INTRODUCTION

Swallowing or deglutition is a complex process by which we take in a substance via the oral cavity and passes through the pharynx and oesophagus. Human beings swallow around 600 times per day, most of it is performed without thought or effort. Only the oral phase requires conscious effort. Once the bolus passes into the pharynx, involuntary reflexes serve to successfully pass it to the stomach.

The coordinated activity of muscles in the oral cavity, the pharynx and larynx, and the oesophagus is needed for swallowing. This is a complex sequence of motor events which is partly reflex and partly voluntary.

Normal swallowing is carried out by the coordinated simultaneous activity of the tongue, pharynx, and oesophagus. An efficiently functioning swallowing mechanism provides efficient, unidirectional flow of the ingested bolus, while avoiding undesired diversion into the nasal cavity or respiratory tree.

DYSPHAGIA:

Dysphagia means "difficulty swallowing" taken from Greek and can be caused by problems with neural control, muscular coordination, inflammation, mechanical obstruction from malignancy etc. Patients present with sensation of food sticking in the throat or chest or choking while eating. Coughing occurs during or after swallowing, which even though a non-specific response may be indicative of a swallowing problem. Swallowing disorder patients can have other associated symptoms like a sore throat, nasal regurgitation, hoarseness of voice, shortness of breath, and chest discomfort or pain.

FEES:

Fibreoptic Endoscopic Evaluation of Swallowing (FEES) is an instrumental procedure done for assessing the anatomy and physiology of swallowing using a flexible fibreoptic laryngoscope and camera. It mainly assesses the oropharyngeal phase of swallowing. Anatomy and physiology of the base of tongue, throat and larynx can be assessed when the person eats and drinks. The efficiency of swallow is visualized. If impaired, the nature of the problem can be diagnosed. The problem thus found out can be improved using dietary, behavioural, and postural interventions. FEES can be used to assess how the swallow improves with exercises and whether the patient can eat safely and effectively.

FEES to evaluate oropharyngeal swallowing disorder was published by Langmore, Schatz, and Olsen in 1988(1). Initially they used video fluoroscopy for dysphagia evaluation, and fibreoptic endoscopic evaluation of swallowing (FEES), was developed as a secondary procedure for ICU patients or obese patients in whom video fluoroscopy could not be done or was not available.

Later FEES developed to become a standard procedure in swallowing disorder evaluation. Visualisation of swallowing directly to identify salient findings and observation of improvement with treatment is the main advantage of FEES.

The structures in view include the nasopharynx, oropharynx, and hypopharynx, with excellent view of the larynx. The anterior two thirds of tongue and the oral cavity are not seen. The pharyngeal phase of swallowing is the centre of attention. Upper

esophageal sphincter (UES) opening is not visualized and the esophageal phase of swallowing is not assessed in the FEES examination.

Also, after FEES, the video recorded can be used to help educate patients and family members about their problem and help in improved decision making and better compliance with recommendations.

ANATOMY AND PHYSIOLOGY OF SWALLOWING IN FEES

ANATOMY:

The main anatomical structures that come into action during swallowing include those of the oral cavity and pharynx. The oral cavity is divided into vestibule and oral cavity proper. Vestibule lies within the lips, cheeks, gums and teeth. The oral cavity proper is within the dental arche with teeth, gums and alveolar processes. There are both oral and pharyngeal surfaces for the tongue. The oral cavity communicates with oropharynx via the oropharyngeal isthmus and is separated from the pharynx by the faucial pillars.

PHARYNX AND LARYNX:

The pharynx extends from base of skull to the lower border of cricoid cartilage. The nasopharynx is situated behind the nose and above the lower border of soft palate. The oropharynx extends from the soft palate to the laryngeal inlet (upper border of the epiglottis). The hypopharynx extends behind the larynx and partly to each side, where it forms the pyriform fossa. The constrictor muscles of the pharynx arise from the cranium and hyoid bone, and the thyroid cartilage anteriorly, and insert on the posterior median raphe. The submental muscles arise from the mandible and insert to tongue and the hyoid bone. The cricopharyngeus muscle which closes the upper esophageal sphincter (UES) is attached to the sides of the cricoid cartilage anteriorly. The epiglottis is positioned upward and backward and attached to larynx and hyoid bone. The space between the pharyngeal surface of the tongue and the epiglottis is called the valleculae. Larynx is divided into supraglottic, glottis and subglottic areas

and the main importance in swallowing act is given to the true and false vocal folds, epiglottis and arytenoids. The laryngeal aditus opens into the lower portion of the pharynx. Lateral to the larynx lie the pyriform recesses (2).

The muscles that elevate and depress the jaw and the tongue play a pivotal role in preparation of the bolus before the initiation of the swallow. They grind and reduce the food between the teeth. The intrinsic muscles of the tongue help in changing the shape of the tongue and the extrinsic muscles modify its position in the mouth. The actions of the extrinsic and intrinsic muscles of the tongue are dependent. Changes in shape of tongue will cause alteration in position and vice versa.

The pharynx is composed of four layers:

1. Outer areolar
2. Muscular
3. Submucous and
4. Mucous membrane.

The muscle layer is divided into circular and longitudinal muscles. The circular muscles are arranged as a triad-

- Superior constrictor
- Middle constrictor
- Inferior constrictor

Inferior constrictor is further divided into two parts:

a) Thyropharyngeus

b) Cricopharyngeus

Except for the cricopharyngeus muscle, the constrictor muscles are paired and are attached to a posterior midline raphe. The cricopharyngeus muscle forms the sphincter at junction of the laryngopharynx and the oesophagus. Palatopharyngeus and the stylopharyngeus are longitudinal muscles present on each side.

The larynx consists of the thyroid, cricoid and arytenoid cartilages. The thyrohyoid membrane and muscle help in suspending the larynx from hyoid bone. So, movement of hyoid bone by the action of suprahyoid and infrahyoid muscles moves the larynx. The epiglottis is attached to the posterior aspect of the thyroid cartilage. The quadrangular membrane is attached between the epiglottis and arytenoids cartilages- anteriorly and posteriorly respectively. The superior margin of the quadrangular membrane forms the boundary of the laryngeal inlet. The aryepiglottic muscles and thyroepiglotticus control the laryngeal inlet- depress the epiglottis and may help in preventing aspiration. The intrinsic muscles of the larynx adduct the vocal cords provides another protective mechanism to prevent aspiration of food and foreign bodies. The pharynx is continuous with the esophagus. The esophagus is a muscular tube having a cervical course and then enters the thorax and lies posteriorly in the midline. The esophagus descends downwards and enters the stomach by piercing the diaphragm.

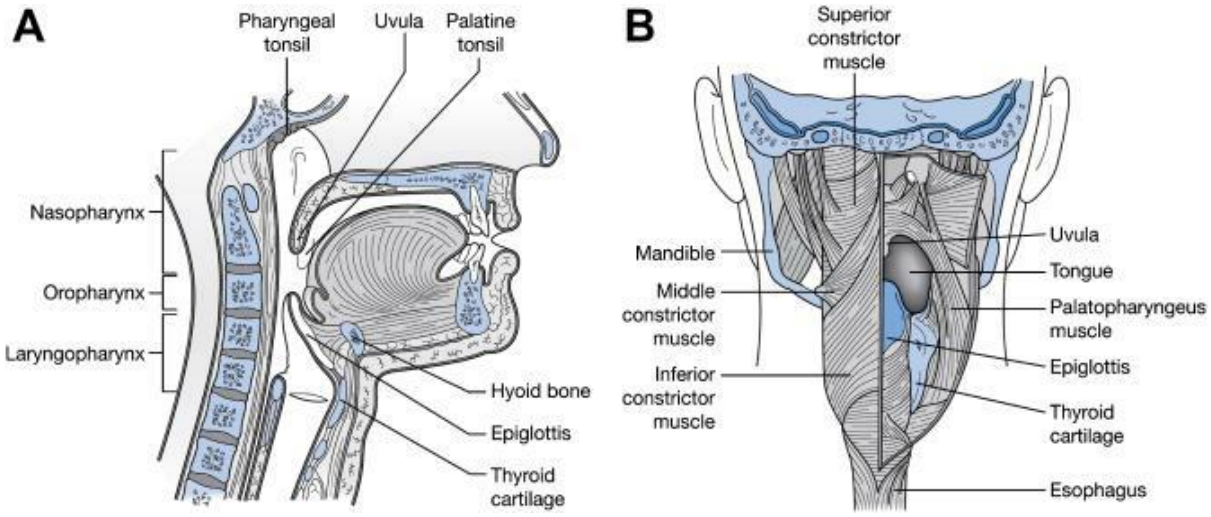
The swallowing physiology consists of simultaneous management of the stream of liquid and food with breathing within the pharynx. So, there is crossing of the ventilatory stream with the alimentary stream. This can be seen as an evolutionary aspect and is developed as a consequence of transition in vertebrates from sea to land living. The pharynx is an organ for both extracting dissolved oxygen from water at the

gills and feeding on suspended food particles in primitive vertebrates. In man, food and air are separated in the pharynx to lead to their pathways simultaneously.

Table 1: Innervation of major muscles related to swallowing

Trigeminal Nerve (V)	Muscles of mastication, mylohyoid, tensor veli palitini, anterior belly of digastric
Facial nerve (VII)	Muscles of facial expression, Posterior belly of digastric, stylohyoid
Glossopharyngeal nerve (IX)	Stylopharyngeus
Hypoglossal nerve (XII)	Intrinsic tongue muscles, hyoglossus, geniohyoid, genioglossus, thyrohyoid, styloglossus
Vagus nerve (X)	Levator veli palatine, palatopharyngeus, Salpingopharyngeus, intrinsic laryngeal muscles, Cricopharyngeus, pharyngeal constrictors

Figure 1:Anatomy



Previously there was a view that the biomechanical events which happen during the movement of bolus (movement of the posterior part of the tongue and elevation of the hyoid bone and larynx) are responsible for the trigger in the pharyngeal phase of swallowing. But certain video-endoscopic and video-fluoroscopic investigations show that the airway protection mechanism is activated first (3).

The major sphincteric protective mechanisms for safe guarding the airways include the pharyngeal isthmus and laryngeal aditus. Airway protective triggers that close the laryngeal inlet, are activated prior to the passing the bolus (initiation of swallow proper). Coordination between swallowing and ventilation physiology is mandatory at this point and swallowing has to be properly and efficiently timed in relation to the respiratory phases. Any defective action or failure in this coordination may affect the smooth swallow and can cause aspiration and swallowing difficulties.

PHYSIOLOGY:

THE ORAL PREPARATORY PHASE

In this phase, initially the food is prepared or made ready for swallowing by reducing the volume and mixing it with saliva by the muscles of the jaw and oral cavity. The timing of this phase can vary depending on the individual and type of the food ingested. The muscles involved in closing the jaw are the jaw elevators-temporalis, masseter and medial pterygoid. Both elevator and depressors aid in the chewing act. A tight seal of the oral cavity is maintained by the lips. This done by the action of the orbicularis oris, the same is affected in facial nerve palsy. Buccinator muscle helps to return food from the vestibule during the process of mastication.

The palatoglossus and palatopharyngeus muscles lower the soft palate, so that the palatoglossal and palatopharyngeal arches are approximated to the posterior part of the tongue. The laryngeal inlet remains open during this period.

This begins when the food is taken in to the mouth. The tongue moves a solid bolus from side to side as it is chewed and formed into a cohesive bolus. Pureed food and liquids are contained in the middle of the mouth. As FEES cannot visualize the anterior two third of tongue directly, the efficiency of this phase can be assessed only from tongue movements. The food can fall into the hypopharynx during the preparatory phase which is known as “premature spillage”. This is immediately seen in FEES as the bolus falls over the base of tongue. Also, the location of spillage and laryngeal or pharyngeal response to this spillage can be assessed.

The lips prevent drooling. The tongue positions all or part of the oral contents on its upper surface. The back of the tongue, palatine arch, and soft palate prevent premature spillage of the bolus into the pharynx.

ORAL TRANSFER STAGE

After preparation, the swallow begins. The oral preparation, oral transfer, and the initiation of the swallow are intertwined. Within a matter of seconds after "dumping" food to the vallecula, the person swallows the contents in the vallecula along with the bolus in the mouth. Pureed food may show this pattern of transport (dumping) to the vallecula, even without mastication. Liquids are swallowed as a whole and do not have pre-swallow transport stage.

MUSCLES INVOLVED:

The oral phase proper is coordinated by multiple distinct muscle actions. The tongue is moved by the action of the intrinsic muscles and the genioglossus. There is elevation of the tongue tip and blade of the tongue towards the hard palate. Mandibular elevation is needed for this action which helps the raise of hyoid bone by the suprahyoid muscles.

Mouth need not be fully closed during the act of swallowing, but it is difficult to swallow if the mouth is open more than a little. After the elevation of the floor of the mouth, stylohyoid lifts the tongue. Concurrently, the tongue is flattened, and food is moved back by these muscles along with the superior longitudinal and transversus muscles as the tongue fills the oral cavity. When the food reaches the back of the tongue with the tongue being deeply grooved, there is elevation of the soft palate with

the muscles levator and tensor veli palatini. This protects the nasopharynx from regurgitation of food. There is also closure of the airways.

ACTION OF THE TONGUE AND PRESWALLOW TRANSPORT:

Previously, this act of bolus formation has often been thought about as a single event. Detailed analysis of formation of bolus suggested that the way in which food is made ready in the oral preparatory phase involved repeated transport of chewed food between the oral cavity and the oropharyngeal surface of the tongue, through the palatoglossal and palatopharyngeal arches. Techniques using video fluoroscopy, and studies have provided evidence that the food bolus, through several cycles of upward and forward movement on the tongue surface gets progressively accumulated on the oropharyngeal surface of the tongue(4).

Palmer et al studied the coordination of mastication and swallowing and when subjects chewed solid food, there were loosely linked cycles of jaw and hyoid motion. A pre-swallow bolus of chewed food was transported from the oral cavity to the oropharynx by protraction of the tongue and hyoid bone. The tongue compressed the food against the palate and squeezed a portion into the pharynx one or more cycles prior to swallowing. This protraction was produced by contraction of the geniohyoid and anterior digastric muscles and occurred during the inter-cuspal and opening phases of the masticatory cycle. The mechanism of pre-swallow transport is highly similar to the oral phase of swallowing. Alternation of jaw adductor and abductor activity during mastication provides a framework for integration of chewing, transport, and swallowing (5).

FEES can record all these including the head of the liquid bolus if it enters the oropharynx prior to initiation of the swallow.

PHARYNGEAL PHASE

The airway protection is initiated in this phase when the bolus enters the pharynx for further transport into the esophagus. Initially there is inhibition of contraction of diaphragm. So, breathing and swallowing becomes impossible at same time (6). Simultaneously there is elevation of the soft palate and closure of vocal cords and protection of nasopharynx and airways respectively.

TRIGGER POINTS:

When the food comes into the oropharynx, a reflux is initiated by stimulation of trigger points. Swallow is initiated by stimulation of glossopharyngeal nerve when the food bolus touches the mucosa of the posterior region of pharynx or the faucial pillars. The reflux relaxes the pharyngeal constrictors so that the pharynx is dilated. The longitudinal muscles raise the larynx and pharynx. The pharyngeal constrictor muscles contract in sequence and the food is propelled over the epiglottis. This then causes closure of laryngeal inlet by contraction of muscles of laryngeal inlet (7).

Certain studies with the help of concurrent video-fluoroscopy and fibre optic endoscopy assessed that the 'trigger point' may involve the 'summation of afferent signals for the entire oropharyngeal sensory field. Food particles were seen in the valleculae and even the pyriform sinuses in 60 percent of liquid and 76 percent of solid swallows before the swallow is triggered (8).

CLOSURE OF GLOTTIS:

As the food passes from oral cavity beyond palatoglossal and palatopharyngeal arches, swallowing becomes a reflexive function. Swallowing may be said to be an automatic action once it is initiated, but many people can voluntarily delay their swallowing up to a certain point. There is a temporal relationship between subsequent events causing the movement of food from the base of the tongue into the oropharynx simultaneous initiation of airway protection. When the food gets into the oropharynx, there is said to be a reflex closure of the glottis.

The vocal folds and the laryngeal inlet show preparatory movements which can be seen as soon as the bolus enters the oral cavity, prior to a full closure of the larynx (8). Full adduction of the vocal folds (vocal cord closure)and medial movement of the arytenoid cartilages(glottic closure) is an absolute necessity for complete closure of larynx to prevent aspiration. There will be closure of the ventricular folds, lowering of epiglottis, and the edges of the laryngeal opening will be tensed to allow supraglottic closure (9). After reflex closure of glottis, the larynx closure is completed by elevation of the larynx and there is apnoea roughly 0.19 seconds before the elevation. The paralleling between breathing and swallowing is an important mechanism for airway protection. It prevents concurrent breathing and swallowing.

