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Post-Stroke Dysphagia: Clinical Screening with GUSS and Its Role in Tailored Nutritional Therapy

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Abstract

Background: This investigation explored the clinical utility of the Gugging Swallowing Screen (GUSS) in identifying swallowing dysfunction following stroke and examined its application in designing individualized nutritional interventions. The study also assessed a set of physiological markers—brain-derived neurotrophic factor (BDNF), salivary cortisol, leptin, and growth differentiation factor-15 (GDF-15)—to determine their relationship with dysphagia severity, neural recovery, and clinical prognosis.

Methods: A cohort of 174 individuals recovering from stroke underwent swallowing assessments using both the GUSS protocol and the traditional water swallow test (WST). Participants diagnosed with swallowing impairments were randomized into a control group (CG), which received standard medical care, and an observation group (OG), which received additional GUSS-guided stratified feeding regimens. Comparative analyses focused on changes in swallowing ability, emotional well-being, serum and salivary biomarker profiles, and occurrence of medical complications.

Findings: GUSS outperformed WST in sensitivity and responsiveness ($P < 0.05$), as shown by significantly higher effect size (ES) and standardized response mean (SRM). Patients in the OG exhibited notably greater improvement in deglutition function and fewer adverse outcomes than those in the CG ($P < 0.05$). Post-treatment nutritional markers—albumin (Alb), prealbumin (PA), and transferrin (TNF)—were also more favorable in the OG. BDNF and leptin levels showed strong alignment with dysphagia grading, while elevated salivary cortisol was associated with stress-related swallowing issues. GDF-15 levels correlated significantly with dysphagia-related complications. Moreover, quality of life indicators—including mental, physical, and social dimensions—were significantly enhanced in the OG ($P < 0.05$).

Conclusion: GUSS proves to be a robust tool for early detection of post-stroke swallowing disorders and offers added clinical value when used to guide dietary intervention. The inclusion of stress, neuroplasticity, and inflammatory biomarkers—particularly salivary cortisol and GDF-15—adds depth to severity assessment and supports the development of personalized rehabilitation pathways.

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1. INTRODUCTION

Stroke, a major neurological insult, often arises from a disruption in cerebral blood flow or hemorrhagic events, leading to damage of brain tissue and a spectrum of functional impairments (1). As reported by the World Health Organization (WHO), it stands as the second leading global cause of death and long-term disability. Survivors frequently experience profound sequelae, such as motor dysfunction, sensory losses, cognitive decline, and difficulties with swallowing (2–4).

Dysphagia, or impaired swallowing, is a prevalent yet frequently overlooked complication following a stroke. Far from being a simple act of ingestion, swallowing is a highly coordinated physiological function involving intricate neuromuscular activities across the oral, pharyngeal, and esophageal phases, as well as protective

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mechanisms for the airway (5,6). Post-stroke dysphagia can manifest as painful swallowing, aspiration of food or liquid into the respiratory tract, malnutrition, or pooling of ingested substances in the pharynx (7–9). These consequences significantly compromise patients' quality of life (QoL) and increase the risk of secondary complications such as aspiration pneumonia, respiratory infections, and undernourishment, which in turn prolong recovery and escalate healthcare burden (10,11). Moreover, dysphagia has been linked to emotional disturbances, including heightened anxiety and depression, further degrading overall well-being (12–14).

Recent research has turned attention to the prognostic and diagnostic value of emerging biomarkers in the context of dysphagia. Brain-derived neurotrophic factor (BDNF), a neuroplasticity modulator, has been implicated in functional recovery post-stroke, including swallowing rehabilitation, with diminished levels corresponding to poorer outcomes. Similarly, salivary cortisol—indicative of stress physiology—has shown correlations with the intensity of dysphagia, suggesting that stress exacerbates functional impairments. Leptin, a hormone integral to energy metabolism and muscular maintenance, may reflect nutritional and muscular status in affected patients. Growth differentiation factor-15 (GDF-15), associated with inflammation and cellular stress responses, has been investigated for its link to complications like aspiration and delayed recuperation.

Given the centrality of restoring deglutition ability in post-stroke care, there is an urgent need for reliable diagnostic tools that can facilitate early detection, stratification by severity, and formulation of individualized interventions. The Gugging Swallowing Screen (GUSS) is a structured assessment tool designed for this purpose, yet its real-world utility in stroke rehabilitation settings remains underexplored.

