Otorhinolaryngology-Head and Neck Surgery

Research Article

ISSN: 2398-4937

FEES ability to detect dysphagia therapeutic-induced changes in patients with sub-acute brain damage

Daniele Farneti[1]*, Patrizia Consolmagno[2], Laura Rosi[1] and Luca Bastiani[3]

[1]Audiology and Phoniatrics Service, ENT Division, Romagna Health Service, Rimini Hospital, Italy

[2]Patrizia Consolmagno, OPA «Sol et Salus», Torre Pedrera, Rimini, Italy

[3]Institute of Clinical Physiology, National Council of Research (CNR) – Pisa, Italy

Abstract

Objective: Neuropsychological (NPS) abilities are frequently compromised in patients with acute brain damage, conditioning oral feeding. The aims of this study are to document, using FEES, an improvement of swallowing and NPS abilities after treatment and a possible correlation between them.

Methods: Patients with swallowing and NPS disorders were retrospectively evaluated during 2004 and 2005, 14 days after a traumatic brain injury or cerebral vascular accident. All the patients underwent a FEES assessment to determine the severity of dysphagia (p-score. p-SCA score) and evaluation of attentive, mnesic, perceptive, executive, intellective and linguistic functions using standardized paper-pen and/or PC protocols.

Results: A sample of 235 consecutive in-patients (mean age 59.8;148M/87F) was considered: all underwent swallowing therapy and 98 underwent NPS therapy. The p-score and the p-SCA score and all the NPS scores were significantly reduced after 60 days. Patients with a p-score ≥ 8 and p-SCA ≥ 9 showed a correlation with attention, memory and executive functions.

Conclusions: FEES seems adequate in detect therapeutic-induced modifications of swallowing abilities. A correlation between swallowing and NPS changes can be postulated.

Introduction

Cognitive changes following acute neurological damage to the brain [1] are a topic of great interest in the care and treatment of patients with swallowing disorders. Cognition [2] refers to different neuropsychological (NPS) abilities [3], such as attention, memory-working memory, judgment and evaluation, reasoning and calculation, problem solving and decision making, comprehension and language, this last considered as superior cortical function. This interest also lies in the related modifications of behavior and awareness, with real and strong implications for diagnosis and treatment plans, especially if other co-morbidities occur or exist. All these activities underlie different processes, but they are unequivocally and reciprocally correlated.

Awareness [4], is a general state of consciousness in which brain activities are able to guarantee knowledge. As a general condition, awareness not only affects cognition but all behavioral manifestations, first of all alertness. Behavior [5] also includes the patient's emotional state, motivation, cooperativeness/agitation, attention/interaction ability, adaptation to disability, ability to implement strategies. In the field of dysphagia, behavior is able to condition the awareness of swallowing problems [6], the awareness of secretions, and the ability to manage secretions. In practice, behavior creates the conditions for an alliance with the patient which is fundamental throughout the diagnostic and therapeutic program. Awareness also conditions prognosis, global and functional outcomes of the patients, with limitations on psychological, social, and working functioning [7].

From this specific point of view, alertness and awareness can be considered prerequisites for oral feeding, being included in different evaluation protocols used to screen patients suspected of having swallowing disorders due to stroke [6,8], age [9], Parkinson's disease [10].

Precociously, after brain damage, swallowing disorders are common in terms of oral and/or pharyngeal alterations [11]. Awareness of these disorders, in the same way as awareness of behavioral disorders, cognition, and motor skills, is essential for the patient, to discriminate the site of the problem, for spontaneous adaptation to defensive strategies and for adherence to therapy. All these events lead to a reduction in complications due to dysphagia [6,8].

Modifications in cognition, communication and behavior linked to a decline in intellectual functions, were not considered in this paper.

With this premise, we evaluated a cohort of patients following acute brain damage, with subsequent NPS and swallowing disorders. The study was conducted with the aim of 1) quantifying cognitive and quantifying swallowing alterations, using endoscopic functional scores, 2) verifying a possible interaction between cognition and swallowing disorders before and after specific treatment.

