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ORIGINAL CONTRIBUTIONS

Impact of Probiotics on Gastrointestinal Function and Metabolic Status After Roux-en-Y Gastric Bypass: A Double-Blind, Randomized Trial

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Abstract

Purpose Postoperative changes in gut microbiota may occur in patients undergoing Roux-en-Y gastric bypass surgery. In this study, we evaluate the impact of administering probiotic tablets on the gastrointestinal function and metabolic status of these patients.

Materials and Methods This double-blinded randomized clinical trial was conducted from 2021 to 2022 on 135 Roux-en-Y surgery candidates. The intervention group underwent the surgical procedure and started receiving probiotic supplements (Familact Co.) 1 week after surgery; the control group received a placebo. The laboratory and anthropometric data were measured and analyzed before and 3 and 6 months after the intervention. GIQLI questionnaire was also used at the beginning and 6 months after the intervention to evaluate GI symptoms.

Results We observed significantly reduced BMI in both groups after surgeries ($P<0.001$). The levels of FBS and HbA1C were significantly lower in the probiotic group compared to the placebo in 3 months ($P=0.02$ and $P=0.001$, respectively) and 6 months ($P<0.001$ for both) after the intervention. The levels of vitamin B12 increased significantly in the probiotic group ($P<0.001$), and the values were substantially higher than the placebo group in 3 and 6 months ($P<0.001$), respectively. Analysis of the GIQLI questionnaire before and 6 months after interventions also revealed significant improvement in the GIQLI score in both groups ($P<0.001$ for probiotics and $P=0.03$ for placebo).

Conclusion Probiotic supplement administration following RYGB improves patients' vitamin and metabolic profile, as well as GI function, although it cannot significantly affect weight loss.

Keywords Obesity · Obesity surgery · Bariatric surgery · Probiotic · Gut microbiota · Clinical trial

Introduction

Obesity, one of the most common multifactorial chronic diseases, is caused by the interplay of environmental factors with genetic predispositions [1]. Excessive fat accumulation can impair health indicators and reduce life expectancy and quality of life [2]. Obesity is a known risk factor for many

Key points
- Bariatric surgery is effective in lowering the BMI and improving the metabolic profile and subjective GI symptoms in patients with obesity.
- Probiotics could result in a more significant post-op reduction in FBS and HbA1C.
- An increase in vitamin B12 level and GIQLI scores compared to placebo was observed in patients who received probiotics.

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health conditions, including diabetes, cardiovascular diseases, renal failure, some cancers, and even musculoskeletal disorders. It is generally accepted that obesity predisposes the patient to a pro-inflammatory state, which can impair many metabolic pathways [3].

Bariatric surgery is one of the most effective treatments for severe obesity. Roux-en-Y gastric bypass (RYGB) and one anastomosis gastric bypass (OAGB) are standard bariatric surgery procedures [4–6]. Many studies have shown that RYGB causes significant excess weight loss (60–70%) in patients with severe clinical obesity [7]. Laparoscopic RYGB also prevents obesity-related comorbidities and improves patients' quality of life [8]. Therefore, many surgeons consider RYGB the surgery of choice for treating patients with severe obesity.

A growing body of evidence shows that the pro-inflammatory state does not resolve in the first few months after surgery [9]. This may have various reasons, including physical damage to gastrointestinal mucosa during surgery and changes in the gut microbiota that cause bacterial translocation and active inflammatory responses [10]. Recent evidence suggests gut microbiota changes could impact obesity, weight loss, and inflammation [11, 12]. Changes in the size and structure of the microbiome (increased *firmicutes* and decreased *Bacteroides*) have been observed in individuals with obesity [13, 14]. Anatomical and physiological changes in the GI tract can also affect gut microbiota [15]. Bacterial overgrowth has been reported after gastric bypass surgery [16]. It is possible that metabolites from the intestinal microbiome, such as lipopolysaccharides, may affect immune cells' secretion of inflammatory factors [17]. Numerous studies show that probiotic supplements can positively affect the microbiota and are associated with decreasing lipopolysaccharides, resolving inflammatory status, and improving anthropometric variables [18, 19].

Since the deficiency of micronutrients may deteriorate or even develop shortly after bariatric surgery, probiotics may also be somewhat useful in this regard. So far, there is little evidence depicting the direct effect of probiotics on the patients' micronutrient status, GI conditions, and blood biomarkers. Therefore, this study is designed to investigate the impact of probiotics on blood biomarkers, anthropometric factors, and GI status and symptoms in patients with obesity undergoing Roux-en-Y surgery.

