Title	Discrepant FA reduction between the frontal and parietal lobes of post irradiation medulloblastoma survivors: preliminary findings of regional susceptibility?
Author(s)	Qiu, D; Leung, L; Kwong, DLW; Chan, GLH; Cao, G; Khong, PL
Citation	The 14th Scientific Meeting and Exhibition of the International Society for Magnetic Resonance in Medicine (ISMRM), Seattle, WA., 6-12 May 2006.
Issued Date	2006
URL	http://hdl.handle.net/10722/105632
Rights	This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License.

Discrepant FA reduction between the frontal and parietal lobes of post irradiation medulloblastoma survivors: preliminary findings of regional susceptibility?

D. Qiu[1], L. Leung[2], D. Kwong[2], G. Chan[3], G. Cao[4], P-L. Khong[1]

[1]Diagnostic Radiology, The University of Hong Kong, Hong Kong, Hong Kong, Hong Kong, [2]Clinical Oncology, The University of Hong Kong, Hong Kong, Hong Kong, Hong Kong, [3]Paediatric and Adolescent Medicine, The University of Hong Kong, Hong Kong, Hong Kong, Hong Kong, [4]GE Medical, Asia, Hong Kong, Hong Kong, Hong Kong

Introduction:

There is emerging evidence that diffusion tensor MR imaging (DTI), using fractional anisotropy (FA) is sensitive in detecting and monitoring white matter injury that is associated with whole brain radiotherapy in medulloblastoma (MED) survivors (1,2). We have described a method of mapping whole brain radiation dose distribution to FA images of MED patients so that FA changes in relation to dose may be studied voxel-by-voxel. Using this tool, we found larger reduction in frontal lobe FA compared to the parietal lobe in two MED patients although both regions received the same radiation dose, suggesting the possibility of radiation susceptibility of the frontal lobe. Therefore, in this cross-sectional study, we test the hypothesis that regional mean FA of the frontal lobe is more severely reduced than the parietal lobe after whole brain irradiation in a larger cohort of MED survivors by quantitative measurement of regional mean FA.

Method:

Sixteen MED survivors (13 males and 3 females) with mean age of 11.2 (SD = 4.9) years and sixteen age-matched normal control subjects (11 males and 5 females) with mean age of 12.3 (SD = 4.7) years were recruited for DTI studies. All the patients underwent surgical resection of the tumor, followed by radiotherapy and chemotherapy. Radiotherapy consisted of 30-40Gy irradiation to the whole brain and additional boost to the posterior fossa to give a total dose of 50-55.8Gy. DTI scan was performed using a 1.5T imager (General Electric Medical Systems, Milwaukee, WI, USA) with a standard head coil. Diffusion weighted images in addition to one non-diffusion weighted (b0) image were acquired in 25 gradient encoding directions using single-shot echo-planar imaging (TR=10000ms, TE=100ms, acquisition matrix=128 x 128, field of view =28cm, slice thickness of 5mm with 1.5mm gap, b factor=1200s/mm^2). Fractional anisotropy (FA) maps were created (FUNCTOOL, GE Medical Systems). Using SPM2 (Wellcome Dept of Imaging Neuroscience, Institute of Neurology, UK), b0 images were normalized to the EPI template and the transformation parameter derived was applied to b0 and FA images, after which warped b0 images were segmented and white matter masks were created using the expression (i2>i1)&(i2>i3)&(i2>(1-i1-i2-i3)). According to the radiotherapy plan, radiation dose to the region superior to the level of the lateral ventricles, comprising the frontal and parietal lobes was uniform so we made a mask to confine our analysis to this region to avoid the confounding effect of dose. Combining brain lobe masks from Talairach Daemon atlas (4, 5) and the masks created above (Fig.1), we computed the mean FA of the frontal lobe and parietal lobe (FFA, PFA respectively) for each subject, the mean F/PFA$_p$ and F/PFA$_c$ (of the patient and controls respectively) and FFA$_{c\text{-}p}$ (difference in FFA between control and patient) and PFA$_{c\text{-}p}$ (difference in PFA between control and patient). We used Wilcoxon Signed Ranks test to test for significant differences of FFA and PFA between MED patients and control subjects, and also for the difference between FFA$_{c\text{-}p}$ and PFA$_{c\text{-}p}$. We also used two way analysis of variance to simultaneously test the effect of radiation (i.e. between patient and control group) and regional differences (i.e. between frontal lobe and parietal lobe) on FA and the interaction between them. A significance level of 0.05 was adopted.

