

The Instrumental Gold Standard: Fees

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ABSTRACT

An instrumental examination of swallowing, has to provide a direct visualization of the effectors, furnishing information on their functional status: all in real-time that is, sometimes, just a few seconds. The real time evaluation of the afferent and efferent components of the pharyngeal reflex (sensation and motility, respectively) are equally important. In relation to its complexity, an instrumental examination that gives the clinician comprehensive information on the entire swallowing act, does not exist. The endoscopic examination of swallowing brings light inside dark cavities, allowing a detailed view of the surface anatomy of the effectors and their functioning during the passage of material other than air, which usually contains (bolus, ascending and descending secretions, gastric content, drugs, foreign bodies). Compared with a dynamic radiological study of swallowing, the endoscopic technique has structural limitations. In the following chapter, these limits will be discussed as well as, in the light of the instrumentation available today, how they can be overcome, getting information useful for diagnostic purposes but especially in the planning of therapy.

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Key words: Instrumental examination; FEES; O-FEES; Endoscopy; Fluoroscopy; VFSS; MBS

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INTRODUCTION

Searching for the instrumental gold standard in the study of swallowing disorders is like following the song of the “Sirens”. This could be so even if this problem is just being discussed. The Sirens’ song may beguile us and distract us from the correct path. For years, “the gold standard” has been an object of fascination in our research and in our work. But behind the enchantment, there remains the pressing need in our work to manage patients with extremely diverse swallowing disorders, patients with different etiologies and comorbidities, linked only by a very complex, fast developing, not to say dangerous disorder.

To date, the endoscopic evaluation of swallowing has been placed alongside many other instrumental investigations^[1] providing the whole team with useful information for the management of the patient, information which can be integrated with that provided by the setting, by the carers, by the bedside evaluation but, above all, by the patients themselves.

This must direct our efforts into formulating parameters able to quantify the swallowing disorder and to relate it to external events which interfere with the normal existence of the patients and their families^[2]. In fact, if we consider the possible aims of the multi-disciplinary team, it can be stated that the diagnostic definition of a swallowing disorder (that is the identification of the physiopathological impairment) and the evaluation of the criteria of severity (with respect to the possible development of complications) become the main goals in planning treatment. The rapid and flexible exchange of information within the team, makes for a better monitoring of the results of treatment and contributes to reducing the development of complications. Together with provisions regarding the patients’ environment, this also improves the patients’ QOL and the positive perception of the team’s work by the patients and their families^[3].

WHICH TOOL?

The prospect of a complete study of swallowing implies the possibility of being able to break down the succession of events which characterise it, identifying for each of them, morphology, neuro-motor activities, pressure and sensation. This in turn leads to quantifying the muscular activity, pressure regimens and temporal

events which determine false paths and residues.

It is obvious that an instrumental examination, which alone provides all this information, does not exist^[4]. So it is necessary to break down the swallowing “continuum” into theoretical phases and to evaluate the same event from different perspectives, expressed by objective data, which are not easily replicable by different clinicians or even by the same one^[5]. The data are also influenced by the diversity of the clinical applications of the instrumental method (that is the use of protocols which are difficult to standardise) to patients with extremely variable characteristics.

In this context the search for a gold standard is not only anachronistic but also utopian.

In daily practice, an instrumental procedure is indicated in the face of any suspected dysphagia^[6] or when a definition in differential diagnostic terms of the oro-pharyngeal situation is required^[7,8,9]. An instrumental procedure is also indicated for patients with pathologies which carry a high risk of complications^[10,11] even if they are apparently asymptomatic^[12,13,14] or when there is a discrepancy between the subjective signs and the outcome of a bedside evaluation. Even the clinical onset of dysphagia with complications^[15] makes an instrumental investigation of swallowing necessary.

ENDOSCOPIC EVALUATION: THE METHOD

Over the past three decades, two procedures conducted with the use of flexible endoscopes, have revolutionized the dynamic evaluation of the pharynx and larynx, so as to give the study of swallowing disorders, an indisputable connotation^[16].

The first is FEES (Fiber-optic endoscopic evaluation of swallowing), proposed in 1988 by S. Langmore^[17] and the second is FEESST (Fiberoptic endoscopic evaluation of swallowing with sensory testing) proposed in 1998 by J. Aviv^[18]. Subsequently, various standardized procedures for the dynamic study of swallowing have been proposed^[19,20].

Firstly FEES has been compared and contrasted to VFSS (Video fluoroscopic study of Swallowing) proposed by J. Logemann^[21]. This examination is now considered the instrumental gold standard for the study of swallowing. Compared to VFSS, FEES redeemed itself in terms of sensitivity, specificity and predictive values, if we consider its ability to identify aspiration as the main sensory-motor event linked to dysphagia and the leading cause of airway

complications^[4,22]. Today, the role of VFSS, as the instrumental gold standard, can be questioned. Studies that have compared VFSS and FEES show that both procedures are comparable and have equivalent values of sensitivity, specificity and predictive abilities^[16,23-29]. A more proper approach is to consider these two exams as complementary^[4]: the availability of both, allows the clinician to choose the method most appropriate to each case, relating to the required information. FEES also shows a considerable versatility in the management of the dysphagic patients, of the multidisciplinary team and of the therapeutic process: the fact that it can be performed at the bedside, in any clinical condition, and repeated over time according to changing clinical needs, makes it an optimal method in the follow-up of any patient. Table 1 summarizes the advantages and disadvantages of the two procedures.

