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Dietary fish oil increases the number of CD1 1b(+)CD27(-) NK cells at the inflammatory site and enhances key hallmarks of resolution of murine antigen-induced peritonitis

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ORIGINAL CONTRIBUTIONS

Dialectical Behavior Therapy for Emotional and Mindless Eating After Bariatric Surgery: a Prospective Exploratory Cohort Study

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Abstract

Purpose To assess the effect of dialectical behavior therapy (DBT) on emotional and mindless eating and, consequently, body mass index (BMI) loss, in patients who have undergone bariatric surgery.

Materials and Methods A prospective exploratory cohort study was conducted with two groups of patients who had undergone bariatric surgery: the DBT group received DBT group skills training sessions, while the control group received no intervention. Outcome measurements included BMI and scores of the Emotional Eating Scale (EES) and Mindful Eating Questionnaire (MEQ).

Results The study included 36 women: 18 in each group. In the DBT group, the interval from surgery was 11.17 ± 7.12 months, and in the control group 10.89 ± 5.74 . Laparoscopic sleeve gastrectomy was done in 88.9% and 83.3% of patients in the DBT and control groups respectively. The rest underwent Roux-en-Y gastric bypass. The DBT group showed significant changes in overall and subscale scores of the EES and MEQ and BMI in kg/m^2 after 6 months of follow-up. BMI in kg/m^2 changed from mean \pm SD 35.45 ± 6.17 to 28.47 ± 4.28 in the DBT group, in control 35.88 ± 5.07 to 31.56 ± 3.71 . The excess weight loss percentage (EWL%) in the DBT was mean \pm SD 75.3 ± 17.9 and in the control was 63.6 ± 14.5 . In the DBT group, the EES score and MEQ score changed from mean \pm SD 45.06 ± 20.19 to 20.50 ± 13.40 and 11.52 ± 2.02 to 15.87 ± 1.92 , respectively. The control group showed no significant change in scores.

Conclusions DBT skills training can reduce emotional eating, increase mindful eating, and facilitate weight loss after bariatric surgery.

Keywords Bariatric surgery · Weight loss · Dialectical behavior therapy · Emotional eating · Mindful eating

Key points

- Some patients find it difficult to deal with their eating behavior after bariatric surgery.
- We assessed the effect of dialectical behavior therapy (DBT) in these patients.
- DBT can be an effective weight loss intervention in these patients after bariatric surgery.

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Introduction/Purpose

Bariatric surgery is the most effective treatment for severe obesity. However, within 2 years after bariatric surgery, 20–30% of patients experience either suboptimal weight loss or significant weight regain [1]. Some factors have been implicated in these poor outcomes,

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including physiological processes, psychological characteristics, behavioral factors, and eating disorders [2]. Several behavioral problems related to mindless and emotional eating have been observed after bariatric surgery, like eating too much, consuming high amounts of high-caloric soft foods, eating while distracted, and/or rapid eating [3]. Furthermore, emotional eating is defined as eating in response to an emotional state rather than physiological hunger [4], which in the end can lead to increased body mass index (BMI) and/or poor weight loss [5, 6]. Emotional eating is prevalent in about 40% of bariatric surgery candidates [7].

However, a study by Gero et al. [8] showed an improvement of eating behavior after bariatric surgery, mainly RYGB without intervention. They used Eating Disorder Examination-Questionnaire (EDE-Q) preoperatively (baseline) and 1 year post-operatively. Evaluation of cases showed a “healthy” EDE-Q in 27.4% at baseline and in 83.7% at 1 year.

Dialectical behavior therapy (DBT) is a treatment based on the affect regulation model [9–11] and it adapted for treating binge eating disorders [12, 13]

DBT is an effective treatment for a variety of emotional and behavioral problems including emotion dysregulation [14]. Nevertheless, the literature is lacking data about the usefulness of DBT skills training for weight loss after bariatric surgery [15–17].

The purpose of this study was to test if DBT skills would reduce emotional eating and help participants acquire mindful eating skills while enhancing emotion regulation, helping them lose weight.