As the food enters bolus comes to the pharynx, the pharyngeal space widens as it is getting raised and there is the relaxation of the pharyngeal constrictor muscles. There is anterior movement of the pharynx as there is elevating action of the suprahyoid muscles. It simulates a snake devouring its prey. There is associated laryngeal elevation also due to the action of the suprahyoid muscles on the hyoid bone

as the larynx rises there is narrowing of the laryngeal inlet. The laryngeal cartilages move anteriorly, and the laryngeal inlet is moved towards the pharyngeal surface of the epiglottis. The muscles interarytenoid, aryepiglottic and thyroepiglottic closes the entrance of the laryngeal aditus by approximating its margin in the manner of closing a drawstring purse.

The food moves the epiglottis downward as the bolus enters the oropharynx. There are two different stages for this downward movement of epiglottis:

1. epiglottis comes from a vertical to a horizontal position
2. the upper third of the epiglottis is moved below the horizontal to cover the narrowed laryngeal aditus.

Usually the laryngeal inlet is not fully closed. But if ever any bolus particles move into the larynx, the true and false vocal cords close the airway. Adduction of the true vocal folds protects from ingestion of any foreign bodies. The cough reflex which ensues is a protective cough reflex can expel the aspirated foreign body to some extent.

PHARYNGEAL PERISTLASIS:

Now there is constriction of the superior constrictor muscle which in turn constricts the pharynx behind the bolus of food. All the three pharyngeal constrictor muscles contracts and there is development of a well-coordinated peristaltic wave.

By this time the food moves from the oropharynx into the laryngopharynx. It enters over and traverses the closed laryngeal aditus and arytenoid cartilages. It moves

on to the pyriform fossae and the inferior constrictor pushes the food bolus into the oesophagus

ONSET OF THE SWALLOW AND FEES

Base of tongue retraction, hyolaryngeal elevation, velopharyngeal closure, pharyngeal contraction, UES opening, and airway closure marks the onset of swallow. With FEES we can see the onset of tongue base retraction, epiglottal retroflexion, and lateral pharyngeal wall squeeze, just before the view is obliterated by "whiteout" which is normal. FEES can also assess the laryngeal movements including airway closure. Laryngeal closure for swallowing is typically occurs from inferior to superior, with the vocal folds adducting first and the epiglottis covering the arytenoids and glottis last.

Shaker et al (10) found that the predominant pattern of closure was true vocal cord adduction first (66% of the swallows), Ohmae et al (11) found that arytenoid adduction was the first event to be observed (86%). Flaherty et al (12) used magnetic resonance imaging to study the relationship of laryngeal closure and laryngeal elevation. They reported that vocal cord adduction was not complete until the peak of laryngeal elevation.

Van Daele et al (13) reported on a simultaneous endoscopy and electromyography study to clarify the order of events. Healthy subjects were used. bipolar hooked-wire electrodes were places on several muscles - the thyroarytenoid, posterior cricoarytenoid and the suprahyoid musculature. A flexible laryngoscope was then inserted to a point just above the epiglottis for half of the swallows and just above

the arytenoids for half of the swallows. The subjects drank 10-mL swallows of grape juice 10 times. Two of the subjects also drank 10 mL of grape juice 10 times using the super-supraglottic swallow (hold breath tightly, then swallow). The order of events for a normal swallow was found out: (1) arytenoid adduction and tilt with cessation of posterior cricoarytenoid activity (2) hyolaryngeal elevation, and (3) vocal cord closure. The authors hypothesized that the initial medialization of the arytenoids was a passive event, due to inhibition of the posterior cricoarytenoid. The first movement to signal the onset of the swallow was Arytenoid adduction, occurring 340 msec before laryngeal elevation. The vocal cords did not completely contact each other until the larynx was at least halfway to its peak elevation. Order of events was reversed for the super-supraglottic swallows, where the subjects were voluntarily holding their breath tightly prior to swallowing. The thyroarytenoid muscle was activated much earlier and caused vocal cord closure simultaneously with tight arytenoid medialization. This contraction was sustained throughout the swallow.

The importance of this clinically is that the airway protection mainly occurs at the level of the arytenoids and aryepiglottic folds during swallowing which covers the glottis and not at the level of vocal cords. In super-supraglottic swallow there is early closure of the vocal cords, so there is early and "double" protection. This can be visualised by FEES.

ESOPHAGEAL PHASE:

There is anterior and superior movement of the laryngo-hyoid components. There is relaxation of the cricopharyngeus muscle and opening up of upper oesophageal sphincter. Once the bolus enters the oesophagus, there is oesophageal

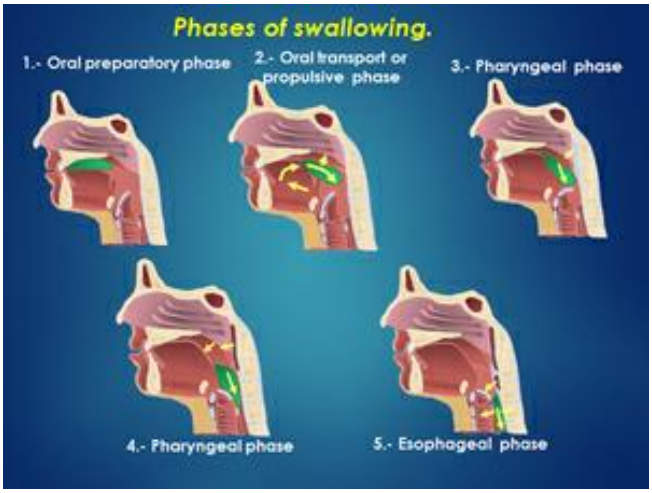
peristalsis which propels the food into the stomach. There is relaxation of the levator and tensor veli palatini muscles. This causes lowering of the soft palate. The hyoid bone drops down, there is opening of the laryngeal vestibule which in turn leads to opening of vocal cords and the airway.

COMPLETION OF SWALLOW AND FEES

There is a period of 0.5 to 0.6 seconds after the onset of the swallow. Here, when the bolus is passing down the pharyngeal air space is obliterated by tissue. From the distal end of the endoscope, the light is reflected back to the eyepiece, causing **whiteout**. It is during this time that there is completion of elevation of hyolaryngeal complex, complete retroflexion of the epiglottis and the pharyngeal constrictors squeeze the bolus into the open upper esophageal sphincter, and the bolus passes into the esophagus.

Once the swallow is over, the air space reopens as all structures returns to normal, and we can see the hypopharynx. In normal swallows, there will be no residue left over in the hypopharynx - that is no part of the bolus is seen.

Figure 2: Phases of swallowing

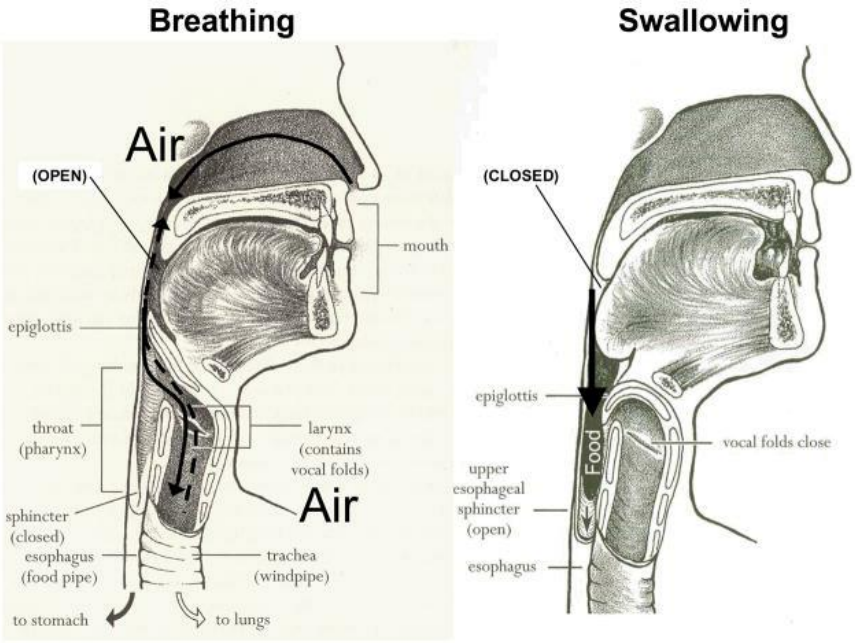


RESPIRATION AND SWALLOWING – SWALLOW APNOEA:

Respiration and swallowing are interconnected coz the same anatomical structures are involved for both and the physiology is interlinked. Effective transfer of food to the oesophagus has to occur simultaneously with maintenance of a protected airway (prevention of food entering the lower respiratory tract). There is an individual swallowing respiration pattern which matures in the teenage years and develops associated peripheral modification by bolus characteristics and is consistent thereafter. Disease or injury may affect this delicate balance, whether due to neurological insult or otolaryngological conditions. Swallowing occurs during the expiratory phase of respiration which is a protective mechanism. That is, any material left in the laryngeal vestibule after the swallow will go to the pharynx and will not be sucked into the airway. Inspiration post-swallow is more seen in patients with impaired swallowing.

Respiration is suspended during pharyngeal transit of the bolus is known as the period of swallow apnoea. There is an apnoea of roughly 0.19 seconds during swallow. It corresponds to the time of the reflex swallow and is less than one second and can be dependent on the volume and consistency of the food bolus (6).

Figure 3: Swallowing and breathing (6)



AGE EFFECTS ON SWALLOWING: PRESBYPHAGIA

With age, like with any physiological process in the body, swallowing is also slowed down. The efficiency of the processes of swallow slows down. There is a diminishing of the strength of muscle contraction, coordination can be impaired and there can be loss of sensation owing to multiple neuro-pathological etiologies. Age can also cause reduction in smell. As smell plays a major role in triggering appetite and eating, affection of smell can lead to reduced food intake and swallowing deficiency (14). As age increases more muscular work is needed to perform the same function which was done with ease previously. They can have increased muscular exhaustion and lingual pressure and reduction in reserve capacity (15). Reserve peak suction pressure during a single swallow may be the same for young and old. Forced repetitive swallows shows differences in older people giving us the inference that

there is reduced reserve capacity for old age (16). Individual aspects of physiology of swallowing may be affected as age increases.

NEURAL CONTROL OF SWALLOWING

Swallowing is planned, initiated and coordinated and regulated by the brain with the help of a hierarchical series of structures. This involves the motor neurones within the motor nuclei of the brainstem up to the cortex. Regulation of swallowing is mainly based on sensory feedback mechanisms. The swallowing initiation can be a voluntary act or a reflex act which is based on the stimulation of the involved mucosa in the oral cavity. This can be due to saliva accumulation or by the presence of food or liquid bolus. This emphasizes the fact that, the neural control of swallowing is divided between two major regions of the brain:

a) The cerebral cortex
b) The brainstem

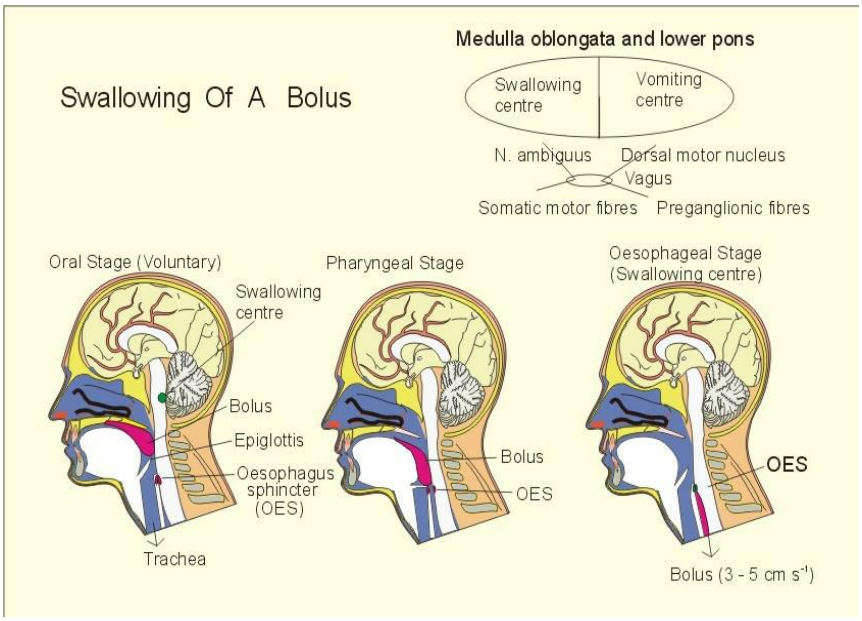
As the swallowing act is partly a reflex, and partly voluntary, several regions of the cortex contribute to the control of swallowing. There is anatomical and physiological relationship between mastication, swallowing, ventilation. So, there is extensive overlap in the brainstem areas controlling these functions. Neural control is an absolute requirement to coordinate these actions. The voluntary initiation of swallowing is done by bilateral areas of the prefrontal, frontal and parietal cortices. Positron emission tomography (PET) of the cortex after passive initiation of swallowing shows activity in several regions of the cortex. This includes:

1. The face areas of both the primary sensory and motor cortex,

2. The prefrontal swallowing areas which are located just anterior to the face region of the precentral gyrus in the primary motor cortex.

Stimulation of these centres produces swallowing activity in the corresponding muscles of the oral cavity, pharynx, palate and larynx.

Figure 4: Swallowing of a bolus



CAUSES OF DYSPHAGIA:

The classification of dysphagia is subdivided into local and general causes. This is based on the fact that there can be obstruction of any tube in the body because of problems-

1. in the lumen,
2. in the wall and
3. external compression of the wall.

Table 2: Causes of dysphagia.

Congenital causes:	**Traumatic:**	I**nfectious causes:**
● Choanal atresia. ● Cleft lip and palate ● Laryngomalacia ● Unilateral vocal cord paralysis ● Laryngeal cleft ● Tracheooesophageal fistula and oesophageal atresia ● Vascular rings	● Accidental and iatrogenic ● Blunt trauma, penetrating injuries and compression effects ● Direct injury and cranial nerve damage ● Head injury.	● Acute pharyngitis, tonsillitis, quinsy ● Glandular fever ● Acute supraglottitis ● Herpetic, fungal, cytomegalovirus mucosal lesions ● Candidiasis ● Tuberculosis ● Submandibular, parapharyngeal and retropharyngeal abscesses.
Inflammatory causes: ● Gastro oesophageal reflux disease ±	**Systemic autoimmune disorders:** ● Scleroderma,	**Neoplastic causes:** ● Benign tumours of the oral cavity,

stricture formation ● Patterson Brown-Kelly or Plummer-Vinson syndrome	'CREST' syndrome ● Systemic lupus erythematosus ● Dermatomyositis ● Primary and secondary Sjogren's diseases ● Mixed connective tissue disease ● Benign pemphigoid and epidermolysis bullosa ● Rheumatoid arthritis ● Crohn's disease Sarcoid	pharynx and oesophagus. ● Malignant tumours of the oral cavity, pharynx and oesophagus ● Nasopharyngeal carcinoma ● Skull base tumours ● Leukaemias and lymphomas ● Enlarged mediastinal lymph nodes.
Oesophageal motility disorders: ● Achalasia ● Diffuse oesophageal spasm	**Neurological causes:** ● Cerebrovascular accidents (stroke) ● Isolated recurrent laryngeal nerve	**Drug-induced:** ● Drugs causing oesophagitis ● Inhibitory drug side effects

● 'Nutcracker' oesophagus.	palsy ● Parkinson's disease ● Multiple sclerosis ● Myasthenia gravis ● motor neurone disease	● Excitatory drug side effects Drug complications
Ageing: Presbyphagia	**Miscellaneous:** ● Foreign bodies in the pharynx and oesophagus ● Caustic stricture ● Pharyngeal pouch ● Globus pharyngeus ● Patients with tracheostomy ● Thyroid disease.	

FINDINGS OF FEES EXAMINATION

FEES PROCEDURE

Patient is usually in sitting position. Fibreoptic endoscope is inserted via nostril and pharynx and larynx visualized. FEES protocol has three components for the comprehensive evaluation of swallowing.

1. Anatomy, mobility and sensation
2. The act of swallowing
3. Postural, dietary, or behavioural alterations to improve swallowing by altering the path of the bolus or the way it is swallowed. The alterations can be monitored by direct visualization.

