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Behavioral Readjustment Therapy versus Vocal Fold Injection in the Management of Swallowing Disorders in Cases of Unilateral Vocal Fold Paralysis

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Abstract
Background: Unilateral vocal fold immobility (UVFI) is the most prevalent neurological disease affecting the larynx.
Objective: This work aimed to evaluate management of oropharyngeal dysphagia in cases of unilateral vocal fold paralysis (UVFP) by either behavioral readjustment therapy (BRAT) or vocal fold injection (VFI) to provide the best management technique regarding safety and effectiveness in these patients.
Methods: This study was carried out on 20 consecutive candidates of both sexes with vocal fold immobility and dysphagia for BRAT or VFI. They were aged from 20 to 60 years old, both sexes. Patients were divided randomly into two equal groups: Group I included odd numbers received BRAT with mean age of 42.3 ± 15.21 years and group II that included even numbers received VFI with mean age of 45.1 ± 12.56.
Results: The glottic gap was significantly better in one week and three months follow-up for injection group than behavioral group. The presence of the residue one week post intervention showed non-significant difference between both groups. Penetration aspiration scale (PAS) after one week and 3 months of intervention for fluids showed a significant difference between both groups but PAS for semisolids and solids showed no significant difference between them. Food consistency was affected and choking of fluid showed a significant difference in both groups.
Conclusions: Injection laryngoplasty (IL) and BRAT could improve oropharyngeal dysphagia in patients with unilateral VFP. IL improved the glottal closure, therefore it improved airway protection and increased cough power, so it helps to prevent aspiration. BRAT improved motor power and motor control of swallowing in oropharyngeal phase, improved impaired sensation, improved bolus flow, and decreased the patient's symptoms.
Keywords: Behavioral readjustment therapy, Vocal fold injection, Swallowing, Unilateral vocal fold paralysis.

INTRODUCTION

Vocal fold paralysis (VFP) refers to the condition when the actual vocal fold becomes immobile due to damage to the neurological pathways, specifically the ipsilateral vagus or recurrent laryngeal nerve. Unilateral vocal fold paralysis (UVFP) is the most common neurological disease observed in the larynx [1].

UVFP is a frequent underlying factor for insufficient closure of the vocal folds [2].

Glottal insufficiency hampers the ability to swallow, breathe, and produce sounds. Glottal insufficiency is characterized by a voice that is breathy and weak, diminished strength in coughing, difficulty swallowing (dysphagia), and difficulty breathing (dyspnea) [2]. Bilateral VFP generally presents with difficulty breathing and a two-phase high-pitched sound during respiration, with voice changes and difficulty swallowing happening less often [3].

When a patient is identified with a swallowing issue, therapies are implemented to enhance the movement of food and improve the physiological process of swallowing. This allows the patient to get sufficient oral nutrition and water necessary for their survival [4].

The process of dysphagia rehabilitation involves the use of both compensatory and rehabilitative strategies. Compensatory tactics are used to mitigate symptoms of dysphagia without modifying the underlying physiology, while rehabilitative treatments aim to enhance swallowing physiology and enhance the safety and tolerance of a less restricted diet [2].

The objective of this study was to assess the treatment of oropharyngeal dysphagia in instances of UVFP by either behavioral readjustment therapy (BRAT) or vocal fold injection (VFI), in order to determine the most optimal approach in terms of safety and efficacy for these patients.

PATIENTS AND METHODS

This research was conducted on a sample of 20 consecutive individuals, both males and females, aged between 20 and 60 years old, who were diagnosed with vocal fold immobility and dysphagia and were candidates for BRAT or VFI. Patients were divided randomly into two equal groups (10 patients each): Group I included odd numbers and received BRAT and group II included even numbers and received VFI.

Exclusion criteria: Previous injection, previous history of neck irradiation, cervical spine problems or difficult exposure of the neck, impaired conscious level, affected intellectual functions, refusing to participate in the study.

Oropharyngeal dysphagia assessment:

Primary diagnostic procedures: Patient's interview and auditory perceptual assessment (APA) of voice, speech, and language. Clinical examination comprised general examination, oropharyngeal tract examination, neck examination, and neurological examination, as well as observations during trial feeding. Diagnostic

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tools used in clinical practice included Fiber-optic Endoscopic Evaluation of Swallowing and formal assessments of speech, language, and cognitive skills, which may include dysphasia tests as well as evaluations of cognitive and perceptual abilities.

