ORIGINAL ARTICLE

Postoperative Rhabdomyolysis Following Laparoscopic Gastric Bypass in the Morbidly Obese

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Hypothesis: Laparoscopic approaches for weight reduction in the morbidly obese have become common with more than 50 000 bariatric surgical procedures being performed in 2001. The objective of this article is to raise awareness among surgeons of a new complication of rhabdomyolysis from this frequent procedure.

Design: Case series extracted from surgical database from January 2, 2001, through December 31, 2002.

Patients and Methods: We identified 5 cases of postoperative rhabdomyolysis in morbidly obese patients who underwent laparoscopic duodenal switch procedures with parietal gastrectomy. The cause, pathogenesis, and clinical features are reviewed and discussed.

Results: Postoperative rhabdomyolysis developed in 5 of 353 morbidly obese patients who underwent consecutive laparoscopic duodenal switch procedures, an incidence of 1.4%. All 5 patients were male, had a mean peak serum creatine kinase level of 19 680 U/L, and reported muscle pain in either the buttock, hip, or shoulder regions during the early postoperative period.

Conclusions: We hypothesized that morbidly obese patients develop critical surface and deep tissue pressures during bariatric surgery, increasing their risk for tissue injury and rhabdomyolysis. Unexplained elevations in the serum creatinine level or reports of buttock, hip, or shoulder pain in the postoperative period should raise the possibility of rhabdomyolysis and prompt clinical investigation. We recommend routine preoperative and postoperative measurements of the serum creatine kinase and serum creatinine levels to aid detection. Surgeons need to keep a low index of suspicion because early diagnosis and treatment are the cornerstones of successful management of rhabdomyolysis.

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MORBID OBESITY PRESENTS a significant medical burden. In the United States, 10 million people are morbidly obese, defined as a body mass index (BMI) (calculated as weight in kilograms divided by the square of height in meters) of 40 or greater, or 35 or more in the presence of comorbidities, and this population is rapidly growing.[1] Life expectancy decreases inversely with weight gain, a trend most pronounced in the morbidly obese in whom men with BMIs greater than 45 have a 22% reduction in life expectancy compared with men with normal BMIs.[2] Modest weight loss of 10% to 15% results in improvement or resolution of multiple medical comorbidities.[3] Surgical treatment of morbid obesity has been shown to be effective at reducing weight.[4-7] With the introduction of laparoscopic approaches, more patients are undergoing bariatric surgery because there is reduced preoperative mortality with shorter recovery times.[8,9] Complications associated with bariatric surgery such as gastrointestinal tract leaks and pulmonary embolism are well documented.[7] We report a new complication of gastric bypass observed over a 2-year period. Postoperative rhabdomyolysis developed in 5 of 353 morbidly obese patients who underwent consecutive laparoscopic duodenal switch procedures with parietal gastrectomy, an incidence of 1.4%. We discuss potential mechanisms of tissue injury and propose preventive measures.

REPORT OF CASES

The clinical features of our 5 patients are summarized in **Table 1**. All 5 patients were morbidly obese men with a mean age of 43 years (age range, 35-48 years). At baseline, the mean (SD) BMI in this series was

56 (12); all patients underwent laparoscopic duodenal switch procedures with parietal gastrectomy as well as routine cholecystectomy, liver biopsy, and appendectomy, yielding a mean (SD) surgical time of 5.6 (1.0) hours and a total mean (SD) anesthesia time of 4.1 (0.9) hours (**Table 2**). Patients 2 and 5 also had umbilical hernias repaired during their laparoscopic procedures.

RESULTS

Intraoperatively, all patients were placed in the supine position on an operating table (Alphamaquet 115; Maquet GmbH & Co KG, Rastatt, Germany) that has standard 5.0-cm (2-in) padding (Maquet Co, Mount Pleasant, SC). Patients 2 and 3 were supported further by a 1.6-cm (⅝-in) gel mattress (Tyco Healthcare Kendall-LTP, Mansfield, Mass), and patient 5 had a 10.2-cm (4-in) Alto surface pad (Hill-Rom Surgical Surfaces from SW MedSource, Southlake, Tex).

Postoperatively, all 5 patients reported muscle pains by postoperative day 3, prompting measurements of the serum creatine kinase (CK) level. The serum CK level was markedly elevated in all patients, with a mean peak serum CK level of 19 680 U/L (Table 2). Rhabdomyolysis in these patients was treated with aggressive intravenous fluid administration with lactated Ringer solution and alkalinization of the urine with sodium bicarbonate, with subsequent normalization of the serum CK levels. Although 3 patients had deterioration in renal function and 2 had bacteremias complicating their postoperative courses, no patient required dialysis. All 5 patients were discharged from the hospital.

