



Very-Low-Calorie Diet Increases Myocardial Triglyceride Content and Decreases Diastolic Left Ventricular Function in Type 2 Diabetes With Cardiac Complications

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Jacqueline T. Jonker,^{1,2}
Roxana Djaberi,³ Linda D. van
Schinkel,^{1,2} Sebastiaan Hammer,²
Mieke T.J. Bus,¹ Gijs Kerpershoek,¹
Aan V. Kharagjitsingh,^{1,4} Johannes
A. Romijn,⁵ Jeroen J. Bax,³
J. Wouter Jukema,³ Albert de Roos,²
Johannes W.A. Smit,⁶
and Hildo J. Lamb²

In healthy subjects and patients with uncomplicated type 2 diabetes, short-term very-low-calorie diet (VLCD) increases myocardial triglyceride (TG) content and decreases diastolic cardiac function (1). We hypothesized that in diabetic patients with cardiac complications, the adaptive capacity of the heart to adjust myocardial TG content, depending on the metabolic context, is diminished or lost. We aimed to assess the effects of a short-term VLCD in type 2 diabetic patients with cardiac complications on myocardial TG content and cardiac function.

Therefore, 14 type 2 diabetic patients were included in this study (7 men, mean age 57 ± 3 years, 10 insulin users). Cardiac complications were defined as 1) obstructive coronary artery disease on multislice computed tomography angiography ($\geq 50\%$ luminal narrowing) and/or 2) myocardial perfusion defect on single photon emission computed tomography (summed stress score ≥ 3) (2). Exclusion criteria were age < 18 years, thiazolidinedione use, congenital cardiac disease, or contraindications for magnetic resonance imaging. Written informed consent was obtained from all patients. This study was approved by the medical ethics committee of the

Leiden University Medical Center and performed according to the Declaration of Helsinki.

Patients were studied on two separate study days. Three days before the first study day, patients used their regular diet. The second study day was after a 3-day VLCD (471 kcal/day, Modifast Intensive; Nutrition & Santé Benelux, Vilvorde, Belgium). Glucose-lowering therapy was adjusted during the VLCD to maintain comparable glucose levels before both study days. The acquisition and postprocessing of myocardial and hepatic proton spectroscopy, magnetic resonance imaging of the heart and abdominal fat, and the assays used for the biochemical parameters have previously been described (1,3,4).

For statistical analysis, within-group changes were assessed using paired sample *t* tests and nonparametric tests for normally and nonnormally distributed variables, respectively, using SPSS (version 17.0; SPSS, Chicago, IL). Data are expressed as means \pm SE or, if nonnormally distributed, as median (interquartile range). $P < 0.05$ was considered statistically significant.

Of the 14 included type 2 diabetic patients, 6 had coronary artery disease

on computed tomography angiography and 11 had myocardial perfusion defects, of whom 3 had both. Table 1 shows all parameters at baseline and after the VLCD.

Plasma nonesterified fatty acid (NEFA) levels increased significantly after the VLCD compared with baseline. Myocardial TG increased by $\sim 30\%$ after the 3-day VLCD (baseline: 0.66 ± 0.08 to $0.89 \pm 0.08\%$, $P = 0.021$). The other measured fat compartments did not significantly change (Table 1).

Several parameters of diastolic heart function decreased after the 3-day VLCD (Table 1). Main parameters are the E/A ratio (early diastolic filling phase/diastolic atrial contraction) (1.03 ± 0.06 to 0.92 ± 0.06 , $P = 0.004$) and E deceleration peak (3.1 ± 0.2 to 2.4 ± 0.2 mL/s² $\cdot 10^{-3}$, $P < 0.001$), whereas estimated filling pressures remained unchanged after the 3-day VLCD.

In conclusion, the current study in type 2 diabetic patients with cardiac complications shows that only 3 days of VLCD increased plasma NEFA levels and myocardial TG content considerably, associated with a decrease in diastolic cardiac function. The observations suggest that type 2 diabetic patients

¹Department of Endocrinology and Metabolism, Leiden University Medical Center, Leiden, the Netherlands

²Department of Radiology, Leiden University Medical Center, Leiden, the Netherlands

³Department of Cardiology, Leiden University Medical Center, Leiden, the Netherlands

⁴Department of Internal Medicine, Medical Center Haaglanden Westeinde, The Hague, the Netherlands

⁵Department of Internal Medicine, Academic Medical Center, Amsterdam, the Netherlands

⁶University Medical Center Nijmegen, Nijmegen, the Netherlands

Corresponding author: Jacqueline T. Jonker, j.t.jonker@lumc.nl, or Hildo J. Lamb, h.j.lamb@lumc.nl.

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Table 1—Biochemical parameters, fat distribution, and cardiac dimensions at baseline and after a 3-day VLCD in 14 patients with type 2 diabetes

	Baseline	VLCD
BMI (kg/m ²)	28.9 ± 1.1	28.0 ± 1.0*
Biochemical parameters (mmol/L)		
Glucose	8.3 ± 1.0	7.3 ± 0.6
Total cholesterol	3.8 ± 0.3	3.7 ± 0.2
TG	1.30 (0.95–2.32)	1.11 (0.99–1.85)
NEFA	0.63 ± 0.08	1.22 ± 0.08*
Fat distribution		
Myocardial TG content (%)	0.66 ± 0.08	0.89 ± 0.08*
Hepatic TG content (%), <i>n</i> = 12	3.1 (1.5–6.3)	2.8 (1.4–7.1)
Visceral abdominal fat (mL)	359 ± 50	321 ± 40
Subcutaneous abdominal fat (mL)	810 ± 89	808 ± 72
Pericardial fat (mL)	11.9 ± 1.6	11.7 ± 1.4
Cardiac dimensions and function		
LV mass index (g/m ²)	42 ± 2	41 ± 1
LVEDV (mL)	149 ± 6	134 ± 6*
LVEDVI (mL/m ²)	75 ± 2	69 ± 2*
LV mass/EDV	0.57 ± 0.02	0.61 ± 0.03*
LVEDV (mL)	66 ± 4	56 ± 3*
LVESVI (mL/m ²)	33 ± 1	29 ± 1*
Cardiac index (L/min/m ²)	2.6 ± 0.1	2.6 ± 0.1
E deceleration peak (mL/s ² · 10 ^{−3})	3.1 ± 0.2	2.4 ± 0.2*
E/A peak flow	1.03 ± 0.06	0.92 ± 0.06*
E/Ea	9.5 ± 1.0	8.0 ± 0.7

Data are means ± SEM. E/Ea, estimate of left ventricular filling pressure; ESV, end systolic volume; LV, left ventricular; LVEDV, LV end diastolic volume; LVEDVI, LVEDV index; LVESVI, LV end systolic volume index. **P* < 0.05 vs. baseline.

with cardiac complications have preserved flexibility of myocardial TG stores, at least in response to short-term caloric restriction.

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of data and drafting of the manuscript. R.D. contributed to interpretation of data and drafting of the manuscript. L.D.v.S. contributed to conception and design of data and revision of the manuscript. S.H. contributed to conception, design, and interpretation of data and drafting of the manuscript. M.T.J.B. and G.K. contributed to analysis and interpretation of data, and revision of the manuscript. A.V.K., J.A.R., J.J.B., J.W.J., and A.d.R. contributed to conception and design of data and revision of the manuscript. J.W.A.S. contributed to conception, design, and interpretation of data and revision of the manuscript. H.J.L. contributed to conception, design, analysis, and interpretation of data and drafting of the manuscript. J.T.J. is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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