Brain volume variations in postmenopausal women: A voxel-based morphometry (VBM) study

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Synopsis: During the past two decades, several studies in females of animal models and human have been performed to unveil the reproductive system changes and the complex interactions with the ovaries. However, morphologic variations in the central nerve system following menopause have not yet been studied. Therefore, this study utilized voxel-based morphometry (VBM) to evaluate the age-related changes and the effects of menopause on the brain volumes in postmenopausal women.

Subjects and Methods: A total of 48 right-handed subjects consisting of 24 nonpostmenopausal (mean age: 39.8±8.1) and 24 postmenopausal women (mean age: 55.5±2.5) took part in this study. All the subjects have no history of neurological and psychiatric illness. Menopause was defined as continuous amenorrhea for more than 12 months and follicle-stimulating hormone (FSH) level more than 30 mIU/mL.

The subjects underwent MRI at a 3 Tesla (Siemens Tim Trio) with a transmit/receive birdcage head coil. Brain images were acquired using a 3-dimensional phase sensitive inversion recovery Turbo FLASH with the following parameters: TR/TE/TI=1700/900/2.2 ms; flip angle=9°; FOV=256×256×256 mm³; matrix size=256×256×256; voxel size=1×1×1 mm³. MR image data were processed by using SPM8 software with diffeomorphic anatomical registration through exponentiated Lie algebra (DARTEL) algorithm. Analyses were performed on gray matter (GM) segments; were multiplied by the non-linear components derived from the normalization matrix(modulated GM volumes); and then, smoothed with a Gaussian kernel of 6 mm full width at half maximum.

The total intracranial volume was measured by using ‘spm_calc_ticv.m’ function from segmented GM, WM and CSF images in each woman. The variation of brain volume between nonpostmenopausal and postmenopausal women was analyzed with independent two sample t-test and analysis of covariance (ANCOVA) with controlling ages. Significance threshold was set at P=0.05, corrected by family wise error (FWE) for multiple comparison.

Results and Discussion: Table 1 compared the total intracranial volumes (mL) of each tissue in nonpostmenopausal and postmenopausal women. The volumes in postmenopausal women averaged decreased GM 9.5 mL and WM 2.9 mL, whereas increased CSF 1.28 mL and total volume 0.4 mL.

Figure 1 shows the significant volume changes with the independent two sample t-test and ANCOVA for controlling aging (FWE, P<0.05) and the brain areas summarized in Table 2. Postmenopausal women show the prominent reduction in brain structures, however there was no increased brain volume.

Conclusions: With the help of SPM8-VBM with DARTEL, this study finds out the regional gray matter atrophies in postmenopausal women. Therefore, these findings would be helpful for an understanding of an interaction of brain morphological changes related with aging and menopause.

References
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![Fig. 1. Comparison of the independent two sample t-test (A) and ANCOVA for controlling aging (B) (FWE corrected at P<0.05). Note that significant maps show the brain volume reductions in postmenopausal women.](Image 4)

![Fig. 2. (Right). Comparison of the two sample t-test and ANCOVA for controlling aging. The dashed line indicates threshold t-value for significant maps (FWE at P<0.05, t-value= 5.96).](Image 5)