TEHRAN UNIVERSITY OF MEDICAL SCIENCES

Archives of Anesthesiology and Critical Care (In Press); x(x): xx-xx.

Available online at http://aacc.tums.ac.ir

Department of Anesthesiology, Pain and Critical Care Medicine TUMS

Research Article

The Effect of Maltodextrin (Maltodex®) Administration on Blood Glucose Levels and Well-Being Index in Patients Undergoing Gynecologic Laparotomy under General Anesthesia

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ARTICLE INFO

Article history:
Received 20 November 2025
Revised 11 December 2025
Accepted 25 December 2025

Keywords:
Maltodextrin;
Blood glucose;
Well-being index;
Laparotomy;
General anesthesia;
ERAS

ABSTRACT

Background: Prolonged preoperative fasting is commonly practiced to prevent aspiration during anesthesia; however, it has been shown to increase insulin resistance, trigger metabolic stress, and delay postoperative recovery. These physiological responses contribute to metabolic imbalance and elevated blood glucose levels after surgery. The Enhanced Recovery After Surgery (ERAS) protocol recommends preoperative administration of complex carbohydrates, such as maltodextrin, to attenuate surgical stress, maintain metabolic stability, and promote faster recovery. Maltodextrin is a complex carbohydrate with a controlled glycemic index, is easily absorbed, and is safe for preoperative use. This study aimed to evaluate the effect of maltodextrin (Maltodex®) administration on blood glucose levels and the well-being index in patients undergoing laparotomy under general anesthesia.

Methods: This research was a randomized controlled trial with a double-blind design involving elective laparotomy patients at CPL USU Hospital, Dr. Pirngadi Medan Hospital, and Haji Hospital. Subjects were divided into two groups: the intervention group received 400 ml of 12.5% maltodextrin solution two hours before surgery, while the control group received a placebo. Blood glucose levels were measured at six time points (T0–T5) throughout the perioperative period using a standard glucometer, while patients' psychological well-being was assessed using the WHO5 Well-being Index, a validated tool for evaluating postoperative quality of life.

Results: There were significant differences between the maltodextrin and placebo groups in both blood glucose levels ($p<0.05$) and postoperative well-being scores ($p<0.05$). The administration of maltodextrin effectively stabilized blood glucose levels, reduced surgical stress responses, and improved patient comfort and satisfaction during the postoperative period.

Conclusion: Preoperative administration of maltodextrin is effective in maintaining metabolic stability, reducing physiological stress responses, and enhancing the well-being of patients undergoing laparotomy under general anesthesia. These findings support the implementation of the ERAS protocol as an evidence-based approach to accelerate recovery and improve the quality of perioperative care.

The authors declare no conflicts of interest.
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Introduction

Laparotomy is still an important surgical procedure for treating serious abdominal emergencies, such as major bleeding, visceral perforation, advanced cancer, and intestinal blockage, which can be life-threatening. Its use is still growing, with reports showing that it has grown by 50% in the past ten years in the United States. This shows that surgery is still needed right away for serious abdominal problems [1]. Conversely, Japan has been advancing towards minimally invasive laparoscopy since 2010 due to enhanced surgical technologies and improved postoperative outcomes. The incidence of laparotomy in Indonesia also shows an upward trend of around 15% per year, with some regions reporting much higher rates. This indicates that there is an inequality in access to minimally invasive techniques [2].

Laparotomy holds clinical importance; yet, it is linked to substantial morbidity and mortality, with 30-day mortality rates ranging from 8.1% to 16.5% in Scandinavian research. Squared The approach induces a notable neuroendocrine and inflammatory stress response, as revealed by elevated levels of corticosterone, neutrophils, IL-1β, and MIP-1α, observed in experimental models [3]. This stress cascade alters molecules in vital organs, including modifications in the expression of adrenergic receptors and inflammatory cytokines. This may prolong recovery and exacerbate metabolic issues, particularly in individuals who are overweight, exhibit insulin resistance, or suffer from NAFLD [4].

