Research

Pharyngeal transit time in different consistency of food using Fiberoptic Evaluation of Swallowing

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ABSTRACT

Background: In Indonesia, no research has been carried out or reported on pharyngeal transit time and a view of the swallowing process in a sample without complaints of dysphagia using the Flexible Endoscopic Evaluation of Swallowing (FEES) method and using five food consistencies. **Purpose:** To obtain the value of pharyngeal transit time and a view of the swallowing process in subjects without dysphagia problems. **Method:** Twenty-eight subjects without dysphagia (based on Ohkuma's Dysphagia Screening) underwent FEES to determine pharyngeal transit time and dysphagia profile based on leakage, standing secretion, residue, penetration, and aspiration. **Result:** The median value of pharyngeal transit time on puree consistency was 0.799(0.499-5.666), gastric rice 0.966(0.433-5.733), oatmeal 0.849(0.533-4.399), thick liquid 0.982(0.399-4.633), thin liquid 0.566(0.366-1.366). The pharyngeal delay time on the puree consistency was 0.566(0.199-5.333), gastric rice 0.799(0.233-2.799), oatmeal 0.899(0.099-3.633), thick liquid 0.833(0.033-3.733), and thin liquid mean was 0.294 (± 0.232). The pharyngeal response time on the puree consistency was 0.566(0.167-1.300), gastric rice 0.583(0.300-2.934), oatmeal 0.583(0.367-1.233), thick liquid 0.549(0.333-1.533), thin liquid 0.549(0.366-1.399). There was no standing secretion, pre-swallowing leakage, penetration, and aspiration found in FEES. A grade 1 residue was found in 3(10.7%) subjects of puree, in 2(7.2%) subjects of gastric rice, in 3(10.7%) subjects of oatmeal, and in 9(32.2%) subjects of thick liquid. **Conclusion:** There was no prolonged pharyngeal transit time, pre-swallowing leakage, standing secretion, penetration, and aspiration in all subjects without dysphagia complaints at all food consistencies. There was minimal residue within normal limits in some subjects.

Keywords: pharyngeal transit time, flexible endoscopic evaluation of swallowing, FEES, normal swallowing

ABSTRAK

Latar belakang: *Di Indonesia, belum pernah dilaporkan penelitian mengenai waktu transit faring dan gambaran proses menelan pada sampel tanpa keluhan disfagia dengan menggunakan metode* Flexible Endoscopic Evaluation of Swallowing (FEES) *dan menggunakan lima konsistensi makanan.* ***Tujuan:*** *Penelitian ini bertujuan untuk memperoleh nilai waktu transit faring dan gambaran proses menelan pada subjek tanpa masalah disfagia.* ***Metode:*** *Dua puluh delapan subjek tanpa disfagia (berdasarkan Skrining Disfagia Ohkuma) menjalani FEES untuk menentukan waktu transit faring dan profil disfagia berdasarkan* leakage, standing secretion, residue, penetration, *dan* aspiration. ***Hasil:*** *Nilai median waktu transit faring pada konsistensi* puree *adalah 0,799(0,499-5,633),* gastric rice *0,966(0,433-5,733),* oatmeal *0,849(0,533-4,399),* thick liquid *0.982(0.399-4.633),* thin liquid *0.566(0.366- 1.366). Waktu tunda faring pada konsistensi* puree *adalah 0,566 (0,199-5.333),* gastric rice *0,799 (0,233-2,799),* oatmeal *0,899 (0,099-3,633),* thick liquid *0,833 (0,033-3,733), dan* rerata thin liquid *0,294 (± 0,232). Waktu respon faring terhadap konsistensi puree adalah 0,566 (0,167-1,300),* gastric rice *0,583 (0,300-2,934),* oatmeal *0,583 (0,367-1,233),* thick liquid *0,549 (0,333-1,533), thin liquid 0,549 (0,366-1,399). Tidak didapati adanya* leakage, standing secretion, penetration*, dan* aspiration *pada pemeriksaan*

