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Fiberoptic Endoscopic Assessment of post- extubation palatopharyngeal incoordination in term neonates: Incidence and Risk Factors

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ABSTRACT

Background: Neonates recovering from mechanical ventilation often experience swallowing dysfunctions, including palatopharyngeal incoordination (PPI), a condition underrecognized in full-term infants. PPI can lead to aspiration, recurrent infections, and prolonged hospitalizations. Current literature mainly focuses on preterm infants, leaving a critical knowledge gap regarding term neonates.

Objective: To determine the incidence of post-extubation palatopharyngeal incoordination (PPI) in full-term neonates and to identify associated risk factors using Fiberoptic Endoscopic Evaluation of Swallowing (FEES) in resource-limited neonatal intensive care settings.

Methods: This cross-sectional study was conducted in two NICUs in Cairo, Egypt, over six months in 2024. Forty full-term neonates with no prior dysphagia, who had been mechanically ventilated, were enrolled. Detailed clinical, laboratory, radiological, and endoscopic assessments were conducted post-extubation. Swallowing function was assessed using FEES. Statistical analysis included logistic regression to identify risk factors associated with PPI.

Results: Out of 40 neonates, 80% exhibited clinical signs of swallowing dysfunction; FEES confirmed PPI in 62.5% of these cases. Significant risk factors included prolonged intubation (>8 days, OR=11.0), delayed initiation of intubation (>4 days postnatal age, OR=21.0), positive CRP (>6 mg/L, OR=7.7), positive blood cultures (OR=4.8), low arterial pH (≤7.36, OR=7.1), and elevated PCO_2 (>41 mmHg, OR=8.3). Fentanyl administration was found to be a protective factor (OR=0.16). Longer hospital stays and systemic inflammation were also associated with increased risk.

Conclusions: Palatopharyngeal incoordination is highly prevalent among full-term neonates following mechanical ventilation. Prolonged intubation, systemic inflammation, and metabolic derangements are key risk factors. FEES serves as a valuable diagnostic tool for early identification. The protective role of fentanyl warrants further investigation. Early recognition and targeted interventions may improve neonatal outcomes.

Keywords: *Palatopharyngeal incoordination, Fiberoptic Endoscopic Evaluation of Swallowing, Neonates, Mechanical ventilation, Swallowing dysfunction, Post-extubation dysphagia, Risk factors, Term infants, NICU, Fentanyl*

1. INTRODUCTION

Neonates recovering from mechanical ventilation frequently have swallowing dysfunction, im-pacting their feeding, respiratory health, and overall developmental outcomes. Among these challenges is palatopharyngeal incoordination (PPI) due to its potential for underdiagnosis and the complexity of its management [1]. Neonates with PPI are at increased risk of aspiration pneumonia, recurrent respiratory infections, and feeding difficulties as PPI disrupts the coordi-nated movements of the pharynx and larynx during swallowing. These complications can lead to prolonged hospitalization, increased healthcare costs, and significant emotional and financial strain on families, thereby placing a significant burden on neonatal intensive care units (NI-CUs) [2].

Mechanical ventilation itself can contribute to the development of palatopharyngeal incoordination (PPI). Post-extubation laryngeal edema, associated inflammation, and prolonged intubation can all disrupt the neuromuscular synchronization required for safe swallowing [3]. Furthermore, while an endotracheal tube is physically present, the pharyngeal and laryngeal muscles which are necessary for coordinated swallowing do not develop and function appropriately. Even after extubation, residual neuromuscular weakness and potential structural changes within the upper airway may persist, thereby increasing the vulnerability to swallowing difficulties. These risks are particularly pronounced in neonates due to the immaturity of their swallowing reflexes and their heightened vulnerability to systemic stressors [2]

Despite the significant therapeutic consequences of palatopharyngeal incoordination (PPI), little is currently understood about this problem in newborns. Since most of the research to date has focused on preterm infants, there is a paucity of data on full-term newborns, who are also far more likely to have swallowing difficulties. In addition, the impact of more general systemic problems including sepsis, acid-base imbalances, and breathing strategies that may contribute to the development of swallowing difficulties have usually been ignored in previous studies. This gap in knowledge highlights the urgent need for targeted research to better understand the etiology and management of palatopharyngeal incoordination, especially in resource constrained NICU settings [4]

Early identification of neonates at risk for PPI allows for timely interventions, such as modified feeding plans, swallowing therapy, and adjustments to ventilation settings. By reducing the risk of aspiration and its complications, these interventions can improve neonatal outcomes and facilitate earlier discharge from the NICU [5].