Material and methods

Participants

In a retrospective study, a sample of in-patients with swallowing and NPS disorders was evaluated during 2004 and 2005, after admission to a

***Correspondence to:** Daniele Farneti, Audiology and Phoniatrics Service, ENT Division, Romagna Health Service, Rimini Hospital, Italy, Tel: +0541705146, E-mail: lele.doc@libero.it

***Keywords:** FEES, dysphagia, neuropsychological abilities, CVA, TBI*

Received: April 05, 2021; **Accepted:** April 23, 2021; **Published:** April 27, 2021

Table 1. p-score and p- SCA score.

Pooling	Endoscopic landmarks		Bedside parameters	
			Sensation	Cooperation
Site	Vallecule – marginal zone Pyriform sinus Vestibule/vocal cords Lower vocal cords	1 2 3 4		
Amount	Coating Minimum Maximum	1 2 3	Presence = - 1 Absence = +1	Presence = - 1 Absence = +1
Management	< 2 2 ><5 > 5	2 3 4		
Score	P 4-11		P-SCA 3-16	

P score:
4-5 = minimum score, corresponding to no endoscopic signs of dysphagia
6-7 = low score, corresponding to a mild dysphagia
8-9 = middle score, corresponding to a moderate dysphagia
10-11 = high score, corresponding to a severe dysphagia

P-SCA score:
3-4 = minimum score, corresponding to no dysphagia
5-8 = low score, corresponding to a mild dysphagia
9-12 = middle score, corresponding to a moderate dysphagia
13-16 = high score, corresponding to a severe dysphagia

Rehabilitation Center, 14 days after acute brain damage due to a trauma (traumatic brain injury, TBI) or cerebral vascular accident (CVA). All the patients were over 18 years old.

Protocol

All the patients underwent a bedside swallowing evaluation (BSE) performed alternately by three SLPs and a Phoniatrician. Subsequently, all the patients were evaluated by a Phoniatrician and submitted to an endoscopic evaluation of swallowing (FEES) according to a protocol in use in the Center [12,13]. The endoscopic evaluation was performed with a Storz endoscope (model 11101RP2, 30 cm long, 3.5 mm in diameter) and recorded with a workstation (Richard Wolf GmbH, Knittlingen, Germany). The patients were given three trials of different consistencies: 5cc pureed, 5cc liquid dyed with 5% methylene blue, 1/4 cracker. After each consistency the severity of dysphagia, in terms of false route and residue, was defined applying the pooling score (p-score) and applying the Sensation, Collaboration and Age score (p-SCA score) [14] (Table 1). The p-score has been documented to have good predictive ability on penetration and aspiration when compared with the penetration aspiration scale (PAS scale) [15,16].

All the patients underwent speech therapy treatment which included, in various combinations and depending on the case, meal surveillance, dietary adaptations, indirect therapy and direct therapy with postures and maneuvers. The rehabilitation program was continued for 60 days, coinciding with the period of hospitalization. At the end of the treatment, all the subjects were re-evaluated and the scores re-calculated.

During hospitalization, all the patients were monitored for the development of respiratory complications and a chest X-ray was performed at the end of the stay. A subgroup was interviewed by telephone after one year to check for lung infections.

Before starting with the swallowing therapeutic program, patients underwent a neuropsychological evaluation assessing attentive, mnesic, perceptive, executive, intellectual and linguistic functions using protocols including standardized paper-pen and/or PC test batteries [17,18] comparing every ability with a standardized Equivalent Score (ES). Patients not able to be tested, due to a very low responsiveness level, underwent only periodic observations of alertness, reaction to environmental stimuli, ability to use a binary code, selective memory, or sustained memory. Patients who had experienced traumatic brain injury had the level of reactivity and cognitive and behavioral changes observed with the L.C.F. Scale-Revised - Level of cognitive functioning Scale of Ranchos Los Amigos (2000) [19].

Based on the results of the psychometric tests, patients were selected to enter specific cognitive treatment, with daily sessions, maintained throughout the period of hospitalization. At the end of the treatment, the patients were re-evaluated and the scores re-calculated.

Statistical analysis

The data were analyzed using SPSS v.23.0 (IBM Corp., Armonk, NY, USA) and STATA version 13 (STATA Corp., College Station, TX, USA). Categorical variables were expressed as percentages, and continuous variables were expressed as mean ± standard deviation. Receiver Operator Characteristic (ROC) curve analysis was performed to determine the sensitivity and specificity for p-score and p-SCA score when compared to gold standard diagnosis (aspiration). Subsequently a multivariate analysis among NPS abilities was performed to identify those NPS abilities correlated with dichotomized p-score and p-SCA score (Odds).