ENDOSCOPIC EVALUATION: THE INSTRUMENTATION

Performing FEES requires various complex and expensive instrumentation depending on whether the procedure is performed at the bedside (non responders, critical and non-transportable patients) or in an outpatient setting. Depending on the case, there should be available^[30]:

Flexible fiberoptic naso-pharyngo-laryngoscope: this instrument is available today in a huge variety of models and sizes, with or without operating and suction channels. These endoscopes can reach a length of up to more than 70 cm, with a diameter ranging from 2.4 to 4.5 mm (1.5 mm for pediatric population);

-a light source: halogen up to 250 W or xenon up to 100 W; light sources equipped with a handle, very easily transportable, and stylus light sources, directly connectable to the endoscope, are available;

-camera to be connected to the head of the endoscope

-video-printer

-monitor

-food for bolus tests.

These devices can be assembled in equipped columns, possibly assisted by a computer, which allow for a complete management of the patient's data (database), of the movies and images collected, in addition to the filling in of standardized assessment protocols report sheets, with the main results of the clinical evaluation^[31].

Table 1 Advantages and disadvantages comparison between VFSS and FEES (from 22, modified – with Author's permission).

	ADVANTAGES	DISADVANTAGES
FEES	Less invasive Easy to perform Well tolerated Possible for a long time (fatigue viewing) Portable (acute and sub-acute patients) Routine Economic Therapeutic feed-back Decision making of oral feeding Natural foods Direct visualization of structures Motor and sensory activities Three-dimensional similar view Optimal pooling evaluation Pooling management viewing	Pharyngeal phase only White-out Indirect consideration about - oral - esophageal phase Fear and discomfort Poor vision in repeated swallowing acts Not possible if changes in upper airway
VFSS	Whole deglutition evaluation Time parameterization	Invasive (radiological exposure) Uncomfortable execution Environment and suitable personnel Expensive Bi-dimensional view (under estimation of pooling matter) Motor activity only (reaction to aspiration, if documented) Fatigue evaluation missing

For some years, flexible electronic endoscopes (video-processors) have been commercially available, with a CCD (Charged Coupled Device) or chip, placed distally, capable of transforming a flow of light (photons) into electrical charges which are then captured by the same chip. The image quality provided by these tools is extremely well defined.

ANYTHING NEW?

Compared to the standard procedure of swallowing evaluation, some variations have to be mentioned.

FEESST

FEESST (Fiberoptic endoscopic evaluation of swallowing with sensory testing), already mentioned, was first introduced by J. Aviv^[18] in 1998, with the aim of improving the assessment of sensation in the hypo-pharynx, checking the laryngeal adductor reflex (LAR), induced by pulsed air supplied in the area of innervation of the superior laryngeal nerve. Operatively, an external device connected to the endoscope, conveys pulsed air to the ari-epiglottic folds. The patient is trained to report the perception of minimal air pressure and, at the same time, the clinician verifies the LAR onset. Correlations between the reflex threshold and respiratory complications were documented^[32,33].

The T-EGD

The T-EGD (trans-nasal pharyngo-esophago-gastroduodenoscopy) is a procedure firstly proposed by R. Shaker^[34] in 1994. Originally a clinical study of the esophagus and stomach with a fine instrument, introduced trans-nasally, was carried out as an alternative to the corresponding oral procedure.

With shorter instruments, and where the study of the stomach or duodenum is not required, a trans-nasal examination of the esophagus is possible (Trans-nasal esophagoscopy - TNE). TNE is a procedure which has also been used for many years in the instrumental evaluation of patients with ENT complaints^[35]. In a short time, it became a procedure performed on outpatients, without anesthesia. Several protocols have been proposed^[34,36,37] for patients with bolus or other complaints of gastro-esophageal reflux diseases (GERD). Later the procedure was resumed and was completed to evaluate the behavior of the esophagus during the passage of the bolus. With this goal, the procedure was proposed in Italy by I. Herrmann^[38,39], giving the possibility of a functional and comprehensive assessment of swallowing, potentially up to the duodenum. It takes about 10-15 minutes to conduct TNE, not considering time necessary to perform FEES.

The procedure allows for a perfect viewing of the esophageal wall and its movements, up to the cardias. Incontinence of the lower sphincter and its resistance to the passage of the tip of the endoscope are other important parameters to note. With the tip of the endoscope in a retrograde position, retracting the instrument close to the upper part, a direct back viewing of the upper esophageal sphincter (UES) and its dynamics during different tasks (swallowing, belching, Valsalva) is possible. TNE also permits the evaluation of the role of saliva, bile and gas during swallowing and digestion, aside from testing the effects of reflux on the upper digestive and respiratory tracts. Finally, it allows for the proper placement of catheters before functional pharyngeal or esophageal assessment. TNE has been compared with the conventional esophagoscopy (CE), initially providing conflicting data, with an inferior diagnostic reliability^[40,41,42]. The use of thinner instruments with distal CCD, enabled this gap to be closed, reaching a diagnostic reliability

of 100%, as the EC gold standard, in a sample of 44 patients^[43]. Today TNE is used as a screening procedure on neoplastic and non-neoplastic esophageal pathologies. In a sample of 426 patients, 38% presented findings that have changed the management of the patient (34% erosive esophagitis, 4% Barrett's esophagus). 12 participants reported fewer complications with minimal complaint of choking, gagging, pain, or anxiety^[44].

