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ORIGINAL RESEARCH **PERIOPERATIVE MEDICINE**

Preoperative oral carbohydrate loading versus fasting in patients undergoing major abdominal surgery: a randomized controlled study

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ABSTRACT

Objectives: Insulin resistance and the stress hormones released by surgery accompany a catabolic response. We intended to validate the impact of preoperative carbohydrate (CHO) loading on the metabolic and inflammatory subsequence of elective major abdominal surgery.

Methodology: This prospective randomized trial was carried out on 54 participants scheduled for elective major abdominal surgery. Patients were randomly assigned to two equal groups: the FAST group followed typical fasting protocols. and received a placebo drink (200 mL of clear water) two hours before the procedure, while the CHO group received a CHO drink at least two hours before the anesthesia induction.

Results: The major outcomes were a statistically significant decrease in muscle mass measured 5 days postoperatively in the FAST group compared to the CHO group, HOMA- IR, and GPS that increased significantly in the FAST group postoperatively compared to the baseline preoperatively. There was a decreased time to independent ambulation and duration of hospitalization in the CHO group than in the FAST group.

Conclusions: Preoperative oral carbohydrate loading significantly mitigates postoperative insulin resistance, maintains better muscle mass, and improves subjective well-being in cases experiencing major abdominal surgery compared to traditional fasting.

Keywords: Oral Carbohydrate Loading, Fasting, Major Abdominal Surgery, Glasgow Prognostic Score, Bioelectrical Impedance Analysis

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1. INTRODUCTION

Numerous stressors, such as extended fasting hours, impact surgical patients throughout the procedure. Crucially, the surgery itself causes an inflammatory and endocrine stress reaction, and it also increases postoperative insulin resistance (PIR), which is further exacerbated via fasting before surgery.[1, 2]

PIR involves diminished insulin-mediated glucose uptake and increased glucose production, leading to hyperglycemia. While adaptive to supply energy to glucose-dependent tissues, this condition results in a catabolic state with glycogen, protein, and fat breakdown. If untreated, it can heighten postoperative complications and extend hospitalization.[3]

Preoperative fasting, traditionally lasting 6–8 hours to prevent pulmonary aspiration, initiates the development of PIR by decreasing insulin sensitivity. This prolonged fasting can exacerbate insulin resistance before the procedure even begins, so reducing fasting time by administering a preoperative carbohydrate drink has been suggested to mitigate this harmful effect, which serves as a breakfast meal and encourages the patient's body to shift towards anabolism, and enhances insulin sensitivity.[4]

This trial aimed to assess the influence of a fasting protocol vs a preoperative CHO loading regimen on the following outcomes: postoperative insulin resistance, Glasgow Prognostic Score (GPS), subjective patient satisfaction, and surgical clinical result.

2. METHODOLOGY

This prospective randomized trial was conducted on cases experiencing major abdominal surgery in the General Surgery Department, Tanta University Hospitals, Egypt, for a duration of 16 months from January 2022 to May 2023, following acquiring agreement from the institutional ethical committee with approval code (35129/12/21) and clinical trial code ID: (NCT06243367). Informed written consent was obtained from all patients.

This study comprised 54 participants, aged between 21 and 70 years, ASA physical status I and II. Every patient provided written informed consent.

Exclusion criteria were; patients having diabetes mellitus, undergoing emergency surgery, a body mass index (BMI) less than 20 or greater than 35 kg/m^2, an increased danger of gastric content aspiration, having disseminated malignant disease, or patient refusal to take part in the research.

2.1. Randomization and blindness:

Patients were randomly allocated to one of the two equal groups; the FAST (control) group and the CHO group, consisting of 27 patients each. Patients were told to fast for six hours in both groups. Participants in the FAST group received a placebo drink (200 mL of clear water) two hours before the procedure. In comparison, those in the CHO group received 200 mL of a clear carbohydrate drink at least two hours before the anesthesia induction. This beverage was made with 200 mL of water and two tablespoonfuls of honey (17 grams of carbohydrates per tablespoonful).[5]

Postoperatively, maintenance IV fluids were restricted to normal saline till oral warm fluids were started 8 hours after the end of the surgery. Oral supplements were provided twice daily on the second day. The patient was encouraged to increase oral intake every two hours, and then more gradually until the patient restored his normal, balanced diet. Early ambulation was encouraged.