FEES. Residu grade *1 ditemukan pada 3 (10,7%) subjek puree, pada 2 (7,2%) subjek* gastric rice*, pada 3 (10,7%) subjek* oatmeal, *dan pada 9 (32,2%) subjek* thick liquid. ***Kesimpulan:*** *Tidak terdapat perpanjangan waktu transit faring, leakage, standing secretion, penetration, dan aspiration pada semua subjek tanpa keluhan disfagia dengan semua konsistensi makanan. Terdapat residu minimal dalam batas normal pada beberapa subjek.*

Kata kunci: *waktu transit faring, evaluasi endoskopi fleksibel untuk menelan,* FEES*, menelan normal*

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INTRODUCTION

A normal swallow needs accurate coordination of more than 30 muscles in the oral cavity, pharynx, larynx, and esophagus, which are controlled by five cranial nerves (CN V, VII, and IX-XII), three peripheral nerves (C1-C3), and mediated centrally by medulla oblongata. Swallowing is a complex and rapid sequence of movements, which can be divided into four stages, namely oral preparatory, oral transport, pharyngeal, and esophageal.[1]

Dysphagia is a symptom that refers to difficulty or discomfort during the passage of the bolus from the oral cavity to the stomach. Dysphagia can occur due to oropharyngeal or esophageal dysfunction. Oropharyngeal dysphagia was caused by difficulty initiating swallow due to anatomic, structural, or neuromuscular problems. Esophageal dysphagia was caused by structural abnormalities, obstructive, or dysmotility.[2] Dysphagia may lead to dehydration, malnutrition, aspiration pneumonia, and mortality.[3] The prevalence of dysphagia is relatively high. It occurs in 40.8% of patients with Alzheimer's disease, 46.3% of patients with the acute phase of stroke, 46.2% of patients with Parkinson's disease, and 35.5% of patients with head/neck cancer.[4]

Videofluoroscopic swallow study (VFSS) and fiberoptic endoscopic evaluation of swallowing (FEES) are the best tools for evaluating dysphagia. VFSS is universally recognized as the gold standard for examining swallowing, and its disorders.[5] VFSS is a process of recording dynamic deglutition events using X-Ray and storing the information on magnetic media. The method allows not only morphological analysis but also physiological evaluation. Events can be observed and reviewed without new exposure. One of the advantages of this method is that it can visualize a region frame by frame or in slow motion.[6] However, VFSS has some challenges, such as radiation exposure, barium usage, transport to radiology unit, limited positioning options, and operational cost.[7]

The Flexible Endoscopic Evaluation of Swallowing (FEES) was first introduced by Susan Langmore and colleagues in 1988. FEES uses a flexible transnasal nasopharyngolaryngoscope inserted into the pharynx through the middle nasal meatus. FEES provides a comprehensive picture of the pharyngeal swallowing phase and allows detection of any abnormalities in the oral, pharyngeal, and esophageal phases.[8] FEES is an efficient, reliable, and easy method to evaluate swallowing.[9] Initially, FEES was intended as an alternative to VFSS when VFSS was not available or was not feasible.[10]

Some studies even reveal that FEES is superior to VFSS in detecting the presence of penetration, aspiration, and residue.[5] The sensitivity of FEES for aspiration was 96%, penetration 87%, and pharyngeal residue 68%. The specificity of FEES for aspiration and laryngeal penetration was 100%, and the pharyngeal residue was 98%.[11]

Until now, in Indonesia, no research has been carried out or reported on pharyngeal transit time and a view of the swallowing process in a sample without complaints of dysphagia using the FEES method and five food consistencies. Therefore, this research was implemented, so that the value of the transit time of the pharynx and a view of the normal swallowing process could be obtained. The outcome of this study could be used as a standard value by clinicians to measure the therapy achievement in managing dysphagia cases.