Analysis of dependent sample (Friedman-test, p 0.005), pre and post treatment, was used to assess differences in p-score and p-SCA score. The McNemar test was performed to compare the pre-post differences in dichotomous items in the same subjects for the evaluation of attentive, mnesic, perceptive, executive, intellectual, and linguistic functions.

Wilcoxon's test (p-value 0.000) was used to determine significant changes in respiratory complications during hospitalization.

All the patients gave their written consent to the procedures, in accordance with the Declaration of Helsinki. The study was approved by the local Ethical Research Committee (n. 2139).

Results

A sample of 235 patients (average age 59.8 yrs; SD 17.8, M/F 148/87), admitted 14 days after acute brain damage (sub-acute patients), was considered. Of these 71 (30.17%) had had a TBI and 164 (69.83%) had suffered a CVA. Table 2 summarises the sites of lesion in the whole cohort and the characteristics of the LCF subgroups. Based on the results of the NPS assessment, a group of 98 patients underwent a cognitive treatment plan, while all 235 patients underwent a therapeutic swallowing treatment approach, as previously summarized.

The results of the main descriptive data, collected from history, bedside, and FEES, are summarized in Table 3.

During the period of hospitalization, no patient developed respiratory complications (negative chest X-ray at discharge) (p-value 0.000 - Wilcoxon's test). Of these patients, 41 were interviewed by telephone one year after discharge, confirming the absence of respiratory complications during that period. The p-score and p-SCA score values significantly reduced (p-value 0.000 - Friedman test) during hospitalization (Table 4). The value of NPS abilities was also

Table 2. Sites of lesion and LCF cohort (TBI patients).

Site of lesion	n.	%	LCF-R level	n.	%
Right	166	70.06	1	71	30
Left	176	74.09	2	1	0,4
Cortical	191	81.03	3	4	1,7
Subcortical	93	39.06	4	23	9,8
Frontal	94	40.00	5	12	5,1
Temporal	90	38.03	6	5	2,1
Parietal	85	36.02	7	6	2,6
Occipital	17	07.02	8	5	2,1
Cerebellar	16	06.08	9	15	6,4
Diffuse axonal injury	58	24.07	10	/	/

Table 3. Categorical variables from history, bedside, FEES.

Variables				n	%
History	Traumatic brain injury (TBI)			71	30,71
	Cerebral vascular accident (CVA)			164	69,83
	Alternative feeding			15	6,40
	Indirect therapy (when possible)			200	85,10
	Direct therapy (when possible)			193	82,10
	NGT already placed			110	46,80
	PEG already placed			27	11,50
	Tracheotomy			94	40,00
BSE	Collaboration			182	77,40
	Gurgling voice			31	13,20
	Sensation			226	96,20
	Dysarthria			24	10,20
	Aphasia			42	17,90
	Laryngeal elevaion			149	63,40
FEES	**Aspirating**			112	47,70
	Delay triggering			117	49,80
	Penetration (with cough)			134	57,00
	Spillage			139	59,10
	Post-swallowing aspiration			15	6,40
	Residue			225	95,70
		Site	Valleculae	79	33,60
			Marginal zone	40	17,00
			Pyriform sinus	63	28,60
			Vestibule	58	24,70
			Below vocal cords	112	47,70
		Amount	Coating	68	28,90
			Minimum	111	47,20
			Maximum	55	23,40
		Management (dry swallowing)		222	94,50
			<2	105	46,50
			2-5	79	35,00
			>5	42	18,60

modified during hospitalization, with an increase in the equivalent score (ES) in the pre/post comparison, with a percentage of improvement summarized in Table IV. This improvement was statistically significant (McNemar test, Sig. < 0.005).

Diagnostic performance of the p-score and p-SCA score using aspiration as determined by FEES as reference test, showed good sensitivity and specificity values after dichotomization (p score ≥ 8, p-SCA score ≥ 9), with a p-score Sensitivity of 97.3 and Specificity of 68.4, a p-SCA Sensitivity of 78.6 and Specificity of 76.4 and area under the ROC curve (AUC) respectively of 84.2 and 72.9.