Figure 5: FEES Procedure

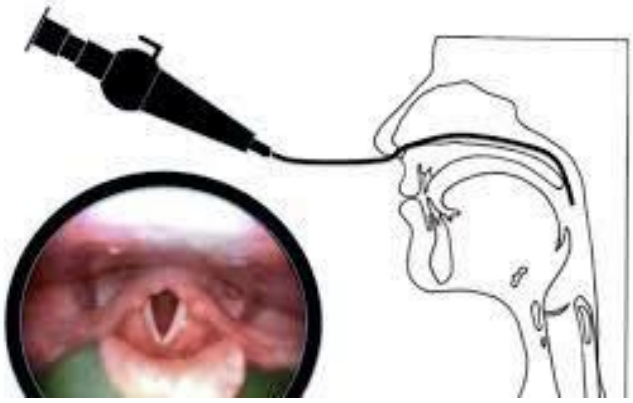


Figure 6 visualisation of larynx and hypopharynx

FEES PART I

PRE-SWALLOWING:

The anatomy of oral cavity and oropharynx is observed for any mass, secretions, mobility, and sensation.

Anatomy:

With FEES, the surface anatomy within the nasopharynx, oropharynx, and hypopharynx can be viewed directly. Altered anatomy from trauma, surgery, or congenital conditions, masses, foreign bodies which affects the bolus path, ability to clear the bolus, and ability to keep it out of the nose and airway is visualized.

Status of standing secretions:

The presence of uncleared excess secretions within the oropharynx and hypopharynx is looked for. The source and duration are predicted by the consistency of the secretions. Their location helps to predict the ability of the patient to swallow food and liquid completely. Murray et al (17) showed that the presence of excess

persistent secretions as seen by the endoscope within the laryngeal vestibule that are not cleared spontaneously by the patient are highly predictive of aspiration of food or liquids. They indicate either a reduced sensory awareness of the secretions (and of a bolus) or reduced ability to clear the secretions (and a bolus) when a swallow is attempted. There was a significant decrease in the frequency of spontaneous swallows in patients who aspirated.

Structural movements:

Base of tongue retraction, velopharyngeal port closure, laryngeal closure, laryngeal elevation, and pharyngeal wall medialization are assessed initially (pre-swallow assessment) without swallow and again with the bolus. Epiglottal retroflexion is seen only during swallowing.

Sensation:

Sensation is assessed in many ways during FEES procedure. Examples include whether the patient can sense the endoscope in the oropharynx or does the patient sense leakage of bolus, residue, penetration, or aspiration. The examiner can also directly assess the patient's response by giving a direct stimulus by lightly touching the aryepiglottic fold or the tip of the epiglottis. A normal person will give a positive response due to perception or a cough. Another method is to administer an air pulse to the aryepiglottic region (formal sensory test) which will evoke a laryngeal adductor reflex (LAR). If the FEES includes this testing, it is known as a FEES sensory test (FEESST) examination. It requires a flexible laryngoscope with a second open port or

an endosheath that has an open port to deliver the air pulse. It also requires a source of air that can be calibrated.

Table 3: Anatomy in FEES

VELOPHARYNGEAL FUNCTION / CLOSURE	**VOCAL CORD CLOSURE**
Complete	Complete
Incomplete	Incomplete
Symmetrical	**Supraglottic closure**
Asymmetrical, deviation to side	complete
SECRETIONS	incomplete
None	**TONGUE RETRACTION**
Vallecula / pyriform sinus	Normal
Penetration with cough	Reduced
Penetration without cough	**PHARYNGEAL WALL INVOLVEMENT**
Aspiration with cough	Normal
Aspiration without cough	Pathology right
VOCAL CORD MOVEMENT	Pathology left
Symmetrical	Bilateral Pathology
Asymmetrical	-

FEES PART II: ABILITY TO SWALLOW FOOD

This includes directly assessing the patient's ability to swallow food and liquid. Solid, liquid and semisolid food is given. Out patients can bring their own food to test. It is also important that the examiner understand how the patient eats in real life. To understand this, in part of the testing session patient is asked to self-feed with no instructions as to bolus size, rate of eating or swallow. If there is any residue left after the swallow in hypopharynx, the examiner should not tell the patient to swallow a second time, but should ask if the food is gone, noting the patient's sensitivity. The patient is allowed to take further food to see if the residue accumulates and how the patient handles it.

TERMS IN RELATION TO FEES EXAMINATION:

1. The normal passage of the food material in the pharyngeal phase is indicated by a **WHITE OUT.**
2. **PREMATURE SPILLAGE**: Material enters the hypopharynx before the laryngeals wallow is initiated

Figure 7 premature spillage

Figure 8: premature spillage solids

3.**RESIDUE/POOLING**:

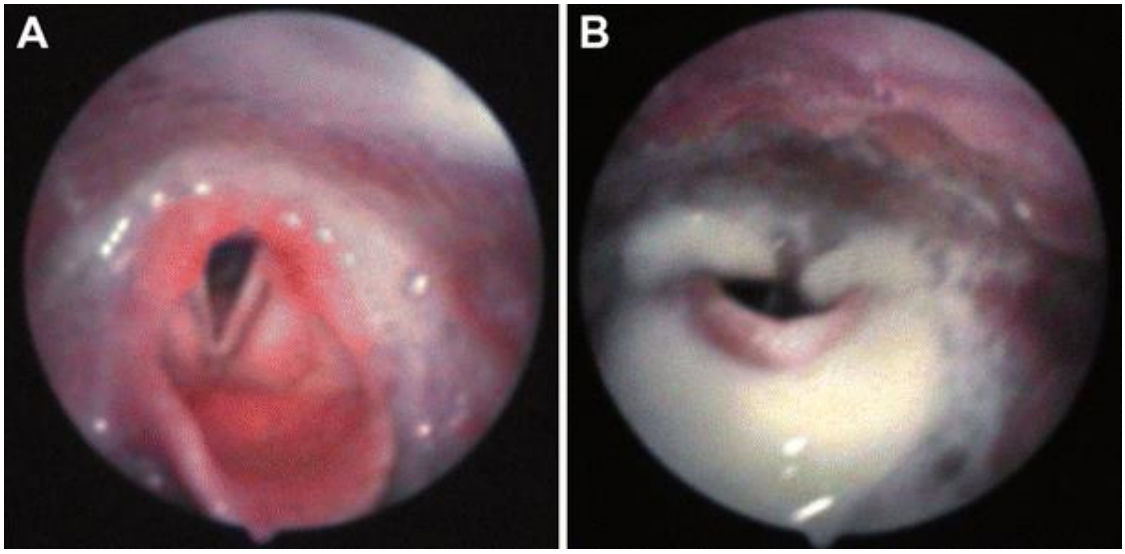
Coating of the walls in the hypopharynx that can be penetrated or aspirated. Can be calculated by the Farneti pooling score(P score)(18).

Table 4: P Score

Pooling	Endoscopic landmarks		Bedside parameters		
			Sensation	Collaboration	Age (years)
Site	Vallecule	1			
	Marginal zone	1			
	Pyriform sinus	2			
	Vestibule/vocal cords	3			
	Lower vocal cords	4			
Amount	Coating	1	Presence = -1	Presence = -1	<65 = +1
	Minimum	2	Absence = +1	Absence = +1	65-75 = +2
	Maximum	3			>75 = +3
Management	<2	2			
	2><5	3			
	>5	4			
Score	P 4-11		P-SCA 3-16		
	4-5= minimum	no dysphagia	3-4= minimum	no dysphagia	
	6-7= low	mild dysphagia	5-8= low	mild dysphagia	
	8-9= middle	moderate dysphagia	9-12= middle	moderate dysphagia	
	10-11= high	severe dysphagia	13-16= high	severe dysphagia	

Figure 9: Pooling of secretions

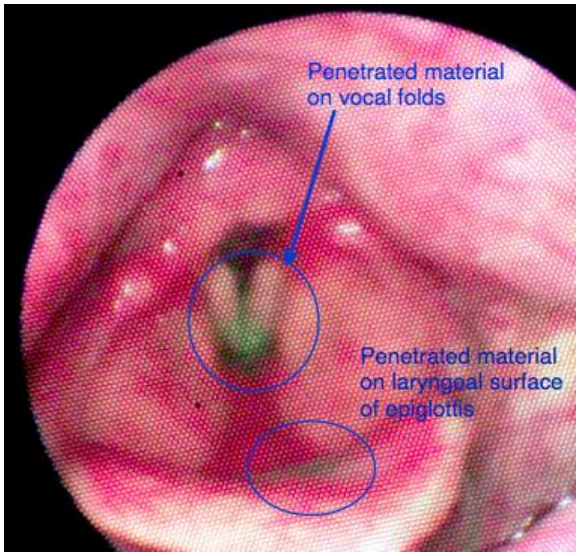
Figure 10: Residue



4.**PENETRATION**:

Bolus sits on the superior surface of the larynx or is above the level of true vocal folds.

Figure 11: Penetration



5.**ASPIRATION**:

Bolus passes into the larynx- that is the entry of food or liquid into the airway below the level of the true vocal folds.

Figure 12: Aspiration

PATHOPHYSIOLOGY IN ASPIRATION

If a fluid with a pH < 2.5 is aspirated, it produces an intense inflammatory reaction. Cytokines like interleukin 8and tumour necrosis factor alpha are released, accompanied by an influx of neutrophils. This causes increased alveolar capillary membrane permeability and leakage of fluid. This damages the epithelial and alveolar lining cells. This causes an increase in total lung water leading to oedema. Patient can develop widespread pulmonary oedema, which can develop into life-threatening acute respiratory distress syndrome. It depends on the severity of cases and is dependent on the pH and the volume of aspirated material.

Figure 13: Aspiration and penetration sites

THERAPEUTIC INTERVENTIONS AND FEES:

One advantage of the FEES examination is that the examiner can teach the patient techniques of swallow and re-examine to assess the function. Different postures, bolus consistencies and sizes, delivery methods, or behavioural changes can

be tested any number of times. The patient can be asked to take a dry swallow or take a liquid wash to see its effect on reducing residue. A new way of swallowing or a breathing manoeuvre or a controlled swallow can be taught to the patient using the image on the monitor as biofeedback.

1. Examples of compensatory techniques

- Modify bolus volume, consistency, viscosity
- Change method of food/liquid delivery
- Modify sequence of delivery
- Change rate of bolus delivery
- Swallowing behaviour alterations (e.g., dry/ clearing swallows, postural changes).

2. Rehabilitative techniques

- Swallow manoeuvres (supraglottic and effortful swallow)
- Muscle strengthening and Postural exercises: Chin down posture, Head extension, Head rotation, Head tilt to stronger side.
- Techniques for sensory stimulation (thermal-tactile stimulation; low-level electrical stimulation)

FINDINGS IN FEES:

Findings from part I of the FEES examination help to reason the cause and nature of dysphagia. In part II we can identify the type of dysphagia and can be demonstrated using FEES:

1. Inability in oral preparation of food,

2. Problem in swallow initiation (timing and coordination)
3. Lack of airway protection or velopharyngeal (VP) closure
4. Incomplete clearance of the food.

ABNORMAL PART I FINDINGS

An ineffective laryngeal closure may be reflected in a delayed initiation of the swallow. Excess secretions in the laryngeal vestibule can be associated with aspiration of food or liquid. Reduced pharyngeal squeeze puts a patient at higher risk for aspirating food (19).

Recently importance is also given to sensory testing along with FEES. Severely reduced or absent sensation in the laryngopharynx was found to be significantly associated with high risk for aspiration of liquids (20) and it may also be associated with increased laryngopharyngeal reflux (21). In laryngopharyngeal reflux (LPR) patients, there are no established methods to quantify the edema due to acid exposure to the posterior larynx. But we can identify and quantify laryngopharyngeal sensation in these patients by endoscopic administration of air pulses to the laryngeal mucosa and eliciting the laryngeal adductor reflex. The study by Aviv et al (21) was to determine whether patients with LPR have associated sensory deficits in the laryngopharynx, and whether these sensations are recovered on treatment with a proton pump inhibitor (PPI). Flexible endoscopic evaluation of swallowing with sensory testing was prospectively performed in 54 patients with dysphagia without neurologic disease and in 25 healthy controls. The laryngopharyngeal sensation, presence of any edema of posterior laryngeal wall, and LPR was assessed. LPR is said to be present when there was passage of food from the esophageal inlet retrograde into

the hypopharynx. Patients diagnosed with LPR by FEEST was given 3 months of omeprazole or lansoprazole and again tested. Patients without LPR were placed on H2 blockers for 3 months and then retested. The differences between the improvement in laryngeal edema and sensory deficits between the LPR, PPI group, and the non-LPR, non-PPI group were significant ($p < .01$, Fisher's exact test). Patients with dysphagia and posterior larynx edema as a result of LPR have sensory deficits in the laryngopharynx. Laryngopharyngeal edema is resolved by treatment with a PPI and it also helped improvement of sensory deficits.

Figure 14: Laryngeal mucosal edema in LPR

- Pseudosulcus vocalis - Infraglottic edema that passes posterior to the vocal process of the arytenoid cartilage and interarytenoid.
- Laryngeal erythema
- Ventricular obliteration, which refers to edema of the true and false vocal folds appearing to obliterate or obscure visualization of the laryngeal ventricle.

Figure 15: post radiotherapy oedema

FEES PART II FINDINGS

"Dysphagia profile" is assessed in this part.

1. **Reduced ability of oral preparation of bolus/food:**

Rate of eating, size of the bolus, pattern of mastication, time taken to masticate are all noted. Pharyngeal consequences of an oral-stage problem are also assessed. Food may leak into the hypopharynx HP prematurely or poorly chewed food may be left behind in the HP as residue after the swallow. It is normal for food to be transported to the vallecula during the masticatory phase for a variable length of time before the onset of swallow, but it is unusual for it to fall lower in the pharynx and certainly will not penetrate the laryngeal vestibule (3).

2. **Problems in initiation of the swallow (time and coordination):**

Onset of the swallow problems are more seen in patients with neurological disorders. Patients with dementia may eat compulsively without allowing the pharyngeal and laryngeal structures time to prepare for the swallow. Patients can have difficulty in swallow initiation and such patients may be holding the bolus in the

mouth for an increased amount of time. Patients with Parkinson's disease can have a tongue-pumping pattern in which they have trouble in swallow initiation. The major side effect of these deficits is that the bolus spills into the larynx before the airway has closed and the bolus can be aspirated.

A temporal measure used to quantify problems in swallow initiation is pharyngeal delay. It measures how long the bolus is in the pharynx before the beginning of the swallow. Research has established that some spillage is normal (4).

All the factors like the length of time the bolus in the pharynx, depth of the bolus spill, the size of bolus, anatomy of the path of the bolus that make one person to aspirate more easily has to be assessed. Spillage to pyriform sinus is not normal.it is abnormal for bolus to remain in the pharynx for several seconds (>5). The swallow will always be initiated when the bolus touches the laryngeal rim, if the sensory system is intact and penetration and aspiration will be avoided. Liquids flow faster and are more likely to spill into the laryngeal vestibule if sensation is sluggish.

3. Inadequate airway protection- laryngeal and velopharyngeal valving:

Inadequate laryngeal or velopharyngeal valving causes misdirection of the bolus. The laryngeal valve is most critical, as any problem in it can lead to aspiration of bolus. The cause is mainly weakness or incomplete closure of the laryngeal structures (epiglottic retroversion, arytenoids covering the glottis, and vocal fold adduction). There can also be mistiming of the bolus movement with airway closure. Also, there can be a delay in laryngeal elevation, which facilitates airway closure.

In the pre-swallow part of the FEES part 1, glottic closure at the level of the true vocal folds can be visualized directly. The fastness of laryngeal movements can also be seen giving an idea of response time to bolus spillage.

Penetration or aspiration of the bolus during the height of the swallow is difficult to be directly viewed during a FEES examination because of whiteout. Presence of aspiration or penetration can be evidenced by residue of bolus in the laryngeal vestibule, on the vocal folds, or below the glottis on the subglottic shelf.

Velopharyngeal valving keeps the food from going to the nasopharynx and into the nasal passages (nasal regurgitation). This sphincter can be directly viewed during the swallow by withdrawing the tip of the endoscope to the nasal passage.

4. Incomplete bolus clearance:

Incomplete bolus propulsion is evidenced by residue of bolus left behind after the swallow. If the residue is sufficient or if it is not cleared and increases with subsequent bolus swallows, it can leak into the laryngeal vestibule and can be aspirated. This usually occurs at the onset of a new swallow, as the larynx begins to elevate, and the pharyngeal walls begin to contract. It is also more likely to be a problem with solid food than with liquids, and with sticky food or small bits of food that can get stuck in the crevices of the pharynx. Liquids can pool in recesses but otherwise will fall to the distal pharynx simply by gravity.

The causes of residue include:

1. Insufficient muscular contraction—base of tongue, pharyngeal walls—to move the bolus caudally to the open UES

2. Insufficient laryngeal elevation, which decreases UES opening diameter.
3. Anatomical causes like an obstruction to bolus flow caused by the presence of a foreign body or tumour an anatomically resected, scarred or reconstructed structure.

The presence of residue, the patient's reaction to it, and the path it eventually takes (cleared or aspirated) are visualised by endoscopy. The source of the problem can be understood from the location of the residue. Residue left on the base of tongue means this region was not squeezed completely against the posterior pharyngeal wall. Research using simultaneous manometry and fluoroscopy has supported the relationship between location of residue and source of the problem(22)(23)(24)(25).