Injection laryngoplasty under general anesthesia: This method necessitated the use of general anesthesia to induce a state of full muscular relaxation in the patient for the duration of the surgery. Steroids were administered intravenously before surgery, unless there were reasons not to do, in order to reduce secretions and swelling after the operation. To minimize the risk of vocal fold damage during intubation and enhance visibility for the surgeon, an appropriately sized endotracheal tube (4.5 mm for men and 4 mm for females) was used.

Technique of injection: The glottal gap was evaluated by using a properly sized laryngoscope and a combination of pre-operative awake stroboscopy and intra-operative visualization using micro-laryngoscopy. This provided immediate entry to the vocal folds (VFs) and facilitated accurate positioning of the needle along the superior arcuate line using a straight and direct path. The needle was used to administer a substance into the top layer of the vocal fold, specifically targeting the back and middle area, resulting in the bulging of the vocal fold body and the free edge almost reaching the centerline. The injection was administered at a depth of roughly 3 to 5 mm under the mucosa, and the needle was positioned at an angle to achieve a lateral injection site in the vocal folds. Effective visualization facilitated the identification of the optimal dosage and injection location by closely monitoring the instantaneous changes in VF shape throughout the injection process.

Postoperative care:

The patient was instructed to rest their voice for one day and to stay hydrated and use humidification. They were also given medication for pain relief. The patient was released the next day. The patients underwent evaluation using the assessment procedure, both one week and three months following the injection, in order to determine the efficacy of the therapy.

Behavioral readjustment therapy (BRAT): Abou-Elsaad and Kotby [5] has summarized the modality of this treatment into: Postural techniques alter the size of the pharynx and the path of food, while sensory enhancement techniques involve introducing a larger, thicker, or more flavourful bolus, such as a sour bolus, to increase oral sensory input before or during swallowing. They also required using more force with the spoon within the mouth when presenting food. To achieve thermal and tactile stimulation, one can use a size 00 laryngeal mirror to rub against the anterior faucial arch. This area contains both tactile and cold receptors. Additionally, to enhance motor control of swallowing, exercises targeting the muscles involved in swallowing can be performed. These exercises included range of motion exercises, as well as resistance exercises for the lips, tongue, and jaw. The tongue-holding method was used to enhance the movement of the posterior pharyngeal wall during swallowing. Exercises that involve bringing the vocal folds closer together to enhance their movement, the act of holding a gentle and deliberate breath was used as a technique to close the vocal folds or the opening of the airway & swallowing procedures that intentionally modify certain features of the pharyngeal swallow physiology. The modification of food variables involved altering the consistency or viscosity of the food. The reason for using fluid thickeners was to raise the viscosity of the fluids consumed, which in turn increases the resistance to the flow of the food bolus. Furthermore, there was an increase in the length of cricopharyngeal opening and oropharyngeal transit time, which led to alterations in eating behavior.

Ethical approval: The research was conducted in accordance with Helsinki Declaration between March 2019 and September 2019, after clearance from the Ethical Committee of Tanta University Hospitals. All patients provided an informed written consents.

Statistical analysis

The statistical study was conducted using SPSS version 26 software (IBM Inc., Chicago, IL, USA). The quantitative variables were expressed as the mean and standard deviation (SD) and comparison between the two groups by using an unpaired Student's t-test. The qualitative variables were shown as frequency and percentage (%) and examined using the Chi-square or Fisher's exact test, as applicable. A $P \leq 0.05$ was deemed to be statistically significant.

RESULTS

There was no significant different between groups regarding age and sex. Thyroidectomy was the most common cause of VF immobility in the studied groups 12 patient (60%) followed by idiopathic cause in 2 (10%) patients, cardiomyopathy in 1 (5%) stroke in 1 (5%), cervical disc operation in 1 (5%), Lt breast cancer with chemotherapy in 1 (5%), vertebral operation in 1 (5%) and neck surgery and Chiari syndrome in 1 (5%). 6 (60%) patients were injected with a temporary material and 4 (40%) patients were injected with a permanent material (Table 1).

