Case Presentation

14yo high school rower presents to emergency department for bilateral arm pain and swelling for past 2 days.

No injury

First year crew athlete who began a pre-season training regimen that included rowing 5 days a week and doing cross-fit 3 days a week.

Meds include OTC ibuprofen and acetaminophen

PMH, PSH and ROS are otherwise negative

Exam: diffuse tenderness throughout L arm musculature with diminished ROM of the L elbow, but no N/T. 2/4 pulses and no signs of compartment syndrome

Case Presentation

Labs (normal except below)

- RBC 4.23 L
- Hgb 12.6 L
- HCT 38.0 L
- CKMB 13400 U/L
- AST 180 H
- ALT 57 H
Case Presentation

Community ED Treatment
- Fluids (NSS)
- Morphine 2mg
- Motrin 400mg
- Transfer to Pediatric ER/Hospital with diagnosis of exertional rhabdomyolysis

Case Presentation

Pediatric ER
- Exam
  - Forearm circumference
    - R 27.75 cm
    - L 28.75 cm
- Labs
  - Stayed essentially the same
  - CK 1254 U/L
  - Urine myoglobin Negative
- Admitted to general pediatrics floor

Hospital Course
- Six day course of aggressive IV fluid rehydration
- CK and LFTs continued to rise, plateaued and trended down
  - Peak CK 26000 U/L
- Discharged home with pediatric follow-up
  - Pediatrician labs
    - LFTs near normal
    - CK 272 U/L
Follow-Up

Pediatrician re-evaluated 10 days later
Still in significant arm pain that is not improved with acetaminophen
Rechecked labs
- CK 94 U/L
- LFT normal
Referred to Sports Med for return to play guidance and continued pain

Sports Medicine Office

Fatigable weakness and pain in left shoulder with rotator cuff muscle testing, fatigable weakness in all strength testing of the elbow more pronounced than right, grip strength diminished on left
Left forearm paresthesia with negative Tinel’s at cubital and carpal tunnel as well as a negative Spurling maneuver

Sports Med Return to Play

Tylenol with codeine for pain
Refrain from gym and school sports
Graded return to play over a 6-8wk period with physical therapy

Patient did not go to PT and had exacerbation of pain 5 months later
CK levels were normal and finally went to PT/OT and has now returned to normal activity (volleyball and basketball) without issues
Definition

- Rhabdo – striated muscle
- Lysis – break down of cells

Rhabdomyolysis Etiologies

- Trauma
- Non-Trauma Exertional
  - Extreme overuse
  - Thermal regulation issues
  - Metabolic Myopathies
- Non-Trauma Non-Exertional
  - Toxins (i.e. Alcohol/Drugs)
  - Infections
  - Electrolyte abnormalities

Rhabdomyolysis Incidence

- 26,000 cases a year in the United States
- 47% are exertional in nature
Exertional Rhabdomyolysis

The acute breakdown of skeletal muscle cells causing a release of myoglobin and other muscle cellular contents throughout the circulatory system.

History

First reported in 1967 in Army recruits undergoing basic training at an altitude of 4060 ft.

- Started as acute renal failure
- Soon after cases were reported in the Air Force

Attention grew in 1971 when 40 men from a single marine platoon were hospitalized due to rhabdomyolysis.

Clinical Signs/Symptoms

- Myalgias
- Muscle swelling
- Muscle weakness
- Darkened (brown or tea colored) urine
Laboratory Findings

- Elevated Serum Creatine Kinase (CK)
  - Greater than 5000
- Myoglobinuria
  - Urine dipstick positive

Other Laboratory Findings

<table>
<thead>
<tr>
<th>Electrolyte/Enzyme</th>
<th>Blood Level Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium</td>
<td>Increased</td>
</tr>
<tr>
<td>Calcium</td>
<td>Decreased</td>
</tr>
<tr>
<td>Phosphate</td>
<td>Increased</td>
</tr>
<tr>
<td>Creatine Kinase</td>
<td>Increased</td>
</tr>
<tr>
<td>Serum Creatine</td>
<td>Increased</td>
</tr>
<tr>
<td>Lactate Dehydrogenase</td>
<td>Increased</td>
</tr>
<tr>
<td>Uric Acid</td>
<td>Increased</td>
</tr>
<tr>
<td>pH</td>
<td>Decreased</td>
</tr>
</tbody>
</table>
Imaging with Exertional Rhabdomyolysis

- Usually not necessary
- Can localize muscle involvement with Scintigraphy with technetium-99m methylene diphosphonate with local radiotracer uptake
- MRI particularly T2-Weighted, fat-saturated images demonstrate diffuse muscle hyper-intensity
  - Uptake in adductor magnus bilaterally
  - Scintigraphy with technetium-99m methylene diphosphonate with local radiotracer uptake
  - Diffuse uptake in the paraspinal musculature

