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# Use of a vacuum mattress during Laparoscopic Sleeve Gastrectomy reduces the concentration of rhabdomyolysis markers and the incidence of acute renal failure - case matched clinical trial.

Mateusz Wierdak

B Habrat, P Małczak, H Rodak, I Lastovetskyi, A Lasek, T Wikar, M Pędziwiatr, P Major

2'nd Department of General Surgery, Jagiellonian University, Krakow, Poland

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# Introduction

One of the potential complications of bariatric surgery is rhabdomyolysis.

The use of muscle relaxants during general anesthesia causes the disappearance

of muscle tonus, which, combined with the large mass of tissues of the patient operated due to obesity, leads to compression of the muscles mainly in the paraspinal and lumbar region, and consequently to their hypoxia and functional and structural damage.

This type of injury leads to the release of significant amounts of myoglobin and other metabolites – rhabdomyolysis (RML).

Rhabdomyolysis can lead to acute kidney injury (AKI) with acute kidney failure.

# How common is this problem?

Literature data indicate the incidence of such complications during bariatric surgery in case of laparoscopic procedures like Roux en Y gastric by-pass for 7 - 13%.

Risc factors of RML are:

- Male gender
- High BMI index- > 50 kg/m$^2$
- Long operative time

| | RML patients ($n$=87) | Non-RML patients ($n$=325) | $p$ value |
|---|---|---|---|
| Age (years) | 39 (32–40) | 40 (34–43) | 0.6 |
| Male/female | 53:47 | 29:71 | <0.001 |
| Body mass Index (kg/m$^2$) | 52 (45–67) | 48 (42–56) | <0.01 |
| Operating time (min) | 255 (221–342) | 207 (173–251) | <0.01 |

An incidance of AKI in bariatric patients with RML is about 14 %

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RESEARCH ARTICLE

## Clinical Features of Rhabdomyolysis After Open and Laparoscopic Roux-en-Y Gastric Bypass

João E. M. T. M. Ettinger · Carlos A. Marcílio de Souza · Euler Ázaro · Carlos A. B. Mello · Paulo V. Santos-Filho · Juliana Orrico · Rodolfo C. Santana · Paulo Amaral · Edvaldo Fahel · Paulo Benigno P. Batista

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**Abstract**
*Background* Rhabdomyolysis (RML) is caused by muscle injury, this may cause kidneys overload and lead to acute renal failure (ARF). The risk factors for RML in bariatric surgery (BS) are operative time (OT) >4 h and high BMI. The frequency of RML in BS varies from 12.9 to 37.8%. This study has the objective of describing the characteristics associated with RML and ARF in BS.
*Methods* We studied retrospectively 114 patients submitted to BS. Criteria for RML were CPK level >950 IU/l (five times the normal value). The variables were BMI, OT, age, intraoperative hydration and diuresis, CPK, creatinine, arterial hypertension, peripheric vascular disease, diabetes, open and laparoscopic techniques—inclusion criteria: patients submitted to gastric bypass; exclusion: renal failure and statins use.
*Results* RML incidence was 7%. The factors associated with RML in the bivariate analysis were hepatic steatosis, high BMI, high weight, higher excess weight, and prolonged OT. The risk factor for RML in the multivariate analysis was BMI≥50 kg/m$^2$. When the OT was below 2 h the incidence of RML was zero, but this was not significant in the multivariate analysis. The factors associated with a higher risk of CPK elevation (multivariate analysis) were hypertension and open technique.

J. E. M. T. M. Ettinger (✉) · C. A. Marcílio de Souza · P. V. Santos-Filho
Escola Bahiana de Medicina e Saúde Pública (EBMSP), Salvador, Bahia, Brazil
e-mail: dr.ettinger@gmail.com

