

# Effects of Varying TES Pulse Duration on Hyolaryngeal Kinematics in Healthy Adults

## Introduction & Objectives

- TES modality is aimed to improve hyolaryngeal excursion through stimulation-induced muscle contractions.
- Submental TES has been shown to have a mixed effect of submental TES on hyolaryngeal excursion.
- Increasing stimulation tolerance following the use of TES with short pulse duration (PD) enhance the impact on deep lingual elevator antagonists.
- A knowledge gap existed regarding the effect of this novel TES protocol on hyolaryngeal kinematics.
- **Study aim:** to compare the effect of TES with varying PD (short vs. long) on mean hyolaryngeal excursion magnitudes and duration during swallowing in healthy adults.

## Materials and Methods

**Subjects:** 24 healthy adults (22-77 years old).

**TES:** VitalStim Plus Electrotherapy System (VitalStim; DJO Global, Vista, CA, USA).

### TES conditions:

1. no stimulation
2. TES with 300  $\mu$ s (short) PD
3. TES with 700  $\mu$ s (long) PD

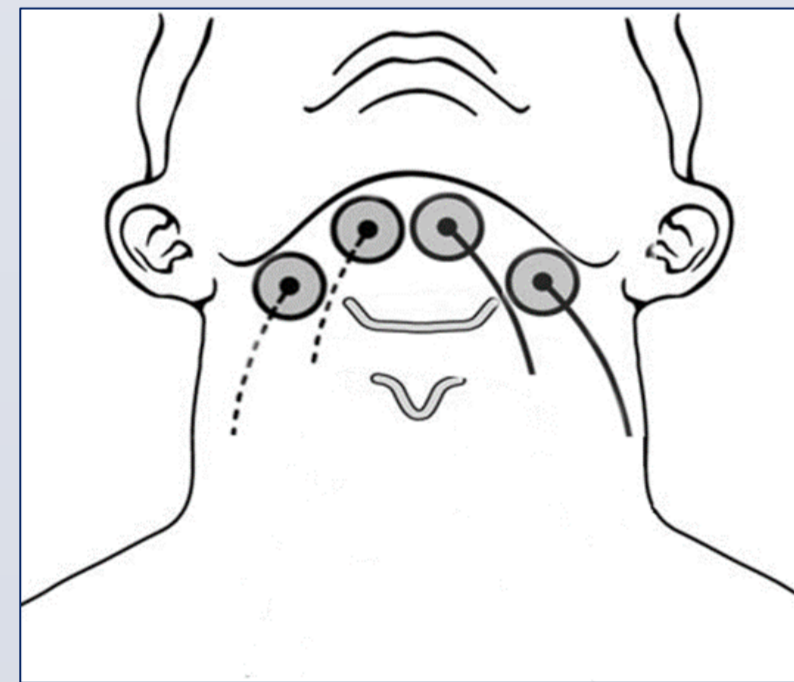


FIGURE 1: TES electrode placement

- Pulse Frequency: 80 HZ.

### Videofluoroscopy Examination (VFE):

All subjects were examined in the lateral perspective with three x10 mL bolus trials with pudding consistency (E-Z-PASTE®, E-Z-EM, Canada Inc)

### Kinematic Measures:

All recorded videos were digitized using Adobe Premier Pro and subsequently analyzed using ImageJ.

### Excursion

For each swallow, video frames depicting swallow onset and maximum hyolaryngeal excursion were identified.

## Outcome Measures:

- The following measures were compared with the reference points (C4) to determine changes in the hyoid and laryngeal positions at rest and during swallowing.
- **Anterior** and **superior hyoid** position at rest, peak excursion, and excursion magnitude
- **Anterior** and **superior larynx** position at rest, at peak excursion, and excursion magnitude
- Superior larynx position at rest, peak excursion and excursion magnitude