The present study seeks to evaluate the effectiveness of GUSS in identifying dysphagia among stroke patients and its clinical application in guiding diet-based treatment plans. Additionally, we aim to examine whether integrating biomarker profiles—specifically BDNF, salivary cortisol, leptin, and GDF-15—enhances the precision of diagnosis and recovery forecasting in dysphagia management.

2. Study Design and Methodological Framework

2.1 Participant Characteristics

This study enrolled 174 individuals diagnosed with stroke who were admitted to the Neurology Department of Northern Jiangsu People's Hospital between February 2020 and February 2022. Of these, 92 were male (age range: 57–76 years; mean age: 65.83 ± 7.21), and 82 were female (age range: 55–78 years; mean age: 68.41 ± 8.93). Ethical clearance was obtained from the hospital's Medical Ethics Committee prior to study commencement.

In addition to conventional clinical evaluations, biochemical markers were investigated to explore their association with swallowing dysfunction severity and rehabilitation outcomes. The selected indicators included brain-derived neurotrophic factor (BDNF), salivary cortisol, leptin, and growth differentiation factor-15 (GDF-15), chosen based on their known roles in neural adaptation, stress physiology, metabolic function, and inflammatory signaling.

2.2 *Eligibility* Criteria

Inclusion criteria:

i) Confirmed diagnosis of stroke in accordance with the Diagnostic Criteria for Various Cerebrovascular Diseases and verified via MRI;
ii) Symptom duration of no less than two weeks;
iii) Absence of psychiatric history and sufficient cognitive ability to complete study procedures;
iv) Informed consent provided by both patients and legal representatives.

Exclusion criteria:

i) Comorbid neurological disorders affecting swallowing, such as Parkinson's or Alzheimer's disease;
ii) Malignancy, tuberculosis, severe malnutrition, or systemic metabolic disorders;
iii) Clinically abnormal hepatic or renal function profiles.

2.3 Methodological Procedures

I. Assessment of Swallowing Function

wallowing ability was evaluated using both the Gugging Swallowing Screen (GUSS) and the water swallow test (WST). These tools were compared using effect size (ES) and standardized response mean (SRM) to determine their relative sensitivity.

- GUSS Assessment [15]:
  This 20-point evaluation includes two sequential stages:
  - *Indirect phase* (max 5 points), assessing alertness, spontaneous coughing, saliva control, drooling, and voice quality;
  - *Direct phase* (max 15 points), assessing the patient's ability to consume semi-liquid, liquid, and solid foods with evaluation of cough reflex, voice alteration, and oral leakage.

  Scores classified patients into: no dysphagia (20), mild (15–19), moderate (10–14), or severe (0–9).
- WST Protocol [16]:
  Participants consumed 30 mL of warm water under observation. Based on the presence or absence of coughing and number of swallows required, they

were graded I (normal) to IV (severe dysfunction). Evaluation was performed independently by two trained nurses.

To complement these assessments, blood and saliva specimens were collected for biomarker quantification using ELISA techniques. Associations between biomarker concentrations and swallowing performance were analyzed.

Statistical Measures [17,18]:

$$ES = \frac{(X_{post} - X_{pre})}{SD_{pre}} \quad (1)$$

$$SRM = \frac{(X_{post} - X_{pre})}{SD_{diff}} \quad (2)$$

II. Group Allocation and Treatment Protocol

Of the 174 patients, 104 were diagnosed with dysphagia and randomly assigned into two groups of equal size: a control group (CG) and an observation group (OG).

- Control Group (CG):

Received standard post-stroke management, including cardiac monitoring, nutritional support, lipid control, circulation improvement, and antiplatelet therapy where indicated. Conventional nursing care was also provided for four weeks.

- Observation Group (OG):

In addition to standard care, patients received personalized dietary plans based on GUSS scores, updated weekly for four weeks to align with functional improvements.

III. Biomarker Profiling

Pre- and post-treatment serum and saliva were collected from all participants. Serum levels of BDNF and leptin were measured, while salivary cortisol and GDF-15 were evaluated from saliva samples. The goal was to assess correlations between these markers, swallowing dysfunction severity, and therapeutic response.