E. Ázaro · P. V. Santos-Filho · P. Amaral · E. Fahel
Department of Surgery, EBMSP, Salvador, Bahia, Brazil

J. E. M. T. M. Ettinger · E. Ázaro · C. A. B. Mello · P. B. P. Batista

## Rhabdomyolysis in Bariatric Surgery: a Systematic Review

Saurav Chakravarthy · Diwakar R. Sarma · Ameet G. Patel

**Abstract**
*Background* Rhabdomyolysis (RML) is a rare complication of bariatric surgery. A systematic review was performed to identify risk factors and patient outcomes in morbidly obese patients undergoing bariatric surgery who develop RML.
*Methods* A comprehensive search was performed between January 1980 and March 2012 using relevant MeSH terms. Studies were chosen based on predefined inclusion criteria. RML was defined as a creatine kinase of more than 1,000 IU/L. The parameters assessed included patient characteristics of the RML population, type of bariatric surgery performed, operating time, complications, presentation and diagnosis of RML.
*Results* Twenty-two studies were analysed which included 11 case reports, two case series, six prospective and three retrospective comparative studies. Overall 145 patients with RML were reported following bariatric surgery. Acute renal failure was found in 20 patients (14 %) and was significantly more likely to occur in patients with postoperative muscle pain ($p$<0.05). The mortality rate after renal failure was 25 % (n=5). In the comparative studies, 87 RML patients were compared with 325 non-RML patients. The RML patients were more likely to be male, had a greater mean body mass index (BMI) (52 vs 48 kg/m$^2$, $p$<0.01) and underwent a longer operation (255 vs 207 min, $p$<0.01) compared to non-RML patients.
*Conclusions* Risk factors of developing RML following bariatric surgery include male gender, elevated BMI and prolonged operating time. Patients with a biochemical diagnosis of RML and postoperative myalgia after bariatric surgery are at increased risk of developing acute renal failure and mortality. These patients must be identified and treated promptly.

**Keywords** Rhabdomyolysis · Bariatric surgery · Myoglobin · Myalgia · Morbid obesity · Systematic review

**Introduction**

Obese patients are at a higher risk of developing rhabdomyolysis (RML), a breakdown of skeletal muscle tissue. This results in a loss of intracellular fluid, release of myoglobin, intracellular enzymes and electrolytes into the bloodstream, which leads to electrolyte imbalance, hypovolaemia and acute kidney injury. Renal failure may be seen in up to 33 % of all RML cases and patients who develop acute renal injury are at an increased risk of death (up to 50 %) [1, 2].

For patients undergoing bariatric surgery, there are a number of additional risk factors making them more susceptible to developing RML. These include prolonged intraoperative immobilisation, high body mass index (BMI), diabetes, hypertension, use of statins and anaesthetic agents [3, 4]. The aim of this systematic review is to identify risk factors and patient outcomes, in morbidly obese patients undergoing bariatric surgery who develop RML.

**Materials and Method**

Data Sources

In case of laparoscopic sleeve gastrectomy this incidance of RML due to usually shorter operetive time should be lower, howewer it is still very severe condition and could lead ewen to death.

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## Rhabdomyolysis as a rare complication of bariatric surgery

Serbec Ünlü[✉] and Koray Karabulut[1]

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Abstract Go to: •

Rhabdomyolysis after bariatric surgery is a quite rare occurrence with low recognition. Due to the breakdown of striated muscle fibers, creatine kinase and myoglobin are released into systemic circulation with variable effects on renal filtering functions. Herein, it was aimed to present a patient who de- veloped rhabdomyolysis following revision bariatric surgery. This 34-year-old male patient was admitted for bariatric surgery. He had had a gastric band surgery approximately six years ago, with regain of weight starting one year after surgery gradually reaching the previous weight level. Consequently, the gastric band had been removed with open surgery three years ago. The patient had a body mass index of 69 kg/m2 as well as an incisional hernia due to previous surgery. Although initially laparoscopic sleeve gastrectomy was planned, a switch to open surgery was made due to the presence of diffuse intra-abdominal adhesions and giant incisional hernia precluding laparoscopic intervention. The total duration of surgery was 420 minutes. Postoperative laboratory work-up showed elevated blood creatine kinase (25837 U/L). Upon the failure of fluid replacement and diuretics, hemodialy- sis was initiated at postoperative day 1. Despite daily sessions of hemodialysis, acidosis did not improve, his general status worsened and the patient died on postoperative day 14. Rhabdomyolysis is a severe and potentially life-threatening complication of bariatric surgery. Its severity may vary from asymptomatic elevations of creatine kinase to death. Postoperative creatine kinase levels should be routinely checked in high-risk patients as a practical and inexpensive laboratory modality for early diagnosis.

Due to this risk, methods of preventing the development of this complication are being sought. One of them is the use of a vacuum mattress.

The use of this device should lead to a more even distribution of loads and reduce the risk of muscle ischemia and, consequently, the risk of RML.

However, there are no clinical data on the effectiveness of such procedure.

## Aim of the study:

The aim of this prospective clinical trial was to assess the usefulness of the usage of a vacuum mattress during laparoscopic sleeve gastrectomy (LSG) in reduction of levels of rhabdomyolysis markers (myoglobin, creatine kinase, creatinine) and incidence of RML and AKI in postoperative period.

# Materials:

The study included 1184 consecutive patients undergoing LSG between January 2015 and December 2022 in our center.

Patients were divided into two groups. The first group (study group) were patients who were laid on vacuum mattresses during the surgery.

The control group consisted of patients for whom a standard operating mattress was used during the surgery.

# Materials:

**Inclusion criteria**

Age between 18 and 65 years

LSG performed

**Exclusion criteria**

Preoperatively diagnosed chronic kidney disease.

