INTRODUCTION: Parkinson's disease (PD) is a common neurodegenerative disorder. Through out the world, the incidence of PD has increased dramatically with the aging of society. In the vast majority of cases, the disease is idiopathic and the diagnosis is dependent on constellation of symptoms. Thus, the definitive diagnosis is not available until post-mortem histologic analysis, where degeneration of the substantia nigra pars compacta (SNc) dopaminergic system is seen as depigmentation of SN. The neurodegeneration SNc result in the release of neuromelanin into the adjacent tissue, where it is phagoyctosed and carried away by macrophages. It is believed that over 60% of dopaminergic neurons are lost before a patient begins to show clinical symptoms of PD, such as bradykinesia, cogwheel rigidity, and tremor. Thus, in vivo direct observation of the SNc in the human brain has been one of the most sought-after goals in PD research, as it has the potential to lead to noninvasive pre-mortem diagnosis of PD. Images obtained using 7.0T MRI began to show deep brain areas [1-2]. These findings suggest that 7.0T MRI could be used to observe the degeneration of the SN in PD patients. Here, we demonstrate that there are visible and distinctive differences in morphology of SNc in PD patients when compared to normal controls and suggest that 7.0 T MRI may be a useful tool in diagnosis of PD.

MATERIALS AND METHODS: 7.0T T2*-weighted MR images of the SN were obtained from 10 patients with PD and 9 age-matched control subjects. The MRI used was a 7.0T MRI scanner (Siemens). All images were acquired using a 2D T2*-weighted gradient echo sequence aligned with AC-PC line. (TR/TE = 750/17.8 ms; flip angle = 45°; in-plane resolution = 0.25 mm; and the slice thickness was 2 mm). For the quantitative analysis, we have segmented SN, and then the center of mass was calculated as the center point. From this center point, we have defined the midline of SN along the direction of anterior-posterior (A-P) which divides the lateral and the ventral aspects of SN. We select the lateral boundary of each subject, and then these boundaries are normalized based on the midline of SN. To make the reference lateral boundary line between SN and CC, we have calculated mean boundary line of control group and used as a reference line. We then measured distance profiles from the midline to the lateral boundary of SN and calculated sum of absolute differences for PD and normal control i.e., sum of absolute differences between individual data along the midline and reference. We referred this sum of absolute difference values as ‘Undulation value’.

RESULTS AND DISCUSSION: Representative samples of 7.0T images of the normal control and PD groups are selected and compared. First, two typical axial images of age-matched normal controls are shown in the left column of Fig.1. These two images clearly show the typical smooth boundaries between the SN and CC. However, in the right column of Fig.1, the boundaries of the two PD cases are severely serrated in both PDs and clearly distinguish the two groups. More specifically, the boundaries of PD patients are no longer smooth ‘arch’ shaped, but rather appear serrated, suggesting probably due to the degradation of cells in the SN. These clear distinctions appear an important maker for the diagnosis of PD in-vivo hither to unable to do with any other devices.

CONCLUSION: The most interesting and important finding of these 7.0T MR imaging study appears to be the clear visualization and eventual quantitation of PDs and normal controls based on the difference in the gross anatomical shape and the quantitative ‘undulation values’ between the controls and PDs. From the quantitative observational analysis such as the ‘undulation value’, in vivo 7.0T T2*-weighted MR imaging could provide direct visualization of morphological deformation as well as quantitative estimation of the PDs from that of the normal controls in vivo. In conclusion, this study has demonstrated that using 7.0T MRI, one can visualize the pathologic features of PD within the SN.