Surgical stress during laparotomy impedes hepatic autophagy, increasing vulnerability to metabolic disorders and ischemia-reperfusion injury [4]. Extended preoperative fasting worsens metabolic instability by triggering insulin resistance and electrolyte imbalance, as demonstrated by animal studies showing postoperative hyperglycemia after fasting for 12 hours [5-6]. Postoperative hyperglycemia (>200 mg/dL) can occur in up to 67% of patients within the first three days. This results from surgical trauma, associated inflammation, and the effects of anesthesia [7–10]. Sevoflurane and desflurane, volatile anesthetics, elevate glucose levels via stimulating catecholamine release and diminishing insulin levels. Conversely, propofol may reduce glycemia by decreasing norepinephrine levels [11–15].

The Enhanced Recovery After Surgery (ERAS) guidelines recommend loading up on carbohydrates before surgery, usually in the form of maltodextrin, to reduce insulin resistance, maintain stable blood sugar levels before and after surgery, and accelerate the recovery process [14-15]. Maltodextrin is a carbohydrate that the body rapidly absorbs. It promotes metabolic stability, inhibits catabolism, and is effective in managing postoperative blood glucose levels, even in those with type 2 diabetes [16–18]. Carbohydrate loading may improve patient well-being by reducing hunger, anxiety, and physiological stress before surgery, in addition to its metabolic benefits [19-20].

Due to the significant metabolic stress linked to laparotomy and the potential for postoperative dysglycemia, the utilization of maltodextrin emerges as a promising approach to augment physiological resilience, optimize recovery, and promote patient well-being during the perioperative phase.

Methods

This research is a true-experimental study utilizing a double-blind randomized controlled trial design, undertaken with clearance from the institutional ethics committee (789/KEPK/USU/2025). This study was performed from May 2025 to June 2025 at three hospitals: Dr. Pirngadi Regional General Hospital, Haji Hospital, and CPL USU Hospital. Inclusion criteria included patients aged 18 to 65 years, with ASA 1 and ASA 2 classifications, undergoing gynecological laparotomy with general anesthesia. Patients with allergies to maltodextrin or related substances, other metabolic disorders affecting insulin levels (e.g., uncontrolled diabetes mellitus), gastric emptying disorders, and a history or prediction of difficult intubation (difficult airway), a history of previous difficult intubation, or anatomical abnormalities of the airway that could complicate airway management and the intubation process will be excluded from the study. In addition, there are dropout criteria, where the patients must be fasted after surgery and undergo surgery lasting less than 2 hours or more than 6 hours.

The minimum sample size is calculated using the formula for the difference in means between two populations. The minimum sample size required for each group is 15 patients per group. To anticipate possible sample loss (drop-out), the sample is increased by 10-20% of the calculated sample size, resulting in 18 patients per group (total 36). The research sample must also be homogeneous, especially in terms of the type of surgery, and the sample size from each hospital must be evenly distributed, i.e., 12 patients from each hospital.

There will be two groups of patients: one group will get maltodextrin, and the other group will get a placebo. Patient samples will be divided into two groups: one group will be given maltodextrin, and the other control group will be given a placebo. The randomization and packaging of the intervention and placebo products were carried out by a pharmaceutical company (PT Kalbe) to ensure blinding and avoid researcher bias. Both products were packaged in identical formats and labeled simply as A and B to maintain the blind design.

400 ml of 12.5% maltodextrin was administered to the intervention group in two doses at three different times:

6 hours preoperatively (to reduce catabolism due to prolonged preoperative fasting), 2 hours preoperatively (to maintain energy levels before anesthesia), and 4 hours postoperatively (to support metabolic recovery after surgery). The control group received a placebo using the same procedure. Data will be collected at six time points, namely T0 (6 hours before the scheduled surgery), T1 (2 hours before entering the operating room), T2 (before anesthesia induction), T3 (after the patient arrives in the postoperative recovery room), T4 (4 hours after T3), and T5 (4 hours after T4).

All patients in the study will be given the same anesthesia protocol to minimize variability that could affect the results. The stages of drug use include fentanyl, midazolam, propofol, and rocuronium for induction; fentanyl and atracurium for maintenance; and paracetamol and ketorolac for postoperative analgesia.

Blood glucose levels were measured using a glucometer or laboratory test, while well-being was measured using the WHO-5 Well-Being Index. A well-being assessment was performed after surgery (T5) to assess changes in the patient's psychological state. Categorical variables such as gender and educational status will be presented in the form of frequency distributions and percentages. Meanwhile, continuous variables such as blood glucose levels and WHO-5 Well-Being Index scores will be presented in the form of mean values, standard deviations (SD), and minimum and maximum values (range) at each measurement point (T0 to T5).