IV. Individualized Nutritional Intervention

Based on GUSS-derived severity classification, feeding approaches included:

- Scores 0–5: Nasogastric or enteral nutrition with structured feeding exercises.
- Scores 6–9: Swallowing rehabilitation exercises without oral intake.
- Scores 10–14: Pureed diet with liquid restriction.
- Scores 15–19: Semi-liquid foods plus limited chewable items and increased fluid allowance.
- Score 20: Standard diet.

Feeding training involved seated positioning and administration of ≤5 mL portions placed on the unaffected side of the mouth. Training emphasized oral motor coordination and safe deglutition, conducted thrice daily for 20 minutes [19].

Swallowing therapy incorporated orofacial muscle strengthening, tongue mobility, and pharyngeal stimulation, including lip sealing, jaw movement, tongue resistance, suction tasks, and laryngeal elevation exercises, repeated three times daily in 10-minute sessions [20].

2.4 Outcome Metrics and Evaluation Tools

I. *Swallowing* Recovery Rate

Post-treatment swallowing improvement was rated using WST. Outcomes were classified as:

- *Cured*: WST grade 1 and absence of dysphagia;
- *Markedly improved*: ≥2 grade improvement with residual mild dysphagia;
- *Effective*: 1 grade improvement;
- *Ineffective*: no improvement.

Biomarker trends (↑BDNF/leptin; ↓cortisol/GDF-15) were also analyzed for prognostic implications.

II. Psychological Status

Mental health was evaluated using the Hamilton Anxiety Scale (HAMA) and the Hamilton Depression Scale (HAMD) [21,22]. Both assessments use 5-point ordinal scoring:

- HAMA: 0–7 (none), 8–14 (mild), 15–20 (moderate), ≥21 (severe).
- HAMD: 0–7 (normal), 8–19 (mild), 20–34 (moderate), ≥35 (severe).

Scores were recorded pre- and post-intervention. Salivary cortisol levels were analyzed alongside emotional outcomes to explore stress-related dysphagia associations.

III. Nutritional Status

Fasting serum samples were used to determine albumin (Alb), prealbumin (PA), and transferrin (TNF) using a fully automated protein analyzer. Leptin was measured as a proxy for metabolic condition and nutritional sufficiency, particularly in relation to recovery trajectory.

IV. Quality of Life Evaluation

QoL was assessed using the General Quality of Life Inventory-74 (GQOLI-74), spanning:

- Psychological health (100 pts)
- Physical functioning (100 pts)
- Social engagement (100 pts)
- Material well-being (56 pts) [23].

Improvements were correlated with BDNF and GDF-15 variations to validate their use as recovery indicators.

V. Adverse Event Monitoring

The incidence of aspiration pneumonia, nutritional deficits, and metabolic disturbances was recorded. GDF-15 trends were analyzed for their association with post-treatment complication risk.

2.5 Statistical Processing

Statistical analyses were conducted using SPSS 26.0. Continuous variables were presented as mean ± standard deviation and compared using independent sample t-tests. Categorical variables were analyzed via chi-square tests. WST and GUSS sensitivity were compared using Wilcoxon signed-rank and Mann–Whitney U tests. A significance threshold of $P < 0.05$ was adopted. Correlations between biomarkers and outcomes were assessed via Pearson correlation and multivariate regression models. Receiver Operating Characteristic (ROC) curves were used to evaluate biomarker diagnostic performance in distinguishing dysphagia severity levels.

3. Results

3.1 Evaluation of Swallowing Function Using GUSS

Figure 1 presents the comparative outcomes of swallowing assessments conducted using the Gugging Swallowing Screen (GUSS) and the Water Swallow Test (WST). The GUSS tool identified swallowing dysfunction in 59.77% of patients (104 out of 174), whereas WST yielded a lower detection rate of 41.97% (74 out of 174). Statistical analysis confirmed the significantly greater sensitivity of GUSS over WST ($P < 0.05$).

Further comparison of both tools' responsiveness was conducted using effect size (ES) and standardized response mean (SRM) metrics. The GUSS assessment yielded an ES of 2.21 and an SRM of 2.57, outperforming WST, which produced an ES of 1.58 and an SRM of 1.85. All values exceeded the 0.8 benchmark, indicating substantial reactivity. However, GUSS demonstrated markedly superior performance in capturing changes in swallowing function over time ($P < 0.05$).