Materials and Methods

Study Design

This was a prospective exploratory cohort study between September 2019 and February 2020 at Madina Women’s Hospital, Alexandria, Egypt, an *International Federation for the Surgery of Obesity* and metabolic disorders (IFSO)–certified bariatric center at the Department of Surgery. Two groups were included, the DBT group ($n = 18$) who received 16 weeks of DBT training after bariatric surgery, and the control group (also $n = 18$) who received no DBT intervention. The patient’s weight loss was followed up immediately, 3 and 6 months after the DBT training ended.

All patients provided written and oral informed consent. All data was used anonymously. The study was

conducted by the principles of the Declaration of Helsinki and approved by the Medical Research Institute’s ethical committee.

Patient Selection

All patients were recruited for the DBT intervention based on a structured psychiatrist-administered interview that revealed high emotional eating ratings and low mindful eating ratings.

Inclusion Criteria

- (1) Adults aged > 18
- (2) Patients who underwent a bariatric procedure, who experienced emotional eating according to the Emotional Eating Scale (EES) and/or mindless eating based on the Mindful Eating Questionnaire (MEQ)
- (3) Willingness to participate.

Exclusion Criteria

- (1) Presence of other factors that could affect weight loss after surgery, including diabetes mellitus (type 1 or 2), and thyroid gland dysfunctions
- (2) Active suicidal ideation
- (3) History of/current substance use disorders
- (4) Compensatory or purging behaviors
- (5) Serious mental illness (psychotic and bipolar disorders).

Dialectical Behavior Therapy

DBT training has four modules: mindfulness, emotion regulation, distress tolerance, and interpersonal effectiveness; and two main components: individual weekly psychotherapy and weekly group skills training sessions [18–20].

Psychometric Measurements

- 1- A structured interview was done by a psychiatry therapist who made the assessment and who gave the verdict of the therapy.
 - A) Sociodemographic data with age, marital status education, and work status
 - B) Data about the bariatric surgery with the type of surgery, BMI, and interval from surgery

C) Eating pattern for the presence of mindless eating, emotional eating, and bulimic behaviors

2- The validated Arabic version of the General Health Questionnaire (GHQ-28):

This was conducted to assess psychiatric symptoms over the last month before the interview.

3- Emotional Eating Scale (EES)

The EES is a 25-item self-report questionnaire designed to measure the desire to eat in response to negative emotions. The items are rated on a 5-point Likert scale from 0 (no desire to eat) to 4 (an overwhelming urge to eat). The scale comprises three subscales: anger/frustration, anxiety, and depression [18]. Higher scores indicate a greater urge to eat in response to emotions.

4- Mindful Eating Questionnaire (MEQ)

The MEQ is a 28-item self-report questionnaire rated on a 4-point Likert scale ranging from 1 (never) to 4 (usually). It measures the five domains of mindful eating: disinhibition, external cues, awareness, emotional response, and distraction. Higher scores indicate more mindful eating [19].

DBT Intervention

The participants in the DBT group received 16 weekly, 2.25-h therapy sessions. Participants were informed that if they were absent for two consecutive sessions or four non-consecutive sessions, they would be out of therapy.

DBT sessions had mindfulness practice, the DBT rationales, and new skills training in emotion regulation and distress tolerance (for the complete DBT training session description and agenda, please see Appendix 1 Table 3 and Appendix 2)).

Statistical Methods

For analyses, we used descriptive statistics and inferential statistics. All data were first tested for normality by a Kolmogorov–Smirnov test, a Q-Q plot, and Levene's test.

Categorical variables were expressed as n (%). Continuous normally distributed variables were expressed by their mean and standard deviation, not normally

distributed data by their median and interquartile range for skewed distributions. To test groups, categorical variables were tested using Pearson's chi-square test or Fisher's exact test, when appropriate. Normally distributed continuous data were tested with the independent sample Students t -test and in case of skewed data, with the independent sample Mann–Whitney U -test.

A mixed-design repeated-measures analysis of variance (ANOVA) was used to test the main effect of time, the main effect of treatment, and if the interaction is present in the form of pattern change of mean quantitative variables along with different points of time between the two treatment groups. Adjusted post hoc pairwise comparisons were conducted using Bonferroni tests. Statistical analyses were performed using IBM SPSS Statistics (IBM Corp. Released 2020. IBM SPSS Statistics for Windows, Version 27.0. Armonk, NY: IBM Corp., NY, USA).