An anesthetist outside the research team, blind to group assignments, recorded demographic data including age, gender, Nutrition Risk Screening 2002 (NRS 2002) score, type and duration of the surgery, and preoperative and postoperative (day 5) muscle mass via Bioelectrical impedance analysis (BIA). Clinical and biochemical parameters, including fasting glucose, fasting insulin, CRP, and albumin levels, were measured from blood samples at preoperative intervals (baseline value, T1), six hours post-surgery (T2), and on the morning of postoperative day 1 (T3). The Glasgow Prognostic Score (GPS) and the HOMA-IR formula were employed to evaluate insulin resistance recorded at the same intervals. Also, subjective measurements, including feelings of hunger, thirst, dry tongue, nausea, and vomiting were assessed before the surgery and repeated at 4, 8, 12, and 24 hours after surgery. Surgical results, including time of independent ambulation and postoperative discharge day, were recorded.

The primary outcomes were assessment of muscle mass with BIA preoperatively and at 5 days postoperatively and biochemical detection of the extent of insulin resistance development by HOMA-IR and the inflammatory response by GPS. The secondary outcomes were an assessment of perioperative well-being, or discomfort as nausea, vomiting, a dry tongue, hunger, and thirst sensation and surgical outcomes by detecting the time to independent ambulation and hospital stay time.

2.2. Statistical Analysis:

Version 20.0 of the IBM SPSS software program was utilized to input and analyze data (Armonk, NY: IBM Corp). Utilizing proportions and numbers, the qualitative data was described. Shapiro-Wilk test was performed to

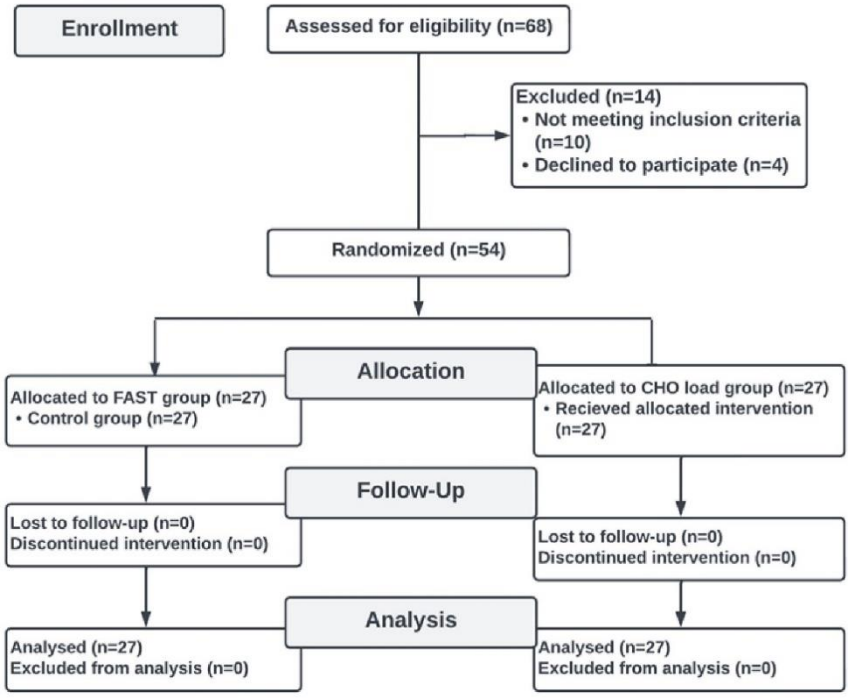

Figure 1: Consort flow chart of the study

confirm that the normality of the distribution. Median (minimum–maximum), and/or mean (standard deviation), were used to describe the quantitative data. The significance of the findings was assessed at the 5% level. Statistical tests used included Chi-square, Fisher's Exact test, Student's t-test, ANOVA, Mann-Whitney U test, Friedman test, and Post Hoc, to compare the studied groups.

2.3. Sample size calculations:

The power analysis and sample size were computed using Epi-Info software statistical package created by the World Health Organization and the Center for Disease Control and Prevention, Atlanta, Georgia, USA version 2002. Sample size calculations were conducted according to the following criteria: 95% confidence limit and 84% power of the study. The sample size was 27 for each study group with a total sample size of at least 54 participants.

