Successful prevention of rhabdomyolysis (RML) after bariatric surgery (BS) in intensive care settings

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Abstract

***Background*: Rhabdomyolysis (RML) has been increasingly recognized as a complication of bariatric surgery. It is potentially fatal postoperative complication in morbidly obese surgical patients.**

***Objective*: Our objective was to examine the effects of interventions, implemented before and after surgery periods for morbidly obese patients to reduce the incidence of RML in an intensive care unit (ICU).**

***Patients and Methods*: An experimental study was conducted in a surgical ICU. Multiple interventions were used to optimize RML prevention. The series of actions were performed during two phases. From January 2009 to December 2009 (control phase 1: P1 20 patients). From January 2010 to December 2010 (phase 2: P2 20 patients), we intervened in these processes at the same time that performance monitoring was occurring at the bedside, interventions were implemented using our bariatric rhabdomyolysis bundle, which consist of prevention of RML. It begins with careful intra- and post-operative padding of all pressure points and close attention to patient positioning post operatively, minimizing operative time, adequate peri- and post-operative hydration, and close postoperative monitoring are obviously essential.**

***Results*: The incidence density of severe RML in the ICU per 25 patients was 16% in phase 1 (4 patients), reduced to 4% (1 patient) in phase 2.**

***Conclusion*: These results suggest that reducing RML rates to zero is a complex process that involves multiple performance measures and interventions.**

Key words: Rhabdomyolysis, bariatric surgery, prevention.

Introduction

Rhabdomyolysis (RML) is a syndrome characterized by muscle necrosis and the release of intracellular muscle constituents into the circulation. The severity of illness ranges from asymptomatic elevations in serum muscle enzymes to life-threatening cases associated with extreme enzyme elevations, electrolyte imbalances, and acute renal failure (ARF). The first modern description of RML is attributed to Bywaters and Beall who, in 1941, reported four crush victims during the bombing of London in the Battle of Britain. All developed ARF and died within one week. Pigmented casts were found in the renal tubules at autopsy although the relationship between muscle injury and renal failure was unclear. (1)

The cause of RML is usually evident from the history or from the immediate circumstances preceding the disorder, such as postoperative surgical trauma, a comatose or postictal state, or

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extraordinary physical exertion. In some cases, however, the precipitant is not obvious. Possible causes include heritable muscle enzyme deficiencies, electrolyte abnormalities, infections, drugs, toxins, and endocrinopathies. (2) RML has been increasingly recognized as a complication of bariatric surgery. (3) Since 2003, several case reports have described postoperative RML after bariatric surgery, some of them fatal. (4)

Rhabdomyolysis is a clinical and biochemical syndrome that varies from asymptomatic increase of muscle enzymes (CK), to ARF, compartment syndrome, and even death. (5) RML is produced by injury and necrosis of skeletal muscles and the subsequent release of intracellular toxic substances into the circulation. Increased compressive pressure owing to excessive weight has been recognized as a risk factor in obese patients. The incidence of RML after bariatric surgery is not clear, having been estimated from 1.4% to 75%. (6) Prolonged surgeries, extreme surgical positions, ASA physical status III–IV, and the presence of diabetes or hypertension have been identified as factors associated with development of RML. (3)

The operating room has been considered as a favorable environment for RML occurrence because of unusual positions and areas with increased pressures under anesthesia. Sustained high muscle pressure induces muscle ischemia, direct injury to sarcolemma, disruption of sodium-potassium pump, electrolyte imbalance, and failure of energy supply to the muscle fiber. Severe RML triggers a cascade with many consequences, including hypovolemia, hypoalbuminemia, anemia, disseminated intravascular coagulation (DIC), hyperkalemia, hypocalcemia, hypercalcemia, hyperphosphatemia, and acute tubular necrosis. It is possible that higher pressures related to increased weight as well as other potential mechanisms related to the metabolic derangement are probably present. (7)

The first signs and symptoms have been usually reported during the first 24 h after the injury, although those may appear early. The suspicion usually based on clinical manifestations (reddish-brown urine, gluteal and back pain, and oliguria) must be confirmed by laboratory studies. A five-fold elevation of serum CK level (1050 U/L) is considered diagnostic. (3,5)

Objective

Our objective was to examine the effects of interventions, implemented before and after surgery periods for morbidly obese patients to reduce the incidence of RML in an ICU.

