Assessment of Dysphagia Outcome and Severity Scale when using Fibreoptic Endoscopic Evaluation of Swallowing

Original Article

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ABSTRACT

Background: The dysphagia outcome and severity scale is a simple scale that gives a full picture of the dysphagic manifestations and rehabilitation needed for each patient to avoid the occurrence of aspiration and other complications that can result from dysphagia.

Objective: The aim of this study is to assess the validity of the Dysphagia Outcome and Severity Scale (DOSS) with Fiberoptic Endoscopic Evaluation of Swallowing (FEES) in order to generalize its use as a complementary to Penetration Aspiration Scale (PAS).

Patients and Methods: This study was conducted on 60 adult patients, complaining of dysphagia. All patients fulfilled the Dysphagia Handicap Index-Arabic version (DHI-A) and then were evaluated by Fiberoptic Endoscopic Evaluation of Swallowing (FEES) while using DOSS and PAS to obtain a full picture of their dysphagic manifestations. Comparison and analysis of their results were done using the Statistical Package for Social Sciences (SPSS) version 20.

Results: Correlation between DOSS, PAS, and DHI-A were done. There was a statistically significant negative correlation (*P 0.000*) between DOSS and PAS during fluid, solid, and semisolid intake and total score of DHI-A whereas the correlation between PAS and DHI-A was of positive statistical significance (*P 0.000*).

Conclusion: DOSS can be used effectively with FEES as a complementary to PAS.

Key Words: DHI-A, DOSS, dysphagia, FEES, PAS.

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INTRODUCTION

Dysphagia is the difficulty in swallowing safely and/or effectively[1]. It is a symptom rather than a disease and is common among patients immediately post-stroke, with a prevalence rate between 19% to 81%. Unfortunately, 81% of patients with initial dysphagia will establish persistent dysphagia over a period of 6 months. Moreover, 80% of patients with motor neuron disease, 68% of patients with dementia, 50% of patients with head and neck cancer in addition to 27% of patients with Chronic Obstructive Pulmonary Disease (COPD) suffer from dysphagia[2-3-4-5].

A variety of clinical and instrumental diagnostic techniques are used for diagnosis and follow-up of dysphagic patients[6].

Videofluoroscopic Swallow Study (VFSS) and Fiberoptic Endoscopic Evaluation of Swallowing (FEES) are the most frequently used tools for the assessment of dysphagia[7].

Despite the ensured effectiveness of VFSS in assessing swallowing physiology and breakdown, its use is limited because of the radiation hazards, medical instability of patients, and liability to GIT blockage by barium[8].

Fiberoptic endoscopic evaluation of swallowing (FEES) has the privilege of being a bedside assessment tool, that can also be used with patients at high risk of aspiration (unsafe for food trials) or patients who cannot undergo videofluoroscopy (due to immobility, hazard of radiation exposure, or medical instability). It can also be used for repeated follow-up and for rehabilitation of patients using postures, strategies, and maneuvers[9-10].

Penetration Aspiration Scale (PAS) is the traditional scale used to assess the severity of penetration and aspiration when using FEES. It is an eight-point scale that ranges between safe swallowing (score 1) and silent aspiration (score 8) depending on the level of the material that entered the airway and the ability of the patient to expel it or not[11].

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On the other hand, Dysphagia Outcome and Severity Scale is a seven-point scale developed to systematically rate the functional severity of dysphagia, based on an objective assessment to make recommendations for diet level, independence level, and type of nutrition[12].

There are 7 levels of DOSS that give a full picture of the dysphagic symptoms and guide for rehabilitation needed for each patient. It ranges between normal swallowing (level 7) to severe dysphagia (level 1) depending on the degree of oral and or pharyngeal stage of retention, the clearance of oral and or pharyngeal stage of retention, penetration, and aspiration[12].

DOSS was initially used in VFSS to assign a severity level, independence level, and nutritional level based on three areas most associated with final recommendations: oral stage bolus transfer, pharyngeal stage retention, and airway protection[12].

The Arabic version of the Dysphagia Handicap Index (DHI-A) is a 25-item self-administered questionnaire. It is a noninvasive tool for measuring the handicapping effect of dysphagia on the physical, functional, and emotional aspects of people's lives, for each question, three answers are considered (never, sometimes, and always) that are scored (0, 2, and 4 respectively). After completing the test by the patients, subjects are asked to measure the severity of dysphagia by a 7-point equal-appearing interval scale. On this scale, number 1 represents no problems, number 7 represents a serious one, and number 4 shows moderate dysphagia[13].

The aim of this study is to assess the validity of the Dysphagia Outcome and Severity Scale (DOSS) with Fiberoptic Endoscopic Evaluation of Swallowing in order to generalize its use as a complementary to PAS.

PATIENTS AND METHODS:

This study is an analytical cross-sectional study that was carried out on 60 adults aged more than 18 years after obtaining informed consent, who attended the phoniatric outpatient clinic complaining of dysphagia in Kasr Al Aini (Cairo) and Al-Azhar University hospitals in the period from May 2020 to May 2021. The study was approved by the institutional research ethics committee in May 2020 with a unique protocol number of md-112-2020 before the experiment was started and that has been conducted in accordance with the principles set forth in the Helsinki Declaration.