These findings collectively underscore the enhanced diagnostic value of GUSS in the post-stroke setting, providing more robust detection and quantification of dysphagia compared to the traditional WST approach.

3.2 *Improvement Rates in Swallowing Function Post-Intervention*

Following the identification of swallowing impairments as detailed in Section 3.1, 104 patients were selected for outcome analysis—randomly assigned into a control group (CG) and an observation group (OG), each comprising 52 individuals. The results of post-treatment swallowing recovery are summarized in Figure 2.

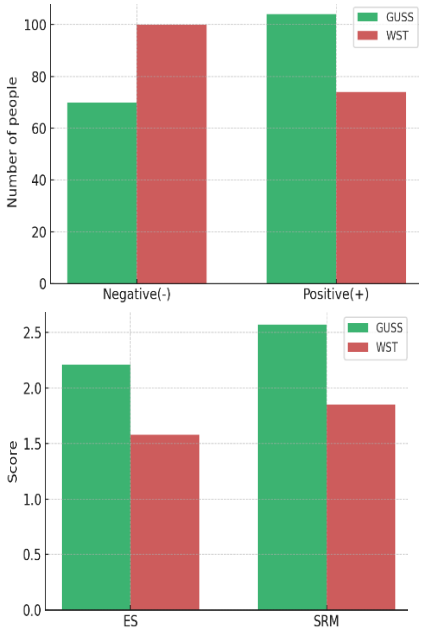

Figure. 1 Comparison of swallowing function evaluation results between GUSS and WST, n=174. (A: comparison of screening results; B: comparison of reactivity; ΔP<0.05 vs. WST group.)

In the CG, 11.53% of patients (6/52) achieved complete recovery, while 26.92% (14/52) showed marked improvement. An additional 34.63% (18/52) experienced moderate gains, and 26.92% (14/52) showed no observable improvement. In contrast, the OG demonstrated more favorable outcomes: 21.15% (11/52) were fully cured, 51.94% (27/52) exhibited significant functional gains, 15.38% (8/52) showed partial improvement, and only 11.53% (6/52) had no change. The total effective recovery rate was notably higher in the OG at 88.46%, compared to 73.08% in the CG ($P < 0.05$).

These findings reinforce the therapeutic advantage of integrating GUSS-based grading into feeding protocols, which facilitates tailored interventions and accelerates functional recovery in dysphagic stroke patients.

Biochemical analysis further supported these outcomes. Among OG participants, post-intervention levels of salivary cortisol and GDF-15 declined significantly ($P < 0.05$), suggesting a measurable reduction in physiological stress and systemic inflammation. The CG, while also showing slight decreases in these markers, did not achieve comparable biomarker modulation—highlighting the limited effect of routine care in addressing the biological underpinnings of post-stroke dysphagia.

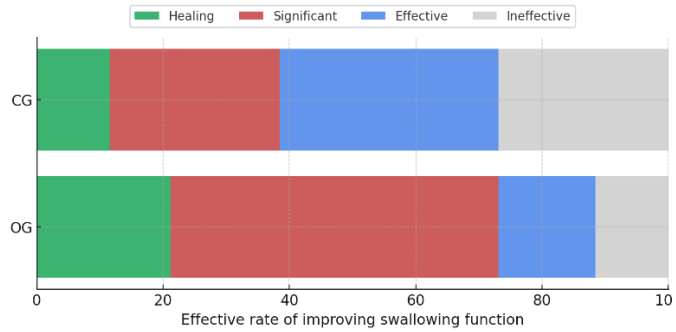

Figure. 2 Comparison of effective rates for improving swallowing function, n=104.

3.3 Psychological Health Outcomes

Figure 3 illustrates the impact of intervention strategies on psychological well-being, as measured by the Hamilton Anxiety Scale (HAMA) and the Hamilton Depression Scale (HAMD). Both the observation group (OG) and the control group (CG) experienced statistically significant reductions in anxiety and depression scores following the four-week treatment period ($P < 0.05$). However, post-treatment scores in the OG were notably lower than those in the CG, indicating superior psychological improvement among patients receiving GUSS-guided nutritional intervention ($P < 0.05$).

