

Determination of Functional Lingual Pressure Impairment Thresholds for Unsafe and Inefficient Swallowing in ALS.

BACKGROUND:

- In limb and autonomic systems, critical reserve depletion thresholds have been identified and established for the emergence of functional impairment (Bortz, 2002).
- Although reductions in lingual strength is frequently noted in people with ALS (pALS), critical lingual strength depletion thresholds for the emergence of swallowing safety and efficiency impairments have not yet been examined in pALS.

AIM:

Identify lingual pressure depletion thresholds (LDT) for impairments in swallowing safety and efficiency in pALS.

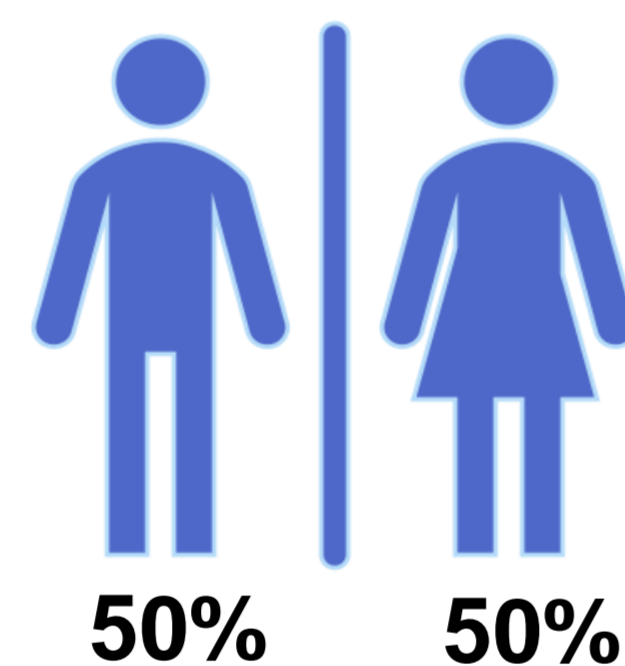
METHODS:

Participants:

- Thirty individuals with ALS were enrolled in this study.
- Race: 96.7% Caucasian, 3.3% African American.
- Disease Onset Type: 60% Spinal, 40% Bulbar.

Table 1. Patient Demographics.

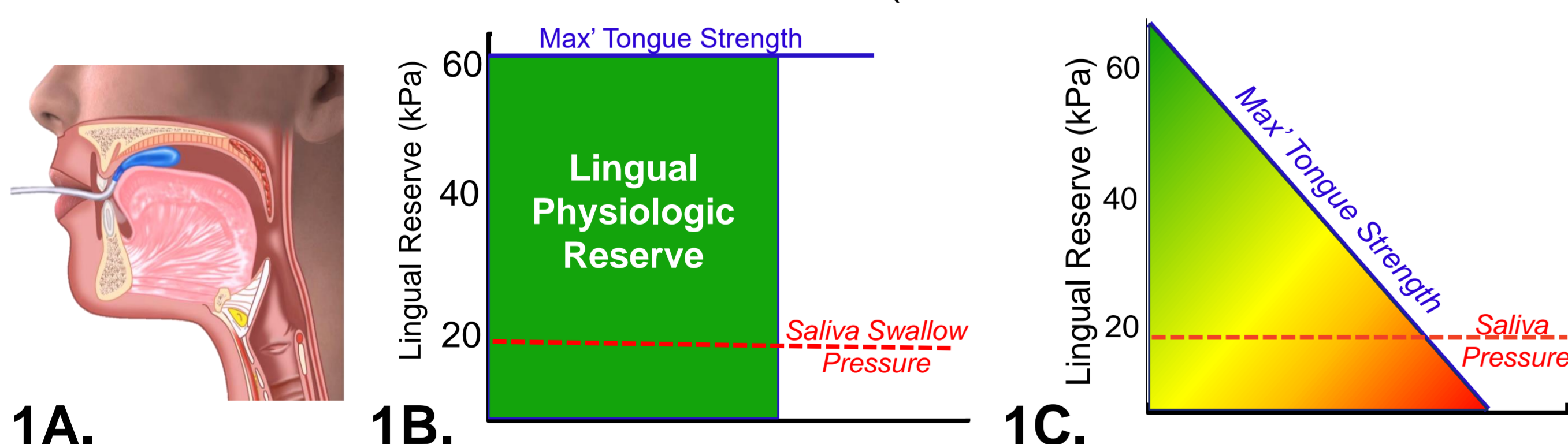
	Mean:	SD:	Range:
Age (years)	63.5	9.4	36 - 81
ALSFRS-R Total	32.5	9.9	10 - 45
ALSFRS-R Bulbar	8.1	3.1	3 - 12
Disease Duration	43.6	29.3	8 - 123