Inclusion criteria:

Patients aged above 18 years old, both genders, complaining of dysphagia and other symptoms of feeding/ swallowing disorders (choking or odynophagia), well-oriented and cooperative.

Exclusion criteria:

Patients with receptive or expressive language disorder (as in DHI-A there are some questions depending on the understanding and expression of the patient's feelings toward their problem) and patients with anatomical abnormalities hindering the performance of flexible nasofibroscopy were excluded from the study.

Subjects under the study underwent the following protocol:

1. Patient interview and full history taking general and neurological examination. Oral examination was done including examination of the muscles of the face, jaw, tongue, palate, and pharynx as well as their relation to the responsible cranial nerves.

2. Dysphagia Handicap index (DHI-A) was used to get an overall view of dysphagic manifestation.

3. Instrumental assessment of swallowing using Fiberoptic Endoscopic Evaluation of Swallowing (FEES).

Fiberoptic Endoscopic Evaluation of Swallowing (FEES) was carried over two steps in two positions. The 1st step is a non-feeding swallow to assess the anatomy and physiology of the selected structures and the ability of subject to swallow their own saliva. The 2nd step is to swallow different food textures to assess swallowing function).

The two positions are:

• Pre-swallow position: With the scope in the nasopharynx, so that the velopharyngeal port is viewed adequately. Then, the tip of the endoscope is advanced to a position between the soft palate and the tip of the epiglottis where the base of the tongue, valleculae, larynx, and both pyriform sinuses can be visualized, this “home position” allows for visualization of bolus transit prior to swallow initiation.

• Post-swallow position: Following the swallow, the Phoniatrician advances the endoscope into the laryngeal vestibule to visualize the larynx, subglottic, and anterior tracheal wall. The post-swallow position allows detection of any laryngeal penetration and/or aspiration, following this close inspection, the endoscope is retracted to the pre-swallow position to detect residue and prepare for the next bolus.

The 3 food consistencies were thin liquids (water), semisolid (yogurt), and solid (cookie). All the food and liquid consistencies were mixed with a food coloring powder (green or blue powdered dye) to be easily tracked during the examination. The assessment proceeded from the easiest consistency for the patient according to history

and moved to harder ones, the amount and number of trials given per bolus ranged from one small teaspoon (one trial) to 3 small teaspoons (3 trials) which increased gradually according to the patient's response.

4. Analysis of FEES findings using Penetration Aspiration Scale (PAS) and Dysphagia Outcome and Severity Scale (DOSS) followed by comparison between the scores of PAS and the scores of DOSS, comparison between the scores of DOSS and the results of DHI-A and correlation between all the performed parameter (DOSS-PAS-DHI-A).

Comparison and correlation between the scores of PAS, DOSS, and DHI-A were done.

The Statistical Package for Social Sciences (SPSS) version 20 was used for data entry and analysis to assess the diagnostic value of DOSS in relation to PAS fluid and PAS solid, The Receiver Operating Characteristics (ROC) curve was done.

P-value was taken at a pre-determined threshold probability with a significance level of 0.005 and a confidence limit of 95%.

RESULTS:

To assess the significance of the observed differences between groups, the following statistical significance tests were used:

• **Pearson's Chi-square Test** for independence was used for qualitative categorical data,

• **The Independent Student's t-test** was used for the differences between means of two continuous variables of unpaired groups.

• **ANOVA test** was used for the differences between means of three continuous variables.

• **Pearson correlation coefficient** was used to measure the correlation between selected scores.

To assess the diagnostic value of DOSS in relation to PAS fluid and PAS solid, the Receiver Operating Characteristics (ROC) curve was used.

• ROC curve is a graphical representation to assess the accuracy of a test that plots sensitivity against 1-specificity for all threshold levels

• ROC analysis is used to quantify how accurately DOSS can discriminate between diseased (have swallowing disorders) and healthy persons. It determines the best cut-off values that would give the highest sensitivity and specificity for DOSS- scores in comparison to PAS diagnosis.

• Area Under Curve (AUC) used to quantify the diagnostic accuracy of DOSS.

Data are classified into:

1. Descriptive data

2. Comparative data

3. Diagnostic data

1- Descriptive data

Table 1: Age and sex of the studied participants

Statistics Variable	Mean ± SD (N=60)	Range (Minimum-Maximum)
Age (Years):	53.42±9.85	61 (20-81)
Sex:	Number (N=60)	%
• Males	28	46.7
• Females	32	53.3

This table shows that there are 28 (46.7%) male patients, and 32 (53.3%) female patients, The mean age of patients ± SD was 53.42±9.85 and the range of their age was 20-81.

Table 2: Distribution of patients according to levels of Dysphagia Outcome and Severity Scale (DOSS).

	Number (N=60)	%
Level 1	6	10.0
Level 2	3	5.0
Level 3	7	11.7
Level 4	7	11.7
Level 5	12	20.0
Level 6	16	26.7
Level 7	9	15.0

(Table 11) This table shows the distribution of patients in each level of DOSS. For example: the number of patients in level 1 was 6 (10%).