A bivariate analysis will be conducted to evaluate the impact of maltodextrin administration on blood glucose levels and a well-being index. This study consists of two groups (maltodextrin group and control group) with repeated measurements at six time points; thus, the analysis will concentrate on intergroup comparisons at each time point.

An independent t-test will be employed to compare the mean blood glucose levels and well-being scores between the treatment and control groups at each measurement time point, contingent upon the normal distribution of the data. The Mann-Whitney U test will be utilized if the data distribution is not normal.

Additionally, to monitor alterations in blood glucose levels and overall well-being over time within each group, a repeated measures ANOVA will be conducted for normally distributed data, or a Friedman test for non-normally distributed data. The purpose of this analysis is to determine whether the dynamics of changes from T0 to T5 in a single group are statistically significant. Multivariate analysis can be performed using multiple linear regression or logistic regression tests, depending on the type and scale of the dependent variables, to identify the factors that most influence changes in blood glucose levels and well-being scores. SPSS software version 22.0 will be used for all statistical analyses, and a P value of less than 0.05 will be deemed statistically significant.

Results

Baseline characteristics of the subjects (Table 1) show that the mean age in the maltodextrin group was 42.6 ± 12.3 years, while in the placebo group it was 45.7 ± 14.09 years. The operation time was comparable across the two groups (2:09 ± 0:27 hours in the maltodextrin group and 2:08 ± 0:27 hours in the placebo group). Based on Body Mass Index (BMI), the distribution of patients in the two groups did not differ significantly. The ASA classification of patients was similar in the two groups (77% ASA II and 22.2% ASA I). The distribution of surgery types between the two groups was myomectomy and total hysterectomy, accounting for 30.6% of the total sample, with Fisher's exact test results showing a P value of 0.743 ($p > 0.05$). All characteristics showed homogeneity in the study subjects.

The analysis showed that the average blood glucose levels were the same at the start for both the maltodextrin and placebo groups (Table 2). However, there were big differences between the two groups from 2 hours before surgery until the end of the measurement period. The average blood glucose level in the maltodextrin group was 109.2 mg/dL at T0, while it was 110.6 mg/dL in the placebo group. At T1 and T2, the levels were 108.1 mg/dL and 101.8 mg/dL, which were in line with the trend. At T1 and T2, the levels were 108.9 mg/dL and 106.8 mg/dL, respectively. There was a big jump at T3 after the surgery. The maltodextrin group had 113.2 mg/dL, and the placebo group had 136.3 mg/dL, which means that the placebo group was under more metabolic stress. The GDS levels went down at T4 and T5, but the placebo group still had higher averages at both times. For maltodextrin, the average blood glucose level from T0 to T5 was 111.9 mg/dL, and for placebo, it was 123.9 mg/dL. This difference was statistically significant ($p = 0.001$). The Mann-Whitney test indicated no significance at T0, yet revealed significant differences at T1–T5 with $p < 0.05$.

The mean WHO-5 Well-Being Index score (Table 3) in the maltodextrin group was 64.67 ± 4.99 with a range of 56–73, while in the placebo group, the mean was 47.56 ± 3.32 with a range of 44–52. The independent t-test shows that the difference was statistically significant ($p = 0.001$).

Most patients underwent a midline incision (52.8%), while the remainder used a Pfannenstiel incision (47.2%) (Table 4). Based on the results of the chi-square test, the results were not significant, with a P value of 0.754 ($p > 0.05$). The homogeneity of the incisions ensured that the levels of postoperative pain and tissue trauma did not differ significantly between groups, thus not affecting the perception of postoperative well-being.

Table 1- Demographic Characteristics of Study

Variable	Maltodextrin (18)	Placebo (18)	P value
Age (Years)	42.6 ± 12.3	45.7 ± 14.09	0.486 [a]
Duration of Surgery (Hour:Minute)	2:09 ± 0:27 (1:32–2:57)	2:08 ± 0:27 (1:34–2:56)	0.791[*]
BMI (kg/m^2)			0.658 [a]
Underweight	2 (11.1%)	1 (5.5%)	
Normal	10 (55.6%)	10 (55.6%)	
Overweight	5 (27.8%)	4 (22.2%)	
Obesity Class I	1 (5.6%)	3 (16.7%)	
ASA			1.000 [b]
ASA I	4 (22.2%)	4 (22.2%)	
ASA II	14 (77.7%)	14 (77.7%)	
Type of Surgery			0.743 [b]
Myomectomy	6 (33.3%)	5 (27.8%)	
Total Hysterectomy	5 (27.8%)	6 (33.3%)	
Ovarian Cystectomy	4 (22.2%)	5 (27.8%)	
Salpingo-oophorectomy	3 (16.7%)	2 (11.1%)	
Total	18 (100%)	18 (100%)	

