

**A view on spinning - induced rhabdomyolysis.***Uma visão sobre a rabdomiólise induzida por spinning.*Marco Agassiz Almeida Vasques<sup>1</sup>, Leani Falcão Gomes<sup>2</sup>**RESUMO**

A prática de ciclismo indoor (spinning) pode levar à rabdomiólise, uma condição potencialmente grave que freqüentemente requer hospitalização e hidratação intravenosa para prevenir complicações como insuficiência renal aguda. A literatura sobre esse assunto é predominantemente de séries e relatos de casos. Este artigo consolida os dados de 92 casos de rabdomiólise induzida por *spinning* (SIR) publicados até dezembro de 2017. Houve predomínio de casos em mulheres jovens iniciando a prática. A duração média da sessão foi de 50 minutos. Os sintomas de mialgia (73%), fraqueza muscular (33%), urina escura (32%) e edema muscular (27%) foram os mais relatados nos pacientes. O início dos sintomas ocorreu 2 dias (média) após o exercício (variação de 0 a 8 dias). Os níveis séricos de creatina quinase na admissão foram entre 4.676 e 261.177 UI / L (média 56.869); a AST variou de 122 a 4.170 UI / L (média de 1.237), a ALT variou de 56 a 2.583 UI / L (média de 444), e os níveis de LDH foram de 834 a 62.970 UI / L (média de 6.112). Os músculos mais freqüentemente envolvidos foram os músculos do quadríceps. Insuficiência renal aguda foi relatada em 8 casos e síndrome compartimental em 4 pacientes. O conhecimento sobre a fisiopatologia dessa doença tem implicações nas medidas preventivas, principalmente nos aspectos educacionais direcionados aos agentes envolvidos na atividade física.

**Palavras-chave:** rabdomiólise, exercício físico, ciclismo, meta-análise.

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## **ABSTRACT**

The practice of indoor cycling (spinning) may lead to exertional rhabdomyolysis, a potentially severe condition that often needs hospitalization and intravenous hydration to prevent complications such as acute renal failure. The literature on this subject is predominantly of series and case reports. This article consolidates the data of 91 cases of spinning induced rhabdomyolysis (SIR) published up to 2018. There was a predominance of cases in young female initiating the practice. The average duration of the session was 50 minutes. The symptoms of myalgia (73%), muscle weakness (33%), dark urine (32%) and muscle swelling (27%) were the most reported in the patients. The onset of symptoms occurred in 2 days (average) after exercise (range 0- 8 days). Levels of serum creatine kinase on admission were between 4,676 and 261,177 IU/L (average 56,869); AST ranged from 122 to 4,170 IU/L (average 1,237), ALT ranged from 56 to 2,583 IU/L (average 444), and LDH levels were from 834 to 62,970 IU/L (average 6,112). Muscles most frequently involved were quadriceps muscles. Acute renal failure was reported in 8 cases and compartment syndrome in 4 patients. Knowledge on the physiopathology of this disease has implications on preventive measures, especially on educational aspects directed towards agents involved in physical activity.

**Keywords:** rhabdomyolysis, physical exercise, cycling, meta-analysis

## **INTRODUCTION**

Over the last years the number of people practicing indoor cycling (spinning) has been growing fast. This predominantly aerobic exercise was designed in 1989 by a South African athlete (Goldberg) and utilizes a stationary bike with variations in speed and resistance, with sessions lasting from 40 minutes to an hour. The effects of physical activity have been extensively studied and comprise not only the classic cardiopulmonary <sup>1, 2</sup> and metabolic <sup>3</sup>, but also encephalic <sup>4</sup> benefits. On the other side, there may be an increase in the potential lesions due to the increase in the amount of exercise, especially if there is no supervision of a professional <sup>5</sup>. One of these possible lesions is the muscle injury known as rhabdomyolysis, which has been associated with different kinds of exercise <sup>6, 7, 8, 9</sup>. This condition presents itself as symptoms of muscle pain, weakness, and dark urine, along with muscle enzymes level elevation in blood, mainly creatine phosphokinase (CPK) and sometimes leads to acute renal failure due to deposition of myoglobin in the kidneys <sup>10</sup>. The present article aims to consolidate the data of published cases of spinning induced rhabdomyolysis (SIR), in order

to contribute to a better understanding of this pathological condition.

## **MATERIALS AND METHODS**

### *Data sources and study selection*

The PubMed-Medline database was searched for case reports and series of cases published from January 01, 2008 up to December 31, 2017. The following search terms were used: "rhabdomyolysis" AND "physical exercise", OR "exercise-induced rhabdomyolysis" OR "exertional rhabdomyolysis" OR "spinning". Titles, abstracts and full-text publications were obtained and screened for original data on clinical and laboratorial features after SIR. Exclusion criteria were: 1. Non-exertional rhabdomyolysis; 2. Non-spinning induced exertional rhabdomyolysis. 3. Experimental studies. No language restrictions were applied. Secondary references were also included if they matched all criteria.