Table 3: Distribution of patients according to the domains of Dysphagia Outcome and Severity Scale (DOSS)

DOSS domains	Number	%
Degree of oral stage retention		
➢ Normal	9	15.0
➢ Mild	35	58.3
➢ Moderate	7	11.7
➢ Severe	9	15.0
Clearance of oral stage retention		
➢ Normal	9	15.0
➢ Cleared spontaneously	28	46.7
➢ Cleared with cue	14	23.3
➢ Unable to clear and need multiple cue	3	5.0
➢ Unable to clear	6	10.0
Degree of pharyngeal stage retention		
➢ Normal	9	15.0
➢ Mild	35	58.3
➢ Moderate	7	11.7
➢ Severe	9	15.0
Clearance of oral stage retention		
➢ Normal	9	15.0
➢ Cleared spontaneously	28	46.7
➢ Cleared with cue	14	23.3
➢ Unable to clear and need multiple cue	3	5.0
➢ Unable to clear	6	10.0
Penetration		
➢ Negative	25	41.7
➢ Positive	35	58.3
Aspiration		
➢ Negative	25	41.7
➢ Positive	29	48.3
➢ Silent	6	10.0
Volitional cough		
➢ Present (positive)	51	85.0
➢ Weak	3	5.0
➢ Absent (negative)	6	10.0
Reflexive cough		
➢ Present (positive)	37	61.7
➢ Weak	14	23.3
➢ Absent (negative)	9	15.0
Ways of nutrition		
➢ Normal diet	25	41.7
➢ Modified diet	26	43.3
➢ Partial Per Oral (PO)	3	5.0
➢ Nothing Per Oral (NPO)	6	10.0
Degree of assistance or supervision		
➢ Independent	25	41.7
➢ Distant	12	20.0
➢ Intermittent	7	11.7
➢ Total	7	11.7
➢ Maximum	3	5.0
➢ NPO	6	10.0

This table shows the distribution of patients according to the domains of Dysphagia Outcome and Severity Scale (DOSS). For example, regarding the degree of oral stage retention 9 patients (15%) were normal, 35 patients (58.3%) had a mild degree, 7 patients (11.7%) had a moderate degree and 9 patients (15%) had a severe degree.

Table 4: Distribution of patients according to the scores of the Penetration Aspiration Scale (PAS) during fluid, solid, and semisolid intake

	PAS Fluid		PAS solid and semisolid	
	Number (N=60)	%	Number (N=60)	%
Score 1	25	41.6	25	41.7
Score 2	2	3.3	2	3.3
Score 3	5	8.3	7	11.7
Score 4	7	11.7	6	10.0
Score 5	9	15.0	7	11.7
Score 6	3	5.0	4	6.7
Score 7	3	5.0	3	5.0
Score 8	6	10.0	6	10.0

This table shows the distribution of patients according to the scores of the Penetration Aspiration Scale (PAS) during fluid, solid, and semisolid intake. For example: regarding the PAS during fluid intake the number of patients who took score 1 was 25 (41.6%).

Table 5: Features of Dysphagia Handicap Index (DHI-A) subscale in the studied participants

DHI scale	Patients scores
Total score	Range: 4-76 Mean ± SD: 34.9±19.4
➢ Physical	Range: 0-22 Mean ± SD: 12.1±6.5
➢ Functional	Range:0-36 Mean ± SD:14.4±8.6
➢ Emotional	Range: 0-26 Mean ± SD: 8.4±6.9
Self-rating scale	
➢ Normal	17 (28.3%)
➢ Moderate	40 (66.7%)
➢ Severe	3 (5%)

This table shows Features of Dysphagia Handicap Index (DHI-A) subscale in the studied participants. For example, the score of patients in the physical domain of DHI ranged between 0-22 (mean 12.1±6.5), In the self-rating scale 17 patients (28.3%) were normal, 40 patients (66.7%) were moderate, and 3 patients (5%) were severe.

Etiology of the population under the study:

37 patients were post-stroke- 7 patients were diabetic- 4 patients were post-traumatic- 4 patients were post thyroidectomy, 2 of them had right vocal folds immobility, other 2 had bilateral vocal folds immobility- 2 patients were post-operative brain tumor-2 patients had right vocal folds immobility- 2 patients have left vocal fold immobility- 1 patient has polyp- 1 patient has phonasthenia

2- Comparative data

Table 6: Association between Dysphagia Outcome and Severity Scale (DOSS) response and Penetration Aspiration Scale (PAS) during fluid, solid, and semisolid intake.