The O-FEES (oral-FEES)

The O-FEES (oral-FEES) is a variation of the standard procedure, proposed for the study of the oral phase of swallowing, recently developed in our Swallowing Center.

By definition, the oral phase of swallowing cannot be assessed by endoscopy^[17,30]: this is a limitation of the method (Table 1). In endoscopy, information about the oral phase of swallowing can be inferred. We can see the base of tongue movements during preparation and propulsion of the bolus and all the events that occur before swallowing: the bolus entering in the pharynx or premature spillage, with the corresponding site of onset of the swallowing reflex. The FEES ability to assess pre-swallowing events is extremely reliable, when compared with VFSS^[22], with the awareness that fluoroscopy is ideal for oral preparation viewing.

In fact, using endoscopes with a reversible tip of 180°, starting from a position intermediate between the high and low (in relation to the anatomy of the patient), it is possible to intercept the soft palate and introduce the tip of the instrument into the oral cavity (anterior position or retrograde position) (Figure 1). From this position, it is

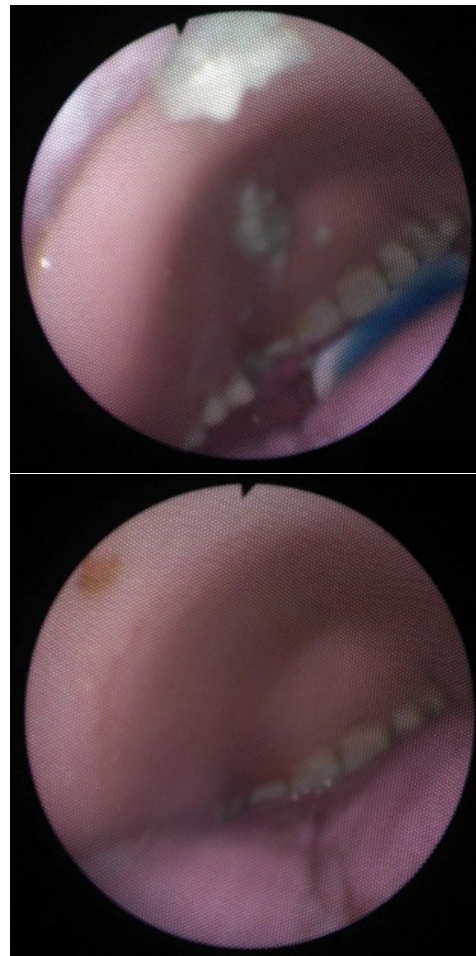


Figure 1 Anterior or retrograde position: the oral cavity is directly visible (all the following photographs have been rotated 180° to obtain viewing equal to the real one and make the images more easily interpretable).

possible to see an inverted image of the oral cavity and its content, up to the teeth and lips, if kept open. With the tip retroflexed and by retracting the endoscope by a few centimeters (anterior posterior position) (Figure 2), the coana with the instrument emerging from the nasal cavity, can be seen. The glosso-palatal port is, thus, visible in a dorsal viewing. Even from the tip in these positions, it is possible to obtain static (anatomical) and dynamic (phono-articulatory) information and test sensation. More information is collected during the bolus tests: bolus preparation (Figure 3) and propulsion (Figure 4) can be checked directly, as well as bolus entering into the pharyngeal cavity.

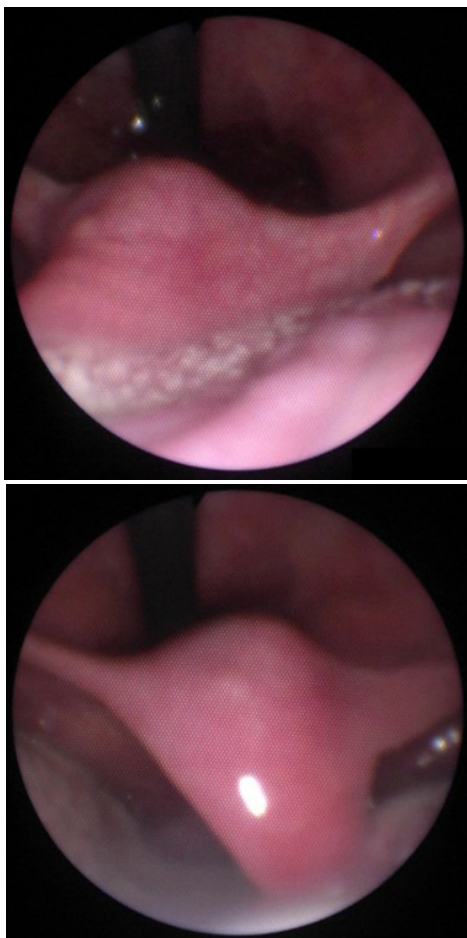


Figure 2 Antero-posterior position: the soft palate is lifted from the base of the tongue or lowered.



Figure 3 Anterior or retrograde position: bolus preparation.



Figure 4 Anterior position: bolus propulsion since the oral whiteout.

Any kind of consistency can be tested, checking oral preparation and propulsion. The passage of the bolus through the fauces is not visible, because of the presence of the white-out, as happens during pharyngeal transit as viewed with the tip in the high position. After the tests with bolus and with the tip in the anterior position, the presence and location of residue (on the hard palate, gums, alveoli, tongue) can be verified.

