

# Swallowing Pathophysiology in Individuals with ALS

Lauren Tabor-Gray, PhD, CCC-SLP <sup>a</sup>; Raele Robison, PhD, CCC-SLP <sup>b</sup>; Emily Plowman, PhD, CCC-SLP <sup>c</sup>

<sup>a</sup> Phil Smith Neuroscience Institute, Holy Cross Health, Fort Lauderdale, FL ; <sup>b</sup> William S. Middleton Memorial Veterans Hospital, Madison, WI; <sup>c</sup> Aerodigestive Research Core, Speech Language and Hearing Science, University of Florida.

## BACKGROUND:

- Dysphagia & dystussia occur in a reported 85% of people with ALS (pALS) that are characterized by reductions in airway protection and airway clearance capacity (Inghilleri, 2017).
- Preliminary data suggest that pALS demonstrate increased time to laryngeal vestibule closure (LVC) and reduced LVC range of motion during swallowing (Waito, 2019).
- Further work is warranted to elucidate these contributing mechanisms to inform the development of efficacious therapeutics.

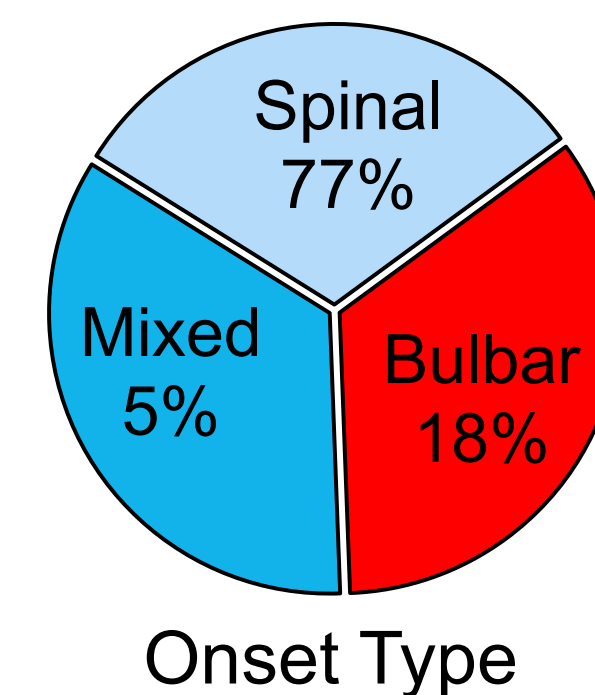
## AIMS:

- 1) Delineate kinematic and timing parameters of swallowing in pALS.
- 2) Compare to established normative reference values (Steele, 2019).
- 3) Examine relationships between swallowing kinematic and timing parameters and airway safety pALS.

## METHODS:

Table 1. Patient Demographics.

N=44	Mean (SD)
Age (years)	65 (10.5)
ALSFRS-R Total	34 (7.8)
ALSFRS-R Bulbar	10.1 (1.6)
ALS Duration (months)	30.4 (23.7)



### Procedures:

- Standardized videofluoroscopic swallowing evaluation.
- Cued, self-administered trials of: 3cc thin, 20cc thin, 3cc pudding 20% w/v Varibar (Bracco, Inc).
- Images acquired at 30 fps
- Two independent and blinded raters completed timing and kinematic analysis (ASPECKT, Steele, 2019, Table 2) and the airway safety ratings (PAS, Rosenbek, 1996, Table 3) with 100% accuracy required.

Table 2. ASPEKT Ratings.

ASPEKT Metrics: Steele et al, 2019
Swallow Reaction Time (ms)
Time to LVC (ms)
LVC Duration (ms)
Pharyngeal Transit Time (ms)
LVC Closure Pattern (complete, partial, incomplete)

Table 3. Penetration Aspiration Scale.

Penetration-Aspiration Scale Score
1 Material does not enter airway.
2 Material enters airway, remains about VF, is ejected from airway.
3 Material enters airway, remains above VF, not ejected from airway.
4 Material enters airway, contacts VF, is ejected from airway.
5 Material enters airway, contacts VF, is not ejected from airway.
6 Material enters airway, passes below VF, is ejected.
7 Material enters airway, passes below VF, not ejected despite effort.
8 Material enters airway, passes below VF, no effort made to eject.

## Statistical Analysis.

- t-tests, Spearman rho' correlations, chi-squared and odds ratios ( $p < 0.05$ ).