This study utilized Fiberoptic Endoscopic Evaluation of Swallowing (FEES), a sensitive diagnostic tool that provides a direct visualization of swallowing function. Unlike clinical observations alone, FEES can detect subtle or mild forms of swallowing incoordination, enabling early intervention and potentially improved outcomes [6]. By integrating advanced diagnostic tools, targeted interventions, and a multidisciplinary approach, we can improve the care of these vulnerable infants and reduce the long-term impact of swallowing difficulties [7]. This study investigated the incidence of palatopharyngeal incoordination in term neonates recovering from mechanical ventilation and identifies possible risk factors associated. The research provides cost-effective insights in resource-constrained settings by utilizing bedside diagnostic methods like Fiberoptic Endoscopic Evaluation of Swallowing (FEES) and focusing on modifiable risk factors.

2. METHODS:

Study Design

This cross-sectional study was conducted between January and July 2024 in the neonatal intensive care units (NICUs) of Ain Shams University Children's Hospital and the Gynecology and Obstetrics Hospital in Cairo, Egypt.

Participants

The study included 40 full-term neonates (gestational age ≥37 weeks) who were mechanically ventilated and assessed post-extubation for swallowing dysfunction. **Inclusion criteria**: Term neonates with no pre-intubation swallowing problems. **Exclusion criteria:** very low birth weight (<1500 g), congenital anomalies of the head and neck, post-head or neck surgery, perinatal asphyxia, neurological issues, post-cardiac surgery, metabolic disorders, genetic syndromes, post-arrest status, and evidence of pre-intubation dysphagia.

Data were collected from patient files, including antenatal history (gestational age, maternal steroid use, premature rupture of membranes >18 hours, and general anesthesia during delivery), natal history (sex, mode of delivery, birth weight, and intrauterine growth restriction), and postnatal history (age at NICU admission, clinical manifestations of swallowing incoordination, indications and type of ventilation, duration of mechanical ventilation, endotracheal tube size, medications used pre- and post-extubation, and patient outcomes). Clinical examination included confirmation of gestational age using the New Ballard Score and comprehensive chest, cardiovascular, abdominal, and neurological assessments. Laboratory investigations included complete blood count (Sysmex XN-1000), C-reactive protein (Roche/Hitachi Cobas® c501), venous blood gas (GEM Premier 5000), and blood culture (BACTEC Peds Plus™/F). Radiological investigations included chest X-rays (GE Optima XR 220 AMX) and echocardiography (Vivid E9, GE Vingmed).

Assessment of Swallowing Function

Swallowing function was evaluated using Fiberoptic Endoscopic. A mobile Olympus fiber rhinolaryngoscope was utilized to assess swallowing function without the administration of anesthetics or vasoconstrictors to ensure a physiologic examination.

Sample Size Calculation

A sample size of 40 neonates was determined using PASS software with a 95% confidence level and a 15% margin of error.

This calculation was based on an anticipated prevalence of palatopharyngeal incoordination (PPI) of 31.3% as reported in previous research by Korraa et al. (2023) [7].

Statistical analyses were performed using IBM SPSS version 27. Quantitative data were presented as mean ± standard deviation (SD) or median with interquartile range (IQR), and qualitative data as numbers and percentages. Chi-square or Fisher's exact tests were used for categorical variables, while t-tests and Mann-Whitney tests were applied for continuous variables based on distribution. Logistic regression analysis (univariate and multivariate) was employed to determine factors associated with palatopharyngeal incoordination, with results expressed as odds ratios (OR) and 95% confidence intervals (CI). A p-value <0.05 was considered statistically significant.

Ethical Considerations

Ethical approval for this study was obtained from the Research Ethics Committee of the Faculty of Medicine, Ain Shams University (Approval No. MS24/2024). Written informed consent was secured from the parents or legal guardians of all participating neonates.

3. RESULTS:

The study enrolled 40 full-term neonates following extubation from mechanical ventilation, with no prior evidence of swallowing dysfunction. Post-extubation, these neonates were evaluated for clinical evidence of swallowing dysfunction.

A total of forty neonates were included in the study, with a male predominance (55%). The primary indication for intubation was pneumonia (77.5%), followed by sepsis (65%). Conventional mechanical ventilation was employed in 70% of cases, with a 3 cm endotracheal tube utilized in 87.5% of neonates. Steroids were administered both pre- and post-extubation, and neuromuscular blockers were administered to 69.2% of the cohort.

