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Research Article

Dietary Fiber in Treatment of Upper Functional Gastrointestinal Disorders

Giga Sordia[1]*, Gela Sulaberidze[1], Maia Okujava[2], Konstantine Liluashvili[1], Vakhtang Shoshiashvili[3] and Marina Tughushi[1]

[1]Department of General Internal Medicine, Tbilisi State Medical University, Tbilisi, Georgia

[2]Department of Medical Pharmacology, Tbilisi State Medical University, Tbilisi, Georgia

[3]First University Clinic, Tbilisi State Medical University, Tbilisi, Georgia

***Corresponding Author:** Giga Sordia, Department of General Internal Medicine, Tbilisi State Medical University, Tbilisi, Georgia.

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Abstract

The Beneficial effect of dietary fiber on lower functional gastrointestinal disorders is well established, but the information about its therapeutic effect on the upper gastrointestinal disorders is insufficient. The aim of the study was to evaluate the effectiveness of dietary intervention using fiber-rich foods in patients with upper functional gastrointestinal disorders. The study involved 164 female patients with corresponding symptoms of functional dyspepsia or nonerosive reflux disease. The average amount of dietary fiber consumed per day was measured at the first visit using the nutritional history questionnaire. The functional state of the gastrointestinal tract was assessed with the clinical questionnaire. To supplement the target rate of dietary fiber to 40 grams per day, patients additionally received 20.2 ± 8.3 grams of fiber. For this purpose, with a regular diet, for breakfast was prescribed 100-400 g bread with a high fiber content or 60-150 g muesli. The clinical condition of patients was assessed initially and after initiation of dietary changes with intervals of two weeks, three times. Assessment of signs and symptoms of functional disorder revealed manifestation of diseases by the overlap of clinical symptoms from different locations. Optimization of the amount of dietary fiber in the diet of patients led to a significant improvement in clinical symptoms. Among the patients with nonerosive reflux disease frequency of esophageal symptoms declined considerably. The frequency of these complaints was estimated at 6 points for the basal condition and decreased to 1.8 after six weeks, in the group of patients with functional dyspepsia esophageal symptoms decreased from 6 to 2.4 points. Optimizing the daily intake of dietary fiber also led to a reduction in symptoms in the epigastric region. In the general group of patients, the initial score of 5.6 points decreased to 2.1 points, the decrease in other symptoms of dyspepsia was also significant. Along with a decrease in symptoms of the upper gastrointestinal tract, intestinal symptoms, in particular constipation, significantly declined, although the number of cases of diarrhea remained almost unchanged. These effects are explained by the influence of dietary fiber on transition time and motility of the intestine.

Keywords: Non-erosive Reflux Disease; Functional Dyspepsia; Dietary Fiber; Esophageal Symptoms; Epigastric Symptoms

Abbreviations

GI: Gastrointestinal; NERD: Non-Erosive Reflux Disease; FD: Functional Dyspepsia

Introduction

Upper functional gastrointestinal (GI) disorders include a number of certain disturbances, among which functional dyspepsia (FD) and nonerosive reflux disease (NERD) are most common [1]. Approximately one third of the globe population suffers from functional GI disorders and represents a serious burden on health care systems. ROME IV criteria define these disorders as combination of persistent or recurrent symptoms without structural changes in GI tract and alteration in biochemical data [2]. The manifestation of symptoms of functional diseases is the result of a variety of disorders, such as changes in the intestinal microbiota, impaired immune function, visceral hypersensitivity and brain-gut axis dysregulation [3].

According to the Montreal definition, NERD is characterized by typical reflux symptoms – heartburn and regurgitation, without visible lesions of the esophageal mucosa. Signs of dyspepsia, like postprandial fullness, early satiety, epigastric pain, and epigastric burning, are common with reflux in NERD patients. According to Rome IV criteria common symptoms of FD are postprandial fullness, early satiation, epigastric burning and epigastric pain. NERD and FD are diagnosed if one or more of the above symptoms appear for at least 3 months, and the symptoms are detected 6 months before the diagnosis [1,4].

It is noteworthy that the combination of dyspepsia with reflux symptoms is a common phenomenon. The similarity of symptoms and pathophysiology of these disorders may be the basis for similar treatment approaches [5]. Studies have shown that in the treatment of NERD, especially in the case of concomitant FD, hypoacid drugs are less effective [6,7]. Moreover, these drugs have the side effects like abdominal discomfort, dyspepsia, bloating, high risk of infections and others. Given the wide prevalence of the diseases and their chronic nature, the development of alternative treatment approaches with fewer side effects is of paramount importance [8].

