

# Application of Four-Channel Electrical Stimulation for Dysphagia in Cervical Spinal Cord Injury: A Case Report

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## Background and Objective

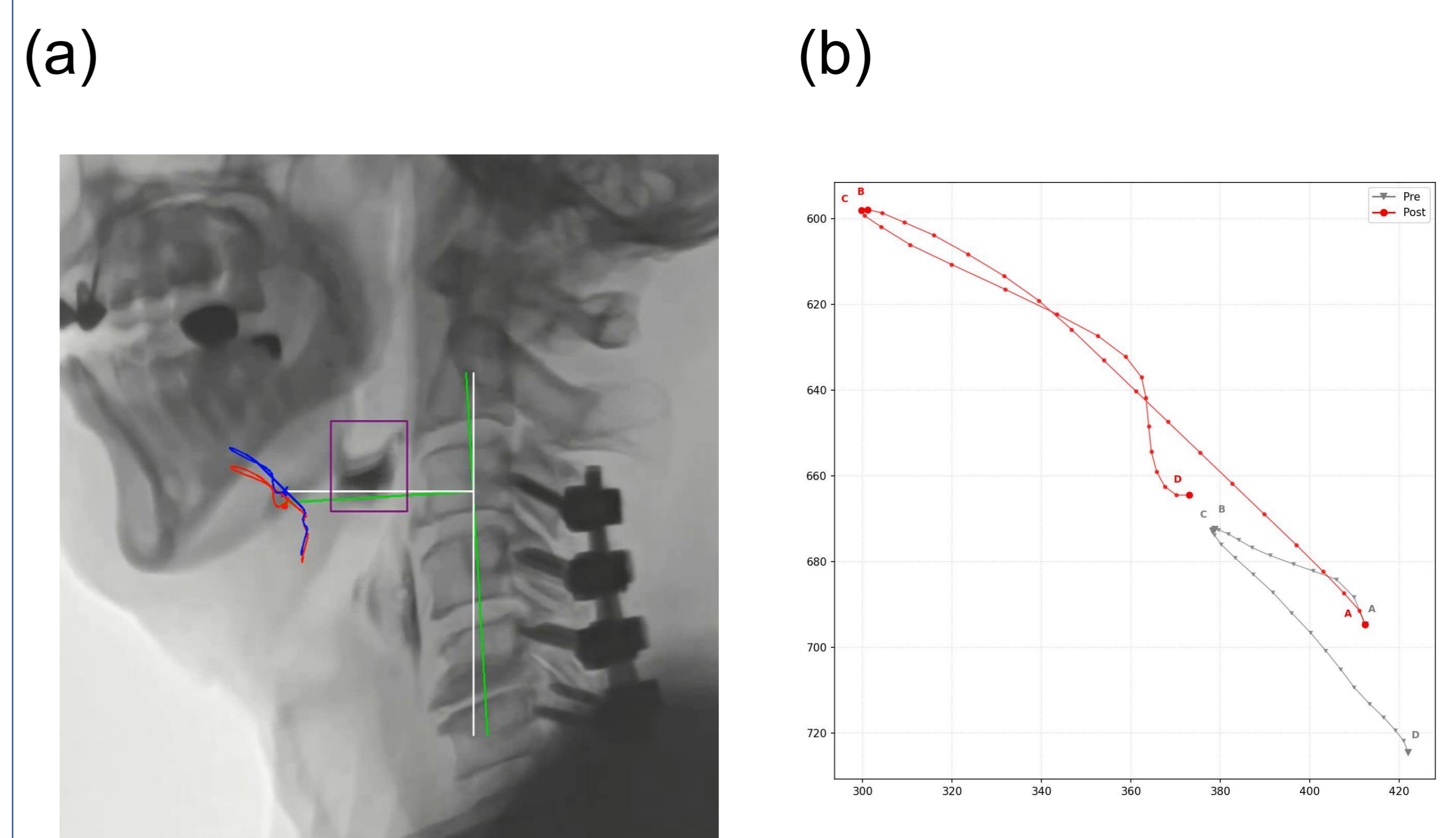
- ▶ Dysphagia after cervical spinal cord injury (SCI)
  - A common complication
  - Strongly associated with aspiration pneumonia
- ▶ Knowledge Gap
  - Neuromuscular electrical stimulation (NMES) : used to improve swallowing function
  - However, evidence for conventional 2-channel NMES remains limited
- ▶ A sequential 4-channel NMES system
  - Developed to mimic the physiological contractile sequence of swallowing-related muscles
- ▶ Case Objective
  - To report therapeutic effect of 4-channel NMES in a patient with cervical SCI-related dysphagia

## Case Presentation

- ▶ History & Presentation
  - 76-year-old male with severe dysphagia following traumatic cervical SCI and posterior cervical fusion (C3–C6)
  - Despite conventional swallowing rehabilitation:
    - Developed aspiration pneumonia
    - Required gastrostomy feeding
- ▶ VFSS (60 days post-injury)
  - Reduced epiglottic rotation
  - Incomplete laryngeal closure
  - Significant vallecular residue
  - PAS score:
    - Liquid: 6
    - Yogurt pudding: 5
- ▶ Intervention
  - Sequential 4-channel NMES (2 weeks)
    - 10 sessions
    - 30 minutes/day, 5 days/week
  - Electrode placement:
    - Suprahyoid
    - Thyrohyoid
    - Infrahyoid
  - Sequential activation to mimic physiological swallowing

## Results

- ▶ After 10 sessions, follow-up VFSS demonstrated significant improvement:
  - Improved epiglottic rotation
  - PAS score reduced from 6 → 3 (liquid) and 5 → 1 (yogurt pudding)
  - Complete resolution of pyriform sinus residue
  - Disappearance of velopharyngeal reflux
- ▶ Quantitative kinematic analysis using AKAS® revealed:
  - Increased vertical and horizontal hyoid excursion
  - Increased hyoid movement velocity
    - indicating improved hyolaryngeal elevation and swallowing efficiency
- ▶ Clinical outcomes:
  - Reduced coughing and sputum production
  - Improved saliva swallowing
  - EAT-10: 8 → 6
  - SWAL-QOL: 77 → 126



**Figure 1. VFSS kinematic analysis using AKAS®.**  
 (a) Anatomical landmarks (hyoid bone and cervical vertebrae) were defined in the initial frame.  
 (b) AKAS® automatically tracked hyoid movement: A (onset), B (max superior), C (max anterior), D (end). Gray = pre-NMES; Red = post 4-channel NMES (2 weeks).

## Conclusion

- ▶ **Sequential 4-channel NMES**
  - Improved swallowing kinematics and reduced aspiration severity in cervical SCI-related dysphagia
  - May represent a promising therapeutic option
  - Further controlled studies are warranted

**Table 1.** Clinical course and dysphagia

	Before 4-channel NMES	After 4-channel NMES
FOIS	1	2
PAS (YP)	5	1
PAS (large fluid)	6	3
VDS-O	0	0
VDS-P	12	4
Vallecular retention	3	3
Pyriformis sinus retention	1	0
Vertical A-B (pixel)	22.30 ± 7.06	96.80 ± 34.28
Horizontal A-C(pixel)	34.10 ± 12.55	112.60 ± 39.60
Velocity A-B (pixel/s)	121.11 ± 64.38	243.74 ± 82.89
Velocity A-C (pixel/s)	110.42 ± 70.74	232.37 ± 91.66
Velocity A-D (pixel/s)	35.98 ± 57.29	42.14 ± 97.49
EAT-10	8	6
SWAL-QOL	77	126