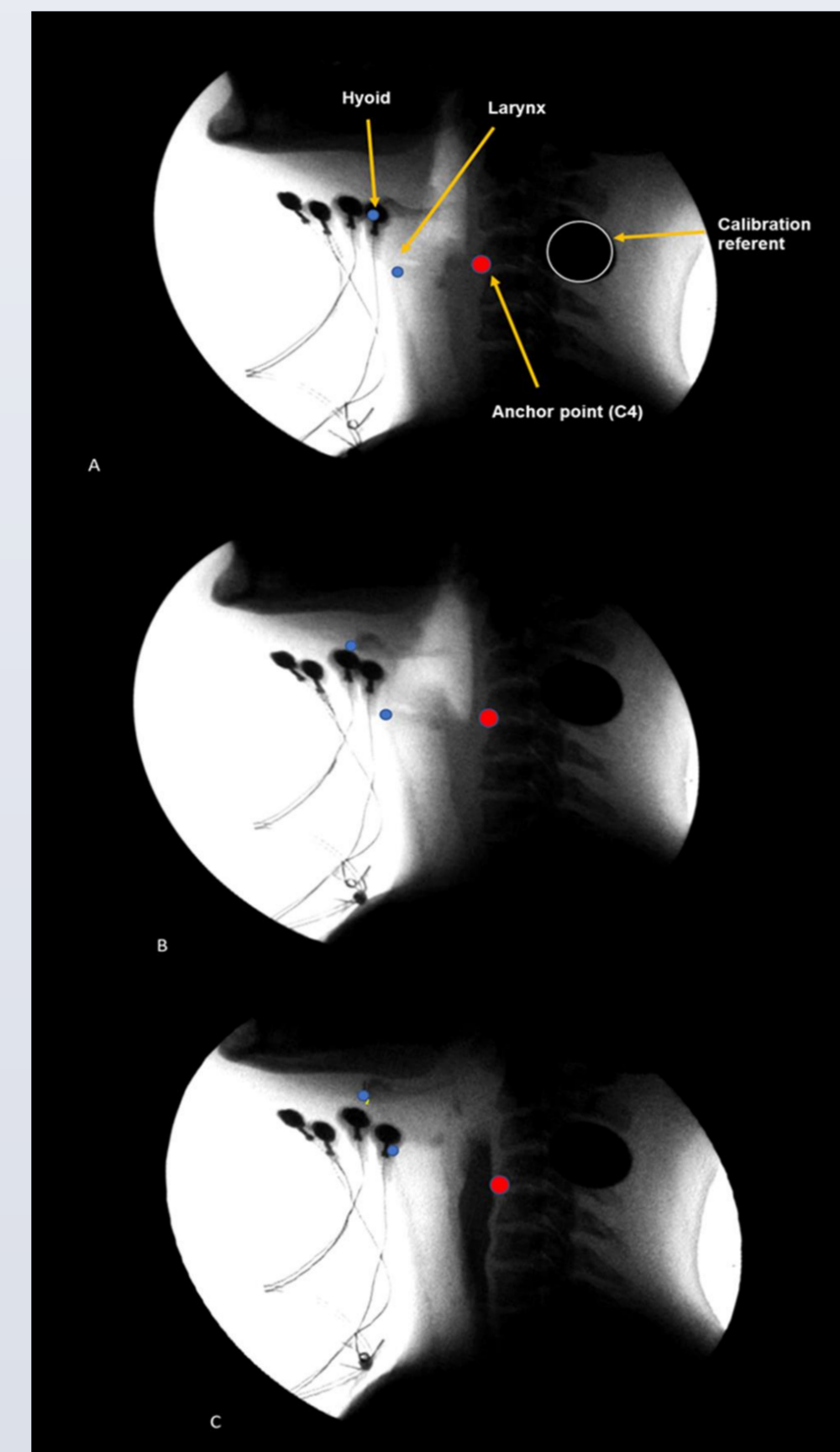


FIGURE 2: A) Hyoid and larynx at rest with TES off. B) Hyoid and larynx at rest with TES on C) Hyoid and larynx peaks during swallowing with TES on

## Results

- A significant main effect of PD was identified for anterior hyoid excursion at rest [F (2, 46) = 5.868, p < .005,  $\eta^2$  = .852] and during swallowing [F (2, 46) = 3.534, p < .037,  $\eta^2$  = .629].