Methods and Material

Trial Design

This double-blinded randomized clinical trial was performed from 2021 to 2022 on Roux-en-Y candidates admitted to Al-Zahra hospital, affiliated to Isfahan University of Medical Sciences, Esfahan, Iran. Our Research Committee approved the study protocol and the Ethics committee has confirmed it (Ethics code: IR.MUI.MED.REC.1399.849, Iranian Registry of Clinical Trials (IRCT) code: IRCT20220702055340N1).

Participants and Eligibility Criteria

The inclusion criteria were 16 to 60 years of age, severe obesity (body mass index (BMI) ≥ 40 kg/m^2 or $35 \leq$ BMI ≤ 40 kg/m^2 with pertinent comorbidities), and signing the written informed consent to participate in this study. Patients with the following criteria did not enter the study: having evidence of chronic gastrointestinal, hepatic, or renal disorders, pregnancy, and breastfeeding. Other exclusion criteria were receiving antibiotics, probiotics or probiotic-enriched foods, non-steroid anti-inflammatory drugs (NSAID), or insulin within 4 weeks before the study initiation, a history of GI surgeries, and a history of any comorbidity, including diabetes, hypertension, etc.

Sample Size

To calculate the sample size in this study, the following formula was used: $[(Z1+Z2)^2(S1^2+S2^2)] / (X1-X2)^2$. In this formula, $Z1$ was the 95% confidence interval of the study, and $Z2$ was the 80% confidence interval of the study. Also, $S1$ was equal to $S2$ and was equal to 1.6 of the range of score changes in the Gastrointestinal Quality of Life Index (GIQLI) questionnaire, which was equal to 24. The denominator of fraction or d was also considered equal to the amount of change in the mean GIQLI in the two groups, which makes the difference statistically significant (S0.75, which was equal to 18). In this way, the sample size was approximately 67 people in each group.

Randomization and Blinding

Eligible patients were selected consecutively from patients referred to the Al-Zahra Hospital clinic for Roux-en-Y surgery. Patients were randomly assigned into two groups using Random Allocation Software. The mechanism of randomization was not revealed to any party until the end. The bio-fermentation pharmaceutical company determined the probiotic and placebo, and the samples in each group were delivered to the researcher after the coding under the names A and B. The groups were decoded after statistical analysis. This trial was also double-blind, which means that neither the patients nor the data collectors and data analysts were aware of the received interventions.

Intervention

The intervention group received the intervention (probiotic supplement), and the control group received a placebo. Patients underwent surgical interventions and started receiving probiotic supplements (Familact) 1 week after surgery, with visits at 1 week, 5 weeks, 9 weeks, and 12 weeks after surgery. Both groups were recommended to follow diet and exercise guidelines based on clinical guidelines for overweight and patients with obesity and guidelines for nutritional, metabolic, and non-surgical support of patients undergoing obesity surgery. Patients were given 40 mg of pantoprazole as well as mineral supplements according to the protocol of the multivitamin treatment center. Also, after 4 months of surgery, 1000 Mg vitamin B12 was prescribed. Other necessary supplements were also prescribed. The duration of medical interventions (placebo or probiotic) was 3 months.

Outcomes

Demographic data of patients were collected using a checklist. These data were age, gender, weight, and height. The amount of weight loss of the patient was calculated based on the formula: $100 \times \frac{preopW - currat W}{Preop W - Ident W}$

Also, BMI, the amount of additional BMI reduction, and the total weight loss of the patient were measured and calculated. The ideal weight was equal to the patient's weight at BMI = 25.

At the beginning of the study, biochemical laboratory data of the patients were also measured. These data were fasting blood sugar (FBS), HbA1C, Total cholesterol (Chol), high-density lipoprotein (HDL), low-density lipoprotein (LDL), Aspartate transaminase (AST), Alanine transaminase (ALT), Alkaline phosphatase (ALK-P), albumin (Alb), Prothrombin Time (PT), Partial Thromboplastin Time (PTT), INR, VitB12, Calcium (Ca), Sodium (Na), potassium (K), Phosphorus (P), magnesium (Mg), Zinc (Zn), blood urea nitrogen (BUN), and creatinine (Cr).

