Return to Competition Following Ischemic Colitis Caused by Severe Dehydration

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Objective: This article summarizes a case of ischemic colitis suffered by a triathlete during an Ironman competition. Background: Exercise results in a significant reduction in splanchnic blood flow to help maintain cardiovascular function. When dehydration and heat stress accompany exercise, blood flow to the splanchnic vasculature is further reduced, increasing the risk of local ischemia and tissue injury. Differential Diagnosis: Ischemic colitis caused by dehydration and heat stress. Treatment: Right hemicolectomy involving a 16-cm segment of ischemic large intestine and appendectomy the day following the race. Uniqueness: This case study highlights one of the risks associated with dehydration during prolonged exercise in the heat. Of particular interest are practical interventions to reduce health and performance issues. Conclusions: Poor hydration and nutrition practices during intense exercise can affect gut function, impair performance, and jeopardize health. Optimal intake of fluid, carbohydrate, and salt will enhance performance and reduce risk to health. Key Words: ischemic colitis, dehydration, heat stress, hemicolecotomy

Background

In October of 1997, a 24-year-old, world-class male triathlete struggled to reach the finish line of the Ironman World Triathlon Championship held in Kona, Hawaii. In sixth place after more than eight hours of competition and only 50 meters from the finish, he staggered and collapsed to the ground while vomiting repeatedly. Soon thereafter he was removed to the race medical tent, where he appeared incoherent and his stomach was visibly distended.

Initial vital signs showed a rectal temperature of 102.7°F, blood pressure 150/80, and pulse 100 beats per minute. His torso was briefly packed with ice as a precaution against hyperthermia and he was subsequently moved to a cot where he remained for the duration of his stay in the medical tent. After receiving 2.5 liters of IV fluid (estimated volume to correct for dehydration; about -3% body mass) and 5 mg of IV Reglan, his nausea and vomiting resolved and he was able to consume oral fluids. With stable vital signs, he walked out of the medical tent under his own power after 90 minutes, looking and feeling reasonably well.

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Late the following evening, after a day of fever, weakness, and worsening abdominal pain, he was admitted to the emergency room at the local hospital. Three hours later, surgeons removed an infarcted 16-cm section of his large intestine (right hemicolectomy). He remained in the hospital ICU for seven days following the procedure.

In retrospect, the athlete reported his gastrointestinal distress began early in the bike leg of the triathlon. He denied gastrointestinal discomfort during the preceding 4.2 km (2.4 mile) swim. During the bike (180 km; 112 mile) and run (42.2 km; 26.2 mile) portions of the race, he intermittently consumed water, sports drink, carbohydrate gels, energy bars, and nutrition shakes, but experienced repeated bouts of nausea, vomiting, and diarrhea (at least 10 to 15 episodes). His abdomen, fingers, and toes became progressively puffy and he does not recall noticing blood in his feces or urine. Despite persistent gastrointestinal discomfort, he managed to remain among the top ten competitors during the latter stages of the bike and throughout the run segments of the race.

**Differential Diagnosis**

Emergency surgery revealed this athlete had sustained a large bowel infarction, thought due to ischemic colitis related to dehydration incurred during intense athletic competition. Gastrointestinal problems are common among Ironman triathletes and often impair performance and cause them to seek medical attention. In the vast majority of cases, such symptoms resolve with rest and oral or IV rehydration. Athletes who have a history of inflammatory bowel disease (eg, ulcerative colitis or Crohn’s disease) can often experience a flare of symptoms during intense exercise. Further, patients with more benign chronic bowel conditions such as irritable bowel syndrome may also associate worsening symptoms with prolonged and strenuous activity. It should be noted that this patient had no history of any chronic gastrointestinal condition and seemed to respond to standard therapy given in the race medical tent.

This athlete experiencing gastrointestinal discomfort during the early portion of the bike leg of the triathlon indicates his gastric and intestinal functions were impaired early in the event. Although the athlete repeatedly ate and drank throughout the race, a reduced rate of gastric emptying likely resulted in abdominal bloating, nausea, and vomiting. To make matters worse, a severe reduction in gastric emptying would reduce fluid delivery to the small intestine, in turn exacerbating existing dehydration and further impeding gastric emptying rate.5

**Treatment**

Prolonged gut ischemia will eventually result in tissue necrosis and, in this case, required resection of a 16-cm segment of the patient’s large intestine. Recovery from surgery was unremarkable, but in subsequent years, the athlete suffered repeated bowel obstructions due to soft tissue adhesions, requiring an additional surgery and numerous hospitalizations through 2001. There is no evidence that the absorptive capacity or function of his gastrointestinal tract was negatively affected.
by the initial ischemic colitis or subsequent surgery and complications. In fact, the athlete successfully competed in numerous Ironman-distance races subsequent to his problems in 1997, but often experienced bloating, nausea, vomiting, and diarrhea during competitions.

