

당뇨병 환자의 운동

Exercise in Diabetes Mellitus

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Abstract

Exercise and diet control are essential for the management of diabetes mellitus. Beneficial effects of exercise have been established. Exercises improve the control of glucose level, decrease cardiac risk factors and prevent type 2 diabetes mellitus. Exercise can cause hypoglycemia or hyperglycemia, cardiac attack, dehydration, foot problems and aggravation of diabetic complications. Pre - exercise medical evaluation is needed to prevent the unwanted effect of exercise. Diabetic patients who have ketonuria and high blood glucose level(more than 250mg/dL) should postpone exercise until the problems are solved. Diabetic patients should enjoy their activities and do warming up and cool down exercise. Vigorous aerobic exercise, 60~85% of maximal oxygen uptake, 20~60 minutes at a time, 3~5 times a week is recommended. Moderate aerobic exercise, 40~60% of maximal oxygen uptake, more than 30 minutes at a time, over 5 times a week is also recommended instead. Muscle strengthening exercises, 2~3 times a week should be added. To prevent hypoglycemia during exercise, the dose of insulin should be reduced. If the patient suffer from hypoglycemic symptom, he or she should take glucose immediately. Therefore diabetic patients should carry some simple carbohydrates. To prevent dehydration during exercise, proper hydration and clothes must be prepared. Wearing well fitting shoes, frequent check up for any wounds on foot are needed to prevent diabetic foot complications. Diabetic patients have the rights to have good quality of life. Regular proper exercise could improve their quality of life.

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1. 2

1)

(2).

1997

Keywords : Diabetes Mellitus; Exercise; Aerobic exercise; Hypoglycemia; Dehydration

(3~5).

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4)

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1. Lower blood glucose concentrations during and after exercise
 2. Lower basal and postprandial insulin concentrations
 3. Improve insulin sensitivity
 4. Lower glycated hemoglobin levels(type 2)
 5. Improve lipid profile :
Decrease triglyceride. Slightly decrease low - density lipoprotein cholesterol
Increase high - density lipoprotein cholesterol
 6. Improvement in mild - to - moderate hypertension
 7. Increase energy expenditure :
Adjunct to diet for weight reduction. Increased fat loss. Preservation of lean body mass.
 8. Cardiovascular conditioning
 9. Increase strength and flexibility
 10. Improve sense of well - being and quality of life
-

5) (Fibrinolysis)

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2

plasminogen activator inhibitor - 1

. Plasminogen activator

2)

inhibitor - 1 tissue plasminogen activator(TPA)

2

가

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, 가) 6)

가

가 7) 2

가가

2

(6).

3)

2

triglyceride - rich VLDL (7~11).

. 2

가

2

HDL

. VLDL HDL

HDL

가

48

48

가 (12).

가 (15).

2. 1

(macrovascular disease)

가 ,

1 (13).

가 (glycogen syn-

thetase)가 가

(A1c)

가 1

1

6~15

24

(14).

가

1

2

10%가

50%

50%가

100%

100%가

(glycogenolysis)

가

2.

1. Hypoglycemia, if treated with insulin or oral agents

- Exercise induced hypoglycemia

- Late - onset postexercise hypoglycemia

2. Hyperglycemia after very strenuous exercise

3. Hyperglycemia and ketosis in insulin - deficient patients

4. Precipitation or exacerbation of cardiovascular disease

- Angina pectoris, Myocardial infarction, Arrhythmias, Sudden death

5. Worsening of long - term complications of diabetes mellitus

- Proliferative retinopathy : Vitreous hemorrhage, Retinal detachment

- Nephropathy : Increased proteinuria

- Peripheral neuropathy : Soft tissue and joint injuries

- Autonomic neuropathy : Decreased cardiovascular response to exercise. Decreased maximum aerobic capacity. Impaired response to dehydration. Postural hypotension.

가

10

10%

가

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UKPDS

(www.dtu.ox.ac.uk/

1.

riskengine /download.htm)

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가

가

(5).

> 40 (

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2.

> 30

* 10

(dyslipidemia),

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3.

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1)

(AACE)

40

3.

