Risk factors and prevention of rhabdomyolysis after laparoscopic nephrectomy

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KEYWORDS

rhabdomyolysis, BMI, laparoscopic nephrectomy, pressure points

INTRODUCTION

Rhabdomyolysis is a frequent trauma-related complication, but it has been described as a complication associated with certain surgical procedures involving extended periods in positions causing muscle ischaemia. Although infrequent, rhabdomyolysis can be a cause of serious morbidity in urological patients after surgery [1]. Procedures like laparoscopic nephrectomy (LN), during which patients are placed in the lateral decubitus position, often for long periods, are particularly associated with rhabdomyolysis. This can be severe enough to precipitate acute renal failure (ARF) requiring dialysis, due to excessive myoglobinuria [2].

Since the introduction of laparoscopic radical nephrectomy in 1991, laparoscopic procedures have gained immense popularity over open operations. LN is increasingly becoming the standard procedure for most benign and many malignant renal diseases, and is deemed now to be as safe as an open nephrectomy [3]. There has also been a rise in the popularity of living-donor kidney donations, due in part to the favourable adverse effects profile of donor LN [3]. The publication of the most recent BAUS Section of Endourology LN audit [4] shows the rapidity with which LN has acquired popularity in the UK over the past 3 years. A specific consideration of rhabdomyolysis as a complication was not mentioned in that report.

We report a case of rhabdomyolysis occurring after radical LN and review previous publications for this specific complication occurring as a sequelae of LN. In this review we aim to highlight the risk factors that lead to this complication through an extensive review of previous reports, and offer possible preventive strategies.

SEARCH STRATEGY

We searched the Ovid Medline, PubMed, EMBASE and EBM reviews databases using the following MeSh search headings: rhabdomyolysis, gluteal myonecrosis, laparoscopic nephrectomy, nephrectomy and renal surgery. The related-articles function was used to broaden the search, and all abstracts and citations were scanned. This yielded six case reports [5–10] of rhabdomyolysis in patients after undergoing nephrectomy or nephro-ureterectomy, either by open or laparoscopic approaches. We excluded two case reports because one [6] was in relation to an open nephrectomy and in the other [7] it was unclear if the complication was secondary to laparoscopic or open nephrectomy. Our search also yielded two recent papers, one [11] describing seven patients developing rhabdomyolysis after LN and the other [3] evaluating the safety of donor LN, which reported one case of rhabdomyolysis in a series of 500 donor LNs.

OUTCOMES OF INTEREST

We analysed the various factors contributing to rhabdomyolysis as described in the reports, and combined it with our experience of a case of rhabdomyolysis after radical LN. Another recent publication [4] by the BAUS Section of Endourology is discussed in a narrative form in the results section.

Table 1 [3,5,9–11] compares the patients from the four case reports, two original papers and the present case. All 13 patients described as developing rhabdomyolysis were obese, with a body mass index (BMI) of ≥28 kg/m^2. The mean (range) duration of surgery was 353.4 (138–510) min. The renal function before LN was normal in all cases. Rhabdomyolysis involving the gluteal muscles, thigh muscles and/or paravertebral muscles was documented clinically and biochemically by an elevated serum creatinine kinase level. The rhabdomyolysis was severe enough to require dialysis in four cases.

Patient comorbidities for the seven patients described by Reisiger *et al.* [11] included hypertension in two, morbid obesity in two, poorly controlled diabetes mellitus, amphetamine abuse, Osler–Weber–Rendu syndrome, glottic cancer status after resection, chronic obstructive pulmonary disease, and hyperlipidaemia in one each. The mean (range) American Society of Anesthesiologists score of their patients was 2 (1–3). Five of the seven patients were smokers, with a mean (range) of 26 (10–50) pack-years. The mean BMI was 34.1 (24–57.6) kg/m^2; Table 1 also gives further details of these patients.

Melcher *et al.* [3] compared the safety of donor LN with the open procedure, and in their series of 500 patients, one developed rhabdomyolysis after surgery that was not severe enough to require dialysis. The operative time was 311 min and the donor's weight was 90 kg.

Davenport *et al.* [4] reviewed their data obtained over 3 years and reported an increase in the number of procedures in each subsequent year. They also reported a better overall outcome for specialized high-volume units.

DISCUSSION

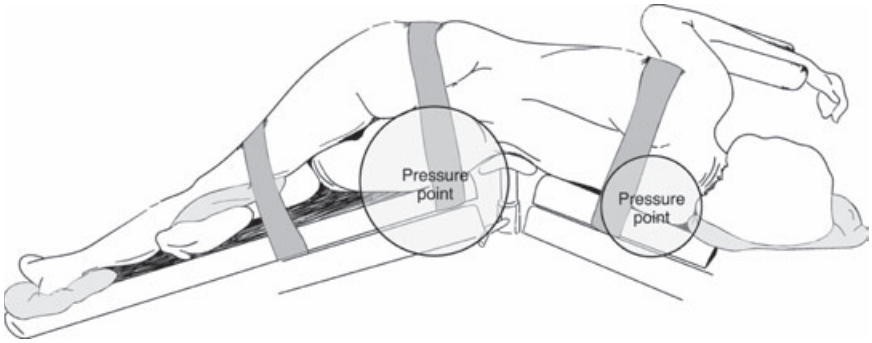
Several factors can be identified from these cases as being potentially causative in the development of rhabdomyolysis. First, a high BMI seems to be a common underlying feature of all the reported cases. Obese patients have previously been recognized as being predisposed to rhabdomyolysis, especially during laparoscopic procedures for obesity [12,13]. Thus, obesity becomes a clear