Post Hoc Power Calculation

Post hoc power analysis was performed using G*Power 3.1.9.4 software based on mixed-design ANOVA, to test the mean change of BMI, overall score of EES, and MEQ from baseline between both groups. It revealed the power of 94%, 80%, and 80.6% respectively.

Results

This prospective exploratory cohort study included 36 patients who had undergone bariatric surgery: 18 in the DBT group and 18 in the control group.

In the DBT group, 88.9% underwent laparoscopic sleeve gastrectomy and 83.3% in the control group. The rest underwent laparoscopic gastric bypass procedures.

All participants were women (100%). The age in DBT was mean \pm SD, 39.11 ± 7.50 and in the control group 38.11 ± 6.50 ($p > 0.05$).

In the DBT group, the interval from surgery was 11.17 ± 7.12 months and in the control group 10.89 ± 5.74 (Table 1) ($p > 0.05$).

BMI in kg/m^2 before surgery was in the DBT group 49.03 ± 7.9 and the control group 48.89 ± 6.8 ($p 0.953$). At baseline DBT training, this was 35.45 ± 6.2 in the DBT group and 35.88 ± 5.07 in the control group ($p 0.822$). The BMI in kg/m^2 changed in 16 weeks of DBT training from mean \pm SD 35.45 ± 6.17 to 31.01 ± 4.57

Table 1 Demographic data

		DBT group (N=18)	Control group (N=18)	p
Age (years) (mean \pm SD)		39.11 (\pm 7.50)	38.11 (\pm 6.50)	0.500
Marital status	Single: n (%)	2 (11.1%)	4 (22.2%)	0.767
	Married: n (%)	14 (77.8%)	12 (66.7%)	
	Divorced: n (%)	2 (11.1%)	2 (11.1%)	
Education	Below diploma: n (%)	5 (27.8%)	3 (16.7%)	0.628
	Diploma and associate degree: n (%)	9 (50.0%)	9 (50.0%)	
	Bachelor and above: n (%)	4 (22.2%)	6 (33.3%)	
BMI before surgery (kg/m ²): mean (\pm SD)		49.03 (\pm 7.91)	48.89 (\pm 6.83)	0.477
Type of surgery	Sleeve: n (%)	16 (88.9%)	15 (83.3%)	1
	Gastric bypass: n (%)	2 (11.1%)	3 (16.7%)	
Interval from surgery (months): mean (\pm SD)		11.17 (\pm 7.13)	10.89 (\pm 5.74)	
Patients on individual therapy	Current therapy: n (%)	3 (16.7%)	4 (22.2%)	1
	Past history of therapy: n (%)	3 (16.7%)	2 (11.1%)	
Patients on antidepressant therapy	Current therapy: n (%)	4 (22.2%)	5 (27.8%)	1
	Past history of therapy: n (%)	3 (16.7%)	2 (11.1%)	
Patients on anxiolytic therapy	Current therapy: n (%)	2 (11.1%)	4 (22.2%)	0.658
	Past history of therapy: n (%)	1 (5.6%)	2 (11.1%)	