The laboratory and anthropometric data were measured and analyzed 3 and 6 months after interventions.

We also used the GIQLI questionnaire at the beginning of the study and 6 months after interventions [20]. The GIQLI is a 36-item questionnaire designed to assess GI-specific health-related quality of life in clinical practice and clinical trials of patients with GI disorders. It has five domains (GI symptoms, emotion, physical function, social function, and medical treatment), and subscores range from 0 to 4. The total score ranges from 0 to 144. Higher scores mean better GI health-related quality of life.

Statistical Analysis

The obtained data were entered into the Statistical Package for Social Sciences (SPSS) (version 24, SPSS Inc., Chicago, IL). Quantitative data were reported as mean ± standard deviation and qualitative data as frequency distribution (percentage). Chi-square, paired and independent *t* test, ANCOVA, and repeated measures ANOVA were used to analyze the data. P value < 0.05 was considered the significance threshold.

Results

In this study, 140 patients were assessed for eligibility. Two cases did not enter the study due to evidence of chronic gastrointestinal disorders. One hundred thirty-eight patients were divided into two groups, each containing 69 patients. During the investigation, one patient in the intervention group and two patients in the placebo group were excluded due to a lack of proper follow-up. In the end, data from 135 patients were analyzed. The CONSORT flow chart of the patients is shown in Fig. 1.

The study population comprised 96 women (71.1%) and 39 men (28.9%) with a mean age of 32.16 ± 8.44 years. The mean BMI of patients was 46.33 ± 3.69 kg/m^2 before the study. The primary analysis of demographic data showed no significant differences between the two groups regarding age, gender, weight, height, and BMI ($P > 0.05$). These data are indicated in Table 1.

The laboratory data of patients 3 and 6 months after interventions were recorded. As shown in Table 2, all patients had significantly reduced levels of FBS, HbA1C, LDL, AST, and ALT at 3 and 6 months after interventions compared to baseline ($P < 0.001$). The levels of FBS and HbA1C were significantly lower in the probiotic group compared to placebo in 3 months ($P = 0.02$ and $P = 0.001$, respectively) and 6 months ($P < 0.001$ for both) after interventions. The levels of vitamin B12 increased significantly in the probiotic group ($P < 0.001$), and the values were substantially higher than the placebo group in 3 and 6 months after interventions ($P < 0.001$ for both). It was observed that the levels of albumin and Na and K decreased in the placebo group. Still, these reductions were insignificant, and all patients had electrolyte levels within the normal range. No other significant changes were observed (Table 2).

Based on these data, we observed significantly reduced BMI in both groups after surgeries. The mean values for BMI were 46.33 ± 3.69, 33.14 ± 4.15, and 29.42 ± 3.66 before, 3, and 6 months after surgeries ($P < 0.001$). The mean reduced BMI value was 16.91 ± 2.77 kg/m^2 in the total study population after 6 months. There were no significant differences between the two groups regarding mean and reduced values of BMI during the study. We also reported total weight loss