MRI Image of Exertional Rhabdomyolysis
Diffuse swelling and uptake in the deltoid muscle

MRI Image of Exertional Rhabdomyolysis

Predisposing Factors

- Deconditioned athlete participating in high intensity, high repetition physical activity
- Exercise in hot, humid conditions
- Sickle cell trait, particularly at higher altitudes
- Can occur in conditioned athletes
- Metabolic myopathies
  - Disorders of glycogenesis, glycolysis or lipid metabolism

Medicines that can contribute to Exertional Rhabdomyolysis

- Prescription Drugs
  - Amphetamines
  - Methadone
  - SSRI's
  - Anti-psychotics
  - Statins
  - Antihistamines
- Drugs of abuse
  - Alcohol
  - LSD
  - Heroin
  - Cocaine
Sickle Cell Trait (SCT) and Exertional Rhabdomyolysis

- 3 million Americans have SCT
- Among 136 studied non-traumatic deaths in HS and College Athletes, Rhabdomyolysis was the 3rd most common cause of death, accounting for 5%

Exertional Sickling
- Usually caused by heat stressors
- Presents much of the time as collapse from exertional rhabdomyolysis caused from the sickling
- Most common in football players

Risk Factors for SCT and Exertional Rhabdomyolysis
- Extreme heat and humidity
- High altitude
- Exercise-induced asthma
- Pre-event fatigue due to illness or sleep deprivation
Recommended measures for preventing Exertional Rhabdomyolysis with SCT

- Implement a pre-season conditioning program
- Modify exercises as needed during season
- Implement aggressive hydration protocols
- Educate athletes on beverages that can cause diuretic effect
- Avoid strenuous activity in hot and humid conditions
- Avoid strenuous activity in altitudes over 2500ft
- Modify activity after illness or sleep deprivation

Treatment

- Hydration, hydration, hydration
  - Normal saline until CK drops below 1000U/L

Sequelae from Exertional Rhabdomyolysis

- Myoglobinuria
- Renal Failure (5-7% of time)
- Disseminated Intravascular Coagulation
- Death
Renal Failure with Exertional Rhabdomyolysis

- Rare
- Caused by myoglobin precipitating into the renal tubules
- NSAID usage during exercise
- NSAIDs have been shown to decrease kidney function
- Has been associated with exertional rhabdomyolysis particularly after marathons
- NSAIDs decrease GFR leading to increased dehydration and predisposition to further renal injury

Return to Play

- Once discharged from hospital, care must be taken to gradually recondition athletes for activity
- Slow progression and build up over time
- Weekly check-ups recommended
Randall et al's RTP secondary to intense push-up training

**Phase 1**
- Active and Passive ROM of shoulder and elbow as pain allows

**Phase 2**
- When ROM has returned upper body ergometer at low intensity for 5m progressing daily until workload can be maintained for 15m

**Phase 3**
- Isotonic weight training with light weights for specific muscle weakness, modified pushups, and bench press. Modified pushups progressed daily from wall to stool to chair to floor until able to do normal pushup

**Phase 4**
- Patient is allowed to resume normal exercise routine with the restriction of only performing 1 set of pushups in a 24h period. Restriction maintained until patient is able to perform at their pre-injury number of pushups without sequelae such as muscle soreness or loss of normal ROM
Modified Kersey Method to increase pushup performance:

1. Perform 3 sets at 50% of pre-training 2m pushup test score
2. When able to complete 3 sets add a 4th
3. When able to complete 4 sets, return to performing 3 sets at 75%
4. When able to complete 3 sets add a 4th
5. When able to complete all 4 sets return to performing 3 sets at 90% of pre-training pushup test score

Special Consideration:
- Extent of muscle damage
- Underlying physical condition
- Previous training (particularly with any weights) and experience

The Problem with High Intensity Circuit Exercise Programs:

- We love a quick effective way to lose weight
- Many times we engage in physical activity we are deconditioned for leading mainly to injury mainly due to poor form or poor instruction
Uncle Rhabd

- Glorified by those who have had this condition while doing CrossFit
- NY Times article first to highlight issue
- Over time CrossFit has worked to eliminate the stigmata that injuries like this with a focus on proper instruction and form over sheer repetition
- It is important whenever engaging in an exercise program like this to critically evaluate the gyms

Education

- Valuable to mention with community hydration discussions and heat illness
- Reach out to gyms and teams and work to educate your community to prevent this from happening
References


NY Times Accessed 10/24/14

Special Thanks

My Loving Wife and Beautiful Daughter

Melissa Tabor, DO
J.R. Barley, DO
Riverside for finally giving me a day off during football season