3. RESULTS

Fifty-four patients were assessed for eligibility in this study and were randomly allocated in two equal groups (27 patients for each). In each of the two groups All 27 patients completed the follow-up, and their data were analyzed statistically (Figure 1).

Comparative analysis of the two categories revealed statistically insignificant differences in mean values of age, sex, weight, BMI and NRS score (P = 0.992, 0.785, 0.927, 0.706 and 1.000, respectively) (Table 1).

There was a statistically insignificant change in the mean values of muscle mass between the two studied groups preoperatively (P = 0.069). There was a significant decrease in the FAST group compared to the CHO group, which was 5 days postoperative (P = 0.003).

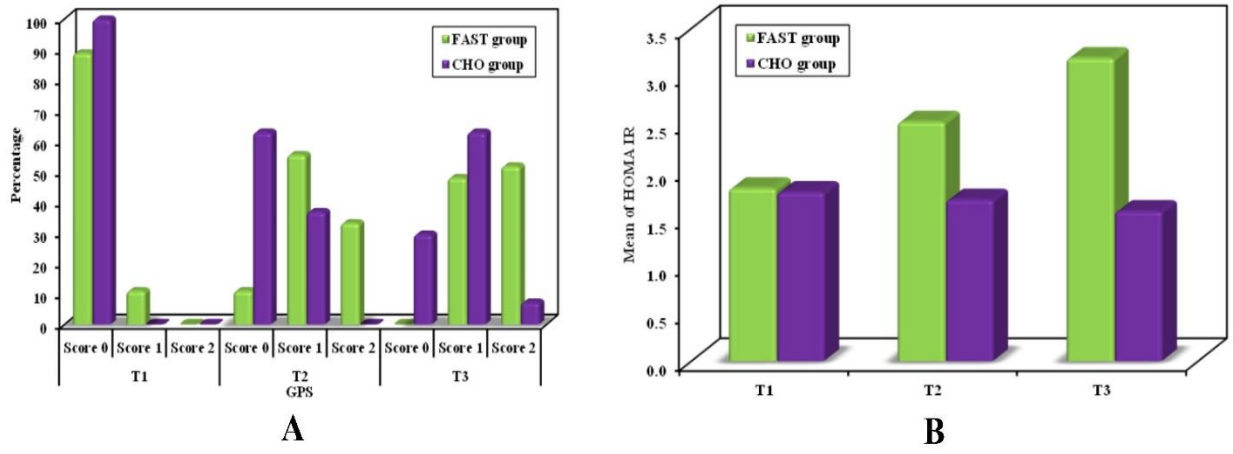

Figure 2: Comparison between the two studied groups as per (A) GPS and (B) HOMA IR
GPS: Glasgow Prognostic Score

Table 1: Comparison between the two studied groups according to demographic data

Parameters	FAST group (n = 27)	CHO group (n = 27)	Test of Sig.	P-value
Gender [n (%)]				
Male	13 (48.1)	14 (51.9)	$\chi^2 = 0.074$	0.785
Female	14 (51.9)	13 (48.1)		
Age [n (%)]				
< 70	26 (96.3)	25 (92.6)	$\chi^2 = 0.353$	$^{FE}P = 1.000$
≥ 70	1 (3.7)	2 (7.4)		
Age (yr) Mean ± SD.	46.44 ± 14.22	46.41 ± 13.37	t = 0.010	0.992
Weight (kg)				
Mean ± SD.	74.43 ± 17.98	74.02 ± 15.13	t = 0.092	0.927
Median (Min–Max)	72.50 (52.0–114.5)	73.50 (50.50–111.5)		
BMI (kg/m^2)				
Mean ± SD.	26.13 ± 4.30	26.60 ± 4.74	t = 0.379	0.706
Median (Min–Max)	26.80 (20.30–34.30)	27.0 (20.0–35.0)		
NRS [n (%)]				
Score 2	26 (96.3)	25 (92.6)	$\chi^2 = 0.353$	$^{FE}P = 1.000$
Score 3	1 (3.7)	2 (7.4)		

SD: Standard deviation, t: Student t-test, χ^2: Chi square test, FE: Fisher Exact, P: P-value for comparing the two studied groups.