Table (1): Distribution of patients between the two studied groups according to demographic data and etiology of VF immobility and Injection material in injection group in the study

		Behavioral (n=10)	Injection (n=10)	P
Age (years)		42.3 ± 15.21	45.1 ± 12.56	0.659
Sex	**Male**	5 (50%)	6 (60%)	0.653
	Female	5 (50%)	4 (40%)	
Etiology of VF immobility (n=20)				
Cardio-myopathy		1 (5%)		
Cervical disc operation		1 (5%)		
Idiopathic		2 (10%)		
breast cancer and chemo-therapy		1 (5%)		
Neck surgery and Chiari Syndrome		1 (5%)		
Strock		1 (5%)		
Thyroidectomy		12 (60%)		
Vertebral operation		1 (5%)		
Material				
Temporary		6(60%)		
Permanent (Long lasting)		4 (40%)		

Data are presented as mean± SD or frequency (%). VF: Ventricular fibrillation.

There was a significant better result in 1 week and 3 months follow up for injection group than in behavioral group regarding the glottic gap (Table 2).

Table (2): Comparison between the two studied groups according to the glottic gap pre, 1weak and 3 months post intervention

Glottis gap		Behavioral (n = 10)	Injection (n = 10)	p. value
Pre	**No**	0 (0%)	0 (0%)	0.865
	Small	2 (20%)	2 (20%)	
	Moderate	6 (60%)	5 (50%)	
	Large	2 (20%)	3 (30%)	
1w	**No**	0 (0%)	1 (10%)	**0.004***
	Small	2 (20%)	9 (90%)	
	Moderate	6 (60%)	0 (0%)	
	Large	2 (20%)	0 (0%)	
3m	**No**	0 (0%)	3 (30%)	**0.020***
	Small	4 (40%)	7 (70%)	
	Moderate	4 (40%)	0 (0%)	
	Large	2 (20%)	0 (0%)	

Data are presented as frequency (%). *Significant p value <0.05

There was no significant difference between both groups in terms of the presence of residue (Table 3).

Table (3): Comparison between the two studied groups according to presence of residue pre- and post-intervention

		Before	After	P
Behavioral	**Fluid (Pyriform Fossa)**	6 (60%)	3 (30%)	0.178
	Fluid (vallecula)	3 (30%)	2 (20%)	0.606
	Semisolid (Pyriform fossa)	4 (40%)	1 (10%)	0.121
	Semisolid (vallecula)	3 (30%)	0 (0%)	0.060
	Solid (Pyriform fossa)	1 (10%)	1 (10%)	1.0
	Solid (vallecula)	1 (10%)	0 (0%)	0.305
Injection	**Fluid (Pyriform Fossa)**	5 (50%)	5 (50%)	1.0
	Fluid (vallecula)	1 (10%)	1 (10%)	1.0
	Semisolid (Pyriform fossa)	5 (50%)	5 (50%)	1.0
	Semisolid (vallecula)	2 (20%)	2 (20%)	1.0
	Solid (Pyriform fossa)	2 (20%)	2 (20%)	1.0
	Solid (vallecula)	2 (20%)	2 (20%)	1.0

Data are presented as frequency (%).

There was no significant difference between both groups in terms of the presence of residue before and after 3 months (Table 4).

Table (4): presence of residue in the studied groups before and 3 months after

	Behavioral (n = 10)	Injection (n = 10)	p
Pre -intervention			
Fluid (Pyriform Fossa)	6 (60%)	5 (50%)	0.653
Fluid (vallecula)	3 (30%)	1 (10%)	0.264
Semisolid (pyriform fossa)	4 (40%)	5 (50%)	0.653
Semisolid (vallecula)	3 (30%)	2 (20%)	0.606
Solid (Pyriform fossa)	1 (10%)	2 (20%)	0.531
Solid (vallecula)	1 (10%)	2 (20%)	0.531
Post -intervention			
1 weak			
Fluid (Pyriform Fossa)	6 (60%)	5 (50%)	0.653
Fluid (vallecula)	3 (30%)	1 (10%)	0.264
Semisolid (Pyriform fossa)	4 (40%)	5 (50%)	0.653
Semisolid (vallecula)	3 (30%)	2 (20%)	0.606
Solid (Pyriform fossa)	1 (10%)	2 (20%)	0.531
Solid (vallecula)	1 (10%)	2 (20%)	0.531
3 months			
Fluid (Pyriform Fossa)	3 (30%)	5 (50%)	0.361
Fluid (vallecula)	2 (20%)	1 (10%)	0.531
Semisolid (Pyriform fossa)	1 (10%)	5 (50%)	0.051
Semisolid (vallecula)	0 (0%)	2 (20%)	0.136
Solid (Pyriform fossa)	1 (10%)	2 (20%)	0.531
Solid (vallecula)	0 (0%)	2 (20%)	0.136