PAS	No problem by PAS		Presence of problem by PAS		Significance test and *P value* (fluid)	Significance test and *P value* (solid and semisolid)
DOSS domains	N=25	%	N=35	%		
Ways of nutrition						
➢ Normal diet	25	100	0	0		
➢ Modified diet	0	0	26	74.2	X^2=60.00 *P=0.000**	X^2=60.00 *P=0.000**
➢ Partial Per Oral (PO)	0	0	3	8.6		
➢ Nothing Per Oral (NPO)	0	0	6	17.1		
The degree of oral and or pharyngeal stage of retention						
➢ Normal	9	36	0	0		
➢ Mild	16	64	19	54.3	X^2=24.26 *P=0.000**	X2=24.26 *P=0.000**
➢ Moderate	0	0	7	20.0		
➢ Severe	0	0	9	25.7		
The clearance of oral and or pharyngeal stage of retention						
➢ Normal	9	36	0	0		
➢ Cleared spontaneously	16	64	12	34.3		
➢ Cleared with cues	0	0	14	40	X^2=31.7 *P=0.000**	X2=31.7 *P=0.000**
➢ Unable to clear and need multiple cues	0	0	3	8.6		
➢ Unable to clear	0	0	6	17.1		
Penetration						
➢ Negative	25	100	0	0	X^2=60.00 *P=0.000**	X2=60.00 *P=0.000**
➢ Positive	0	0	35	100		
Aspiration						
➢ Negative	25	100	0	0		
➢ Positive	0	0	29	82.9	X^2=60.00 P=0.000*	X^2=48.6 P=0.000*
➢ Silent	0	0	6	17.1		
Volitional cough						
➢ Present	25	100	26	74.2		
➢ Weak	0	0	3	8.5	X^2=7.56 *P=0.047**	X2=7.6 *P=0.023**
➢ Absent	0	0	6	17.1		
Reflexive cough						
➢ Present	25	100	12	34.3		
➢ Weak	0	0	14	40.0	X^2=26.64 *P=0.000**	X2=48.6 *P=0.000**
➢ Absent	0	0	9	25.7		

Degree of assistance or supervision						
➢ Independent	25	100	0	0		
➢ Distant	0	0	12	34.3		
➢ Intermittent	0	0	7	20	X^2=60.00 *P=0.000**	X2=60.00 *P=0.000**
➢ Total	0	0	7	20		
➢ Maximum	0	0	3	8.6		
➢ NPO (Nothing Per Oral)	0	0	6	17.1		

*Statistically significant (*P<0.005*)
This table shows that, during fluid intake. There was a highly significant correlation between all the domains of the DOSS and PAS scale (*P value, .000*) except the domain of volitional cough which shows a significant correlation (*P value 0.047*).
Also, there was a highly significant correlation between all the domains of the DOSS and PAS scale (*P value, .000*) except the domain of volitional cough which shows a significant correlation (*P value 0.023*).

Table 7: Association between Dysphagia Outcome and Severity Scale (DOSS) responses and Dysphagia Handicap Index (DHI).

DHI Domains	DHI P	DHI F	DHI E	Total DHI
DOSS domains	Mean±SD	Mean±SD	Mean±SD	Mean±SD
Ways of nutrition				
➢ Normal diet	7.8±5.3	8.6±4.5	4.0±3.6	20.4±10.9
➢ Modified diet	16.7±3.9	18.9±9.0	12.6±6.0	48.2±15.7
➢ Partial PO	14.7±1.2	36.0±0.0	24.6±2.3	75.3±1.2
➢ NPO	7.3±5.7	16.7±5.3	6.7±10.5	30.7±19.0
➢ Significance test and *P value*	F=18.1 *P=0.000**	F=23.9 *P=0.000**	F=20.5 *P=0.000**	F=26.4 *P=0.000**
Degree of oral and or pharyngeal stage of retention				
➢ Normal	8.2±4.8	6.2±4.7	4.2±3.8	18.7±12.1
➢ Mild	12.1±6.3	11.9±4.1	6.7±4.2	30.7±12.9
➢ Moderate	20.0±2.8	25.7±7.3	16.9±1.9	62.6±3.4
➢ Severe	9.7±5.8	23.1±10.5	12.7±12.3	45.6±26.9
➢ Significance test and *P value*	F=6.2 *P=0.001**	F=22.7 *P=0.000**	F=8.7 *P=0.000**	F=13.7 *P=0.000**
Clearance of oral and or pharyngeal stage of retention				
➢ Normal	8.2±4.8	6.2±4.7	4.2±3.8	18.7±12.1
➢ Cleared spontaneously	11.1±6.2	11.4±3.9	6.4±4.1	28.8±12.4
➢ Cleared with cue	18.0±4.6	20.0±8.3	12.6±5.6	50.6±15.5
➢ Unable to clear and need multiple cues	14.7±1.2	36.0±0.0	24.7±2.3	75.3±1.2
➢ Unable to clear	7.3±5.8	16.7±5.3	6.7±10.6	30.7±19.0
➢ Significance test and *P value*	F=6.7 *P=0.001**	F=23.1 *P=0.000**	F=11.8 *P=0.000**	F=15.9 *P=0.000**
Penetration				
➢ Negative	7.8±5.3	8.6±4.5	4.0±3.5	20.4±10.9
➢ Normal	8.2±4.8	6.2±4.7	4.2±3.8	18.7±12.1
➢ Positive	15.1±5.5	18.5±8.4	11.6±7.2	20.4±10.9
➢ Significance test and *P value*	F=26.2 *P=0.001**	F=28.8 *P=0.000**	F=24.1 *P=0.000**	F=39.5 *P=0.000**
Aspiration				
➢ Negative	7.8±5.3	8.7±4.5	4.0±3.4	20.4±10.9
➢ Positive	16.7±3.9	18.9±9.0	12.6±6.0	48.2±15.7
➢ Silent	7.3±5.8	16.7±5.3	6.7±10.6	30.7±15.7
➢ Significance test and *P value*	F=27.1 *P=0.001**	F=14.5 *P=0.000**	F=15.7 *P=0.000**	F=27.7 *P=0.000**