There was an insignificant difference in the mean values of fasting glucose (FG) between the two studied groups at T1, but it was significantly greater in the FAST group than in the CHO group at T2 and T3 (P < 0.001 at T2 and T3). There was an insignificant difference in the mean values of fasting insulin comparison between the two groups under trial at T1 interval P = 0.664. But there was a significant increase in the FAST group than the CHO group at T2 and T3 (P < 0.001 at T2 and T3). The mean albumin values of the two groups under study did not differ significantly at the T1 interval (P = 0.461). However, at T2 and T3, the CHO group exhibited a significant elevation when compared to the FAST group (P = 0.001, <0.001 at T2 and T3, consecutively). Additionally, at T1 interval P = 0.754, there was no significant difference in the mean CRP values between the two groups under study; however, at T2 and T3, there was a significant increase in group FAST compared to group CHO (P < 0.001, P < 0.001 at T2 and T3 consecutively) (Table 2).

There was an insignificant difference in the mean GPS values between the two studied groups at T1 interval (P = 0.236). GPS at T2 patients in group CHO with a score 0 was significantly increased in group FAST 17 and 3, respectively; while in patients with scores 1 and score 2, significantly increased in group FAST than in group CHO. GPS at T3 was significantly greater than in group FAST in patients with score 0 and score 1 in group CHO. While patients with a score of 2 were greater in the FAST group than in the CHO group (Figure 2A).

There was no significant difference in the mean values of HOMA-IR between the two studied groups at T1 interval (P = 0.807, but there was a significant increase in HOMA IR in the FAST group than in the CHO group at T2 and T3 (P < 0.001, <0.001 at T2 and T3 respectively) (Figure 2B).

Regarding nausea and vomiting, there was an insignificant change at all measuring times pre- and postoperatively (P = 1.000) between both groups. As regards thirst, there was insignificant change preoperatively (P = 0.05) between both groups, but there was a significant elevation in the FAST group in comparison to the CHO group at all intervals postoperatively (P = 0.001 at 4 h interval, < 0.001 at 8, 12, and 24 h intervals). As regards the dry mouth, there was a significant elevation in the FAST group than in the CHO group at all intervals pre- and postoperatively (P = 0.23 preoperatively, P = 0.001 at 4 h postoperatively, and P < 0.001 at 8 h, 12 h, and 24 h intervals).

The number of patients complaining of hunger was significantly elevated in the FAST group than in the CHO group at all intervals pre- and postoperatively (P < 0.5) (Table 3).

Table 2: Comparison between the two studied groups as per muscle mass, fasting glucose, fast insulin, albumin (g/L) and CRP

Parameter		FAST group	CHO group	T	P
Muscle mass					
Preoperative (Mean ± SD).		49.63 ± 8.88	54.86 ± 11.61	1.857	0.069
Median (Min–Max.)		47.50 (35.0–71.0)	54.0 (36.0–83.0)		
5 days postop (Mean ± SD)		46.01 ± 8.76	54.67 ± 11.64	3.089*	0.003*
Median (Min.–Max.)		45.0 (30.50–67.20)	53.80(35.50–82.70)		
FG					
T1	Mean ± SD	101.9 ± 16.13	103.2 ± 16.07	0.862	0.393
	Median (Min–Max)	100.0 (75.0–134.0)	100.0 (80.0–137.0)		
T2	Mean ± SD	132.7 ± 25.66	97.30 ± 14.28	6.353*	< 0.001*
	Median (Min–Max)	130.0 (85.0–194.0)	95.0 (80.0–122.0)		
T3	Mean ± SD	165.5 ± 47.49	74.37 ± 12.08	8.098*	< 0.001*
	Median (Min–Max)	180.0 (65.0–220.0)	75.0 (55.0–110.0)		
Fast insulin					
T1	Mean ± SD	13.73 ± 4.37	13.24 ± 3.72	0.437	0.664
	Median (Min–Max)	13.60 (8.30–23.60)	13.80 (7.23–22.20)		
T2	Mean ± SD	18.23 ± 3.97	12.66 ± 3.82	5.257*	< 0.001*
	Median (Min–Max)	20.10 (11.30–23.80)	12.50 (8.40–24.50)		
T3	Mean ± SD	22.43 ± 5.91	11.74 ± 3.79	7.911*	< 0.001*
	Median (Min–Max)	23.0 (10.40–35.0)	11.0 (6.32–20.0)		
Albumin					
T1	Mean ± SD	40.70 ± 5.08	41.67 ± 4.43	0.742	0.461
	Median (Min–Max)	40.0 (30.0–50.0)	42.0 (35.0–50.0)		
T2	Mean ± SD	36.33 ± 4.30	40.44 ± 4.07	3.610*	0.001*
	Median (Min–Max)	35.0 (30.0–47.0)	42.0 (33.0–47.0)		
T3	Mean ± SD	35.0 ± 3.95	40.26 ± 4.16	4.765*	< 0.001*
	Median (Min–Max)	34.0 (30.0–45.0)	41.0 (34.0–48.0)		
CRP					
T1	Mean ± SD	6.22 ± 2.28	6.0 ± 2.63	346.50	0.754
	Median (Min–Max)	6.0 (2.0–9.0)	6.0 (2.0–10.0)		
T2	Mean ± SD	30.37 ± 18.49	10.63 ± 4.55	75.0*	< 0.001*
	Median (Min–Max)	24.0 (8.0–74.0)	10.0 (5.0–20.0)		
T3	Mean ± SD	63.70 ± 24.58	18.70 ± 8.31	35.0*	< 0.001*
	Median (Min–Max)	65.0 (15.0–112.0)	20.0 (9.0–33.0)		