Perioperative complications which required postoperative hospitalization at the Intensive Care Unit

Compliance with ERABS Protocol < 85%

# Materials:

| Demographic analysis of groups | | | |
|---|---|---|---|
| **Parameter** | **Group 1**<br>**Vacuum Mattress** | **Group 2**<br>**Control** | **p value** |
| **Number of patients, n** | **550** | **555** | **n/a** |
| Females, n (%) | 319 (58 %) | 321 (57.8%) | 0.956 |
| Males, n (%) | 231 (42 %) | 234 (42.2%) | |
| Mean age, years ± SD | 42.7±10.2 | 42.2±10.6 | 0.471 |
| Body Weight, kg ± SD | 137.62 ±24.96 | 141.0±27.5 | 0.063 |
| Body Mass Index, kg/m$^2$ ± SD | 45.01 ±5.64 | 45.7±6.8 | 0.105 |
| ASA 1, n (%) | 10 (1.8%) | 12 (2.1%) | 0.169 |
| ASA 2, n (%) | 382 (69.5%) | 411 (74,.1%) | |
| ASA 3, n (%) | 158 (28.7%) | 132 (23.8%) | |
| Cardiovascular, n (%) | 49 (8.9%) | 54 (9.7%) | 0.639 |
| Hypertension, n (%) | 302 (54.9%) | 341 (61.4%) | 0.053 |
| **Diabetes, n (%)** | **186 (33.8%)** | **136 (24.5%)** | **0.001** |
| Insulin treatment, n (%) | 20 (3.6%) | 23 (4.1%) | 0.942 |
| Pulmonary disease, n (%) | 126 (22.9%) | 121 (21.8%) | 0.900 |
| **Liver steatosis, n (%)** | **75 (13.6%)** | **159 (28.7%)** | **0.003** |
| Endocrine disease, n (%) | 51 (9.2%) | 41 (7.4%) | 0.303 |
| Smoking, n (%) | 88 (16%) | 69 (12.4%) | 0.319 |
| Revisional operation, n (%) | 19 (3.5%) | 13 (2.3%) | 0.097 |
| **Preoperative intragastric baloon n (%)** | **88 (16%)** | **21 (3.7%)** | **0.001** |

SD – standard deviation, ASA – American Society of Anaesthesiologists Scale

# Materials:

| Perioperative outcomes in analysed groups | | | |
|---|---|---|---|
| **Parameter** | **Group 1**<br>**Vacuum Mattress** | **Group 2**<br>**Control** | **p value** |
| **Number of patients, n** | **550** | **555** | **n/a** |
| **Median operative time, minutes (IQR)** | **75 (60-90)** | **85 (70-100)** | **n/a** |
| **Mean operative time, minutes ± SD** | **77.3 ± 27.7** | **87.5 ± 28.9** | **0.001** |
| **Median perioperative blood loss, ml (IQR)** | **50 (30-100)** | **55 (30-110)** | **0.654** |
| **Patients without any intraoperative complication, n (%)** | **512 (93.1%)** | **500 (90.1%)** | |
| **Patients with intraoperative complication, n (%)** | **38 (6.9%)** | **55 (9.9%)** | **0.080** |
| **Mean complince with ERAS protocol, % ± SD** | **92±7** | **89±9** | **0.730** |

**NPWT – negative pressure wound therapy SD – standard deviation IQR – inter-quartile range**

# Results:

| Postoperative RML markers and kidney complications | | | |
|---|---|---|---|
| **Parameter** | **Group 1 Vacuum Mattress** | **Group 2 Control** | **p value** |
| **Mean creatine kinase concentration (CPK) U/l ± SD** | **282.5 ± 235.4** | **596.5 ± 2538.2** | **0.001** |
| **Median creatine kinase concentration U/L (IQR)** | **220.0 (164 - 336)** | **285 (189 - 447)** | **0.001** |
| **Mean myoglobin concentration ng/ml ± SD** | **89.4 ± 73.7** | **104.2 ± 204.6** | **0.113** |
| **Median myoglobin concentration ng/ml (IQR)** | **67.0 (48 - 102)** | **59 (38 – 99)** | **0.001** |
| **Mean creatinine concentration umol/l ± SD** | **72.8 ± 16.3** | **76.1 ± 21.9** | **0.001** |
| **Median creatinine concentration umol/l (IQR)** | **70.0 (63 - 79)** | **73.0 (63 - 83)** | **0.010** |
| **RML biochemical ( CPK 5x normal concentration) n %** | **3 (0.7 %)** | **30 (5.3 %)** | **0.001** |
| **RML clinical n %** | **1 (0.2 %)** | **14 (2.2 %)** | **0.001** |
| **AKI biochemical (1,5 x increase in kreatinine concentration) n %** | **2 (0.4 %)** | **12 (2.2%)** | **0.007** |
| **AKI clinical n %** | **1 (0.2 %)** | **9 (1.6 %)** | **0.011** |