Of the 40 participants, 32 neonates (80%) exhibited clinical evidence of swallowing dysfunction, while 8 neonates (20%) did not show clinical signs of the condition. They were further assessed using Fiberoptic Endoscope, 25 (78%) neonates of them confirmed to have swallowing dysfunction based on FEES results**.**

Laboratory investigations revealed elevated C-reactive protein (CRP) levels in 80% of neonates, and 62.5% exhibited positive blood cultures. Venous blood gas analysis demonstrated a mean pH of 7.37 ± 0.05 and a mean PCO_2 of 39.74 ± 5.09 mmHg.

Radiological findings revealed abnormalities on chest X-ray in 35% of neonates, with increased broncho-vascular markings being the most frequent observation. Furthermore, echocardiography identified congenital heart defects in 17.5% of the study population.

Swallowing dysfunction in neonates was found to have significant evidence with a prolonged duration of intubation, a higher incidence of sepsis, and an increased need for mechanical ventilation. The administration of fentanyl appears to have a protective effect against the development of swallowing dysfunction. Physiological disparities between neonates with and without swallowing dysfunction include significantly lower arterial pH levels, elevated PCO_2 levels, increased C-reactive protein (CRP) levels and higher prevalence of positive blood cultures. Table 1

Table 1: Comparison of Clinical and Laboratory Parameters in Neonates with and Without Palatopharyngeal Incoordination

	With swallowing dysfunction by FEES	Without swallowing dysfunction by FEES	Test value	P-value
Post natal Age of intubation (days)				
Median (IQR)	6 (3 - 10)	2 (1 - 4)	3.509	**0.000**
Range	1 – 20	1 – 6		
Indications of mechanical ventilation, n(%)				
pneumonia	17 (68%)	14 (93.3%)	3.450*	0.063
Sepsis	20 (80%)	6 (40.0%)	**6.593***	**0.010**
Types of mechanical ventilation				
Conventional	12 (80%)	16 (64%)	1.143*	0.285
HFOV	3 (20%)	9 (36%)		

Size of ETT Mean ± SD Range	 3.06 ± 0.17 3 – 3.5	 3.07 ± 0.18 3 – 3.5	 0.120•	 0.905
Administration of sedatives Fentanyl Midazolam Both	 3 (12.0%) 2 (8.0%) 20 (80.0%)	 7 (50.0%) 0 (0.0%) 7 (50.0%)	 6.797* 1.181* 3.792*	 **0.009** 0.277 0.051
Duration of intubation (days) Median (IQR) Range	7 (4 - 15) 3 – 24	4 (3 - 7) 2 – 9	 -2.478≠	 **0.013**
Administration of steroid before and after extubation, n (%) Before extubation Before and after	 17 (68%) 8 (32%)	 12 (80%) 3 (20%)	0.677*	0.411
Chest Xray, n (%) Increase Broncho vascular markings Consolidation Collapse	 8 (32.0%) 10 (40.0%) 7 (28.0%)	 6 (40.0%) 9 (60.0%) 0 (0.0%)	 5.161•	 0.076
ECHO, n (%) PDA ASD VSD Congenital cyanotic heart disease	 1 (6.7%) 1 (6.7%) 2 (13.3%) 0 (0%)	 1 (4%) 2 (8%) 2 (8%) 1 (4%)	 1.031*	 0.905
CRP (mg/L), n(%) Positive >6	 9 (60%)	 23 (92%)	 6.000*	 **0.014**
Blood culture, n(%) Positive	 6 (40%)	 19 (76%)	 5.184*	 **0.023**
VBG at intubation				
PH Mean ± SD Range	 7.4 ± 0.04 7.34 – 7.46	 7.36 ± 0.05 7.27 – 7.45	 2.586•	 **0.014**
PCO2 (mmHg) Mean ± SD Range	 37.43 ± 4.99 25 – 44.6	 41.12 ± 4.73 32 – 49.9	 -2.337•	 **0.025**
HCO3 (mmol/L)	22.41 ± 2.14	21.36 ± 3.73	0.990•	0.328

Mean ± SD Range	19 – 26	16 – 29.6		

Neonates with prolonged hospital stays, delayed intubation (>4 days), and metabolic disturbances (low pH and high PCO_2) have a higher risk of developing PPI. Fentanyl may play a protective role, while sepsis and systemic inflammation (elevated CRP and positive blood cultures) are contributing factors.

Discussion:

This study aimed to investigate the incidence and associated risk factors of palatopharyngeal incoordination (PPI) in a full-term neonate following extubation from mechanical ventilation. The study found a high prevalence of palatopharyngeal incoordination (PPI) (80%) in full-term neonates after mechanical ventilation extubation, with 62.5% confirmed using FEES. Factors such as clinical, laboratory, and mechanical ventilation were associated with PPI development, highlighting the complexity of neonatal swallowing dysfunction.