*t: Student t−test, SD: Standard deviation, P: P value for comparing between the two studied groups, *: Statistically significant at p ≤ 0.05. U: Mann Whitney test*

4. DISCUSSION

Prolonged fasting before surgery has traditionally been to decline the perioperative risk. PIR and patient discomfort are increased by preoperative fasting. PIR is exacerbated by surgery, which triggers an inflammatory and endocrine stress response.[6]

Our outcomes were in accordance with Rizvanović N. et al.[7] exhibited that PIR was reduced by 30%, and insulin sensitivity was increased by 15% in the CHO group than in the FAST group. A preoperative CHO drink minimises the metabolic and inflammatory responses that occur postoperatively response, as indicated by the GPS a decrease in the CHO group.

Table 3: Comparison between the two studied groups as per subjective well-being, ambulation and length of hospital stay

Parameters		FAST group n (%)	CHO group n (%)	χ^2	^{FE}P
Nausea	**Pre**	1 (3.7)	0 (0.0)	1.019	1.000
	4h	7 (25.9)	1 (3.7)	5.283	0.051
	8h	7 (25.9)	1 (3.7)	5.283	0.051
	12h	5 (18.5)	1 (3.7)	3.000	0.192
	24h	3 (11.1)	0 (0.0)	3.176	0.236
Vomiting	**Pre**	0 (0.0)	0 (0.0)	–	–
	4h	4 (14.8)	1 (3.7)	1.984	0.351
	8h	2 (7.4)	0 (0.0)	2.077	0.491
	12h	3 (11.1)	1 (3.7)	1.080	0.610
	24h	3 (11.1)	0 (0.0)	3.176	0.236
Thirst	**Pre**	7 (25.9)	1 (3.7)	5.283	$^{FE}P = 0.050$
	4h	11 (40.7)	1 (3.7)	10.714*	0.001*
	8h	14 (51.9)	2 (7.4)	12.789*	< 0.001*
	12h	17 (63.0)	3 (11.1)	15.565*	< 0.001*
	24h	17 (63.0)	4 (14.8)	13.169*	< 0.001*
Dry mouth	**Pre**	6 (22.2)	0 (0.0)	6.750*	$^{FE}P = 0.023$*
	4h	11 (40.7)	1 (3.7)	10.714*	0.001*
	8h	15 (55.6)	2 (7.4)	14.509*	< 0.001*
	12h	19 (70.4)	3 (11.1)	19.636*	< 0.001*
	24h	20 (74.1)	5 (18.5)	16.759*	< 0.001*
Hunger	**Pre**	6 (22.2)	0 (0.0)	6.750*	$^{FE}P = 0.023$*
	4h	12 (44.4)	1 (3.7)	12.259*	< 0.001*
	8h	12 (44.4)	2 (7.4)	9.643*	0.002*
	12h	16 (59.3)	4 (14.8)	11.435*	0.001*
	24h	17 (63.0)	0 (0.0)	24.811*	< 0.001*
		FAST group (n = 27)	**CHO group (n = 27)**	**Test of Sig.**	**P**
Ambulation					
Mean ± SD.		6.48 ± 1.63	1.85 ± 0.82	T = 13.216	< 0.001*
Median (Min–Max.)		6 (4-9)	2 (1-4)		
Hospital stay					
Mean ± SD.		8.63 ± 2.10	5.52 ± 1.25	U = 66.500	< 0.001*
Median (Min–Max.)		8 (6–14)	5 (4–8)		