# Results:

**Univariate logistic regression analyses of biochemical RML incidence**

| Parameter | OR (95% CI) | p value |
|---|---|---|
| **Vacuum Mattress (yes vs. no)** | 0.06 (0.02 - 0.27) | **0.001** |
| Sex (male vs. female) | 2.05 (1.00 - 4.21) | **0.048** |
| Intraoperative complications (yes vs. no) | 3.31 (1.32 - 8.31) | **0.011** |
| BMI (≥50 vs. <50 kg/m$^2$) | 2.37 (1.14 - 4.94) | **0.020** |
| Operative time (≥ 90 vs. < 90 min ) | 0.16 (0.03 - 0.65) | **0.011** |
| Operative time (/min) | 1.03 (1.02 - 1.04) | **0.001** |
| Preoperative baloon (yes vs. no) | 1.02 (0.04 - 27.13) | 0.992 |
| Cardiovascular disease (yes vs. no) | 1.40 (0.48 - 4.09) | 0.377 |
| Diabetes ( yes vs. no ) | 0.95 (0.44 - 2.06) | 0.897 |
| Pulmonary disease ( yes vs. no ) | 1.37 (0.63 - 3.01) | 0.580 |
| Hypertension ( yes vs. no ) | 2.22 (0.98 - 4.98) | 0.106 |
| Liver steatosis (yes vs. no)) | 1.46 (0.61 - 3.54) | 0.405 |
| Revisional surgery (yes vs. no) | 2.19 (0.09 – 51.96) | 0.619 |

**Multivariate logistic regression analyses of biochemical RML incidence**

| Parameter | OR (95% CI) | p value |
|---|---|---|
| **Vacuum Mattress (yes vs. no)** | 0.07 (0.01 - 0.33) | **0.001** |
| Sex (male vs. female) | 1.96 (0.92 - 4.20) | 0,082 |
| BMI (≥50 vs. <50 kg/m$^2$) | 1.38 (0.61 - 3.12) | 0.432 |
| Intraoperative complications (yes vs. no) | 2.25 (0.85 - 5.97) | 0.102 |
| Operative time (/min) | 1.02 (1.01 - 1.03) | 0.001 |

Results:

Case matched analysis were performed.

The following criteria were used for matching:

- difference in operation time < 4 min
- difference in male gender up to 3 cases in groups
- difference in BMI up to 1 $kg/m^2$

# Results after matching cases

| Postoperative RML markers and kidney complications | | | |
|---|---|---|---|
| **Parameter** | Group 1<br>Vacuum Mattress | Group 2<br>Control | p value |
| **Number of patients after matching, n** | **390** | **390** | **n/a** |
| **Mean operative time, minutes ± SD** | **81.0 ± 23.9** | **81.1 ± 23.8** | **0.966** |
| **Mean creatine kinase concentration (CPK) U/l ± SD** | **293.1 ± 258.9** | **435.6 ± 694.6** | **0.001** |
| **Median creatine kinase concentration U/L (IQR)** | **227.5 (165 - 336)** | **272.5 (183- 421)** | **0.001** |
| **Mean myoglobin concentration ng/ml ± SD** | **94.2 ± 80.1** | **88.8 ± 134.8** | **0.497** |
| **Median myoglobin concentration ng/ml (IQR)** | **70.0 (49 - 108)** | **57 (38 – 93)** | **0.095** |
| **Mean creatinine concentration umol/l ± SD** | **73.4 ± 16.1** | **76.5 ± 22.7** | **0.028** |
| **Median creatinine concentration umol/l (IQR)** | **71.0 (63 - 80)** | **74.0 (64 - 83)** | **0.061** |
| **RML biochemical ( CPK 5x normal concentration) n %** | **2 (0.5 %)** | **17 (4.4 %)** | **0.005** |
| **RML clinical n %** | **0 (0 %)** | **8 (2.1 %)** | **0.045** |
| **AKI biochemical (1,5 x increase in kreatinine concentration) n %** | **1 (0.3 %)** | **7 (1.8%)** | **0.033** |
| **AKI clinical n %** | **0 (0 %)** | **4 (1.0 %)** | **0.045** |

# Summary:

- The use of a vacuum mattress reduced the incidence of both biochemical and clinically symptomatic RML and AKI.

- The use of a vacuum mattress reduced the level of creatine kinase and creatinine on the 1st postoperative day without affecting the concentration of myoglobin on the 1st postoperative day.

- We recommend use of vacuum mattress in case of all LSG cases.

# Thank you for your attention

Mateusz Wierdak MD PhD

mateusz.wierdak@uj.edu.pl