A number of studies have proven the beneficial effect of dietary fiber on disorders of the gastrointestinal tract. Their use largely depends on the physical and chemical properties of the fibers. The data already obtained show a link between various dietary fibers and clinical effects, but there is insufficient information about the optimal dosages and therapeutic effects of fibers from various sources and different treatments [9,10]. In addition to the beneficial effect of dietary fiber on gastrointestinal disorders, their impact on the oral cavity and gastric secretion, as well as on the peristalsis of the upper gastrointestinal tract, is noteworthy [11-13].

The oral cavity, esophagus, stomach and duodenum are important for mechanical, chemical and enzymatic processing, the regulation of appetite and the protective function of the GI tract, as well as the functioning of the neurohumoral system. Modulation of these functions is possible due to the effect of dietary fibers on the physico-chemical properties of the obtained food, but the role of dietary fibers in this direction is less studied [14].

The effect of dietary fiber is significantly influenced by its physicochemical characteristics: particle size, solubility, ability to retain water and viscosity. In oral processing, solid food is mechanically broken down into small particles. The degree of fragmentation determines better uptake of nutrients contained in the fiber, the ability to retain water is improved due to wall damage, changes in fiber structure and size of the particles. The preprocessed fiber dissolves better in water and its viscosity also increases [15,16]. In addition to structural changes, dietary fiber also undergoes chemical treatment in the upper gastrointestinal tract. Normally, dietary fiber is resistant to hydrolysis under the influence of digestive enzymes, but at a very low pH it undergoes hydrolysis, which can subsequently be associated with its low glycemic index and antioxidant effect [17,18].

Taking into account the wide prevalence of functional diseases of the upper gastrointestinal tract, heterogeneity of the approaches to the treatment and the small number of available research results, the effect of dietary fiber on FD and NERD is an urgent and important area of research.

Materials and Methods

The study involved 164 female patients with corresponding symptoms of functional dyspepsia (FD) or nonerosive reflux

disease (NERD) who were on outpatient treatment. All patients were introduced to and signed informed consent for participation in the study. Their average age was 31.4±7.7 years. In all cases, patients have already visited the clinic several times, and at least 6 months have passed since the first symptoms of the disease appeared. Patients were grouped by disease variants and age, to analyze the obtained results of the study.

The majority of patients - 71.9% (118/164) were less than 35 years old and only 28.1% (46/164)-exceeded 35 years. 80 (48.8%) patients were diagnosed with FD and 84 (51.2%) with NERD. Among the patients with FD, 66 (82.5%) belonged to <35 years old and only 14 (17.5%) to ≥35 years old groups, from the NERD cases, 52 (61.9%) were <35 years old and 32 (39.1%) ≥35 years old.

Before initiation of the research all patients were introduced to and signed the informed consent. Presence of upper functional GI disorders was determined with ROME IV clinical-diagnostic criteria [19,20]: A2 functional heartburn, A3 reflux hypersensitivity, B1 functional dyspepsia, manifested with B1a postprandial distress, or with B1b epigastric functional pain.

Patients with exclusion criteria established before or during the study were excluded from the research. These criteria are: "red flag"symptoms, clinically significant chronic disease with organ function failure, malignant tumor, inflammatory or obstructive bowel disease, surgery of the gastrointestinal tract, pregnancy, breastfeeding, as well as taking medications that affect the secretory and motor function of the gastrointestinal tract during the last 4 weeks, other factors that prevent or make it impossible to provide medical care. Patients did not take proton pump inhibitors or at least a month passed after treatment with these drugs. During the study, patients did not take hypoacid drugs and prokinetics.

At the first visit, the average amount of dietary fiber consumed per day was measured using the nutritional history questionnaire. The functional state of the gastrointestinal tract was assessed with the clinical questionnaire. Both questionnaires are based on internationally recognized and validated questionnaires [21-23]. We used bread and muesli under the brand name "Margi" with wheat bran processed according to the original technology to supplement the diet of patients with dietary fiber [24]. According to the technology, wheat bran undergoes mechanical and chemical processing, which affects the ability of the bran to retain liquid and changes solubility and viscosity of dietary fibers. To supplement the target rate of dietary fiber to 40 grams per day, patients additionally received 20.2 ± 8.3 grams of fiber. For this purpose, with a regular diet, for breakfast was prescribed 100-400 g bread with a high fiber content or 60-150 g muesli (Table 1). The clinical condition of patients was assessed initially before the intervention with dietary fiber and after initiation of dietary changes with intervals of two weeks, such an assessment was carried out three times. The frequency of complains were converted into the points of the Likert scale from 0 to 6.67 (0, 0.445, 0.667, 1, 2.44, 4.45, 6.67). Statistical analysis was performed with SAS/STAT software.

