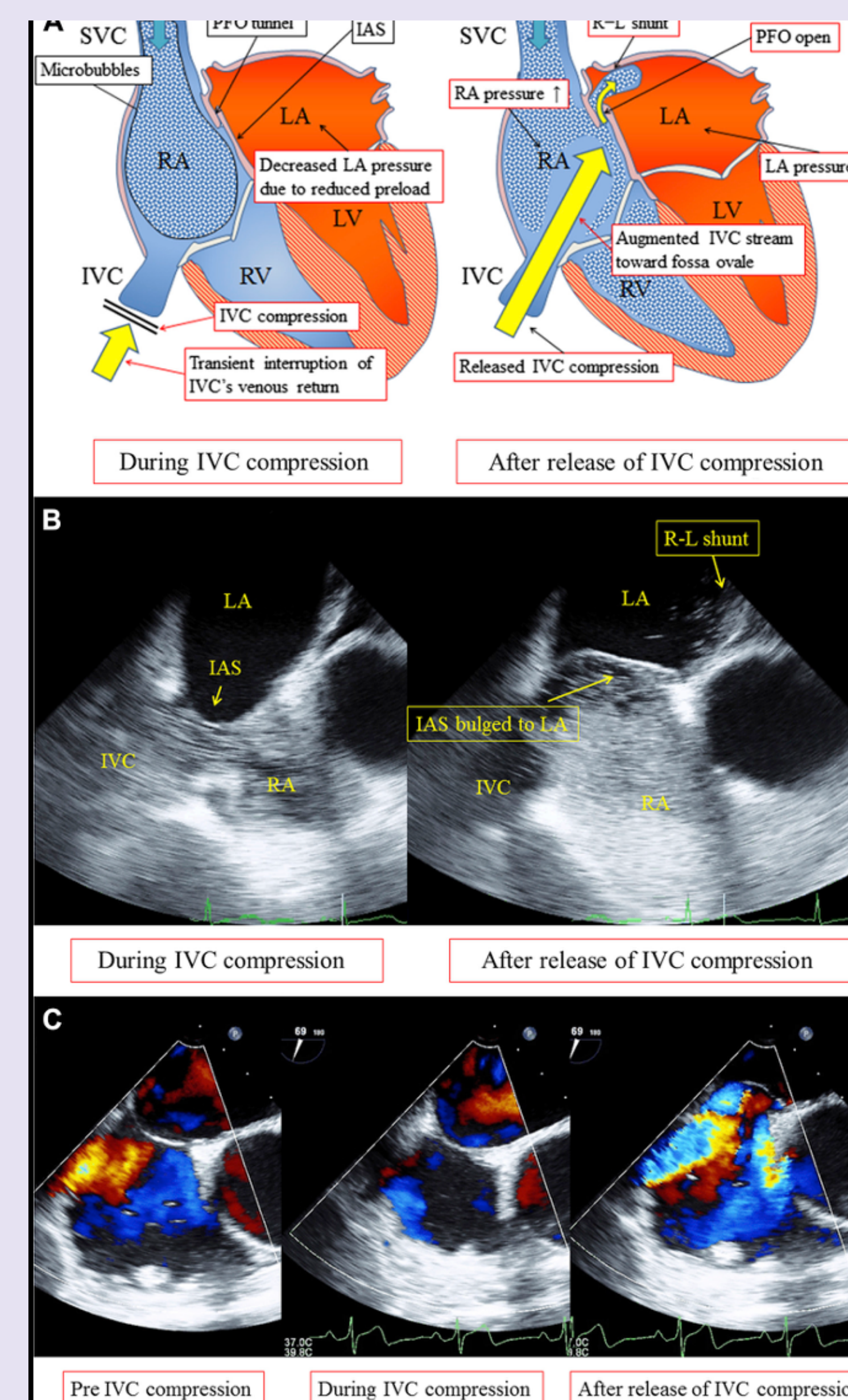


Figure 3: The schematic and images presented in (A), (B), and (C), represent the Inferior Vena Cava compression maneuver that has helped improve detection of PFO. During compression, the interatrial septum is neutral, however, after release, there is a leftward bulge of the IAS, showing right to left shunting, confirming PFO. For patients who are unable to perform the traditional Valsalva maneuver, this is an alternative method for detection (Yamashita et al., 2017)

