Brain volume variation in female-to-male transsexuals

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Synopsis: Since sex differentiation of the brain occurs later in development than sex differentiation of genitals, the morphogenesis of the brain plays a critical role in determining gender identity or transsexualism. A few studies investigated the variation of brain structures of male-to-female (MtF) transsexuals. However, no study on the gray matter (GM)-based volume variation of female-to-male (FtM) transsexuals has not yet been studied. This study used a 3 Tesla MRI to compare the volumes of gray matters between FtM transsexuals and female controls using voxel-based morphometry (VBM) analysis.

Subjects and Methods: A total of 27 subjects were consisting 12 FtM transsexuals (mean age: 43.8±6.3) and 15 female controls (mean age: 43.1±6.7) took part in this study. Both groups have no history of neurological illness, who were all age-matched and right-handed. FtM transsexuals had sex-reassignment surgery.

The subjects underwent on MR imaging at a 3 Tesla (Siemens Magnetom Tim Trio, Germany) with a 12-channel receive birdcage head coil. Brain images were acquired using a 3-dimensional phase sensitive inversion recovery(PSIR) Turbo FLASH with the following parameters: TR/TI/TE = 1700/900/2.2 ms; flip angle = 9°; FOV = 256×256 mm^2; matrix size = 256×256; voxel size= 1×1×1 mm^3. MR image data were processed by using SPM8 software with diffeomorphic anatomical registration through exponentiated Lie algebra (DARTEL) algorithm: gray matter segmentation; multiplication with the non-linear components derived from the normalization matrix (modulated gray matter volumes); followed by smooth with a Gaussian kernel of 6 mm full width at half maximum. We used independent two sample *t*-test for examination of voxel-wise gray matter differences between FtM transsexuals and normal females. Statistical outcomes were corrected for multiple comparisons using family-wise error (FWE; p<0.05) (Fig. 1).

Results and Discussion: FtM transsexuals showed significantly larger volumes of gray matters in the regions of the thalamus, hypothalamus, gyrus rectus, head of caudate nucleus, midbrain and subcallosal area as contrast with the female controls (FWE; p<0.05). On the other hand, the female controls showed larger volumes than did the FtM transsexuals, especailly in the regions of the superior temporal gyri including the Heschl's gyrus and Rolandic operculum. The Heschl's gyrus is a part of the primary auditory cortex, which is activated during auditory processing of the tone and semantic tasks. The Rolandic operculum is a speech-related region.

Conclusions: These findings support that the volume difference of brain substructures in FtM transsexuals is likely to be associated with transsexualism, and the transsexualism is probably associated with distinct cerebral structures, determining gender identity.

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References

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Table 1. Volume variation of the GM-based brain structures by female-to-male (FtM) transsexuals and female controls (FWE; p<0.05)

Anatomical area	Abbr.	*t*-value	MNI coordinate			Lateralization (%)
			x	y	z	
FtM > female controls						
Thalamus	Th	9.68	7	-13	10	-37
Hypothalamus	Hy	8.78	5	-7	-5	-49
Gyrus rectus	GRe	7.17	14	17	-11	-100
Head of caudate nucleus	HCd	7.05	14	17	-10	-100
Midbrain	MB	7.03	-4	-9	-7	27
Subcallosal area	SCA	6.78	10	15	-11	-100
Female controls > FtM						
Heschl's gyrus	HeG	6.67	44	-32	17	-100
Rolandic operculum	RoO	6.38	44	-33	19	-100

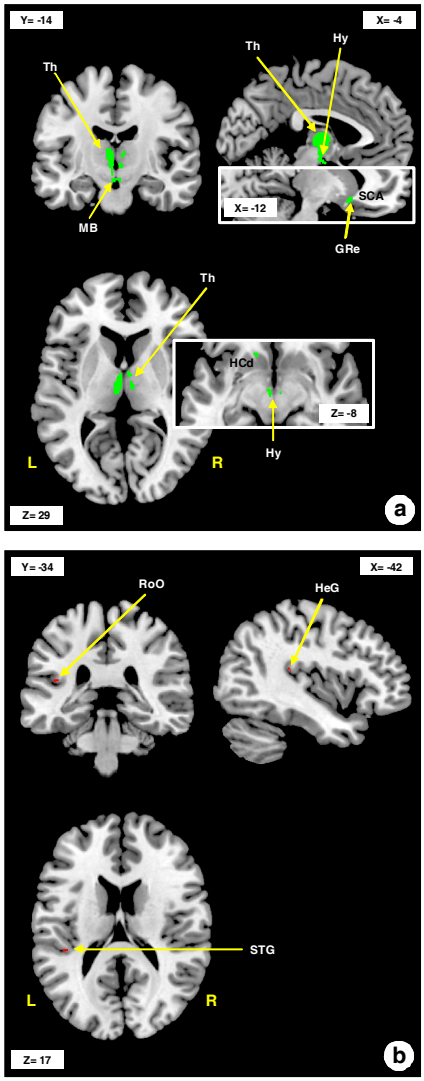

Fig. 1. 3-dimensional plane images overlaying with distinct brain structures having volume variation from the contrasts of FtMs and female controls (FWE; p<0.05): (a) FtMs over female controls, and (b) female controls over FtMs.

GRe: gyrus rectus, HCd: head of the caudate nucleus, HeG: Heschl's gyrus, Hy: hypothalamus, MB: midbrain, SCA: subcallosal area, STG: superior temporal gyrus and Th: thalamus