

Pathophysiology and Evaluation of Chronic Aspiration

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I. Introduction

- Impairment of normal swallowing mechanisms and airway protective function can result in aspiration
- : Aspiration is common in patients with dysphagia. For instance, it is reported that 50% of dysphagic stroke patients penetrate their airways to some extent.
- Definition of aspiration
- : the action of material such as saliva, ingested liquids or solids, and refluxed gastric contents penetrating the larynx and entering the airway below the true vocal folds
- : Penetration → a passage of material into the larynx that does not pass below the vocal folds
- : chronic aspiration → repeated episodes of aspiration
- : expectorated if the patient has an intact cough reflex, plus adequate laryngeal and respiratory control or gradually removed by ciliary action (mucociliary transport)
- Respiratory complication of aspiration
- : bronchospasm, tracheitis, bronchitis, pneumonia, airway obstruction, pulmonary abscess, sepsis, and death
- Penetration-Aspiration Scale

Table 1. The original 9-Point Penetration-Aspiration Scale

1. Material does not enter the airway
2. Material enters the airway, remains above the vocal folds, and is ejected from the airway
3. Material enters the airway, remains above the vocal folds, and is not ejected from the airway
4. Material enters the airway, contacts the vocal folds, and is ejected from the airway
5. Material enters the airway, contacts the vocal folds, and is not ejected from the airway
6. Material enters the airway, passes below the vocal folds, and is ejected from the airway
7. Material enters the airway, passes below the vocal folds, and is not ejected from the trachea into the larynx
8. Material enters the airway, passes below the vocal folds, and is not ejected from the trachea despite effort
9. Material enters the airway, passes below the vocal folds, and no spontaneous effort is made to eject the material

Table 2. Final version of the 8-Point Penetration-Aspiration Scale

1. Material does not enter the airway
2. Material enters the airway, remains above the vocal folds, and is ejected from the airway
3. Material enters the airway, remains above the vocal folds, and is not ejected from the airway
4. Material enters the airway, contacts the vocal folds, and is ejected from the airway
5. Material enters the airway, contacts the vocal folds, and is not ejected from the airway
6. Material enters the airway, passes below the vocal folds, and is ejected into the larynx or out of the airway
7. Material enters the airway, passes below the vocal folds, and is not ejected from the trachea despite effort
8. Material enters the airway, passes below the vocal folds, and no effort is made to eject

- Grade of aspiration

Table 3. Aspiration Classification(Level I-IV)

I. Occasional aspiration without complications
II. Intermittent aspiration of liquids but able to handle own secretions and solids; no clinical evidence of pneumonitis or chronic hypoxia
III. Unable to manage safe oral intake(solids or liquids); intermittent pneumonia/hypoxemia
IV. Severe life-endangering aspiration of liquids, solids, and saliva; chronic pneumonia/hypoxemia

- The circumstances in which aspiration may occur (3 types of aspiration)
 - : before the swallowing reflex is triggered, when the airway has not elevated or closed during the swallowing if the laryngeal valves are not functioning adequately after the swallow when the larynx lowers and opens for inhalation
- major goal of any swallowing evaluation
 - : identify the patients who are at risk of aspirating or have aspirated
 - identify the etiology of the aspiration so that appropriate treatment can be initiated
- multidisciplinary approach
 - : helpful in planning management of aspiration, particularly for the complicated cases

II. Physiology of deglutition

: frequency of deglutition varies with activity (580 swallow per day)

Oral preparation

- (1) lip closure (2) rotary and lateral motion of the tongue (3) rotary and lateral motion of the jaw (4) buccal and facial tone (5) anterior bulging of the soft palate

Oral stage

- tongue moves upward and backward, contacting the palate in a sequential squeezing or rolling action, propelling the bolus ahead of it into the pharynx

Elicitation of the pharyngeal swallow

- tongue action, as it propels the bolus backward and contacts the faucial arch area and the oropharynx
 - stimulate receptors in the oropharyngeal region or tongue base itself

Pharyngeal stage

- (1) velopharyngeal closure

- prevent food or liquid from refluxing into the nose
- velar elevation (levator m.) and retraction(palatopharyngeus m.)