The comparison between NPS abilities and p-score and p-SCA score (dependent variables) showed that attentive abilities are significantly correlated with a p-score ≥ 8 while attentive, mnesic and executive abilities are significantly correlated with a p-SCA score ≥ 9. A multivariate analysis among NPS abilities, once again, shows that attention is statistically correlated with the p-score ≥ 8 (OR 3.90) while memory is statistically correlated with the p-SCA score ≥ 9 (OR 4.28); intellectual abilities, although non statistically correlated, have a negative OR: 0.36 (Sig. 0.07) and 0.41 (Sig. 0.035) respectively with dichotomized p-score and p-SCA score.

Considering the cohort of NPS patients who underwent both NPS and swallowing treatment (98 out of 235), it was shown that the differences in the p-score and p-SCA score before/after treatment were statistically significant for both groups (Friedman test 0.000). A similar trend was show in the LCF sub-group (71 patients) except that the difference between the p-score and p-SCA scores at admission was statistically significant (Kruskal Wallis Test <0.005). Table 5 summarizes these data in the NPS group.

Discussion

Coexistence of swallowing and NPS alterations is an issue in the management of patients with sub-acute brain damage. In this population, cognitive and behavioral impairments add up with oral and pharyngeal swallowing alterations, in generating complex clinical associations, requiring specific and personalized therapeutic approaches.

The data emerging from our study document a considerable number of patients with swallowing disorders, endoscopically confirmed, in terms of false route (penetration, aspiration) and inefficient swallow (residue). Of the whole sample, 47.7% were aspirating, while 95.7% had residue (Table 3). The data also document a majority of pre/intra swallowing aspiration events in our sample, indirectly suggested by a high number of penetration episodes (57%) associated with spillage (59.1%) and delayed triggering (49.8%); in contrast, the number of post-swallow aspiration episodes (6.4%) is low. This is in line with previous data in the literature [20]. It is worth to be mentioned that

Table 4. p-score and p-SCA pre/post score comparison. NPS abilities pre/post comparison: % of improvement-Significance <0.005.

p-score	≤ 7	8-9	10-11	p-value (Friedman's Test)	NPS abilities	Admission	Discharge	Sig
Admission	27,7	49,4	23,0		Attentive	69,8%	55,5%	0,000
Discharge	46,0	41,7	12,3	0,000	Mnesic	46,0%	84,3%	0,000
					Perceptive	1,3%	100,0%	0,000
p-SCA score	**≤ 8**	**9-12**	**13-16**	**p-value (Friedman's Test)**	Executive	33,2%	91,0%	0,000
Admission	55,3	32,3	12,3		Intellectual	17,0%	95,0%	0,000
Discharge	67,7	24,3	8,1	0,000	Linguistic	24,3%	54,4%	0,000

Table 5. p-score and p-SCA score variations before and after NPS treatment. *Friedman's Test Sig. 0.000

NPS Treated (98 patients)					NPS not Treated (137 patients)				
p-score	≤ 7	8-9	10-11		**p-score**	≤ 7	8-9	10-11	
before	24,5	53,1	22,4	*	before	31,4	46,7	21,09	*
after	49,0	40,8	10,2	*	after	43,8	42,3	13,9	*
Δ after-before	24,4	-12,2	-12,2		Δ after-before	12,4	-4,4	-8	
NPS Treated					**NPS not Treated**				
p-SCA score	≤ 8	9-12	13-16		**p-SCA score**	≤ 8	9-12	13-16	
before	60,2	21,4	18,4	*	before	51,8	40,1	8	*
after	74,5	15,3	10,2	*	after	62,8	30,7	6,6	*
Δ after-before	14,3	-6,1	-8,2		Δ after-before	10,9	-9,5	-1,4	

recent data in the literature have confirmed a correlation with residue and false routes as main indicators of dysphagia [16,21,22], with a significant correlation of the sub-scale "site" 3-4 of the p-score with, respectively, the scores 2-5 and 6-8 of the PAS scale [16].