Table 5: Physiology in FEES

BOLUS TYPE	Valleculae
Liquid	Beside epiglottis
Semisolid	Laryngeal aditus/aspiration
Solid	
LEAKING	PENETRATION
None	No
Valleculae	Yes bolus type
Pyriform sinus	Cough
TIMING OF SWALLOWING ACT	Delayed cough
Coordinated	No cough
Delayed	Pre swallow
Lacking	During swallow
BOLUS POSITION AT SWALLOWING TRIGGER POINT (TYPICAL/MAXIMUM)	Post swallow
Tongue base	

Table 6: Physiology in FEES

ASPIRATION	Posterior pharyngeal wall
No	Nasogastric tube
Yes bolus type	Pyriform sinus
Sufficient cough	Upper esophageal sphincter
Reduced cough	**AMOUNT OF RESIDUE**
Lack of cough	None / thin coat
Pre swallow	Mild, < half of spaces filled
During swallow	Moderate, all spaces filled
Post swallow	Severe, spillage in laryngeal aditus
RESIDUE	● No aspiration
No	● Aspiration with cough
Valleculae	● Silent aspiration

FIBREOPTIC ENDOSCOPIC EVALUATION OF SWALLOWING TO TREAT DYSPHAGIA:

During the FEES evaluation, interventions are tried for their potential benefit and the results can be visualized immediately. Re-evaluations can be done any number

of times as needed to monitor progress, to assess the continued benefit of an intervention, or a dietary change.

Patients who are transitioning from NPO (nothing by mouth) to PO status (or vice versa) can be monitored regularly with serial FEES exams (26). Also, the recorded study can be used to educate patients, family members, nurses, or referring physicians about the nature of their problem and help in joint decision making, and better compliance with recommendations.

FEES can also be used directly as a treatment tool. The visual image provides direct feedback to patients about their swallowing behaviour. It can also be used to increase their awareness of residue, spillage, penetration, or aspiration. Denk and Kaider found that when endoscopy was used with head and neck cancer patients to teach them swallow strategies, they progressed faster than the patients who did not have the benefit of endoscopic biofeedback (27).

Endoscopy can be used to teach patients exercises to strengthen the swallowing muscles. Exercises using base of tongue, laryngeal, and pharyngeal muscles can be taught to patients, using endoscopy as biofeedback to ensure that the patient is doing the exercises correctly. Swallowing behaviours like controlled swallow or a super-supraglottic swallow can be taught more efficiently using endoscopy as biofeedback as patient can himself see the results.

Table 7: Swallowing manoeuvres

ORAL PREPARATORY PHASE	**ORAL TRANSFER STAGE**	**PHARYNGEAL PHASE**
Reduced Labial closure – stretch and isometric exercises	Tongue thrust – applying downward pressure to the middle of the tongue	Delayed triggering – anterior faucial pillar stimulation
Elevation and lateral movements of tongue		Bilateral or unilateral reduction in pharyngeal contraction – masalo swallow
Jaw opening and holding		Reduced laryngeal elevation – singing Mendelsohn maneouver
Spoon used to facilitate gross manipulation of food material in patients with inability to form bolus		Cricopharyngeal dysfunction – residue in pyriform fossa Spasm – cricopharyngeal myotomy

Table 8: Swallowing manoeuvres with mechanism

MANOEUVRE	**CAUSE IN WHICH IT CAN BE USED**	**MECHANISM OF ACTION**
Supraglottic swallow	Reduced or late vocal cord closure	Vocal cords adducted by voluntary breath holding.
Super-supraglottic swallow	Closure of laryngeal vestibule/airway entrance	Effortful breath holding tilts arytenoids forwards, closing airway entrance before, during and after swallowing
Effortful swallow	Posterior movement of tongue base is improved, which increases oropharyngeal pressure.	Posterior tongue base movement is increased by effort
Mendelsohn manoeuvre	• Height of laryngeal movement is improved. • Opening time of cricopharyngeus improved.	UES is opened by the laryngeal movement upwards and forwards, elevation of the hyoid and sphincter movement time prolonged
Shaker manoeuvre	Increases time of opening of the upper oesophageal sphincter by increasing hyoid motion.	Helps in cricopharyngeal opening

AIMS OF THE STUDY

1. Diagnose the prevalence of pharyngeal dysphagia using FEES.
2. Determine underlying anatomic and physiologic cause of dysphagia as visualised by FEES.
3. Advice the patient regarding oral feeding, type of feeds and use of appropriate behavioural/positional modifications that facilitate safe swallowing.

MATERIALS AND METHODS

METHODOLOGY

1. Design of study-Prospective Study
2. Period of study-February 2018 to August 2018
3. Place of study – Government Kilpauk Medical College Hospital and Government Royapettah Hospital attached to Kilpauk Medical College.
4. Ethical clearance - Obtained
5. Financial support – nil
6. Sample size - 78 patients
7. Patients included under specified criteria was selected.
8. Written informed consent was obtained from all participating subjects. Privacy was ensured.
9. A thorough clinical examination of the patient including an indirect laryngoscopy and if necessary other investigations like routine blood tests or x-rays were done.
10. The procedure:

    All patients underwent FEES examination using flexible fibreoptic nasopharyngoscope introduced transnasally. The procedure was done as an outpatient procedure. No topical anaesthetics were used. All patients evaluated in sitting posture. The endoscope was passed via most patent nostril moved forward along the floor of the nose. The base of the tongue, pharynx, and larynx were observed. Presence of oropharyngeal secretions, pooling and spontaneous swallowing was observed. Then the patients were given teaspoon-

sized portions of 3 different consistencies of food. Milk, ripe banana, and biscuit was used in our study and swallowing for different foods assessed. The findings of FEES were recorded and evaluated as per the protocol given by ASHA (American speech and hearing association). Presence and cause of swallowing disorder was assessed, and dietary modification and biofeedback was given to patients.

11. Whole information was compiled, and Statistical analysis was done.

INCLUSION CRITERIA

1. More than 18 years of Age.
2. All Patients with complaints of dysphagia.

EXCLUSION CRITERIA

1. Age less than 18 years.
2. Patient with morbid medical conditions and medically unfit, patients with severe aspiration problems, bleeding disorders, nasal trauma, patients in whom it can't be done as an outpatient evaluation, patients who are unwilling for the procedure.

SAMPLE SIZECALCULATION:

As per formula, SAMPLE SIZE = Z2 x P x(1-P) / C2

The sample size was calculated to be 75

Where, with 95% confidence interval Z value is taken as 1.96.

P: prevalence of pharyngeal dysphagia – 69.3% relative precision taken is 15%

REVIEW OF LITERATURE

D. S. Deenadayal, Vyshanavi Bommakanti, Bashetty Naveen Kumar, Nabeelah Naeem (28) studied the role of fibreoptic endoscopy in evaluating swallowing disorders. They told that FEES can be performed at bedside in the wards and also in the intensive care unit. Repeated examination with wide range of boluses altering their sizes and consistencies could be done. The procedure is safe even in infants. They concluded FEES to be an effective and valuable tool for evaluating pharyngeal dysphagia, to guide the patients for diet and rehabilitation.

Aviv JE, Kaplan ST, Thomson JE, Spitzer J, Diamond B, Close LG(29) studied regarding the safety of flexible endoscopic evaluation of swallowing with sensory testing (FEESST). Patients discomfort during the examination and complications like epistaxis, airway compromise, and significant changes in heart rate before and after the evaluation were monitored. There were no cases of airway compromise in their series. There were no significant differences in heart rate between pre- and post-test ($p > 0.05$). Eighty-one percent of patients noted either no discomfort or mild discomfort. They concluded that FEESST is a safe method of evaluating dysphagia.

A Nacci, F Ursino, R La Vela, F Matteucci, V Mallardi, and B Fattori(30) proposed the need for a written informed consent before FEES examination. It is the ethical responsibility of the physician to obtain the patient's consent prior to any procedure. FEES is not a simple diagnostic procedure implying implicit consent (not written). Complications like epistaxis may occur, hence they concluded that informed consent for FEES procedures is fundamental.

Reynolds J, Carroll S, Sturdivant C (31) studied FEES as a Multidisciplinary Alternative for Assessment of Infants with Dysphagia in the Neonatal Intensive Care Unit. They found out that Fibreoptic endoscopic evaluation of swallowing is a safe alternative to video fluoroscopic swallowing study in NICU. It can be used for the diagnosis and treatment of swallowing disorders and providing a safe feeding plan.

Kelly et al compared Video fluoroscopy and Fibreoptic Endoscopic Evaluation of Swallowing in Assessing Penetration and Aspiration (32) and they found out that Penetration Aspiration Scale scores were significantly higher for the FEES recordings than for the video fluoroscopy recordings (ANOVA $P < .001$)

Mc Gowan et al did a pilot study that demonstrated the feasibility of using the FEES for assessment of swallowing in patients with cuffed tracheostomy tubes. This helped to allow earlier fluid intake in such patients along with confirming the safety(33).

Suterwala et al found no differences between FEES pre-feeding and post-feeding vital signs (respiratory rate, heart rate or oxygen saturation) in NICU infants. FEES reliability was 80% assessing laryngeal penetration and tracheal aspiration(34) in this study.

Brady S, Donzelli J reviewed the evaluation of swallow function using the modified barium swallow (MBS) and the functional endoscopic evaluation of swallowing (FEES) and found that both are valuable for evaluating swallowing and dysphagia. Both has its own advantages and disadvantages and helps to identify

problems like laryngeal penetration and aspiration, pharyngeal residue, diet tolerated, and compensatory swallow techniques and safety measures (35).

Pisegna and Langmore did across-sectional, descriptive study to compare selected parameters of fibreoptic endoscopic evaluation of swallowing (FEES) and the modified barium swallow (MBS). They created a questionnaire with(a) anatomy they could visualize on each video, (b) pharyngeal residue after swallow, (c) clinical impression of the pharyngeal residue, and (d)opinions of the evaluation styles. They found out a significant difference in the visualization of anatomy, 11 of the 15 sites reported as better-visualized ($p < 0.05$) on the FEES than on the MBS (36).

Cohen et al did a study, in which out of 100 patients in whom swallowing evaluation was done, 97 patients underwent 102 FEES examinations. Three patients couldn't tolerate the examination. Swallowing pathology was seen in 63% of the patients (37).

Leder studied the use of serial FEES examinations to detect in all subjects, pharyngeal phase dysphagia, aspiration, and risk of aspiration. It helped to determine initial feeding status (NPO or PO), when to start oral feeding, and what bolus consistencies to use for successful swallowing. 15 of 32 (47%) subjects received FEES 3 to 5 times within only 6 to 22 days. Timely serial FEES allowed 22 of 32 (69%) subjects to resume an oral diet as early and safely as possible. No one developed aspiration pneumonia when started on oral diet based on results of FEES. So Serial FEES can be used to change from NPO to PO, with minimal health risk(26).

Coscarelli et al used bedside FEES to assess swallowing function in patients admitted to acute care units, neurological and internal medicine units with dysphagia. FEES helped to select safer nutritional method (oral intake, feeding tube or percutaneous gastrostomy) and reduce the risk of aspiration pneumonia. More than 50% of the dysphagic patients had cerebrovascular injuries. In 2% of the population, the first diagnostic hypothesis of Myasthenia Gravis can be made with the FESS technique. In 60%, change in nutritional method was needed, in 20% percutaneous endoscopic gastrostomy (PEG) was advised. None of them managed as per FEES results developed aspiration pneumonia (38).

Dziewas et al summarized recommendations for implementation and execution of FEES. It's an easy to use, non-invasive method for assessment of dysphagia in acute stroke, so a 3-step process is recommended to acquire the relevant knowledge and skills for carrying out FEES. First step is systematic training. Second is that endoscopy should be done under close supervision which is then followed by independent practice with indirect supervision -third step (39).

Warnecke et al used FEES to study the nature of swallowing impairment in Progressive Supranuclear Palsy. The findings of FEES in 18 PSP patients were compared with those of 15 patients with Parkinson's disease (PD). In 7 PSP patients, FEES was done to see the response to dysphagia with levodopa (L-dopa). Most frequent abnormalities detected by FEES were leakage, delayed swallowing reflex, and residue. in 30% of PSP patients, aspiration events with at least one food consistency happened. In 4 PSP patients, pharyngeal saliva pooling was significant. Severity of the dysphagia severity in PSP correlated positively with duration of the

disease, disability, and cognitive impairment. In early PSP patients, there was liquid leakage with aspiration during the oral phase of swallowing. Two PSP patients had significant improvement of swallowing after L-dopa challenge. The most useful swallowing manoeuvres were the Chin tuck-manoeuvre, hard swallow, and modification of food consistency. Thus, they concluded that FEES can be used for diagnosis and also help to intervene and help in refined therapy of dysphagia in PSP patients (40).

Thottam et al found out that FEES can be used as a management tool in children with psychogenic dysphagia because it provides direct visualization of the oropharyngeal swallowing mechanism. Five patients (4 males, 1 female) with ages ranging from 5 to 13 years old (mean=8.6) were chosen with three weeks duration of dysphagia. All the children showed refusal of solids, choking episodes, intermittent odynophagia and estimated weight loss (mean 2.8kg). Fibreoptic endoscopic evaluation of swallowing was performed on all patients. In FEES there was no abnormalities in the oropharyngeal swallow. FEES can be used to visually reassure and provide biofeedback to patients and parents. Three of the five children reported complete resolution of symptoms after FEES at follow-up visit (41).

Leder et al showed FEES to be successful in assessing pre-swallow anatomy, physiology, diagnosing pharyngeal phase dysphagia, and for therapeutic interventions to promote safer oral intake in patients with amyotrophic lateral sclerosis. Visual biofeedback by FEES was successful for both patient and family education and to implemented immediately individualized therapeutic swallowing strategies (42).

Leder and Espinosa compared a clinical swallowing examination consisting of six clinical identifiers of aspiration risk- dysphonia, dysarthria, abnormal gag reflex, abnormal volitional cough, cough after swallow, and voice change after swallow, with FEES to determine reliability in identifying aspiration risk following acute stroke. A referred consecutive sample of 49 first-time stroke patients was evaluated within 24 hours poststroke, first with the clinical examination followed immediately by FEES. It was concluded that the clinical examination, when compared with FEES, underestimated aspiration risk in patients with risk. Swallow evaluation with FEES should be done for patients following acute stroke (43).

Colodny used Fibreoptic Endoscopic Evaluation of Swallowing (FEES(R)) to assess the reliability of the Penetration-Aspiration Scale (PAS) using 79 swallows and four judges in a replication of a study using video fluoroscopy (VFSS). The swallows were diagnosed using FEES, which allowed for comparison between the two techniques. The findings indicated that all categories of the PAS achieved adequate reliability, both on intra-judge and inter-judge assessments. Their findings suggested that FEES was more reliable on assessing penetration than VFSS, but that VFSS was more reliable on the assessment of the various severities of aspiration. The two techniques were equally effective in discriminating between penetration and aspiration. This study found that FEES was just as reliable as VFSS when using the PAS (44)

Wolf and Meiners found that FEES allows for the detection and classification of dysphagia as well as therapeutic management evaluation in patients with acute cervical spinal cord injury (45).

Rademaker et al correlated oropharyngeal swallow efficiency (OPSE), as a measure of swallowing function. multiple measures of swallow function in five patient populations and a group of normal volunteers were done. 759 swallows were studied in 149 people. In patients with impairments of swallow, OPSE was shown to be representative of the features of impairment (46).

Hiss and Postma evaluated the technique, interpretation, predictive value, and safety of fibreoptic endoscopic evaluation of swallowing (47).

Madden et al Compared efficacy of assessment of swallowing function between video fluoroscopy and milk-swallow by a prospective study of 20 sets of video fluoroscopic and endoscopic assessments. Endoscopy was found to be a highly sensitive and specific method of determining swallowing safety. Reduced or absent laryngeal sensation at endoscopy correlated with silent aspiration (48).

Farneti et al studied a procedure to evaluate the oral phase of swallowing using endoscopes. This examination is minimally different from that of FEES and is called oral- FEES (O-FEES). The procedure is done by just by reversing the tip of the fibreoptic endoscope just back in the oral cavity or behind the soft palate. The anatomical the oral cavity and all the events that occur inside the cavity (mainly the tongue movements as in verbal articulation, manoeuvres, mastication, bolus formation) are visible. Considerations can also be made about the efficiency of the oral phase, evaluating the residues after swallowing (49).