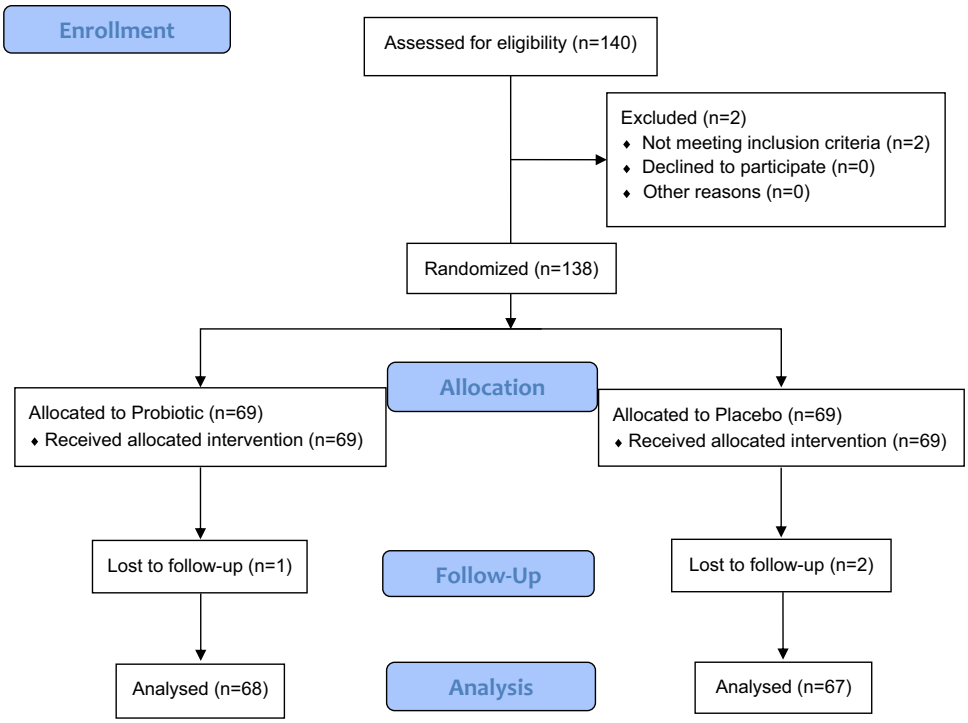

Fig. 1 CONSORT flow diagram

Table 1 Comparison of demographic data between patients

Variable		Group		Total ($N=135$)	P value
		Probiotic ($N=68$)	Placebo ($N=67$)		
Age (year) (mean ± SD)		33.28 ± 9.18	31.83 ± 8.62	32.16 ± 8.44	0.386
Weight (kg) (mean ± SD)		125.33 ± 5.02	125.95 ± 4.38	125.47 ± 4.24	0.822
Height (cm) (mean ± SD)		165.42 ± 15.39	164.19 ± 14.07	164.68 ± 14.27	0.179
BMI (kg/m^2) (mean ± SD)		45.98 ± 3.92	46.50 ± 4.57	46.33 ± 3.69	0.633
Gender (N (%))	Male	19 (27.9%)	20 (29.8%)	39 (28.9%)	0.144
	Female	49 (72.1%)	47 (70.2%)	96 (71.1%)	

(TWL) and excess weight loss (EWL) in both groups at both 3 and 6 month post op. No significant difference was observed between groups. These data are shown in Table 3.

Analysis of the GIQLI questionnaire before and 6 months after interventions also revealed significant improvement in the GIQLI score in both groups ($P<0.001$ for probiotics and $P=0.03$ for placebo). Before interventions, there were no significant differences between the two groups, but after 6 months, the probiotic group had significantly higher scores compared to the placebo group ($P<0.001$) (Table 4).

Discussion

In the present study, we evaluated data from 133 patients that have undergone bariatric surgery. Our results imply probiotics could result in a more significant post-op reduction in FBS and HbA1C and an increase in vitamin B12 and GIQLI scores compared to placebo. Furthermore, the effectiveness of bariatric surgery in improving the metabolic profile and subjective GI symptoms in patients with obesity was improved when patients were supplemented with probiotics. However, the BMI change was shown to have no significant difference among two groups.

Previous studies have also investigated the use of probiotics after bariatric surgery. Primarily, in 2009, Woodard et al. reported a significantly higher excess weight loss (EWL) in probiotic group compared to control group at 6 weeks and 3 months in probiotic-supplemented patients. Interestingly, they observed this trend until 6 months, but it did not show any statistical significance at that point. Additionally, their intervention group had higher vitamin B12 level, post-op. Significantly improved GIQoL was also reported in both groups [21]. Later on, Fernandes et al., in 2016,

