DTI Metrics Differentiate Chronic Infective from Chronic Inflammatory Knee Arthritis

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Introduction: It is not possible to differentiate infective arthritis from non-infective chronic inflammatory arthritis on conventional MRI. Synovial histology is the only means to differentiate between these two pathologies. However, it is not always possible depending upon the location of the joint, availability of the specialist and patient related co-morbidities. Thus there is a great need for availability of non-invasive imaging technique that can differentiate between the infective vs non-infective inflammatory pathology. Recently, we have demonstrated that diffusion tensor imaging (DTI) derived metrics [fractional anisotropy (FA), mean diffusivity (MD), linear anisotropy (CL), planar anisotropy (CP) and cylindrical isotropy (CS)] assess microstructural changes in the synovial membrane of the joint during inflammation. (1). We hypothesize that since in infection, there is a greater degree of inflammation caused by increased up-regulation of various proinflammatory cytokines and chemokines and infiltration of various inflammatory cells, there should be a greater variation in DTI metrics as compared to the non-infective pathology.

Material and methods:

MR Imaging: This study was performed on seventeen patients who had inflammation in knee joint with age ranging from 16-40 years. Conventional (T2, T1 pre and post contrast with fat saturation) as well as DT MRI were performed on a 3T MR scanner (Signa Hdxt, General electric, Milwaukee, USA), using a quadrature knee coil after the approval from the institutional ethics committee. DTI data were acquired using a single-shot echo-planar dual spin-echo sequence with ramp sampling with 10 uniformly distributed directions. The acquisition parameters were: TR=10sec/TE=100ms/slice no.=28/thickness=3mm/interslice gap=0/FOV=240mm/image matrix=256×256 (following zero-filling)/NEX=2/diffusion weighting b-factor=1000 s mm^{-2}. DTI data was processed by using JAVA based in-house developed DTI-soft-ware (2). Post- contrast T1-weighted images were acquired after intravenous injection of gadolinium diethylenetriaminepenta-acetic acid (Gd-DTPA; Omniscan, Amersham Health, Oslo, Norway) at a dose of 0.1 mmol/kg body weight. Regions of interests (ROIs) were placed on color coded FA map overlaid on MD map to quantify the DTI measures of tubercular synovial fluid & membrane (TBSF & TBSM) and non-tubercular synovial fluid & membrane (NONTBSF & NONTBSM).

***Statistical analysis*:** Independent samples t-test was performed to look whether any of the DTI metrics were significantly different between patients with infective and non- infective pathologies.

Results: Out of 17 patients (age: 14-48 yrs, 11 male &6 female), 7 were detected to have tuberculosis (Mycobacterium tuberculosis positive on culture of synovial fluid 2, synovial membrane 1, acid fast bacilli staining with epithelioid cell granulomas 4). Ten had chronic inflammatory arthritis (undifferentiated chronic monoarthritis 7, rheumatoid 1, osteoarthritis 2). Among all DTI metrics, FA and CL values were significantly higher in TBSM as compared to NONTBSM (Fig.2). FA, CL and CP were found to be significantly increased in TBSF while MD of TBSF was significantly lower as compared to NONTBSF (Fig.2).

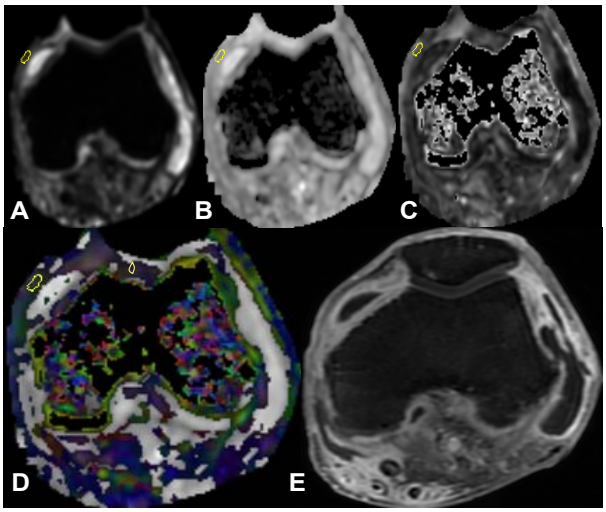

Fig1. A) T2 weighted, B) MD, C) FA, D) Color coded FA map overlaid on ADC showing placement of ROIs on synovial membrane (right upper corner) and synovial fluid(upper central region)& post contrast T1 images.

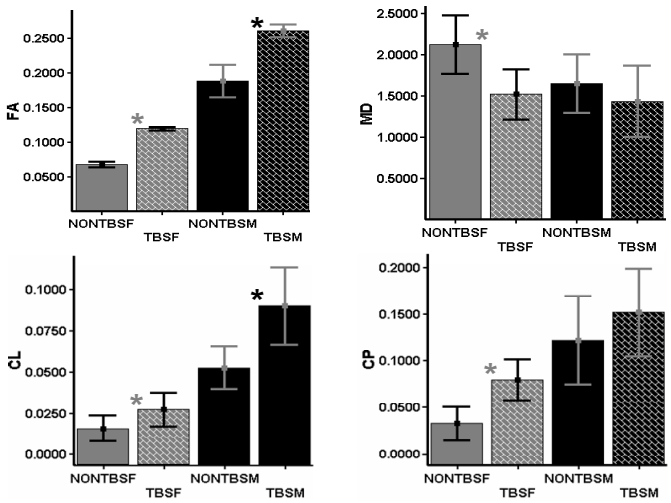

Fig.2. Plots showing significant differences between tubercular and non-tubercular synovial membrane and fluid in FA, MD, CL and CP values

Discussion: In this study we have found a significant difference between tubercular & non-tubercular arthritis in FA and CL values obtained either from synovial membrane or from synovial fluid. FA values in the SF were characteristically less than 0.08 in non-TBSF whereas all the TBSF had a FA value >0.11. Inflammation is presented with pathological features such as activation of synovium with release of pro-inflammatory cytokines into the synovial fluid (3). Aggregation of the inflammatory cells due to adhesion molecules has been shown to increase FA in brain abscess cavity (4). In a study on brain abscess wall, FA and linear anisotropy (CL) showed a significant positive correlation with ICAM-1 and LFA-1 expression whereas FA and planar anisotropy positively correlated with NMs quantified from aspirated pus respectively (5). The increased FA and CL in tubercular arthritis may have resulted from increased infiltration of various inflammatory cells, facilitated by different cytokines and chemokines. We conclude that the DTI metrics may help in differentiating chronic infective from chronic inflammatory arthritis. DTI may be used as a non-invasive tool eliminating the need of biopsy in its differentiation.

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