Aviv et al did a study to find out the incidence of complications associated with FEES in outpatients and inpatients. It was a prospective study 1,340 consecutive

evaluations done over a period of 4 1/2-years.Incidence of epistaxis and airway compromise were the primary outcome variables were. The incidence of epistaxis was 1 in 1,340 (0.07%). There were no cases of airway compromise (50)**.**

Aviv et al studied regarding laryngeal adductor reflex (LAR) and pharyngeal squeeze as predictors of penetration and aspiration of the food bolus. Absence of the LAR and deficient pharyngeal squeeze puts patients with dysphagia at high risk for laryngeal penetration and aspiration. The same was found to be less in patients with an intact LAR and pharyngeal squeeze. This shows the strength of association between motor and sensory deficits in laryngopharynx which can affect swallowing (51)**.**

Kelly et al compared the efficiency of Fibreoptic endoscopic evaluation of swallowing and video fluoroscopy to perceive of pharyngeal residue severity**.** Pharyngeal residue was consistently found to be greater from FEES than from video fluoroscopy. These findings have significant clinical implications as FEES and video fluoroscopy evaluations are used to calculate aspiration risk and to make recommendations for per oral intake for a dysphagic patient (52).

Kaye et al assessed the role of flexible laryngoscopy in evaluating aspiration. In this study, they used Flexible fibreoptic laryngoscopy to evaluate dysphagia and its clinical utility has not been compared to that of the video fluorographic swallowing study (VFSS). This study correlates parameters of both procedures. It identifies laryngoscopic predictors of aspiration. Presence of aspiration, pharyngeal residue, laryngeal sensation, vocal cord mobility, and glottic closure using flexible laryngoscopy (FL), and gag reflex were correlated with aspiration during examination with VFSS. An algorithm for laryngoscopically detecting aspiration was found out.

Aspiration (p = .004) and pharyngeal residue (p < .00001) were highly correlated between the two studies (53)**.**

Aviv et al did a study on Supraglottic and pharyngeal sensory abnormalities in stroke patients with dysphagia. Dysphagia and aspiration were two devastating sequelae due to stroke. There are estimated nearly 40,000 deaths from aspiration pneumonia each year in the United States. motor deficits in the larynx and pharynx are thought responsible for dysphagia and aspiration in stroke patients. There is no prior study to evaluated whether these patients also had sensory deficits. This study evaluated the sensory capacity of the laryngopharynx (LP) in supratentorial or brain stem stroke patients who had dysphagia**.** Fifteen stroke patients (mean age, 66.7 +/- 13.8 [SD] years) were prospectively evaluated for sensation. Air pulse stimuli were delivered via a flexible fibreoptic endoscope to the mucosa which is innervated by the superior laryngeal nerve. 15 age-matched controls were there, and no LP sensory deficits were found in any of the controls. In all stroke patients studied, unilateral (n = 9) or bilateral (n = 6) sensory deficits were diagnosed. Deficits were defined as:

1. Moderate impairment in sensory discrimination thresholds (3.5 to 6.0 mm Hg) or
2. A severe sensory impairment (> 6.0 mm Hg).

In patients with unilateral deficits, the sensory thresholds were moderately to severely elevated in all 9 cases on the affected side compared with the unaffected side (p < .01, Fisher's exact test). And the thresholds of the unaffected side were not significantly different from the thresholds of age-matched controls. All six of their patients with bilateral deficits had severe neurological impairments. The results showed that stroke

patients with dysphagia will have significant sensory deficits in the LP. These impairments are responsible to contribute to the development of aspiration (54).

Spain Da did a study regarding start of oral feeding for seriously ill patients. critically ill patients should be started on enteral nutrition within 24 to 48 hours of intensive care unit admission. Critically ill patients who need catecholamine support or heavy sedation or therapeutic neuromuscular blockade should not receive enteral nutrition until they have been properly stabilized (55).

Leder et al studied regarding the presence of a tracheotomy tube and aspiration status. The study was done in early, postsurgical head and neck cancer patients. The effects caused by the presence of a tracheotomy tube on swallowing and the aspiration status in early, postsurgical head and neck cancer patients evaluated. The result was that neither presence of a tracheotomy tube nor decannulation affected aspiration status in their group. So, the clinical idea that a tracheotomy or tracheotomy tube increases aspiration risk and decannulation of the tracheostomy results in improved swallowing function are not supported. But the presence of a tracheotomy indicates comorbidities. This includes respiratory failure, trauma, stroke, advanced age, reduced functional reserve, and medications used to treat the critically ill. These co morbidities themselves predispose patients for dysphagia and aspiration(56).

Badenduck et al studied the head position and swallowing outcomes using Fibre-optic endoscopic evaluation of swallowing in a normal population. They examined 840 swallows. There was one event of aspiration and five events of penetration. More than 50% participants found head positions they preferred over the centre position for swallowing. But in this study head position was not associated with

penetration-aspiration scores. Significant associations and non-significant trends were found between pharyngeal residue and three variables:

1. Age
2. Most preferred head position,
3. Least preferred head position.

They concluded that head position during swallowing in age greater than 40 years can result in increased pharyngeal residue. This did not affect laryngeal penetration or aspiration (57).

In a study by **Thompson and Heaton** 1 adult in 3 experienced occasional heartburn. 1 in 10 suffered it once a week or more often (58).

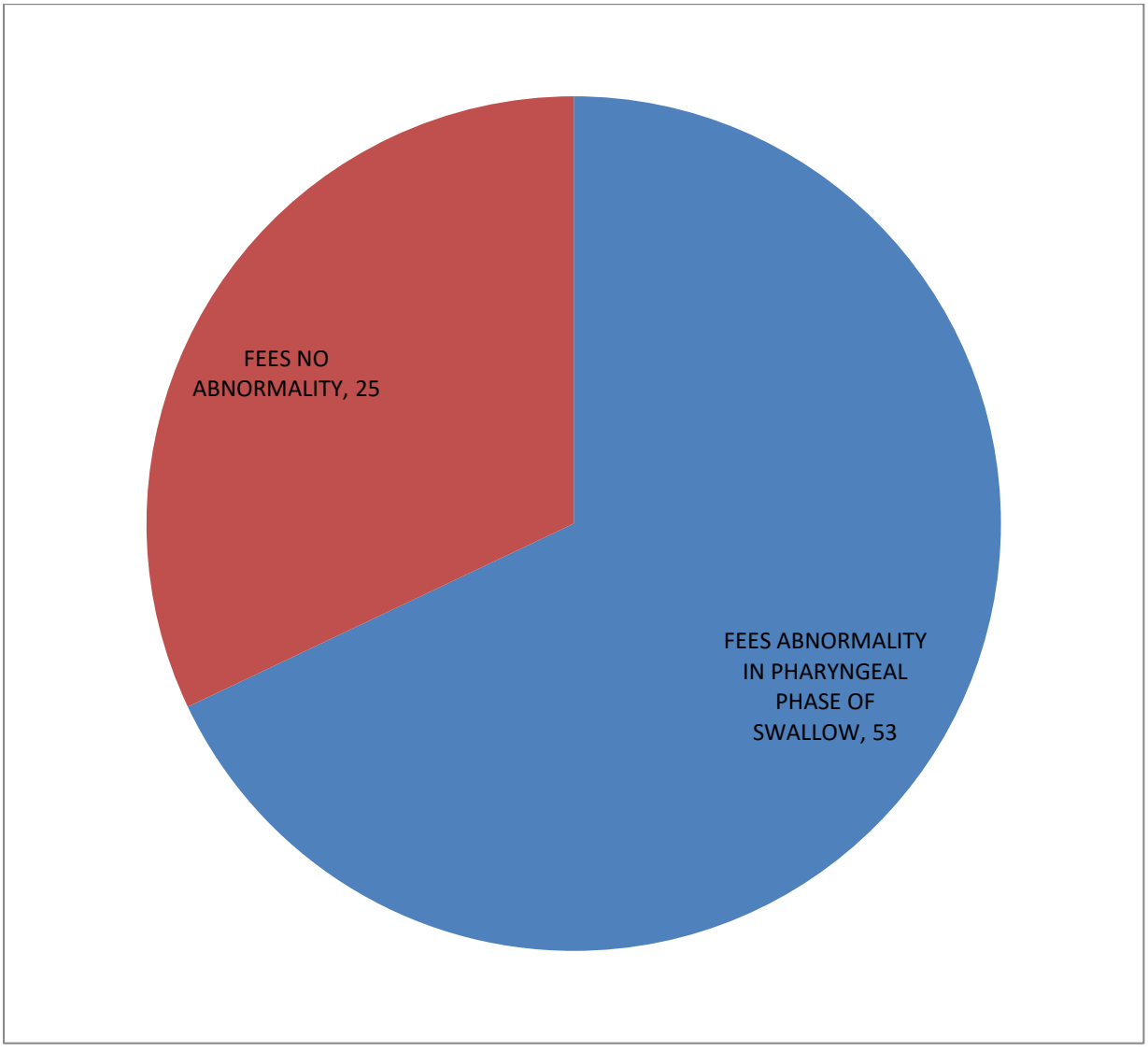
A study by **Li et al** found that there were no significant differences between globus patients and normal adults in hyoid bone displacement, pharyngeal transit time, pharyngeal constriction ratio, or maximum opening of the upper esophageal sphincter ($p > 0.05$). This study told that pharyngeal swallowing function are not affected in globus patients (59).

RESULTS

Total of 78 patients above 18 years of age, where studied, who presented with dysphagia to ENT OPD.

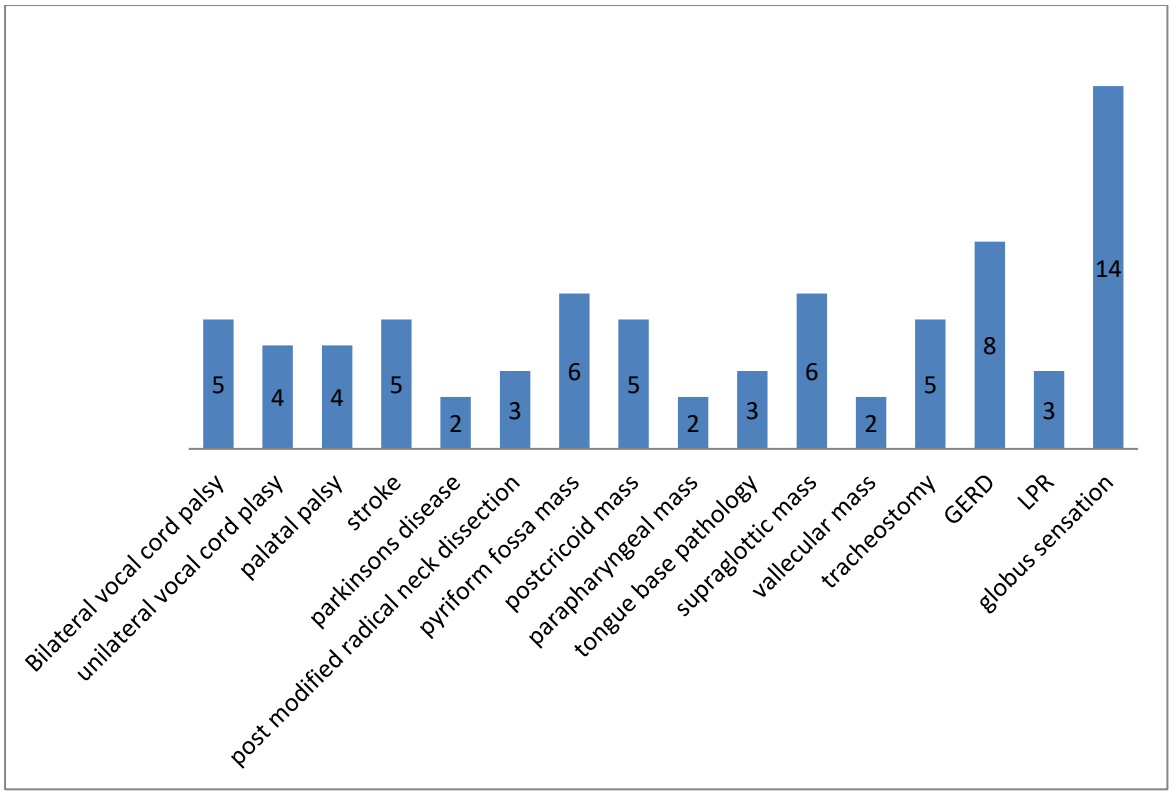
Among the 78 patients with complaints of dysphagia, 53 of them had pharyngeal phase swallowing disorder as assessed by FEES. The prevalence was found to be 67.94%.

Figure 16: prevalence of dysphagia using FEES



THE INITIAL SUSPECTED CLINICAL DIAGNOSIS WITH RESPECT TO ANATOMY AND PHYSIOLOGY:

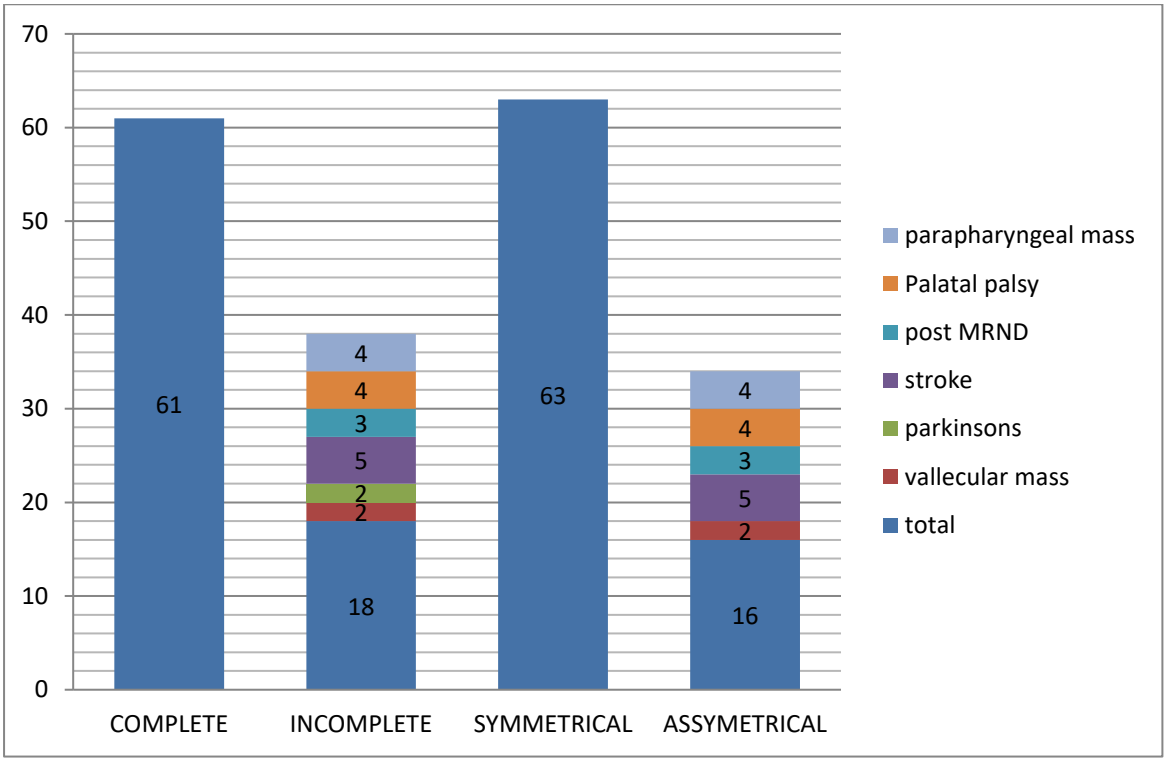
Figure 17: Distribution of clinical diagnosis



There were 14 patients with globus sensation, 3 with LPR and ,8 with GERD in whom anatomical abnormality was not detected in clinical examination. All the GERD AND LPR patients were confirmed diagnosis with OGD scopy before FEES. All the head and neck malignancy cases were evaluated with prior CT scan to rule out metachronous or synchronous growth elsewhere. Neurological cases were subjected to FEES after completer neurological examination.

VELOPHARYNGEAL CLOSURE:

Figure 18: Velopharyngeal closure in different diseases



SECRETIONS:

Table 9: Secretions

secretions	Disease no	Disease yes	total
no	25	7	32(41%)
yes	0	46	46(59%)

Among the 46 people who has secretions, 40 (87%) of them had secretions in vallecula and pyriform sinus whereas 6 of them had secretions elsewhere also.