## RESULTS:

A total of 131 individual bolus clips were obtained. Twelve clips were excluded due to artifact. A total of 119 rated bolus clips.

### 1. Swallowing Timing & Kinematics: ALS vs. Healthy Reference

Compared to healthy controls, pALS demonstrated:

1. Increased time to LVC ( $p < 0.001$ , Fig. 3a)
2. Shorter LVC duration, thin only ( $p < 0.05$ , Fig 3b)
3. Increased impaired LVC movement ( $p < 0.05$ , Fig. 3c)
4. Longer pharyngeal transit time ( $p < 0.05$ , Fig. 3d)

### 3A.

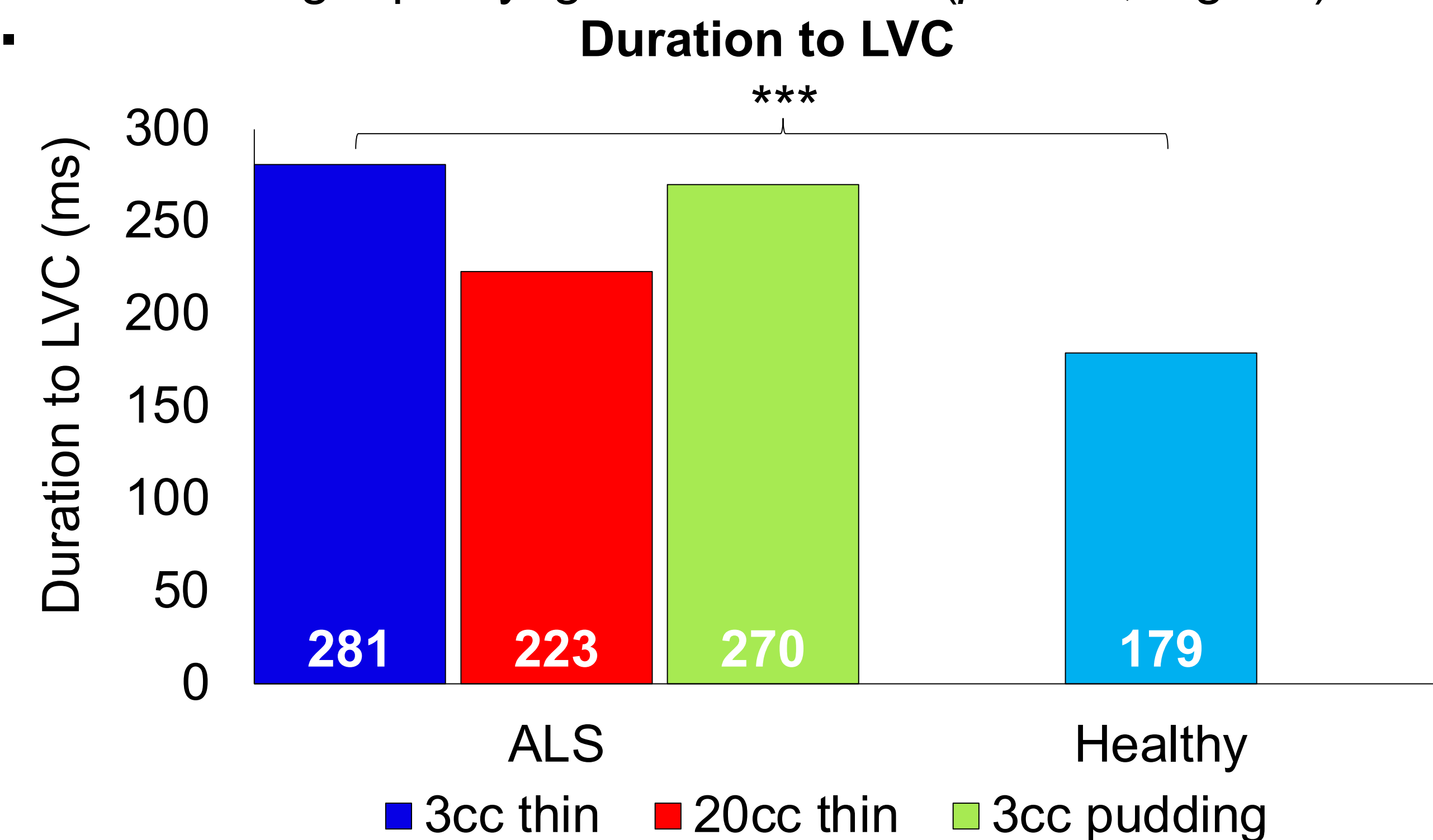


Fig. 3A. Compared to healthy reference data, pALS demonstrated increased duration to LVC across all bolus trials ( $p < 0.05$ ).