Procedures:

Lingual Pressure Testing:

- Maximum anterior isometric lingual pressure (kPa) obtained with Iowa Oral Performance Instrument (IOPI Medical, Redmond, WA).



LINGUAL RESERVE = MAX' LINGUAL STRENGTH – SALIVA SWALLOW PRESSURE (kPa)

Fig. 1A: IOPI bulb placement; Lingual physiologic reserve in states of homeostasis (Fig. 1B.) and homeostenosis (Fig. 1C).

Videofluoroscopic Swallowing Examination:

- VFSS with a standard bolus presentation was completed.
- Two independent and blinded raters analyzed all swallows with a 100% agreement requirement. Discrepancy meetings were used to finalize ratings not in agreement.

Validated Outcomes of Swallowing:

Penetration Aspiration Scale:

- PAS scores were derived for every bolus trial to index swallowing safety.
- The worst PAS score across trials was used for statistical analysis and established criteria used for binary safety classifications:
 - ✓ *Safe Swallowing*: Worst PAS ≤ 2
 - ✓ *Unsafe Swallowing*: Worst PAS ≥ 3

Table 2. Penetration Aspiration Scale.

1	Material does not enter airway	Safe
2	Material enters airway, remains above vocal folds, and is ejected from airway	Penetration
3	Material enters airway, remains above vocal folds, and is not ejected from airway	
4	Material enters airway, contacts the vocal folds, and is ejected from airway	Aspiration
5	Material enters airway, contacts the vocal folds, and is not ejected from airway	
6	Material enters airway, passes below vocal folds, ejected into larynx or out of airway	Aspiration
7	Material enters airway, passes below vocal folds, not ejected out of airway despite effort	
8	Material enters airway, passes below vocal folds, and no effort made to eject	

(Rosenbek et al., 1995)

Swallowing Efficiency:

- The ASPEKT residue component (Steele, 2019) was used to index efficiency.
- Established binary efficiency classifications were derived:
 - ✓ *Efficient Swallowing*: Worst total residue = $<3\%$ (C2-C4)²
 - ✓ *Inefficient Swallowing*: Worst total residue = $\geq 3\%$ (C2-C4)²

ASPEKT area of residue outlined in the vallecular (orange, V), pyriform sinuses (red, PS) and extra pharyngeal spaces (yellow, EX) are expressed as a percentage relative to the C2-C4 vertebrae distance squared (blue box).