Volitional cough				
➢ Present	12.5±6.5	12.8±7.2	7.7±5.4	32.9±17.4
➢ weak	14.7±1.2	36.0±0.0	24.7±2.3	75.3±1.2
➢ Absent	7.3±5.7	16.7±5.3	6.7±2.3	30.7±19.0
➢ Significance test and *P value*	F=2.0 *P=0.142**	F=15.9 *P=0.000**	F=11.7 *P=0.000**	F=8.7 *P=0.000**
Reflexive cough				
➢ Present	10.4±5.9	10.1±4.6	5.8±4.1	26.3±12.9
➢ weak	18.0±4.6	20.0±8.31	12.6±5.6	50.6±15.5
➢ Absent	9.8±5.8	23.1±10.5	12.7±12.3	45.6±26.9
➢ Significance test and *P value*	F=10.1 *P=0.001**	F=20.1 *P=0.000**	F=8.3 *P=0.001**	F=13.7 *P=0.000**
Degree of assistance or supervision				
➢ Independent	7.8±5.2	8.6±4.5	4.0±3.5	20.10.9
➢ Distant	15.7±3.1	13.3±2.9	9.7±2.2	38.7±6.3
➢ Present	12.5±6.5	12.8±7.2	7.7±5.4	32.9±17.4
➢ Intermittent	16.0±5.3	14.3±4.7	8.3±4.5	38.6±13.2
➢ Total	20.0±2.8	25.7±7.2	16.9±1.9	62.6±3.4
➢ Maximum	14.7±1.2	36.0±0.0	24.7±2.3	75.3±1.2
➢ Nothing Per Oral (NPO)	7.3±5.8	16.7±5.3	6.7±10.6	30.7±19.0
➢ Significance test and *P value*	F=12.2 *P=0.001**	F=29.6 *P=0.000**	F=18.6 *P=0.001**	F=27.5 *P=0.000**

*Statistically significant (*p< 0.005*)

This table shows that all domains of DHI-A were highly significantly correlated to the ways of nutrition that were recommended by DOSS, the degree of oral and pharyngeal stage retention, the clearance of oral and pharyngeal stage retention, penetration, aspiration,, reflexive cough, and the degree of assistance and supervision that was recommended by DOSS, In volitional cough: the functional, emotional domains and total score of DHI show highly significant correlation to the volitional cough domain of DOSS whereas, the physical domain of DHI-a shows non-significant correlation to volitional cough domain of DOSS (*P value 0.142*).

Table 8: Comparison between the scores of participants in the Dysphagia Outcome and Severity Scale (DOSS), total Dysphagia Handicap Index (DHI), and Penetration Aspiration Scale (PAS) scales

DOSS levels	PAS scores		DHI scores
	fluid	Solid and semisolid	
Level 1	8	8	Range:14-64 Mean:30.67±19.002
Level 2	7	7	Range:74-76 Mean:75.33±1.155
Level 3	5	5	Range: 74-76 Mean: 75.33±1.155
Level 4	3 5	3	Range:22-52 Mean:38.57±13.151
Level 5	2 4 6	2 4 6	Range:28-48 Mean:38.67±6.286
Level 6	1	1	Range:4-36 Mean:21.38±10.576
Level 7	1	1	Range:4-40 Mean:18.67±12.124

This table shows the score of participants on the PAS scale and the total score of DHI-A in each level of DOSS which explains the correlation between all scales. For example: In level 1, the PAS scale was 8 and the mean of total DHI-A was 30.67±19.002.

Table 9: Correlation matrix between all performed parameters; Dysphagia Outcome and Severity Scale (DOSS), Penetration Aspiration Scale (PAS), and Dysphagia Handicap Index (DHI)

		DHI total score	DOSS	PAS fluid	PAS solid/semisolid
DHI total score	Pearson Correlation (r)		-0.88	0.83*	0.80
	P value		0.000*	0.000*	0.000*
DOSS	Pearson Correlation (r)	-0.88		-0.89	-0.87
	P value	0.000*		0.000*	0.000*
PAS fluid	Pearson Correlation (r)	0.83*	-0.89		0.95
	P value	0.000*	0.000*		0.000*
PAS solid	Pearson Correlation (r)	0.80	-0.87	0.95	
	P value	0.000*	0.000*	0.000*	

*Correlation was significant (*P 0.005*).
This table shows a highly statistically significant negative correlation (*P 0.000*) between DOSS and PAS during fluid, solid, and semisolid intake and total score of DHI-A whereas the correlation between PAS and DHI-A was statistically significant positive (*P 0.000*).