- (2) laryngeal closure

- TVC → FVC → epiglottis and A-E fold via glottic closure reflex

- (3) laryngeal elevation and anterior movement

- carry the larynx up under the tongue, out of the path the bolus, apply extrinsic stretch to the cricopharyngeal region

- (4) opening of the cricopharyngeal region

- UES or PE segment : post. and lat. wall ⇔ cricopharyngeal m., ant. wall → cricoid lamina
- at rest cricoid lamina touches the post. pharyn. wall ⇔ maintains closure
- opening of the UES : cricopharyngeal m. relaxation and ant., sup. movement of larynx (ant. movement of hyolaryngeal complex) → separate the cricoid lamina from the post. pharyngeal wall

(5) pharyngeal peristalsis

- superior-to-inferior muscular contraction (nasopharynx → hypopharynx)
- movement of tongue and larynx : generation of pressure within pharynx

Esophageal stage

- active peristalsis or sequential contraction from top to bottom

III. Etiology and pathophysiology of aspiration

1) Etiology

Table 4. Causes of Chronic Aspiration

Cerebrovascular accidents	Trauma
Atherosclerotic thrombosis	Closed head injury
Embolism	Hematoma
Intracranial hemorrhage	Anoxic brain injury
Degenerative neurologic diseases	Intracranial infection
Parkinson's disease	Pharyngeal disorders
Amyotrophic lateral sclerosis	Neoplasms
Progressive supranuclear palsy	Postsurgical dysfunction
Multiple sclerosis	Postirradiation dysfunction
Neuromuscular and muscular disorders	Zenker's diverticulum
Poliomyelitis	Cricopharyngeal dysfunction
Myasthenia gravis	Stricture
Muscular dystrophy	Esophageal disorders
Myopathies	Reflux
Peripheral nerve disorders	Achalasia
Cranial nerves	Caustic injury
Guillain-Barré syndrome	Miscellaneous
Intracranial neoplasms	Severe illness
Primary dysfunction related to neoplasm	Multisystem disease
Postsurgical dysfunction	Drug intoxication

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2) Pathophysiology

Before the swallowing reflex is triggered, when the airway has not elevated or closed

- reduced tongue control of the bolus during mastication
- reduced range or coordination of tongue movement to hold the bolus in the preparatory phase of the swallow
- reduced tongue elevation in the oral phase of the swallow
- reduced oral sensitivity in the oral phase of the swallow
- delayed or absent swallowing reflex in the pharyngeal phase of the swallow

During the swallowing if the laryngeal valves are not functioning adequately

- reduced laryngeal closure (impaired VC adduction, unequal VC height) in the pharyngeal phase of the swallow

After the swallow when the larynx lowers and opens for inhalation

1) Disorders affecting the pharyngeal phase of the swallow

- reduced pharyngeal peristalsis : no delay in the triggering of the reflex, no hesitation of the bolus in the valleculae ⇨ residual is left in the BOT, the valleculae, and the PS
- scarred pharyngeal wall
- cricopharyngeal dysfunction : cricopharyngeal achalasia (or spasm), functional neuromuscular incoordination
- reduced laryngeal elevation

2) Disorders affecting the cervical esophageal phase of the swallow

- Lax cricopharyngeus (reflux), reduced esophageal peristalsis, diverticulum
- partial or total cervical esophageal obstruction
- T-E fistula

IV. Evaluation of aspiration

- the examination may guide the physician's decision regarding need for a feeding tube or may provide prognostic information regarding the patient's ability to resume a more normal oral diet at some point in the future
- the evaluation should, at the very least, provide guidance to the patient regarding how he or she can eat more safely and efficiently with the use of dietary modifications or behavioral strategies.