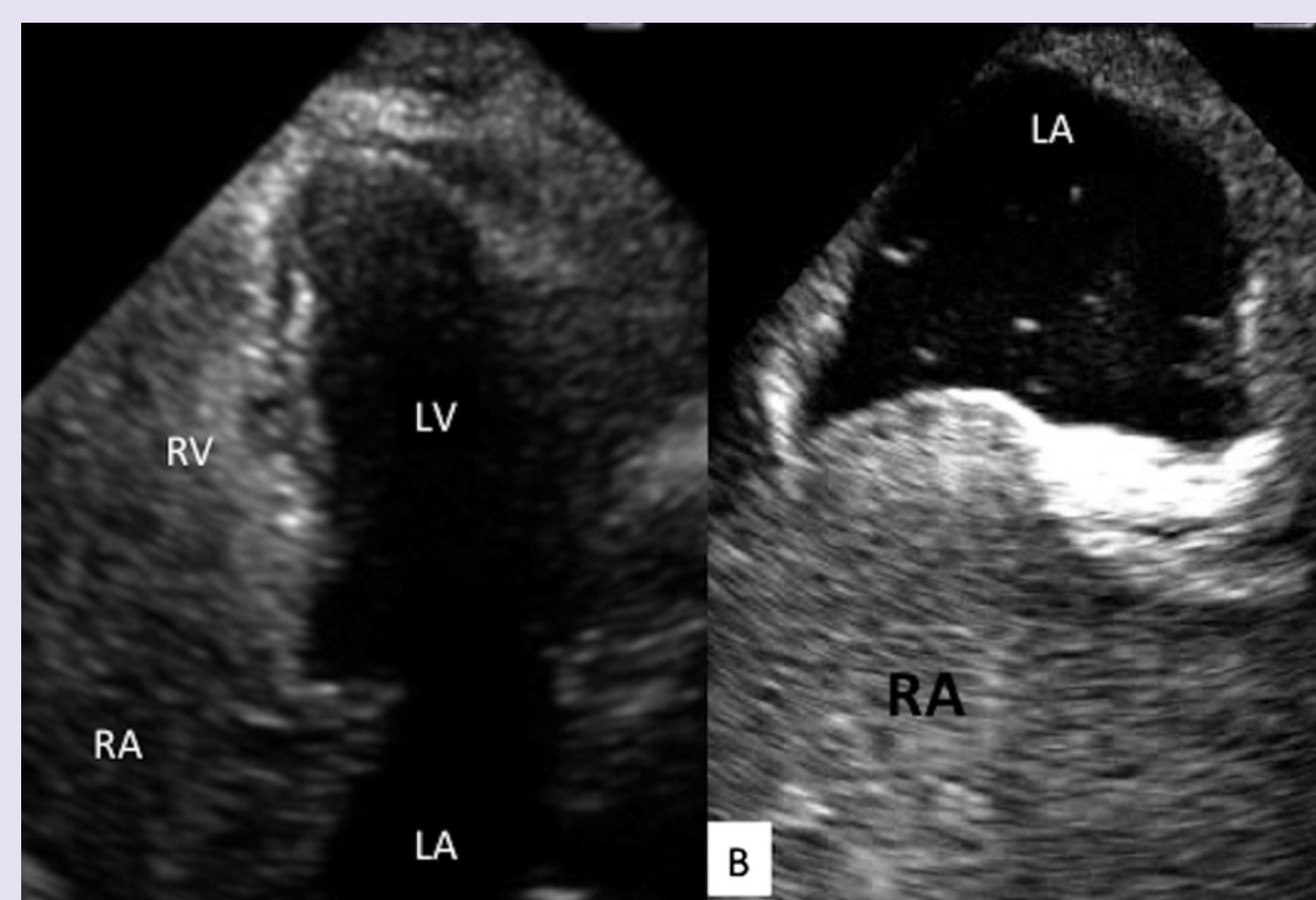


Figure 4: This is a PFO observed during TEE with adequately performed Valsalva maneuver, with sensitivity of 90%. No micro-bubbles are seen prior to maneuver, however, after maneuver, a few micro-bubbles are seen (Rodriguez, 2013).