3- Diagnostic data

Validity of Dysphagia Outcome and Severity Scale (DOSS) in diagnosis of swallowing disorders by FEES as compared to Penetration Aspiration Scale (PAS) during fluids, semisolid and solids intake:

On comparing findings detected by the DOSS versus PAS (checking sensitivity, specificity of DOSS to detect swallowing disorders), the Receiver Operating Characteristic (ROC) curve analysis was used and shows that sensitivity of DOSS was 100%, specificity was 100% (Figure 1-2).

Receiver Operating Characteristics (ROC) curve in diagnosing swallowing disorders using Penetration Aspiration Scale (PAS) during solid and semisolid intake as a standard.

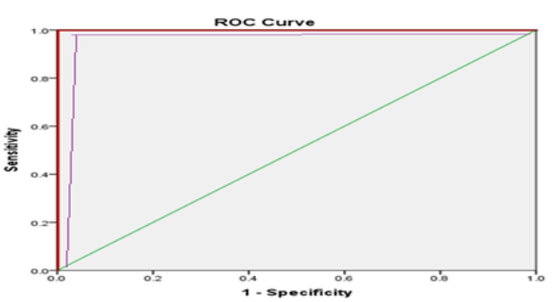

Fig. 1: ROC curve in diagnosing swallowing disorders using PAS solid as a standard
From (Figure 1) AUC of DOSS was 1.00 (Good test), by using PAS to solid the cut off point for detection of swallowing disorder is 1 at which best sensitivity (100%) and best specificity (100%).

Receiver Operating Characteristics (ROC) curve in diagnosing swallowing disorders using Penetration Aspiration Scale (PAS) during Fluid intake as a standard

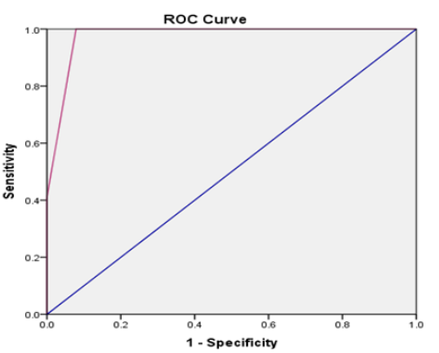

Fig. 2: ROC curve in diagnosing swallowing disorders using PAS Fluid as a standard
From (Figure 2) AUC of DOSS was 1.00 (Good test), by using PAS to liquid the cut off point for detection of swallowing disorder is 1 at which best sensitivity (100%) and best specificity (100%).

Table 10: Diagnostic accuracy of Dysphagia Outcome and Severity Scale (DOSS) depending on Penetration Aspiration Scale (PAS) during fluid intake

PAS Fluid (reference standard)	Positive	Negative	Total	Significance test	*P value*
DOSS					
Positive	35 (TP)	13 (FP)	48	X^2=18.21	0.000*
Negative	0 (FN)	12(TN)	12		
Total	35	25	60		
Sensitivity			100%		
Specificity			100%		
PPV (Positive predictive value)			-		
NPV (Negative predictive value)			100%		
AUC (Area under curve)			1.0		

*Statistically significant (*P<0.005*).TP: True Positive- FP: False Positive- FN: False Negative- TN: True Negative. Positive means: the patient who has a PAS score of 2-3-4-5-6-7-8 while negative means: the patient who has a PAS score of 1.
This table shows that the AUC (area under the curve) of DOSS was 1.00 (Good test), by using PAS to liquid the cut-off point for detection of swallowing disorder is 1 at which best sensitivity (100%), and the best specificity (100%).

Table 11: Diagnostic accuracy of Dysphagia Outcome and Severity Scale (DOSS) depending on PAS during solid intake.

PAS solid (reference standard) DOSS	Positive	Negative	Total	Significance test	*P value*
Positive	35 (TP)	16 (FP)	51	X^2=18.84	0.000*
Negative	0 (FN)	9 (TN)	9		
Total	35	25	60		
Sensitivity			100%		
Specificity			100%		
PPV (Positive predictive value)			-		
NPV (Negative predictive value)			100%		
AUC (Area under curve)			1.00		

*Statistically significant (*P<0.005*), TP: True Positive- FP: False Positive- FN: False Negative- TN: True Negative. Positive means: the patient who has a PAS score of 2-3-4-5-6-7-8 while negative means: the patient who has a PAS score of 1.

This table shows that the AUC (area under the curve) of DOSS was 1.00 (Good test), by using PAS during solid intake the cut-off point for detection of swallowing disorder is 1 at which the best sensitivity (100%), and the best specificity (100%).

Limitation of the study: no specific scale used to detect the amount of retention (residue) in both the oral cavity and pharynx, it is measured by the clinical expertise of the physicians who are participated in the study.