MATERIAL AND METHOD

This was a cross-sectional descriptive study to obtain pharyngeal transit time and normal FEES in subjects without complaints of dysphagia. This research was conducted at the Integrated Dysphagia Clinic, Bronchoesophagology Endoscopy Sub-department, ENT Department, Faculty of Medicine Universitas Indonesia-Cipto Mangunkusumo Hospital, Jakarta, Indonesia. The Committee of Medical Research Ethics of the Faculty of Medicine, Universitas Indonesia, regarding to the protection of human rights and welfare in medical research, had given approval to this study. The participants submitted written and verbal informed consent before study participation. The inclusion criteria included 20-60 years old patients who did not have severe symptoms based on Ohkuma's Dysphagia Screening and without anatomic abnormalities and neurological function disorders that could interfere with the swallowing process. The exclusion criteria were patients with dysphagia symptoms, anatomic abnormalities and neurological function disorders in oral cavity, oropharynx, hypopharynx, and larynx, and patients with contraindications for the FEES examination such as bleeding disorders or unstable vital signs, or patients with lingual tonsil hypertrophy grade III. This study examined FEES on 28 stroke subjects who came directly or were sent from the Neurology Department and from outpatient clinic. The participants went through anamnesis, a general ENT examination, followed by a FEES examination to assess five parameters (pres-wallowing leakage, standing secretion, residue, penetration, and silent aspiration) to get pharyngeal transit time.

RESULT

Out of the 28 study subjects, there were 18 subjects of young adults (64.3%), consisted of 15 females (53.6%) and 13 males (46.4%). Based on Ohkuma's dysphagia screening of 15 questions regarding symptoms of dysphagia, all subjects were included in the asymptomatic category. (Table 1)

Table 1. Characteristics of subjects (n = 28)

Characteristics of subjects		**N (%)**
Age group	Young adults (20-40)	18 (64.3)
	Adults (41-60)	10 (35.7)
Gender	Male	13 (46.4)
	Female	15 (53.6)

The calculation of the 28 subjects obtained an abnormal distribution, so that the distribution of the characteristics of the pharyngeal transit time was taken based on the median value, in the consistency of puree food the pharyngeal transit time were 0.799 (0.499-5.666), gastric rice 0.966 (0.433-5.733), oatmeal 0.849 (0.533-4.399), thick liquid 0.982 (0.399-4.633), thin liquid 0.566 (0.366-1.366). (Table 2)

Table 2. Characteristics of pharyngeal transit time based on food consistency

Consistency	Median (min-max)
Puree	0.799 (0.499-5.666)
Gastric rice	0.966 (0.433-5.733)
Oatmeal	0.849 (0.533-4.399)
Thick liquid	0.982 (0.399-4.633)
Thin liquid	0.566 (0.366-1.366)

Regarding the pharyngeal delay time in Table 3 in 16 subjects with the consistency of puree food, the median value was 0.566 (0.199-5.333), 18 subjects with the consistency of gastric rice food obtained a median value of 0.799 (0.233-2.799), 20 subjects of the consistency of oatmeal food obtained a median value of 0.899 (0.099-3.633), 15 subjects of the consistency of thick liquid food obtained a median value of 0.833 (0.033-3.733). Seven subjects of thin liquid food consistency obtained a mean value of 0.294 (± 0.232). (Table 3)

Table 3. The characteristics of the pharyngeal delay time in puree, gastric rice, oatmeal, thick liquid, and thin liquid

Consistency (n)	Median/Mean (min-max)
Puree (n=16)	0.566 (0.199-5.333)
Gastric rice (n=18)	0.799 (0.233-2.799)
Oatmeal (n=20)	0.899 (0.099-3.633)
Thick liquid (n=15)	0.833 (0.033-3.733)
Thin liquid (n=7)	0.294 (± 0.232)*

*Mean value (± standard deviation)

Regarding the pharyngeal response time in Table 4, the consistency of puree food has a median value of 0.566 (0.167-1.300), the consistency of gastric rice food is a median value of 0.583 (0.300-2.934), the consistency of oatmeal food has a median value of 0.583 (0.367-1.233), the consistency of thick liquid food obtained a median value of 0.549 (0.333-1.533), the consistency of thin liquid food had a median value of 0.549 (0.366-1.399). (Table 4)