Spontaneous or requested tasks, performed to clear the material pooling, can also be verified, especially their effectiveness (Figure 5). The subjective perception of residue gives the clinician indirect information on sensation. These positions of the tip are otherwise tolerated by the patients, with good acceptance and unchanged ability to carry out tests with bolus or causing an increase in spontaneous swallowing acts. Sometimes gagging or excessive anxiety of the

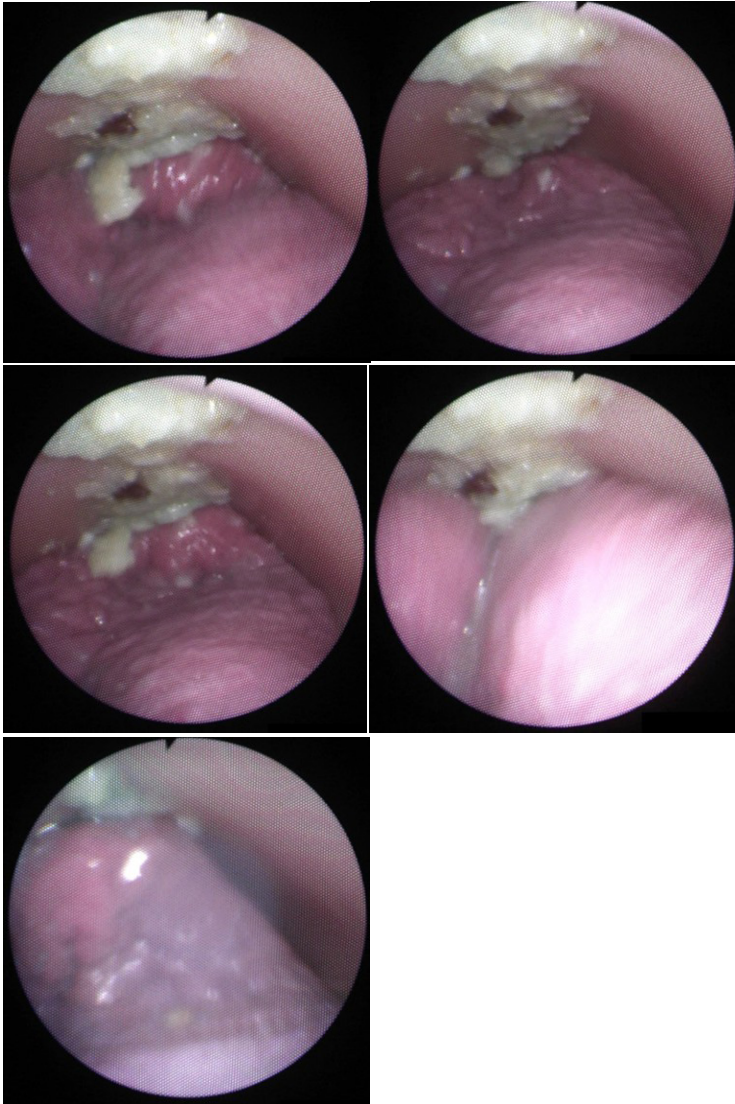


Figure 5 Anterior position: tongue clearing of material coating the oral cavity.

patient oblige the clinician to stop the assessment.

It takes about 10-15 minutes to conduct the procedure in all its parts, not considering time necessary to perform FEES.

In our department O-FEES has been in use for some years in selected patients with swallowing disorders of different etiology: regardless of the possible cause of dysphagia any condition suspicious of a preeminent involvement of the oral phase of swallowing is eligible for O-FEES. Precious information comes from viewing preparation and propulsion of the bolus, verifying the motor activities of anterior and posterior tongue in such activities. The evaluation of material pooling, before or after swallowing (residue), is another very important piece of information, similarly to the evaluation of the patient's reaction to residues, but mainly the efficiency of the motor strategies used to clear them. All these activities are now directly visible.

In our experience O-FEES has proved to be useful with any kind of patients. With HN patients O-FEES allows the clinician to verify the efficiency of oral effectors of swallowing, surgically amputated, in sealing cavities up and creating inside them pressure gradients, as during the previously mentioned motor tasks. No less important is the possibility to evaluate their sensation. Likewise in patients with any neurological pathology, O-FEES gives information about motor abilities of oral swallowing effectors: force, tone, speed, precision,

sequentiality in praxis schemes, resistance and reflexivity can be well described. All these activities are basic in expressing the motion control exerted by the central nervous system. Similarly O-FEES gives information about tiredness, the main clinical manifestation of any motor impairment. During the tests with bolus this condition becomes overt: early, during the endoscopic evaluation, secretions and bolus residues tend to increase, in parallel with a decrease in the motor response induced by them.

This parameter, for the pharyngeal phase of swallowing, is considered, for example, in the P-score^[5], mentioned later: similar considerations for the oral phase of swallowing could now be made. The possibility of including the O-FEES findings in existing standardized protocols of evaluation is conceivable and desirable (Table 3). Further research is being undertaken to check the effectiveness of the O-FEES procedure in neurological patients.

As previously explained O-FEES is performed with the tip of the endoscope introduced backward in the oral cavity, entering through the fauces instead of through the lips. So the term "retrograde oral FEES" should be more suitable to define this new approach, although the term oral FEES sounds more easily accessible.