Data are presented as frequency (%).

There was a significant difference between both groups regarding PAS after 1 week of intervention and PAS 3 months post intervention for fluids (Table 5).

Table (3): Comparison between the two studied groups according to 8-point Penetration-Aspiration scale pre-intervention and post intervention

			Behavioral (n = 10)	Injection (n = 10)	P
Pre					
Fluid PAS	**Normal**	**1**	0 (0%)	0 (0%)	**0.053**
	Penetration	**2**	2 (20%)	1 (10%)	
		3	4 (40%)	0 (0%)	
		4	0 (0%)	3 (30%)	
		5	0 (0%)	0 (0%)	
	Aspiration	**6**	3 (30%)	6 (60%)	
		7	0 (0%)	0 (0%)	
		8	1 (10%)	0 (0%)	
Semisolid PAS	**Normal**	**1**	1 (10%)	0 (0%)	**0.316**
	Penetration	**2**	4 (40%)	6 (60%)	
		3	3 (30%)	1 (10%)	
		4	0 (0%)	2 (20%)	
		5	0 (0%)	0 (0%)	
	Aspiration	**6**	2 (20%)	1 (10%)	
		7	0 (0%)	0 (0%)	
		8	0 (0%)	0 (0%)	
Solid PAS	**Normal**	**1**	5 (5%)	2 (20%)	**0.232**
	Penetration	**2**	2 (20%)	6 (60%)	
		3	2 (20%)	2 (20%)	
		4	0 (0%)	0 (0%)	
		5	1 (10%)	0 (0%)	

			Behavioral (n = 10)	Injection (n = 10)	P
	Aspiration	**6**	0 (0%)	0 (0%)	
		7	0 (0%)	0 (0%)	
		8	0 (0%)	0 (0%)	
Post 1w					
Fluid PAS	**Normal**	**1**	0 (0%)	0 (0%)	**0.003***
	Penetration	**2**	2 (20%)	2 (20%)	
		3	4 (40%)	0 (0%)	
		4	0 (0%)	8 (80%)	
		5	0 (0%)	0 (0%)	
	Aspiration	**6**	3 (30%)	0 (0%)	
		7	0 (0%)	0 (0%)	
		8	1 (10%)	0 (0%)	
Semisolid PAS	**Normal**	**1**	1 (10%)	0 (0%)	**0.116**
	Penetration	**2**	4 (40%)	6 (60%)	
		3	3 (30%)	1 (1%)	
		4	0 (0%)	3 (30%)	
		5	0 (0%)	0 (0%)	
	Aspiration	**6**	2 (20%)	0 (0%)	
		7	0 (0%)	0 (0%)	
		8	0 (0%)	0 (0%)	
Solid PAS	**Normal**	**1**	5 (5%)	2 (20%)	**0.232**
	Penetration	**2**	2 (20%)	6 (60%)	
		3	2 (20%)	2 (20%)	
		4	0 (0%)	0 (0%)	
		5	1 (10%)	0 (0%)	
	Aspiration	**6**	0 (0%)	0 (0%)	
		7	0 (0%)	0 (0%)	
		8	0 (0%)	0 (0%)	
Post 3w					
Fluid PAS	**Normal**	**1**	2 (20%)	1 (10%)	**0.025***
	Penetration	**2**	2 (20%)	1 (10%)	
		3	2 (20%)	0 (0%)	
		4	1 (10%)	8 (80%)	
		5	0 (0%)	0 (0%)	
	Aspiration	**6**	3 (30%)	0 (0%)	
		7	0 (0%)	0 (0%)	
		8	0 (0%)	0 (0%)	
Semisolid PAS	**Normal**	**1**	3 (30%)	2 (20%)	**0.177**
	Penetration	**2**	5 (50%)	4 (40%)	
		3	0 (0%)	1 (1%)	
		4	0 (0%)	3 (30%)	
		5	0 (0%)	0 (0%)	
	Aspiration	**6**	2 (20%)	0 (0%)	
		7	0 (0%)	0 (0%)	
		8	0 (0%)	0 (0%)	
Solid PAS	**Normal**	**1**	6 (60%)	3 (30%)	**0.212**
	Penetration	**2**	3 (30%)	5 (50%)	
		3	0 (0%)	2 (20%)	
		4	1 (10%)	0 (0%)	
		5	0 (0%)	0 (0%)	
	Aspiration	**6**	0 (0%)	0 (0%)	
		7	0 (0%)	0 (0%)	
		8	0 (0%)	0 (0%)	