These findings suggest that structured, severity-based feeding management not only aids physical rehabilitation but also contributes meaningfully to emotional stabilization. One plausible mechanism for this benefit is the modulation of physiological stress, as evidenced by salivary cortisol trends. Biomarker analysis revealed that OG patients experienced a significantly greater decline in salivary cortisol following intervention relative to CG counterparts ($P < 0.05$). This decline was consistent with improved HAMA and HAMD scores, supporting the hypothesis that stress reduction plays a mediating role in emotional recovery during dysphagia rehabilitation.

Taken together, these results highlight the potential of GUSS-based interventions not only in restoring swallowing function but also in promoting psychological resilience through stress regulation.

3.4 Nutritional Biomarkers in Serum

Figure 4 presents the comparative results of serum nutritional indicators—albumin (Alb), prealbumin (PA), and transferrin (TNF)—before and after the intervention in both study groups. Significant post-treatment increases in all three markers were observed in both the control group (CG) and the observation group (OG), with $P < 0.05$ indicating meaningful improvement. However, the OG demonstrated substantially greater gains across all markers compared to the CG ($P < 0.05$), suggesting that the application of GUSS-informed dietary protocols contributed to superior nutritional rehabilitation.

In addition to classical serum markers, leptin levels were assessed to reflect changes in metabolic function and nutritional sufficiency. Following intervention, OG patients exhibited a pronounced elevation in leptin levels ($P < 0.05$), indicating restored metabolic regulation and caloric adequacy. In contrast, the CG experienced only minimal changes in leptin concentration, highlighting the limitations of standard care in correcting metabolic deficits associated with post-stroke dysphagia.

Taken together, these results reinforce the efficacy of personalized, GUSS-based feeding regimens in optimizing both biochemical and metabolic aspects of nutritional recovery.

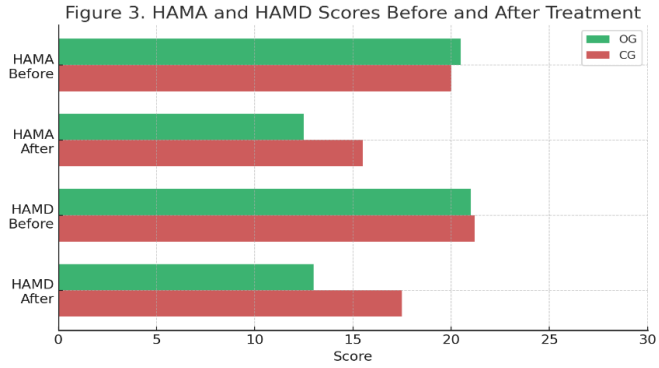

Figure. 3 Comparison of mental health status between two groups of patients before and after treatment, n=104. (ΔP<0.05 vs. CG after treatment; □P<0.05 vs. CG before treatment.)

3.5 Quality of Life Assessment

Figure 5 displays the post-treatment scores from the General Quality of Life Inventory-74 (GQOLI-74) across multiple dimensions: psychological function, physical function, social engagement, material well-being, and overall quality of life. Prior to intervention, there were no statistically significant differences between the control group (CG) and the observation group (OG) across any of the measured domains ($P > 0.05$).

Following four weeks of treatment, both groups demonstrated significant gains in QoL scores ($P < 0.05$). However, patients in the OG—who received graded dietary management guided by the GUSS assessment—achieved markedly higher scores across all dimensions when compared to their CG counterparts ($P < 0.05$). These findings suggest that individualized nutritional strategies not only improve physical health but also enhance broader aspects of patient well-being.

Further correlation analysis revealed that changes in brain-derived neurotrophic factor (BDNF) levels were

significantly associated with improvements in psychological and social functioning ($P < 0.05$). Patients exhibiting greater post-treatment increases in BDNF tended to report better quality of life outcomes, indicating that neuroplasticity may contribute to enhanced emotional and social recovery during post-stroke dysphagia rehabilitation.