ENDOSCOPIC EVALUATION: THE PROCEDURE

Endoscopic evaluation, with the instruments previously described, can be used with patients from different age groups and settings. Every patient, on the basis of his/her individual characteristics, can undergo the investigation, according to technical and methodological variations, which make for a closer adaptation of the method to the individual patient's situation. With these presuppositions, the information obtained permits an optimum diagnostic definition of the patient, and allows the clinician to furnish the team, and in particular those concerned with the rehabilitation, essential information to set up a treatment plan^[3].

In performing the evaluation, pre-defined protocols^[22,30] or personalised schemes can be used. It is, in any case, essential that our observations concentrate on the behaviour of the effectors during the swallowing process, under different conditions: (1) while at rest: to assess the anatomical details of the areas passed through by the endoscope; (2) during respiration, swallowing and speaking: to evaluate the bio-mechanical response to the effectors in these normal conditions of activity; (3) during the passage of the bolus: to evaluate the bio-mechanical response to the effectors in these unusual conditions of activity, with diverse volumes and consistencies of the bolus; (4) while performing postures and manoeuvres: to verify their protective efficiency (therapeutic utility).

Table 2 shows the principal parameters of evaluation.

THE STATIC ASSESSMENT

The preliminary morphological assessment is important. Some basic anatomical features could modify the physiology in such a way as to create pre-conditions for danger during the passage of the bolus. These conditions can be verified as a precaution, with the aim of interpreting in a correct way the swallowing neuro-motor patterns and the outcome of the tests with bolus.

For example (Figure 6): (1) the position at rest of the epiglottis (more or less raised), affects the volume of the valleculae predisposing to anterior episodes of penetration; (2) the position at rest of the arytenoids (more or less forward) conditions the volume of retro-cricoid space, predisposing to posterior episodes of penetration; (3)

Table 2 Main parameters of anatomical and functional assessment.

SITE	Morphological evaluation	Functional evaluation	Motor activities	Pooling - dry swallows	Sensation
(1) Epi-pharynx (soft palate)	Tumor Ulcer Erythema	Symmetry	(1) velo-pharyngeal closure	Site	Reaction to the endoscope
(2) Meso-pharynx (tongue base)	Morphological defects	Reduced speed of movement	(2) Base tongue retraction	Color	Reaction to light touch of structures
(3) Hypo-pharynx (larynx)	Hypertrophy	Reduced range of movement	(3) Pharyngeal movements	Viscosity	
	Hypotrophy	Altered coordination	(4) True vocal cords movements	Awareness	
	Atrophy		(5) Sphincter activity	Patient reaction	
	Asymmetry			Dry swallow frequency	
	Pathological events at rest				

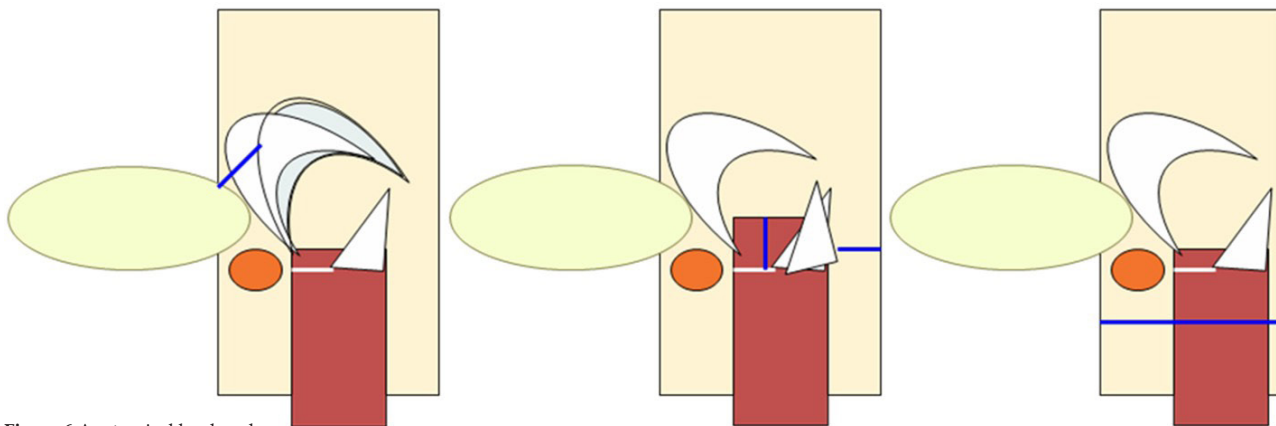


Figure 6 Anatomical landmarks.

the height of the aryepiglottic folds conditions the volume of the pyriform sinuses, predisposing to lateral episodes of penetration (overflowing); (4) finally the diameters of the hypo-pharynx (anterior-posterior and traverse) in relation to the dimension of the larynx, condition the volume of the hypo-pharynx, and in general the maximum volume through which the bolus passes.

Ultimately, it has to be considered that the anatomy influences the function.

The static assessment must consider material pooling wherever present: in the nasal-rhino-pharyngeal container and in the hypo-pharyngeal and laryngeal containment cavities. Increased secretions (due to local inflammation or foreign bodies) or reduced clearing (reduced dry swallowing, reduced opening of the upper oesophagus sphincters, reduced contraction efficiency of the pharynx) may be the cause. The presence of endo-laryngeal secretions is an alarming clinical sign, predisposing to aspiration and bronco-pulmonary infection^[45,46,47]. The observation of the number of dry swallowing acts, needed to clear accumulated secretions, is another important parameter to evaluate, considering the interference induced by the endoscope and other devices (SNG)^[48,49,50]. The possibility to clear secretions with small sips of water, should also be verified.