Data are presented as frequency (%). *Significant p value <0.05, p1, p2 and p3 values showed significant difference regarding injection group (Table 6).

Table (4): 8-point Penetration-Aspiration scale within the pre-intervention, 1weak and 3 months post intervention in behavioral and injection groups

Behavioral			**Pre**	**Post 1w**	**Post 3m**		
Fluid PAS	**Normal**	**1**	0 (0%)	0 (0%)	2 (20%)	**X2**	**7.800**
	Penetration	**2**	2 (20%)	2 (20%)	2 (20%)	**P value**	**0.648**
		3	4 (40%)	4 (40%)	2 (20%)	**P1**	**1.0**
		4	0 (0%)	0 (0%)	1 (10%)	**P2**	**0.458**
		5	0 (0%)	0 (0%)	0 (0%)	**P3**	**0.458**
	Aspiration	**6**	3 (30%)	3 (30%)	3 (30%)		
		7	0 (0%)	0 (0%)	0 (0%)		
		8	1 (10%)	1 (10%)	0 (0%)		
Semisolid PAS	**Normal**	**1**	1 (10%)	1 (10%)	3 (30%)	**X2**	**4.754**
	Penetration	**2**	4 (40%)	4 (40%)	5 (50%)	**P value**	**0.576**
		3	3 (30%)	3 (30%)	0 (0%)	**P1**	**1.0**
		4	0 (0%)	0 (0%)	0 (0%)	**P2**	**0.250**
		5	0 (0%)	0 (0%)	0 (0%)	**P3**	**0.250**
	Aspiration	**6**	2 (20%)	2 (20%)	2 (20%)		
		7	0 (0%)	0 (0%)	0 (0%)		
		8	0 (0%)	0 (0%)	0 (0%)		
Solid PAS	**Normal**	**1**	5 (5%)	5 (5%)	6 (60%)	**X2**	**5.411**
	Penetration	**2**	2 (20%)	2 (20%)	3 (30%)	**P value**	**0.713**
		3	2 (20%)	2 (20%)	0 (0%)	**P1**	**1.0**
		4	0 (0%)	0 (0%)	1 (10%)	**P2**	**0.368**
		5	1 (10%)	1 (10%)	0 (0%)	**P3**	**0.368**
	Aspiration	**6**	0 (0%)	0 (0%)	0 (0%)		
		7	0 (0%)	0 (0%)	0 (0%)		
		8	0 (0%)	0 (0%)	0 (0%)		
Injection							
Fluid PAS	**Normal**	**1**	0 (0%)	0 (0%)	1 (10%)	**X2**	**17.132**
	Penetration	**2**	1 (10%)	2 (20%)	1 (10%)	**P value**	**0.009***
		3	0 (0%)	0 (0%)	0 (0%)	**P1**	**0.014***
		4	3 (30%)	8 (80%)	8 (80%)	**P2**	**0.026***
		5	0 (0%)	0 (0%)	0 (0%)	**P3**	**0.513**
	Aspiration	**6**	6 (90%)	0 (0%)	0 (0%)		
		7	0 (0%)	0 (0%)	0 (0%)		
		8	0 (0%)	0 (0%)	0 (0%)		
Semisolid PAS	**Normal**	**1**	0 (0%)	0 (0%)	2 (20%)	**X2**	**6.750**
	Penetration	**2**	6 (60%)	6 (60%)	4 (40%)	**P value**	**0.564**
		3	1 (10%)	1 (1%)	1 (1%)	**P1**	**0.753**
		4	2 (20%)	3 (30%)	3 (30%)	**P2**	**0.463**
		5	0 (0%)	0 (0%)	0 (0%)	**P3**	**0.494**
	Aspiration	**6**	1 (10%)	0 (0%)	0 (0%)		
		7	0 (0%)	0 (0%)	0 (0%)		
		8	0 (0%)	0 (0%)	0 (0%)		
Solid PAS	**Normal**	**1**	2 (20%)	2 (20%)	3 (30%)	**X2**	**0.403**
	Penetration	**2**	6 (60%)	6 (60%)	5 (50%)	**P value**	**0.982**
		3	2 (20%)	2 (20%)	2 (20%)	**P1**	**1.0**
		4	0 (0%)	0 (0%)	0 (0%)	**P2**	**0.865**
		5	0 (0%)	0 (0%)	0 (0%)	**P3**	**0.865**
	Aspiration	**6**	0 (0%)	0 (0%)	0 (0%)		
		7	0 (0%)	0 (0%)	0 (0%)		
		8	0 (0%)	0 (0%)	0 (0%)		

Data are presented as frequency (%), P1: p value between Pre intervention & 1 weak post intervention, P2: p value between Pre intervention & 3 months post intervention, P3: p value between 1 weak & 3 months post intervention, *P value <0.05 is significant, P value>0.05 non-significant.

Regarding food consistency, chocking was significant in both groups (Table 7).

Table 5: Comparison between the two studied groups regarding the result (the outcome) subjectively according to food consistency affected

	Food consistency	Chocking			Difficult to swallow		
		Pre	Post	p. value	Pre	Post	p. value
Behavioral	Fluid	10 (100%)	5 (50%)	0.010*	3 (30%)	2 (20%)	**0.606**
	Semisolid	2 (20%)	2 (20%)	1.0	2 (20%)	1 (10%)	**0.531**
	Solid	0 (0%)	0 (0%)	-	2 (20%)	0 (0%)	**0.136**
Injection	Fluid	10 (100%)	6 (60%)	0.025*	2 (20%)	1 (10%)	**0.531**
	Semisolid	1 (10%)	0 (0%)	0.305	2 (20%)	2 (20%)	**1.0**
	Solid	0 (0%)	0 (0%)	-	2 (20%)	2 (20%)	**1.0**

Data are presented as frequency (%). *Significant p value <0.05.

DISCUSSION

By studying the effect of BRAT therapy on glottic gap closure, there was no significant improvement after 1 weak and 3 months although there was some improvement after 3 months (2 cases of moderate glottic gap improved to small gaps). Finally, there was no significant effect on glottal gap because voice therapy was not applied because we were concerned with dysphagia not dysphonia in UVFP. This is consistent with **Miyata *et al.*** [6]. The study demonstrated that the VT group had enhanced glottis closure after voice treatment, perhaps resulting from the activation of the motor unit, which remained unaffected by surgical interventions. Likely, **El-Banna *et al.*** [7] demonstrated that implementing early intervention with vocal therapy via the forceful glottal assault technique might effectively avoid the transition to excessive vocal cord closure and promote proper closure of the vocal folds. **LaGorio *et al.*** **[8]** by presenting a case report found that the patient had enhanced laryngeal function as a consequence of dysphagia treatment. The findings suggest that there is a correlation between enhanced vocal fold tension and a greater degree of glottal closure.