Table 2 Comparison of different laboratory data between patients

Lab data		Group		*P* value
		Placebo ($N=67$)	Probiotic ($N=68$)	
FBS (mg/dL) (mean ± SD)	Before	103.42 ± 12.36	103.91 ± 13.07	0.338
	After 3 months	95.51 ± 10.74	91.32 ± 11.18	0.02
	After 6 months	93.35 ± 11.26	87.21 ± 10.54	< 0.001
P value		< 0.001	< 0.001	
HbA1C (%) (mean ± SD)	Before	6.05 ± 0.18	5.98 ± 0.42	0.217
	After 3 months	5.76 ± 0.41	5.42 ± 0.31	0.001
	After 6 months	5.59 ± 0.47	5.33 ± 0.53	< 0.001
P value		< 0.001	< 0.001	
TChol (mg/dL) (mean ± SD)	Before	182.11 ± 11.34	180.95 ± 10.47	0.418
	After 3 months	180.68 ± 9.75	181.22 ± 9.57	0.362
	After 6 months	181.19 ± 10.71	181.30 ± 9.87	0.647
P value		0.633	0.511	
HDL (mg/dL) (mean ± SD)	Before	46.15 ± 7.55	47.69 ± 8.13	0.714
	After 3 months	47.82 ± 7.69	46.29 ± 7.75	0.244
	After 6 months	47.19 ± 6.04	47.40 ± 7.88	0.253
P value		0.816	0.457	
LDL (mg/dL) (mean ± SD)	Before	127.51 ± 27.11	129.47 ± 26.91	0.527
	After 3 months	106.07 ± 24.96	105.58 ± 22.62	0.241
	After 6 months	97.81 ± 19.51	95.53 ± 21.08	0.677
P value		< 0.001	< 0.001	
AST (U/L) (mean ± SD)	Before	28.43 ± 15.44	28.15 ± 14.33	0.117
	After 3 months	26.60 ± 15.67	25.86 ± 15.81	0.415
	After 6 months	22.16 ± 14.30	22.39 ± 14.97	0.361
P value		< 0.001	< 0.001	
ALT (U/L) (mean ± SD)	Before	35.20 ± 15.14	35.92 ± 14.75	0.435
	After 3 months	27.19 ± 16.80	28.07 ± 15.52	0.249
	After 6 months	24.36 ± 14.87	25.29 ± 16.45	0.511
P value		< 0.001	< 0.001	
ALK-P (IU/L) (mean ± SD)	Before	174.22 ± 43.11	170.15 ± 46.19	0.727
	After 3 months	169.44 ± 47.31	171.24 ± 47.90	0.569
	After 6 months	176.28 ± 46.07	178.92 ± 45.24	0.614
P value		0.325	0.254	
Alb (g/dL) (mean ± SD)	Before	5.31 ± 1.27	4.71 ± 1.24	0.083
	After 3 months	4.86 ± 1.09	4.53 ± 1.41	0.284
	After 6 months	5.01 ± 0.97	4.83 ± 0.85	0.119
P value		0.087	0.244	
PT (s) (mean ± SD)	Before	11.32 ± 2.44	11.62 ± 2.07	0.256
	After 3 months	11.55 ± 2.37	11.34 ± 1.82	0.812
	After 6 months	11.49 ± 1.18	11.53 ± 1.26	0.424
P value		0.749	0.682	
PTT (s) (mean ± SD)	Before	64.11 ± 14.21	65.86 ± 13.66	0.481
	After 3 months	62.85 ± 13.65	63.49 ± 14.39	0.618
	After 6 months	67.37 ± 14.77	66.50 ± 13.57	0.597
P value		0.089	0.076	
INR (mean ± SD)	Before	1.22 ± 0.42	1.16 ± 0.25	0.663
	After 3 months	1.13 ± 0.33	1.14 ± 0.39	0.748
	After 6 months	1.11 ± 0.47	1.17 ± 0.27	0.680
P value		> 0.99	> 0.99	

Table 2 (continued)

