Impact of Exercise on Diabetes Management

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Objectives

- Understand how exercise improves health outcomes in diabetes
- Understand exercise impacts on physiology of diabetes
- Be able to discuss pre-exercise evaluation and impact on exercise prescription
- Know complications of exercise on glucose control
- Know guidelines for type I diabetics in exercise

Outline

- Benefits of exercise
- Pre-exercise evaluation
- Exercise prescription
- Exercise effects on hormones
- Avoiding hyperglycemia
- Avoiding hypoglycemia
- Insulin/nutrition
- References

Exercise Benefits

- 50-80% VO2 Max
- 4 days a week
- 30 – 60 min
- Overall rate reduction for CAD and diabetes
- Moderate intensity
  - at least 30 minutes per day,
  - most days of the week

Exercise Benefits

- Glucose intolerance
  - Decreases incidence of diabetes by 58%
  - 31% with metformin alone

NEJM 2001;344:1343-50

Exercise Benefits

- 20-30% reduction in HbA1c in Type II
- Decrease lipids
- Decrease blood pressure
- Weight loss and maintenance
- Reduce metabolic syndrome
- Reduce risk of CAD !!

Pre-exercise evaluation

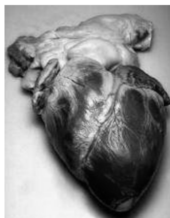
- Control
- CAD Risk factors
- Complications
  - Retinopathy
  - Neuropathy
  - Nephropathy

Control in Athletes

- Good control of blood sugars
  - HbA1c < 7.5%, not if >9.0
  - Measuring BS at least 4x/day, prefer 6x
  - Most BS are 80-180
- Know symptoms and what to do for
  - Hypoglycemia
  - Hyperglycemia
- Know how to adjust insulin/carbs before and after exercise
- Where inject insulin

ADA guidelines

- Age > 35
- Type II > 10 yrs
- Type I > 15 yrs
- 2 more CAD risk factors
- Retinopathy
- Nephropathy
- PVD
- Autonomic neuropathy



Handbook of Exercise in Diabetes 2002
Med Sci Sports Exer 1997;29:1-6

Pre-exercise evaluation

- Cardiac screening is controversial
- Decreased risk in DM of unexpected cardiac death who exercise
- 79% of perfusion abnormalities resolved 3 yrs with medical therapy
- If exercise treadmill +, poor prognosis
  - Don't know result of interventions

Clin Sports Med 2009;28:379-92
Diabetes Care 2007;30:2892-8

Pre-exercise evaluation

- Asymptomatic Type II with + adenosine stress compared with non screened
  - No reduction in cardiac events
- High risk Type II revascularization vs aggressive medical therapy
  - No difference in long term mortality

JAMA 2009;301:1547-55
NEJM 2009;360:2503-15

Who to do stress test?

- Low to moderate intensity, good control, not many risk factors
  - Start program
- Out of shape, starting program
  - Start low to moderate intensity
  - OR non-exercise imaging

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Clin Sports Med 2009;28:379-92

Who to do stress test?

- If moderate to high intensity exercise
- AND/OR ADA guideline risk factors
- Autonomic neuropathy
- PVD, retinopathy
- + EKG

  - Stress test
  - OR modify risk factors prior to exercise

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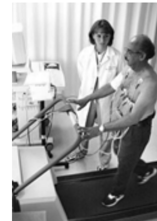
Clin Sports Med 2009;28:379-92

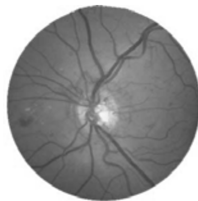
Exercise prescription

- After deciding or doing CAD screening
- Exercise prescription
  - Retinopathy
  - Neuropathy



Retinopathy

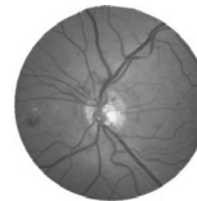
- Type I with severe diabetic retinopathy
- Type II, no CAD but microvascular dz
  - Reduced exercise capacity
  - Impaired cardiovascular response with exercise