Among the 46 patients with secretions, 36 also had penetration with cough while 10 had aspiration with cough

Table 10: Location of secretion and its effects

Secretions in vallecula pyriform sinus	Secretions else where	Secretion – penetration with cough	Secretion – aspiration with cough
40(87%)	6(13%)	36	10

Figure 19: Location of secretion and its effects

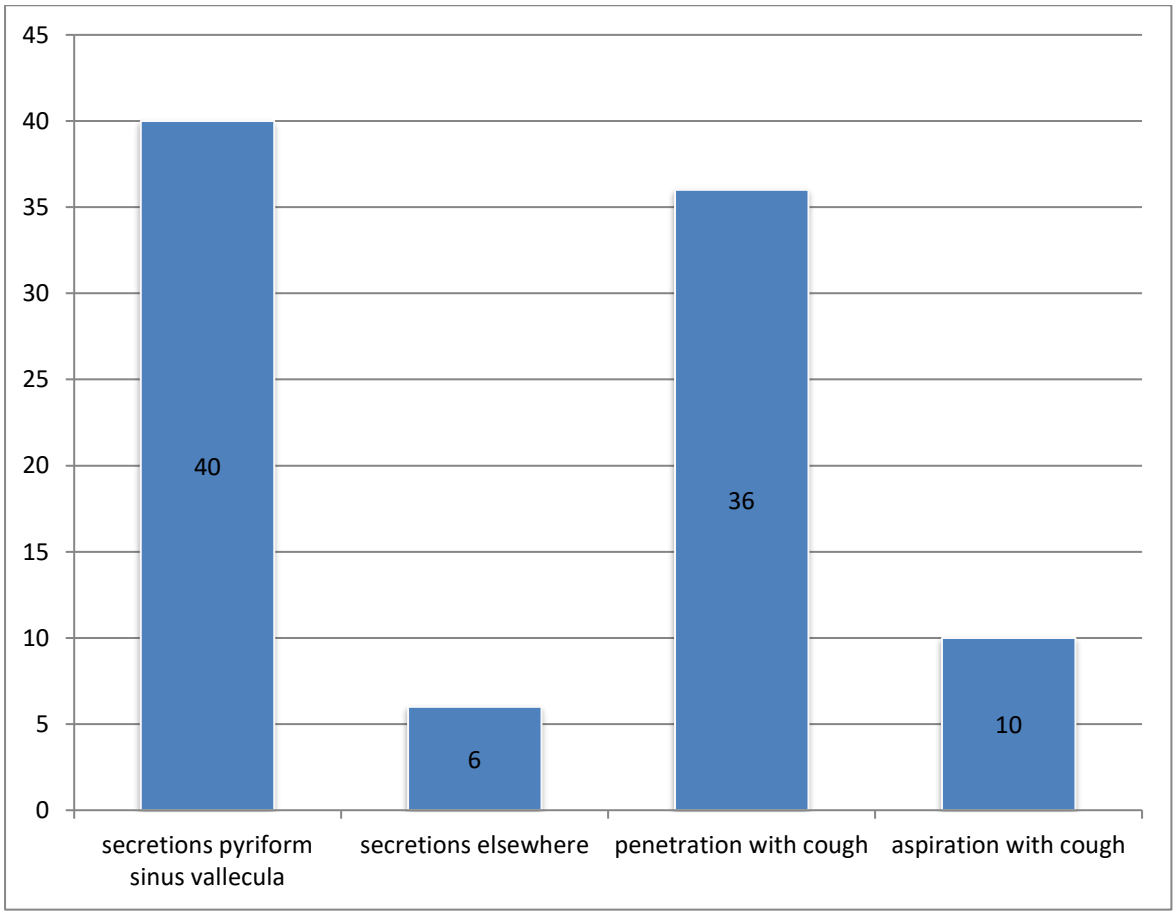


Figure 20 : Penetration of secretions with cough in different diseases

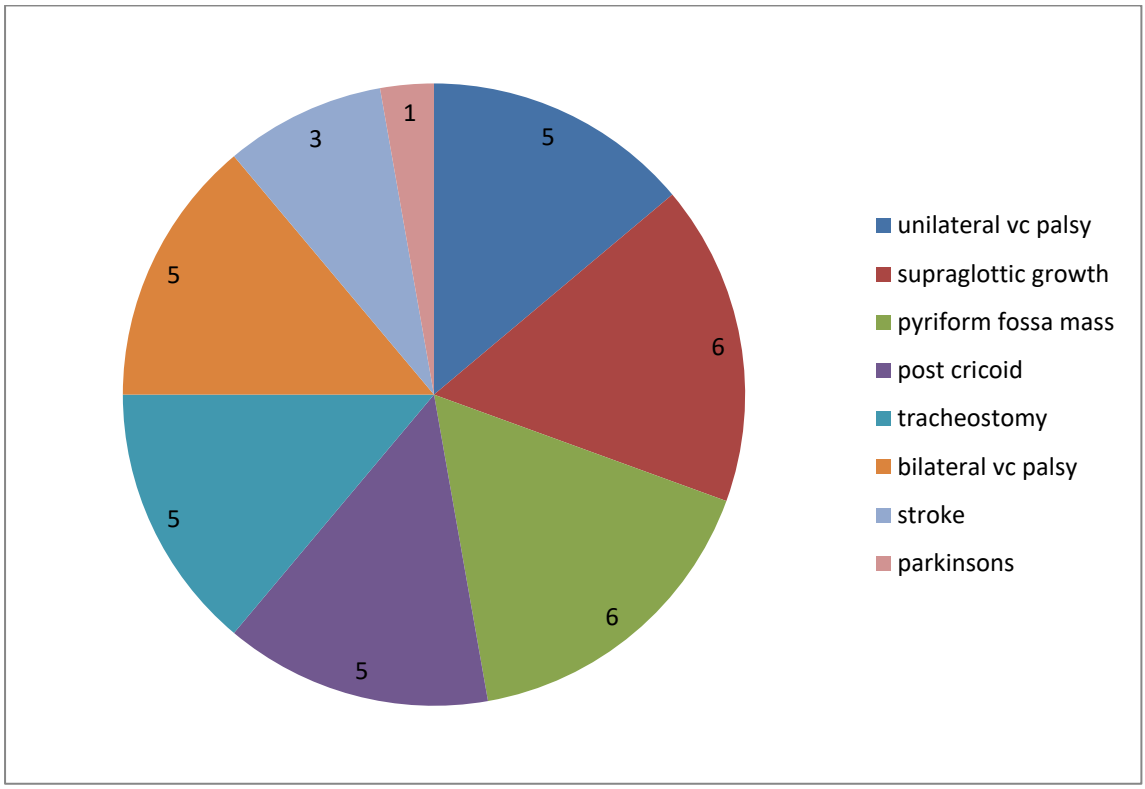
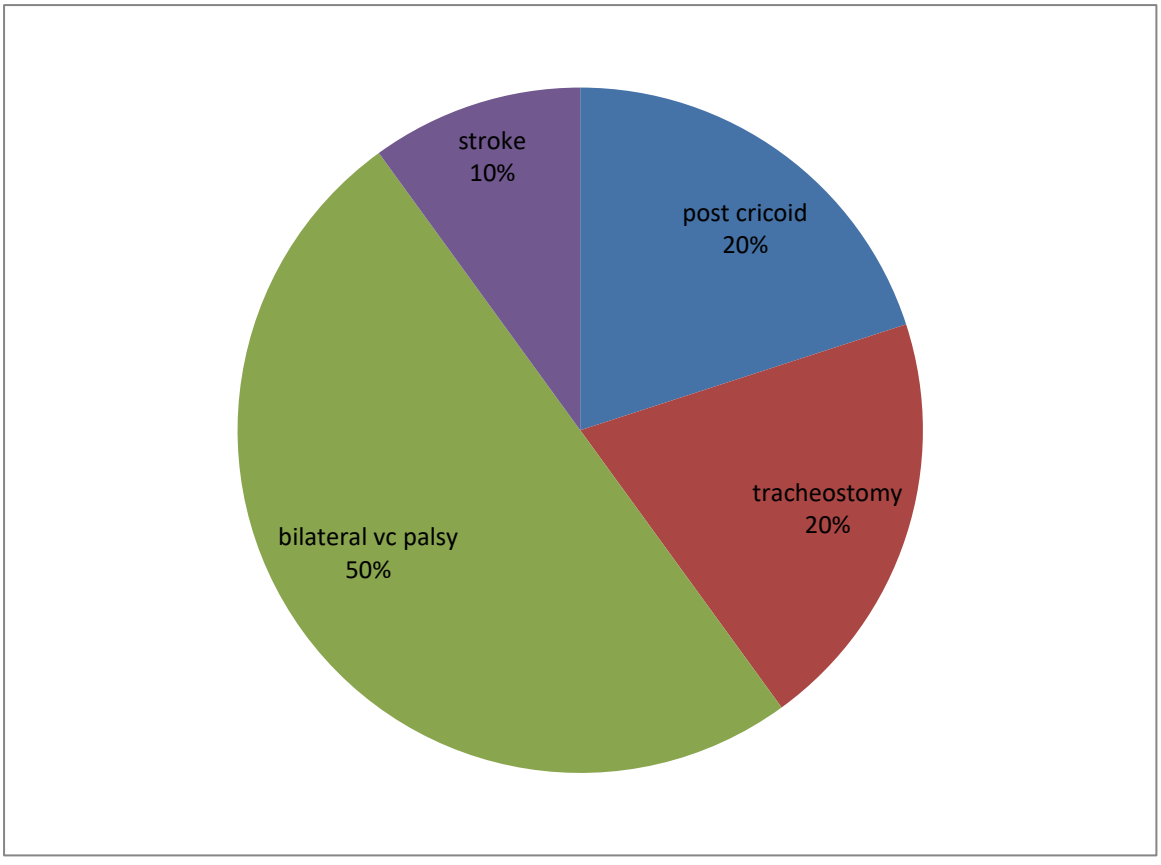
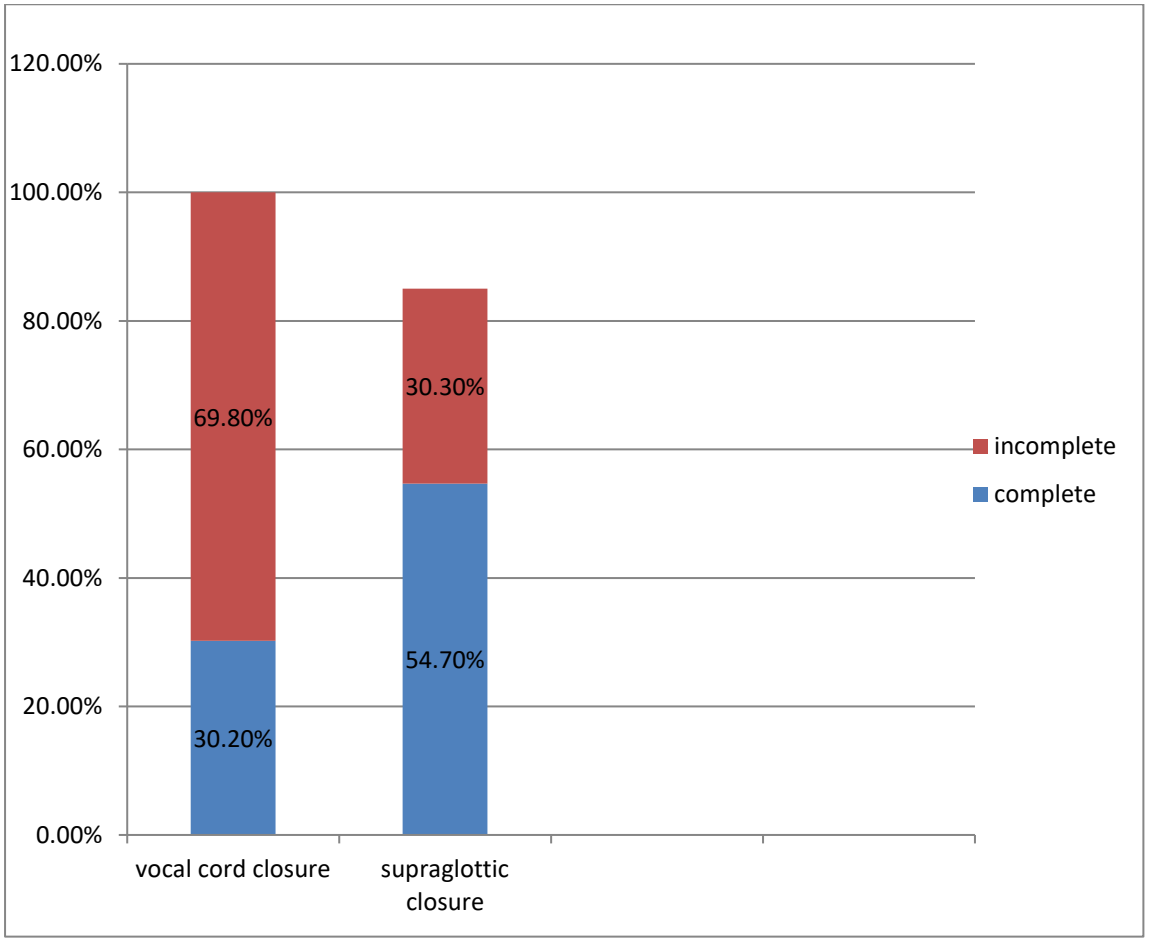


Figure 21: Aspiration of secretions with cough in different diseases.



VOCAL CORD AND SUPRAGLOTTIC CLOSURE

Figure 22: Vocal cord and supra glottic closure



Among the diseased (53), vocal cord closure was complete in 16 of them where as incomplete in 37 patients. supraglottic closure was complete in 29 patients and incomplete in 24 patients.

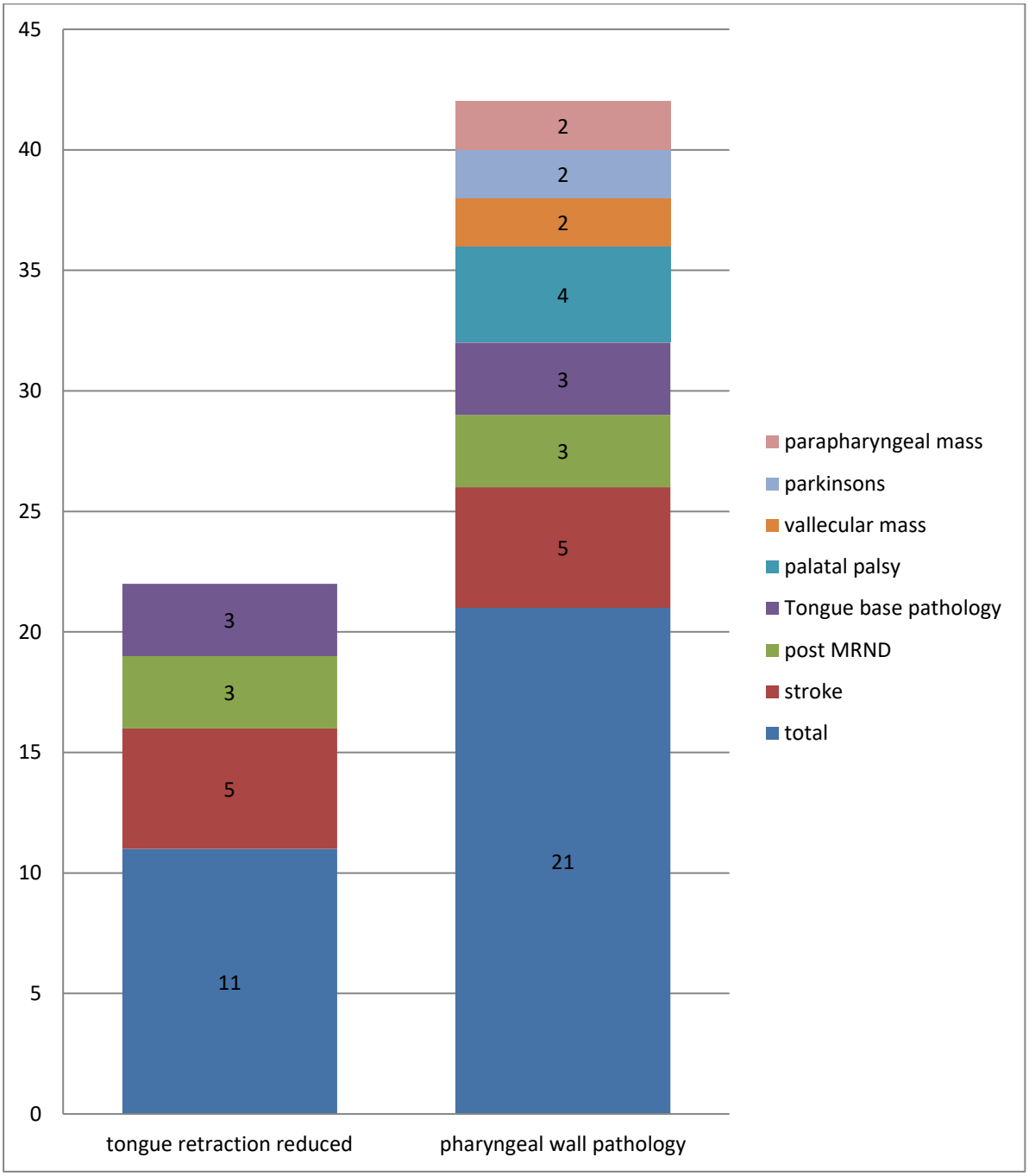
TONGUE RETRACTION

Tongue retraction was reduced in 11 of them (20.8%) whereas it was normal in 42(79.2%) patients with dysphagia.