Patients and Methods

Patients

A total of 50 adults underwent bariatric surgeries (BS) for morbid obesity was enrolled on the study. A database was created for all patients (sex, age, BMI, duration of the operation, duration of ICU stay, levels of serum CK systematically measured before surgery and on the first and second postoperative days). The protocol was approved by the Ethics in Research Committee of the Institution.

Setting and study design

A time series study was conducted in a 12-bed, medical-surgical ICU of a tertiary care hospital in Alexandria, Egypt. This is an open staffing model ICU where approximately 1100 patients are admitted annually. This study was carried out in 2 phases: phase 1 from January 2009 to December 2009 (control phase 1: P1 25 patients), and phase 2 from January 2010 to December 2010 (phase 2: P2 25 patients).

In phase 1, we studied the incidence of RML in intensive care settings, retrospectively, in phase 2, we intervened in these processes at the same time that performance monitoring was occurring at the bedside, interventions were implemented using our bariatric rhabdomyolysis bundle, which consist of serial measures to prevent RML. 1) It begins with careful intra- and post-operative padding of all pressure points; 2) close attention to patient positioning post operatively; 3) minimizing operative time; 4) adequate peri- and post-operative hydration; and 5) close postoperative monitoring are obviously essential. We tried to reach RML to zero. Every month, we provided feedback on compliance with the bundle components for the ICU team (doctors, and nurses). Also, we provided posters in the ICU with bar graphs displaying compliance with process of care measures.

Laboratory studies

In the present study, we used a fivefold or greater increase in serum CK in patients without apparent cardiac or brain injury as the only diagnostic criterion for RML (males CK>1160 U/L and females CK>1075 U/L). (8,9) Severe RML diagnosed when CK is above 10000 U/L. (10) A urine dipstick test for blood has positive results in the presence of hemoglobin or myoglobin. Myoglobinuria may be sporadic or resolve early in the course of RML. Urine dipstick findings are positive in only 50% of patients with RML; therefore, a normal urine dipstick test result does not rule out this condition. Aldolase, lactate dehydrogenase (LDH), and serum glutamic-oxaloacetic transaminase (SGOT) are nonspecific enzyme markers that are elevated in patients with rhabdomyolysis. (11)

Statistical analysis

The description of the data was done in the form of mean±SD for quantitative data and frequency and proportion for qualitative data. The analysis of the data was done to test the statistically significant difference between groups. For quantitative data, a student's t test was used to compare the two groups. For qualitative data, a Chi-square test was used and Odds Ratio was detected. Multivariate regression analysis was done for significant data in a univariate analysis. (12) The primary outcome for the study was defined as peak CPK. Clinical and laboratory data were entered into a database (Microsoft Excel 97, Redmond, WA, USA) and statistical analyses were performed (SPSS Inc., Version 16. Chicago IL, USA).

Results

Fifty patients were enrolled in this study with mean age 34.5±12.8, all patients got surgery for morbid obesity the mean weight was 134.9±15.4, 8 patients had significant elevation of their CK in group 1, 4 of them were above 10000 U/L, while 6 patients had elevation of their CK in group 2 with only one had elevation of his CK above 10000 U/L.

Table 1 shows descriptive data among the studied group. 11 males and 14 females were enrolled in group 1, 6 patients were smokers in group 1 and 7 in group 2, 9 patients suffered hypertension in group 1 and 7 in group 2, 13 patients were treated from diabetes in group 1 and 12 in group 2, 10 patients in group 1 had symptoms suggesting obstructive sleep apnea, 16 patients in group 1 and 12 in group 2 had gastric reflux, while 6 patients in group 1 suffered a joint disease with only 5 in group 2.

Table 2 shows the mean characteristic differences between both groups, both groups were matched regarding the age 34.4 in group 1 versus 32.9 in group 2, no significant difference regarding the weight in both groups, the mean CPK was significantly higher in group 1 4907.2±722 versus 2196±229 U/L in group 2 ($p<0.01$). There were no statistical differences regarding the surgery time or the pre-operative serum creatinine between both groups. However the post operative serum creatinine was significantly higher in group 1 1.5±1.17 versus 1.02±0.14 in group 2 ($p=0.049$), the length of stay in the ICU was significantly lower in group 2 ($p=0.05$).

Figure 1 shows four patients developed severe RML in group 1, two of them developed acute kidney injury (AKI), and all had recovery at the end of the course. Only one patient in group 2 had severe RML with peak CK 11000 U/L, without AKI.