Table 1. Summary of the Baseline Clinical Features of the 5 Male Patients Who Developed Postoperative Rhabdomyolysis Following Laparoscopic Gastric Bypass

Patient No./ Age, y	BMI	Weight, kg (lb)	Medical History
1/35	73	236.7 (526)	Morbid obesity, hypertension, gastric reflux disease, and degenerative joint disease
2/42	62	208.8 (464)	Morbid obesity, hypertension, degenerative joint disease, obstructive sleep apnea, depression, asthma, and urinary stress incontinence
3/45	50	142.2 (316)	Morbid obesity, hypertension, degenerative joint disease, diabetes mellitus, gastric reflux disease, obstructive sleep apnea, and hypercholesterolemia
4/48	57	160.2 (356)	Morbid obesity, hypertension, gastric reflux disease, degenerative joint disease, diabetes mellitus, and depression
5/43	40	172.8 (384)	Morbid obesity, hypertension, gastric reflux disease, degenerative joint disease, obstructive sleep apnea, reactive airway disease, and bilateral avascular necrosis
Mean (SD) 43	56 (12)	184.1 (409)	

Abbreviation: BMI, body mass index (calculated as weight in kilograms divided by the square of height in meters).

COMMENT

Rhabdomyolysis is a clinical and biochemical syndrome characterized by skeletal muscle necrosis with the release of intracellular muscle contents into the circulatory system. The severity of the illness ranges from asymptomatic elevations of muscle enzyme levels in the serum to life-threatening cases associated with extreme enzyme elevations, electrolyte imbalances, compartment syndrome, and acute renal failure.[10,11] Volume depletion resulting in renal ischemia, tubular obstruction due to heme pigment casts, and tubular injury from free unchelated iron, all contribute to the development of renal dysfunction. Crush injuries, extensive burns, trauma, electric shock, and prolonged immobilization produce rhabdomyolysis through direct muscle injury or through muscle ischemia. Other nontraumatic causes of rhabdomyolysis include strenuous physical exercise, malignant hyperthermia, myopathies, infections, toxins, seizures, drugs, and alcoholism.[12]

The operating room provides favorable conditions for the development of rhabdomyolysis. Prolonged sur-

Table 2. Intraoperative and Postoperative Features of the 5 Case Reports

Patient No.	Anesthesia Time, h	Surgery Time, h	Use of Additional Intraoperative Padding	Peak Serum CK Level, U/L	Creatinine Level, mg/dL		Postoperative Reports and Physical Signs	Complications and Outcome
					Preoperative	Peak		
1	7.0	5.0	None	14 223	0.7	0.6	POD 1: Buttock and flank pain with soreness to palpation	Discharged on POD 9
2	5.2	4.0	1.6-cm (⅝-in) pad	29 760	0.8	1.3	POD 1: Flank and hip pain with pain to palpation	Discharged on POD 8
3	6.0	5.0	1.6-cm (⅝-in) pad	25 554	0.6	0.6	POD 1: Hip and buttock pain with induration and edema	Discharged on POD 6
4	4.5	3.5	None	10 769	0.7	3.1	POD 2: Flank pain with ecchymosis of the right hip	Fungemia and bacterial sepsis; discharged on POD 55
5	5.2	3.0	10.2-cm (4-in) pad	18 093	0.7	7.4	POD 3: Shoulder pain with pain to palpation	Line sepsis; discharged on POD 16
Mean (SD)	5.6 (1.0)	4.1 (0.9)		19 680	0.7	2.7		

Abbreviations: CK, creatine kinase; POD, postoperative day.
SI conversion factor: To convert creatinine to micromoles per liter, multiply by 88.4.

gery in certain positions has been associated with increased adverse pressure-related sequelae. Anesthesia is believed to augment these complications by preventing patients from spontaneously shifting their weight to relieve the pressure on dependent areas. In previous case reports, postoperative rhabdomyolysis was attributed to prolonged position-dependent muscle compression or to lengthy procedures.[13,14] Rhabdomyolysis has been demonstrated after surgery in nonobese patients placed in exaggerated lithotomy, lateral decubitus, and knee-to-chest positions. Furthermore, even routine supine positioning in nonobese patients has resulted in increased pressure-related complications when the surgery is markedly prolonged (>7 hours).[13,14]

Although our patients were in the supine position for the duration of their surgery, their mean (SD) surgery time was only 4.1 (0.9) hours (Table 2). Furthermore, classic risk factors for rhabdomyolysis such as personal or family history of myopathy, endocrine or metabolic disorders, malignant hyperthermia, chronic renal failure, or air embolism were absent in all patients. No patient had preoperative or postoperative anemia, perioperative hypotensive episodes, or sepsis prior to the development of rhabdomyolysis. One of the 5 patients (patient 3) was receiving a statin preoperatively that has been reported to be a risk factor for postoperative rhabdomyolysis.[15] On the other hand, these patients were morbidly obese, with a mean (SD) BMI of 56 (12) (Table 1). We hypothesized that morbid obesity is an underappreciated risk factor for postoperative pressure-related complications, allowing rhabdomyolysis to occur even with surgical and anesthesia times that are not markedly prolonged.