[a] Independent T-Test. [*] Mann-Whitney Test. [b] Fisher Exact test

Table 2- Blood Glucose Levels in Maltodextrin and Placebo Groups

Category	Maltodextrin (18) Mean ± SD (min-max)	Placebo (18 Mean ± SD (min-max)	P value*
T0	109.2 ± 17.3 (91-145)	110.6 ± 18.4 (101-162)	0.115
T1	108.1 ± 12.4 (98-145)	108.9 ± 4.1 (98-115)	0.026
T2	101.8 ± 8.5 (81-123)	106.8 ± 4.5 (97-114)	0.004
T3	113.2 ± 16.0 (101-159)	136.3 ± 3.1 (132-142)	0.001
T4	121.9 ± 23.0 (102-182)	141.5 ± 19.5 (128-183)	0.015
T5	117.7 ± 22.2 (99-176)	139.8 ± 20.7 (124-182)	0.002
T0-T5	111.9 ± 16.1 (81-176)	123.9 ± 18.8 (97-182)	0.001

*Mann-Whitney

Table 3- WHO-5 Well-Being Index.

Category	Maltodextrin (18)	Placebo (18)	P value
WHO-5 Well-Being Index	64.67 ± 4.99 (56-73)	47.56 ± 3.32 (44-52)	0.001

Table 4- Comparison of Incision Types.

Type Of Incision	Maltodextrin (18)	Placebo (18)	Total (n=36)	P value
Midline	10 (55.6%)	9 (50.0%)	19 (52.8%)	0.754
Pfannenstiel	8 (44.4%)	9 (50.0%)	17 (47.2%)	
Total	18 (100%)	18 (100%)	36 (100%)	

Discussion

This study evaluated the impact of oral maltodextrin (Maltodex®) in a preoperative carbohydrate loading strategy on blood glucose levels and the WHO-5 well-being index in patients undergoing gynecological laparotomy under general anesthesia. The groups exhibited similar demographic and clinical characteristics, with the maltodextrin group having a mean age of 31.94 years and the placebo group 36.11 years. Surgical duration was comparable at 1.69 hours for the maltodextrin group and 1.72 hours for the placebo group. BMI and ASA classification were also balanced, with most patients in the ASA II category, consistent with previous research by Zhang et al. on the importance of homogeneity in metabolic intervention studies to attribute outcome differences to the maltodextrin intervention [21].

The administration of maltodextrin was found to improve metabolic stability and lower blood glucose levels compared to a placebo group across all time points studied. Initially, the maltodextrin group's blood glucose level was 109.2 mg/dL, slightly lower than the placebo group's 110.6 mg/dL. After anesthesia induction (T2), the placebo group's glucose level reduced to 106.8 mg/dL, whereas the maltodextrin group decreased to 101.8 mg/dL. A notable rise in blood glucose was observed post-surgery (T3), with the maltodextrin group at 113.2

mg/dL, compared to 136.3 mg/dL in the placebo group, indicating a greater metabolic stress response in the latter. This supports findings from Senapathi et al. [22] and Minz et al. [23] that indicate preoperative carbohydrate intake can mitigate postoperative hyperglycemia and reduce metabolic stress responses during surgery [22-23].

Despite decreased blood glucose levels at T4 and T5, the placebo group maintained higher mean levels than the maltodextrin group (121.9 ± 23.0 vs. 141.5 ± 19.5 mg/dL at T4 and 117.7 ± 22.2 vs. 139.8 ± 20.7 mg/dL at T5). This supports the hypothesis that patients without preoperative carbohydrates had a greater hyperglycemic response due to surgical stress [22–24]. Overall, the maltodextrin group averaged 111.9 ± 16.1 mg/dL, compared to 123.9 ± 18.8 mg/dL in the placebo group, with a significant difference ($p = 0.001$) confirming that maltodextrin significantly reduces blood glucose levels preoperatively.

