P-119

Development of an LLM-Based Automated VFSS Analysis and Report Generation System

Min Jae Lee, Kwang-Ik Jung, Woo-kyoung Yoo, Jae min Yoo
Department of Rehabilitation Medicine, Hallym University Sacred Heart Hospital, Anyang, Republic of Korea

BACKGROUND

Videofluoroscopic swallowing study (VFSS) is the gold standard for evaluating dysphagia.
However, traditional interpretation relies entirely on the evaluator's subjective, real-time judgment during brief fluoroscopic sequences — a process inherently prone to inter-rater variability and lacking in objectivity.
Key limitations of conventional VFSS interpretation:

- Subjective visual assessment with no quantitative output
- Inter-rater variability in diagnosis and scoring
- High time burden in clinical documentation
- No systematic data accumulation for research

This preliminary study aimed to develop an LLM-based AI system that automatically analyzes VFSS recordings and generates structured clinical reports — replacing subjective impression with objective, quantitative measurements such as hyoid elevation magnitude, pharyngeal constriction ratio, residue area, and phase transit times.

METHODS

Patient Data

- 2 patients: acute ischemic stroke & pharyngoglottic stenosis
- 6 bolus conditions each, PACS(512×512, 5FPS)

AI System Design

- LLM (Claude Opus 4.6, Anthropic) given anatomical/swallowing knowledge + institutional VFSS template
- AI autonomously generated image processing algorithms per report item
- Iterative clinician feedback loop for error correction

Analysis Modules

Oral Phase
- Bolus preparation & propulsion
- Premature spillage

Pharyngeal Phase
- Swallowing initiation & hyoid tracking
- Hyoid elevation : quantified via template matching (trajectory over time)
- pharyngeal constriction : multi-level kymography
- laryngeal elevation, epiglottic inversion, valleculae/pyriform residue, PAS/DOSS

