Diabetes in Athletes

Background
1. Definition
   o Person with diabetes participating in athletic activity
2. General info
   o In persons without diabetes, blood glucose well-maintained during exercise
      ▪ Hypo- or hyperglycemia during exercise in non-diabetic patient-
        extremely uncommon
   o Type I diabetics lose adaptation to maintain blood glucose during exercise
      ▪ Diabetic ketoacidosis
      ▪ Hypoglycemia
   o Type II diabetics-less problems with hypoglycemia during exercise
   o Intensive diabetes management needed to balance insulin, carbohydrate
     intake and exercise
   o Goal:
      ▪ Allow persons with diabetes to participate in a wide range of athletic
        activities
3. ADA/ACSM Joint Statement:
   o Diabetes Mellitus and Exercise
4. ACSM Position Stand:
   o Type II Diabetes and Exercise
5. Diabetes Exercise and Sports Association:
   o http://www.diabetes-exercise.org
   o Resource for athletes with diabetes

Pathophysiology
1. In athletes
   o Exercise-induced glucose uptake can cause hypoglycemia
   o Late onset hypoglycemia after exercise
   o Exercising with elevated blood sugar can cause paradoxical increase in
     blood sugar
      ▪ Epinephrine, norepinephrine, glucagon, growth hormone, cortisol-
        released during very intense exercise-lead to increased blood glucose
      ▪ Can lead to diabetic ketoacidosis (DKA)
   o Blood sugar during exercise influenced by:
      ▪ Time of day
      ▪ Decreased risk of hypoglycemia in early morning
        ▪ Low circulating levels of insulin
        ▪ Higher cortisol levels
      ▪ Timing of insulin or oral hypoglycemic administration
        ▪ Do not use short acting insulin immediately before exercise
      ▪ Insulin injection site
        ▪ Areas with increased fat density (abdomen) slow absorption of
          insulin
        ▪ Areas with decreased fat density (legs) increase absorption of
          insulin
• Time of last meal
  • Splanchnic circulation decreased during exercise
    o Slows absorption of food

• Type of food
  • Fatty foods digest/absorb more slowly

• Blood sugar level prior to exercise

• Intensity of exercise

• Ambient temperature

• Hydration status

• Acute illness
  • Increased blood glucose levels
  • More difficult to estimate insulin/carbohydrate needs

2. Morbidity / mortality
  o Hypoglycemia
    • Blood sugar <70 mg/dL
    • Increased risk during physical activity
      • Imbalance of increased glucose uptake with inadequate hepatic glucose release
  o Diabetic ketoacidosis
    • Increased risk in diabetics during exercise secondary to hypoinsulinemia induced by physical activity
      • Hypoinsulinemia → decreased glucose uptake → reliance on fat for energy → ketosis
  o Dehydration
    • Some athletes withhold insulin and fluid intake to make weight
      • Wrestling, boxing, weightlifting
  o Cardiovascular disease
    • Increased risk of hypertension
    • Consider exercise testing before allowing athletic participation in certain individuals
      • Age >35 years
      • Type 2 diabetes >10 years duration
      • Type 1 diabetes >15 years duration
      • Presence of any additional risk factor for coronary artery disease
      • Presence of microvascular disease (retinopathy or nephropathy, including microalbuminuria)
      • Peripheral vascular disease
      • Autonomic neuropathy
  o Peripheral vascular disease
    • May improve with low intensity exercise
  o Nephropathy
    • Strenuous exercise is contraindicated
  o Autonomic neuropathy
    • Maintain adequate hydration
    • Avoid exercise in hot/cold environment
    • Cannot use heart rate as a measure of exercise intensity in these patients
  o Peripheral neuropathy
    • Diabetic foot ulcers secondary to decreased proprioception and pain
      • Poor glycemic control is associated with decreased wound healing
• Significant neuropathy:
  • Limit the intensity of exercise
  • Limit weight bearing exercise
• Athletes with diabetes with/without neuropathy should:
  • Use supportive athletic shoes
  • Use gel inserts to avoid blisters/trauma
  o Gastroparesis
  o Retinopathy
    • Avoid anaerobic exercise, straining, Valsalva, and jarring
  o Female athletes with type I diabetes in running, cheerleading, gymnastics, ballet
    • May be at increased risk for Female Athlete Triad
      • Attempt to decrease weight by skipping or using less insulin
  o Performance enhancement may interfere with diabetes control
    • Unsafe diets
    • Nutritional supplements
    • Ergogenic aids
    • Illegal drugs/anabolic steroids

3. Benefits of exercise in persons with diabetes
  o Increased muscle mass, decreased body fat
  o Improved glycemic control
    • Decreased requirements for insulin therapy
  o Decreased cardiovascular risks
    • Increased HDL cholesterol
    • Decreased LDL cholesterol, triglycerides
    • Decreased blood pressure
  o Decreased risk of thrombosis
  o May enhance weight loss
  o Enhanced self-esteem, team work, skills mastery

