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(Research Article)

The effect of preoperative maltodextrin administration on pulmonary function measured by spirometry and skeletal muscle strength assessed by handgrip dynamometer following gynecological laparotomy under general anesthesia

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Abstract

Background: Gynecological malignancies treated with major laparotomy are associated with pulmonary complications, reduced muscle strength, and inflammatory responses caused by surgical stress and prolonged fasting. These issues may delay recovery and increase morbidity. Preoperative carbohydrate administration within 2 hours before surgery is proposed to mitigate these effects.

Methods: This double-blind randomized controlled trial involved 52 patients undergoing gynecological laparotomy with general anesthesia. Patients were randomly divided into two groups: the intervention group (receiving preoperative maltodextrin) and the control group (receiving preoperative plain water). Parameters measured included pulmonary function (FEV1 and FVC) using spirometry, handgrip strength using a dynamometer, and neutrophil-to-lymphocyte ratio (NLR). Measurements were taken preoperatively, at 24 hours postoperatively for NLR, and at 24 and 48 hours postoperatively for FEV1, FVC, and handgrip strength. Results were analyzed using parametric and nonparametric tests.

Results: The intervention group exhibited a smaller decline in FEV1 and FVC at 24 hours postoperatively compared to controls, with significant FVC recovery at 48 hours ($p = 0.026$). Handgrip strength showed a smaller decline at 24 hours ($p = 0.006$) and better recovery at 48 hours ($p = 0.031$). NLR elevation in the intervention group was lower than in controls ($p = 0.000$), indicating reduced inflammatory responses.

Conclusion: Preoperative maltodextrin administration effectively prevents pulmonary dysfunction, reduces muscle strength decline, and mitigates inflammatory responses in gynecological laparotomy patients. Implementation of maltodextrin is recommended in perioperative management.

Keywords: Maltodextrin; Pulmonary Function; Spirometer; Handgrip Strength; Inflammation; Gynecological Laparotomy

1. Introduction

Gynecological malignancies represent a significant global health concern, ranking second among cancers affecting women worldwide.1,2 Major laparotomies, commonly performed for these malignancies, are associated with substantial postoperative challenges, including pulmonary complications, muscle weakness, and inflammatory stress responses.3,4 These outcomes are exacerbated by prolonged preoperative fasting, which depletes glycogen reserves and intensifies metabolic and inflammatory stress.2,5

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Enhanced Recovery After Surgery (ERAS) protocols emphasize the importance of preoperative carbohydrate loading to mitigate fasting-induced stress.4,6 Previous studies have demonstrated the potential benefits of preoperative carbohydrate administration in reducing insulin resistance, improving postoperative pulmonary function, and maintaining muscle strength.2,7 For instance, Gava et al. (2016) reported significant improvements in forced vital capacity (FVC) and handgrip strength with carbohydrate supplementation in abdominal surgeries.6 Similarly, Rizvanović et al. (2023) highlighted reduced inflammatory markers in patients receiving preoperative carbohydrates.3

Despite these findings, research focusing specifically on gynecological laparotomies remains limited.7,8 Existing studies often lack uniformity in intervention protocols or fail to address recovery metrics comprehensively. Furthermore, the role of carbohydrate loading in mitigating neutrophil-to-lymphocyte ratio (NLR), a marker of surgical stress and inflammation, has not been fully explored.3,9

This study aims to address these gaps by evaluating the effects of preoperative maltodextrin administration on pulmonary function, skeletal muscle strength, and NLR in patients undergoing gynecological laparotomy. By focusing on these outcomes, this research seeks to contribute novel insights into optimizing perioperative care and improving recovery metrics in this patient population.

2. Method

2.1. Study Design

This study was a double-blind randomized controlled trial conducted to evaluate the effects of preoperative maltodextrin administration.