Lab data		Group		*P* value
		Placebo (*N* = 67)	Probiotic (*N* = 68)	
Vitamin B12 (pg/mL) (mean ± SD)	Before	560.29 ± 75.65	571.36 ± 68.30	0.071
	After 3 months	547.14 ± 80.15	683.44 ± 105.77	< 0.001
	After 6 months	571.63 ± 73.22	840.62 ± 114.30	< 0.001
P value		0.118	< 0.001	
Ca (mg/dL) (mean ± SD)	Before	9.32 ± 1.16	9.56 ± 1.30	0.211
	After 3 months	9.75 ± 1.25	9.67 ± 1.18	0.317
	After 6 months	9.47 ± 1.39	9.32 ± 1.44	0.415
P value		0.265	0.422	
Na (mEq/L) (mean ± SD)	Before	142.32 ± 14.07	138.31 ± 15.69	0.843
	After 3 months	137.41 ± 15.66	139.44 ± 14.13	0.622
	After 6 months	139.05 ± 17.21	137.81 ± 16.55	0.652
P value		0.064	0.413	
K (mmol/L) (mean ± SD)	Before	4.96 ± 1.22	4.63 ± 1.81	0.344
	After 3 months	4.12 ± 1.09	4.40 ± 1.92	0.251
	After 6 months	4.35 ± 1.34	4.57 ± 1.43	0.392
P value		0.073	0.244	
P (mg/dL) (mean ± SD)	Before	3.25 ± 1.23	3.32 ± 1.53	0.544
	After 3 months	3.44 ± 1.30	3.40 ± 1.39	0.308
	After 6 months	3.38 ± 1.44	3.21 ± 1.77	0.416
P value		0.288	0.412	
Mg (mEq/L) (mean ± SD)	Before	0.86 ± 0.12	0.84 ± 0.18	0.841
	After 3 months	0.73 ± 0.17	0.81 ± 0.13	0.326
	After 6 months	0.84 ± 0.16	0.82 ± 0.15	0.427
P value		0.147	0.209	
Zn (mcg/mL) (mean ± SD)	Before	0.85 ± 0.24	0.86 ± 0.30	0.227
	After 3 months	0.77 ± 0.29	0.82 ± 0.26	0.413
	After 6 months	0.86 ± 0.27	0.84 ± 0.28	0.581
P value		0.614	0.319	
BUN (mg/dL) (mean ± SD)	Before	15.62 ± 4.55	16.41 ± 4.28	0.411
	After 3 months	17.24 ± 3.97	15.28 ± 4.77	0.317
	After 6 months	14.10 ± 4.18	15.13 ± 5.09	0.469
P value		0.215	0.408	
Cr (mg/dL) (mean ± SD)	Before	1.14 ± 0.26	1.09 ± 0.37	0.339
	After 3 months	0.97 ± 0.37	1.12 ± 0.25	0.278
	After 6 months	1.11 ± 0.29	0.99 ± 0.31	0.325
P value		0.211	0.376	

showed a 53.8% higher body weight decrease in patients undergoing RYGB receiving the prebiotic compared with the placebo group ($P = 0.001$). Additionally, they observed that BMI decrease and the EWL were significantly higher in the prebiotic and the placebo groups compared with the synbiotic group ($P < 0.05$) [22, 23].

In addition to clinical trials, many literature reviews have shown the positive impact of probiotic supplementation on bariatric surgery outcomes. In 2020, Cook et al. investigated the role of gut microbiota alteration in bariatric surgery. This study showed that post-op administration of probiotics in bariatric surgery candidates resulted in significantly decreased blood sugar but could not significantly affect weight loss [24]. Another investigation was performed by Ciobârcă et al. in 2020, assessing the effects of probiotics in patients undergoing bariatric surgery. They stated that gut microbial modification has a pivotal role in treatment responses in patients, and probiotics could contribute to reduced post-op blood sugar and accelerated weight loss [25]. These previous findings are mainly in line with our study's findings; we also observed that the administration of probiotics was associated with a significant decrease in

Table 3 Evaluation of mean BMI and reduced values of BMI during the study

Lab data		Group			*P* value
		Probiotic (*N* = 68)	Placebo (*N* = 67)	Total (*N* = 135)	
Mean BMI (kg/m^2) (mean ± SD)	Before	45.98 ± 3.92	46.50 ± 4.57	46.33 ± 3.69	0.633
	After 3 months	32.84 ± 3.55	33.40 ± 3.28	33.14 ± 4.15	0.215
	After 6 months	29.63 ± 2.10	30.15 ± 3.27	29.42 ± 3.66	0.371
P value		< 0.001	< 0.001	< 0.001	
Mean reduced BMI (kg/m^2) (mean ± SD)	After 3 months	13.14 ± 2.17	13.1 ± 2.58	13.19 ± 2.68	0.711
	After 6 months	16.35 ± 1.22	16.35 ± 2.63	16.91 ± 2.77	0.693
P value		< 0.001	< 0.001	< 0.001	
Mean TWL (kg) (mean ± SD)	After 3 months	28.3 ± 4.44	28.51 ± 3.52	28.4 ± 4.07	0.761
	After 6 months	35.31 ± 3.21	35.47 ± 2.98	35.39 ± 3.09	0.765
P value		< 0.001	< 0.001	< 0.001	
Mean EWL (kg) (mean ± SD)	After 3 months	62.31 ± 5.26	61.32 ± 5.13	62.31 ± 5.19	0.270
	After 6 months	77.74 ± 4.99	76.28 ± 5.55	77.01 ± 5.27	0.110
P value		< 0.001	< 0.001	< 0.001	

Table 4 Comparison of GIQLI questionnaire before and 6 months after interventions

Variable	Group		*P* value
	Probiotic (*N* = 68)	Placebo (*N* = 67)	
GIQLI before (mean ± SD)	65.38 ± 11.58	68.12 ± 10.47	0.079
GIQLI after (mean ± SD)	118.30 ± 9.74	84.13 ± 9.66	< 0.001
P value	< 0.001	0.03	

FBS and HbA1C. However, there seems to be a controversy regarding the impact of probiotic administration and weight loss, as we, similar to Cook et al., were unable to find any significant association between probiotic administration and weight loss.