Discussion

Weight reduction through laparoscopic approaches for the morbidly obese have become common with more than 50000 bariatric surgical procedures being performed in 2001. Morbidly obese patients develop critical surface and deep tissue pressures during bariatric surgery, increasing their risk for tissue injury and RML. Unexplained elevations in the serum creatinine level or reports of buttock, hip, or shoulder pain in the postoperative period should raise the possibility of RML and prompt clinical investigation from this frequent procedure. (13)

Our study was intentioned to inquire the value of interventions, implemented before and after surgery periods for morbidly obese patients to subsequently reduce the incidence of RML in ICU. Previous reviews addressed the later issue and recommend intra- and post-operative measures to reduce RML after surgery. (14)

High prevalence of hypertension and diabetes was note in morbid obese patients before the surgery as 58% of our patients were hypertensive and 50% were diabetic. This was similar to the study by Sugerman et al., (15) who linked this relation and association later with RML. In another study by Bostanjian et al., (16) the authors conclude that individuals with increased risk for RML are super-obese male patients with hypertension and/or diabetes, and prolonged duration of surgery.

The incidence of RML in our study was relatively high 32% in group 1 and 24% in group 2. This was similar to work done by de Oliveira, et al., (17) who confirmed a high incidence of RML diagnosing it in 77% of their patients, with level above 5000 U/L in 40.9% of their patients and describe it as a common complication after BS. Our results were in contrary to others who portray RML in BS as a rare complication in individual case reports. (16,18,19)

We tried to reach RML to zero using our bariatric rhabdomyolysis bundle, which consists of prevention of RML. 1) Careful intra- and post-operative padding of all pressure points; 2) close attention to patient positioning post operatively; 3) minimizing operative time; 4) adequate peri- and post-operative hydration; and 5) close postoperative monitoring are obviously essential.

Our approach was conjunctions of previous strategies to prevent RML in ICU include adequate padding at all pressure points during surgery and aggressive fluid replacement. Prevention, early diagnosis, and early aggressive treatment will decrease the potential serious outcomes of this uncommon complication. (16,18,20)

Bostanjain et al., (16) concluded that prevention is enhanced by careful padding on the operative table. The same opinion was assigned by Mognol et al., (11) who agreed that in morbidly obese patients, prevention includes adequate padding at all pressure-points during surgery. Khurana et al., (21) advised protective padding added around the hips, shoulders and buttocks to minimize the surface and deeper pressure, by distributing pressure over a greater surface area. Hofmann and Stoller (22) signalize that obese surgical patients can position themselves on the surgical table before induction of anesthesia, to the most appropriate position, avoiding positions that can increase muscle compression. These authors also propose the use of two combined surgical tables to decrease the pressure on the back surface of the massively obese patient. Wiltshire et al. (18) advocated that special attention should be given to protect injured and uninjured muscle tissue in the morbidly obese patient. This can be achieved by frequently changing patient position, both intraoperatively (for operations lasting >2-3 hours) and postoperatively.

Regan et al., (23) commend to decrease the longer operative time by dividing the procedure into two stages, doing a gastric sleeve resection initially, and then when the patient has lost considerable weight performing the definitive bypass. This two-stage approach is a reasonable alternative for surgical treatment of the high-risk super-super-obese (BMI >60) patient. Mognol et al. (11) state that the gastric bypass in two stages is ideal for the morbidly obese hypertensive male with type II diabetes.

Aggressive fluid replacement after surgery is another means of preventing RML. (11,24) For Iseri et al., (25) a high urine output should be instituted with the administration of IV fluids and diuretics, before, surgical procedures, if adequate preoperative weight loss can be achieved.

Cholesterol-lowering agents also promote myolysis. As obese patients usually have elevated cholesterol, many are on statins at the time of surgery. This may increase the risk of muscle damage, with the other associated factors - elevated BMI, lengthy surgery, peripheral vascular disease, and metabolic disorders. However, in the study of Bostanjian at al., (16) there was no difference in RML risk between patients who used cholesterol-lowering agents and those who did not.