### 3B.

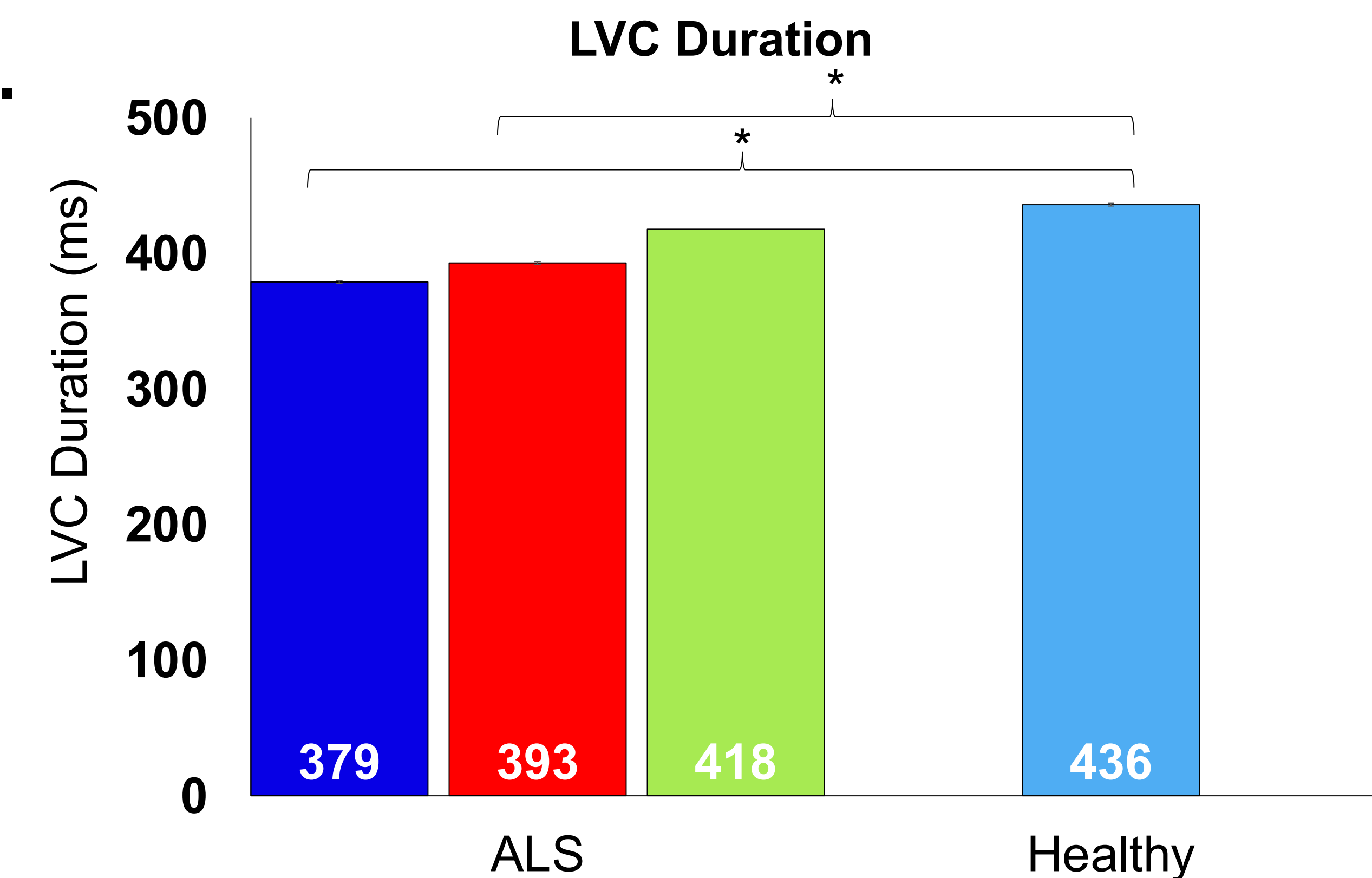
