

# Type 2 Diabetes and Exercise: The Importance of Screening

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## A B S T R A C T

### OBJECTIVE

To illustrate the importance of screening patients with type 2 diabetes prior to a supervised exercise program.

### METHODS

The patient was given a Medical Profile Test (MPT), which included a modified Bruce Protocol multi-stage exercise test (MSET), a 12-lead electrocardiogram (ECG) and a risk factor assessment.

### RESULTS AND COMMENTS

A significant ECG abnormality was observed during the MSET. A 5-year survival value of 0.70 and average annual mortality of 6% were obtained with the Duke nomogram. Using the Framingham Point Scores, a 10-year risk for coronary heart disease (CHD) of 25% was calculated. The patient was referred for coronary angiography, which revealed significant 3-vessel disease requiring a quintuple coronary artery bypass graft (CABG).

### CONCLUSION

This report underlines the importance of appropriate and careful screening for patients with diabetes prior to their participation in a supervised exercise program. Failure to do so with this patient would likely have placed him in great peril.

## R É S U M É

### OBJECTIF

Faire ressortir qu'il est important d'évaluer les patients atteints de diabète de type 2 avant qu'ils entreprennent un programme d'exercices supervisé.

### MÉTHODE

Le profil du patient a été établi au moyen d'une épreuve d'effort modifiée en plusieurs étapes de Bruce, d'un électrocardiogramme à 12 dérivation et d'une évaluation des facteurs de risque.

### RÉSULTATS ET COMMENTAIRES

Une importante anomalie de l'électrocardiogramme a été observée au cours de l'épreuve d'effort. Le nomogramme de Duke a révélé une survie après 5 ans de 0,70 et un taux annuel moyen de mortalité de 6 %. Au moyen du score de l'échelle de Framingham, on a calculé un risque de 25 % de maladie coronarienne après 10 ans. Une coronarographie a mis en évidence une grave affection touchant trois vaisseaux et nécessitant un quintuple pontage aortocoronarien par greffe.

### CONCLUSION

Ce compte rendu souligne l'importance de l'évaluation convenable et consciencieuse des patients atteints de diabète avant le début d'un programme d'exercices supervisé. À défaut d'évaluation, ce patient aurait probablement été exposé à un grave danger.

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## INTRODUCTION

Current opinion holds that a comprehensive program of exercise should be an integral part of patient care, and that low cardiorespiratory fitness and physical inactivity are independent predictors of all-cause mortality in type 2 diabetes mellitus (1). Intervention studies in the United States (US) (2), Sweden (3), China (4) and Finland (5) have also convincingly demonstrated that regular physical activity, either alone or combined with other strategies, can delay or prevent type 2 diabetes and related complications in high-risk subjects. Table 1 lists some of the substantial benefits that may contribute to these favourable clinical outcomes (6-9).

Physical activity and related lifestyle interventions can significantly reduce premature all-cause mortality and disability, improve quality of life and increase chances for longevity in the population at large (10), and would be presumed to benefit patients with diabetes as well. In a recent editorial on the role of physical fitness in managing patients with diabetes, Clark (11) commented: "The data supporting the health benefits of physical activity are overwhelming. We must move from demanding more data to learning how to apply what we already know."

Exercise, however, is not without risks (7), and patients with diabetes should be screened carefully for existing macro- and microvascular complications prior to beginning an exercise program. A thorough medical history and physical examination, which focusses on signs and symptoms of diseases affecting the cardiovascular system, eyes, kidneys and nervous system, should be part of the pre-participation medical profile. A graded exercise test may prove useful for some patients (Table 2). Absolute contraindications to exercise participation include severe hyperglycemia, ketosis,

recent significant electrocardiographic changes, unstable angina pectoris, uncontrolled cardiac arrhythmias causing hemodynamic compromise, untreated high-risk proliferative retinopathy and retinal hemorrhage (7-9,11-13).

Comorbid conditions, such as hypertension, dyslipidemia, retinopathy, renal disorders, peripheral and autonomic neuropathy, previous myocardial infarction (MI) and a history of revascularization procedures, are commonly observed in patients with type 2 diabetes. It is also not uncommon for these patients to have occult ischemic heart disease relative to cardiac autonomic neuropathy (CAN) and silent myocardial ischemia.