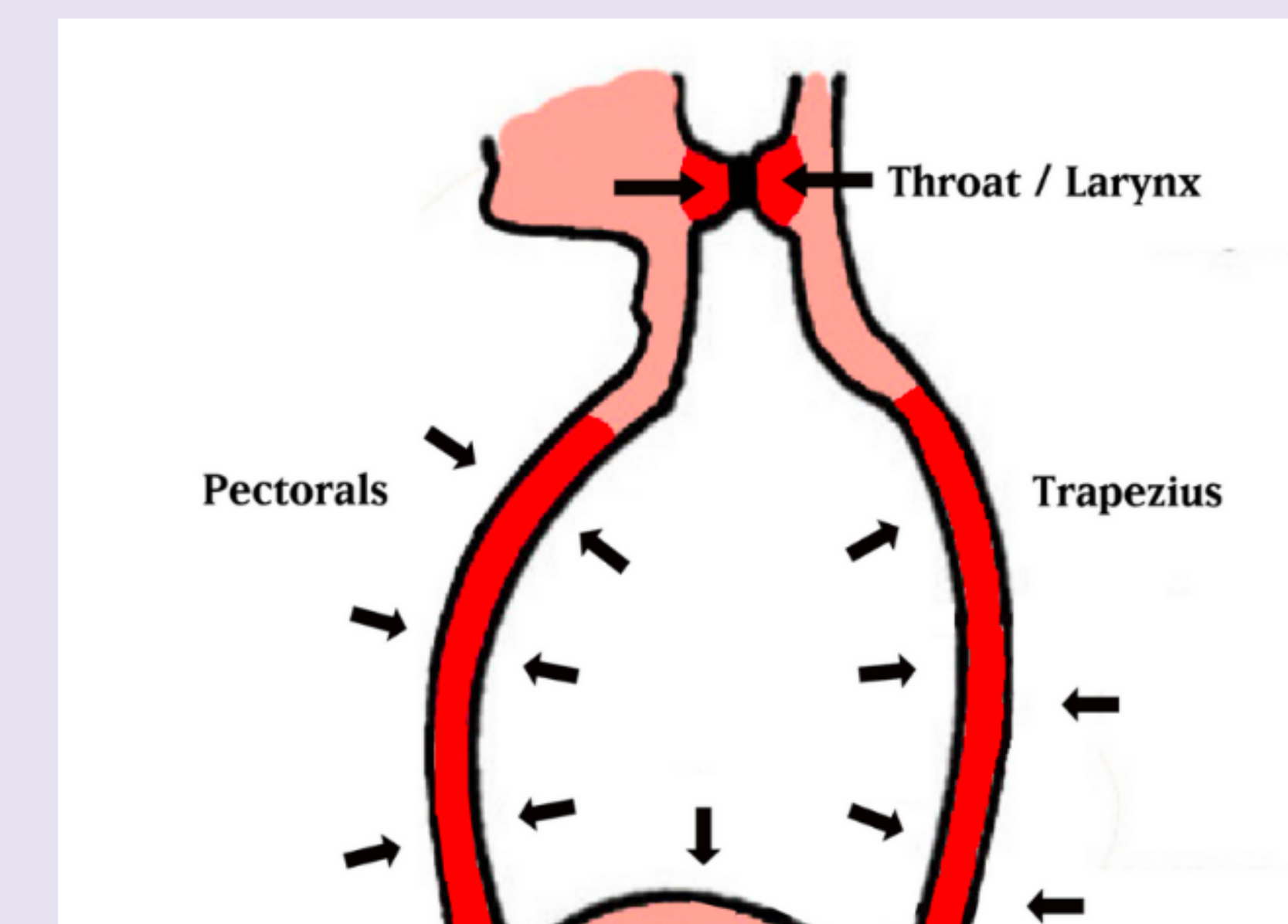


Figure 5: A visual representation of the Valsalva maneuver, performed to increase pressure in the chest cavity.

<https://www.the-wilson-method.com/blog/our-other-health-pandemic-the-unconscious-chronic-valsalva-maneuver-ucvm>

## Future Directions

- Finding approaches that shift towards non-invasive procedures, more accurate testing, and can be patient tailored.
- Taking advantage of the use of artificial intelligence (AI) in PFO detection.
- AI can be a useful aid to the operators of TEE, TTE, and TCD methods by learning specific algorithms and recognizing patterns in data (Sheng et al., 2024)
- There are no set procedures as to which works best because of PFO and patient population variability.
- Future research should be geared towards finding standard multimodal procedures that can take into account various patient factors.
- Prevention: early detection and treatment to prevent strokes and related events.



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## References:

