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Chapter

Nutrition Management in Neurogenic Dysphagia

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Abstract

Neurogenic dysphagia is an increasingly common problem. This chapter describes current approaches to enteral nutrition in patients with neurogenic dysphagia. We have shown the possibilities and our experience of using diet with a measured degree of density, specialized thickeners for drinks and food, ready-made enteral mixtures. We also identified patients who need a nasogastric tube or gastrostomy.

Keywords: neurogenic dysphagia, diet, nasogastric tube, gastrostomy tube, thickeners, dense enteral feeding mixtures

1. Introduction

The term "dysphagia" means difficulty in swallowing that a person experiences either during the primary phases of swallowing (usually described as" oropharyngeal dysphagia") or when solid food or liquid is blocked or even passed through with difficulty during its passage from the mouth to the stomach (usually described as "esophageal dysphagia"). Thus, dysphagia is a feeling of an obstacle to the typical passage of ingested food.

The problem of dysphagia of various origins is widespread. The 2011 study in the United Kingdom shows a prevalence of dysphagia in 11% of the general population [1, 2]. Dysphagia develops in 40–70% of stroke patients, 60–80% of patients with neurodegenerative diseases, in almost 13% of adults aged over 65 years, and in more than 51% of elderly patients in nursing homes [3–6]. From a study in Russia, the incidence of dysphagia in hospitals reaches up to 33% and up to 30–40% at home care [5, 7]. Dysphagia is often a prominent condition in various neurological diseases.

The risk of this pathology lies in the high probability of developing formidable complications—malnutrition, dehydration, weight loss, airway obstruction, aspiration pneumonia. Malnutrition with dysphagia is detected during the first week after a stroke in 48.3% of cases, without dysphagia in 13.6% (several authors stated that this complication occurs in 75% of cases). Malnutrition resulting from dysphagia complicates the course of the underlying disease due to the activation of catabolic processes. Among patients requiring long-term rehabilitation, malnutrition can be as high as 50% [1, 8, 9]. Malnutrition syndrome increases susceptibility to

oropharyngeal flora, increases the risk of developing septic complications, leads to suppression of the immune status, reduces the strength of the cough push, reduces the level of wakefulness, impedes the implementation of rehabilitation measures. Aspiration is one of the most severe complications of dysphagia, leading to airway obstruction, aspiration pneumonia [10–12].

Dysphagia—it is a frequent and sometimes even life-threatening complication in patients with central nervous system injury. In patients with a low level of consciousness, dysphagia can cause severe destructive pneumonia, respiratory failure, and death. Nevertheless, even with a preserved level of consciousness, the fact that the presence of dysphagia carries a potential risk of aspiration and asphyxia and this fear of aspiration makes patients with speech disorders avoid taking liquid diet, which leads to dehydration of the body, which is diagnosed by doctors quite late [13, 14].

In addition to such severe complications as aspiration, destructive pneumonia, patients with dysphagia have a high risk of developing protein-energy malnutrition (PEM) due to a reduction in substrate supply. In turn, this problem worsens the quality of life and complicates the course of infectious processes, complicates wound healing, and significantly reduces physical activity [15–19]. In combination with dysphagia (moderate and severe), protein-energy malnutrition is a significant problem in patients with pressure sores. At the same time, the risk of developing pressure ulcers increases in the presence of severe concomitant pathology (spastic paresis, diabetes mellitus, destructive pneumonia), which often accompanies patients with severe brain damage. If the patient is in a chronic critical illness (CCI), the rate of pressure ulcers can reach 80%, despite ongoing preventive measures [20–23].

There are several approaches to nutritional support for neurological patients in the clinic, depending on the severity of dysphagia.

2. Diet with a measured degree of density

The first method aimed not to change the physiology of swallowing (such as surgical or rehabilitation methods) but to improve the passage of the food bolus from the oral cavity into the esophagus and reduce the risk of aspiration. In the case of an acute illness, a diet with a modified degree of density allows starting oral nutrition earlier, reducing the risk of developing disorders in the cerebral cortex's swallowing centers, and preventing digestive disorders. With progressive neurological diseases, this diet helps maintain the natural way of eating as long as possible and improves the quality of life [4, 9, 24]. However, this method also has many disadvantages:

- labor intensity; in a hospital setting, it becomes necessary to create an additional specialized therapeutic diet, which may not consider the patient's characteristics.

- limited use; this method can be safe only in the absence of aspiration, and with progressive neurological disease, there is still a risk of micro aspiration.

Thus, a diet with a certain degree of thickening is suitable for patients with mild dysphagia. From the point of view of economic feasibility, this diet is more applicable at home and in hospitals specializing in neurogenic dysphagia. In the conditions of emergency hospitals, where there are few patients with mild dysphagia, the described method, in our opinion, is too strenuous.

3. Use of nasogastric tube or gastrostomy tube for feeding

This method is justified in severe dysphagia or the absence of sufficient fruitful contact with the patient. Of course, tube feeding is also necessary for acute illness. However, tube feeding disrupts the digestion process in the oral cavity, disrupting synchronization of the secretion of the digestive glands and the entry of the food lump into the lumen of the stomach and intestines, and significantly reduces the quality of life. Moreover, tube feeding does not improve the survival rate of patients with chronic neurological diseases (for example, with dementia) [11, 25–28].

Percutaneous endoscopic gastrostomy (PEG) has several advantages over the nasogastric tube for dysphagia, notably after strokes and severe traumatic brain injury. The gastrostomy tube is more convenient from the point of view of care, and its unconscious or spontaneous removal is less likely. Also, according to several studies, patients with PEG usually receive a sufficient amount of enteral nutrition and, accordingly, have better indicators of nutritional status in comparison with a nasogastric tube [29]. In addition, prolonged standing of the nasogastric tube has a high risk of complications (such as pressure ulcers of the nasal mucosa, esophagus), significantly limits the volume of speech therapy, and may even contribute to the progression of dysphagia. Therefore, it is essential for the timely placement of gastrostomy tubes in such patients. According to clinical guidelines, the placement of a gastrostomy is necessary no later than 4 weeks of using a nasogastric tube or earlier if it is evident that the patient will not be able to return to eating through natural routes soon [5, 7, 30]. Introducing a gastrostomy tube facilitates the work of a speech therapist, increases the effectiveness of rehabilitation measures, and can accelerate the positive dynamics of dysphagia treatment.

4. Use of specialized thickeners

The most crucial point in the treatment of dysphagia is the selection of the food consistency [30–32]. The modern functional food market now offers specialized products for enteral oral nutrition with varying degrees of thickening. Products of the *NUTRI* company are of great scientific and clinical interest in this regard. Nevertheless, in our practice, we used the *Softia S* product to solve swallowing problems (fluids) and facilitate the swallowing of solid food, the *Softia G* product, based on xanthan gum, made it possible to expand thtient's diet[1].

We have conducted a study of the effectiveness of the use of these products. The Federal State Budgetary Scientific Institution "Federal Research and Clinical Center of Intensive Care Medicine and Rehabilitology" approved the studies; protocol No. 5/19 dated December 26, 2019.

Comparison of two groups (primary—*Softia S, Softia G*; control—standard diet) numerically was carried out using the nonparametric Mann-Whitney method. We compared three or more groups in terms of quantitative variables using the nonparametric Kruskal-Wallis method. The statistical significance of the differences between groups for paired and nominal indicators was carried out using the Pearson Chi-square (χ^2) and McNeimer tests in the case of independent and dependent groups, respectively. Relationship analysis was performed using Spearman's nonparametric rank correlation. The analysis of dependent indicators in the case of comparing two periods was carried out based on the Wilcoxon nonparametric test. In the case of comparing three or more measurements, the Friedman nonparametric

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[1] Instructions for use of *Softia S*. http://nutri-us.com/products/softias/index.html and instructions for use of *Softia G*. http://nutri-us.com/products/softiau/index.html [Accessed: September 14, 2021].

test is used. The level of statistical significance was fixed at 0.05. Statistical data processing was performed using Statistica 10 and SAS JMP 11 software packages.

4.1 Product Softia S

According to the initial speech therapy assessment data, all patients had a mild degree of neurogenic dysphagia. According to the instrumental assessment of swallowing function on the Rosenbek scale (PAS), four patients had an aspiration rating of 3 (food enters the airways, remains above the vocal cords, but is not excreted from the airways), 26 patients had an aspiration rating of 2 (food enters the airways, stays above the vocal cords, and clears his throat from the airways). On the Fiberoptic Endoscopic Dysphagia Severity Scale (FEDSS) scale, all patients had a penetration score of 3 (fluid penetration with an excellent protective reflex).

By the end of the study, eight people of the primary group showed restoration of the swallowing function; residual effects of choking persisted in seven people. In the control group, we observed a slight improvement in two patients. In the remaining 13, changes in the degree of dysphagia were not observed (**Table 1**). Laboratory parameters and the bodyweight of patients during the observation period in both groups did not change significantly. In addition, there were no cases of pyrexia during the observation period.

To test the hypothesis about significant changes that occurred during the periods "Day 1," "Day 3," "Day 5," "Day 7," and "Day 14," a statistical analysis was carried out. In the considered period in the category "Breakfast," four out of 16 indicator changes were statistically significant. The most significant changes were found for the indicators "Food consumption time, thickener" (on average, 3.7 min; p = 0.0033); "The number of chokes after fluid intake, thickener" (on average, 7.0 min; p < 0.0001); "Number of chokes during fluid intake, thickener" (average for 8.8 min; p < 0.0001). On the other hand, the minor changes between periods are observed for the following indicators: "Calorie content, control," "F" (fats), and "C" (carbohydrates) (p > 0.6184) (**Table 1**).

In the considered period in the "Lunch" category, three out of 16 indicators change statistically significantly. The most significant changes were found for the indicators "Number of chokes after hydration, thickener" (on average, 8.1 min; p < 0.0001); "The number of chokes during fluid intake, thickener" (on average, 12.1 min; p < 0.0001); "Food consumption time, thickener" (on average, 6.9 min; p < 0.0001). On the other hand, the smallest changes between periods were observed for the following indicators: "Number of chokes after fluid intake, control," "Food consumption time, control," and "C" (carbohydrates) (p > 0.6015) (**Table 2**).

In the considered period in the category "Dinner," eight out of 16 indicators change statistically significantly. The most significant changes were found for the indicators "Number of chokes after fluid intake, thickener" (on average, 6.8 min; p < 0.0001); "The number of chokes during fluid intake, thickener" (average of 8.7 min; p < 0.0001). On the other hand, the pettiest changes between periods were observed for the following indicators: "P" (protein), "Number of chokes after fluid intake, control," and "Amount of fluid consumed, control" (p > 0.4098) (**Table 3**).

Assessing qualitative indicator dynamics (the presence or absence of dysphonia with sputum), statistically significant differences in the dynamics of dysphonia from the 1st to the 14th day of the study were revealed in the primary group all meals. In contrast, in the control group, there were no significant differences (**Table 4**).

4.2 Product Softia G

The duration of the study was 28 days. For the first 14 days, patients received a standard hospital diet, then for another 14 days—a diet supplemented with Softia

Groups	Index	M ± S	M ± S (%)				p
		Day 1	Day 3	Day 5	Day 7	Day 14	
Thickener	Food consumption time, min	32.93 ± 5.57	31.87 ± 5.72 (−3.24)	32.13 ± 5.88 (−2.43)	31.80 ± 5.66 (−3.44)	29.27 ± 5.73 (−11.13)	0.0033
Thickener	Number of chocks during fluid intake	9.80 ± 4.16	8.80 ± 3.78 (−10.20)	6.80 ± 3.76 (−30.61)	5.00 ± 3.68 (−48.98)	1.00 ± 1.31 (−89.80)	<0.0001
Thickener	Number of chocks after fluid intake	7.60 ± 3.64	6.60 ± 3.52 (−13.16)	5.27 ± 3.43 (−30.70)	3.93 ± 3.35 (−48.25)	0.60 ± 0.83 (−92.11)	<0.0001
Thickener	Calorie content	410.28 ± 48.14	454.82 ± 82.89 (10.85)	445.15 ± 57.42 (8.50)	421.65 ± 57.36 (2.77)	416.85 ± 63.71 (1.60)	0.4022
Thickener	P (proteins)	16.27 ± 4.32	18.62 ± 3.95 (14.44)	16.37 ± 2.40 (0.59)	17.58 ± 4.97 (8.04)	17.58 ± 4.97 (8.04)	0.0289
Thickener	F (fats)	17.95 ± 5.05	21.12 ± 3.94 (17.61)	22.43 ± 9.72 (24.90)	22.11 ± 8.03 (23.12)	22.11 ± 8.03 (23.12)	0.8652
Thickener	C (carbohydrates)	50.89 ± 21.36	46.04 ± 17.31 (−9.52)	52.53 ± 12.49 (3.23)	55.03 ± 28.42 (8.15)	48.37 ± 25.85 (−4.95)	0.2491
Thickener	Amount of fluid intake	232.00 ± 24.55	227.33 ± 23.74 (−2.01)	222.00 ± 23.36 (−4.31)	218.00 ± 23.96 (−6.03)	218.67 ± 21.34 (−5.75)	0.5255
Control	Food consumption time, min	34.20 ± 1.66	33.73 ± 1.98 (−1.36)	33.87 ± 2.50 (−0.97)	33.53 ± 2.26 (−1.95)	33.27 ± 1.22 (−2.73)	0.3533
Control	Number of chocks during fluid intake	10.60 ± 3.11	10.87 ± 2.92 (2.52)	10.13 ± 2.77 (−4.40)	10.60 ± 2.90 (0.00)	10.20 ± 3.69 (−3.77)	0.1532
Control	Number of chocks after fluid intake	8.40 ± 2.97	9.00 ± 3.00 (7.14)	8.60 ± 2.82 (2.38)	8.67 ± 2.79 (3.17)	8.20 ± 3.38 (−2.38)	0.3317
Control	Calorie content	452.83 ± 93.07	447.25 ± 85.48 (−1.23)	429.08 ± 63.31 (−5.24)	412.03 ± 62.98 (−9.01)	412.03 ± 62.98 (−9.01)	0.6184
Control	P (proteins)	19.55 ± 5.90	18.00 ± 4.81 (−7.94)	16.76 ± 3.39 (−14.28)	18.00 ± 5.34 (−7.94)	18.20 ± 5.25 (−6.91)	0.5710
Control	F (fats)	26.92 ± 9.89	19.69 ± 5.21 (−26.84)	20.55 ± 8.14 (−23.65)	25.32 ± 9.22 (−5.94)	25.32 ± 9.22 (−5.94)	0.0515
Control	C (carbohydrates)	53.11 ± 25.48	48.99 ± 18.41 (−7.75)	48.17 ± 13.04 (−9.30)	56.46 ± 32.78 (6.31)	56.46 ± 32.78 (6.31)	0.9939
Control	Amount of fluid intake	212.00 ± 15.21	210.67 ± 14.38 (−0.63)	214.67 ± 18.85 (1.26)	214.67 ± 16.42 (1.26)	208.00 ± 16.12 (−1.89)	0.2101

statistically significant differences in indicators are highlighted in color, the p level is presented between the indicators "Day 1" and "Day 14."

Table 1.
Analysis of the dynamics of quantitative indicators for the "Breakfast" category (Softia S).

Groups	Index	M ± S		M ± S (%)				p
		Day 1	Day 3	Day 5	Day 7	Day 14		
Thickener	Food consumption time, min	46.67 ± 3.96	44.27 ± 4.42 (−5.14)	41.40 ± 5.93 (−11.29)	41.73 ± 5.50 (−10.57)	39.73 ± 6.63 (−14.86)		<0.0001
Thickener	Number of chocks during fluid intake	13.47 ± 6.03	11.53 ± 5.69 (−14.36)	9.13 ± 5.74 (−32.18)	6.33 ± 5.33 (−52.97)	1.40 ± 1.80 (−89.60)		<0.0001
Thickener	Number of chocks after fluid intake	8.67 ± 4.50	7.73 ± 4.23 (−10.77)	6.20 ± 3.93 (−28.46)	4.67 ± 3.58 (−46.15)	0.53 ± 0.92 (−93.85)		<0.0001
Thickener	Calorie content	898.33 ± 123.12	847.17 ± 117.86 (−5.69)	778.87 ± 142.40 (−13.30)	782.87 ± 196.44 (−12.85)	784.67 ± 194.25 (−12.65)		0.1960
Thickener	P (proteins)	36.16 ± 11.57	38.56 ± 6.61 (6.65)	35.21 ± 8.94 (−2.61)	35.63 ± 12.40 (−1.46)	35.63 ± 12.40 (−1.46)		0.2171
Thickener	F (fats)	32.01 ± 7.27	30.29 ± 5.96 (−5.39)	26.69 ± 10.09 (−16.62)	27.37 ± 10.33 (−14.51)	27.37 ± 10.33 (−14.51)		0.3131
Thickener	C (carbohydrates)	103.19 ± 24.25	100.61 ± 24.16 (−2.50)	96.09 ± 16.59 (−6.88)	95.40 ± 22.82 (−7.56)	95.53 ± 22.58 (−7.43)		0.1363
Thickener	Amount of fluid intake	406.67 ± 25.26	404.00 ± 13.52 (−0.66)	414.67 ± 32.26 (1.97)	415.67 ± 28.59 (2.21)	417.33 ± 35.75 (2.62)		0.2708
Control	Food consumption time, min	44.27 ± 2.19	43.20 ± 2.08 (−2.41)	43.47 ± 2.56 (−1.81)	43.73 ± 2.91 (−1.20)	43.33 ± 3.62 (−2.11)		0.7084
Control	Number of chocks during fluid intake	14.80 ± 4.26	14.33 ± 4.37 (−3.15)	13.93 ± 4.25 (−5.86)	14.13 ± 4.60 (−4.50)	13.60 ± 5.07 (−8.11)		0.1298
Control	Number of chocks after fluid intake	11.13 ± 3.64	10.93 ± 3.99 (−1.80)	10.73 ± 3.77 (−3.59)	10.93 ± 4.15 (−1.80)	10.53 ± 4.41 (−5.39)		0.6015
Control	Calorie content	899.49 ± 176.08	834.33 ± 147.55 (−7.24)	804.50 ± 114.16 (−10.56)	890.00 ± 157.84 (−1.06)	890.00 ± 157.84 (−1.06)		0.5456
Control	P (proteins)	43.35 ± 11.33	39.44 ± 11.35 (−9.00)	38.05 ± 6.09 (−12.23)	41.84 ± 11.60 (−3.49)	41.37 ± 11.04 (−4.56)		0.0916
Control	F (fats)	34.75 ± 8.90	31.33 ± 6.98 (−9.84)	31.06 ± 7.60 (−10.63)	33.71 ± 7.64 (−3.00)	33.31 ± 7.55 (−4.15)		0.1444
Control	C (carbohydrates)	100.92 ± 21.81	94.93 ± 19.43 (−5.93)	90.07 ± 17.86 (−10.75)	102.55 ± 22.93 (1.61)	102.55 ± 22.93 (1.61)		0.7859
Control	Amount of fluid intake	417.33 ± 18.70	420.00 ± 20.70 (0.64)	421.33 ± 20.66 (0.96)	420.67 ± 19.44 (0.80)	402.67 ± 57.88 (−3.51)		0.4963

Statistically significant differences in indicators are highlighted in color, the p level is presented between the indicators "Day 1" and "Day 14."

Table 2.
Analysis of the dynamics of quantitative indicators for the "Lunch" category (Softia S).

Groups	Index	M ± S	M ± S (%)				p
		Day 1	Day 3	Day 5	Day 7	Day 14	
Thickener	Food consumption time, min	35.40 ± 5.04	35.47 ± 5.68 (0.19)	33.80 ± 6.57 (−4.52)	33.40 ± 6.09 (−5.65)	30.33 ± 6.18 (−14.31)	0.0098
Thickener	Number of chocks during fluid intake	9.40 ± 3.72	8.33 ± 3.89 (−11.35)	6.67 ± 3.96 (−29.08)	5.00 ± 3.53 (−46.81)	0.67 ± 0.90 (−92.91)	<0.0001
Thickener	Number of chocks after fluid intake	7.00 ± 3.05	5.87 ± 2.70 (−16.19)	4.73 ± 3.08 (−32.38)	3.80 ± 2.93 (−45.71)	0.21 ± 0.58 (−96.94)	<0.0001
Thickener	Calorie content	447.55 ± 54.75	496.98 ± 112.01 (11.05)	530.92 ± 79.63 (18.63)	448.04 ± 43.34 (0.11)	448.04 ± 43.34 (0.11)	0.0058
Thickener	P (proteins)	27.03 ± 4.83	30.49 ± 1.74 (12.78)	26.97 ± 3.31 (−0.25)	27.21 ± 3.36 (0.65)	27.21 ± 3.36 (0.65)	0.0186
Thickener	F (fats)	19.68 ± 4.44	21.82 ± 5.79 (10.87)	25.45 ± 3.11 (29.30)	22.74 ± 5.03 (15.52)	21.94 ± 5.38 (11.46)	0.1574
Thickener	C (carbohydrates)	38.26 ± 11.54	45.66 ± 13.33 (19.32)	44.67 ± 15.77 (16.75)	33.29 ± 11.11 (−13.01)	33.29 ± 11.11 (−13.00)	0.1551
Thickener	Amount of fluid intake	226.00 ± 22.30	226.00 ± 20.63 (0.00)	229.33 ± 17.10 (1.47)	219.33 ± 23.14 (−2.95)	213.33 ± 28.45 (−5.60)	0.1568
Control	Food consumption time, min	35.87 ± 3.46	33.67 ± 2.79 (−6.13)	34.47 ± 3.04 (−3.90)	34.33 ± 2.06 (−4.28)	32.87 ± 2.36 (−8.36)	0.0515
Control	Number of chocks during fluid intake	10.67 ± 2.55	9.87 ± 2.77 (−7.50)	10.47 ± 2.90 (−1.87)	10.27 ± 3.15 (−3.75)	10.47 ± 3.48 (−1.87)	0.0573
Control	Number of chocks after fluid intake	8.67 ± 2.79	8.20 ± 2.81 (−5.38)	8.60 ± 2.75 (−0.77)	8.47 ± 2.77 (−2.31)	8.67 ± 3.09 (0.00)	0.4334
Control	Calorie content	461.08 ± 66.18	536.11 ± 92.53 (16.27)	540.05 ± 86.38 (17.13)	438.73 ± 45.20 (−4.85)	438.78 ± 45.26 (−4.84)	0.0024
Control	P (proteins)	28.86 ± 3.03	29.58 ± 3.23 (2.50)	27.43 ± 3.82 (−4.95)	27.43 ± 3.31 (−4.93)	27.43 ± 3.31 (−4.93)	0.4098
Control	F (fats)	19.23 ± 3.56	23.18 ± 5.44 (20.50)	25.84 ± 4.12 (34.36)	20.73 ± 5.27 (7.78)	21.40 ± 4.25 (11.25)	0.0094
Control	C (carbohydrates)	40.77 ± 15.90	50.69 ± 16.18 (24.31)	46.89 ± 16.35 (15.00)	32.09 ± 9.64 (−21.29)	30.76 ± 10.63 (−24.56)	0.0015
Control	Amount of fluid intake	215.33 ± 15.06	214.67 ± 16.85 (−0.31)	213.33 ± 14.96 (−0.93)	213.33 ± 14.96 (−0.93)	218.00 ± 16.12 (1.24)	0.9375

Statistically significant differences in indicators are highlighted in color, the p level is presented between the indicators "Day 1" and "Day 14."

Table 3.
Analysis of the dynamics of quantitative indicators for the "Dinner" category (Softia S).

Groups	Numbers yes/no, Day 1	Increase/Decrease (%)				p
		Day 3–Day 1	Day 5–Day 1	Day 7–Day 1	Day 14–Day 1	
Thickener, breakfast	11/4	+2 (+50.0)/−1 (−9.1)	+2 (+50.0)/−2 (−18.2)	+2 (+50.0)/−4 (−36.4)	+0 (0.0)/−11 (−100.0)	0.0026
Control, breakfast	14/1	+0 (0.0)/−0 (0.0)	+0 (0.0)/−0 (0.0)	+0 (0.0)/−0 (0.0)	+0 (0.0)/−1 (−7.1)	10.000
Thickener, lunch	15/0	+0 (0.0)/−4 (−26.7)	+0 (0.0)/−4 (−26.7)	+0 (0.0)/−10 (−66.7)	+0 (0.0)/−14 (−93.3)	0.0005
Control, lunch	14/1	+0 (0.0)/−0 (0.0)	+0 (0.0)/−0 (0.0)	+0 (0.0)/−0 (0.0)	+0 (0.0)/−1 (−7.1)	10.000
Thickener, dinner	12/3	+0 (0.0)/−3 (−25.0)	+1 (+33.3)/−7 (−58.3)	+2 (+66.7)/−9 (−75.0)	+0 (0.0)/−12 (−100.0)	0.0015
Control, dinner	14/1	+0 (0.0)/−0 (0.0)	+0 (0.0)/−0 (0.0)	+0 (0.0)/−0 (0.0)	+0 (0.0)/−1 (−7.1)	10.000

Statistically significant differences in indicators are highlighted in color, the p level is presented between the indicators "Day 1" and "Day 14."

Table 4.
Analysis of the dynamics of quality indicators (Softia S).

G. On the 1st, 14th, and 28th days of the study, the patients underwent a blood test, determining the level of prealbumin and urea in the blood serum. Furthermore, the patients were examined daily by a speech therapist and a nutritionist. During the daily assessment, the amount of food consumed orally (kcal), the amount of oral nutritional support performed (kcal), the content of proteins, fats, and carbohydrates of the food consumed, the amount of choking during or after drinking, body temperature (number of cases of pyrexia), the presence of dysphonia with phlegm (hoarse/hoarse voice if phlegm is present) are assessed. In addition, we assessed body weight every 2 weeks. The study of the product Softia G included 15 patients, including 8 men and 7 women, with the following distribution:

- By age: four patients—from 73 to 79 years old, five patients—from 63 to 69 years old, four patients—from 45 to 47 years old, two patients—from 22 to 39 years old;

- By pathology: traumatic brain injury (TBI)—2, cerebrovascular accident (CVA)—13.

According to the initial speech therapy evaluation, all patients had a mild degree of dysphagia, making it unnecessary to place a tracheostomy and insert a nasogastric tube for feeding. Moreover, the selected patients, according to the Rosenbek scale (PAS), had an aspiration rating of 2 (food enters the airways, remains above the vocal cords, and clears his throat from the airway), according to the Fiberoptic Endoscopic Dysphagia Severity Scale (FEDSS) scale, all—a penetration rating of 3 (fluid penetration with good protective reflex).

According to the speech therapy examination data, by the end of the study, nine patients showed a complete recovery of the swallowing function, six patients retained residual effects in mild choking (no significant changes were noted outside the use of the product).

During the first 14 days of observation (without *Softia G*), there was no significant increase in food intake. After introducing Softia G into the diet of patients, there was

Groups	Index	M ± S	M ± S (%)				p
		Day 1	Day 3	Day 5	Day 7	Day 14	
Thickener	The amount of food consumed, kcal	320.13 ± 62.22	354.27 ± 109.48 (10.66)	388.47 ± 89.01 (21.35)	463.27 ± 94.30 (44.71)	532.60 ± 111.39 (66.37)	0.0010
Thickener	Number of chocks during fluid intake	9.87 ± 3.48	8.20 ± 3.00 (−16.89%)	6.20 ± 2.78 (−37.16%)	4.40 ± 2.20 (−55.41%)	1.20 ± 1.70 (−87.84%)	<0.0001
Thickener	Number of chocks after fluid intake	8.33 ± 3.27	6.87 ± 3.02 (−17.60%)	5.13 ± 2.42 (−38.40%)	3.53 ± 1.81 (−57.60%)	0.73 ± 1.03 (−91.20%)	<0.0001
Thickener	P (proteins)	11.93 ± 4.22	14.27 ± 5.62 (19.55)	14.13 ± 5.22 (18.44)	15.80 ± 3.93 (32.40)	18.20 ± 4.31 (52.51)	0.0276
Thickener	F (fats)	11.87 ± 3.31	15.13 ± 4.07 (27.53)	14.07 ± 4.03 (18.54)	18.40 ± 4.73 (55.06)	21.13 ± 5.79 (78.09)	0.0021
Thickener	C (carbohydrates)	41.93 ± 8.62	41.20 ± 17.72 (−1.75)	51.00 ± 11.05 (21.62)	59.00 ± 12.36 (40.70)	67.67 ± 13.67 (61.37)	<0.0001
Control	The amount of food consumed, kcal	309.00 ± 75.28	336.87 ± 63.51 (9.02)	292.73 ± 58.80 (−5.26)	324.73 ± 75.18 (5.09)	356.60 ± 72.81 (15.40)	0.1135
Control	Number of chocks during fluid intake	9.47 ± 3.81	9.53 ± 3.07 (0.70)	10.07 ± 3.26 (6.34)	9.67 ± 3.22 (2.11)	9.80 ± 3.30 (3.52)	0.4692
Control	Number of chocks after fluid intake	8.33 ± 3.52	8.00 ± 3.02 (−4.00)	9.00 ± 3.02 (8.00)	8.40 ± 3.29 (0.80)	8.67 ± 2.82 (4.00)	0.3376
Control	P (proteins)	12.73 ± 4.13	13.93 ± 3.24 (9.42)	11.33 ± 2.77 (−10.99)	12.33 ± 3.09 (−3.14)	12.80 ± 2.81 (−0.52)	0.1389
Control	F (fats)	11.13 ± 4.21	13.93 ± 3.28 (25.15)	10.27 ± 2.94 (−7.78)	12.67 ± 4.06 (13.77)	13.93 ± 4.27 (25.15)	0.1355
Control	C (carbohydrates)	39.20 ± 9.35	38.27 ± 11.29 (−2.38)	38.93 ± 8.84 (−0.68)	40.40 ± 9.43 (3.06)	44.07 ± 8.60 (12.41)	0.3772

Statistically significant differences in indicators are highlighted in color, the p level is presented between the indicators "Day 1" and "Day 14."

Table 5.
Analysis of the dynamics of quantitative indicators for the "Breakfast" category (Softia G).

Groups	Index	M ± S		M ± S (%)			p
		Day 1	**Day 3**	**Day 5**	**Day 7**	**Day 14**	
Thickener	The amount of food consumed, kcal	463.80 ± 143.57	499.33 ± 135.98 (7.66)	473.93 ± 109.50 (2.18)	555.80 ± 103.80 (19.84)	643.40 ± 83.55 (38.72)	0.0024
Thickener	Number of chocks during fluid intake	15.73 ± 5.56	13.93 ± 6.11 (−11.44)	11.13 ± 5.66 (−29.24)	8.40 ± 5.21 (−46.61)	2.33 ± 3.52 (−85.17)	<0.0001
Thickener	Number of chocks after fluid intake	12.60 ± 5.79	10.80 ± 6.55 (−14.29)	8.67 ± 5.50 (−31.22)	6.93 ± 4.45 (−44.97)	1.60 ± 2.75 (−87.30)	<0.0001
Thickener	P (proteins)	17.13 ± 5.22	18.80 ± 4.97 (9.73)	19.13 ± 3.31 (11.67)	21.33 ± 2.41 (24.51)	25.40 ± 2.35 (48.25)	<0.0001
Thickener	F (fats)	18.20 ± 6.14	21.53 ± 9.31 (18.32)	17.27 ± 5.66 (−5.13)	17.60 ± 5.77 (−3.30)	21.13 ± 6.63 (16.12)	0.0768
Thickener	C (carbohydrates)	53.33 ± 24.42	62.20 ± 20.71 (16.63)	61.27 ± 15.41 (14.88)	73.93 ± 9.87 (38.63)	88.20 ± 8.23 (65.38)	<0.0001
Control	The amount of food consumed, kcal	357.53 ± 105.37	358.93 ± 94.52 (0.39)	269.40 ± 90.68 (−24.65)	298.33 ± 92.58 (−16.56)	301.87 ± 89.63 (−15.57)	0.0983
Control	Number of chocks during fluid intake	16.33 ± 6.66	15.60 ± 5.88 (−4.49)	16.20 ± 5.68 (−0.82)	15.67 ± 5.22 (−4.08)	15.80 ± 5.95 (−3.27)	0.5060
Control	Number of chocks after fluid intake	13.80 ± 7.01	13.33 ± 6.16 (−3.38)	13.80 ± 5.95 (0.00)	13.47 ± 5.44 (−2.42)	13.13 ± 5.96 (−4.83)	0.4799
Control	P (proteins)	13.40 ± 3.68	13.93 ± 3.58 (3.98)	11.13 ± 3.52 (−16.92)	11.47 ± 3.48 (−14.43)	11.80 ± 3.10 (−11.94)	0.1165
Control	F (fats)	14.53 ± 4.44	14.20 ± 4.35 (−2.29)	9.93 ± 4.42 (−31.65)	10.33 ± 4.39 (−28.90)	10.73 ± 4.57 (−26.15)	0.0468
Control	C (carbohydrates)	43.40 ± 13.39	43.60 ± 11.26 (0.46)	33.60 ± 11.24 (−22.58)	36.80 ± 11.51 (−15.21)	37.93 ± 10.46 (−12.60)	0.0816

Statistically significant differences in indicators are highlighted in color, the p level is presented between the indicators "Day 1" and "Day 14."

Table 6.
Analysis of the dynamics of quantitative indicators for the "Lunch" category (Softia G).

Groups	Index	M ± S	M ± S (%)				p
		Day 1	Day 3	Day 5	Day 7	Day 14	
Thickener	The amount of food consumed, kcal	356.00 ± 82.37	426.80 ± 133.60 (19.89)	499.13 ± 107.84 (40.21)	504.20 ± 85.97 (41.63)	530.53 ± 69.18 (49.03)	0.0056
Thickener	Number of chocks during fluid intake	10.00 ± 3.16	7.80 ± 3.45 (−22.00)	6.47 ± 2.75 (−35.33)	5.07 ± 3.97 (−49.33)	1.13 ± 1.64 (−88.67)	<0.0001
Thickener	Number of chocks after fluid intake	8.60 ± 2.92	6.40 ± 2.90 (−25.58)	5.20 ± 2.37 (−39.53)	3.53 ± 2.26 (−58.91)	0.73 ± 1.16 (−91.47)	<0.0001
Thickener	P (proteins)	17.20 ± 5.28	21.93 ± 4.99 (27.52)	24.00 ± 4.71 (39.53)	27.20 ± 4.21 (58.14)	28.93 ± 4.43 (68.22)	<0.0001
Thickener	F (fats)	16.00 ± 4.87	19.07 ± 6.95 (19.17)	21.20 ± 4.09 (32.50)	20.47 ± 5.71 (27.92)	21.40 ± 4.97 (33.75)	0.0942
Thickener	C (carbohydrates)	35.33 ± 8.54	41.07 ± 14.99 (16.23)	51.27 ± 18.85 (45.09)	52.33 ± 9.86 (48.11)	55.13 ± 8.80 (56.04)	0.0006
Control	The amount of food consumed, kcal	278.07 ± 79.93	292.67 ± 74.94 (5.25)	317.33 ± 77.43 (14.12)	305.47 ± 79.86 (9.85)	251.67 ± 68.26 (−9.49)	0.2569
Control	Number of chocks during fluid intake	9.80 ± 3.21	9.47 ± 3.25 (−3.40)	9.87 ± 3.29 (0.68)	9.47 ± 3.04 (−3.40)	9.80 ± 3.34 (0.00)	0.4647
Control	Number of chocks after fluid intake	8.47 ± 3.25	8.33 ± 2.94 (−1.57)	8.27 ± 3.13 (−2.36)	8.13 ± 3.11 (−3.94)	9.13 ± 3.25 (7.87)	0.2949
Control	P (proteins)	13.73 ± 4.61	14.07 ± 3.01 (2.43)	16.80 ± 5.25 (22.33)	16.73 ± 5.64 (21.84)	13.53 ± 3.94 (−1.46)	0.2139
Control	F (fats)	12.33 ± 5.08	12.00 ± 4.86 (−2.70)	14.07 ± 3.99 (14.05)	12.53 ± 3.80 (1.62)	10.73 ± 4.33 (−12.97)	0.3589
Control	C (carbohydrates)	29.73 ± 9.58	33.47 ± 10.90 (12.56)	31.13 ± 9.46 (4.71)	32.13 ± 9.45 (8.07)	26.73 ± 8.10 (−10.09)	0.4474

Statistically significant differences in indicators are highlighted in color, the p level is presented between the indicators "Day 1" and "Day 14."

Table 7.
Analysis of the dynamics of quantitative indicators for the "Dinner" category (Softia G).

Groups	Numbers yes/no, Day 1	Increase/decrease (%)				p
		Day 3– Day 1	Day 5– Day 1	Day 7–Day 1	Day 14–Day 1	
Thickener, breakfast	8/7	0 (0.0)/−3 (−37.5)	0 (0.0)/−6 (−75.0)	0 (0.0)/−8 (−100.0)	0 (0.0)/−8 (−100.0)	0.0133
Control, breakfast	8/7	0 (0.0)/0 (0.0)	0 (0.0)/0 (0.0)	0 (0.0)/0 (0.0)	0 (0.0)/0 (0.0)	10.000
Thickener, lunch	8/7	0 (0.0)/−3 (−37.5)	0 (0.0)/−6 (−75.0)	0 (0.0)/−6 (−75.0)	0 (0.0)/−8 (−100.0)	0.0133
Control, lunch	8/7	0 (0.0)/0 (0.0)	0 (0.0)/0 (0.0)	0 (0.0)/0 (0.0)	0 (0.0)/0 (0.0)	10.000
Thickener, dinner	8/7	0 (0.0)/−2 (−25.0)	0 (0.0)/−7 (−87.5)	0 (0.0)/−8 (−100.0)	0 (0.0)/−8 (−100.0)	0.0133
Control, dinner	8/7	0 (0.0)/0 (0.0)	0 (0.0)/0 (0.0)	0 (0.0)/0 (0.0)	0 (0.0)/0 (0.0)	10.000

Statistically significant differences in indicators are highlighted in color, the p level is presented between the indicators "Day 1" and "Day 14."

Table 8.
Analysis of the dynamics of quality indicators (Softia G).

a consumption increment in the amount of food both once (during one meal) and daily. Laboratory values during the observation period were relatively stable.

For statistical analysis, the stage without using a thickener was designated as "Control group," the stage with the use of this product as "Thickener Group." To test the hypothesis about significant changes—the periods of "Day 1," "Day 3," "Day 5," "Day 7," and "Day 14" were statistically analyzed. Six out of 12 indicators in the "Breakfast" category during the period under review had statistically significant changes. The most significant changes are found for the indicators in the thickener group: "Number of chocks after fluid intake" (an average of 7.6 min; $p < 0.0001$); "the Number of chocks during fluid intake" (average of 8.7 min; $p < 0.0001$); "the food consumption time" (an average of 26.5 min; $p < 0.0001$). Whereas, the tiniest changes between periods are observed in the following indicators in the control group: "The number of gasps after hydration", "C (fats)" and "The number of chocks during fluid intake" ($p > 0.0001$). (see **Table 5**).

Six out of 12 indicators in the "Lunch" category had statistically significant changes during the time under review. The most significant changes are found for the indicator in the thickener group: "Number of chocks during fluid intake" (average 13.4; $p < 0.0001$); indicator "C (fats)" (average of 34.9; $p < 0.0001$); indicator "P (proteins)," (average 8.3; $p < 0.0001$). The few changes between periods are observed in the following indicators: "P (proteins), in the control group," "The number of chocks after fluid intake, control," and "The number of chocks during fluid intake, control" ($p > 0.0001$) (**Table 6**).

During the time under review, five out of 12 indicators in the "Dinner" category had statistically significant changes. The most significant changes are found for the indicator: "Number of chocks after fluid intake, the thickener" (average of 7.9; $p < 0.0001$); indicator "Number of chocks during fluid intake, the thickener" (an average of 8.9; $p < 0.0001$); indicator "P (proteins), the thickener" (average 11.7; $p < 0.0001$). The few changes between periods are observed in the following indicators: "F (fats), in control," "C (carbohydrates), in control," and "The number of chocks during fluid intake, in control" ($p > 0.0001$) (**Table 7**).

When we assessed the changes in the qualitative indicator (the presence or absence of dysphonia with sputum), we found out that there were statistically significant differences in the dynamics of dysphonia from the 1st to the 14th day of the study in the primary group during all meals. In contrast, no significant differences were present in the control group (**Table 8**).

5. Discussion

The thickening products have found wide applications in our practice. An option for a household-friendly thickener expands the possibilities for adequate oral fluid intake. Earlier, in treating and preventing dysphagia, starch was used to thicken liquids (fruit jelly, milk jelly), which had several disadvantages: the need for thermal processing and the difficulty of dosing the degree of thickening. Currently, many specialized thickeners are easy to use and adjust the required degree of thickening. One of them is the reviewed product *Softia S* of NUTRI company, which allows thickening of any liquid, including drinking water, without changing the organoleptic properties of the drink.

The use of this product facilitated the fluid intake by patients after stroke and TBI with mild dysphagia when swallowing is complicated. Therefore, the use of the product has led to significant facilitation of patient care by medical staff and optimization of their working hours. Furthermore, the regular use of the product decreased the degree of dysphagia resulting from the normalizing act of swallowing due to the training of the oropharyngeal phase in conditions of collective work of the oral-articulatory apparatus, the muscles of the larynx; also, reducing the time of eating, reducing the frequency of choking and manifestations of dysphonia with sputum contributed to an improvement in the quality of life of patients and the effectiveness of rehabilitation measures.

It is difficult to achieve a uniform consistency of mashed products at home. Often, patients take factory-made and ready-made baby purees. Although, on the one hand, this somewhat limits the choice of flavor combinations, on the other, it significantly increases the financial burden on the patient's family. Therefore, we considered the possibility of using the product *Softia G* from NUTRI.

This product made it easier for patients to take food after stroke and TBI with mild dysphagia and difficulty swallowing food, which has led to significant ease of patient care by medical personnel and, most importantly, increased the amount of food consumed.

The degree of dysphagia decreased with regular use of the product, as in the above-considered option for thickening drinks, due to the oropharyngeal phase training in conditions of the oral-articulatory collective work apparatus and the muscles of the larynx.

The frequency of choking and manifestations of dysphonia with sputum decreased significantly, contributing to an improvement in the quality of life of patients and the effectiveness of rehabilitation measures. In addition, an increase in the consumption of macronutrients and the total amount of food received helps prevent the development of protein-energy malnutrition due to underfeeding and improve the nutritional status of patients.

Providing oral food and drink intake in patients with mild dysphagia of various origins is of great importance both in the process of rehabilitation and in subsequent care. It is necessary, if possible, to strive to obtain the total amount of nutrition through natural routes in this category of patients. For these purposes, the use of thickeners *Softia S* and *Softia G* is suitable. The inclusion of these products in the diet increases the safety of oral intake of food and liquids for patients, increases

the amount of food eaten, and can also help to eliminate the phenomena of mild dysphagia during rehabilitation.

6. Ready-made dense enteral feeding mixtures

Along with the use of thickeners in the clinical practice of nutritional support in dysphagia, ready-made dense enteral nutrition mixtures are now widely used:

- grade 1: syrup consistency; it can be drunk through a straw or from a cup, a thin layer remains on the walls

- grade 2: honey consistency; it can be drunk from a cup, a thick layer remains on the walls.

- grade 3: yogurt consistency; cannot be drunk, but we can eat with a spoon

- grade 4: consistency of thick sour cream, in which the spoon can stand on the mixture.

The positive aspect of these mixtures is, first of all, the fact that they are completely ready for use and do not require additional costs. In addition, they have good palatability based on patient preferences, are easy to use by patients, meet the needs with a minimum amount of nutrition, and maintain compliance with therapy. They are mainly high in calories (over 1.2 kcal/ml) and protein. The stable consistency of the mixtures corresponds to the adaptation of food and liquid by the type and degree of swallowing disorders. The use of ready-made mixtures is currently one of the most common medical recommendations. According to the literature, over 80% of physicians consider the intake of thickened liquids to be the most effective therapeutic strategy. One of the reasons for the widespread use of ready-made mixtures is that thickened mixtures do not require adequate cognitive and linguistic abilities. Therefore, the use of such mixtures increases the effectiveness of nutritional support [15, 32–34].

7. Conclusion

Neurogenic dysphagia is a multidimensional and multifactorial problem. This syndrome is typical for many conditions with different etiology, pathogenic mechanisms, and predictable outcomes. Therefore, it is essential to select an adequate nutritional therapy, considering all the patient's characteristics. Each of the described approaches has advantages and limitations. The choice of nutritional support method depends on the degree of dysphagia, the structure of the neurological disease, and short- and long-term prognosis. Patients with mild dysphagia, especially with progressive neurological diseases, should initially be offered ready-made dense enteral feeding mixtures or specialized thickeners, according to the recommendations of a speech therapist. Acute patients with severe-to-moderate dysphagia should be fed with a nasogastric tube. If, in the next 4 weeks, a transition to *per os* feeding is not expected, a gastrostomy is required. However, we recommend that you do not overstretch with the PEG. In the process of rehabilitation, it is effective to combine nutrition through a gastrostomy tube and training of feeding through the mouth with the use of thickeners or ready-made nutritional mixtures.

Conflict of interest

Financial support of the studies *Softia S* and *Softia G* was provided by the Ministry of Agriculture, Forestry and Fisheries of Japan; NUTRI participated in the design of the studies *Softia S* and *Softia G* and discussion of the results.

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