**Table 1. Benefits of exercise for patients with type 2 diabetes (6-9)**

- Improved insulin sensitivity
- Decreased cardiovascular risk factors
- Enhanced fibrinolysis
- Improved psychological status
- Increased muscle mass, reduced body fat
- Improved glycemic control

**Table 2. Characteristics of patients with type 2 diabetes who may benefit from exercise testing before beginning exercise (7-9,11-13)**

- Age >35 years
- Type 2 diabetes >10 years' duration
- Known or suspected cardiovascular disease (CVD)
- CVD risk factors
- Presence of microvascular disease
- Autonomic neuropathy with incompetence

**Table 3. Lipid profiles: 65-year-old male with type 2 diabetes and PVD**

| Variable        | Baseline | 1 year | 2 years* | 3 years | 4 years |
|-----------------|----------|--------|----------|---------|---------|
| TSC (mmol/L)    | 4.73     | 5.07   | 4.45     | 3.83    | 3.57    |
| STG (mmol/L)    | 1.63     | 1.29   | 1.31     | 1.10    | 1.05    |
| HDL-C (mmol/L)  | 0.80     | 0.85   | 0.83     | 1.01    | 0.93    |
| VLDL-C (mmol/L) | 0.75     | 0.59   | 0.59     | 0.49    | 0.49    |
| LDL-C (mmol/L)  | 3.18     | 3.62   | 3.03     | 2.33    | 2.15    |
| TSC/HDL         | 5.9      | 6.0    | 5.4      | 3.8     | 3.8     |
| LDL/HDL         | 4.0      | 4.3    | 3.7      | 2.3     | 2.3     |

Lipid values have been established by the National Cholesterol Education Program (NCEP) (15).

\*Lovastatin was initiated following this test (20 mg QD, titrated to 40 mg QD)

HDL-C = high-density lipoprotein cholesterol

LDL-C = low-density lipoprotein cholesterol

PVD = peripheral vascular disease

STG = serum triglycerides

TSC = total serum cholesterol

VLDL-C = very low-density lipoprotein cholesterol

They may be asymptomatic, even during a conventional multi-stage exercise test (MSET), in the presence of significant ischemia observed on the electrocardiogram (ECG). Not surprisingly, sudden death has been associated with CAN in such patients (9). This paper considers a patient screened prior to entering the Diabetes Exercise Center program at Marshall University, Huntington, West Virginia, US.

## THE PATIENT

A 65-year-old white male was referred by his primary care physician for supervised exercise to assist him in the management of his type 2 diabetes, diagnosed 15 years prior. He presented with peripheral vascular disease (PVD), requiring previous bilateral angioplasty of the lower extremities and a left carotid bruit with no neck vein distention, but no history of stroke or transient ischemic attack (TIA).

The patient's family history is remarkable for cardiovascular disease (CVD) and diabetes. He is a nonsmoker and reports social alcohol consumption. His hypertension is treated with felodipine (10 mg BID, titrated to 10 mg QD). Other medications include acetylsalicylic acid (ASA) (325 mg QD), cilostazol (100 mg QD) and glipizide (10 mg BID). A lipid abnormality

characterized by a low high-density lipoprotein cholesterol (HDL-C) fraction is treated with lovastatin (40 mg QD). He exercised infrequently in the past with a stationary bike and walking.

## METHODS

Prior to beginning his program, the patient was given a Medical Profile Test (MPT). The MPT included a detailed history, physical examination, lipid profile, related bloodwork, anthropometric measures, coronary risk factor assessment, and an MSET utilizing a modified Bruce Protocol for treadmill exercise (14). Twelve-lead ECG tracings, along with heart rate, blood pressure and ratings of perceived exertion, were obtained for each MSET workload. MPT findings permit careful patient screening and risk factor management as well as development of the exercise prescription.