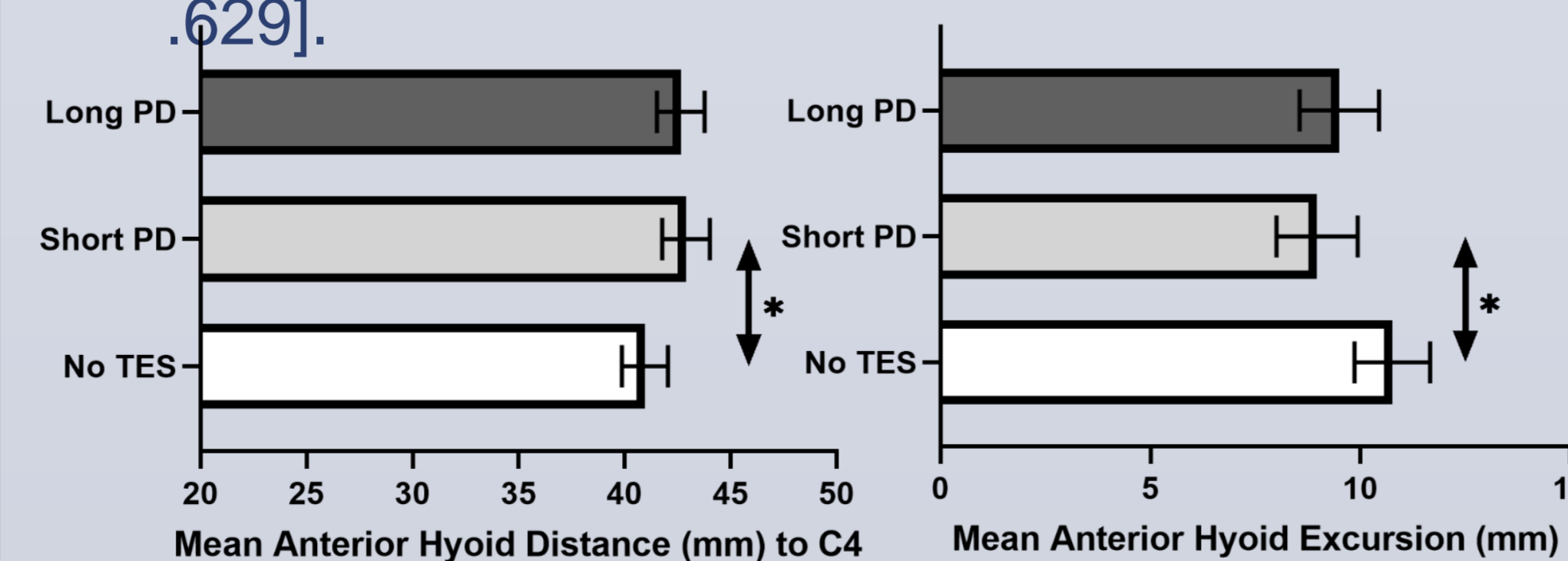


FIGURE 3: Mean distance between anterior hyoid position at rest relative to C4 (mm) (left) and mean anterior hyoid excursion during swallowing (right) across different TES conditions

## Results-Contd.

- **Short PD** resulted in **increased** anterior hyoid excursion at rest and **reduced** anterior hyoid excursion magnitude during swallowing.
- A significant main effect of PD was identified for anterior laryngeal position at rest [F (2, 46) = 7.877, p < .001,  $\eta^2$  = .940] and during swallowing [F (2, 46) = 10.858, p < .000,  $\eta^2$  = .986].