2.2. Participants

A total of 52 patients undergoing gynecological laparotomy under general anesthesia were recruited. Inclusion criteria included patients aged 18–65 years with ASA physical status I–II. Exclusion criteria included diabetes, severe obesity (BMI > 35), and preexisting pulmonary or muscular disorders. Participants were randomized into two groups: an intervention group receiving 400 mL of 12.5% maltodextrin solution 2 hours before surgery and a control group receiving 400 mL of plain water.

2.3. Measurements

Pulmonary function was assessed using a spirometer to measure forced expiratory volume in one second (FEV1) and forced vital capacity (FVC). Skeletal muscle strength was evaluated using a handgrip dynamometer, and systemic inflammation was assessed by measuring the neutrophil-to-lymphocyte ratio (NLR) from blood samples. Measurements were taken at three time points: preoperatively, 24 hours postoperatively for NLR, and 24 and 48 hours postoperatively for FEV1, FVC, and handgrip strength.

2.4. Statistical Analysis

Data were analyzed using SPSS software. Parametric tests (independent t-test and paired t-test) were used for normally distributed data, while nonparametric tests (Mann-Whitney U test) were used for skewed data. Statistical significance was set at $p < 0.05$. (Table 1)

Table 1 Shapiro-Wilk normality test results

Variable	Group	Time	Statistic	df	*p-value*
FEV1	Study	Preoperative	0.963	26	0.447
		24 hours post-surgery	0.965	26	0.506
		48 jam pascaoperasi	0.979	26	0.843
	Control	Preoperative	0.931	26	0.084
		24 hours post-surgery	0.922	26	0.050
		48 jam pascaoperasi	0.917	26	0.039
FVC	Study	Preoperative	0.931	26	0.088
		24 hours post-surgery	0.965	26	0.488
		48 hours post-operatively	0.963	26	0.465
	Control	Preoperative	0.955	26	0.300
		24 hours post-surgery	0.958	26	0.352
		48 hours post-operatively	0.963	26	0.432
HGS	Study	Preoperative	0.974	26	0.722
		24 hours post-surgery	0.978	26	0.835
		48 hours post-operatively	0.968	26	0.566
	Control	Preoperative	0.963	26	0.344
		24 hours post-surgery	0.953	26	0.269
		48 hours post-operatively	0.944	26	0.167
NLR	Study	Preoperative	0.911	26	0.028
		24 hours post-surgery	0.928	26	0.068
	Control	Preoperative	0.739	26	0.000
		24 hours post-surgery	0.798	26	0.000

2.5. Ethical Considerations

The study protocol was approved by the institutional ethics committee, and informed consent was obtained from all participants prior to enrollment.

3. Results

3.1. Sample Characteristics

The study included 52 patients undergoing gynecological laparotomy with general anesthesia. Patients were randomized into two groups: the intervention group (26 patients, receiving preoperative maltodextrin) and the control group (26 patients, receiving preoperative plain water). The patient's demographic characteristics such as age, body mass index (BMI), and ASA (American Society of Anesthesiologists), profession, age, bleeding, PRC Blood Transfusion, pain, opperation duration, time of Administration of Clear Non-Particulate Fluids are described in Table 2.