Therapeutics: Type 1 Diabetes
1. Medications
  o Review types of insulin, doses, use of insulin pump

2. Guidelines for athletes/exercisers with diabetes
  o Pre-Participation Evaluation
    • Similar to pre-participation in other athletes
    • Assess diabetes knowledge and self care skills
      • Review blood sugar log/labs
      • Review episodes of hypoglycemia and DKA
      • Sick day plan
      • Treatment for hypoglycemia symptoms
        o Glucose tabs
        o Glucagon
      • Understand insulin onset and duration
      • Understand insulin pump
      • Understand carbohydrate counts
    • High risk sports for athletes with diabetes
      • Skydiving
      • Scuba diving
- Rock climbing
- Activities far from medical facilities
  - Obtain metabolic control before exercise
    - Exclude athlete from participation if:
      - Blood sugar >250 mg/dl with ketosis (via urine testing)
      - Blood sugar >300 mg/dl with or without ketosis
    - Delay an athlete from participation if
      - Blood sugar is <100 mg/dl
        - Blood sugar should be 150-180 mg/dl before participation
  - Blood glucose monitoring done before, during, and after exercise
    - Identify when changes needed in insulin
      - Decrease intermediate acting insulin by 30% on days of intense exercise
      - Do not use rapid acting insulin just before exercise
      - Insulin pump users
        - Should not give themselves a bolus infusion for the meal just prior to or just following exercise
        - May need to adjust basal insulin during and shortly after activity
      - Do not inject insulin into muscles that will be or have recently been exercised
        - Exercised muscle has increased insulin absorption
  - Food/fluid intake
    - Carbohydrates should be consumed to avoid hypoglycemia
      - Prior to exercise, 15-30 g for every 30 minutes of intense exercise
      - After exercise, consume carbohydrates within 30 minutes to avoid late onset hypoglycemia
    - Carbohydrates should be available to athlete during and after exercise
      - Glucose tablets
      - Carbohydrate rich foods (fresh fruits, bars)
    - Avoid dehydration
      - Athletes with diabetes are at high risk of dehydration
        - Elevated blood sugar causes increased sugar in the urine which leads to polyuria
      - Hydrate before, during, after exercise
        - Diluted fruit juices and sport drinks
  - Severe hypoglycemia
    - Oral glucose load 15-30 g of carbohydrate, if able
    - If unable to take oral glucose, glucagon should be administered 1 mg IM/SC
      - Follow with oral glucose load
      - Glucagon has short duration of activity
  - Additional nutritional recommendations
    - Calcium
      - Diabetes increases bone mineral loss
    - Chromium
      - May increase insulin sensitization
    - Zinc
      - Used in glucose metabolism
Antioxidants
- May minimize oxidative tissue damage

Pearls
- Avoid evening exercise
  - Increases risk of nocturnal hypoglycemia
- Remove pump for collision sports
  - Athlete may require subcutaneous injection of long-acting insulin on participation days
- Athletes with diabetes should wear medic alert tag while exercising
- Coaches, players, and parents should be trained in:
  - Signs/symptoms of hypoglycemia
  - Emergency treatment of hypoglycemia
  - Glucose monitoring

**Therapeutics: Type 2 Diabetes**
1. Review medication doses, use of insulin
2. Guidelines
   - Exercise recommended to persons with type 2 diabetes to control their blood sugar and decrease diabetic complications
     - Assists with insulin sensitization
     - Assists with glucose utilization at the tissue level
     - Decreases hepatic glucose production
     - Increases oxygen delivery to peripheral tissues
     - With consistent exercise, may be able to discontinue or decrease oral hypoglycemics/insulin
     - HgA1C improvement of 10-20% may be possible with exercise
     - Decreases risk of hypertension
     - Lowers lipids
     - Encourages weight loss/decreases body fat
   - Obtain metabolic control before exercise
     - Exclude athlete from participation if:
       - Blood sugar is >250 mg/dl with ketosis (urine testing)
       - Blood sugar is >300 mg/dl with/without ketosis
3. Type of exercise
   - Low to moderate aerobic activity 30-60 minutes 5 days or more per week
     - Goal energy expenditure of 1,000 kcal/week from aerobic activity
     - Intensity 40-70% of VO2 max
     - An RPE (rating of perceived exercise) scale can be used to monitor intensity of physical activity
   - Resistance training:
     - Build muscle mass
     - Increasing endurance
4. Avoid hypoglycemia
   - Less common in type 2 diabetes
   - Oral hypoglycemics (sulfonylureas) or insulin may need to be adjusted during exercise
5. Avoid dehydration
   o Difficult if blood sugar poorly controlled
     - Elevated blood sugar causes glucosuria/polyuria
   o Increase fluid intake before, during, after exercise

References

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