THE FUNCTIONAL ASSESSMENT DEVELOPMENT

The observation of the motor activity of the effectors is another important parameter to assess. For every movement, symmetry, range (amplitude), speed, precision, coordination and diadococinesis should be noted. The purpose of this assessment is to determine whether the movement of the structures can support swallowing. These same parameters will even affect the biomechanical valving events (velo-pharynx, larynx, UES) which regulate the timing and the direction of the bolus through the pharynx. The comprehensive assessment of these performances of the effectors, and particularly the presence of incomplete or reduced movements, with a sluggish onset or imprecise

motorial sequences, allow the clinician to advance hypotheses about the subsequent swallowing act.

In the nasal-rhino-pharyngeal position, the activity of the velum will be assessed: this evaluation is needed in any case of voice nasalisation or dysarthria, to verify an adequate closure of the rhino-pharynx.

In the high position, we assess the activity of the base of the tongue and whether there is adequate retraction towards the posterior wall of the pharynx (speech tasks), and the contraction of the pharynx, performing the pharyngeal squeeze manoeuvre^[51]. The procedure is simple: the patient is asked to sustain a forceful “e” evaluating the medialization of the pharyngeal wall. This simple procedure has been evaluated in its reliability^[52] and validated^[53].

In the low position, we assess the laryngeal activity during respiration (sagittal movements), phonation-speech tasks (adequate glottic and supra-glottic closure, arytenoids gliding) and airway protection (cough, breath holding).

In the anterior and antero-posterior position (tip retrograde), it is possible to directly observe the oral cavity and its content, up to the teeth and lips, and the glosso-palatal port in a dorsal viewing, respectively. Movement abilities and articulatory skills can be seen.

In the deep position, the endoscope is introduced into the lumen of the esophagus, with a direct viewing of the walls and their peristaltic movements. The esophago-gastric junction and, with the tip in a retrograde position, the pharyngo-esophageal junction are also directly visible. The behaviour of these sphincters during the passage of the endoscope (hypertonia or hypotonia) or under particular tasks (swallowing, belching, Valsalva) can be tested.

Endoscopy allows the clinician to test sensation. This is the most important advantage of the tool, compared to fluoroscopy. Sensation has to be recorded in all the areas passed through by the endoscope: the evaluation of defensive reaction of the patient to the endoscope and to the light touch of the base of the tongue, of the pharyngeal walls, of the epiglottis and, with great attention, of the false and true vocal cords, are foreseen by the procedure.

During the examination, the perception of secretions or bolus pooling, has to be verified.

Table 3 The main steps of anatomo-functional evaluation.

	Static evaluation	Dynamic evaluation	Sensation
Endoscope position			
NASAL-RHINOPHARYNGEAL (naso-rhino-pharynx)	Morphology of: - Nasal cavities - rhinopharynx - pathological muscular activities Pooling site: . nasal cavities . rhinopharynx . tubal ostium	Speech Velo-pharyngeal sphincter: - Velum deviation - Gap of closure - /s/ forced Deglutition - nasal regurgitation	General of the area: - reaction to the endoscope - reaction to light touch of structures Pooling - perception - cleaning efforts - cleaning effectiveness
HIGH (meso-pharynx)	Morphology of: - base of tongue - pharyngeal wall - pathological muscular activities Pooling site: . valleculae . pyriform synus . post-pharyngeal wall . retro-cricoidal space	Speech - base of tongue: retraction . /l/ ball . /k/ cocco - Pharyngeal wall deviation: . /e/ strained . /e/ repeated Deglutition (dry swallowing) - Base of tongue movements	General of the area: - reaction to the endoscope - reaction to light touch of structures - gag reflex (base of tongue) Pooling - perception - cleaning efforts - cleaning effectiveness
ANTERIOR (retrograde) (oral cavity)	Morphology of: - tip, medium and base of tongue - hard palate and gums/teeth - lips Pooling site: . hard palate tongue: tip, medium, base	- Pharyngeal movements Speech - tongue movements: . /ka/ repeated - lips movements: . /pa/ repeated Deglutition (dry swallowing) - medium, base of tongue movements	General of the area: - reaction to the endoscope - reaction to light touch of structures - gag reflex (tongue) Pooling - perception - cleaning efforts - cleaning effectiveness
ANTERIOR POSTERIOR (oral cavity)	Morphology of: - base of tongue - soft palate (superior face) - glosso-palatal seal - coana Pooling site: . hard palate tongue: body, base	Speech - tongue movements: . ka/ repeated - palate movements . /ma/ repeated Deglutition (dry swallowing) - tongue movements - palate movements - pharyngeal movements	General of the area: - reaction to the endoscope - reaction to light touch of structures - gag reflex (tongue) Pooling - perception - cleaning efforts - cleaning effectiveness
LOW (hypo-pharynx)	Morphology of - hypo-pharynx - larynx during respiration - pathological muscular activities Pooling site: . Sopra-glottic . glottic . sub-glottic . cervical trachea	Speech - Glottic closure: . /a/ strained . /a/ repeated - posterior commissure deviation . /a/ strained . /a/ repeated - glottic opening: . sniff - vocal quality Sphincter activities - True vocal cords closure: /a/ strained (time) - False vocal cord closure: . /a/ forced . glide up /ee/ . Valsalva . cough - epiglottis inversion: . dry swallows Sphincter activities - UES . Valsalva . cough . belching . dry swallows . LES muscular activity - body	General of the area: - reaction to the endoscope - reaction to light touch of: . aryepiglottic folds . arytenoids . true vocal folds . false vocal cords Pooling - perception - cleaning efforts - cleaning effectiveness
DEEP (esophagus)	Morphology of - UES - body - LES		General of the area: - reaction to the endoscope