Regarding the FEES examination in 28 (100%) subjects, there were no standing secretion, pre-swallowing leakage, penetration, and neither aspiration. For the distribution of residue level at five food consistencies, a grade 1 residue was obtained where the minimum amount of water consistency bolus coats the medial portion of the vallecular mucosa as many as 3 (10.7%) subjects with puree, 2 (7.2%) subjects with gastric rice, 3 (10.7%) subjects with oatmeal and 9 (32.2%) on the consistency of the thick liquid. There was no residue with a thin liquid. (Table 5)

Table 4. Characteristics of pharyngeal response time based on food consistency

Consistency (n)	Median/Mean (min-max)
Puree	0.566 (0.167-1.300)
Gastric rice	0.583 (0.300-2.934)
Oatmeal	0.583 (0.367-1.233)
Thick liquid	0.549 (0.333-1.533)
Thin liquid	0.549 (0.366-1.399)

Table 5. FEES examination

Consistency	Standing secretion		Pre-swallowing leakage		Residue				Penetration		Aspiration	
	Yes	No	Yes	No	0	1	2	3	Yes	No	Yes	No
Puree	0	28 (100%)	0	28 (100%)	25 (89.3)	3 (10.7)	0	0	0	28 (100%)	0	28 (100%)
Gastric rice	0	28 (100%)	0	28 (100%)	26 (92.8)	2 (7.2)	0	0	0	28 (100%)	0	28 (100%)
Oatmeal	0	28 (100%)	0	28 (100%)	25 (89.3)	3 (10.7)	0	0	0	28 (100%)	0	28 (100%)
Thick liquid	0	28 (100%)	0	28 (100%)	19 (67.8)	9 (32.2)	0	0	0	28 (100%)	0	28 (100%)
Thin liquid	0	28 (100%)	0	28 (100%)	28 (100)	0	0	0	0	28 (100%)	0	28 (100%)

DISCUSSION

The distribution of gender in this study showed more women than men. The number of female subjects was 15 (53.6%), and the number of male subjects was 13 (46.4%), while the young adults (64.3%) were more than adults (35.7%). Based on data from the Central Bureau of Statistics in 2020, the number of men compared to women aged 20-59 years was 50.53% compared to 49.46%. Meanwhile, the 20-39 year age group compared to the 40-59 year age group was 32.5% and 24.7%, which was in accordance with the comparison of age group subjects obtained in this study.[12]

Twenty-eight subjects were screened for dysphagia using the Ohkuma dysphagia questionnaire before the FEES examination. In this study, all subjects answered without complaint and symptoms to each question. Ohkuma's dysphagia screening was used because it has high reliability, sensitivity, and specificity to detect dysphagia. The sensitivity of this questionnaire is 92%, and the specificity is 90.1%.[13] Besides, it is an accurate, brief, and easy-to-understand questionnaire for patients. It has all the basic indication questions needed to assess dysphagia patients and can be applied in all swallowing stages.[14] For the interpretation of the screening results, the presence of dysphagia is characterized by at least one severe symptom. It is suspected that dysphagia is characterized by the presence of at least one mild symptom. An absence of symptoms characterizes the absence of dysphagia.[13]

Pharyngeal transit time is the time it takes for the bolus heads to transit from the point where the mandibular ramus crosses the base of the tongue, and the tail of the bolus

reaches the cricopharynx area. The results of the pharyngeal transit time can be influenced by age, sex, volume, and bolus consistency.[15] In normal ingestion, the pharyngeal transit time is 1 second in young adults with a thin liquid consistency, and 1.5 seconds in the elderly.[16] In this study, based on calculations on 28 subjects at five food consistencies (2.5 ml), the distribution was not normal, so the distribution of pharyngeal transit time was taken based on the median value. In consistency of puree food, the pharyngeal transit time was 0.799 (0.499-5.666), gastric rice 0.966 (0.433-5.733), oatmeal 0.849 (0.533-4.399), thick liquid 0.982 (0.399-4.633), thin liquid 0.566 (0.366-1.366). These results showed that the pharyngeal transit time of all subjects (100%) at all food consistencies were within normal limits.