The study found a high incidence of palatopharyngeal incoordination (PPI) post intubation, linked to prolonged intubation and systemic inflammation. neonates intubated later (>4 days postnatal age) are at a higher risk. Prolonged intubation duration (>8 days) was associated with an 11-fold increased risk of PPI, indicating that prolonged airway instrumentation can disrupt laryngeal sensitivity and swallowing coordination aligning with previous research linking prolonged intubation and systemic inflammation to PPI development [2]. These findings are clinically significant and offer insights for improving neonatal care through early extubation protocols, targeted swallow therapy, and non-invasive respiratory support [8].

The study found that sepsis is a significant factor; Elevated inflammatory markers, such as C-reactive protein (CRP) and positive blood cultures, were linked to PPI, indicating that systemic inflammation may contribute to neuromuscular dysfunction and impaired pharyngeal coordination. This aligns with previous research suggesting that inflammation-induced neuronal injury and cytokine-mediated disruption of swallowing reflexes increase the risk of dysphagia in critically ill neonates [9]. The study emphasizes the importance of early infection control measures, aggressive sepsis management, and targeted interventions to reduce the risk of post-extubation dysphagia [10].

The study found that neonates with palatopharyngeal incoordination (PPI) exhibited significantly lower arterial pH and higher PCO_2 levels, suggesting a possible role of respiratory acidosis in swallowing dysfunction [11]. Acidosis and hypercapnia impair neuromuscular function, which may explain their association with impaired swallowing [12]. A hospital stays longer than 13 days were an independent predictor of PPI, reinforcing the notion that prolonged illness and hospitalization exacerbate neuromuscular impairment and feeding difficulties [13]. These findings align with previous research indicating that acid-base imbalances can affect brainstem control of swallowing, increasing the risk of dysphagia in critically ill neonates [10]. Strategies aimed at optimizing respiratory function, preventing prolonged acidosis, and minimizing hospital stays may be crucial in reducing the incidence of PPI.

Interestingly, the study found that fentanyl administration was associated with a lower risk of palatopharyngeal incoordination (PPI), suggesting a potential protective role in neonates requiring mechanical ventilation. Fentanyl, a short-acting opioid analgesic, is known for its neuroprotective effects and ability to reduce stress responses associated with prolonged intubation. This may help preserve laryngeal sensitivity and swallowing function [14]. This aligns with previous research suggesting that adequate analgesia can mitigate the adverse effects of mechanical ventilation on upper airway coordination by reducing excessive physiological stress and inflammatory responses [15]. These results suggest that fentanyl may serve as a protective pharmacological strategy for neonates at risk of PPI [16]. However, further investigation is needed to explore its long-term safety, optimal dosing strategies, and potential effects on feeding outcomes in neonates. Factors such as opioid tolerance, withdrawal effects, and variability in individual responses should also be considered in future studies to ensure safe and effective clinical application.

Conclusion

Post-extubation swallowing assessments should be considered in mechanically ventilated neonates, especially those with prolonged intubation, sepsis, or metabolic disturbances. FEES is a valuable diagnostic tool in this setting. Future studies with larger cohorts and long-term follow-up are needed to determine the long-term impact of PPI on feeding and neurodevelopmental outcomes. The potential protective role of fentanyl presents an avenue for further research Exploring its pharmacological and rehabilitative strategies may improve neonatal care.

Conflict of interest

No conflict of interest

Table 2: Univariate logistic regression analysis for factors associated with FEES (incoordination) among the studied neonates

	Univariate			
	P-value	**OR**	**95% C.I. for OR**	
			Lower	upper
Post natal Age of intubation > 4 days	**0.006**	21.000	2.372	185.930
Indications of mechanical ventilation (sepsis)	**0.014**	6.000	1.445	24.919
Positive CRP >6	**0.025**	7.667	1.298	45.289
Positive blood culture	**0.027**	4.750	1.193	18.916
PH ≤ 7.36	**0.011**	7.111	1.577	32.056
PCO2 > 41 mmHg	**0.014**	8.273	1.534	44.618
Fentanyl	**0.021**	**0.156**	0.032	0.754
Duration of intubation > 8 days	**0.031**	11.000	1.247	97.021

OR: Odds ratio; CI: Confidence interval

MV: mechanical ventilation, PH: potential hydrogen, CRP: C reactive protein

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