*FE: Fisher Exact, $\chi 2$: Chi-square test, P: P-value for comparing between the two studied groups, *: Statistically significant at P ≤ 0.05. U: Mann Whitney test: Student's t-test*

The outcomes of our study were also endorsed by Onalan E, et al.,[8] who documented an alteration in glucose levels that was significantly greater in the control group than in the oral carbohydrate solution (OCS) group. HOMA-IR values did not alter significantly in the OCS group, and they assumed that preoperative carbohydrate load declined insulin resistance.

In line with this study, Pexe-Machado PA, et al. exhibited that the duration of preoperative fasting abbreviation to 3 h utilizing a solution encompassing carbohydrates decreases the acute-phase inflammatory reaction and declines the postoperative duration of stay in cases experiencing major surgical procedure to treat malignancy.[9]

Moreover, Ertural F. et al. supported our findings by their study confirming that the reduction in postoperative and preoperative anxiety, thirst, pain, nausea/vomiting, and hunger levels were significantly reduced in the OCS group compared with the FAST group.[10]

Jani A. et al. noted that the preoperative carbohydrate load in cases with maxillofacial trauma was linked with a shorter hospital stay, early recovery, lesser postoperative complications, and significantly declined cost analysis in comparison with FAST group, which was in line with our outcomes.[11]

Our findings were confirmed by Kuiper M, et al.,[12] who noted that hospital stay duration, time to tolerate a consistent oral diet following the operation, and time to meet 50% of predictable fluid demands were shorter. Patients who receive preoperative carbohydrate in comparison to those who underwent preoperative fasting after laparoscopic nephrectomy.

Compared to our results, Pędziwiatr M. et al. noted that CHO-loading lacked clinical justification in the laparoscopic cholecystectomy cases.[13] No clinical advantage was observed regarding CHO-loading before laparoscopic cholecystectomy despite the treatment being safe. Likewise, in comparison to our results, Choi YS, et al. noted that no clinical advantage was observed for CHO-loading.[14]

No distinction existed between the control and CHO groups as regards (HOMA-IR) in patients undergoing total hip arthroplasty, and this can be explained by the fact that this study was on geriatric patients with ages more than 65 years with their different metabolic changes.

Additionally, in comparison to our results, Mathur S, et al. concluded that preoperative CHO therapy did not enhance the duration of hospitalization and postoperative fatigue after major abdominal surgery.[15]

5. LIMITATIONS

The limitations of this trial were that assessed parameters were continuously tracked until the postoperative day 1 only. The findings obtained exclusively pertaining to participants with ASA I and II. participants with ASA grade III or IV may have been necessary to optimize the technique for anesthesia and perioperative management.

6. CONCLUSION

Preoperative oral carbohydrate loading significantly mitigates postoperative insulin resistance, maintains better muscle mass, and improves subjective well-being in cases experiencing major abdominal surgery compared to traditional fasting. Carbohydrate loading before surgery is a beneficial strategy for enhancing postoperative recovery and clinical outcomes.

7. Data availability

The numerical data generated during this research is available with the authors.

8. Acknowledgement

We gratefully thank Faculty of Medicine, Tanta University, Tanta, Egypt.

9. Conflict of interest

The study utilized the hospital resources only, and no external or industry funding was involved.

10. Authors' contribution

EMTSAO: Conceptualization

SMS: Data collection

TMAA: Data analysis

NKMY: First draft of the manuscript

All authors approved this manuscript for submission.