1) Clinical bedside evaluation

- careful history taking, chart review, patient descriptions/symptomatology
 - : alert the clinician that the patient's swallowing is disordered and point toward the nature of the dysfunction
 - : signs and symptoms
- aspiration pneumonia, recurrent pneumonia of unknown etiology, "bronchorrhea" following tracheotomy, coughing, choking with eating, dysphagia and prolonged time for eating, weight loss, gargly (wet) voice quality on vocalization after a swallow, excessive and copious secretions (an attempt of the cilia in the respiratory tract to clear away foreign material), excessive lingual movement, delayed or absent elevation of the hyoid bone and thyroid cartilage, expectoration or regurgitation of material through the mouth or nose
- physical and neurologic examination
 - : specific abnormalities in anatomy or neuromuscular functioning that result in the disturbed motility pattern/aspiration
 - : the examination of oral anatomy, function, and sensitivity- labial, lingual, soft palate function
 - laryngeal function examination
 - pulmonary function test

2) Imaging study

- reliability of clinical examination

- : prediction of aspiration risk using clinical markers has had varying success
- : clinical bedside assessment has been shown to miss up to 40% of those patients who aspirate, the so called silent aspirators
- indication : any patients whose disordered deglutition is not clearly limited to the oral cavity and of pharyngeal origin or who may be aspirating
- how does the clinician use the information from the imaging study
- : (1) define anatomic and/or neuromuscular dysfunctions present in the patient's swallow
- (2) determine whether the patient should eat by mouth or not, and if so, the consistency of food to be given
- (3) plan direct or indirect treatment appropriate for the specific swallow disorders causing aspiration

3) Videofluoroscopy (VFS) or Modified Barium Swallow (MBS)

- 1983, Jeri A. Logemann

: MBS is designed to study the anatomy and the physiology of the oral preparatory, oral, pharyngeal, and cervical esophageal stages of deglutition and to define management and treatment strategies that will improve the oropharyngeal dysphagic patient's swallowing safety or efficiency

: remains the gold-standard for determining pathology of deglutition, assessing the presence of airway penetration by the food bolus, and formulating a dysphagia treatment plan

- Procedures

(a) Positioning of the patient

: usual normal eating position (upright position) in a chair or wheelchair or lying on a cart with a back support to elevate the patient to vertical

(b) Presentation of material

: at least three different consistencies of material containing barium

→ a liquid, a paste or pudding like material, and something requiring mastication (a cookie)

: very small amount of barium to swallow (initially 1ml-1/3teaspoon)

: initially 1ml, followed by 3ml, 5ml, 10ml of the liquid and cup drinking of the liquid, if tolerated

→ 1/3 teaspoon of the pudding material → one-quarter of an easily chewed shortbread cookie

(c) Introduction of treatment strategies

: once the problem is identified, the examiner intervenes with postural or behavioral strategies to change the dynamics and lessen the problem

(d) Measurements and observations

: lateral and AP view

duration of bolus movement

oral transit time : <1.5sec (1 - 1.25sec)

 pharyngeal transit time : <1sec (0.35 - 0.48sec)

 pharyngeal delay time : under age 60 - 0.24sec, over age 60 - 0.36sec

 esophageal transit time : 8-20sec

movement pattern of oropharyngeal structure that control the bolus and cause aspiration or inefficient swallowing

4) Fiberoptic endoscopic evaluation of swallowing (FEES)

- 1988, Susan E. Langmore

: modified the traditional fiberoptic endoscopic assessment of the pharynx and larynx to evaluate the pharyngeal stage of the swallow

→ provides a clear, direct view of the hypopharynx and larynx

→ aspiration, and/or evidence of aspiration, can be directly observed

→ required modifications to the traditional procedure are minimal and do not interfere with normal swallowing function.