PERFORMING AN ENDOSCOPIC EVALUATION

The patient is seated (in an armchair or in bed, with the thorax raised to an angle of at least 45 degrees) with the head in a primary position. It is possible to carry out a contact anaesthesia in the nasal cavity or

use a simple decongestant (either with a spray or on a cotton support). Lubricant or anaesthetic gel can also be used (e.g. lidocaine 1%) (22). A good rule is to conduct the examination in the most comfortable way for the patient, to avoid: (1) excessive defensive reactions to the instrument, which could alter the motor activity of the effectors; (2) neuro-vegetative reactions (lacrimation, increased salivation, excessive dry swallowing); (3) complications such as anterior or

posterior epistaxis, laryngeal-spasm, vagal reflex, mucous laceration with cervical subcutaneous emphysema)^[54,55,27,56].

During the procedure, observations and considerations will be made with the endoscope in the nasal-rhinopharyngeal, mesopharyngeal and hypo-pharyngeal position (Table 3).

TESTS WITH BOLUS

The real evaluation of the motor and sensorial potentiality of the effectors necessarily requires that they are placed in contact with food. In order to offer the patient some food, they must be in the condition to accept oral nutrition^[57,58]. In this case, the instrumental evaluation is completed by tests with bolus. If not, tests with only a minimum volume of bolus can reveal the behaviour of the structures and the degree of the impairment of swallowing. In these terms, the endoscopic evaluation can be considered similar to a bedside evaluation, carried to the point of the hypo-pharynx.

As previously said, the patient is seated or in bed, with the thorax raised. After the static and dynamic evaluation, the patient is offered different kinds of food, in increasing amounts, and is instructed to retain the bolus in the oral cavity and to swallow after the clinician's order. The tests start with consistencies and volumes easier to handle by the patient, then moving on toward more difficult consistencies, with ever-increasing volumes. In carrying out the test, standardised protocols can be adhered to^[59] (Table 4) or one can proceed according to previous BSE findings. This latter option places the patient in real conditions of feeding, and allows for the verification of effective difficulty and potentiality of the effectors. If possible, the patient takes the bolus freely and independently, choosing the volume and the manner of oral preparation. These parameters will be verified, together with the time taken, besides noting the eventual positions or posturing, spontaneously used to facilitate the act of swallowing. In the former case, pre-defined foodstuffs of standardised amounts are used.

Table 4 Standardized bolus test.

VOLUMES	CONSISTENCIES
	Natural colors or methylene blue
Ice	Ice chips
< 5 mL	Thin liquid: milk, blueberry juice
5 mL (teaspoon)	Soft liquids: fruit juices, liquid yogurt, creams/purees
10 mL	Semi-solids: banana, boiled potatoes
15 mL (spoon)	Soft solid (requiring mastication): bread, cheese, biscuits, cooked vegetables, minced meat
20 mL	Hard or crisp solids: bread's crust, cracker
From glass	Mixed consistencies: fresh fruits and vegetables
With straw	

As previously said, the main skill in judging the adequacy of swallowing is represented by the bolus passage through the effectors. Endoscopy offers important advantages in this field: it visualises the bolus with considerable sensitivity, clarifying the endo-laryngeal site of that which is identified as residue by fluoroscopy^[22].

The airway invasion (aspiration/penetration) is another crucial parameter to evaluate: any kind of reaction performed by the patient, and its efficacy (clearing of material pooling) as well as its absence or inefficiency, should be verified. The penetration/aspiration scale (PAS) can be used to quantify airway invasion^[60,61].

Table 5 summarizes and shows the main sensory-motor events of swallowing.

Many studies have compared the considerable agreement between the two procedures with respect to the principal findings: aspiration, penetration, spillage, residue^[54,62,63,64,65,66,27].

Table 5 Main sensory motor events of swallowing.

PHASE	SENSORY-MOTOR EVENT
Bolus test: different volumes and consistencies	
ORAL	
Endoscope in high position	
Lingual-palatal sphincter competence	Spillage (premature bolus falling):
Base tongue movements	- bolus flow
Tongue propulsion	- site of pharyngeal reflex onset
Oral transport	- pre-swallow penetration
Total time	- pre-swallow aspiration
PHARYNGEAL	
Endoscope in low position	
Velo-pharyngeal closure	- bolus flow
Vocal cords closure	- site of pharyngeal reflex onset
Laryngeal elevation	- pre/ intra-swallowing penetration
Epiglottic inversion	- pre/ intra-swallowing aspiration
WHITE OUT	
Endoscope in high and then low position	
	Pooling evaluation (site, amount, management):
	- post-swallow penetration
	- post-swallow aspiration
	- awareness
Laryngeal returns low	- dry swallows
Epiglottis returns to rest	- clearing
	- gurgling
	- cough with/without emission residues
	- effective management (larynx-trachea cleaned)

Interesting results have emerged from the simultaneous assessment carried out with endoscopy and fluoroscopy. Rao *et al*^[67] tested 5 consistencies on 11 patients with suspected dysphagia, scoring penetration, aspiration, and pharyngeal residue. The agreement of findings between the two examinations has been evaluated, reporting 97% for aspiration, 90% for penetration and 84% for residue. In some cases, endoscopy detected the event more often.