This significant decrease in the glottal gap appeared in the follow up periods after VFI was close to the results reported by **Rudolf and Sibylle** **[9]**, and **Fang *et al.*** **[10].** Also, this improvement resembled that of **Bergamini *et al.*** **[11]** and **Matiolli *et al.*** **[12]** who reported significant improvement in glottal closure within the 1st week after injection. So, these results demonstrated that there was significant improvement in injection group vs BRAT group in 1 weak and 3 months follow up regarding the glottal gap closure. This because the immediate fullness effect of VFI versus the delayed effect of BRAT needs patient motivation, training regularity, training continuity and longer time follow up. Swallowing was observed and analyzed using flexible fibreoptic laryngoscopy (FEES) pre-, 1 weak and 3 months post-intervention for observation of swallowing of different consistencies of food for presence of residue in vallecula and pyriform fossa and entrance of the airway by penetration aspiration scale (PAS). FEES was the preferred investigative method used to assess swallow function in our patients. The video-fluoroscopic examination of swallow (VFS) has traditionally been regarded as the definitive method for evaluating pharyngeal swallow function. Nevertheless, various studies have shown that flexible endoscopic evaluation of swallowing (FEES) offers several distinct benefits compared to VFS. VFS and FEES are now regarded as the benchmark of excellence **[13] [14].**

In the current study in behavioral group, after 3 months of BRAT, there was some improvement as regards presence of fluid and semisolid residue in both pyriform fossa and vallecula and presence of solid residue in vallecula but no improvement of solid residue in pyriform fossa. However, p value showed no significant difference. **Bulow *et al.*** **[15]** Outlined the impacts of supraglottic swallow, chin tuck, and effortful swallow. None of these methods decreased the quantity of erroneously directed swallows. Nevertheless, the use of deliberate swallowing or the action of tucking the chin led to a significant decrease in the extent to which the contrast substance entered the larynx, as well as a reduction in the amount of material remaining in the pharynx. Weak pharyngeal constriction was not enhanced by swallowing procedures **[16].**

Regarding presence of residue in injection group, there was nearly no change at all in presence of residue in both pyriform fossa and vallecula between before, 1 week and 3 months after the VF injection. This was expected because IML affects the glottic closure only not the pharyngeal and tongue muscle weakness or the sensory affection in the UVFP and glottic closure. Also, there was no significant difference between either group regarding presence of residue 1week and 3 months post-intervention. This is in agreement with **Kang *et al.*** **[17]** who reported by videofluoroscopic dysphagia scale that no significant improvement in presence of vallecular or pharyngeal residue because IML improves glottic incompetence, but injection laryngoplasty (IL) cannot enhance the sensory abnormalities of the larynx owing to the inconsistent timing of the procedure. Patients who got injectable laryngoplasty after 8 weeks of symptoms start demonstrated more significant improvements compared to those who underwent the surgery after 8 weeks or longer. **Nayak *et al.*** **[18]** found that there was no significant change in the presence of bolus residues in the valleculae, pyriform sinus, or posterior pharynx after undergoing medialization laryngoplasty.

The current research used the PAS to assess the level of aspiration or penetration across all consistencies. There was a significant improvement regarding PAS for fluid consistency after 1 week and after 3 months post IL. Also, there was a significant improvement in PAS for fluid between both groups in both 1 week and 3 months follow up. This phenomenon is logical since glottal closure serves as a tangible obstruction that prevents aspiration when swallowing. UVFP impairs the ability to close the vocal folds and raises the risk of aspiration. IL reduces the likelihood of inhaling foreign objects by increasing the size of the immobile vocal fold and minimizing the space between the vocal folds. **Khadivi *et al.*** [19] found that autologous fat injection in 20 patients with UVFP resulted in a significant improvement in patient aspiration of fluids and solids as documented by fiberoptic examination of swallowing. After six months following surgery, there was a significant 80% reduction in the inhalation of liquids and a complete elimination of the inhalation of solid meals.

Anderson and Mirza [20] reported that All 11 patients who had injections showed progress in their diet, transitioning from NPO to being able to consume food orally. However, eight of these patients needed to have re-injection or thermoplasty throughout the long-term follow-up period, which lasted 132 days. In contrast to our results, **Kang *et al.*** [17] noted that percutaneous IL had a substantial positive effect on glottal closure and vocal fold position in individuals suffering from unilateral vocal cord paralysis caused by malignancy. However, there was no substantial enhancement seen in the PAS. Several potential reasons accounted for the absence of distinction. Firstly, this phenomenon may be ascribed to the ceiling effect, which may have originated from the relatively low severity of ambition among the participants.