Nutrients	Whole wheat bread (100g)	Wheat grain muesli (100g)	Nutrients for 1 g dietary fiber
Dietary fiber (g)	9.51	22.4	-
Carbohydrates (g)	33.72	29.7	2.51
Protein (g)	7.56	7.33	0.45
Fat (g)	1.31	1.47	0.09
Energy (kcal)	177	212	12.47

Table 1: Nutritional composition of dietary fiber rich bread and muesli.

Study Results and Discussion

Signs and symptoms of functional disorder of the gastrointestinal tract were assessed using a clinical questionnaire, namely:

- Esophageal symptoms: Pain, heartburn.
- Epigastric symptoms: Pain, burning, fullness.
- Other symptoms: Nausea, vomiting, belching
- Symptoms of functional disorders of the intestine: Pain in the abdomen, bloating, abdominal distension, stomach growling.

On the initial visit 69.7% of all patients had esophageal symptoms, 27.3% had pain separately, and only 3% of patients had heartburn separately. In the FD group, 25% of patients complained of both esophageal symptoms, 40% had only pain and 5% - only

heartburn. Among patients with NERD, both symptoms - pain, heartburn, appeared in 95.2% of cases, separately pain showed up in 4.8% of cases and there was not a single patient with heartburn separately (Table 2).

In the whole group of patients, the overlap of all epigastric symptoms was identified in 52.65%, pain was recorded in 25% of cases, burning sensation – in 17.5% and fullness – in 5%. In 90% of FD patients several epigastric symptoms were found in 90%, separately fullness or burning in 5%, 45% of patients with NERD complained of pain, 35% separately of burning and 5% - of fullness. Mixed epigastric symptoms were observed in 15% of NERD patients (Table 2).

The distribution of other symptoms of diseases of the GI tract was as follows: in the whole group, the coincidence of several symptoms was in 43.3% of patients, only nausea – in 26.7%, separately belching – in 30%. Half of the patients with FD had several symptoms at the same time, and nausea or belching were observed separately in 25% of patients. Among patients with NERD, 30% had an overlap of symptoms, only nausea was in 30% of cases and only belching was in 40% (Table 2).

Simultaneously with symptoms from the upper gastrointestinal tract, some patients complained of functional disorders from the lower gastrointestinal tract. Abdominal pain and bloating were observed in 81.8% of all cases. Separately, abdominal pain was observed in 12.1%, and separately bloating/distention - in 6.1% of the total group of patients. In 81.3% of patients with FD, symptoms from the lower gastrointestinal tract coincided, and abdominal pain was reported in 18.8% of cases. Among the patients of the NERD group, 82.8% had several symptoms, 5.9% had abdominal pain, and 11.8% had bloating/distention (Table 2).

In the general group of patients, 58.8% complained of constipation and 15% of diarrhea. Constipation was detected in 50% of cases among patients with FD and 52.4% among NERD, diarrhea was observed in 25% of patients with FD and 4.8% of patients with NERD (Table 2).

Location	Manifestation of symptoms	unit	General group	FD	NERD
Esophagus	Coincidence of several symptoms	%	69.7	25.0	95.2
	Separately heartburn	%	3.0	5.0	0
	Separately pain	%	27.3	40.0	4.8
Epigastrium	Coincidence of several symptoms	%	52.6	90.0	15.0
	Separately pain	%	25.0	5.0	45.0
	Separately burning	%	17.5	0	35.0
	Separately fullness	%	5.0	5.0	5.0
Other symptoms of dyspepsia	Coincidence of several symptoms	%	43.3	50.0	30.0
	Separately nausea	%	26.7	25.0	30.0
	Separately belching	%	30	25.0	40.0
	Separately vomiting	%	0	0	0
Intestine	Coincidence of several symptoms	%	81.8	81.3	82.3
	Separately pain in the abdomen	%	12.1	18.8	5.9
	Separately bloating	%	6.1	0	11.8
	Separately distension/growling	%	0	0	0
Constipation	Manifestation of symptoms	%	51.2	50.0	52.4
Diarrhea	Manifestation of symptoms	%	15.0	25.0	4.8

Table 2: Manifestation of clinical symptoms in different study groups.

After evaluating the dietary model and clinical symptoms of patients, bread and muesli enriched with dietary fiber were included in the diet to ensure daily intake of dietary fiber in an amount of up to 40 g. To assess the effect of the intervention, we compared the frequency of various clinical symptoms after the inclusion of fiber-rich foods in the diet with baseline data. Dietary intervention was evaluated three times with an interval of two weeks.