In 2006, Kelly and coworkers^[68] compared the agreement among 17 raters scoring for residue in 15 patients with dysphagia. The scale was none, coating, mild, moderate, severe. The results show a more severe score from FEES, with a high inter-intra rater reliability ($p < 0.001$). With the same sample similar results for penetration and aspiration were obtained by the same authors^[69]. FEES ratings were overall higher for both consistencies ($p < 0.001$): endoscopy, with the only exception of the PAS score 2 (transient penetration), seems to visualize penetration and aspiration more often than fluoroscopy, although the inter-rater reliability was similar for each procedure (Kappa 0.64-0.67).

These results are apparently in disagreement with the assumption that bolus transit is not viewed in endoscopy because of the white-out. Actually only a few (10%)^[70] episodes of aspiration occur during the passage of the bolus through the pharynx (intra-swallowing aspiration): in these cases, residue below the vocal cords and the reaction of the patient can be viewed. Endoscopy seems to be less sensitive to visualizing material in the trachea: quantifying aspirated material is still a concern today.

Particular attention needs to be paid to material residue and its evaluation. During FEES, with the instrument first in the high position and then in the low position, it is important to define the site of residue (secretions or bolus) as well as the amount and management by the patient. Using these parameters, it is possible to obtain a clinical criterion of severity, which can then be integrated with other parameters of the clinical non-instrumental evaluation (bedside evaluation). The management of material pooling, expressed in terms of implementation and efficiency of reflexive or requested strategies

adopted by the patient to clear them, can be considered in endoscopy: the number of dry swallows, clearing, gurgling and cough will be considered^[71,5]. Table 6 summarizes the clinical-endoscopic criteria to express a criterion of severity of dysphagia using endoscopic parameters (P-score) or other parameters taken from bedside (P-SCA score). The inter-rater and intra-rater reliability of the P-score has been evaluated among 4 expert judges on a sample of 30 short films of 23 patients with swallowing disorders of different etiology (CVA, neurological degenerative, head and neck, GERD). These films, in different random orders, were viewed at time 0, after 24 hours and after 7 days, following a training session about the use of the score. The intra-class correlation coefficient (ICC 3,k) resulted very high for site, amount, management parameters and for P-score total value of the score. The ICC 3,k value realized were respectively: 0.999, 0.997, 1.00 and 0.999^[5]. These first data make possible a clinical use of the P-score in the management of patients with deglutition disorders of different etiology by a multidisciplinary team.

With endoscopes, it is also possible to obtain a direct visualization of the oral phase of swallowing: information that we derive from this evaluation partly overlaps with that which comes from the evaluation with the endoscope in the high position, but other information is specific and comparable to that provided by the radiological assessment. The clinical value of this information and the usefulness in terms of diagnostic considerations and modification of the therapeutic outcomes for our patients, has yet to be determined.

The main data, however, can be synthesized in a topographic extension of the area directly visualized by endoscope. This has led to an increase in the functional diagnostic potential of the endoscopic evaluation of swallowing, towards those that are considered as areas of radiological specificity, that is the oral, esophageal phase of swallowing and interaction between the upper airways and the digestive tract. So, the endoscopic evaluation is now approaching the radiological gold standard. Would it not be right to consider videofluoroscopy as the “standard” rather than the gold standard?

Table 6 Anatomical functional parameters of the Pooling-score (P-score) and Pooling-sensation, collaboration, age score (P-SCA score).

Pooling	Endoscopic landmarks		Bedside parameters		
			Sensation	Collaboration	Age (years)
Site	Vallecule	1			
	Marginal zone	1			
	Pyriiform 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	

IN CONCLUSION

Comparing endoscopy and fluoroscopy as the instrumental gold standard, what final considerations can be made?

Fluoroscopy is considered the instrumental gold standard because of its ability to visualize well the movement of structures during the whole swallowing act, from the mouth to the stomach (Table 1). Considering this target, to date, how can endoscopy be compared to fluoroscopy in a direct visualization of swallowing?

With endoscopes, and in the same setting, we can study the interaction between the upper airways and the upper digestive tract. A direct visualization of the airways is possible from the nasal cavity towards the tracheal carena, passing through the vocal cords or a tracheotomy tube. The behavior of the airways to the passage of air or anything different than air, can be directly visualized collecting information about sensation and motor pathways integrity. After removing a tracheotomy tube, it is possible to directly visualize, with a retrograde position of the tip, material entering the sub-glottis space.

With endoscopes, and in the same setting, we can study the esophageal phase of swallowing, with immediate information on the anatomical and functional status of the esophagus (and possibly of the stomach and duodenum, in relation to the length of the instrument) and of the upper and lower valving activity. Also in this case, the behavior of the esophagus can be compared with the passage of the bolus, with direct information about this interaction.

CONFLICT OF INTERESTS

There are no conflicts of interest with regard to the present study.

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