On admission, most patients were documented with medium severity dysphagia, as expressed by the p-score, while most were documented with moderate dysphagia when considering the p-SCA score. This is in keeping with the data in the literature, documenting that bedside parameters mitigate the severity expressed by the instrumental assessment [21,23]. Nonetheless, the severity of dysphagia of the whole sample was reduced on discharge, considering both the p-score and the p-SCA score values (Table 4). The sample also included patients with severe dysphagia and complex clinical conditions: patients with tracheotomy and alternative feeding (Table 3). The BSE also confirmed a considerable number of non-collaborating patients with reduced sensation. These latter data seem to be in line with the p-SCA score severity.

As for NPS abilities, a first consideration to be made regards the site of the lesion [24]. Right and left lesions were equally represented, and were mainly cortical: Frontal, Temporal and Parietal respectively, considering their recurrence in the sample (Table 2). These findings seem to be in line with the NPS characteristics of the sample on admission (also considering the evaluated TBI patients), documenting respectively a considerable impairment of attentive, mnesic, executive and intellectual abilities (Table 4). Patients undergoing a specific NPS treatment plan, documented a statistically significant improvement in all these abilities (Table 4).

More speculative are the considerations about a possible interaction between NPS and swallowing abilities. The data in the literature suggest a correlation [24,25] between them. Also, our data document a significant correlation between NPS and swallowing abilities with an increase in any kind of severity expressed by the p-score (≥ 8) and attention, and p-SCA score (≥ 9) and attentive, mnesic, and executive abilities.

Comparing the patients who underwent both NPS and swallowing treatment with those who did not have an NPS therapeutic approach, it seems that the contribution of NPS treatment is not relevant in swallowing improvement, as the improvement also occurred in non-NPS treated patients. But following a more attentive observation, it is also evident that the percentage of improvement in the NPS treated group is higher compared with those in the NPS non-treated group (Table 5).

This NPS trend, with more reduced percentages, is visible in the LCF treated/non- treated sub-groups. The improvement in all the NPS abilities, possibly facilitated by a specific rehabilitation approach, may have influenced the overall improvement of swallowing, with a possible better management of residue, an optimization in the execution of defensive strategies, and with better protection offered to the lower airway. The absence of broncho-pulmonary infections during the hospitalization period (60 days) indirectly underlines the result achieved by the specific treatment on dysphagia.

The lack of a control groups, not conceivable for ethical concerns, is one of the main limitations of our study. Another limitation is the date of the evaluation carried out (2004-2005), which does not allow a further revision of the data used, compared to what was reported.

Conclusions

The endoscopic evaluation of swallowing and NPS abilities pre-post specific treatment plans shown, in our sample, an improvement in both NPS and swallowing abilities, identifying some NPS parameters correlated with dysphagia severity. The p-score and p-SCA score showed the strongest correlations with attention, mnesic and executive abilities. These correlations could justify the clinical complexity of these patients and the particular contribution of NPS alterations could, in turn, justify the statistical performance of the functional endoscopic p-score and p-SCA scores. The first, in fact, showed a good statistical performance compared to the p-SCA score in terms of sensitivity, despite the specificity being lower for both and more for the p-score. The good sensitivity of the p-score and the p-SCA score seem to underline, in our sample, their ability to detect changes in the severity of dysphagia after a treatment plan.

NPS and swallowing treated patients had shown a major percentage of improvement of the p-score and p-SCA score without however being able to support a mutual interaction between the two treatments. Further research is needed to support this hypothesis. However, the importance of our study is that it provides information on the bedside and endoscopic characteristics of a considerable sample of sub-acute patients with brain damage.