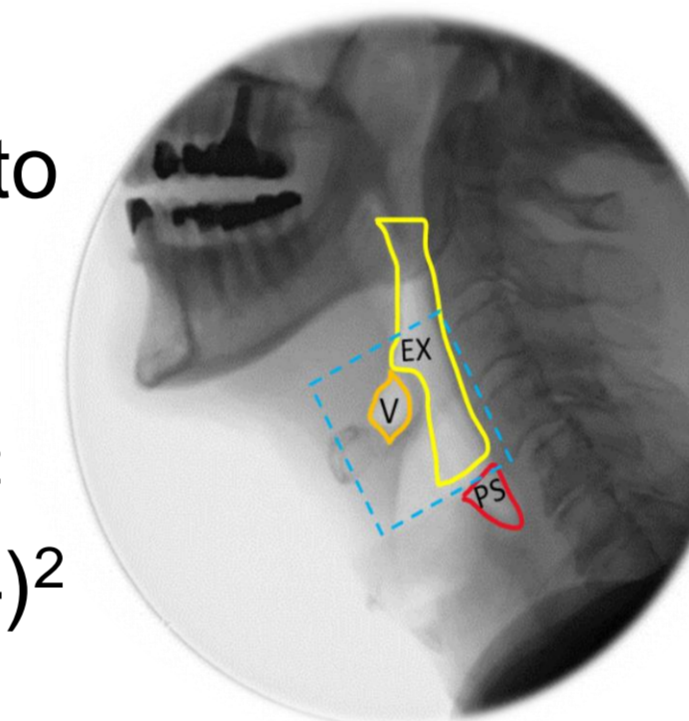


Fig 2. Residue Sites.

Statistical Analysis: Descriptive statistics and receiver operating characteristic curve (ROC) analyses were performed with alpha = 0.05/

RESULTS:

Safety and Efficiency Profiles:

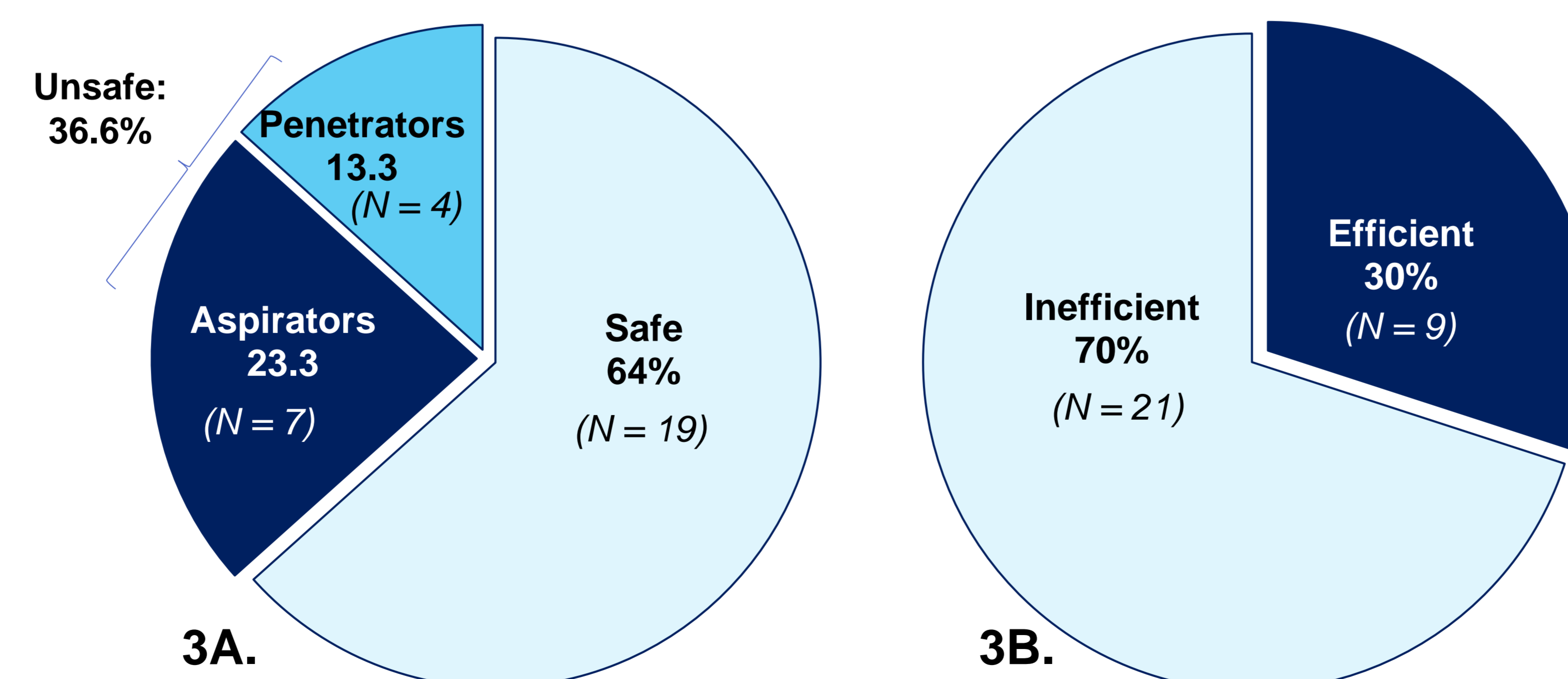


Fig. 3. Safety (3A) and efficiency profiles (3B) for this cohort of patients with ALS. Efficiency impairments (70%) were noted to be more prevalent than safety impairments (36.6%) in this cohort.

Lingual Depletion Threshold for Swallowing Efficiency:

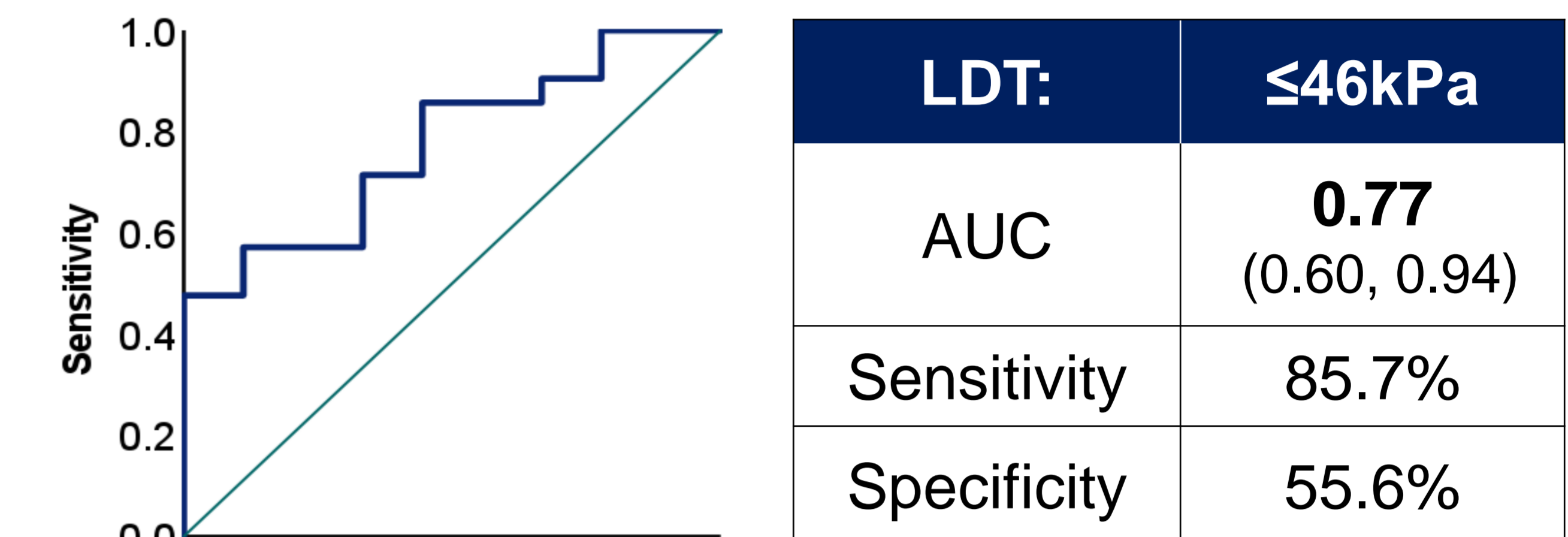


Fig. 4.

ROC curve analysis revealed a lingual depletion threshold of 46kPa optimized sensitivity (86%) and specificity (56%) for inefficient swallowing. This threshold value correctly classified efficiency status in 77% of pALS (AUC=0.77, p=0.02).