Esophageal Phase
- UES opening, pyriform residue
- post-swallowing aspiration

RESULTS

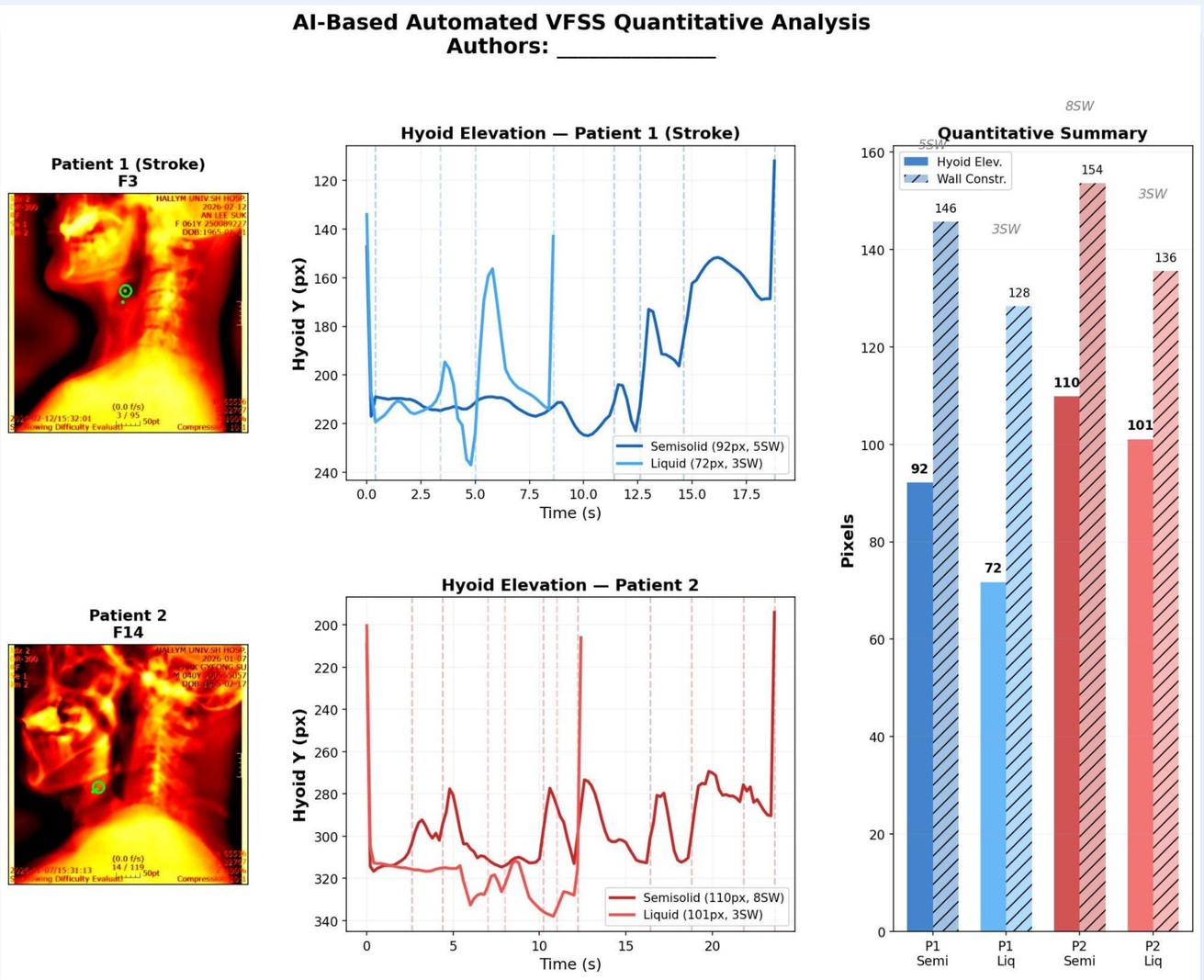

Figure 1. Hyoid elevation trajectories (Patient 1 stroke F3 / Patient 2 pharyngoglottic stenosis F14) and quantitative summary of hyoid elevation and pharyngeal wall constriction across bolus conditions

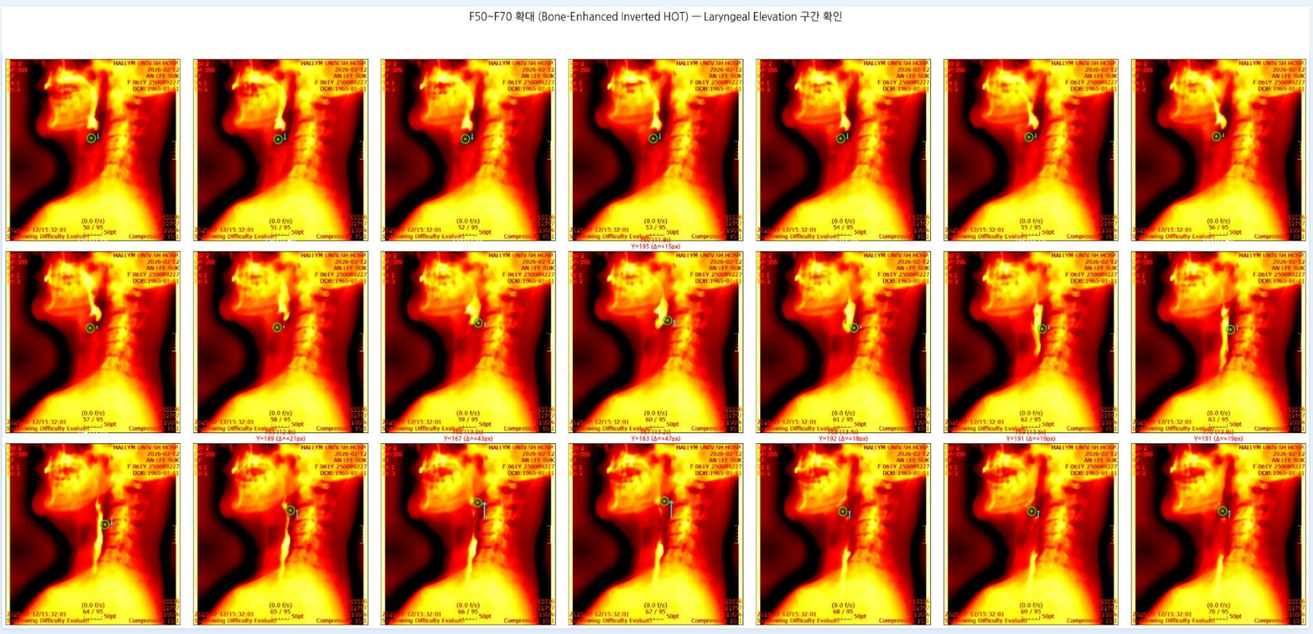

Figure 2. Frame-by-frame laryngeal elevation visualization (F50–F70, Bone-Enhanced Inverted HOT) — Patient 1, semisolid condition

Key Quantitative Findings

AI Development Process The LLM was provided with VFSS anatomical knowledge and the institutional report template. A clinician manually annotated key landmarks (hyoid bone position, pharyngeal wall boundaries) on selected frames to guide and correct the AI's detection.

Hyoid tracking (template matching):
- Template matching on bone-enhanced frames; swallow events detected at elevation peaks
  P1 - 5 swallows / P2 - 8 swallows detected
- Mean hyoid elevation : P1 Semi 92px · Liq 72px / P2 Semi 110px · Liq 101px

Pharyngeal wall constriction
- 5-level kymography across the posterior pharyngeal wall
- P1: 146px · P2: 154px mean constriction width

Phase segmentation: Oral-pharyngeal-esophageal boundaries extracted with clinician-verified accuracy

Residue quantification: Valleculae >50%, pyriform sinus residue graded per institutional criteria correction protocols developed

CONCLUSION

This study demonstrates the feasibility of an LLM-based system for automated, objective VFSS analysis and report generation. Where conventional interpretation depends on a clinician's subjective judgment in real-time, this system produces reproducible quantitative measurements that eliminate inter-rater variability and enable systematic data accumulation. The quantitative database built through this system may serve as a valuable resource for future research investigating correlations between biomechanical parameters and clinical outcomes including PAS scores and functional recovery. Further validation with larger cohorts and completion of the penetration-aspiration detection module are warranted.

Keywords: VFSS · large language model · automated report generation · dysphagia · hyoid tracking · pharyngeal constriction