Innovative application of MR in the complementary and alternative medical system of ayurveda

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Introduction: Multitude of data on cellular components from state of the art 'omic' studies (eg. proteomics, metabolomics, etc) is redefining the understanding of the cell as a system rather than as a sum of its components. This has not only revolutionised the emerging field of systems biology but has also fuelled growing interest in applying a systems perspective to clinical medicine. In this regard, there is increasing interest in complementary and alternative medical systems, which are thought to have a systemic and holistic approach to health and disease. This study explores how MR can be used innovatively for scientific research in traditional medicine, and focuses on the predictive and personalised Indian medical system of ayurveda (1). Central to the personalised practice of ayurveda is assessment of body constitution types. There are 7 phenotypes (labeled V, P, K, VP, PK, KV and VPK) comprehensively covering different combinations of a number of physical, physiological and psychological attributes. Knowledge of the phenotype is used to identify those pre-disposed to diseases like diabetes and osteoarthritis, to customise diet & lifestyle activities for healthy living, and also to diagnose and personalise treatment (1). This study combines ayurvedic phenotyping and body composition analysis using MRI to measure objectively some of the ayurvedic physical phenotyping indices such as fat distribution and subcutaneous fat. The aim of the work is two fold : (a) get objective markers for ayurvedic phenotype indices, which can ultimately be used to identify risk groups for diabetes from normal population (b) scientific validation of ayurvedic concepts and parameters. To facilitate the first aim, biochemical risk factors for diabetes such as insulin sensitivity and lipid profile have also been assessed.

Materials and methods: Twenty eight healthy volunteers (19 males, 9 females) in the age group of 17-35 yrs, having no history of diabetes were recruited for the study. A questionnaire for clinical phenotyping based on ayurvedic indices for physical, physiological and psychological features was used to assess the constitution types of the volunteers using a scoring method. MRI evaluation of subcutaneous fat (SF) in abdomen (SF_{abd}) and thigh (SF_{thigh}) was carried out at 1.5 T (Avanto, Siemens) 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) (T9 vertebra to the superior surface of hip joint) and leg (superior surface of hip joint to the lower end of medial condyle). Area of SF was evaluated for each slice by drawing regions of interest (Fig. 1) and % fat was calculated with respect to the entire region. T_1-weighted whole body MRI (10 mm contiguous slices in the coronal plane) was also carried out to evaluate the whole body fat distribution. Body Mass Index (BMI), insulin sensitivity using Glucose Tolerance Test, serum triglycerides, total cholesterol, Low Density Lipoproteins and High Density Lipoproteins were also assessed using standard procedures (2).

Results and Discussion: Of the 28 volunteers studied, 7 were classified as KV, 6 as VP, 7 as PK , 3 as K, 3 as V and 2 as P phenotypes. Figure 2 shows MR images of whole body fat distribution in 3 different phenotypes (K, V and P). It is clearly seen that SF in K type is maximum followed by P and V phenotypes. It is interesting to note that these observations are in agreement with ayurvedic understanding of K and V phenotypes as having contrasting physical attributes with P as an intermediate. According to ayurveda, K phenotypes are associated with presence of more fat (and pre-disposed to obesity and diabetes) as opposed to V types, who have very little fat and pre-disposed to diseases like osteoarthritis. Figure 3 shows the histograms of MRI assessed % SF for abdomen and thigh regions (% SF_{abd} and % SF_{thigh}) for phenotypes VP, PK and KV. Significant differences between constitution types and subcutaneous fat ($p < 0.02$) were observed in both abdomen and thigh. Triglyceride levels also differed significantly ($p = 0.009$) between KV (high) and VP. This observation supports the association between higher fat content in K dominated phenotypes mentioned in ayurveda. In this study, the KV phenotypes are associated not only with the maximum subcutaneous fat in abdomen & thigh regions and triglyceride levels but also a higher insulin resistance, implying that this group may be more predisposed to diabetes. Interestingly, this is in agreement with that mentioned in ayurvedic texts (1). This preliminary data is the first report to phenotype normal volunteers according to the comprehensive ayurvedic indices and correlate them with MRI evaluated subcutaneous fat and other metabolic risk factors for diabetes.
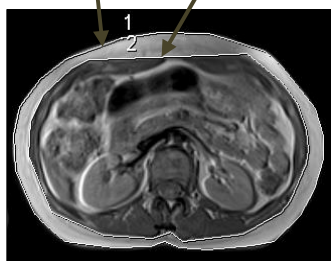

Fig. 1: Boundaries delineating abdominal subcutaneous fat

Fig. 2: Whole body coronal images of volunteers showing varying fat distribution corresponding to three different phenotypes
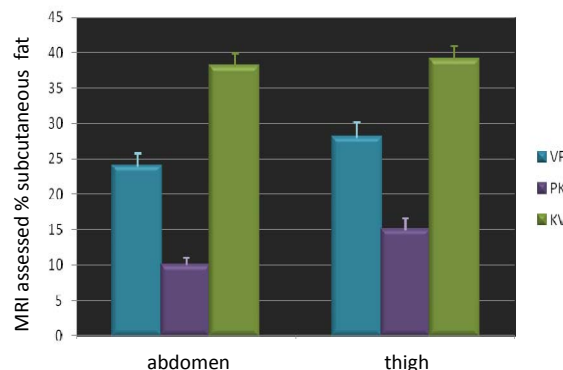

Fig. 3: Association between physical characteristics of different phenotypes and MRI assessed % subcutaneous fat in abdomen and thigh regions

Conclusion: With increasing interest in predictive and personalised medicine, the ayurvedic concept of phenotyping is evoking scientific curiosity (3). What is required however, is scientific validation of this phenotyping. In this study, a successful combination of ayurvedic concepts and modern technology such as MRI has provided the much needed objective parameters for some of the ayurvedic indices of phenotyping. This is the first report of innovative use of MR in the traditional medicine of ayurveda. A more detailed study including evaluation of Human Leucocyte Antigen (HLA) DRB1 typing is underway by extracting genomic DNA and using polymerase chain reaction (PCR) sequence specific primers and oligonucleotide probes in peripheral blood samples of these volunteers.

References:
1. R Jayasundar, *Leadership Medica*, 15, 6-21, 2009.
2. CW Yeckel, *et al. Clinical Endocrinol Metab*, 89, 1096-1101, 2004.
3. S Aggarwal *et al. Proc Natl Acad Sci USA,* 107, 18961-18966, 2010.