Level of DR	Acceptable activity	Discouraged activity	Ocular reevaluation
No DR	Dictated by medical status	Dictated by medical status	12 months
Mild NPDR	Dictated by medical status	Dictated by medical status	6-12 months
Moderate NPDR	Dictated by medical status	Activities that dramatically elevate blood pressure (Power lifting, Heavy Valsalva)	4-6 months
Severe NPDR	Dictated by medical status	Activities that substantially increase systolic blood pressure, Valsalva maneuvers and active jarring (Boxing, Heavy competitive sports)	2-4 months (may require laser surgery)
PDR	Low impact, cardiovascular conditioning(Swimming, Walking, Low - impact aerobics, Stationary cycling, Endurance exercises)	Strenuous activities, Valsalva maneuvers pounding or jarring (Weight lifting, Jogging, High - impact aerobics, Racquet sports, strenuous trumpet playing)	1-2 months (may require laser surgery)

DR: diabetic retinopathy

NPDR: nonproliferative diabetic retinopathy

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2)

(16).

ST - T 가 가 .
 (radionuclide stress testing) . (dorsalis pedis artery, tibialis posterior artery) (fore-foot) 가
 60% 가 (doppler pressure)

3)

(exercise ischemic threshold) 가
 (strenuous exercise) vitreous hemorrhage traction retinal detachment가

()
 가
 (가,)
 가
 4)

4.

Contraindicated exercise	Recommended exercise
Treadmill	Swimming
Prolonged walking	Bicycling
Walking on uneven surface	Arm exercises
Jogging	Rowing
Step exercises	Chair exercises
	Other non - weight - bearing exercises

thallium myocardial scintigraphy가

5)

monofilament

, 5.07(10g) monofilament

가 (low impact)

(4).

250mg/dL

6)

300mg/dL

(100)

(20mmHg)

5.

Long - Term Contraindications(exercise adjustment required)

- * Autonomic neuropathy with orthostatic hypotension after exercise in upright position - bicycling and swimming are OK, but running and hiking should be avoided.
- * Severe peripheral neuropathy of the feet, which could lead to Charcot's degenerative joint disease in the lower extremity with weight - bearing exercises.
- * Retinopathy - anaerobic exercise involving sudden stress must be avoided.

1.

Temporary Contraindications(correction of condition required)

- * Blood glucose level 300 mg/dl
- * Ketonuria > 36 mg/dl or level of beta - hydroxybutyric acid > 9 mg/dl
- * Hypoglycemia before exercise
- * Dehydration

30

3

20

300mg/dL

가

5

가

가

가

5~10

가

가

(5).

3

8~10

5~10

8~10 3

가

가

6. (60)

Intensity	Relative intensity		
	VO _{2max} (%)	Maximal heart rate(%)	RPE*
Very light	< 20	< 35	< 10()
Light	20~39	35~54	10~11()
Moderate	40~59	55~69	12~13()
Hard	60~84	70~89	14~16()
Very hard	> 85	> 90	17~19()
Maximal	100	100	20()

40~60%
55~70% 150
(30 5)
(Rate of perceived exertion, RPE)
RPE 12~13
40~60% (6).

RPE: Borg rating of relative perceived exertion

(5).

3.

5~10 , 20~60
5~10 .

4.

3 ,

가

5 .

가 가 .

5. 가

2.

60~85%가

3

, 2~4

180mmHg

가 .

70~90%

, 7

「220 -」

30

5 ,

가

가 ,

2

(IGT)

150

7. (19)

100mg/dL
가 10~15
60~85% 70~90%
20~60 5~10 가
: (), 3~5 ()
:1 2~3 ()
(metformin, - glucosidase inhibitors, thiazolidinediones)

()

1.

30 15~30g

가 , 가

가 , 가 1

가 , 가

100mg/dl 15~30g

60~120kcal

가 2~3

가 ty) 가
. 가

가
,
, (callus)
,
가
가

2.

가 가 가
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2 500cc , 30
1~2 , 15
29 , 70%
30

가 가
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가 가
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가 가
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3.

가 가
4
가

foot Charcot (deformi-

가

가 ()

가 가

가

가

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