

Exploring the application of laryngeal ultrasound as a biofeedback tool for enhancing the learning of Supraglottic Manoeuvre

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Introduction

- Swallow rehab can be challenging as it needs patients to convert automatic behaviours like swallowing into conscious actions.
- SLTs verbally prompt patients to complete vocal fold closure technique like the supraglottic manoeuvre (Logemann, 1998). Typically saying
➤ “Take a deep breath, hold it, swallow [a bolus], then cough immediately after”
- But 58% of healthy people were unable to fully close their vocal folds when instructed to “hold their breath” under endoscopic evaluation (Hirst et al.,1998).
- Verbal instructions and a lack of visual feedback make it challenging to successfully complete manoeuvre, especially for those with sensory or cognitive impairments.

Objective

Overarching Goal:

Explore the use of laryngeal ultrasound (LUS) in supporting the acquisition of different components of the supraglottic swallow.

Specific Aims:

- Explore the impact of three different verbal instructions for breath holding (easy breath hold, inhale/easy hold, inhale/exhale hard hold) on the outcome of voluntary vocal fold closure.
- Assess participants' ability to maintain vocal fold closure for at least five seconds to determine the effectiveness of these instructions.

Methods

Participants: 10 healthy adults (9 F & 1 M) aged (26 - 49), no dysphagia or laryngeal abnormalities reported.

Equipment: Pocket-sized ultrasound with 40mm linear probe using an anterior approach to visualize true/false vocal folds and arytenoid.

Procedure: Participants performed three breath-hold tasks across three trials while seated in a neutral position:



- Easy breath-hold:
Instruction: “Hold your breath while I count to 5.”
- Inhale/easy breath-hold:
Instruction: “Take a deep breath, then hold it while I count to 5.”
- Inhale/exhale hard breath-hold:
Instruction: “Take a deep breath, exhale completely, and hold your breath tightly while I count to 5.”

- Participants were instructed to maintain laryngeal closure for at least 5 seconds in each task.

Data Analysis:

- Success for each breath-hold task was evaluated by:
 - Arytenoid adduction
 - True and false vocal fold closure (VFC)
- Complete laryngeal closure was defined as false vocal fold closure for at least 2 seconds (Guedes et al., 2017).
- Closure was classified as:
 - Fully closed
 - Partially closed
 - Absent
- Vocal fold closure duration was measured manually using frame-by-frame analysis.

Results

- On the In/Ex hard hold instruction: 90% of participants achieved complete laryngeal closure. (See figure 1)
- On the Inhale easy hold instruction: Only 20% of participants achieved full closure.
- Sustained closure: 100% of participants maintained voluntary vocal fold closure for 5 seconds.
- Reliability: 20% of the data was reanalysed by other researcher, yielding 100% reliability in the measurements.