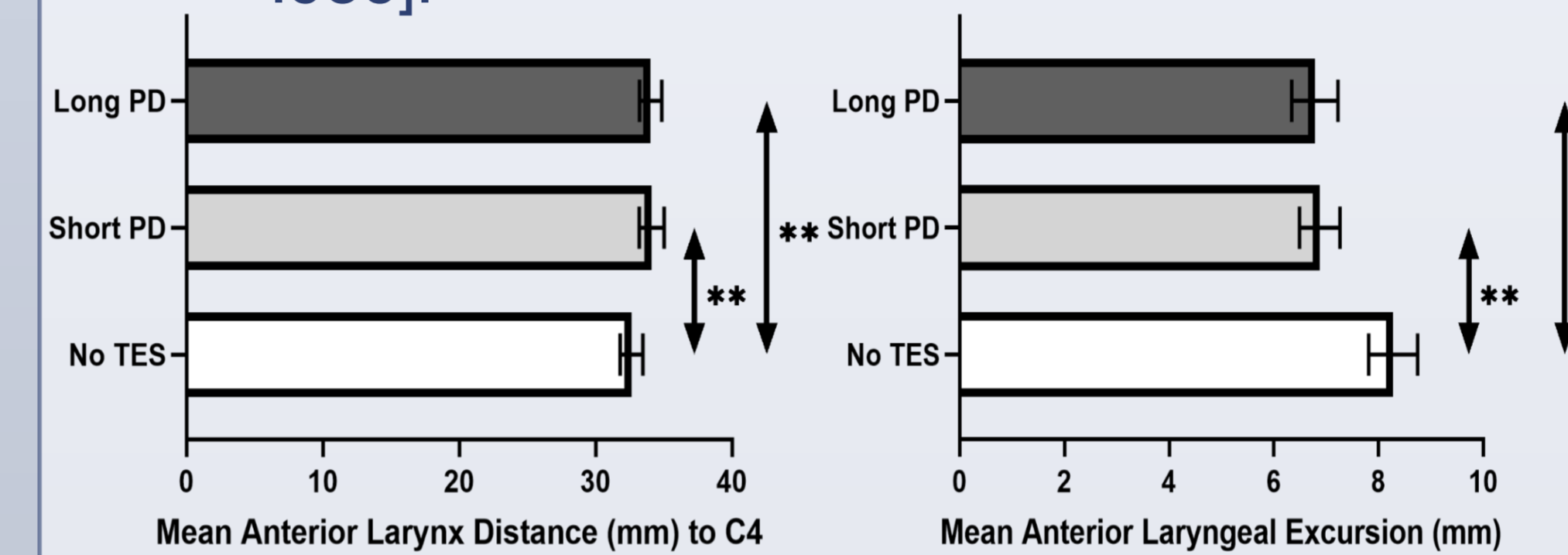


FIGURE 4: Mean distance between anterior larynx position at rest to C4 (mm) (left) and mean anterior laryngeal excursion during swallowing (right) across different TES conditions

- **Both TES protocols** increased anterior laryngeal excursion at rest and reduced anterior laryngeal excursion magnitude during swallowing.

## Conclusions

- **Submental TES reduced the extent of anterior hyoid (primarily with TES with short PD) and laryngeal excursions during swallowing.**
- **Both TES protocols had a comparable effect on shortening the duration of hyolaryngeal excursion during swallowing**
- Since submental TES had no significant impact on the anterior hyoid and laryngeal excursions at peak positions, this reduced range of motion may result from placing the hyolaryngeal complex at rest closer to their peak excursion points, reducing their range of anterior excursion by 21%.
- This reduced range of motion resulted in shorter hyolaryngeal excursion duration during swallowing.
- For hyoid excursion magnitude, the effect of TES was only observed in the TES protocol with short PD.
- Using short PD can increase stimulation tolerance, which may subsequently improve the depth of electrical current penetration.

## Conclusions-Contd.

- Enhancing the stimulation of deep hyoid elevator muscles such as mylohyoid and geniohyoid may place the hyoid in an increased forward position before swallow onset, reducing the extent of hyoid excursion.
- **Varying PD had no significant impact on superior hyoid and laryngeal excursions.**
- Besides submental muscles, superior hyolaryngeal excursion during swallowing relies on contraction of extrinsic pharyngeal muscles such as stylopharyngeus, palatopharyngeus, and salpingopharyngeus.
- Due to this anatomical configuration, submental TES may not be able to travel far enough to stimulate these muscles.
- **Collectively, submental TES may facilitate anterior hyolaryngeal excursion during swallowing. This effect is more enhanced for the TES protocol with short PD.**
- **It is suggested to reserve submental TES for patients with no or limited anterior hyolaryngeal excursion during swallowing.**

## References

- Park JW, Oh JC, Lee HJ, Park SJ, Yoon TS, Kwon BS (2009) Effortful Swallowing Training Coupled with Electrical Stimulation Leads to an Increase in Hyoid Elevation During Swallowing. *Dysphagia* 24 (3):296-301
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