Handbook of Exercise in Diabetes 2002

Retinopathy

- Moderate nonproliferative
  - Avoid what elevates BP
  - Power lifting
  - Valsalva maneuvers
- Severe nonproliferative
  - Limit systolic BP and jarring
  - Contact and competitive sports



Handbook of Exercise in Diabetes 2002

Proliferative Retinopathy

- Do's
  - Swimming
  - Walking
  - Low-impact aerobics
  - Cycling
- Don't
  - Pounding, jarring
  - Valsalva
  - Weight lifting
  - Jogging
  - High impact
  - Racquet sports
  - Brass instruments
  - Diving

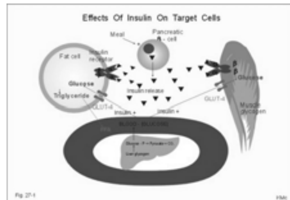
Handbook of Exercise in Diabetes 2002

Neuropathy

- Proper foot care
- Lower impact activities
  - Avoid blisters
  - Charcot joints
- Avoid treadmill, prolonged walking, jogging
- Do
  - Swimming, biking
  - Chair and arm exercises

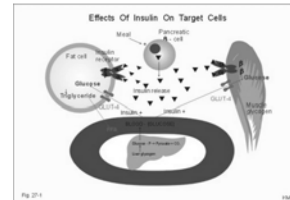
Exercise in non-diabetics

- Decreases insulin release
- Stimulates glucose transport into muscle
- Therefore, increase in insulin sensitivity



Exercise in non-diabetics

- Increases cortisol, catecholamines
- Increases glucagon
- Free fatty acids and liver glycogen to be mobilized for energy



Exercise Type II

- Exercise reverses deficits in metabolism
- ↓ Basal insulin
- ↓ HbA1c
- ↓ Basal glucose
- ↓ Liver glucose production
- ↑ Insulin stimulated glucose uptake
- ↑ GLUT4 receptors
- ↑ Insulin sensitivity
- ↓ Cholesterol, triglycerides

GSSI #90 2003;16(3)

Exercise Type I

- Insulin doesn't decrease due to exogenous insulin
- Under-insulinization
- Over-insulinization
- Decrease glycogen storage recovery

Hyperglycemia

- Under-insulinization
- BS increases with exercise
- Excessive counter-insulin hormones
  - Increases liver glucose release
- Prolonged exercise
  - Mobilization of fatty acids
  - Ketones and DKA
- Post exercise hyperglycemia
  - lack of increase in post exercise insulin

GSSI #90 2003;16(3)
Med Sci Sports Exerc 1997;29(12):1-6
Handbook of Exercise in Diabetes 2002

Hyperglycemia

- Illness
  - Avoid exercise when sick
- Injury

Hyperglycemia

- High intensity exercise
  - May increase BS
  - Temporary from glucagon and catecholamines
  - Transient then fall
  - Don't treat it with insulin

Clin Sports Med 2009;28:479-95

Guidelines for Type I

- If BS < 80-100,
  - eat extra carbohydrate prior to exercise, recheck in 30 minutes.
- If BS 100-200, goal
- If BS >250,
  - Check urine ketones, if + no exercise
- If BS > 300,
  - Don't workout, wait until under control

GSSI #90 2003;16(3)
Clin Sports Med 2009;28:479-95
Pediatric Diabetes 2006;7:60-70

Hypoglycemia

- Over-insulinization
  - Insulin doesn't decrease with exercise
  - Suppresses glucagon
  - Prevents mobilization of glucose from liver and FFA
  - Increased muscle sensitivity
- Accelerated insulin absorption

GSSI #90 2003;16(3)
Clin Sports Med 2009;28:479-95
Handbook of Exercise in Diabetes 2002

Hypoglycemia

- Impaired counter regulation
- Autonomic neuropathy
  - Decrease in epinephrine, norepinephrine
- Hypoglycemic episode
  - Blunts response to subsequent hypoglycemia
  - More likely to have another event
  - Post exercise hypoglycemia can cause next day hypoglycemia with exercise

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Pediatric Diabetes 2006;7:60-70

Hypoglycemia

- Late-onset Post-exercise hypoglycemia
- 2 hrs and 18 hrs after
  - Can be 30 hrs after
- Careful with night time hypoglycemia
- Especially late afternoon or evening workouts