TABLE 1 Analysis of patients developing rhabdomyolysis

Ref	Age, years	BMI or weight	Duration of surgery, min	Serum creatinine, mg/dL		Serum creatinine kinase (U/L)	Dialysis	Duration of dialysis	Hospital stay, days
				Before LN	Peak after LN				
Present	64	32	138	135*	284*	52 394	Yes	9 days	18
[5]	32	31	285	1.2	17	101 000	Yes	5 sessions	11
[9]	60	31	510	1.0	3.0	33 682	No	NA	7
[10]	29	110 kg NS	420	NS	NS	28 522	No	NA	NS
[8]	29	33	350	0.8	8.5	10 960	No	NA	Day 1†
[3]	NS	90 kg¶	311	Normal	ME	6 070	No	NA	>3
[11]	NS	24	490	1.4	1.5	9 350	No	NA	7.3 (3–13)‡
(7 patients)		29.5	360	0.8	2.1	99 193	No	NA	
		28.2	398	0.9	1.6	28 372	No	NA	
		57.6	495	1.2	6.6	13 090	No	NA	
		32.4	566	0.9	1.2	39 220	No	NA	
		42.3	350	1.0	9.7	22 053	Yes	1 month	
		28.9	387	0.9	9.1	26 112	Yes	1 month	

*NS, not stated; ME, mild elevation; NA, not available; *value in μmol/L; †but readmitted day 4 and finally discharged day 8; ‡mean (range); ¶mean (SD) BMI of the cohort was 26 (4.0) kg/m².*

FIG. 1. The lateral decubitus position with table flexion during LN; note the pressure points.



risk factor in the development of rhabdomyolysis.

The second common factor was the long duration of the reported procedures. Long periods of direct pressure can compromise the compartment pressure in the buttock and initiate the start of a compartment syndrome. Direct prolonged external pressure decreases compartment size and consequently increases tissue pressure [14]. When tissue pressures are within 10–30 mmHg of the diastolic blood pressure, muscle ischaemia develops [15]. Hypotensive anaesthesia can thus significantly increase the risk of myonecrosis secondary to direct pressure [10]. More than 3 h of ischaemia leads to increased capillary permeability [16], and myonecrosis and myoglobinuria can occur after up to 4 h of ischaemia [12,13]. However, rhabdomyolysis is often evident only immediately after surgery [8] when the ischaemic muscle bed is reperfused, leading to muscle oedema and further elevation of the compartment pressure, promoting worsening muscle ischaemia [8].

This process, combined with a high BMI, further compromises the compliance of the compartments under direct pressure, and thereby their ability to compensate for increased compartmental pressures [11]. Adequate padding of these pressure areas can be helpful, but it decreases pressures in dependent compartments by only 16% compared with hard surfaces [17].

The third common factor was the lateral decubitus position, as illustrated, along with pressure points, in Fig. 1. The lateral decubitus position significantly reduces tissue perfusion secondary to a decreased cardiac output and there is a reduction in the mean arterial pressure with table flexion and kidney-bridge elevation [18].

Although all patients from Table 1 had normal renal function before LN, it is understandable that pre-existing renal compromise can significantly reduce the threshold for developing rhabdomyolysis-induced ARF and the subsequent need for dialysis treatment.

Renal hypoperfusion in the presence of large amounts of plasma heme-containing proteins has been described as a critical insult contributing to the development of myoglobinuric ARF [19,20]. Thus, preventing peri-operative volume depletion is essential.

The mainstay of treatment is thus early recognition and aggressive fluid resuscitation with forced diuresis to prevent the development of ARF. Patients might require dialysis if they develop ARF. Early recognition might be difficult, as the main symptom is pain, and postoperative analgesia might efficiently mask this. The condition resolved completely in all the patients described in Table 1.

PREVENTION

Preoperative recognition of high-risk patients is imperative; it should be anticipated as a potential complication for those patients with a high BMI, cardiac problems that could potentially lead to inadequate tissue perfusion, and those who will be placed in positions leading to a possible increase in compartment pressures.

As experience is gained in any laparoscopic procedure, those patients with a high BMI are at higher risk and it was recommended by de Menezes *et al.* [13] in their review article that surgeons should select their patients with care during the introductory phases of any new procedure. In those patients the 'quickest' option might be the best option and in the best interest of the patient. This has also been emphasized by Davenport *et al.* [4] who recommended fewer specialists centres performing more procedures to maximize the outcome and reduce the rate of complications. Certainly LN can take longer than an open procedure [3], especially early in the training period.

Peri-operative precautions include awareness of the duration of the procedure, with a willingness to convert to open surgery if progress is slow. Adequate soft padding of pressure points (Fig. 1) can reduce the risk and is a vital preventive measure. The anaesthetist needs to be aware of the significance of avoiding hypotensive anaesthesia and the importance of adequate peri-operative hydration. The anaesthetist thus plays a major role in the prevention and early recognition of this complication.

CONCLUSION

Rhabdomyolysis is a rare but serious complication that can occur in patients undergoing laparoscopic surgery, and can contribute quite significantly to morbidity afterward. Lengthy surgery combined with a high BMI and the lateral decubitus position are the major risk factors. Adequate peri-operative hydration and renal perfusion, with generous padding of pressure points, reduce the risk of this complication. Appropriate patient selection, especially during training, with an awareness of the surgeon's limitations, and possible conversion to open surgery, should be considered in the best interest of the patient.

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CONFLICT OF INTEREST

None declared.

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Abbreviations: **LN**, laparoscopic nephrectomy; **ARF**, acute renal failure; **BMI**, body mass index.