PHARYNGEAL WALL MOVEMENT PATHOLOGY:

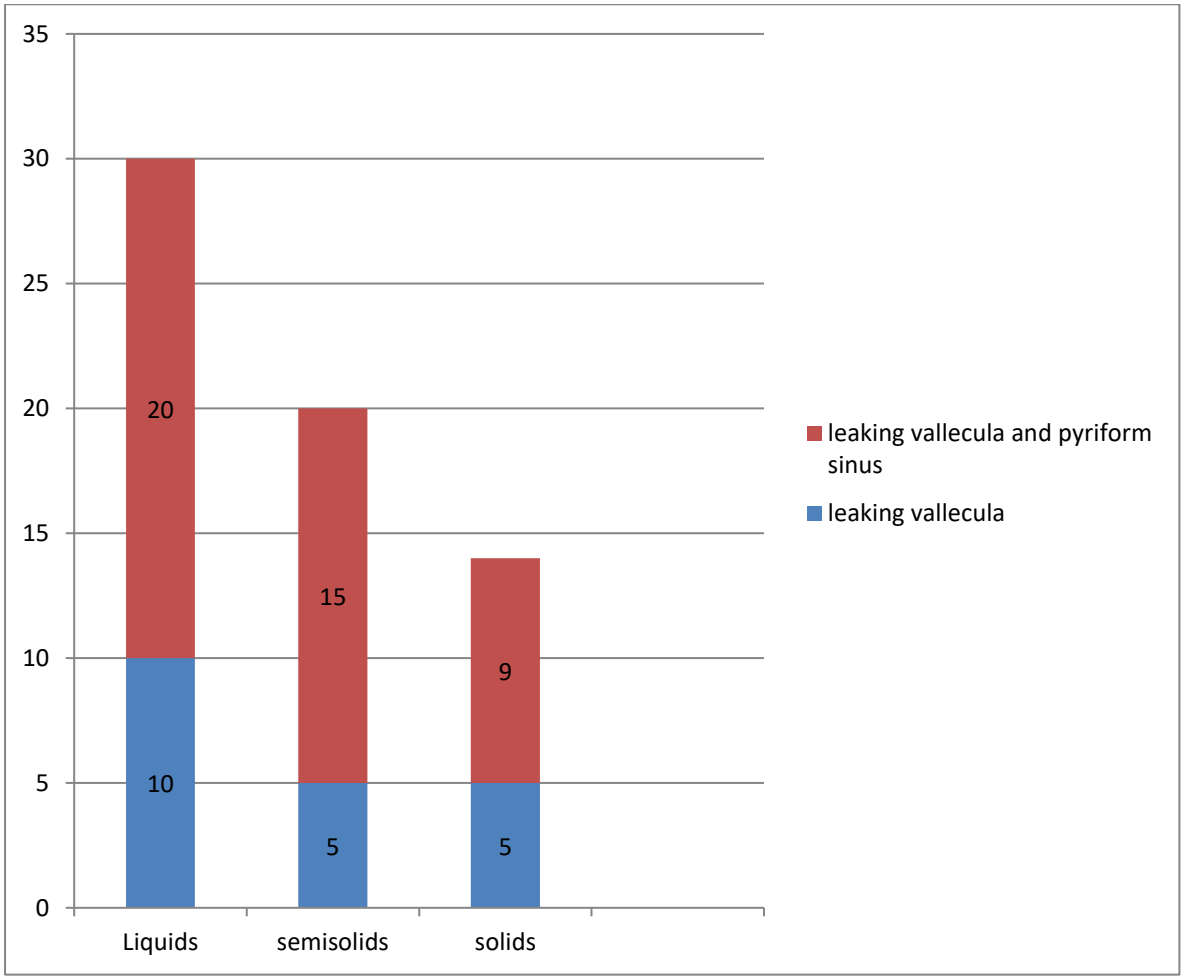
21 (39.6%) among the 53 had pharyngeal wall movement pathology.

Figure 23: Tongue retraction and posterior wall movement pathology



LEAKING

Figure 24: Leaking

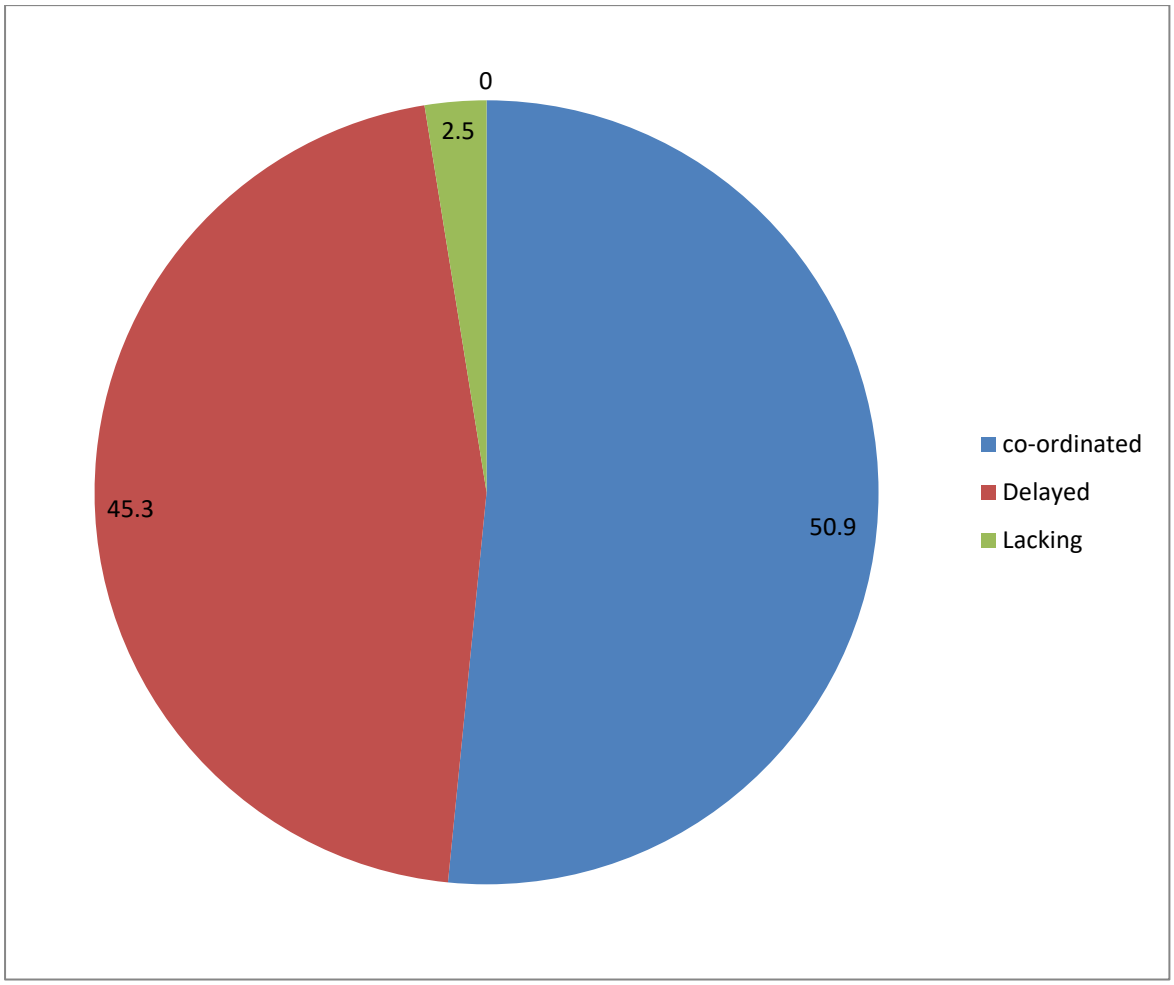


30 (56.6%) had leaking with liquids of which 20 (69%) involved leaking to both pyriform sinus and vallecula. 20(37.7%) had leaking with semisolids-among which 15(75%) had leaking into pyriform sinus and vallecula. 14(26.4%) had leaking with solids- among which 9(64.3%) had leaking to both vallecula and pyrifrom sinus.

TIMING OF SWALLOW

Timing of swallow was coordinated in 27(50.9%) of patients where as it was delayed on 24(45.3%) and was lacking in 2(3.8%) of the patients with dysphagia.

Figure 25: Timing of swallow



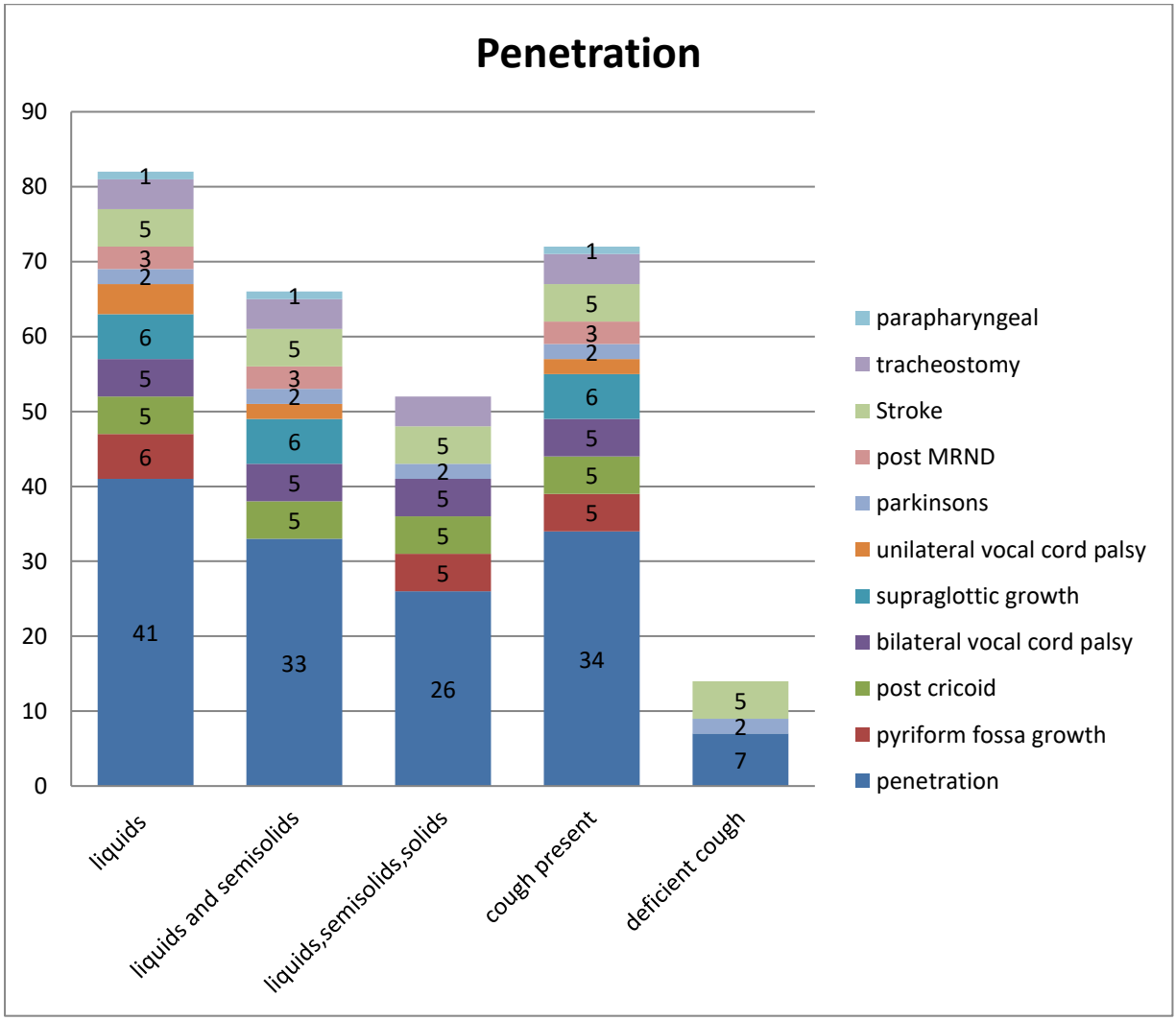
PENETRATION

Among the 53 people with dysphagia 41(77.4%) had penetration of the food bolus (Bolus enters the superior surface of the larynx or is above the vocal folds). Effective cough while penetration was present in 82.9% - 34 of the patients.

Table 11: Penetration

	yes	no
Penetration	**41(77.4%)**	**12(22.6%)**
Liquids	**41(100%)**	**-**
Semisolids and liquids	**33(80.5%)**	**-**
Solids, semisolids and liquids	**26(63.4%)**	**-**
Cough	**34(82.9%)**	**7(17.1%)**

Figure 26: Penetration in different diseases.



PENETRATION TIMING

Penetration before initiation of swallow was present in 26 patients, during the act of swallowing in 39 patients and 27 has penetration post swallow.

Table 12: Timing of penetration in swallow

Pre-swallow	**26**
During swallow	**39**
Post swallow	**27**

ASPIRATION

Of the 53 Patients diagnosed with swallowing disorder,23(43.4%) had aspiration (bolus enters the larynx). Effective cough during aspiration was present in 91.3% (21) of the patients.

Table 13: Aspiration

	yes	**No**
Aspiration	**23(43.4%)**	**30(56.6%)**
liquids	**21(91.3%)**	**-**
semisolids	**10(43.5%)**	**-**
cough	**21(91.3%)**	**2(8.7%)**

ASPIRATION TIMING:

Aspiration during the swallow was seen in 21 patients and aspiration post swallow was seen in 15 of them.

Table 14: Timing of aspiration in swallow

Pre-swallow	**6**
During swallow	**21**
Post swallow	**15**

Figure 27: Aspiration in different diseases.

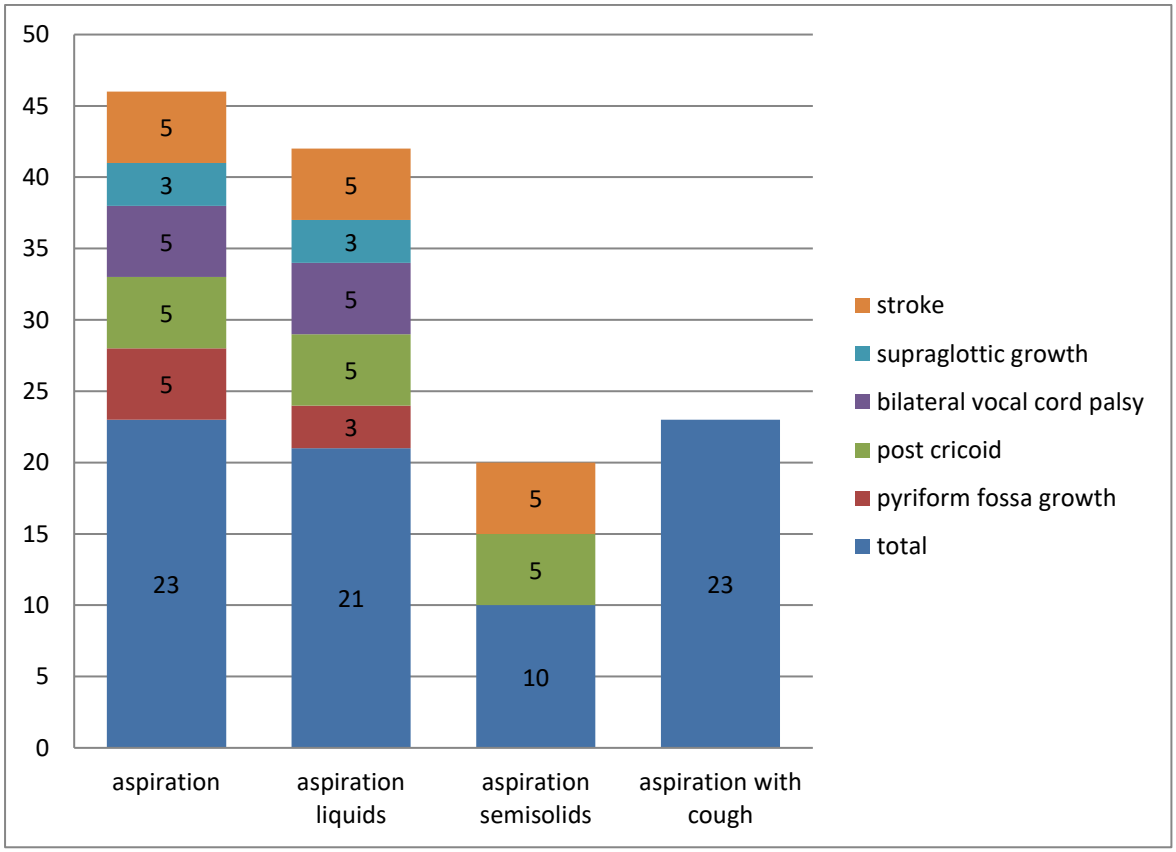
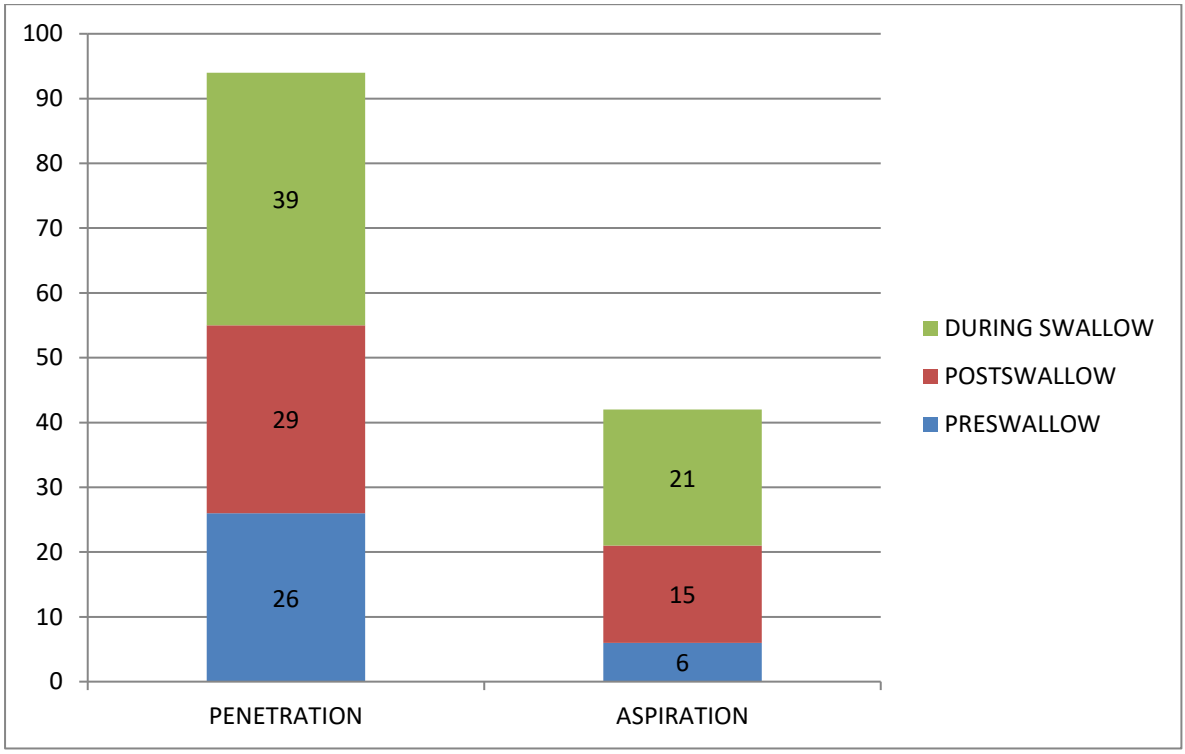