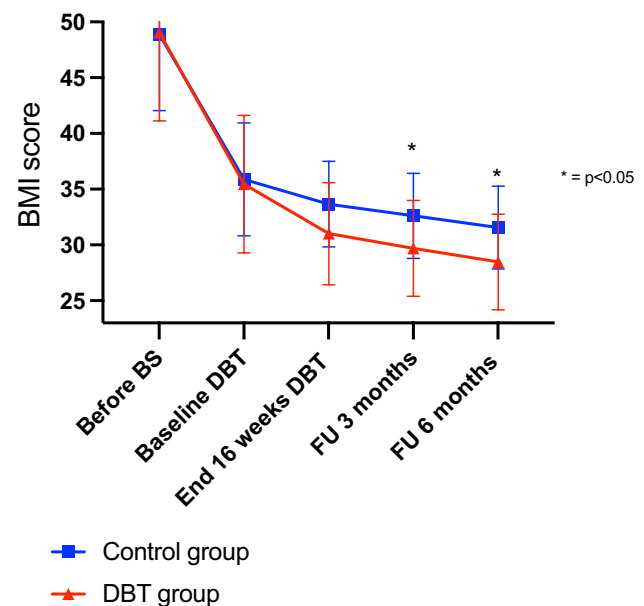
SD, standard deviation

($p < 0.001$) in the DBT group and the control group from mean \pm SD 35.88 ± 5.07 to 33.66 ± 3.84 ($p < 0.001$). BMI in kg/m² between DBT and control after 16 weeks of training was not significantly different (31.01 ± 4.5 vs 33.7 ± 3.8 , p 0.06). In the follow-up period, 3 and 6 months after the end of DBT training, the BMI in kg/m² was significantly lower in the DBT group compared to the control group: 3 months (29.69 ± 4.2 vs 32.61 ± 3.81 , p 0.038) and 6 months (28.47 ± 4.28 vs 31.56 ± 3.71 , p 0.027).

EWL% until 6-month follow-up in the DBT was mean \pm SD 75.3 ± 17.9 and in the control was 63.6 ± 14.5 . (p 0.001). The effect size of 0.558 was measured in the DBT group for change in BMI compared to the control group ($p < 0.001$) (Fig. 1).

EES

The EES score changed from mean \pm SD 45.06 ± 20.19 to 20.50 ± 13.40 ($p < 0.05$) in the DBT group and the control group from mean \pm SD 45.72 ± 17.94 to 45.33 ± 6.15 ($p > 0.05$). There were significant changes in all EES sub-scores and total scores between the two groups related to the DBT intervention (Table 2).

**Fig. 1** BMI changes in the DBT group and the control group

MEQ

The MEQ score changed from mean \pm SD 11.52 ± 2.02 to 15.87 ± 1.92 ($p < 0.05$) in the DBT group and the control group from mean \pm SD 11.25 ± 1.85 to 11.59 ± 1.70

Table 2 EES changes in the DBT group and the control group

		DBT group	Control group	Sig	Effect size
		Mean \pm SD			
Anger and frustration	Baseline	17.61 \pm 9.12	18.83 \pm 8.34	< .001	.383
	After 4 months	7.72 \pm 6.41	17.78 \pm 4.61		
		.012			
Anxiety	Baseline	16.617.79	16.116.81	< .001	.317
	After 4 months	7.284.80	16.283.58		
		.013			
Depression	Baseline	16.7 \pm 38.35	11.1 \pm 32.34	.044	.114
	After 4 months	22.2 \pm 42.78	27.8 \pm 46.09		
		> .999			
Overall score	Baseline	45.06 \pm 20.19	45.72 \pm 17.94	< .001	.391
	After 4 months	20.50 \pm 13.40	45.33 \pm 6.15		
		.006			
Median (IQR) percentage change from baseline		Interaction < .001		< .001	
		– 54.08 (– 70.68 to – 43.49)	5.28 (– 26.78 to 2.70)		

DBT, dialectical behavior therapy; EES, Emotional Eating Scale

($p > 0.05$). All the subscales of MEQ also showed significant changes between the groups related to the DBT intervention (Table 2).

Reliability and Validity EES and MEQ

Before the study, the EES and MEQ were only available in the English language. Before this study, a pilot study was conducted to validate the psychometric properties of the translated Arabic versions of the EES and MEQ. We received permission from the authors of the EES and MEQ or their representatives to translate the EES and MEQ to Arabic and to use them in our study. The pilot study was conducted on 30 patients. The EES and MEQ were translated by two blinded independent translators who speak Arabic as a mother tongue and are fluent in English. They are also healthcare professionals familiar with the terminology used in the tools. Back translation to the original language was performed to avoid any problems across the two cultures and to ensure quality and accuracy since inconsistencies in translation would jeopardize the accuracy of the results. The translated EES showed good internal reliability, with an overall Cronbach's alpha of 0.914 and the subscale values as follows: anger and frustration: 0.815, anxiety: 0.759, and depression: 0.747. Cronbach's alpha

of the translated MEQ was 0.703. The patients included in the pilot study did not participate in the current study. Therefore, we can conclude that this therapy is also possible for countries whereby the English language is not common practice.