The pharyngeal delay time is the interval from the time the bolus head reaches the point where the mandibular ramus crosses the base of the tongue to the onset of laryngeal elevation, indicating pharyngeal swallowing.[17] In this study, the pharyngeal delay time was obtained in 16 subjects with puree had a median value of 0.566 (0.199-5.333), 18 subjects with gastric rice obtained a median value of 0.799 (0.233-2.799), 20 subjects with oatmeal obtained a median value. 0.899 (0.099-3.633), 15 subjects with thick liquid consistency obtained a median value of 0.833 (0.033-3,733). Seven subjects of thin liquid consistency obtained a mean value of 0.294 + 0.232. This was in accordance with what was stated by Martin-Harris et al.[18], that the variability of the pharyngeal delay time is normally not more than one second.

The pharyngeal response occurs when food passes from the oral cavity to the pharynx during swallowing. The pharyngeal response causes larynx elevation, which prevents food aspiration to the trachea.[19] A study by Leonard, et al.[20] showed that the response time of the swallowing reflex was 0.53 ± 0.64 s in the elderly subject (> 65 years old) and 0.21 ± 0.26 s (second) in healthy young subjects using VFSS examination.[20] In this study, the consistency of puree food had a median value of 0.566 (0.167-1.300), the consistency of gastric rice food had a median value of 0.583 (0.300-2.934), the consistency of oatmeal food had a median value of 0.583 (0.367-1.233), the consistency of thick liquid food obtained a median value of 0.549 (0.333-1.533), the consistency of thin liquid food had a median value of 0.549 (0.366-1.399).

Standing secretion is defined as the accumulation of secretions in the hypopharynx before swallowing. The presence of a standing secretion indicates a weakness in the pharyngeal response or a decrease in the ability of spontaneous swallowing to clear the secret.[21] Pre-swallowing leakage is the occurrence of premature bolus escape to the hypopharynx before the swallowing reflex occurs. Oral incoordination and decreased pharyngeal response are two main factors for pre-swallowing leakage. Penetration is the presence of bolus material at the top of the vocal cords during the swallowing process. Whereas aspiration is when the bolus material passes under the vocal cords.[22] In this study, there was no standing secretion, pre-swallowing leakage, penetration, and aspiration in all subjects (100%).

The residue is the presence of incomplete bolus clearance in the vallecular or pyriformis recesses due to weak pharyngeal vigor, poor propulsion, or impaired upper esophageal sphincter (UES) relaxation.[23] From the outcome of 28 (100%) subjects in this study, there was a residue of grade 1 on four food consistencies where the remaining bolus of liquid consistency with a minimum amount coated the medial part of the vallecular mucosa, as many as 3 (10.7%) subjects on puree consistency food, 2 (7. 2%) subjects of food consisted of gastric rice, 3 (10.7%) subjects of foods with a smooth consistency, and 9 (32.2%) of foods with a thick liquid consistency. A previous study stated that

a small amount of residue was commonly retained in pyriform sinus or valleculae after swallowing in normal persons. Excessive amounts of food in the pharynx may be retained in patients with pharynx obstruction by tumor, stricture, poor opening of the upper pharyngeal, or weakness of the pharyngeal muscles, leading to aspiration.[24] Factors that can cause changes in the swallowing process are viscosity, taste, the volume of the food swallowed, and age. The normal ageing process will result in a prolongation of the pharyngeal phase, an increase in residue in the oral cavity or pharynx after ingestion, and an increase in the frequency of food penetration to the top of the airway.[25]

In this study, the majority of age distribution of subjects without dysphagia was young adults, with female gender more than male. The pharyngeal transit time, pharyngeal delay time, and pharyngeal response time based on food consistency were within normal limits in all subjects without complaints of dysphagia. In the FEES parameter assessment, there was no standing secretion, pre-swallowing leakage, penetration, and aspiration for all subjects without complaints of dysphagia. The remaining bolus residue in the form of a minimal liquid layer on the vallecula was found in several subjects after swallowing for the first time; it was still within normal limits because to use up the residue normally takes 1-2 swallowing attempts.

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CONFLICTS OF INTEREST

The authors declare that no conflicts of interest exist in this study.

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