## RESULTS

The patient is a nonsmoker with a body mass index (BMI) of 23. As seen in Table 3, his baseline total serum cholesterol (TSC) of 4.73 mmol/L is classified as desirable, but his HDL-C (0.80 mmol/L) is low (15). Table 4 shows both his

| Variable                                | Baseline | 2 years | 3 years | 4 years |
|---|----------|---------|---------|---------|
| HbA <sub>1c</sub> (%) (Goal: <0.07) (9) | 0.078    | 0.085   | 0.088   | 0.069   |
| FPG (mmol/L) (Goal: 5.0–7.2) (9)        | 14.2     | 9.9     | 6.7     | 5.1     |

FPG = fasting plasma glucose

PVD = peripheral vascular disease

|                               |   |
|-------------------------------|---|
| <b>Heart rate (bpm)</b>       |   |
| Resting . . . . .             | 62  |
| Peak . . . . .                | 127   |
| Post . . . . .                | 82  |
| <b>Blood pressure (mm Hg)</b> |   |
| Resting . . . . .             | 148/82  |
| Peak . . . . .                | 204/96  |
| Post . . . . .                | 180/88  |
| <b>Stopping codes</b>         | <ul style="list-style-type: none"> <li>• Significant contour changes (4 mm) and silent ischemia</li> <li>• Contraindication and referral</li> </ul>   |
| <b>Clinical outcome</b>       | <ul style="list-style-type: none"> <li>• Positive angiogram</li> <li>• CABG x 5</li> </ul>  |
| <b>Medications</b>            | <ul style="list-style-type: none"> <li>• Felodipine 10 mg QD</li> <li>• Glipizide 10 mg BID</li> <li>• Lovastatin 40 mg QD</li> <li>• Cilostazol 100 mg QD</li> <li>• ASA 325mg QD</li> </ul> |

ASA = acetylsalicylic acid

CABG = coronary artery bypass graft

MSET = multi-stage exercise test

PVD = peripheral vascular disease

fasting plasma glucose (FPG) (14.2 mmol/L) and HbA<sub>1c</sub> (0.078%) to be above normal at baseline.

This patient reported no angina during his MSET, but demonstrated strikingly positive ECG contour changes in the inferior, anterior and lateral leads. A 4 mm ST segment depression was observed at peak exercise. The patient completed 13.5 minutes on the test, achieving a functional capacity of 7 metabolic equivalent units (METS) or 24.5 mL O<sub>2</sub>/kg/min. His peak double product (peak blood pressure x peak heart rate) was 25 908.

During recovery, 4 premature ventricular contractions (PVCs) were noted, but the test was completed without incident (Table 5).

The Duke nomogram (16) was used to assist in establishing this patient's prognosis with the MSET results. Accordingly, a 5-year survival value of 0.70 and an average annual mortality of 6% were computed. A risk assessment to determine 10-year risk for developing coronary heart disease (CHD) was also calculated using Framingham Point Scores (15). This patient's calculated 10-year risk score was 25%.

## DISCUSSION

The American College of Cardiology/American Heart Association (17) guidelines state that patients with a strongly positive test or a predicted average annual cardiac mortality  $\geq 4\%$  should be considered at high risk and should usually be referred for cardiac catheterization. The high Framingham CHD risk score in this patient confirmed this finding. Accordingly, the patient was referred for coronary angiography and significant 3-vessel coronary artery disease (CAD) was observed. A successful quintuple coronary artery bypass graft (CABG) was completed within 3 weeks of the positive MSET. The patient's recovery was uneventful.

The high Framingham Point Score, dyslipidemia and elevated HbA<sub>1c</sub> indicated the need for vigorous lifestyle intervention. Thus, the patient was enrolled in our Cardiac Rehabilitation Program and has participated actively for 4 years. The values in Table 3 reflect improved glycemic status and better clinical control of his diabetes. The addition of lovastatin has improved his lipid profile (Table 4). He has made a lifetime commitment to his new lifestyle and maintains excellent compliance with his risk factor management strategies as well as his nutritional, medication and exercise regimens.

## CONCLUSION

This patient presented with CAN and occult ischemic heart disease. His case underlines the importance of screening patients with diabetes before they initiate a supervised exercise program. Dyslipidemia and poor plasma glucose (PG) control comparable to that observed in this patient are strongly predictive of CHD in patients with type 2 diabetes (15). The positive MSET and subsequent coronary angiography provided strong clinical documentation of CHD.

Failure to carefully screen this patient would likely have resulted in serious consequences. Undiagnosed, his cardiac status presented a high probability of premature sudden cardiac death, especially during exertion, even in the presence of close supervision. Careful screening permitted him to establish a new lifestyle and his commitment in the ensuing 4 years may have reduced his chances of premature morbidity and mortality. Time will tell.

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