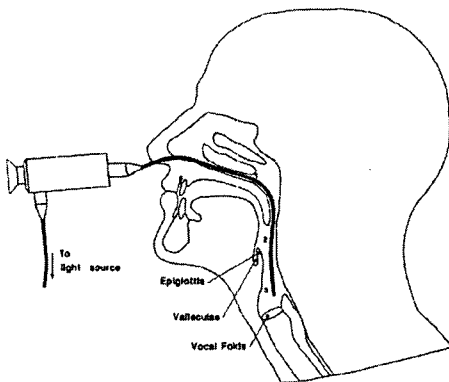


Table 5. Indications for FEES procedure

Characteristics of patients
Facing immediate discharge
Requiring an immediate decision
With severe contractures
With severe arthritis
Who are minimally alert
In intensive care units
On ventilators/respirators
Who are restrained
Who are in extreme pain/distress
Who are in nursing homes
Who are in hospitals without access to fluoroscopy

- Fiberoptic endoscopic evaluation of swallowing with sensitivity test (FEESST)

: 1998, Jonathan E. Aviv

: delivering quantified air pulses to the aryepiglottic folds through a separate scope channel to elicit the laryngeal adductor reflex (LAR) → the greater the pressure is of air that is pulsed onto the aryepiglottic folds to elicit the LAR, the greater the laryngeal sensory loss is

- Disadvantages

: not visualize the oral stage swallow

blocking the image during the swallow

difficult to define the physiology and effectiveness of treatment

- Advantages

: no radiation exposure

excellent superior view of the pharyngeal and laryngeal anatomy

test laryngeal sensation

- Techniques

(a) Pre-swallow position

: Throughout the examination, the tip of the endoscope is largely maintained in the pre-swallow position. The tip of the endoscope is between the soft palate and the tip of the epiglottis where the entire larynx and both pyriform sinuses are visualized. This allows for the optimum detection of premature spillage of a bolus and/or delay in swallowing initiation.

(b) Post-swallow position

: After the patient has finished swallowing the bolus, the endoscopist passes the endoscope inferiorly

into the larynx so that the subglottis is visualized. This allows for optimum detection of laryngeal penetration and aspiration. Once the trachea has been visualized, the endoscope is pulled back to the pre-swallow position so that the tip of the endoscope does not touch the larynx during laryngeal elevation with phonation and/or further swallows.

(c) Pre-swallowing tasks

: The pharyngeal and laryngeal function assessment incorporates tasks such as the high pitched /i/ or cough to assess symmetrical pharyngeal wall approximation, laryngeal adductory tasks such as phonation, laryngeal abductory tasks such as panting and sniffing, and effortful breath holding to assess glottic and supraglottic closure mechanisms. Breath holding of a few seconds provides support that one can maintain swallowing apnea of a sufficient duration for the pharyngeal swallow.

Item	VESS	VFSS
Palate mobility and closure	Excellent	Good
Pharynx squeeze	Excellent	Good
Vocal fold mobility and closure	Excellent	Fair
Sensation	Excellent	Fair
Anatomic detail	Excellent	Fair
Pooling	Excellent	Excellent
Aspiration	Good	Excellent
Latency	Good	Excellent
Duration of swallow	Good	Excellent
Laryngeal elevation	Good(include neck palpation)	Excellent
Oral cavity behavior	Fair(use direct inspection)	Excellent
Esophagus	Poor	Excellent

5) Scintigraphy

- scintigraphy provides important data on airway penetration and clearance that is useful in the dietary management of dysphagic patients
- scintigraphy can determine the relative amount of material aspirated, the extent of the respiratory tree penetrated, or the rapidity of that material's removal from the airways -> these factors, among others, are thought to be critical determinants in the development of pulmonary disease following aspiration, i.e. pneumonia.

6) Ultrasound

7) Chest X-ray

8) Manometry

9) EMG

10) Acoustic analysis

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