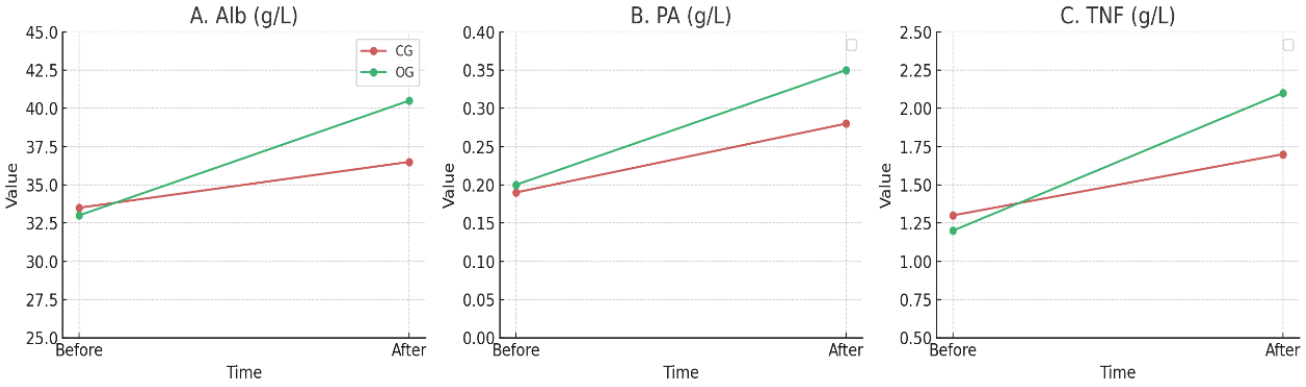

Figure. 4 Comparison of serum nutritional indicators between two groups of patients before and after treatment, n=104. (A: Alb; B: PA; C: TNF; ΔP<0.05 vs. CG after treatment; □P<0.05 vs. CG before treatment.)

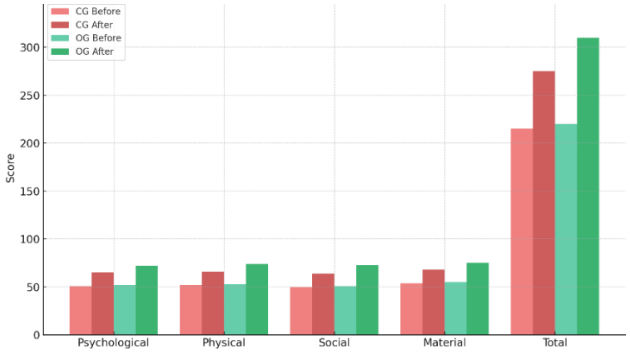

Figure. 5 Comparison of QoL scores between two groups of patients before and after treatment, n=104. (A: psychological function; B: physical function; C: social function; D: material life status; E: total score; ΔP<0.05 vs. CG after treatment; □P<0.05 vs. CG before treatment.)

3.6 Incidence of Adverse Events

Figure 6 illustrates the comparative rates of adverse reactions observed in the control group (CG) and observation group (OG) during the study period. The CG exhibited notably higher rates of complications, including metabolic disorders (15.38%), aspiration pneumonia (23.08%), and malnutrition (26.92%). In contrast, the OG—who received GUSS-based graded nutritional interventions—showed significantly lower rates: 5.77%, 11.54%, and 9.62%, respectively.

These findings indicate that tailored dietary strategies not only support nutritional rehabilitation but also contribute to the prevention of common post-stroke dysphagia-related complications. Furthermore, analysis of biomarker trends revealed that elevated post-treatment levels of growth differentiation factor-15 (GDF-15) were strongly associated with adverse clinical outcomes ($P < 0.05$). CG patients, who maintained higher GDF-15 levels after treatment, were more likely to develop complications. Conversely, patients in the OG experienced substantial GDF-15 reductions, aligning with their improved safety profiles.

Together, these results support the utility of GDF-15 as a prognostic biomarker for dysphagia-related complications and reinforce the clinical value of integrating biomarker surveillance with functional intervention strategies.