Another way to prevent RML is to protect injured and uninjured muscle tissue in the obese patient. This can be achieved by frequently changing the surgical position that is done every 30 minutes and encouraging early ambulation. (26) The intermittent compression pneumatic bed which was designed to promote intermittent compression of the dorsal region of patients submitted to bariatric surgery or in a long-term hospital stay, with the purpose of preventing posterior tissue compression, mainly in buttocks, lumbar region and shoulders, avoiding ulcers and RML. (26) Other risk factors should be corrected to prevent RML after surgery. They are hypoalbuminemia, hyperkalemia or hypophosphatemia,

sepsis, CPK peak >6000 U/L, systemic arterial hypertension, diabetes, and pre-existing azotemia. (11,26)

Table 2 shows the mean characteristic differences between both groups, both groups were matched regarding the age 34.4 in group 1 versus 32.9 in group 2, no significant difference regarding the weight in both groups, the mean post operative CPK was significantly higher in group 1 4907.2±722 versus 2196±229 U/L in group 2 ($p<0.01$). There were no statistical differences regarding the surgery time or the pre-operative serum creatinine between both groups. However the post operative serum creatinine was significantly higher in group 1 1.5±1.17 versus 1.02±0.14 in group 2 ($p=0.049$), the length of stay in the ICU was significantly lower in group 2 ($p=0.05$).

Figure 1 shows four patients developed severe RML in group 1, two of them developed acute kidney injury (AKI), and all had recovery at the end of the course. Only one patient in group 2 had severe RML with peak CK 11000 U/L, without AKI. We were able to achieve a lower post operative CPK, lower post operative serum creatinine and subsequently lower ICU length of stay. This was similar to a unique study by Thakar et al., (27) who concluded that postoperative AKI is not infrequent after gastric bypass surgery. Although the overall postoperative mortality is low, AKI is associated with increased duration of hospital stay.

Limitations of this study

There are two limitations that need to be acknowledged and addressed regarding the present study. First it was a single-center report, second were the relatively small number of patients included and lack of follow up of patients till time of discharge from hospital. The strengths points of this study were performance of the surgical procedure by two consultants with the same experiences in a single center and postoperative data collected by single blinded investigator.

Conclusions

Rhabdomyolysis is a frequent serious condition after bariatric surgeries that could be prevented by a serious of measures. These results suggest that reducing RML rates to zero is a complex process that involves multiple performance measures and interventions.

Table 1. Descriptive among the studied group

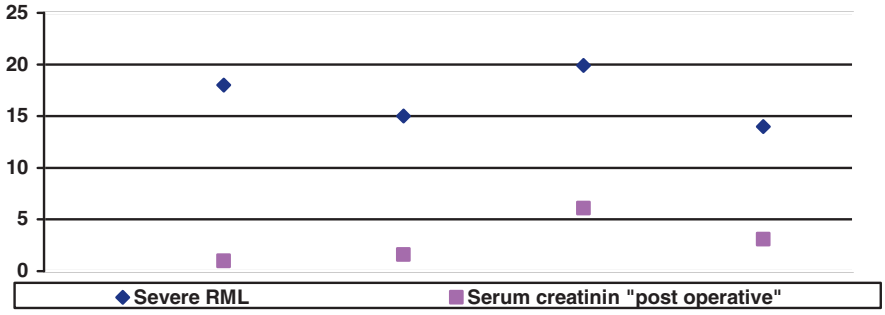
		Group 1	Group 2
Sex	Male	11	13
	Female	14	12
Smoking	Smokers	6	7
	Non Smokers	18	19
Hypertension	HTN	9	10
	No HTN	16	15
Diabetes	DM	13	12
	No DM	12	13
OSA	OSA	10	8
	No OSA	15	17
GR	GR	16	12
	No GR	9	13
JD	JD	6	5
	No JD	19	20

Legend: OSA=obstructive sleep apnea; GR=gastric reflux; JD=joint disease

Table 2. The mean characteristic differences between both groups

	Group 1	Group 2	T test
Age mean±SD (years)	34.4±14.08	32.9±12.9	0.109
Weight mean±SD (Kg)	134.6±16.7	135.1±13.4	0.337
Peak CK post operative (U/L)	4907.2±722	2196±229	0.01
Anesthesia time (hours)	5.348±0.894	5.4±1.01	0.858
Surgery time (hours)	4.308±0.88	4.212±1.01	0.96
Pre operative creatinine (mg)	0.92±0.11	0.86±0.13	0.789
Post operative creatinine (mg)	1.5±1.17	1.02±0.14	0.049
ICU time (days)	1.9±1.0	1.4±0.7	0.05

Figure 1. Rhabdomyolysis and relation to renal function in group 1



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