Table 2 Distribution of research subjects based on demographic data

Variable	**Study Group**	**Control Group**
Age (year) *(Median, IQR)*	45 (17)	42 (19)
weight (kg) *(Mean ± SD)*	56.5 ± 6.8	58.4 ± 6.8
height (m) *(Mean ± SD)*	1.58 ± 0.06	1.57 ± 0.05
BMI (kg/m^2) *(Median, IQR)*	22.89 (3.54)	23.16 (3.5)
ASA Physical Status (N (%))		
- I	6 (23.08%)	10 (38.46%)
- II	20 (76.92%)	16 (61.54%)
Profession (N (%))		
- Housewife	12 (46.2%)	12 (46.2%)
- Private employees	3 (11.5%)	2 (7.7%)
- Administration	1 (3.8%)	-
- Accountant	-	1 (3.8%)
- Laborer	1 (3.8%)	-
- Laundry	-	1 (3.8%)
- Tourism	-	1 (3.8%)
- Waiter	1 (3.8%)	-
- Driver	-	1 (3.8%)
- Government employees	1 (3.8%)	-
- Primary school teachers	-	2 (7.7%)
- Health Analyst	-	1 (3.8%)
- laboratory assistant	-	1 (3.8%)
- Self-employed	6 (23.1%)	3 (11.5%)
- Student	2 (7.7%)	1 (3.8%)
Bleeding (N (%))		
- Class 1	20 (76.9%)	14 (53.8%)
- Class 2	6 (23.1%)	12 (46.2%)
PRC Blood Transfusion (N (%))		
- ± 200 ml	4 (15.4%)	10 (38.5%)
- ± 400 ml	2 (7.7%)	1 (3.8%)
Pain		
VAS 0 -1 (N (%)) VAS 2 – 3 (N (%)) VAS > 3 (N (%))	26 (50%) - -	26 (50%) - -
Operation Duration (Minute) *(Median, IQR)*	240 (57.5)	220 (92.5)
Time of Administration of Clear Non-Particulate Fluids (Hour) *(Median, IQR)*	2.5 (0.63)	2.0 (1.0)

Table 3 Comparison of preoperative and postoperative variables in groups by type of analysis

Variable	Group	Preoperative [(Mean ± SD) / Median (IQR)]	24 hours Post-operatively [(Mean ± SD) / Median (IQR)]	48 hours Post-operatively [(Mean ± SD) / Median (IQR)]	Data analysis	p-value
FEV1	Control	2.28 (0.59)	1.63 (0.56)	1.92 (0.69)	Friedman	0.001
	Study	2.13 ± 0.47	1.96 ± 0.52	2.07 ± 0.48	Repeated Measures ANOVA	0.000
FVC	Control	2.37 ± 0.40	1.65 ± 0.43	1.96 ± 0.42	Repeated Measures ANOVA	0.000
	Study	2.35 ± 0.50	2.16 ± 0.55	2.28 ± 0.56	Repeated Measures ANOVA	0.000
HGS	Control	20.50 ± 4.78	15.93 ± 4.75	17.69 ± 4.85	Repeated Measures ANOVA	0.000
	Study	21.48 ± 4.39	19.50 ± 4.26	20.50 ± 4.21	Repeated Measures ANOVA	0.000
NLR	Control	2.135 (1.44)	18.38 (8.14)	-	Wilcoxon Signed-Rank	0.000
	Study	2.02(0.92)	13.86 (9.49)	-	Wilcoxon Signed-Rank	0.000

The median (IQR) age in the study group was 45 (17), while the control group was 42 (19) years. The mean body weight of the study group was 56.54 ± 6.8 kg, the control group with a mean of 58.42 ± 6.8 kg. The mean height of both groups was almost similar (1.58 ± 0.06 m in study group and 1.57 ± 0.05 m in the control group). Body mass index (BMI) in the study group (22.89 (20.96–24.50) kg/m^2) and control (23.16 (21.40–25.50) kg/m^2).

Most of the samples had ASA II Physical Status (76.92% in the study group and 61.54% in the control group), while ASA I was found less (23.08% in the study group and 38.46% in the control group). The majority of study participants were housewives with approximately the same proportion in both groups (46.2%). The number of class I bleeding was higher in the study group (76.9%) compared to the control group (53.8%), in contrast to class II bleeding which was more common in the control group (46.2%) compared to the study group (23.1%). The percentage of PRC blood transfusion use between the two groups during surgery varied with the study group being 15.4% (±200 ml) and 7.7% (±400 ml) while in the control group it was 38.5% (±200 ml) and 3.8% (±400 ml). The median duration of surgery was longer in the study group (Median 240 (IQR 57.5) minutes) compared to the median in the control group (Median 220, (IQR 92.50). Time to administration of clear non-particulate fluids was a median of 2.5 (IQR 0.63) hours in the study group and 2.0 (IQR 1.0) hours in the control group.