**Uniqueness**

In September 2003, the athlete underwent strenuous, lab-based exercise testing, coupled with evaluation of his nutrition practices. This was done in an attempt to determine if modifications to his training and nutrition regimen might help reduce gastrointestinal problems and improve his performance.

To accomplish this, he undertook a 4-hour exercise bout (2-hour cycle ergometry; 2-hour treadmill running) in an environmental chamber where WBGT was maintained at 28.2°C (dry bulb = 31°C; relative humidity = 71%). He arrived for testing with a urine specific gravity reading of 1.032, indicating that he was hypohydrated. During testing, he maintained a self-selected exercise intensity consistent with typical training conditions under similar circumstances (average heart rate = 142 beats per minute; 75% of age-predicted maximal heart rate).

The subject lost 8.8 liters of sweat (2.2 L/h) during the 4-hour test. He ingested 5.5 liters of various fluids (water, sports drink, other carbohydrate beverages: 3.2 L on the bike and 2.3 L on the treadmill, average of 1.375 L/h) as well as additional foods (energy bars, carbohydrate gel, protein paste, electrolyte tablets, and amino-acid tablets). This amounted to an intake of 3,200 kcal, of which carbohydrate intake accounted for 2560 kcal (640 grams; 160 grams per hour.

During the 4 hours of exercise, the subject replaced 62% of his sweat loss, but concluding exercise was dehydrated by 3.8% of his starting weight. Considering that he began exercise in a hypohydrated state (pre-exercise USG = 1.032), total dehydration from a euhydrated condition likely exceeded -3.8%, further increasing risk for premature fatigue, as well as hydration and heat-related problems. Peak core temperature during testing reached 39.0°C.

Sweat electrolyte concentration was measured using a five-site regional sweat assessment technique, with the absorbent patches removed at various times during exercise. Centrifugation of the patches extracted the sweat, which was then analyzed for sodium and potassium concentration via flame photometry.

Total sodium loss over the four hours was estimated to be 12,995 mg, the equivalent of six teaspoons of table salt (~ 32.5 g). During exercise, his sodium intake from fluids and foods was 6275 mg, resulting in a sodium deficit of -6720 mg. However, his plasma sodium concentration did not fall below 136 mmol/L (the normal range for plasma sodium concentration is 135 to 145 mmol/L). Even though he lost substantial sodium in his sweat and a small amount of sodium in the 105 milliliters of urine he produced, his plasma sodium concentration was maintained within normal range due to dehydration-induced contraction of fluid within the vascular space. Losses of potassium in sweat were unremarkable (3.72 mmol/L; a total loss of 1280 mg).

Evaluation of the athlete’s daily nutrition routine (one-day recall) revealed that his total energy intake was 2,500 kcal and his carbohydrate intake was 350 grams (< 5 g/kg BW; current recommendations indicate that athletes in heavy training should
ingest 6 to 10 grams of carbohydrate per kilogram of body weight per day\textsuperscript{1}). This intake occurred on a day in which he trained for 4.3 hours (1.3-hour swim; 1.5-hour bike; 1.5-hour run). Estimated energy expenditure for that amount of activity was 3800 kcal, requiring oxidation of about 600 grams of carbohydrate. Although one-day dietary recalls are often not an accurate representation of longer-term dietary intake, these data did indicate that this athlete was at least occasionally prone to days of inadequate energy and carbohydrate intake.

The athlete’s recall of nutrition practices during racing indicated a typical intake of 160 grams of carbohydrate per hour (in addition to ingesting proteins, amino acids, and fat). This rate of carbohydrate intake was consistent with the amount he ingested during laboratory testing and exceeds the maximal rate at which muscle can oxidize ingested (exogenous) glucose during exercise. Research shows that approximately 60 to 100 grams of exogenous carbohydrate can be oxidized per hour during prolonged exercise.\textsuperscript{4} Ingesting greater amounts of carbohydrate provides no further increase in exogenous carbohydrate oxidation.