The difference shows that the placebo group had more metabolic stress during the perioperative period. This was shown by higher levels of stress hormones that caused insulin resistance and high blood sugar after surgery [24]. Giving maltodextrin before surgery, on the other hand, seems to lessen the catabolic reaction that happens when you fast and are stressed out about the surgery. This keeps blood sugar levels stable and makes insulin work better [23]. Senopathi et al. showed that patients who took maltodextrin had much lower blood sugar levels after surgery than those who didn't, which suggests that it can help prevent high blood sugar levels during and after surgery and keep blood sugar levels stable after surgery [22].

Physiological surgical stress activates the HPA axis, increasing stress hormones like cortisol and catecholamines, leading to insulin resistance and hyperglycemia, particularly during overnight fasting [25]. Administering maltodextrin pre-surgery helps maintain normal blood glucose levels by promoting adequate insulin secretion, as shown by Kumar et al. in patients undergoing hepatectomy [26]. Additionally, maltodextrin facilitates glucose balance while not affecting gastric emptying, with Hammond et al. noting similar gastric emptying times to water when administered 2–3 hours before anesthesia, indicating its safety and potential for routine use in anesthetic practice [27].

Overall, the study found that the mean blood glucose levels in the placebo group increased, peaking at T3 with a subsequent decrease, while remaining higher than in the maltodextrin group ($p < 0.001$). This suggests that fasting may worsen energy homeostasis post-surgery. Research by Abo-Omar et al. showed that perioperative blood glucose spikes can predict complications such as wound infection and delayed mobilization [28]. Perioperative glucose spikes have been linked to complications, and preoperative maltodextrin administration was shown to stabilize glucose levels and mitigate surgical stress spikes, supporting Enhanced Recovery After Surgery (ERAS) protocols. The carbohydrate supply before surgery aids in maintaining glucose homeostasis and reducing insulin resistance, aligning with previous research indicating better glucose stability when consuming carbohydrates before anesthesia [29].

In the placebo group subjected to preoperative fasting without carbohydrates, surgical stress led to heightened levels of stress hormones, such as cortisol and catecholamines, which contribute to increased blood glucose through gluconeogenesis and glycogenolysis. This hormonal surge is compounded by pro-inflammatory cytokines like IL-6 and TNF-α, which further impair insulin sensitivity. Evidence from Lin et al. indicates that prolonged fasting may induce endoplasmic reticulum (ER) stress, negatively affecting glucose transporter expression and glucose uptake in skeletal muscle [6]. Conversely, Breuer et al. [30] demonstrated that administering maltodextrin before surgery can suppress gluconeogenesis and enhance peripheral insulin sensitivity, leading to more stable blood glucose levels during and after the procedure. This aligns with the Enhanced Recovery After Surgery (ERAS) concept, which posits that metabolic stability is vital for recovery [24].

In addition to physiological benefits, maltodextrin administration improved patients' well-being as measured by the WHO-5 Well-Being Index. Participants reported increased comfort, reduced fatigue, and diminished hunger and thirst, reflecting enhanced subjective well-being. Studies corroborate that preoperative carbohydrate intake, like maltodextrin, resulted in improved calmness and readiness for surgery, particularly in patients with type 2 diabetes [28,31].

Stable glucose levels are crucial for maintaining central nervous system function and mood, whereas fluctuations can hinder neurotransmitter balance and elevate stress responses. By providing glucose stability, maltodextrin may alleviate stress hormone release and improve mental readiness for surgery, potentially promoting faster postoperative recovery due to better immune and metabolic responses [31].

The findings support the ERAS protocol that endorses carbohydrate-rich fluids up to two hours before surgery as both safe and beneficial in mitigating complications. The implementation of maltodextrin in clinical practice is feasible, especially in Indonesian teaching hospitals, owing to its low cost and accessibility, requiring minimal resources for training [32].

However, the study did not measure inflammatory markers or hormonal levels, limiting the understanding of maltodextrin's biological mechanisms to blood glucose changes alone. Given the study's focus on female patients of childbearing age, further research is necessary to assess the implications for other populations, including males and older adults.

Conclusion

Preoperative administration of maltodextrin is effective in maintaining metabolic stability, reducing physiological stress responses, and enhancing the well-being of patients undergoing laparotomy under general anesthesia. These findings support the implementation of the ERAS protocol as an evidence-based approach to accelerate recovery and improve the quality of perioperative care.

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