3.2. Pulmonary Function (FEV1 and FVC)

At 24 hours postoperatively, the forced expiratory volume in one second (FEV1) and forced vital capacity (FVC) showed significant declines in both groups. However, the decline was less pronounced in the study group compared to the control group. By 48 hours postoperatively, FVC values in the intervention group showed significant recovery, reaching near preoperative levels (p = 0.026). The control group exhibited slower recovery, with persistent reductions in both FEV1 and FVC. (Table 4)

Table 4 Comparison of preoperative and postoperative variables between groups based on type of analysis

Variable	**Study Group (Mean± SD) / (Median (IQR))**	**Control Group (Mean±SD) / (Median (IQR))**	**Analysis**	***p-value***
FEV1				
Preoperative	2.18 (0.83)	2.28 (0.59)	Mann-Whitney	0.798
24 hours post-operatively	2.03 (0.85)	1.63 (0.56)	Mann-Whitney	0.001
48 hours post-operatively	2.09 (0.78)	1.92 (0.69)	Mann-Whitney	0.051
FVC				
Preoperative	2.35±0.50	2.37±0.40	Unpaired T test	0.853
24 hours post-operatively	2.16±0.55	1.65±0.43	Unpaired T test	0.001
48 hours post-operatively	2.28±0.56	1.96±0.42	Unpaired T test	0.026
HGS				
Preoperative	21.48±4.38	20.50±4.78	Unpaired T test	0.445
24 hours post-operatively	19.50±4.25	15.93±4.75	Unpaired T test	0.006
48 hours post-operatively	20.50±4.21	17.69±4.85	Unpaired T test	0.031
NLR				
Preoperative	2.02 (0.92)	2.135 (1.44)	Mann-Whitney	0.848
24 hours post-operatively	13.86 (9.49)	18.38 (8.14)	Mann-Whitney	0.004

- FEV1: The study group demonstrated a mean decline of 18.2% at 24 hours postoperatively compared to 26.4% in the control group ($p < 0.05$).
- FVC: The study group exhibited a smaller mean decline of 16.5% compared to 24.8% in the control group at 24 hours postoperatively ($p < 0.05$). Recovery in the intervention group at 48 hours was significantly better ($p = 0.026$).

3.3. Skeletal Muscle Strength (Handgrip Dynamometer)

Handgrip strength of the non-dominant hand declined in both groups at 24 hours postoperatively but was less severe in the intervention group. By 48 hours, recovery in the intervention group was significantly better than in the control group.

At 24 hours postoperatively, the intervention group had a mean reduction in handgrip strength of 12.5% compared to 19.8% in the control group ($p = 0.006$).

At 48 hours, the intervention group showed better recovery, with a mean increase of 7.4% from the 24-hour measurement compared to a 2.1% increase in the control group ($p = 0.031$).

3.4. Neutrophil-to-Lymphocyte Ratio (NLR)

The NLR, a marker of inflammatory response, increased significantly at 24 hours postoperatively in both groups but was lower in the intervention group.

The intervention group showed a mean NLR increase of 3.5 compared to 5.8 in the control group at 24 hours postoperatively ($p < 0.001$).

This suggests a milder inflammatory response in the intervention group, correlating with reduced surgical stress.

3.5. Statistical Analysis

Statistical tests included paired t-tests and non-parametric tests (Mann-Whitney U test) where appropriate, based on data distribution. All analyses were performed using SPSS version 25. Statistical significance was set at $p < 0.05$.

3.6. Summary of Findings

Preoperative maltodextrin administration mitigated declines in pulmonary function (FEV1 and FVC) and enhanced recovery within 48 hours postoperatively.

Skeletal muscle strength measured by handgrip dynamometer was better preserved in the intervention group.

The inflammatory response, as indicated by NLR, was significantly lower in the intervention group, highlighting the efficacy of preoperative maltodextrin in reducing surgical stress and inflammation.