In all three groups of patients: the general group, FD and NERD, the manifestation of various clinical symptoms was reduced compared to the untreated condition. The most noticeable difference was between the basic visit and the first study visit. Especially significant was the change in epigastric symptoms from the first to the second study visit, the frequency of scores decreased from 3.7 to 2.1 ($p < 0.006$). Over the next two weeks, the trend continued to decrease in all types of symptoms (Figure 1).

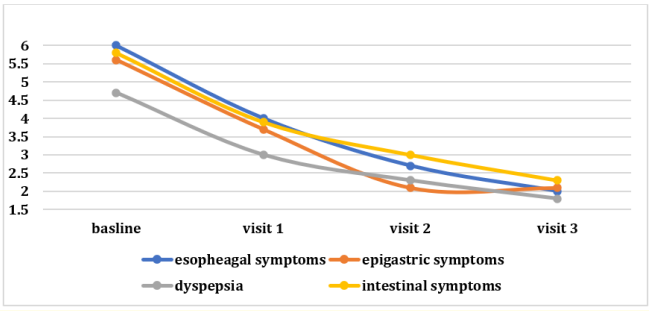

Figure 1: Changes of the frequency score of the clinical symptoms in the general group of patients.

Among FD patients most considerable was a decrease in esophageal and epigastric symptoms. In both cases, difference between basal and final estimates was 3.6. However, epigastric symptoms changed more significantly during the first two weeks, while the epigastric symptoms decreased at a stable rate throughout the follow-up period. Thus, the curve reflecting the change in these symptoms is almost linear. The change in all symptoms compared to the starting point was significant ($p < 0.002$) (Figure 2).

A significant improvement in symptoms was also observed in NERD group. The most noticeable was the change in esophageal

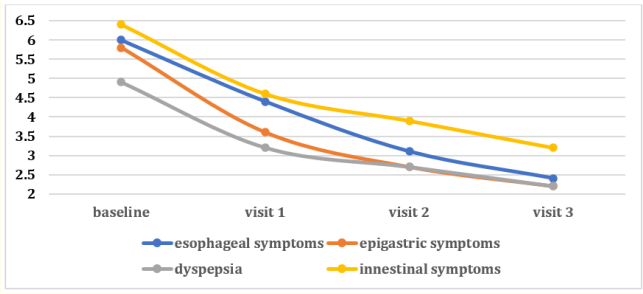

Figure 2: Changes of the frequency score of the clinical symptoms in the patients with FD.

symptoms, in particular, the initial 6.0 points decreased to 1.8. All four types of complaints decreased almost equally from the initial to the first study visit, after the rate of changes decreased, especially with regard to dyspepsia and intestinal symptoms. In all cases, the difference between the initial and final values was significant ($p < 0.002$) (Figure 3).

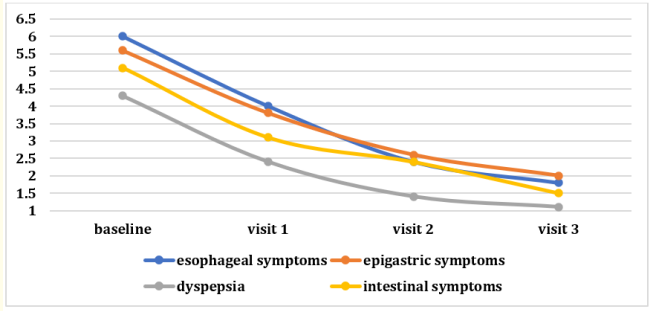

Figure 3: Changes of the frequency score of the clinical symptoms in the patients with NERD.

Along with symptoms from the upper gastrointestinal tract, intestinal functions have also improved. At the time of inclusion in the study, 51.2% of all patients had constipation. In the general group, the stool frequency was estimated at 2.7 points, at the last visit the same indicator was 5.5, in the FD and NERD groups, and the final value of the stool frequency was 5.2 and 5.7, respectively. The improvement of this symptom in all groups was significant ($p < 0.007$) (Figure 4).

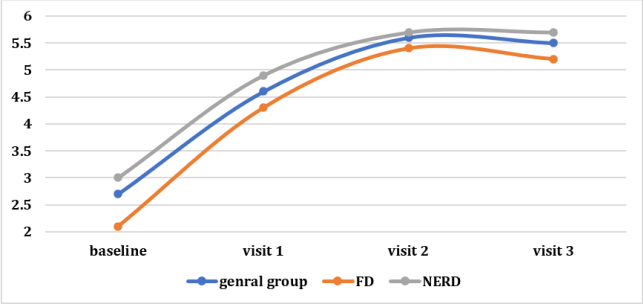

Figure 4: The effect of the optimization of the daily consumption of dietary fiber on constipation.

