

Resistance exercise–induced rhabdomyolysis: Need for immediate intervention and proper counselling

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Background

Rhabdomyolysis results from damage to skeletal muscle. Improper resistance training may result in rhabdomyolysis, which can cause acute kidney injury, serious metabolic abnormalities, compartmental syndrome and even death. Proper counselling for athletes may prevent this condition.

Objectives

We present two patients with unilateral swelling after resistance exercise. The workup revealed rhabdomyolysis. We highlight the importance of counselling to prevent rhabdomyolysis secondary to resistance exercise.

Discussion

Trainers and primary care physicians need to be educated about the main features of rhabdomyolysis and urgently refer trainees suspected of having this condition. Treatment consists mainly of hydration and correction of metabolic abnormalities. Primary care physicians need to counsel patients on ways to prevent rhabdomyolysis. Trainers and primary care physicians should instruct novice trainees who are performing resistance exercise to start low and gradually increase the load. Training with loads of 60–70% of one repetition maximum for 8–12 repetitions and use of one to three sets per exercise is recommended.

Resistance exercise has an important impact on the health and wellbeing of adults. There are worldwide recommendations on the type and amount of exercise to avoid adverse events. Physical activity guidelines in Australia,¹ Canada,² UK³ and the US⁴ concur with the World Health Organization (WHO) recommendations that ‘muscle strengthening activities should be done involving major muscle groups on two or more days a week’.⁵

Primary care physicians are well placed to counsel their patients and the public on proper resistance exercise. They should counsel on the type, duration and amount of physical exercises to be performed. Face-to-face consultations or brief advice delivered by phone calls or emails from physicians were found to be more cost-effective than advice or education delivered in the gym.⁶ However, this is infrequently done. Sixty-six per cent of general practitioners (GPs) in Ireland never gave advice on resistance exercise to healthy individuals.⁶ The reason behind that was that 83% of GPs never received training on exercise counselling.⁶ Moreover, healthy adults are less likely to receive exercise counselling when compared with those who are obese or have health problems.⁶ This deficiency may contribute to more musculoskeletal injuries and exercise-induced rhabdomyolysis.

In this article, we review the presenting symptoms, diagnosis and treatment of rhabdomyolysis using two patients as examples. Both patients were university students who presented on the same day to the emergency department after doing resistance exercise at the same university gym. Both were novices to resistance exercise. A trainer gave them instructions on which exercises to do, but did not tell them how to do the exercises. We highlight the importance of counselling for those who plan to start a resistance training program.

The patients

A student, 19 years of age, presented with swelling in the upper right extremity after starting biceps and triceps strengthening exercises four days before presentation (Figure 1). He started with a one-hour session that was repeated two days later. The patient carried out two sets of 12 repetitions for each major muscle group. The weight carried was 25 kg. The patient did not have pain or other complaints. On physical examination, he had a body mass index (BMI) of 18.9 kg/m², and had non-tender right elbow swelling extending to the forearm with normal skin colour and tactile temperature (Figure 1). Blood tests revealed a creatine phosphokinase (CPK) level of 9000 IU/L and normal kidney function (normal creatinine and urine analyses).

The second student, 20 years of age, presented with right chest swelling (Figure 2). This student started pectoralis muscle strengthening exercises one week before presenting. He started with a one-hour session, where he carried out two sets of 12 repetitions for each major muscle. The weight carried was 30 kg. Physical examination revealed a BMI of 19.7 kg/m², and swelling involving the right chest. Blood tests showed a CPK level of 11,000 IU/L and normal kidney function.

The classic triad of rhabdomyolysis symptoms include muscle pain, muscle weakness and tea-coloured urine. Less than 10% of patients present with this triad and more than 50% do not complain of muscle pain or weakness. Tea-coloured urine is noted in only 3.6% of patients and muscle swelling is noted in only 5% of patients.⁷ Mild forms of rhabdomyolysis are characterised only by elevated levels of CPK and myalgia.⁸ Other presenting symptoms include systemic manifestations (eg tachycardia), fever, generalised malaise and gastrointestinal complaints (eg nausea and vomiting). Some patients may develop manifestations of acute renal failure (ARF), disseminated intravascular coagulation and multi-organ failure (complications with escalating severity).

The patients were admitted to hospital with a diagnosis of exercise-induced rhabdomyolysis. They received 3–4 L of normal saline on the day of admission

and had serial monitoring of CPK, creatinine, lactate dehydrogenase and uric acid, in addition to a repeated urine analysis. The next day, CPK levels in both patients dropped significantly and they were discharged.

Diagnosis

Early diagnosis of rhabdomyolysis prevents complications; the patient's history is of utmost importance. In the two cases presented above, knowledge that patients were involved in resistance exercise raised suspicion for rhabdomyolysis. CPK, which has a half-life of 36 hours, is the most reliable indicator of muscle injury. A CPK level that is more than five times the normal value, as stated by the laboratory performing the test on your patient, may suggest rhabdomyolysis, and is predictive of an increased likelihood of developing ARF.⁸

Serum myoglobin has a short half-life of around three hours. In patients who present early, an elevated myoglobin level >15,000 µg/L is significantly associated with ARF.⁸ The urine dipstick would appear to be positive for the presence of blood but without finding erythrocytes.⁹ Other tests to be performed include serum creatinine, urea nitrogen, uric acid, electrolytes, calcium, phosphorus, lactate dehydrogenase, transaminases and arterial blood gases.