11. REFERENCES

1. Scott M, Baldini G, Fearon K, Feldheiser A, Feldman L, Gan T, et al. Enhanced Recovery After Surgery (ERAS) for gastrointestinal surgery, part 1: pathophysiological considerations. Acta Anaesthesiol Scand 2015 2015;59:1212-31. PMCID: PMC5049676 DOI: 10.1111/aas.12601
2. Akbarzadeh M, Eftekhari MH, Shafa M, Alipour S, Hassanzadeh J. Effects of a new metabolic conditioning supplement on perioperative metabolic stress and clinical outcomes: a randomized, placebo-controlled trial. Iran Red Crescent Med J 2016;18. PMCID: PMC4752820, DOI: 10.5812/ircmj.26207
3. Jodłowski T, Dobosz M. Preoperative fasting–is it really necessary? Pol Przegl Chir. 2014;86:100-5. DOI: 10.2478/pjs-2014-0019
4. Ishizuka M, Nagata H, Takagi K, Iwasaki Y, Shibuya N, Kubota K. Clinical significance of the C-reactive protein to albumin ratio for survival after surgery

for colorectal cancer. Ann Surg Oncol. 2016;23:900-7. DOI: 10.1245/s10434-015-4948-7

5. Gunaydin D. Does partial reduction of added sugar in chocolate milk and yogurt benefit glycaemic response? : Mount Saint Vincent University; 2022. https://ec.msvu.ca/handle/10587/2226

6. Gustafsson U, Scott M, Hubner M, Nygren J, Demartines N, Francis N, et al. Guidelines for perioperative care in elective colorectal surgery: Enhanced Recovery After Surgery (ERAS®) Society recommendations: 2018. World J Surg. 2019;43:659-95. DOI: 10.1007/s00268-018-4844-y

7. Rizvanović N, Nesek Adam V, Čaušević S, Dervišević S, Delibegović S. A zrandomized controlled study of preoperative oral carbohydrate loading versus fasting in patients undergoing colorectal surgery. Int J Colorectal Dis. 2019;34:1551-61. DOI: 10.1007/s00384-019-03349-4

8. Onalan E, Andsoy II, Ersoy OF. The effect of preoperative oral carbohydrate administration on insulin resistance and comfort level in patients undergoing surgery. J Perianesth Nurs. 2019;34:539-50. PMID: 30401602 DOI: 10.1016/j.jopan.2018.07.007

   Pexe-Machado PA, de Oliveira BD, Dock-Nascimento DB, de Aguilar-Nascimento JE. Shrinking preoperative fast time with maltodextrin and protein hydrolysate in gastrointestinal resections due to cancer. Nutrition. 2013;29:1054-9. PMID: 23759267DOI: 10.1016/j.nut.2013.02.003

9. 10. Ertural F, Çelik GK, Özçelik H. Effect of oral carbohydrate solution administered before hip arthroplasty on preoperative anxiety and postoperative patient comfort: a randomized controlled trial. J Perianesth Nurs . 2023;38:461-8. PMID: 36803737, DOI: 10.1016/j.jopan.2022.08.012

10. Jani A, Chaudhry K, Kaur A, Bhatia PK, Kumar P, Gigi P, et al. Efficacy of Enhanced Recovery after Surgery (ERAS) Protocol in Maxillofacial Trauma: A Randomized Controlled Trial. J Stomatol Oral Maxillofac Surg. 2023:101576. DOI: 10.1016/j.jormas.2023.101576

11. Kuiper M, Gillingham M, Martin J, Gardner D, Van Calcar S. The Effect of Preoperative Carbohydrate Intake on Length of Stay and Postoperative Recovery Following Laparoscopic Living Donor Nephrectomy. J Ren Nutr. 2023;33:405-11. DOI: 10.1053/j.jrn.2022.12.005

12. Pędziwiatr M, Pisarska M, Matłok M, Major P, Kisielewski M, Wierdak M, et al. Randomized clinical trial to compare the effects of preoperative oral carbohydrate loading versus placebo on insulin resistance and cortisol level after laparoscopic cholecystectomy. Pol Przegl Chir. 2015;87:402-8. DOI: 10.1515/pjs-2015-0079

13. Choi YS, Cho BW, Kim HJ, Lee YS, Park KK, Lee B. Effect of Preoperative Oral Carbohydrates on Insulin Resistance in Older Adults Who Underwent Total Hip or Knee Arthroplasty: A Prospective Randomized Trial. J Am Acad Orthop Surg. 2022;30:971-8. DOI: 10.5435/JAAOS-D-21-00656

14. Mathur S, Plank L, McCall J, Shapkov P, McIlroy K, Gillanders L, et al. Randomized controlled trial of preoperative oral carbohydrate treatment in major abdominal surgery. Br J Surg 2010;97:485-94. PMID: 20205227, DOI: 10.1002/bjs.7026