In **Kang *et al.*** [17] research, the occurrence of aspiration was seen in only 5 out of 15 patients, representing a prevalence rate of 33%. Furthermore, PAS just indicates the existence or non-existence of aspiration, without providing information about the amount of ambition. IL diminishes the glottal gap and perhaps lowers aspiration. Nevertheless, PAS does not provide evidence of a decrease in the risk of aspiration caused by a reduction in aspiration volume. Furthermore, injectable laryngoplasty is incapable of enhancing the sensory abnormalities of the larynx. Safe swallowing requires intact laryngeal sensation. Mere alterations in structure may not be enough to signify a substantial improvement in the ability to swallow. Furthermore, this might also be ascribed to the inconsistent timing of IL. Unlike our study too, **Kammer *et al.*** [21] reported no observed enhancements in the risk of aspiration after undergoing IL. The research findings indicated that there was no statistically significant change in PAS scores at different time intervals, including before the injection, one week after the injection, and one month after the injection.

Also, **Bhattacharyya *et al.*** [18] showed no notable enhancement in PAS scores seen between the pre-injection and post-injection periods. **Oestreicher-Kedem *et al.*** [22] documented their experience administering treatment to individuals with profound aspiration. Among the three patients who were using a device to remove fluids from their bodies, the administration of an injection allowed them to leave the hospital without needing to be fed via a tube. However, the two remaining patients who received the injection continued to rely on tube feeding for a period of two and 14 months respectively. Furthermore, the one patient who was eligible for release had undergone a total of five injections. Therefore, it is possible that IL does not provide any lasting advantage.

But in BRAT, there was no significant difference in PAS although there was improvement in PAS of fluids and semisolids between before and 3 months post BRAT, but it did not reach the significance. This improvement did not reach the significance, and this may be due to the short period of training and follow-up and the need of BRAT for more time for making better effect. Also, BRAT depends on the patient motivation, regularity of training and continuity of training at home so this needs to be assessed in further research. This enhancement corresponds with a prospective research conducted by **Abou-Elsaad and Kotby** [5], where the findings demonstrated the effectiveness of BRAT procedures in enhancing penetration and aspiration. **Rasley *et al.*** [23] showed that postural strategies have the potential to prevent the inhalation of even tiny amounts of fluid in the majority of patients. In addition, they determined that the video fluoroscopic swallowing test may be broadened to include the impact of different postures, while posing little risk of heightened aspiration.

In our study, by the comparison between the two studied groups according to the subjective outcome according to food consistency affected, chocking of fluid was improved with significance in both groups but there was no significance regarding chocking of semisolids and solids in both groups. Regarding swallowing difficulty of different food consistencies, there was no significance in both groups. However, there was improvement in behavioral group in all consistencies.

Zuniga *et al.* [24] investigations showed a more significant derived advantage compared to various previous studies. The observed advantage can be attributed to isolated unilateral recurrent laryngeal nerve (RLN) injury as the cause of UVFI. In contrast, other studies included patients with UVFI caused by radiation, cerebrovascular accident, skull base pathology, or central nervous system dysfunction, which involve multiple levels of laryngeal dysfunction rather than just RLN injury induced UVFP. **Lin *et al.*** [25] Examined the results of a swallowing training

regimen in a cohort of 49 stroke patients. The patients were allocated into two groups: an experimental group (N = 35) that underwent an 8-week swallowing training regimen (30 min per day, 6 days per week), and a control group (N = 14) that did not receive any treatment. Following the training, the experimental group exhibited substantially greater mean differences compared to the control group in terms of volume per second, volume per swallow, midarm circumference, and body weight changes between pre- and post-training.

There are many constraints in our investigation. Initially, this research did not include a control group for the purpose of comparing swallow results. Furthermore, this research exhibited a somewhat limited sample size. Third, the duration of follow up was short and prolonged study is needed. Fourth, the severity of dysphagia, the duration of dysphagia and the details of the patient continuity on the training at home need to be discussed in other studies in detail. Finally, variance in the timing of IL and its effect on the result needs also to be discussed.

CONCLUSIONS

IL and BRAT can improve oropharyngeal dysphagia in patients with unilateral VFP. IL improved the glottal closure. Therefore, it improves airway protection and increases cough power and helps to prevent aspiration. BRAT improved motor power and motor control of swallowing in oropharyngeal phase, improved impaired sensation, improved bolus flow, and decreased the patient's symptoms.

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