Figure 28: Timing of Aspiration and Penetration



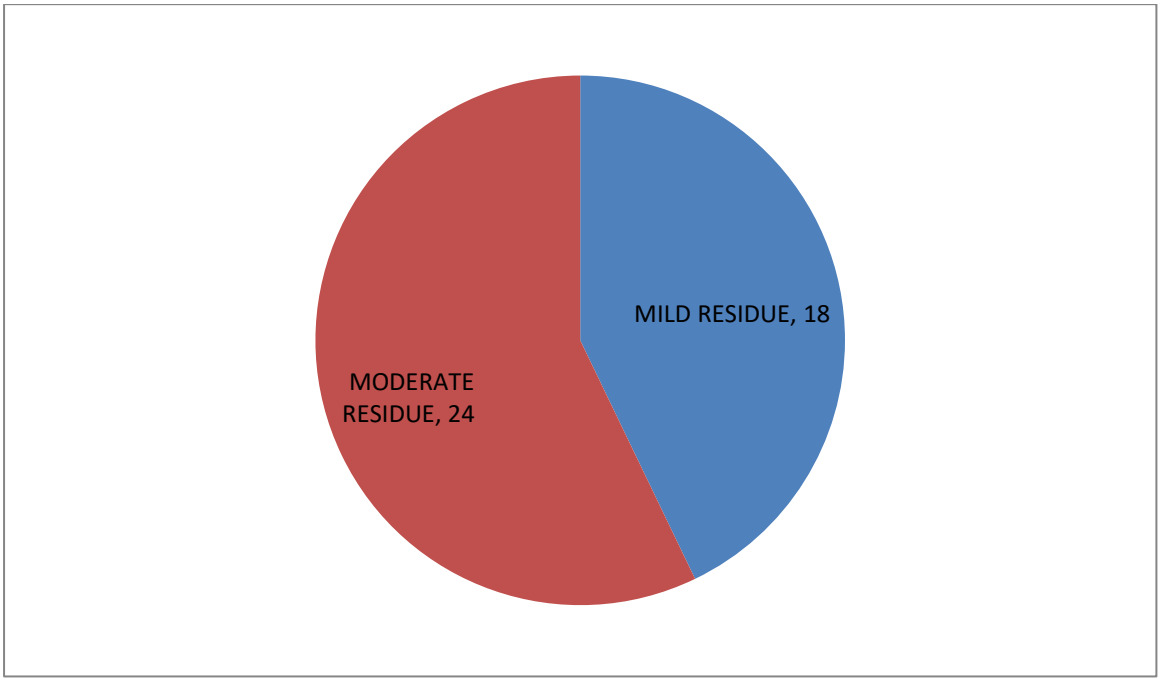
RESIDUE

Among the total patients with dysphagia 42(79.2%) had residue whereas no residue was seen in 11(20.8%) patients. Among those with residue, it was mild in 18 of them and 24 patients had moderate amount of residue.

Table 15: Residue

	yes	no
Residue	42(79.2%)	11(20.8%)
Mild	18(42.9%)	-
Moderate	24(57%)	-

Figure 29: Residue.



Among the 53 patients with swallowing disorder, Laryngeal sensations where absent in 7 patients. That gives us a result that 86.8 % had a normal laryngeal sensation.

The total patients with swallowing disorder as assessed by FEES was 53. Among these 53 cases, we could suggest swallowing manoeuvres and find improvement in swallow in 30 patients. Thus, we can conclude that 56.7 % of the patients benefited with FEES.

DISCUSSION

The main aim of our study is to analyse, visualize and diagnose the presence of pharyngeal phase swallowing disorder using FEES, in patients presenting with dysphagia. With endoscopy, secretions can be visualized; surface anatomy and mucosal abnormalities visualized directly, and sensation of the oropharynx and hypopharynx can be assessed. Effect of altered anatomy and sensation on the food bolus movement, efficiency of airway protection, glottic closure, bolus clearance, location of bolus within the hypopharynx can all be assessed.

In the study we conducted, 53 patients among the total 78 examined for where found to have pharyngeal phase abnormality with FEES. Remaining 25 patients although they had difficulty in swallowing complaint, no abnormality was found in FEES. Previously, the usual method of diagnosis used for swallowing disorder was modified barium swallow. In previous studies where they compared video fluoroscopy (VFS), fibreoptic endoscopic evaluation of swallowing (FEES) and oro-pharyngo-oesophageal scintigraphy (OPES) with respect to premature spillage, post-swallowing residue and aspiration, both the FEES and the OPES showed good sensitivity with high overall values (≥ 80% and ≥ 90% respectively) in detecting oropharyngeal dysphagia. FEES also gave significant results in the assessment of post-swallowing residues (60). In our study the prevalence of dysphagia was 67.94% as assessed by FEES.

Diagnosis specific findings we observed:

Table 16: FEES findings in different diseases and manoeuvres.

Diagnosis	**FEES Findings**	**Manoeuvre found helpful**
Vallecular mass	Velopharyngeal closure incomplete	
Tongue pathology/mass	Tongue retraction reduced Delay in initiation of oropharyngeal phase	Chin down
Post MRND	Secretions which is penetrated. Leaking present Reduced tongue retraction	Chin down and head tilt Suck swallow action Effortful swallow
Tracheostomy	Hyolaryngeal elevation affected. Airway closure delayed	Mendelsohn manoeuvre
Unilateral vocal cord palsy	Penetration present mainly for liquids Secretions present Cough present	Head rotation towards damaged side Semisolid and solid foods
Bilateral vocal cord palsy	Secretions which are penetrated and aspirated	Supraglottic swallow Super supraglottic swallow

	Sensation (LAR)reduced Pooling present Residue present	Semisolid and solid foods are taken more
Stroke	Reduced pharyngeal contraction Trigger of swallow delayed Tongue movements reduced Penetration and aspiration present Residue present	Lying down on one side to reduce the effect of gravity on the bolus. Head tilt towards stronger side in hemiplegic patients Thermo tactile stimulation Shaker manoeuvre
Parapharyngeal mass	Secretions present there was penetration LAR reduced on the affected side Penetration present, coughing present on aspiration which cleared the bolus.	Supraglottic swallow Suck swallow
Pyriform fossa mass	Pooling with penetration	Head rotation towards damaged side
Post-cricoid mass		Head rotation (it reduces the pressure on the

		cricopharyngeous sphincter by pulling the cricoid cartilage away from the posterior pharyngeal wall. Most of post-cricoid patients needed either ryle's tube or feeding jejunostomy.
GERD As diagnosed by OGD scopy	Pseudosulcus vocalis oedema of laryngeal structures. LPR could be demonstrated and visualized	-
Globus pharyngeus	Normal study	-

In our study, 77.4% had penetration where as 43.4% of the patients had Aspiration. Most patients with impaired superior and recurrent laryngeal nerve function had aspiration as in bilateral vocal cord palsy and a parapharyngeal tumor involving both prestyloid and post styloid compartments. Penetration and Aspiration was seen in malignancy patients with obstruction of either of the pyriform sinuses and postcricoid

obstruction. A patient with postcricoid growth with circumferential obstruction with tracheostomy was found to have food aspirated and coughed and expelled via the tracheostomy tube.

In our study, we could find out the percentage of people with secretions extending to vallecula and pyriform fossa (75%). Tracheostomised patients had ineffective clearance of the secretions. Patients with sensory loss as in stroke were also not aware of the aspiration and most of them were aspirating one's own saliva. We could assess what the patient is in turn doing with the pooled secretions, whether it is aspirated or penetrated there by determining the risk of aspiration.

The amount of the residue (pooling amount) in the hypopharynx was calculated with Farneti pooling-score scale. FEES provides a broader view of anatomical details of pharyngeal and laryngeal surfaces with presence of secretions or bolus residues. It can either be a coating that just moistens the mucosa or can be a residue or pooling.

The Pooling score, P-score was assessed with different parameters:

1) Anatomical site where there is pooling;
2) Amount of pooling, whether it is coating, or if the content is more or less than 50% of the area
3) Management of the residue by the patient.

This also takes into account the consistency and volume of the bolus (18).

Oropharyngeal pathology can cause aspiration in many ways. Tongue movement pathology while chewing, affects the oral swallow phase. This was seen in patients with tongue base pathology and those with neurological deficits as in stroke and in

patients with Parkinson's in our study. This causes the food to fall into the pharynx and into larynx before the swallowing starts. Such patients are prone for aspiration.

Delayed triggering of the pharyngeal swallow causes food to fall into larynx as the airway is still open as seen in stroke patients and those with bilateral cord palsy with superior laryngeal nerve involvement and those with pharyngeal plexus involvement.

Stagnation of food in the pharynx due to reduced peristalsis (unilateral or bilateral) causes residue in the pharynx after the swallow, which can get aspirated. In our study, residue was seen in 42 patients (79.2%). It was seen in patients with post-cricoid growth with circumferential obstruction and those with stroke, pharyngeal plexus involvement and reduced pharyngeal peristalsis.

Reduced laryngeal elevation causes food to lodge at the top of the larynx which is aspirated during the inhalation after the swallow. Reduced laryngeal closure also can cause aspiration during the pharyngeal swallow. Both these were seen in tracheostomised patients in our study. This could be improved to a certain extent by the Mendelsohn manoeuvre,

Cricopharyngeal dysfunction causes residue in the pyriform fossa, with aspiration after the swallow. Food refluxed from esophagus back into the pharynx can also cause aspiration. The reflux of food was directly visualized by FEES in cases of LPR and distal esophageal obstruction.

References show that up to 45 percent of the general population have mild, intermittent symptoms resembling globus at some time in their lives and peak incidence was middle age (58). In our study among the 78 with dysphagia,14 of them

had globus i.e. prevalence was 17.9%. We also found that there was no impairment of pharyngeal phase of swallowing in patients with globus pharyngeus. Among the 14 patients with globus, there were 10 females and 4 male patients.

In previous studies it was said that accurate and in-depth evaluation of oral-pharyngeal and esophageal swallowing anatomy and physiology is needed in successful re-establishment of oral nutrition in patients with swallowing disorder (61). We found that the same can be achieved with FEES.

All the patients were taught swallowing manoeuvres depending on the type of problem. It included all the non-direct interventional aspects like:

1. Education of both patient and family.
2. Cooperation and collaboration with family members
3. Modifying the eating environment.
4. Teaching swallowing and bolus behaviours.

Equally important is the timing of swallowing rehabilitation. Early decisions regarding nutrition and support have to be taken for people undergoing treatment for head and neck cancer chemotherapy or radiotherapy. Especially patients with circumferential obstruction of the upper GI tract require a feeding jejunostomy or PEG. Also, patients with evidence of aspiration not improving by manoeuvres or food bolus alteration are advised nasogastric tube feeding.

All these can be directly visualised by the endoscope and an effective improvement given.

SAFETY OF FEES:

In our study none of the patients had any adverse effects or complications like epistaxis or laryngeal spasm. There are many studies like those by aviv et al(did 1340 consecutive examinations and found out that FEES is an effective and safe procedure for sensory and motor assessment of dysphagia(50)) and Wu et al (compared FEES with video fluoroscopy(62) showing FEES to be a safe and effective procedure.

In our study among the 25 patients with normal FEES findings,3 patients with globus and 1 patient with GERD as provisional diagnosis was above 65 years of age and can be considered to be included in the subset for diagnosis of presbyphagia. This can be due to sarcopenia and can be confirmed only by measuring lingual isometric and swallowing pressures. Such patients if confirmed via manometry can be advised tongue elevation exercises and re-evaluated for improvement with FEES.

Advantages of FEES that we observed:

- Direct visualization of the oropharyngeal phase of swallowing
- Surface anatomy within the nasopharynx, oropharynx, and hypopharynx viewed
- Investigates motor and sensory (FEEST) component of swallowing.
- presence and efficacy of the coughing reflex
- Non-invasive: Easy to perform.
- Immediate results including dietary recommendations.
- can be used as a biofeedback tool in therapy
- No radiation exposure with FEES

- No unpleasant barium-tainted foods and no cause for patient constipation
- FEES can be used with patients on mechanical ventilation
- FEES can be performed easily on morbidly obese patients
- FEES can be utilized in both inpatient and outpatient for patient intubation

LIMITATIONS

- No view for evaluation of bolus management in the oral cavity.
- Loss of view (whiteout) during the swallow due to pharyngeal constriction around the endoscope lens.
- Upper esophageal sphincter (UES) opening is not visualized and the esophageal phase of swallowing is not assessed in the FEES examination.
- Quantitative measures of structure displacement are not possible.
- Limited ability to estimate quantitative amount of aspirated material.
- Certain suspected FEES findings like presbyphagia needs further evaluations with Manometry.

So, we can conclude that FEES is not only a screening procedure, but we can get a complete assessment of pharyngeal phase of swallowing and also aid in therapeutic interventions.

CONCLUSION

FEES is an efficient examination and therapeutic tool. Swallowing is a complex act even though done effortlessly by normal population.

We were able to visualize the pharyngeal and laryngeal structures and diagnose problems involved in swallowing. It has proved to be a useful, reliable, cost-effective, and efficient procedure for diagnosing, categorizing and treating dysphagia.

We could categorize the randomly selected 78 patients based on the FEES findings. With the help of FEES, we can identify the level of disorder whether neurological or mechanical, whether the patient can continue to take food per orally, without any complication and whether the patient can be cut down or modified on the type of food (liquid, solid, semisolid) swallowed.

The ability of patients to improve with swallowing exercises and their compliance can be assessed. Patient himself and the family member can be shown the video of the examination, problems explained and educated. Multiple FEES examinations in a single patient can be done to see the improvement with exercises or treatment as FEES does not involve exposing the patient to any harmful radiations or drugs and is an office procedure.

Research is to be continued to the next level. Standardization of the FEES protocol and reliability testing are all part of it. This has opened the doors to an exciting field of research, clinical examination and treatment.

Annexure - I

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