Clin Sports Med 2009;28:479-95

Hypoglycemia

- Late-onset Post-exercise hypoglycemia
- Glucose uptake to restore glycogen
- Increased insulin sensitivity
- Blunted glucoregulatory response

Clin Sports Med 2009;28:479-95
triabeticdave.blogspot.com

Hypoglycemia Type II

- Not as common in Type II
- Unless
  - Insulin
  - Sulfonylureas
- Metformin not a problem

How to avoid hypoglycemia

- Decrease insulin
- Nutrition
  - Increase carbohydrates
- Know where to inject

Insulin changes

- Decrease pre-exercise meal insulin by 30-50%
- Decrease basal insulin by 30-50%
- Prolonged exercise by 80%
- Increase in insulin sensitivity, adjust insulin:BS
- Don't use insulin for pre-exercise carbs or carbs during exercise
- Avoid exercise during peak insulin levels

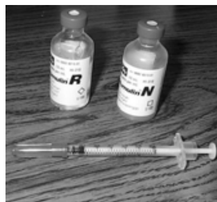
Clin Sports Med 2009;28:479-95
Handbook of Exercise in Diabetes 2002

Insulin Pump

- Decrease rate by 50% 1 hour before
- Up to 80% decrease in rate
- Sweat can dislodge
- Can disconnect 30 minutes prior to event
- Effects last 60 minutes
- Check BS for 30-60 min of exercise

Insulin changes

- Due to stress, change with competition
- Individualize treatment
  - Intensity and duration
  - Frequent BS checks and record
  - Trial and error
  - See patterns and adjust



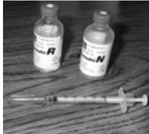
GSSI #90 2003;16(3):1-6

Post exercise hypoglycemia

- Decreased glycogen recovery
- Diabetic athletes don't recover as quickly
- 30-40g carbs/30 min intense exercise
- Need insulin to restore glycogen stores
- Restoration of glycogen stores normalizes insulin sensitivity
- Bedtime snacks

Injection site

- Know where to inject-
  - Don't inject in working muscle
  - Heat increases absorption
  - Cold decreases absorption
  - Massage increases absorption
- Insulin storage between 40-80 degrees



Curr Sports Med Reports 2006;5:92-98
J Athletic Training 2007;42(4):536-45

Nutrition

- 60% carbs daily, 6-10g/kg body wght
- Time with exercise and insulin
- 200-350g carbs 3-6 hr before exercise
- 1g/kg body wght 1 hr before exercise
- 15g 15-30 min before
- Likely don't need insulin 1 hour before
- Crackers, muffins, toast, yogurt, breads, pancakes, fruit

Clin Sports Med 2009;28:479-95
GSSI #90 2003;16(3)
Curr Sports Med Reports 2006;5:93-8

Nutrition

- During exercise
  - 15g carbs every 30-60 min
  - Liquid better like sports drinks
- If intense exercise over 1 hr/day
  - May need 5-6g/kg body weight
- Don't need insulin with this

Clin Sports Med 2009;28:479-95
GSSI #90 2003;16(3)
Curr Sports Med Reports 2006;5:93-8

Nutrition

- Post exercise
  - 30-40g carbs/30 min intense exercise
  - 1.5g/kg 30 min after and 1-2 hrs later
  - Decreases Late-onset post-exercise hypoglycemia
  - Restores glycogen
  - Milk, high starchy foods, low glycemic index
  - Bedtime snacks to avoid night time hypoglycemia

Conclusion

- Exercise is Medicine
- Cardiac screening is controversial
- Optimize risk factors with medical management
- With exercise
  - Insulin decreases
  - Glucagon increases
  - Insulin sensitivity increases

Conclusion

- Good control of blood sugars
  - HbA1c < 7.5%, not if >9.0
  - Measuring BS at least 4x/day, prefer 6x
- Know symptoms and what to do for
  - Hyperglycemia
  - Hypoglycemia
- Decrease insulin with exercise
- Extra carbs before and after exercise
- Where inject insulin

Conclusion

- Individualize treatment
- Follow patterns for duration and intensity
- Make adjustments as necessary

References

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