It is also known that the rate of gastric emptying is extremely sensitive to the energy content within the stomach.\textsuperscript{6} Based on this information, it was concluded the athlete was over-consuming carbohydrate and total energy during training and racing, resulting in suboptimal gastric emptying and intestinal absorption of fluid.\textsuperscript{11} It was felt that these nutritional errors likely predisposed him to gastrointestinal discomfort and dehydration.

Based on these results, it was recommended this athlete modify his hydration and nutrition practices during prolonged, intense training and competition to allow for a fluid intake up to two liters per hour, a carbohydrate intake of 75 to 100 grams per hour, and a sodium intake of 3000 mg per hour. To accomplish these goals, the athlete was instructed to favor sodium-containing sports drinks over water during exercise and to modify ingestion of various macro- and micronutrients to satisfy guidelines for water, carbohydrate, and sodium intake during exercise. In addition, the athlete was counseled on how to progressively increase his fluid intake during training to enable his gut to eventually accommodate the increased volume of fluid required to minimize dehydration during hard training sessions and races.

**Conclusions**

The case described provides an example of the serious health risks that can be associated with dehydration during intense, prolonged exercise in the heat. Physical activity in the heat places a great stress on the cardiovascular system because there is not enough blood, even in a well hydrated athlete, to fill a dilated vasculature. For that reason, the body has compensatory mechanisms to reduce blood flow to some tissues while increasing it to others. For example, during exercise in the heat, the increased activity of the sympathetic nervous system reduces splanchnic and renal blood flow by 50 to 80\%. This normal response shunts blood from these “less active” tissues into the central circulation to help sustain cardiac output and meet the increased demand for blood flow to active muscle (to support energy production and CO\textsubscript{2} removal) and to the skin (to aid in heat loss). Dehydration makes matters significantly worse by further reducing blood volume, venous return, and cardiac output, changes that result in decreased blood flow to muscles, skin, and other tissues.\textsuperscript{3}
Because of the alterations in blood flow to the gut, it is not uncommon for otherwise healthy athletes to experience occasional episodes of bloody stool, diarrhea, cramping, nausea, vomiting, or other transient gastrointestinal problems during vigorous exercise. Dehydration likely increases the risk for such maladies, while in the case of diarrhea, ingesting too much energy (carbohydrate, protein, and/or fat) can predispose. In similar fashion, proper fluid and nutrient intake can reduce risk for gastrointestinal problems and aid performance.

The athlete discussed had a long history of significant gastrointestinal distress during prolonged training and competition. His problems were likely complicated by lingering effects from emergency hemicolectomy done in 1997 to remove a section of infarcted bowel, followed by several bowel obstructions and a second surgery done to remove intestinal adhesions. In this case, modification of the athlete’s intake of food and fluid during competition successfully eliminated most of his gastrointestinal symptoms, enabling him to elevate his level of performance, particularly in half-Ironman-distance competitions where he has recently excelled. Reducing the duration of his competitive events decreased his water and salt losses and lowered the athlete’s risk of dehydration, gastrointestinal discomfort, cramping, and premature fatigue.

Proper energy intake during prolonged exercise clearly benefits endurance performance by augmenting muscle carbohydrate oxidation and by providing fuel for the central nervous system. Ingesting too much energy (carbohydrate, protein, or fat) during exercise, however, can impede gastric emptying and intestinal absorption and, in the case of carbohydrate, exceed the body’s capacity for exogenous carbohydrate oxidation. For these reasons, athletes are advised to limit energy intake during exercise to approximately 250 to 400 kcal per hour (the equivalent of 60 to 100 grams of carbohydrate per hour), while trying to match fluid and sodium ingestion with losses.

Although it is not necessary to replace 100% of fluid and sodium losses during prolonged exercise, endurance athletes should strive to drink enough fluid to keep loss of body mass at less than -2% of starting body weight. Depending on the athlete, the environmental conditions, and exercise intensity, sweat rates for endurance athletes are roughly 500 to 1500 ml (~16 to 50 oz) per hour. Ingesting 125 to 375 ml (4 to 13 oz) at 15-minute intervals would replace 100% of those losses. These and lesser volumes are usually easy for athletes to ingest during prolonged exercise. Sodium intake during prolonged exercise should be at least 450 mg per hour to help replace sweat sodium losses and protect plasma sodium concentration.

Athletes who follow a well-thought-out plan for nutrition and hydration during endurance events and training will maximize performance and minimize gastrointestinal symptoms and risk for serious illness.

References


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