In 2021, Gutiérrez-Repiso et al. explained that little is known about how gut microbiota alteration could contribute to the outcome of bariatric surgery. They stated that peri-operative antibiotics prophylaxis and probiotic supplementation early after surgery are strategies studied so far. They could constitute a novel tool for managing weight loss and metabolic profile improvement after bariatric surgery [26]. In another study by Abenavoli et al. in 2019, it was shown that there is evidence for the association between gut microbiome and obesity in both childhood and adulthood. As mentioned earlier, several genetic, metabolic, and inflammatory pathophysiological mechanisms are involved in the interplay between gut microbes and obesity. They also stated that probiotics could better manage blood sugar and metabolic parameters [27].

Previous studies also seem to depict similar results regarding a B12 increase observed in our patients who received probiotics. A recent study by Ramos et al., conducted on patients undergoing RYGB, showed that vitamin B12 levels in the probiotic group tended to be higher than in the placebo group ($P = 0.063$) [23]. They specifically stated that supplementing with *Lactobacillus* and *Bifidobacteria* may be a suitable tactic to enhance the status of vitamin B12 by modifying the gut microbiota. In another research conducted by Woodard et al., patients who underwent RYGB and received *Lactobacillus* species supplements for 6 months had substantially greater postoperative vitamin B12 levels than the control group [21].

A study was conducted by Chen et al. in 2016 evaluating 60 candidates for bariatric surgery. It showed that administering probiotics or digestive enzymes might improve symptomatic GI episodes after gastric bypass surgery and improve quality of life, at least early after the procedure [28]. Similar results were observed by Swierz et al. in 2020 [29]. They observed short-term improvement in GI symptoms after the administration of probiotics. There was no significant impact on quality of life or meaningful adverse events. On the other hand, Wagner et al. in their 2021 study also reported no difference in the mean Gastric Symptom Rating Scale (GSRS) score between groups [30]. Because probiotic supplementation might provide some benefit concerning weight loss, it might also alleviate some gastrointestinal symptoms and is associated with minor or no adverse events; continuous supplementation might be worth considering in specific individuals. As we indicated, patients in both groups had elevated GIQLI scores after interventions. Still, these scores were significantly higher in patients receiving probiotics, which clearly implies positive subjective outcomes in patients who received probiotic supplementation.

The shortcomings of this study were the limited study population, short follow-up, lack of access no clinical data

on obesity-related diseases, and the fact that it was confined to a single center. Multicentric studies on larger populations could highlight the use of probiotics in candidates for bariatric surgery.

Conclusion

In recent years, the convergence of probiotic research and its implications for bariatric surgery and obesity has developed as a fascinating and vibrant area of study. Concurrently, there is a growing body of research indicating that the microbiome plays an important role in regulating metabolism and affecting body weight and has been proven to significantly change after bariatric surgery. In the current study, all patients had decreased FBS, HbA1C, LDL, AST, and ALT, post op, while, patients who received probiotics had significantly lower FBS and HbA1C and substantially higher vitamin B12 levels after 3 and 6 months compared to the control group. We also observed a significant decrease in BMI, as well as increased TWL, EWL, and GIQLI scores in all patients. Patients in the probiotic group had substantially higher GIQLI scores compared to controls, while TWL and EWL did not show any significant difference between these two groups. These findings are of clinical significance, and based on them, we recommend that surgeons consider the beneficial use of probiotics in bariatric surgery candidates.

Declarations

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards (Ethics code: IR.MUI.MED.REC.1399.849, Iranian Registry of Clinical Trials (IRCT) code: IRCT20220702055340N1).

Consent to Participate Informed consent was obtained from all individual participants included in the study.

Conflict of Interest The authors declare no competing interests.

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