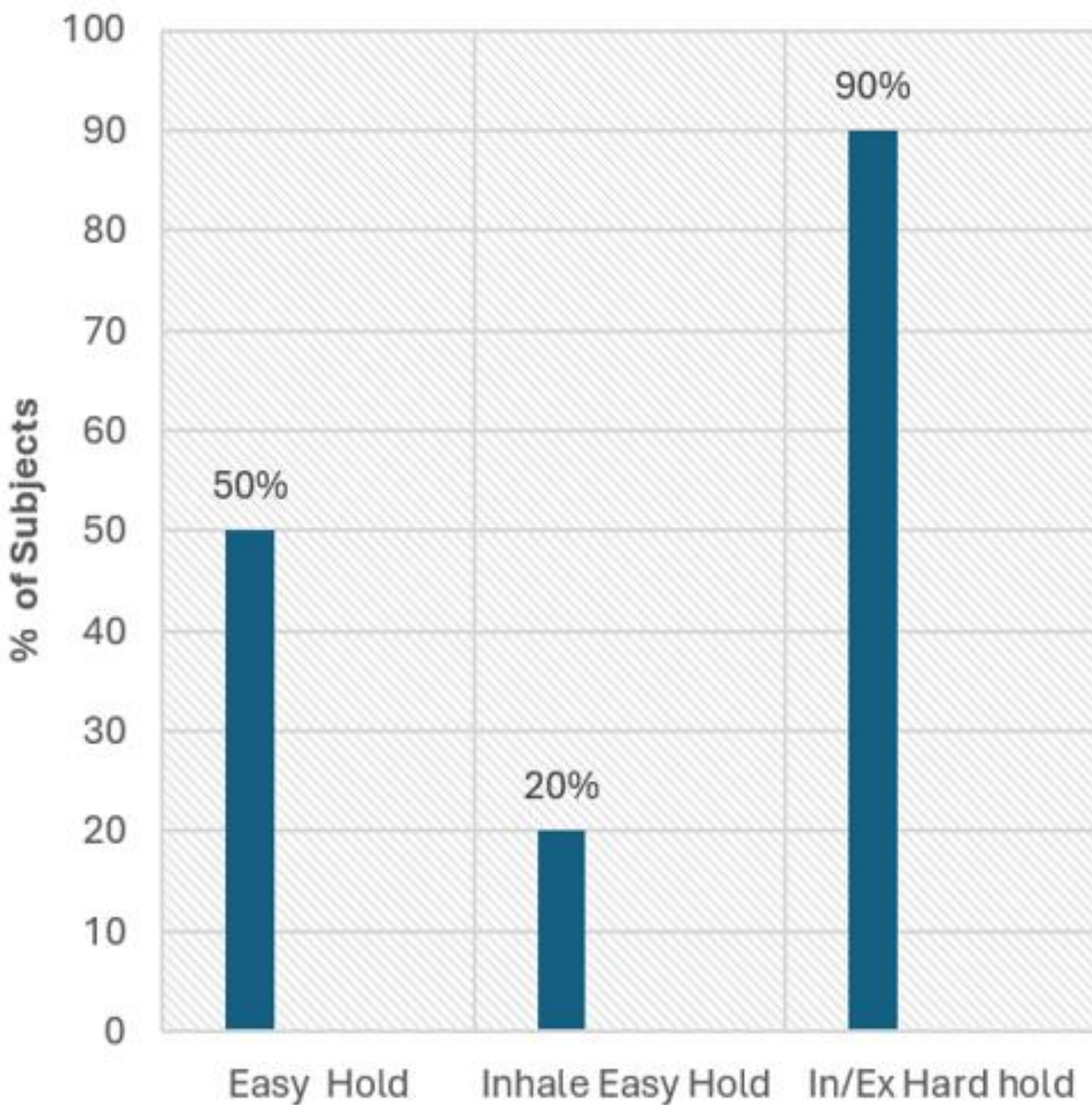


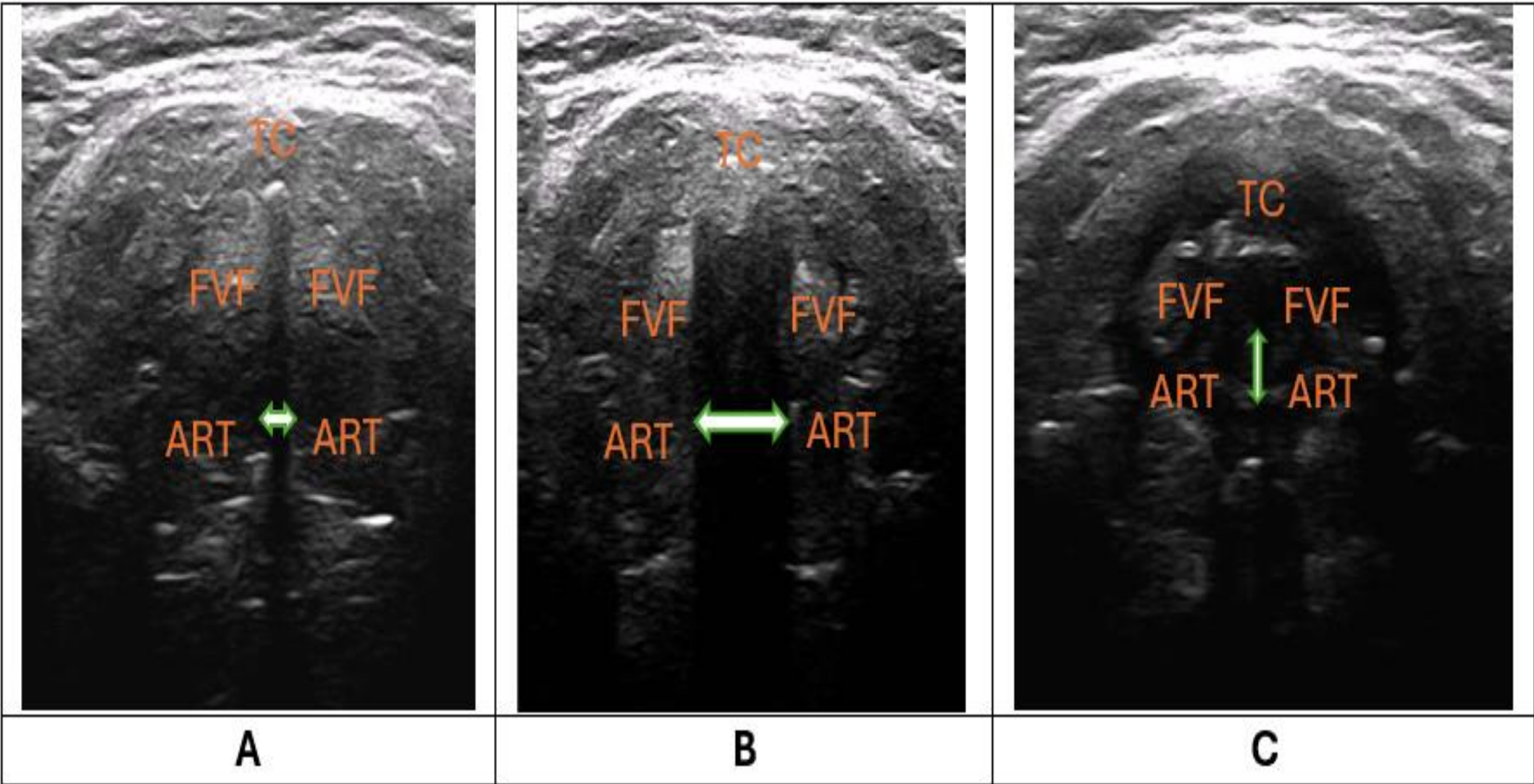
Figure 1. Percentage of subjects demonstrating optimal laryngeal closure on each breath-hold instruction

References

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Hirst, L. J., Sama, A., Carding, P. N., & Wilson, J. A. (1998). Is a ‘Safe Swallow’ Really Safe? *International Journal of Language & Communication Disorders*, 33(S1), 279–280. <https://doi.org/10.3109/13682829809179436>

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Ultrasound transverse view of breath-hold responses in healthy participants (anterior approach). The images illustrate the laryngeal closure (white arrow) in response to three breath-holding instructions. Key structures: TC = Thyroid Cartilage, FVF = False Vocal Folds, ART = Arytenoids.

- A. Easy Breath-Hold: Participants hold their breath for 5 seconds.
- B. Inhale Easy Breath-Hold: Participants take a deep breath in, then hold for 5 seconds.
- C. Inhale/Exhale Hard Breath-Hold: After a deep inhalation, participants fully exhale and hold for 5 seconds.

Discussion

- Results indicate that voluntary laryngeal closure varies depending on the instruction given by the researcher. When instructed to:
 - "Take and hold breath" (typical instruction), showed mostly absent to partial (TVFs) closure.
 - “In/Ex hard hold” instruction resulted in optimal closure.
 - All managed at least 5 seconds of voluntary closure in all tasks, showing control under different conditions.
- Clinically, understanding how specific breath-hold instructions affect laryngeal closure helps assess a dysphagic patient's readiness for oral intake.
- These differences suggest that using visual feedback like ultrasound could improve training for the supraglottic manoeuvre.

Conclusion

- Laryngeal ultrasound offers a promising, non-invasive, radiation-free, and portable tool for dysphagia rehabilitation, providing real-time visualization of anatomical movements without disrupting the swallowing process.
- Although ultrasound biofeedback is well-established in physical therapy, its use in dysphagia management remains novel.
- The study suggests that has the potential to supplement traditional rehabilitation methods, ultimately improving patient outcomes in dysphagia therapy
- Further research is needed to explore its potential for improving the learning of swallowing manoeuvres by offering real-time visual feedback, potentially improving patient outcomes and supplementing traditional rehabilitation methods.