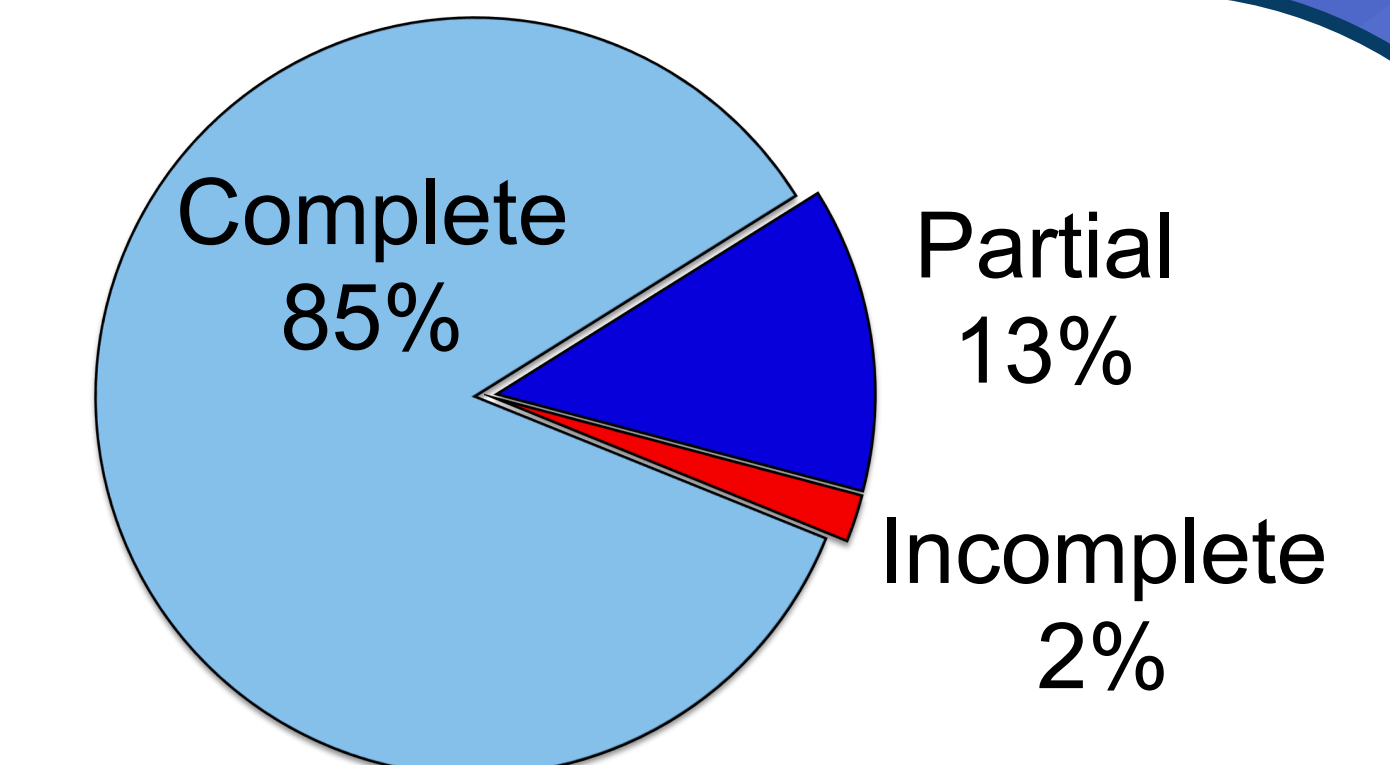


