Correlation of lipid profile and insulin sensitivity with body fat evaluated using MRI, Dual Energy X-ray Absorptiometry and Bioimpedance

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Introduction: Body composition analysis, in particular, measurement of body fat and its distribution is gaining popularity. There is increasing interest in using this information to identify health risks such as obesity, diabetes and cardiovascular diseases (CVD). The importance of identifying predictive markers for diseases is being increasingly acknowledged in management of diseases such as diabetes, the prevalence of which is increasing worldwide posing a major health challenge (1). From effective therapeutic management for diseases, emphasis is shifting to their prevention and identification of risk factors. There are different methods to assess the body fat and its distribution. In this study, fat content assessed using MRI, Dual energy x-ray absorptiometery (DEXA) (2) and Bio-impedance analysis (BIA) (3) methods are correlated individually with biochemical parameters such as lipid profile, insulin sensitivity, BMI and BMR and compared. These biochemical parameters are considered risk factors for diabetes, obesity, CVD, etc.

Materials and methods: Twelve healthy volunteers (9 males, 3 females) in the age group of 17-35 yrs, having no history of diabetes and hypertension were recruited for the study. MRI evaluation of subcutaneous fat (SF) was carried out at 1.5 T (Siemens Avanto, Germany) using the following parameters: TR of 650 ms, TE of 11 ms and 256 x 256 matrix. For abdomen, T_1-weighted breath hold sequences were used to obtain transverse images (8mm contiguous slices) from T9 vertebra to the superior surface of hip joint. Subcutaneous fat area was evaluated for each slice by drawing regions of interest and its volume calculated using slice thickness. Fat volume for the entire region studied was converted to fat mass (in kg) by multiplying the volume by specific density of fat (0.92 kg/L). T_1 weighted whole body MRI (10 mm contigual slices in the coronal plane) was also carried out to study the fat distribution. In addition, DEXA (HOLOGIC QDR 4500W densitometer, Hologic Inc, Bedford MA, USA) was used to assess abdominal fat mass and Bioimpedance (Tanita TBF-215 analyser, Japan) to evaluate BMI, BMR and total body fat mass. The body fat assessed using each of these techniques was correlated individually with BMI, BMR, lipid profile and insulin sensitivity [assessed Glucose tolerance test (GTT)] and compared.

Results: Figure 1 shows the whole body coronal images of 2 of the volunteers. Figure 1a shows a higher fat distribution in the abdomen and thigh region. This volunteer had a BMI of 23.2 and BMR of 5640 KJ. Figure 1b is that of a volunteer with BMI of 20.5 and BMR of 6273 KJ. It can be seen that this volunteer had uniform (and very little) SF fat distribution throughout the body. Figure 2 shows the correlation of fat mass assessed by MRI (Fig. 2a), DEXA (Fig. 2b) and BIA (Fig. 2c) with insulin sensitivity. MRI data shows the highest correlation (r = 0.7), followed by DEXA (r = 0.67) and BIA (r = 0.65). While BMI also showed good correlation with fat mass assessed with all the 3 techniques, only MRI data showed good correlation with cholesterol levels (r=0.76).
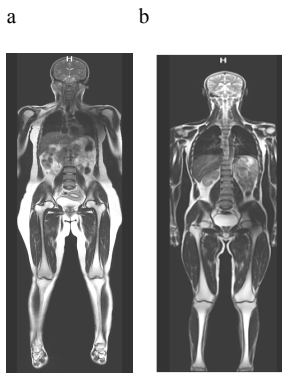

Figure 1: Whole body coronal images of two volunteers with different fat distribution
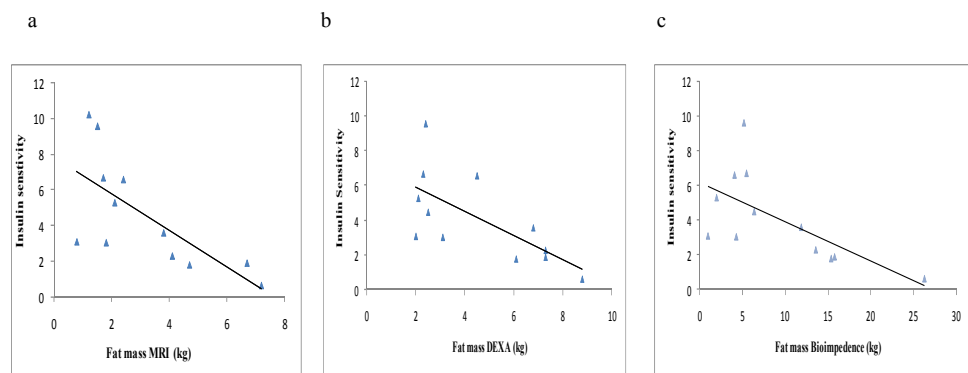

Figure 2 : Correlation of insulin sensitivity with fat mass

Discussion: It is now acknowledged that location of body fat in a person is important in identifying the risk population – for eg, fat around abdomen is considered a greater risk factor for conditions such as obesity and diabetes. Though DEXA gives accurate measurements, it uses ionising radiation (x-rays) making it unsafe for use in not only children and adolescents but also for repeated studies in adults. Bioimpedance method measures the resistance / impedance offered by the different tissues to the flow of current. While it is easy to use, it does not give accurate results. On the other hand, MRI while providing accurate results is also safe to use due to lack of radiation exposure. It can therefore be used safely on children as well and also on adults repeatedly. In addition, unlike the other techniques, whole body MRI showing the fat distribution can also be obtained.

Conclusion : The data indicates that while all the three techniques (MRI, DEXA and BIA) can be used interchangeably for correlating insulin sensitivity and BMI with fat mass, MRI has the additional advantage of giving information on fat distribution in the whole body. More studies are required to draw further conclusions.

References :

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