Result:

We found significant reduction of FFA (p=0.013), but not PFA (p=0.352) of MED survivors compared to controls. However no significant difference was found between FFA$_{c\text{-}p}$ and PFA$_{c\text{-}p}$ (p = 0.179) although it was in the direction we hypothesized with FFA$_{c\text{-}p}$ larger than PFA$_{c\text{-}p}$ (Fig.2). Analysis of variance revealed significant effects of radiation (p = 0.010) and regional differences (p = 0.001) but no significant effect of interaction between them (p = 0.557).

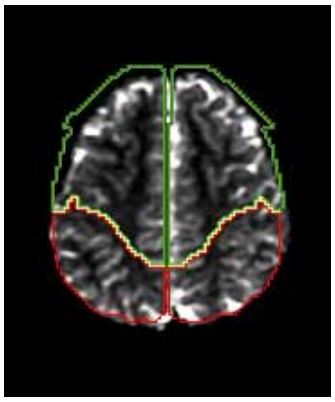

Fig. 1 showing b0 image with frontal and parietal masks superimposed

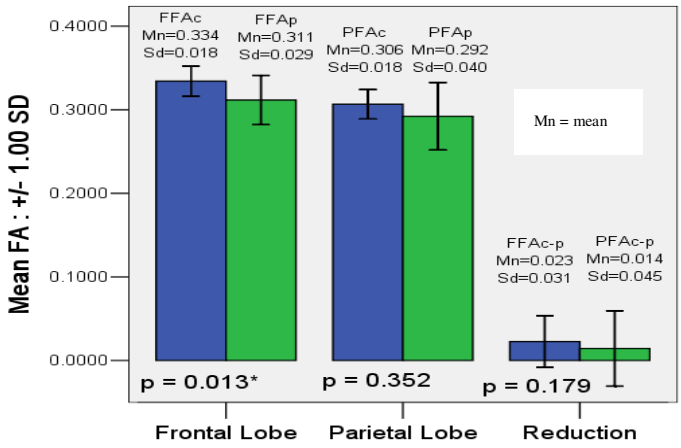

Fig. 2 showing bar plot of mean FA of frontal lobe of control and patients (FFA$_c$, FFA$_p$), mean FA of parietal lobe of control and patients (PFA$_c$, PFA$_p$) and also the difference in FFA and PFA between controls and patients (FFA$_{c\text{-}p}$ and PFA$_{c\text{-}p}$).

Discussion:

We confirmed our previous findings that FA is reduced significantly in the white matter of MED survivors compared to normal control subjects (1, 2). In addition, this study shows that the overall reduction in FA of the combined frontal and parietal lobes is caused predominantly by frontal lobe FA reduction rather than the parietal lobe. Although the difference between frontal and parietal lobe FA reduction failed to reach statistical significance, we found a trend of regional susceptibility of the frontal lobe to radiation. These preliminary findings warrant further evaluation by larger scale studies.

References: 1. Khong PL, et al, 2003. AJNR. 24: 734-740. ***2.*** Leung LH, et al, 2004. Neuroimage. 21: 261-268. ***3.*** Lancaster JL, et al 1997. NeuroImage 5: S633. ***4.*** Maldjian JA, et al, 2003. NeuroImage 19, 1233– 1239.