Insulin sensitivity and substrate utilization in obese subjects

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Background

Obesity is often associated with insulin resistance (IR), though 30 % of the obese Caucasian population is not affected (3). IR elevates health risk (4), especially for cardiovascular diseases (1), while obese people without IR suffer from lot of other adverse effects on health (2). IR-induced changes in substrate utilization (SU) may also have consequences for diet recommendations (5).

Purpose

To investigate whole-body SU in obese subjects with different insulin sensitivity (IS) non-invasively in the fasted, fed and exercising state by means of indirect calorimetry (IC).

Subjects and methods

10 pairs of obese (BMI > 30 kg·m^{-2}), non-diabetic subjects with largely different IS were matched by their sex and BMI. IS was determined by oral glucose tolerance testing (OGTT, 75 g glucose diluted in 300 ml of water), measurement of serum insulin concentration (Chemiluminescence-assay by DPC – Biermann, Germany) and calculation of area under the curve for insulin (6). Energy expenditure and SU were measured by indirect calorimetry (Cortex device, Leipzig, Germany, Meta Max Software, Version 3.5, Cortex) (7) under the following conditions:

- at rest and during cycling (run-in measurements, no statistical evaluation)
- at rest after one week of isocaloric nutrition (energy expenditure was calculated from resting energy expenditure measurement plus thermogenic effect of food plus estimated energy expenditure for spontaneous and non-spontaneous physical activity, patient received nutritional counseling to maintain a diet with 50 % carbohydrates, 20 % protein and 30 % fat)
- at rest 60 min after an OGTT
- during exhaustive incremental cycle ergometry 2 hours after the OGTT, beginning with 50 or 100 Watts, stepwise elevation every 3 minutes by 25 Watts resp. 50 Watts, depending on physical fitness and health status, the matched pairs followed an identical ergometry protocol

Results

Fasting and post-OGTT respiratory exchange ratio (RER) showed no difference between IR and IS subjects (0.84±0.06 vs. 0.85±0.03, p=0.68; 0.93±0.04 vs. 0.92±0.05, p=0.37, respectively). During graded exercise, RER was significantly different between groups starting from the 2nd stage (see figure). This was probably due to a non-significantly different endurance capacity between groups (VO_{2max} 24±6 for IR vs. 26±7 ml·min·kg^{-1} for IS), i.e. a lower fitness level of IR.

Anthropometric data (mean ± SD)

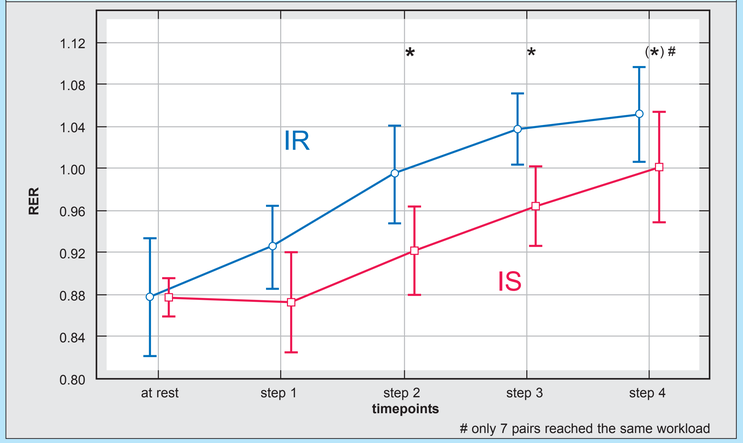
	Total (N=20)	IS (N=10)	IR (N=10)	Difference P
Age [years]	44.7 ± 12.0	38.1 ± 13.2	51.3 ± 6.0	0.04
Height [m]	1.73 ± 0.10	1.76 ± 0.10	1.70 ± 0.11	0.04
Weight [kg]	111.6 ± 25.1	116.2 ± 27.6	107.0 ± 22.9	0.05
BMI [kg·m^{-2}]	37.2 ± 7.6	37.2 ± 7.2	37.3 ± 8.4	0.92
Fat mass [kg, by BIA]	48.0 ± 16.4	48.2 ± 14.9	47.9 ± 18.5	0.97

BIA = Bioelectric Impedance Analysis

Ergometric performance data (mean ± SD)

	Total (N=20)	IS (N=10)	IR (N=10)	Difference P
HR_{max} [min^{-1}]	160 ± 15	165 ± 11	154 ± 16	0.17
La_{max} [mmol·l^{-1}]	7.1 ± 1.9	6.5 ± 1.9	7.6 ± 1.9	0.08
RER_{max}	1.03 ± 0.06	1.01 ± 0.05	1.06 ± 0.05	0.03
P_{max} [Watt]	161 ± 58	182 ± 61	141 ± 51	0.02
P_{max} [Watt·kg^{-1}]	1.5 ± 0.6	1.6 ± 0.6	1.4 ± 0.5	0.10
VO_2peak [l·min^{-1}]	2.7 ± 0.7	2.9 ± 0.7	2.5 ± 0.5	0.01
VO_2peak [ml·min^{-1}·kg^{-1}]	25 ± 6	26 ± 7	24 ± 6	0.20

RER values



only 7 pairs reached the same workload

Conclusions

By indirect calorimetry no IR-induced influences on whole-body fasting, postprandial and exercise-related substrate utilization in obesity were detected. Thus, no consequences for food composition arise. IR-dependent differences in age and fitness level may have prevented more pronounced contrasts between groups (8).

Literature

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