It is noteworthy that diarrhea during treatment with dietary fiber increased, but did not decrease. The most significant increase in the frequency of stool was observed in the group of patients with PD during the first and second visits for the study (Figure 5).

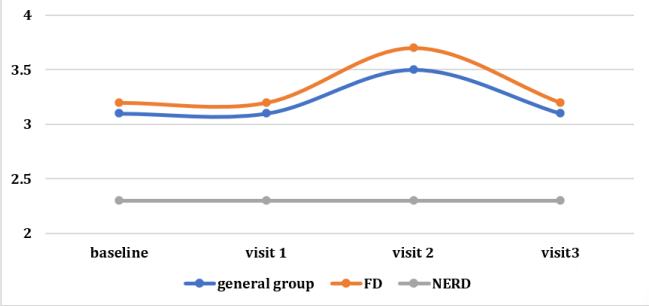

Figure 5: The effect of the optimization of the daily consumption of dietary fiber on diarrhea.

According to the results obtained, optimization of the amount of dietary fiber in the diet of patients with functional disorders of the upper GI tract led to a significant improvement in clinical symptoms. The changes that occurred in the first two weeks were particularly significant. Among the patients with NERD frequency of esophageal symptoms declined considerably. The frequency of these complaints was estimated at 6 points for the basal condition and decreased to 1.8 after six weeks. These symptoms also decreased significantly in the group of patients with FD. It is noteworthy that data on the effect of dietary fiber on functional disorders of the upper GI tract are very limited. Improvement of esophageal symptoms, in addition to gastric empting and motility, is the result of other mechanisms. Nobel and co-authors have established the beneficial effect of dietary fiber on the microbiome of the esophagus, in particular, the number of firmicutes increases and the proportion of gram-negative microorganisms decreases [25]. According to the mentioned study, dietary fiber deficiency causes disorders of the esophageal microbiome and leads to chronic inflammation of the organ.

Our study demonstrated an improvement in intestinal symptoms simultaneously with thecomplains related to upper gastrointestinal tract. Along with other mechanisms, changes in the microbiome are of particular importance. Clostridium IV and XIVa clusters increase the synthesis of short-chain fatty acids. Especially important for improving intestinal health is production of butirate, which supply energy to colonocytes and help maintain the integrity of the mucosal barrier. This, on the other hand, reduces the likelihood of developing opportunistic intestinal infections and mucosal damage [26].

Optimizing the daily intake of dietary fiber also led to a reduction in symptoms in the epigastric region. In the general group of patients, the initial score of 5.6 points decreased to 2.1 points for complaints in the epigastric region, the decrease in other symptoms of dyspepsia was also significant. The beneficial effect of dietary fiber may be associated with the antioxidant effect of phenolic compounds. For the interaction between dietary fibers and phenolic compounds, preprocessing of the source of dietary fiber, particle size and composition of the food product is especially important. Phenolic compounds, in turn, play an important role in the health of the upper and lower gastrointestinal tract, due to the antioxidant, antiestrogenic, immunomodulatory, anti-inflammatory and anti-carcinogenic properties of these compounds [27]. Oxidative stress and changes in the immune function of the mucous membranes play an important role in the pathogenesis of functional dyspepsia [1]. Thus, the improvement of symptoms due to optimization of the consumption of dietary fiber may be the result of enhanced antioxidant activity and improved immune dysfunction.

Evaluation of clinical data of the patients with upper functional GI disturbances revealed that the most common intestinal symptom

was constipation, and the reliable positive effect of products rich in dietary fiber should be explained by the improvement of motility and evacuation function, which is a well-known effect of the fiber [9].

Conclusions

Functional disorders of the upper gastrointestinal tract are characterized by a wide range of clinical symptoms. Both functional dyspepsia and nonerosive reflux disease are more often manifested by the overlap of clinical symptoms from different locations.

By optimizing the daily consumption of dietary fiber, all types of clinical symptoms were significantly reduced. In the general group of patients and both groups of upper functional GI disorders, the decrease in clinical symptoms was more pronounced at the initial stage of the intervention with dietary fiber, followed with stabilization of the effect in the subsequent period.

Along with a decrease in symptoms of the upper gastrointestinal tract, intestinal symptoms, in particular constipation, significantly declined, although the number of cases of diarrhea remained almost unchanged. These effects are explained by the influence of dietary fiber on transition time and motility of the intestine.

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Conflict of Interest

No potential conflict of interest was reported by the authors.

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