The metabolic/electrolytes abnormalities associated with rhabdomyolysis include hyperkalaemia, metabolic acidosis, hypocalcaemia or hypercalcaemia, hyperuricaemia, hyponatraemia and hyperphosphataemia, with a risk of developing cardiac arrhythmias.⁸

Complications of rhabdomyolysis include ARF due to myoglobinuria. Acute compartment syndrome (ACS) is another serious complication that results from severe muscle swelling and decreases in the macrocirculation and microcirculation. Symptoms of ACS include pain that is usually burning in nature and is increased on stretching the involved muscle. A decrease in two-point discrimination and vibration sense may be observed. Normal pulses (in the patient with the swollen forearm) do not rule out this possibility, as this is a late sign.⁹ A definite diagnosis of ACS is confirmed by measuring the intra-compartmental pressure. Magnetic resonance imaging and ultrasonography may be of help.¹⁰ Other possible complications include disseminated intravascular coagulopathy.⁸

Management

The goal of therapy for rhabdomyolysis is to prevent complications, particularly azotemia. Aggressive hydration is important.⁸ Hydration is carried out in one of the following forms until CPK levels start to drop:

- Hydration with normal saline at a rate of 1.5 L/hour.
- Hydration with normal saline at a rate of 500 mL/hour, alternating with 5% glucose with 50 mmol of sodium bicarbonate (in each 2–3 L solution) at a rate of 500 mL/hour.⁷

A urine output of 200 mL/hour is the goal; hence, clinicians should accurately measure fluid intake and output to ensure forced diuresis.⁷ Moreover, plasma acidosis, if present, should be corrected, as well as any electrolyte imbalance. In some patients, haemodialysis is mandated by renal



Figure 1. Unilateral swelling in the right forearm of a young adult after two sessions of resistance training



Figure 2. Unilateral right chest swelling in a young adult after two sessions of resistance training

or metabolic indications; however, prophylactic haemodialysis is not recommended.⁸ If the patient has severe oliguria or anuria, it is important to watch for pulmonary oedema.

ACS may need surgical intervention. Specialist opinion should be sought if fasciotomy is considered.⁹

Prevention

Prevention of rhabdomyolysis is possible by training primary care physicians and coaches in gyms on how to provide sound counselling for individuals who are new to physical training. As is the case for introduction of some medications, when embarking on resistance exercise, one needs to 'start low and go slow'. This applies to the duration of the session, number of repetitions, number of sets and intensity. For example, a single set of eight repetitions performed slowly is advisable (Table 1).

To attain muscle strength, the load carried should be around 60–70% of one-repetition maximum.⁴ A one-repetition maximum is determined by trial and error, where the exerciser follows systematic progression in the test load until the maximum resistance can be lifted for

one repetition using proper exercise technique.¹¹

The current guidelines recommend a program of 8–10 exercises covering all major muscle groups (eg upper body, lower body and trunk). Novice trainees are advised to start with one to three sets for each exercise and 8–12 repetitions per set. A rest of two minutes is preferred between each set.⁴ The recommended frequency is two to three days per week on non-consecutive days.^{4,12} Advancement in intensity and duration should be gradual.

One meta-analysis showed that performing eccentric exercises (muscle lengthens as tension in the muscle increases, attained by slowly lowering a weight) were found to give better results in regard to muscle strength when compared with concentric exercises (muscle shortens as tension in the muscle increases, attained by lifting a weight). One should keep in mind that eccentric exercise predisposes more to rhabdomyolysis.¹³

Qualified professionals should supervise the trainees and ensure a safe environment that is free of hazards. Each session should also end by cooling down with less intense activities and static stretching.² Some lifestyle factors, such as adequate

sleep, sufficient hydration and proper nutrition, can also prevent resistance exercise injuries.¹⁴ Special care ought to be delivered to younger children who are more likely to sustain accidental injuries.¹⁵

Current guidelines for resistance exercise are complex; trainers need better education on using the guidelines (Table 1) to help initiate and achieve health benefits, and avoid problems.¹⁶

Conclusions

Exercise-induced rhabdomyolysis can lead to significant morbidity and mortality due to kidney injury, ACS and electrolytes imbalance. Clinicians should have a high index of suspicion to diagnose this disease, and initiate early and aggressive treatment. Prevention of such injuries is of utmost importance. Trainers and primary care physicians should counsel those planning to start resistance training exercises to start low and go slow. This means two sets of 8–12 repetitions per set at an intensity of not more than one-repetition maximum, and lifting and lowering weights slowly.

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Table 1. Recommendations for resistance training with evidence rating⁴

Evidence statement	Grade*
Strength training	
Training with loads 60–70% of one-repetition maximum for 8–12 repetitions for novice-to-intermediate individuals	A
Use one to three sets per exercise by novice individuals	A
Rest periods of at least two minutes for core exercises using heavier loads for novice, intermediate and advanced training	B
Slow and moderate concentric velocities to be used for untrained individuals	A
Novice individuals train the whole body two to three days per week	A
Muscle hypertrophy	
Training with loads 70–85% of one-repetition maximum for 8–12 repetitions per set for one to three sets per exercise for novice and intermediate trainers	A
Novice individuals train the whole body two to three days per week	A

*Evidence rating:
 A. Recommendation based on consistent and good quality patient-oriented evidence
 B. Recommendation based on inconsistent or limited quality patient-oriented evidence

- 5 World Health Organization. Global recommendations on physical activity for health. Geneva: WHO, 2010. Available at www.who.int/dietphysicalactivity/publications/9789241599979/en [Accessed 15 July 2015].
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