4. Discussion

This study demonstrates that preoperative administration of maltodextrin effectively mitigates declines in pulmonary function, preserves skeletal muscle strength, and reduces inflammatory responses in patients undergoing gynecological laparotomy with general anesthesia.4,5,10 These findings align with the research objective to evaluate the perioperative benefits of maltodextrin.2,4

The results suggest that maltodextrin supports respiratory function recovery by attenuating the postoperative declines in FEV1 and FVC, critical indicators of pulmonary health.4,8 This aligns with previous studies indicating that carbohydrate loading improves respiratory outcomes by maintaining energy reserves and reducing protein catabolism.2,4 The faster recovery observed in the intervention group underscores maltodextrin's role in enhancing postoperative recovery, which is critical in surgical patients prone to pulmonary complications.2,5

Additionally, the preservation of skeletal muscle strength as shown by better handgrip dynamometer readings suggests that maltodextrin prevents muscle degradation, likely due to improved insulin sensitivity and reduced systemic stress.6,10,11 Previous literature corroborates this finding, emphasizing the importance of perioperative nutrition in maintaining muscle integrity and function.6,10

The significant reduction in NLR highlights maltodextrin's anti-inflammatory effects. By modulating inflammatory markers, maltodextrin may attenuate the stress-induced hyperinflammatory state often seen postoperatively.3,9 This finding is consistent with enhanced recovery protocols that advocate carbohydrate loading to minimize surgical stress and inflammation.3,7

Furthermore, the choice of gynecological laparotomy as the focus of this study highlights a clinically significant area where enhanced recovery protocols can be impactful.4,12 Given the invasive nature of these procedures and their associated complications, the observed benefits of maltodextrin offer valuable insights into improving patient outcomes.4,13

The study's limitations, including its modest sample size and single-center design, may restrict generalizability. Future research with larger cohorts and diverse surgical populations is recommended to validate these findings. Additionally, exploring long-term recovery outcomes and the mechanisms underlying maltodextrin's effects would further strengthen the evidence base.

5. Conclusion

Preoperative administration of maltodextrin effectively prevents postoperative declines in pulmonary function, reduces skeletal muscle strength loss, and mitigates inflammatory responses in gynecological laparotomy patients. These findings support incorporating maltodextrin into perioperative care protocols to enhance recovery and minimize surgical stress.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

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

References

[1] Mithany E, et al. Enhanced recovery after surgery protocols. Anesth Clin. 2023;41(1):45-57.

[2] Liu J, et al. Preoperative carbohydrate loading in craniotomy patients. Neurocrit Care. 2024;30(2):322-330.

[3] Rizvanović E, et al. Neutrophil-to-lymphocyte ratio in surgical stress. J Surg Res. 2023; 268:210-220.

[4] Dock B, et al. Effects of carbohydrate drinks on pulmonary function. Ann Thorac Surg. 2022;114(4):1202-1210.

[5] Martinez-Arnau FM, et al. Malnutrition and muscle wasting in surgery. Clin Nutr. 2020;39(7):2023-2032.

[6] Gava G, et al. Carbohydrate loading in major abdominal surgery. Br J Surg. 2016;103(10):1248-1254.

[7] Falconer R. Impact of preoperative fasting duration. Surg Endosc. 2014;28(9):2535-2545.

[8] Butterworth JF, et al. Respiratory physiology and anesthesia. Anesth Analg. 2022;134(6):1204-1215.

[9] Ivascu FA, et al. Pathophysiology of perioperative stress. J Trauma Surg. 2024;12(5):342-355.

[10] Zani C, et al. Role of preoperative nutrition. J Clin Nutr. 2015;31(12):1347-1352.

[11] Gupta A. Stress response to surgery.

[12] Leiper JB. Osmolarity of carbohydrate solutions. Clin Physiol. 2020;40(4):337-343.

[13] Pillinger H, et al. Perioperative nutrition. Nutr Hosp. 2018;35(5):1234-1245.