Lingual Depletion Threshold for Swallowing Safety:

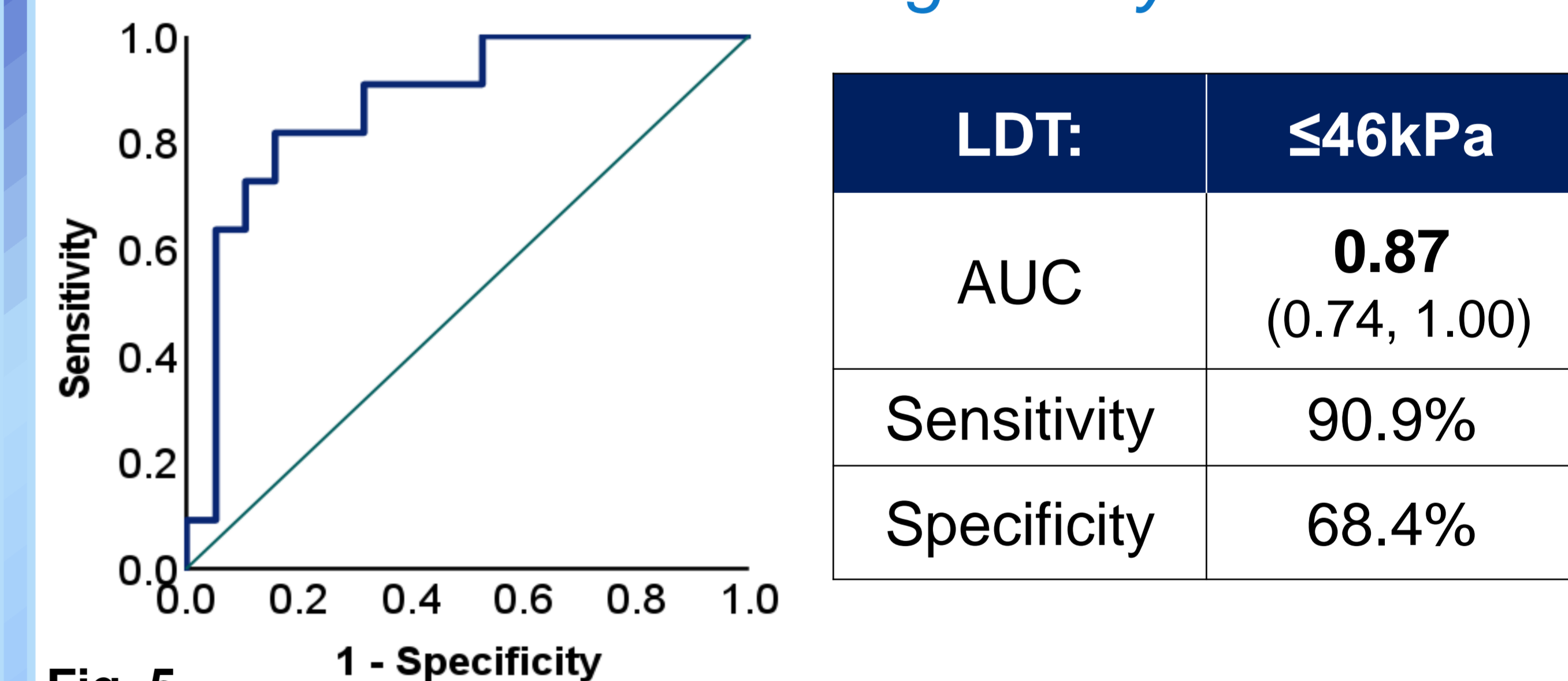


Fig. 5.

ROC curve analysis revealed a lingual depletion threshold of 37kPa optimized sensitivity (91%) and specificity (68%) for identification of unsafe swallowing. This threshold value correctly classified safety status in 87% of pALS (AUC 0.87, p=0.001). LDT demonstrated a superior discriminant ability to identify swallowing safety (AUC: 87) versus efficiency impairments (AUC: 77).

CONCLUSIONS:

- These cross-sectional data in 30 pALS demonstrated that emergence of swallowing efficiency impairment occurred at a higher lingual strength depletion threshold (i.e., milder strength reduction), compared to the emergence of swallowing safety impairment, that was on average 9kPa lower.
- Future longitudinal research is necessary to validate this preliminary finding.