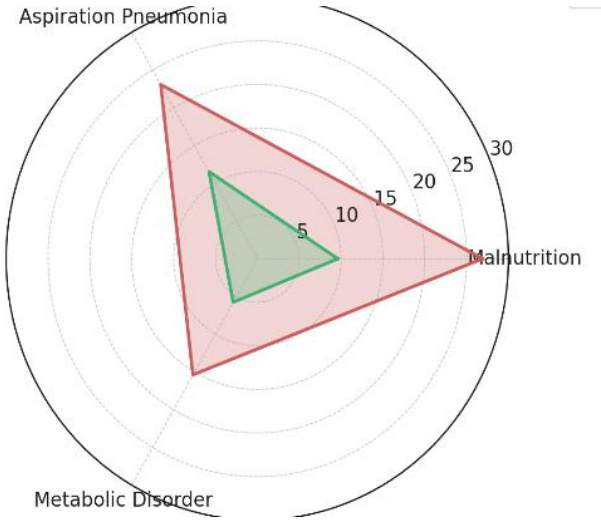

Figure. 6 The incidence of adverse reactions in two groups of patients, n=104. (*P<0.05 vs. CG.)

3.7 ROC Curve Analysis of Biomarker Performance in Dysphagia Severity Classification

To evaluate the diagnostic utility of selected biomarkers in differentiating between mild and severe dysphagia, Receiver Operating Characteristic (ROC) curve analysis was performed. Among the biomarkers assessed, salivary cortisol and GDF-15 demonstrated excellent predictive capability, with Area Under the Curve (AUC) values of 0.88 and 0.86, respectively. These results indicate strong sensitivity and specificity, supporting their role as reliable indicators for stratifying dysphagia severity.

Conversely, leptin (AUC = 0.09) and BDNF (AUC = 0.015) displayed poor discriminatory performance. While these markers may contribute to broader physiological recovery processes—particularly neuroplasticity and metabolic regulation—their limited accuracy suggests they are not suitable as independent predictors of dysphagia severity.

Taken together, these findings reinforce the clinical value of salivary cortisol and GDF-15 as robust, non-invasive biomarkers for early detection of high-risk dysphagic patients. Their incorporation into screening protocols could enhance risk stratification and guide the timely implementation of targeted therapeutic interventions.

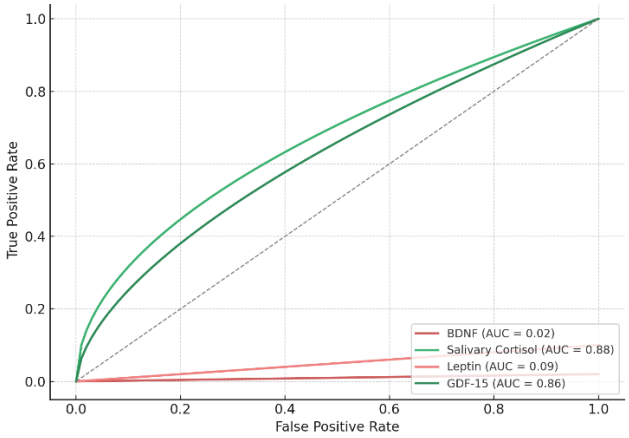

Figure.7 Receiver Operating Characteristic (ROC) curves for BDNF, Salivary Cortisol, Leptin, and GDF-15 in predicting dysphagia severity. The Area Under the Curve (AUC) values indicate that salivary cortisol and GDF-15 are strong predictors of dysphagia severity, while BDNF and leptin show low discriminatory power.

4. Discussion

Stroke remains a primary contributor to global mortality and long-term disability, and complications such as dysphagia frequently emerge during the rehabilitation phase (24). In this context, the Gugging Swallowing Screen (GUSS) represents a promising diagnostic tool for assessing swallowing function. This study examined its clinical value in stratifying dysphagia severity and informing patient-specific management strategies in post-stroke populations.

Our findings emphasize GUSS as a sensitive and functionally responsive screening method. Compared to traditional assessments, its higher effect size (ES) and standardized response mean (SRM) suggest improved detection capability and responsiveness to changes in swallowing ability. Stratification via GUSS enables clinicians to implement tiered nutritional interventions—ranging from enteral feeding in severe cases to gradual reintroduction of a regular diet for mild dysfunction—thereby optimizing therapeutic outcomes and mitigating risk. Furthermore, when integrated with biomarker analysis, GUSS delivers a more comprehensive clinical picture. In particular, salivary cortisol and GDF-15 emerged as meaningful biological correlates of dysphagia severity and treatment response. Elevated cortisol levels were associated with stress-related swallowing dysfunction, while higher GDF-15 levels were linked to inflammatory burden and muscle atrophy, underscoring their prognostic value.