### *Data extraction and quality assessment*

The following data were extracted from the selected articles: age, gender, previous experience with the exercise, duration of sessions, symptoms, levels of serum CPK, Aspartate

Aminotransferase (AST), Alanine Aminotransferase (ALT), Lactate Dehydrogenase (LDH), muscles compromised, and development of acute renal failure or compartment syndrome.

#### ***Data synthesis and analysis***

Risk factors were associated with clinical endpoints by cross-tabulation. Risk ratios (RRs) and 95% confidence intervals (CIs) were calculated using a spreadsheet calculation – Episheet<sup>11</sup>. A P value of less than 0.05 was considered significant.

#### **RESULTS**

The search strategy resulted in a final total of 91 cases of SIR, reported in 23 papers<sup>8, 12-34</sup>. There was an increase in the reports of SIR from 2 cases in 2003/2004 to 46 in 2016/2017. There was a predominance of women (75%) with an average of 28 years-old. The clinical features of published cases are displayed in table 1. Symptoms usually developed 2 days (range 0 to 8) after a first or second spin class (55%) with an average session time of 50 minutes. Myalgia (73%), muscle weakness (33%), dark urine (32%) and muscle swelling (27%) were the most reported symptoms, although other symptoms like lightheadedness, asthenia, nausea,

vomiting, tachycardia, tingling, numbness, tightness, stiffness, coolness and oliguria were also reported.

Muscle involvement was most frequently reported as “thighs” (51%) or “lower extremities” (24%), but quadriceps muscle compromise was specified in 23% of cases. Acute renal failure and compartment syndrome were reported in 9% and 4% of patients, respectively. Levels of serum creatine kinase on admission were between 4,676 and 261,177 IU/L (average 56,869); AST ranged from 122 to 4,170 IU/L (average 1,237), ALT ranged from 56 to 2,583 IU/L (average 444), LDH levels were from 834 to 62,970 IU/L (average 6,112), and creatinine ranged from 0,1 to 7,39 (average 1,16). The risk of developing renal failure was increased in patients older than 30 years-old (RR:8,77; CI:1,62 – 47,51; p=0,0033). Therapeutic measures consisted on hydration, rest and when necessary dialysis and fasciotomy.

#### **DISCUSSION**

We found a prevalence of young women in reported cases of SIR. This probably reflects demographics of participants in this exercise. Although

the “spinning” exercise was introduced in 1989, the first cases of spinning induced rhabdomyolysis were published only in 2003<sup>12</sup> and 2004<sup>13</sup>. This exercise has beneficial effects on cardiovascular performance and fat loss and is generally safe, but the introduction to its practice is especially dangerous. The characteristic of repetitive exercise is present in most cases of exercise induced rhabdomyolysis, and the fact that most cases reported here were in beginners also reflect the physiopathology of the disease.

Diverse causes of exertional rhabdomyolysis have essentially two pathways, the mechanical (muscle tension related) and the metabolic (cellular energy depletion)<sup>35</sup>. The cellular energy depletion leads to a Na/K – ATPase and Ca – ATPase pump dysfunction, an increase of intracellular ion imbalance and of proteolytic enzyme activities, osmotic swelling, causing myocyte destruction and release of cellular components into blood stream, including potassium, phosphate, creatine phosphokinase, aldolase, myoglobin, lactate dehydrogenase, aspartate transaminase and urate<sup>29</sup>. The high levels of free myoglobin in the blood stream may

lead to its deposition in the renal tubules, with consequent renal failure<sup>36</sup>. Future research should point to the development of ways of protecting mitochondrial energy supply during exercise. We acknowledge that this study has many weaknesses, as the lack of data on some points in some reports, and the obvious publication bias that is common to these kinds of studies. Nevertheless, the reported data are not despicable. The increasing number of people committed to exercising may seem like good news, but also brings along the increase in the number of rhabdomyolysis cases when the practice is inappropriate. Cases occurring after an effort that could be long in time, with high number of repetitions or too intense, like it is in a first class of spinning, shows that disproportion between previous physical conditioning and specific exercise routine seems to be the main cause of exercise induced rhabdomyolysis, in line with results found in literature<sup>37</sup>. This situation may occur in sedentary people and also in athletes<sup>38, 39</sup>. The higher frequency of SIR in young people may reflect higher levels of physical activity at this age range and also a motivational psychological factor causing people go beyond their own physical limits. The