The sample size was calculated as follows:

The required sample size was calculated using the standard formula of sampling for a cross-sectional study within the conventionally acceptable level of precision (+ 5%) and 95% confidence level based on the original formula of Cochran (National Center for Health Statistics, 2005).

$$\textbf{Sample size} = \frac{Z^2.P.\ Q}{e^2}$$ Where;

 Z2 is the abscissa of the normal curve that cuts off an area α at the tails (1-α equals the desired confidence level of 95%). The value of Z is found in statistical tables which contain the area under the normal curve equal to 1.96 for a 95% confidence level.

 P is the proportion of an attribute that is present in the population i.e. the prevalence of swallowing disorders.

 Q is 1-P

 e is the desired level of precision[8].

Accordingly, the sample size was determined to be 60

DISCUSSION

According to O'Neil *et al*.[12]. the DOSS rating scale is one of the scales that describes the dysphagia severity levels, taking into consideration the three aspects of swallowing, making recommendations for nutrition, diet, and independence. Currently, existing scales that have been based on too general and subjective definitions per level have not included all important dysphagia issues or have not presented an adequate degree of reliability[12].

DOSS can describe the details of swallowing problem as (oral stage transfer, pharyngeal stage transfer, and penetration and aspiration); in oral stage transfer patients were clinically evaluated on the degree of bolus loss or retention and patient ability to compensate with or without cueing on the other hand pharyngeal stage retention which means that material remains in the pharynx (vallecula and/or pyriform sinuses) after a swallow has been completed[12].

The severity of retention is based on the relative amount of foods retained in the valleculae and/ or pyriform sinuses (mild-moderate or severe) and the patient's ability to either clear the retention spontaneously or after cues[12].

The aim of this study is to assess the validity of the Dysphagia Outcome and Severity Scale (DOSS) with Fiberoptic Endoscopic Evaluation of Swallowing against Penetration Aspiration scale (PAS) and Dysphagia Handicap Index (DHI-A) in order to generalize its use as a complementary to PAS.

Using a comprehensive self-assessment tool is important so a patient can rate the impact of his/ her swallowing problem. This tool can give an idea about how the patient perceives his/her swallowing problem and can be helpful in monitoring the patient's prognosis[13].

The scores of DOSS showed a significant correlation to the scores of DHI-A for the levels between 2-7 whereas, DOSS level 1 showed a non-significant correlation to DHI-A. According to Takeshi *et al*. (2018), DOSS level 1 reflects silent aspiration, where the patient is completely unaware of his dysphagia and cannot rate it by DHI-A due to Impaired ability to produce a reflexive cough as a result of central or local causes[14].

The correlation between DOSS and PAS was different in some patients. Patients may appear normal according to PAS and impaired according to DOSS as DOSS has the privilege of exploring whether clearance has occurred spontaneously during normal swallowing or occurred after mild retention.

However, the majority of patients showed comparable degrees of penetration and aspiration on both PAS and DOSS. The aforementioned results declare a highly significant correlation between the Dysphagia Outcome and Severity Scale (DOSS) and Penetration Aspiration Scale (PAS).

A study done by O'Neil *et al* 1999 declared that: DOSS gives more details about the way of nutrition and the degree of severity which facilitate the design of therapy program. DOSS addresses both objective severity (retention, oral stage deficits) and functional parameters (independence, nutrition, diet) with excellent interrater (90%) and interrater (93%) reliabilities[12].

The penetration-aspiration scale by Rosenbek *et al*. (1996) provides excellent delineation of the severity of airway penetration. However, interrater reliability was only fair (57–75%). In addition, it did not allow for an overall assessment of the functional severity of dysphagia or address regularity of diet, nutrition, or independence recommendations[11].

Although DOSS yielded 100 % sensitivity and 100 % specificity in the diagnosis of dysphagia it cannot thoroughly define each parameter (i.e., what constitutes "mild retention") and therefore requires subjective clinical determination usually based on clinical experience[12].

In the current study correlation between the DOSS levels, PAS scores, and DHI-A showed that there was a high statistically significant negative correlation between DOSS and PAS during fluid intake (-0.89%) and during solid and semisolid intake (-0.87%). The correlation is negative because the DOSS levels start from level 7 which means no dysphagia to level 1 which means severe dysphagia while the PAS score starts from 1 which means no dysphagia to 8 which means severe dysphagia.

There was a high statistically significant negative correlation between DOSS and total score of DHI-A (-0.88%). The correlation is negative because DOSS levels start from level 7 which means no dysphagia to level 1 which means severe dysphagia while DHI-A total score starts from 0 which means no dysphagia to 100 which means severe degree of dysphagia.

There was a high statistically significant correlation between PAS during fluid and solid intake and total score of DHI-A (0.83%) and (0.80%) respectively.

CONCLUSION

This highly statistically significant correlation between Dysphagia Outcome and Severity Scale (DOSS), Penetration Aspiration Scale (PAS) and Dysphagia Handicap Index (DHI-A) proves that DOSS can be used effectively with FEES as an alternative or complementary to PAS.

CONFLICT OF INTEREST

There are no conflicts of interest.

