Body composition analysis using MRI, Dual Energy X-ray Absorptiometry and Bio-impedance

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Introduction : From effective therapeutic management, emphasis is now shifting to disease prevention and identification of risk factors. There is, hence, an increasing interest in using body composition analysis to identify predictive markers especially for diseases such as diabetes, the prevalence of which is increasing worldwide posing a major health challenge (1). Various methods such as Magnetic Resonance (MR), Dual energy x-ray absorptiometry (DEXA) and Bio-impedance analysis (BIA) can be used for this purpose (2,3). In this study, using these three techniques fat content and its distribution, considered risk factors for a number of diseases, were assessed and correlated with each other.

Materials and Methods : Thirty healthy volunteers (16 males, 14 females) in the age group of 17-35 yrs were recruited for the study. MRI evaluation of abdominal and thigh subcutaneous fat (SF_{abd} and SF_{thigh}) were carried out at 1.5 T (Avanto, Siemens, Germany) using the following parameters: TR of 650 ms, TE of 11 ms, 256 x 256 matrix and 8mm contiguous slices. T_1-weighted transverse images were obtained from abdomen (breath hold sequences) [from T9 vertebra to the superior surface of hip joint (Fig. 1a)] and leg [from superior surface of hip joint to the lower end of medial condyle (Fig. 1b)]. Area of subcutaneous fat was evaluated for each slice by drawing regions of interest (Fig. 2) and its volume calculated using slice thickness. Fat volume was then converted to fat mass (FM) using the specific density of fat (0.92 kg/L). T_1-weighted whole body MRI (10 mm contiguous slices in the coronal plane) was also carried out to evaluate the fat distribution (Fig. 3). DEXA (HOLOGIC QDR 4500W densitometer, Hologic Inc, USA) to assess Fat Mass in trunk (FM_{trunk}) and leg (FM_{leg}) and Bioimpedance (Tanita TBF-215 analyzer, Japan) for total Body Fat Mass (BFM) were used.

Results

MRI and DEXA

Subcutaneous Fat Mass$_{abd}$ (MRI) and Fat Mass$_{trunk}$ (DEXA) - SFM_{abd} and FM_{trunk} from both techniques correlated well in both males (r = 0.92) and females (r = 0.96). This study is in agreement with that by Enzi G *et al*, who have reported significant correlation between Computerized Tomography (CT) assessed SFM_{abd} with FM_{trunk} (DEXA) (4).

Subcutaneous Fat Mass$_{thigh}$ (MRI) and Fat Mass$_{leg}$ (DEXA) – There was significant correlation between SFM_{thigh} (MRI) and FM_{leg} (DEXA) in both males (r = 0.58) and females (r = 0.61), although DEXA provides information from the whole leg and MRI was obtained from the thigh region only. There are no earlier reports comparing these two measurements.

MRI and BIA

SFM$_{abd}$ (MRI) and BFM (BIA) - There was significant correlation between these two parameters in both males (r = 0.91) and females (r = 0.78). There are no reports in the literature showing such correlation.

SFM$_{thigh}$ (MRI) and BFM (BIA) - There was no significant correlation between these two parameters for any group - males (r = 0.13), females (r = 0.01).

This is the first report in literature comparing these two techniques, in particular, with reference to evaluation of fat.

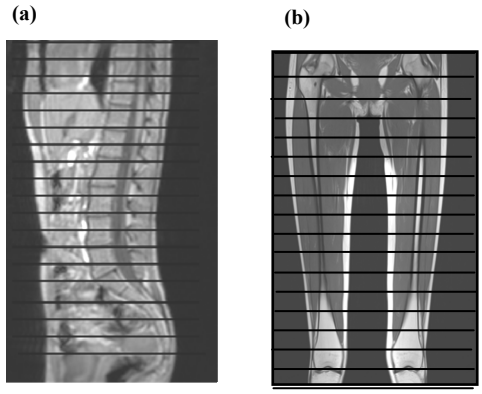

Fig. 1: Transverse slices planned for (a) abdomen - from T9 vertebra to hip joint (b) thigh - from hip joint to medial condyle

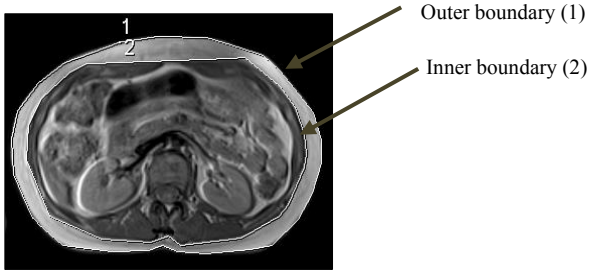

Fig. 2: Boundaries delineating abdominal subcutaneous fat

Fig. 3: Whole body coronal images of two volunteers with different fat distribution

Discussion : It is now acknowledged that location of fat in a person is important in identifying the risk population predisposed to diseases such as obesity and diabetes – for eg, abdominal fat is considered a greater risk factor for these conditions. Though DEXA gives accurate measurements, it uses ionising radiation making it unsafe for use in not only children and adolescents but also for repeated studies in adults. Bioimpedance method measuring the resistance offered by the different tissues to the flow of current, is easy to use but does not give accurate and location specific results. On the other hand, MRI while providing specific information on abdominal fat, is also safe to use due to lack of radiation exposure. In addition, unlike the other techniques, fat distribution can also be studied.

Conclusion : The data, in general, shows good agreement between the three techniques, MRI, DEXA and BIA, indicating they can be used interchangeably. The absence of correlation between the MRI measured SF data for the thigh region with that of the whole body from BIA indicates that fat from thigh is not an indicator of body fat. Though the three techniques (MRI, DEXA and BIA) can be used interchangeably, MRI has the additional advantage of giving location specific details and information on fat distribution.

References

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