References

1. Gazzaniga MS, Ivry RB, Mangun GR (2014) Cognitive Neuroscience: the biology of the mind. (4th edn), Norton & Company, Inc., New York, USA.
2. Matlin MW, Farmer TA (2015) Cognition. (9th edn), John Wiley & Sons, Inc. Hoboken, NJ.
3. Zillmer EA, Perry W (1996) Cognitive-neuropsychological abilities and related psychological disturbance: a factor model of neuropsychological, Rorschach, and MMPI Indices Assessment. *Sage Journals* 3: 209-224.
4. Morin A (2017) Towards a glossary of Self-related terms. *Front Psychol* 8: 280.
5. Hayes SC, Wilson KG (1995) The role of cognition in complex human behavior: a contextualistic perspective. *J Behav Ther Exp Psychiatry* 26: 241-248. [Crossref]
6. Parker C, Power M, Hamdy S, Bowen, A, Tyrrell P, et al. (2004) Awareness of dysphagia by patients following stroke predicts swallowing performance. *Dysphagia* 19: 28-35. [Crossref]
7. Schmidt J, Lannin N, Fleming J, Ownsworth T (2011) Feedback interventions for impaired self-awareness following brain injury: a systematic review. *J Rehabil Med* 43: 673-680. [Crossref]
8. Logemann JA, Veis S, Colangelo L (1999) A screening procedure for oropharyngeal dysphagia. *Dysphagia* 14: 44-51. [Crossref]
9. Boczko F (2006) Patients' awareness of symptoms of dysphagia. *Am J Med Dir Assoc* 7: 587-590. [Crossref]
10. Bayés-Rusiñol À, Forjaz MJ, Ayala A, Crespo Mde L, Prats A, et al. (2011) Awareness of dysphagia in Parkinson's disease. *Rev Neurol* 53: 664-672. [Crossref]
11. Falsetti P, Acciai C, Palilla R, Bosi M, Carpinteri F, et al. (2009) Oropharyngeal dysphagia after stroke: incidence, diagnosis, and clinical predictors in patients admitted to a neurorehabilitation unit. *J Stroke Cerebrovasc Dis* 18: 329-335. [Crossref]
12. Langmore SE, Schatz K, Olsen N (1988) Fiberoptic endoscopic examination of swallowing safety: a new procedure. *Dysphagia* 2: 216-219. [Crossref]
13. Farneti D (2014) The instrumental gold standard: FEES. *J GHA Sci Ass* 3: 1055-1060.
14. Farneti D, Fattori B, Nacci A, Mancini V, Simonelli M, et al. (2014) The Pooling score (P-score): inter- and intra-rater reliability in endoscopic assessment of the severity of dysphagia. *Acta Otorhinolaryngol Ital* 34: 105-110. [Crossref]
15. Rosenbek JC, Robbins JA, Roecker EB, Coyle JL, Wood JL (1996) A penetration-aspiration scale. *Dysphagia* 11: 93-98. [Crossref]
16. Farneti D, Fattori B, Bastiani L (2019) Time as a factor during endoscopic assessment of swallowing: relevance in defining the score and severity of swallowing disorders. *Acta Otorhinolaryngol Ital* 39: 244-249. [Crossref]
17. Spinnler H, Tognoni G (1987) Standardizzazione taratura italiana di Test Neuropsicologici. *Ital Neurolog Sci.* Masson, Milano.
18. Lezak MD (1995) Neuropsychological Assessment. 3rd Edition. Oxford University Press, Oxford.
19. The Rancho Los Amigos scale-revised. 2000. Available from: https://www.neuroskills.com/education-and-resources/rancho-los-amigos-revised/

20. Oliveira DL, Moreira EA, de Freitas MB, Gonçalves JA, Furkim AM, et al. (2017) Pharyngeal residue and aspiration and the relationship with clinical/nutritional status of patients with oropharyngeal dysphagia submitted to videofluoroscopy. *J Nutr Health Aging* 21: 336-341. [Crossref]

21. Farneti D, Genovese E (2015) Endoscopic criteria in assessing severity of swallowing disorders. In Renee Speyer Editor. Seminars in dysphagia. *InTech.*

22. Nordio S, Di Stadio A, Koch I, Stritoni P, Meneghello F, et al. (2020) The correlation between pharyngeal residue, penetration/aspiration and nutritional modality: a cross-sectional study in patients with neurogenic dysphagia. *Acta Otorhinolaryngol Ital* 40: 38-42. [Crossref]

23. Leder BS, Espinosa JF (2002) Aspiration risk after acute stroke: comparison of clinical examination and fiberoptic endoscopic evaluation of swallowing. *Dysphagia* 17: 214-218. [Crossref]

24. Dehaghani SE, Yadegari F, Asgari A, Bagheri Z (2019) The mediator effect of cognition on the relationship between brain lesion location and dysphagia in patients with stroke: Applying a structural equation model. *J Oral Rehabil* 46: 33-39. [Crossref]

25. Daniels KS (2006) Neurological disorders affecting oral, pharyngeal swallowing. *GI Motility online*: 10.1038/gimo34.