presence of certain environmental and body conditions can also predispose to exertional rhabdomyolysis, as well as previous conditions like infection, use of drugs or genetic or metabolic disorders<sup>40, 41, 42, 43</sup>. Clinical features of rhabdomyolysis are classically described as a triad of myalgia, dark urine and weakness but also include muscle edema, fatigue, nausea and other general symptoms<sup>44</sup>. A high clinical suspicion of this condition must occur whenever there is a story of possible muscle damage. Imaging methods as ultrasound or magnetic resonance imaging may be useful to diagnosis<sup>16, 45</sup>, but it will be confirmed by the elevation of serum CPK levels. The magnitude of CPK level elevation does not seem to be a relevant factor in the development of acute renal failure or other complications. The basis of treatment of exertional rhabdomyolysis are muscle rest, hydration, in some cases urine alcalinization, along with monitoring for compartment syndrome and acute renal failure, adopting specific measures whenever necessary<sup>46</sup>. Prevention of SIR should start with educational measures aiming a gradual scaling of exercises (or a gradual return to training after an inactive period). An

adequate awareness of physical education professionals about the possibility of SIR is important to ensure early diagnosis and treatment, avoiding complications.

## CONCLUSION

Spinning induced rhabdomyolysis is a potentially fatal condition, that may occur when people exercise beyond muscle capacity. Knowledge of its clinical features, pathophysiological mechanisms, and therapeutic protocols by health and fitness professionals should be a good and cost-rewarding way towards prevention of complications.

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**Table 1. Features of spinning-induced rhabdomyolysis cases**

Reference	Year published	Number of cases	Age	Gender	Clinical features
Beavis et al <sup>[34]</sup>	2017	1	19	Female	Myalgia, dark urine.
Brogan et al <sup>[35]</sup>	2017	3	20 to 33	1 Male 2 Fem.	Lightheadedness, nausea, vomiting, decreased urine output. One patient developed acute renal failure.
Cutler et al <sup>[28]</sup>	2016	14	23 to 39	8 Male 6 Fem.	Myalgia. One patient developed compartment syndrome and other acute renal failure.
Gould et al <sup>[29]</sup>	2016	1	19	Female	Myalgia, dark urine, muscle weakness, tingling, numbness, compartment syndrome.
Hu and Ng <sup>[30]</sup>	2016	1	35	Female	Myalgia, swelling, tingling, numbness, tightness
Jeong et al <sup>[31]</sup>	2016	1	21	Female	Myalgia, dark urine, muscle weakness, swelling, reduced hip and knee range of motion
Kim et al <sup>[32]</sup>	2016	13	18 to 37	1 Male 12Fem.	Not reported. Two patients developed acute renal

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					ailure.
Marcalain et al <sup>[33]</sup>	2016	12	19 to 49	2 male 10Fem.	Myalgia, dark urine, muscle weakness, swelling.
Eichner <sup>[23]</sup>	2015	1	42	Male	Myalgia, muscle weakness, stiffness.
Fidan et al <sup>[24]</sup>	2015	1	26	Female	Myalgia, swelling.
Hernández-Contreras et al <sup>[25]</sup>	2015	11	22 to 33	5 Male 6 Fem.	Not reported. Two patients developed acute renal failure.
Kim et al <sup>[26]</sup>	2015	11	15 to 31	11Fem.	Myalgia, dark urine, muscle weakness, reduced hip and knee range of motion.
Pinel et al <sup>[27]</sup>	2015	1	30	Female	Myalgia, dark urine.
DeFilippis et al <sup>[8]</sup>	2014	2	24	1 Male 1 Fem.	Myalgia, dark urine, swelling, tachycardia, stiffness, foot coolness, low <i>dorsalis pedis</i> pulse. One patient developed compartment syndrome and acute renal failure.
Pena-Irun et al <sup>[21]</sup>	2014	1	24	Male	Myalgia, dark urine, muscle weakness, swelling, oliguria.
Young and Thomson <sup>[20]</sup>	2014	1	26	Female	Myalgia.
Severini et al <sup>[19]</sup>	2013	1	29	Female	Myalgia.
Benish et al <sup>[17]</sup>	2012	1	21	Female	Myalgia, dark urine, muscle weakness, stiffness.
Parmar et al <sup>[18]</sup>	2012	2	26 to 38	1 Male; 1 Fem.	Myalgia, dark urine, swelling, reduced knee range of motion.
Boni and Rabitti <sup>[16]</sup>	2011	1	19	Female	Myalgia, dark urine, swelling.
Inklebarger et al <sup>[15]</sup>	2010	1	63	Female	Myalgia, dark urine, stiffness.
Montero et al <sup>[14]</sup>	2009	9	Not available	1 Male 8 Fem.	Myalgia, dark urine, asthenia, functional impotence of lower limbs. One patient developed acute renal failure.
Young and Thomson <sup>[13]</sup>	2004	1	Not available	Female	Not available.
Bertoldo et al <sup>[12]</sup>	2003	1	49	Male	Myalgia, dark urine, swelling, compartment syndrome.