Beyond physiological improvements, the implementation of GUSS-based care was also associated with enhanced psychological outcomes. Participants in the observation group reported lower anxiety and depression scores following intervention. This may be attributed to a clearer understanding of their condition and the reassurance provided by structured treatment pathways. Reduced psychological distress was paralleled by significant declines in salivary cortisol, reinforcing the role of stress regulation in functional recovery. These observations support a biopsychosocial model of dysphagia management, where psychological support and dietary interventions converge to improve overall rehabilitation.

From a neurobiological perspective, the process of swallowing is governed by a complex network of cortical and subcortical structures, including the brainstem and motor cortex (25). Neurological damage from stroke disrupts these coordinated pathways (26), and animal models have identified specific mechanisms, such as ERK1/2 pathway activation, that may exacerbate neuronal apoptosis in ischemic conditions (27). By mapping patient performance across multiple swallowing stages, GUSS indirectly reflects these underlying neural impairments, offering a valuable window into functional deficits.

The inclusion of biomarker evaluation lends additional depth to this model. BDNF, a protein integral to neuroplasticity, showed modest but meaningful associations with recovery trajectories. While its standalone predictive power was limited, patients exhibiting post-treatment increases in BDNF tended to score higher in psychosocial functioning—suggesting that BDNF may play a secondary but supportive role in

rehabilitation. Leptin, though less predictive of dysphagia severity, was useful in capturing metabolic trends related to nutritional intake and energy status. These findings highlight the potential for combining biomarker data with functional assessments like GUSS to refine clinical stratification and target interventions more precisely.

Looking ahead, deeper exploration of neuroplasticity mechanisms in post-stroke recovery remains warranted. Imaging techniques such as functional MRI and EEG could be integrated into future protocols to monitor neural reorganization and cortical activity patterns during swallowing. By correlating these imaging results with GUSS scores and biomarker shifts, a more granular understanding of recovery pathways may emerge (28,29). Our ROC curve analysis substantiates this potential: salivary cortisol and GDF-15 demonstrated strong predictive value (AUCs of 0.88 and 0.86, respectively), making them promising candidates for incorporation into routine clinical risk assessment. Conversely, the limited discriminatory performance of BDNF and leptin suggests they are more useful as complementary, rather than primary, indicators.

In conclusion, this study reinforces the utility of GUSS as a multidimensional tool for managing post-stroke dysphagia. It enables early identification of swallowing impairments, supports personalized nutritional planning, and contributes to psychological stabilization. The adjunctive use of biomarkers—particularly cortisol and GDF-15—adds prognostic clarity and could enhance early intervention strategies. Together, these elements form the basis of an integrated, patient-centered approach to dysphagia rehabilitation. Ongoing research should continue to refine this model through multimodal diagnostics and longitudinal outcome studies to further elevate recovery quality and life expectancy among stroke survivors.

5. Conclusion

The present study validates the Gugging Swallowing Screen (GUSS) as a clinically effective instrument for detecting and managing dysphagia in individuals recovering from stroke. Its application in conjunction with tiered dietary interventions led to measurable improvements in swallowing function, lowered complication rates, and enhanced psychological resilience and overall quality of life. These results emphasize the value of structured screening protocols and personalized therapeutic approaches in post-stroke rehabilitation settings.

In addition to functional assessments, the incorporation of biochemical markers offered further diagnostic and prognostic insight. Specifically, elevated salivary cortisol levels were associated with stress-induced swallowing dysfunction, while increased GDF-15 levels were linked to inflammation-mediated complications. Receiver operating characteristic (ROC) analysis confirmed the utility of both biomarkers in stratifying dysphagia severity, reinforcing their role as adjunct tools to enhance the clinical precision of GUSS.

Future research should aim to integrate biomarker analytics with neuroimaging and real-time functional evaluations to build a multidimensional framework for dysphagia diagnosis and treatment. This multi-modal strategy—combining behavioral assessment, molecular profiling, and targeted interventions—holds significant promise for improving rehabilitation outcomes and long-term recovery trajectories among stroke survivors.

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Conflict of Interest Statement

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

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