Discussion

This was a prospective exploratory cohort study whereby 36 post-bariatric patients were included. Fifty percent got 16 weeks of DBT therapy and we evaluated the effect of DBT on emotional and mindless eating and consequently on weight loss after bariatric surgery. BMI in kg/m^2 was significantly lower in the DBT group compared to the control group at 3-month (29.69 ± 4.2 vs 32.61 ± 3.81 , $p = 0.038$) and 6-month follow-up (28.47 ± 4.28 vs 31.56 ± 3.71 , $p = 0.027$). The EES and MEQ scores are significantly changed in favor of the DBT group.

Inadequate weight loss and weight regain are known drawbacks of bariatric surgery that may be related to psychological or behavioral issues [20]. Non-compliance with dietary recommendations is strongly linked to insufficient weight loss after bariatric surgery [21, 22].

Post-bariatric patients who maintain unhealthy eating habits have a more than twofold higher risk of failure to achieve weight loss [23]. In that study, participants showed improvement in emotional eating as they acquired skills that helped them deal with their emotions. Also, participants showed improvements regarding mindful eating, as they learned to pay complete attention to their food. This effect was also seen in this study regarding the DBT group that showed significant changes in the overall and subscale scores of the EES and MEQ as well as BMI after the 16-week training was significantly reduced after the training. In total, the reduction in the DBT group was significantly greater compared to the control group.

Since this type of psychological intervention is somehow new and already increasingly described in the literature of bariatric surgery [15–17], we hope to highlight that this could be a new way of looking at post-operative care for all bariatric patients in the future. It is always good to see in all the published papers what implementation brings of surgical techniques within the bariatric surgery and therefore to decrease the insufficient weight loss after bariatric surgery. However, the aspect of psychology should never be underestimated. Noting this, this study only looked at post-operative care. In the future, it might also help to test and perform the EES and MEQ as early as preoperatively. However, before we can judge this, larger comprehensive studies should be conducted first.

In the past, a systematic review was conducted by David et al. [24] on the preoperative and post-operative psychosocial interventions for bariatric surgery patients and found strong evidence regarding eating behaviors. The systematic review found that psychosocial interventions such as mindfulness, acceptance, and DBT can improve eating pathology among bariatric patients, and the optimal time to initiate treatment appears to be early in the post-operative period before significant problematic eating behaviors and weight regains occur. David et al. [24] found in three of their included studies that the treatments did not improve weight loss outcomes [25–27]. These findings are consistent with studies analyzing the effect of DBT on eating behaviors and obesity. In Glisenti and Strod's study [28] concerning the treatment of individuals with obesity who rated high on emotional eating using four case studies that involved 22 sessions of DBT, at the 8-week follow-up, the two cases that had received DBT had lost 10.1% and 7.6% of their initial body weight. However, also here the number of included patients is still too little for a good judgment, but it shows the potential of this therapy as part of the bariatric procedure in all aspects. Further within the

scientific community, there is no consensus known about the cutoff values of the EES and MEQ. Again, this study was only able to demonstrate a meaningful difference and not indicate at what value it would no longer be relevant. The studies conclude that there should be more correction for confounding factors and stratification of the groups to get a better insight on cutoff values.

Currently, this research group is conducting a follow-up study among larger numbers with more distribution of demographic characteristics to hopefully arrive at a valid cutoff value within the bariatric population and increase the power of this research.

Limitations

It included a relatively small number of candidates in a single clinic, and all the participants were female. A known fact is that $\pm 80\%$ of the patients for a bariatric procedure are females. Due to the prevalence of indications among post-bariatric patients visiting the clinic, this was women in our case. Also, many groups still run in parallel sessions in our follow-up research. This study is the primary result of accidentally single-gender focus. The fact is that our study started before the pandemic. Subsequently, new recruitment was not possible due to bariatric surgeries being briefly put on hold as recommended by the IFSO. Since more patients were further recruited when vaccination started, new inclusions and follow-up research have been restarted and will be presented in the future. Furthermore, studies like this would ask for randomization between groups. Know is that non-randomized trials cause a possible selection bias and therefore an overestimation of the effect. Nevertheless, this type of investigation and therapy are not blinded possible, and an assessment is always necessary to include the right patients. Therefore, a larger study with more equal distribution and the possibility to correct for more confounding factors could help.

Also, we included only one component of DBT, the group skill training sessions; the individual psychotherapy sessions were not included in this study. Finally, the lack of follow-up assessment could hinder a more powerful analysis of the results of the intervention over time, especially regarding the generalization of the skills learned.

Conclusions

DBT skills training can reduce emotional eating, increase mindful eating, and facilitate weight loss after bariatric surgery.

Appendix 1

Table 3 Complete DBT training session description and agenda

Session	Agenda DBT sessions
1st	Orientation about DBT for emotional eating, basics, assumptions, roles, and goals, and encourage them to reduce behaviors and increase behaviors
2nd	Presenting mindless eating. How skills and mindful eating, encourage client to practice daily food records
3rd	Presenting three states of mind (rational mind, emotional mind, wise mind), wise mind skill
4th	Practicing mindful eating, what skills (observation skills, description, and being)
5th	How skills (non-judgmental state, one thing at moment, effectively)
6th	Emotional regulation, myths about emotion, encourage client to keep a food diary
7th	The model of emotion description, observing, describing, and expressing emotions skill
8th	Reduce the vulnerability of the emotional mind, accumulate positive emotions in the short term (pleasure activities, PLEASE skills)
9th	Accumulate positive emotions in the long term (values, avoid avoiding, building mastery)
10th	Cope ahead, surfing the urges
11th	Changing emotional responses (check the facts, problem-solving, opposite action)
12th	Presenting TOLERANCE (STOP skills [stop, take a step back, observe, and proceed mindfully], pros and cons)
13th	Distracting skills, TIPP skills (temperature, intense exercise, paced breathing, progressive muscle relaxation)
14th	Improving the moment skills, self-soothing skills
15th	Reality acceptance step by step, turning the mind
16th	Reviewing mindfulness, emotion regulation, distress tolerance, discussing future

Appendix 2 (DBT training by therapist and co-therapist)

DBT has four modules: mindfulness, emotion regulation, distress tolerance, and interpersonal effectiveness; and two main components: individual weekly psychotherapy and weekly group skills training sessions.

In weekly group therapy sessions, people learn skills from one of four different modules: interpersonal effectiveness, distress tolerance/reality acceptance skills, emotion regulation, and mindfulness skills.

Group sessions began with a mindfulness practice, then moved to homework revision (approximately 40 min), ending on a new skill (1.15 h) with a 15-min break in between, according to the standard DBT skills group format.

The treatment consisted of one introductory session presenting the DBT rationale and orientation and commitment to therapy: the remaining 15 focused on skill development including three modules—mindfulness (sessions 2–5), emotion regulation (sessions 6–11), and distress tolerance (sessions 12–16)—according to other protocols of skills training that targeted problematic eating behaviors and obesity.

Mindfulness skills focused on non-judgmental awareness and how to observe and describe moment-to-moment emotional experiences and thoughts. Participants also learned about eating mindfully, adopting non-judgmental eating behavior, enjoying the taste of food regardless of amount, and deliberately chewing slowly.

Emotion regulation skills encouraged an understanding of how emotions function, dealing with vulnerability to negative emotions, increasing positive emotions, changing certain negative emotions through opposite to emotion action, accepting emotions instead of ignoring them, and managing urges regarding specific types of food (urge surfing).

Through the distress tolerance skills imparted, participants became familiar with effective and adaptive means for enduring stressors and painful experiences without turning to emotional eating, developing new ways of soothing themselves other than through food, and acceptance of food, the self, and body image. In the final session, a relapse prevention plan was developed. All sixteen sessions followed a standardized outline (Appendix 1 Table 3).

All participants completed the post-test questionnaire and shared their feedback.

Following each group session, participants were assigned homework (to practice the skills taught in the group). They also completed a weekly diary card that focused on tracking their emotions, mindful eating, behaviors, and DBT skills practice.

Declarations

ICMJE disclosure form is signed by all the authors.

Ethics Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the insti-

tutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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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