Minimal direct evidence links obesity to the development of postoperative rhabdomyolysis. Previous work identified 2 risk factors for the development of pressure ulceration–high surface pressures and the duration of time exposed to these high surface pressures.[16] In a cohort of surgical patients, Garfin et al[17] recorded the highest surface pressures in the dependent regions of obese patients. The link between critical surface pressures during and after surgery and the subsequent development of deep tissue injury and skin ulcers may include capillary and lymphatic occlusion, contact stresses, and capillary bursting with load removal.[18,19] However, it is difficult to define the relationships between surface pressure, vessel occlusion, and tissue damage because of many confounding factors. Pressures within the subcutaneous and deep tissues do not necessarily correlate with surface pressures, as the amount of pressure transmitted from the surface to the deep tissues depends on tissue composition (fat, muscle, and interstitial fluid), tissue thickness, lymphatic circulation, and duration of loading.[20] Despite this limitation, measured surface pressures in obese patients exceed the estimated critical pressure required for capillary occlusion, placing morbidly obese patients at greater risk for tissue injury and subsequent rhabdomyolysis. Furthermore, pressure at the skin surface and deep tissue pressure may be more tightly correlated at areas adjacent to bony prominences. The high stiffness of bone acts to constrain the movement of the adjacent tissue, causing higher pressures to develop. In addition, the regions of soft tissue adjacent to bone experience high shear stresses owing to the extreme mismatch in stiffness between bone and soft tissue.[21] Thus, direct mechanical forces compounded by muscle ischemia due to capillary occlusion in dependent areas may contribute to the development of rhabdomyolysis in obese patients undergoing bariatric surgery.

Although obesity may augment the risk of postoperative rhabdomyolysis and ulceration in dependent body areas, direct clinical correlation following bariatric procedures has been the subject of only one previous report.[22] Our case series has similarities with this previous report of 6 cases of rhabdomyolysis among 650 patients who underwent open bariatric surgery. Bostanjian et al[22] demonstrated a 0.9% incidence of rhabdomyolysis, with a median peak serum CK level of 26 000 U/L, values consistent with the incidence of 1.4% in our population of bariatric surgery patients, who had mean peak serum CK levels of 19 680 U/L. Since serum CK levels were not routinely measured in our study, the incidence of rhabdomyolysis in this setting is likely underestimated.

Interestingly, these 6 previously reported cases were first heralded by extensive gluteal decubitus ulcerations, a clinical feature not seen in our series. Three of the previous 6 patients developed renal failure requiring dialysis; they ultimately died.[22] Although 3 of our 5 patients developed worsening renal function, none required dialysis and none died. Potentially, the nonspecific reports of muscle pain allowed us to detect rhabdomyolysis at an earlier stage in our patients, none of whom had skin ulceration. Additionally, the routine infusion of lactated Ringer solution instead of an isotonic sodium chloride solution may have lessened the severity of renal failure by producing more alkaline urine in our patients, a hypothesis that merits further study. Both case series identify a potential sex predisposition to postoperative rhabdomyolysis. Even though 85% of the surgical procedures reported by Bostanjian et al[22] were performed in women, 5 (83%) of the 6 rhabdomyolysis cases occurred in men. Similarly, 81% of the cases in our institution were performed in women, yet 5 (100%) of the 5 rhabdomyolysis cases occurred in men.

To minimize the surface and deep surface pressures, protective padding could be added around the buttock, hip, and shoulder regions during the perioperative period. Although padding helps by distributing pressures over a greater surface area, the addition of the 1.6-cm (⅝-in) gel mattress for patients 2 and 3 was insufficient to prevent tissue injury and the ultimate development of rhabdomyolysis. In patient 5, the 10.2-cm (4-in) Alto surface pad was placed under the back and gluteal regions; the patient reported shoulder pain but not buttock or flank pain.

Further research should define the incidence of rhabdomyolysis following bariatric surgery, as well as delineate the optimum protective padding to prevent these injuries; the benefit of routine preoperative and postoperative measurement of serum CK levels; the optimal patient positioning; and the ideal intravenous fluid administration for preventing and treating postoperative rhabdomyolysis in morbidly obese patients undergoing bariatric surgery. We have adopted a policy of placing

the 10.2-cm (4-in) Alto surface pad under obese patients, and serum CK levels are screened both preoperatively and postoperatively. Recognition of this complication can often be difficult and delayed as many of these patients already have preoperative musculoskeletal pain because of their morbid obesity, are receiving postoperative narcotic agents, or have delayed extubation. Preoperative and postoperative serum CK levels are important not only for earlier detection of rhabdomyolysis but also to better determine the incidence of this postoperative syndrome in the morbidly obese. In addition, when medical management of rhabdomyolysis fails and persistent or worsening serum CK levels are detected, surgical debridement of necrotic tissues with fasciotomies for decompression of tense compartments should be strongly considered. If necrotic muscle beds cannot be detected on physical examination, a computed tomographic scan of a suspicious area may help direct exploratory surgery. Early diagnosis and treatment are the cornerstones for the successful management of this rare but serious complication.

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