MR based evaluation of subcutaneous, visceral and intermuscular adipose tissue as markers for metabolic disorders

Rama Jayasundar[1], Somenath Ghatak[1], Ankur Poddar[2], Ariachery C Ammini[3], and Ashok K Mukhopadhyaya[4]

[1]Department of NMR, All India Institute of Medical Sciences, New Delhi, Delhi, India, [2]Department of Biotechnology, All India Institute of Medical Sciences, New Delhi, Delhi, India, [3]Department of Endocrinology, All India Institute of Medical Sciences, New Delhi, Delhi, India, [4]Department of Laboratory Medicine, All India Institute of Medical Sciences, New Delhi, Delhi, India

Introduction

Increasing prevalence of metabolic disorders such as obesity and diabetes has become a matter of great public health concern, affecting not only the health of individuals but also that of a nation's economy with their increasing healthcare cost.[1] There is now compelling evidence on the importance of preventability of these disorders by identifying potential risk factors. In this regard, noninvasive body composition analysis using MR can play an important role. Given the known high predisposition of Asian Indian population to type 2 diabetes,[1] the present study has explored in this group, the predictive role of MR assessed subcutaneous, visceral and intermuscular adiposity as an index of metabolic health. These have been evaluated by correlating MRI data with putative biochemical metabolic risk indices, and also with other body composition analysis techniques like Dual Energy X-ray Absorptiometry (DEXA) and Bioimpedance Analyser (BIA).

Materials and Methods

Study design: A total of 47 healthy Asian Indian volunteers (26 males and 21 females) aged 20-35 yrs were examined after obtaining written informed consent. Exclusion criteria included history of diabetes and hypertension. The study was approved by the Institute Ethics Committee.

MR : Single cross-sectional MR images were obtained using T1-weighted images (TR of 650 ms, TE of 11 ms, 256 x 256 matrix and 8 mm slice thickness) from the following regions: L3-L4 intervertebral space and midthigh (mT) in right leg. The following were evaluated from the images : Subcutaneous Adipose Tissue (SAT) in abdomen (SAT_{L3}) and midthigh (SAT_{mT}); Visceral Adipose Tissue in abdomen (VAT_{L3}); and Intermuscular Adipose Tissue in midthigh ($IMAT_{mT}$). Fat volume and mass were calculated. All the MR studies were carried out at 1.5 T (Avanto, Siemens).

DEXA and BIA: HOLOGIC QDR 4500W densitometer (Hologic Inc, Bedford MA, USA) (DEXA) and Tanita TBF-215 analyser (Japan) (BIA) were used to assess a number of physical and metabolic parameters such as Fat Mass (FM), Free Fat Mass (FFM), Total Fat Mass (TFM), Lean mass (LM), Total Body Water (TBW), Body Mass Index (BMI), Basal Metabolic Rate (BMR), Bone Mineral Density (BMD) and Bone Mineral Content (BMC).

Metabolic indices: Lipid profile, Oral-Glucose Tolerance Test (OGTT), insulin level and sensitivity were assessed using standard procedures.

Data analysis: Independent Samples T-test was used to assess the robustness of parameters and those with $p < 0.05$ and confidence interval > 95% were considered statistically reliable and selected for further analysis. Euclidean Distance Matrix analysis was used to assess the correlation of MR data with other parameters with a cut off value of < 8. Pearson's bivariate correlation analysis was performed for all the parameters with MR data as the independent and others as dependent variables. The mean $\pm$ SD of different groups of variables were also compared. The entire data was also analysed according to the following groupings: all volunteers as one group and also split by gender. $P < 0.05$ was considered statistically significant.

Results and Discussion

Figure 1 shows the gender data distribution (mean $\pm$ SD) for all the statistically reliable parameters. Gender specific differences were seen only for some parameters assessed by DEXA and BIA. Figure 2 shows the statistically significant correlations for the MR acquired parameters. Maximum correlations were observed for SAT_{L3}. It correlated well with fat assessed by both DEXA and BIA, and also correlated with VAT_{L3}. In males, testosterone showed negative correlation with $IMAT_{mT}$ and also with FM (leg) measured by DEXA indicating that the correlation of testosterone with appendicular fat is technique independent. Although MR data did not show any gender specificity, BMD, BMC and Lean mass showed significant correlations with TFM, FFM and TBW in both genders. Implications of these various correlations are under further investigation.

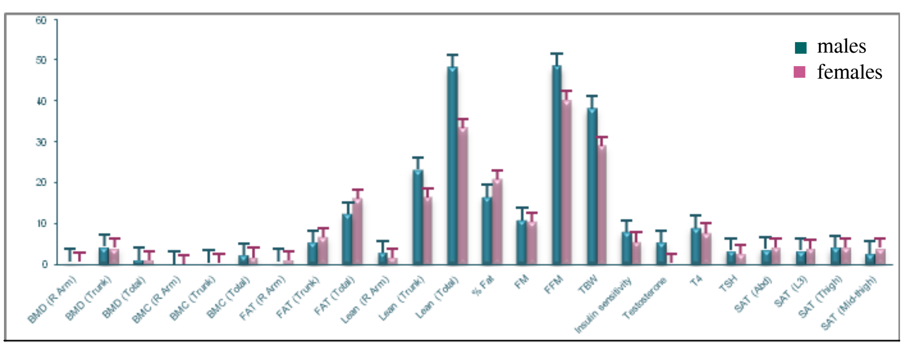

Figure 1: Histogram of MR, DEXA, BIA and biochemical data (mean $\pm$ SD) for all volunteers

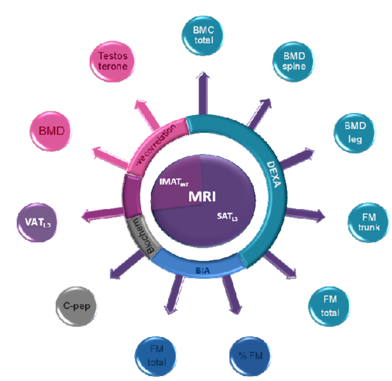

Figure 2: Statistically significant correlations between MR, DEXA, BIA and metabolic indices. C-pep: C-peptide

Conclusion

As the prevalence of metabolic disorders such as diabetes and obesity increases worldwide, it is becoming imperative to focus on prevention using predictive biomarkers. This study has explored the potential of MR (safe for all sections of population) in predictive health with specific reference to metabolic disorders like diabetes. SAT_{L3} with maximum correlations and $IMAT_{mT}$ with its interesting association with testosterone could be statistically reliable and robust markers in identifying risk population for metabolic disorders. This is a longitudinal study and further indepth studies are underway.

Reference

1. Pradeepa R, Prabhakaran D, Mohan V. Emerging economies and diabetes and cardiovascular disease. Diab Technol Therap. 2012; 14 (Supp 1): S59-S67.