Fig. 3B. Compared to healthy reference data, pALS demonstrated shortened LVC duration for 3cc thin liquid (blue), 20cc thin liquid (red) ( $p < 0.05$ ). No differences in LVC duration for 3cc pudding ( $p > 0.05$ ).

### 3C. LVC Range of Motion Profiles



### 3D.

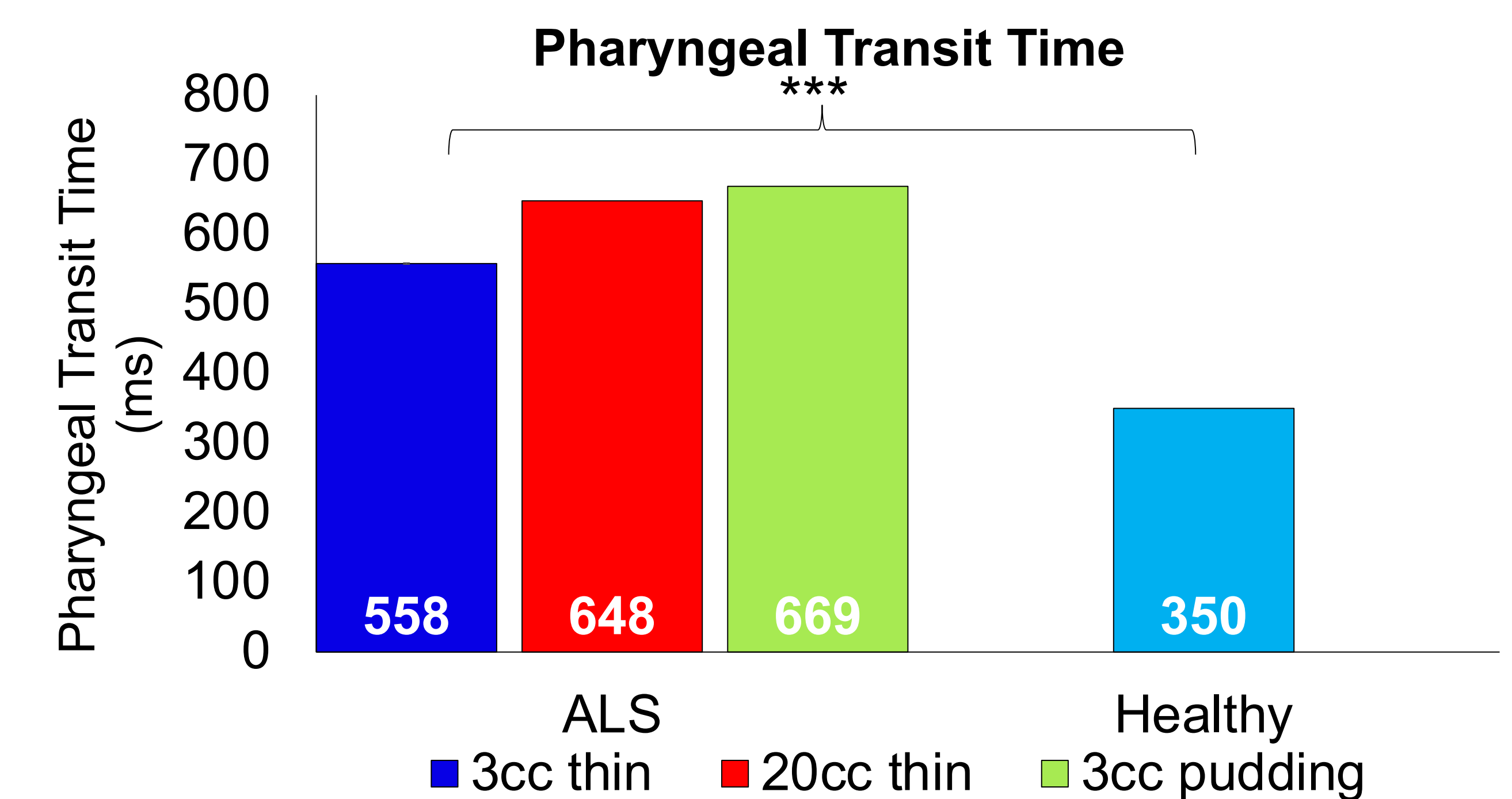


Fig 3D. Compared to healthy reference data, pALS demonstrated longer pharyngeal transit time across all bolus types ( $p < 0.05$ ).

- Swallow reaction time did not differ between healthy reference data and pALS across all bolus types ( $p > 0.05$ ).

### 2. Swallow Physiology and Airway Safety:

- In pALS, Unsafe swallowing was associated with:
  - Increased Time to LVC ( $r = 0.31$ ,  $p < 0.001$ )
  - Longer Pharyngeal Transit Time ( $r = 0.19$ ,  $p < 0.03$ )
  - Impaired LVC movement integrity ( $\chi^2(2) = 11.1$ ,  $p < 0.004$ )

Table 4. pALS with impaired LVC demonstrated a 3.7 higher odds of unsafe swallowing (95% CI: 1.1, 12.4).

	Complete	Incomplete	(%)
Safe	99 (77%)	15 (12%)	89%
Unsafe	9 (7%)	5 (4%)	11%
(%)	84%	16%	100%

## CONCLUSIONS:

- Compromised airway protection in pALS was associated with delayed airway closure, longer bolus transit times and impaired laryngeal closure patterns.
- Interventions targeting speed and extent of LVC utilizing biofeedback of respiratory-swallow coordination and volitional LVC training may be beneficial to alter these biomechanics during swallowing.