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Appendix A

مؤشر إعاقة صعوبة البلع (DHI-A) (Farahat *et al*., 2014)

ضع علامة في المربع لكل سؤال والذي يصف البلع لديك

	أبدا	أحيانا	دائما
الجزء الأول			
1. أتجنب بعض الأطعمة بسبب مشكلة البلع لدي			
2. قمت بتغيير طريقة بلعي ليسهل علي تناول الطعام			
3. أصبحت المدة التي استغرقها لتناول وجبة أطول من المعتاد			
4. في كثير من الأحيان أتناول وجبات أصغر بسبب مشكلة البلع لدي			
5. أتجنب المناسبات الإجتماعية قدر الإمكان بسبب مشكلة البلع لدي			
6. أتجنب الأكل بسبب مشكلة البلع لدي			
7. قللت تناولي للطعام بسبب مشكلة البلع لدي			
8. يتوجب علي تناول الطعام بطريقة بديلة (مثل "أنبوب التغذية") بسبب مشكلة البلع لدي			
9. غيرت نظامي الغذائي بسبب مشكلة البلع لدي			
الجزء الثاني			
1. أكح عندما أشرب السوائل			
2. أكح عندما أكل طعاما صلبا			
3. فمي جاف			
4. احتاج لشرب السوائل لانزال الطعام			
5. خسرت بعض الوزن بسبب مشكلة البلع لدي			
6. اضطر للبلع مرة أخرى قبل أن ينزل الطعام			
7. أشرق (أغص) عندما أتناول دوائي			
8. أشعر باحساس خانق عندما أبلع			
9. أكح طعام بعدما أبلع			
الجزء الثالث			
1. احرج عندما أتناول الطعام أمام الجميع			
2. أشعر بالاكتئاب لعدم تناولي الطعام الذي أريد			
3. لا استمتع بالأكل كما اعتدت			
4. أنا عصبي بسبب مشكلة البلع لدي			
5. أشعر بالإعاقة (العجز) بسبب مشكلة البلع لدي			
6. أغضب من نفسي بسبب مشكلة البلع لدي			
7. أخاف من أنني سأشرق (سأغص) وأتوقف عن التنفس بسبب مشكلة البلع لدي			

ضع دائرة حول الرقم الذي يتماشى مع صعوبة البلع لديك حيث:

١= لا توجد صعوبة ٤= صعوبة بلع متوسطة ٧= صعوبة بلع شديدة

١	٢	٣	٤	٥	٦	٧

Appendix B

Dysphagia Outcome and Severity Scale (O'Neil K, *et al*., 1999).

Table 1. Dysphagia outcome and severity scale—final revision

Full per-oral nutrition (P.O): Normal diet
Level 7: Normal in all situations Normal diet No strategies or extra time needed
Level 6: Within functional limits/modified independence Normal diet, functional swallow Patient may have mild oral or pharyngeal delay, retention or trace epiglottal undercoating but independently and spontaneously compensates/clears May need extra time for meal Have no aspiration or penetration across consistencies
Full P.O: Modified diet and/or independence
Level 5: Mild dysphagia: Distant supervision, may need one diet consistency restricted May exhibit one or more of the following Aspiration of thin liquids only but with strong reflexive cough to clear completely Airway penetration midway to cords with one or more consistency or to cords with one consistency but clears spontaneously Retention in pharynx that is cleared spontaneously Mild oral dysphagia with reduced mastication and/or oral retention that is cleared spontaneously
Level 4: Mild–moderate dysphagia: Intermittent supervision/cueing, one or two consistencies restricted May exhibit one or more of the following Retention in pharynx cleared with cue Retention in the oral cavity that is cleared with cue Aspiration with one consistency, with weak or no reflexive cough Or airway penetration to the level of the vocal cords with cough with two consistencies Or airway penetration to the level of the vocal cords without cought with one consistency
Level 3: Moderate dysphagia: Total assist, supervision, or strategies, two or more diet consistencies restricted May exhibit one or more of the following Moderate retention in pharynx, cleared with cue Moderate retention in oral cavity, cleared with cue Airway penetration to the level of the vocal cords without cough with two or more consistencies Or aspiration with two consistencies, with weak or no reflexive cough Or aspiration with one consistency, no cough and airway penetration to cords with one, no cough
Nonoral nutrition necessary
Level 2: Moderately severe dysphagia: Maximum assistance or use of strategies with partial P.O. only (tolerates at least one consistency safely with total use of strategies) May exhibit one or more of the following Severe retention in pharynx, unable to clear or needs multiple cues Severe oral stage bolus loss or retention, unable to clear or needs multiple cues Aspiration with two or more consistencies, no reflexive cough, weak volitional cough Or aspiration with one or more consistency, no cough and airway penetration to cords with one or more consistency, no cough
Level 1: Severe dysphagia: NPO: Unable to tolerate any P.O. safely May exhibit one or more of the following Severe retention in pharynx, unable to clear Severe oral stage bolus loss or retention, unable to clear Silent aspiration with two or more consistencies, nonfunctional volitional cough Or unable to achieve swallow

Appendix c

Penetration aspiration scale (Rosenbek J, *et al*., 1996).

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

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