Reduced Fractional Anisotropy in the Splenium of Adolescents with Alcohol Use Disorder

S. F. Tapert[1], R. J. Theilmann[2], A. Schweinsburg[3], S. Yafai[4], L. R. Frank[5]

[1]VA San Diego Healthcare System, Department of Psychology, UCSD, San Diego, CA, United States, [2]VA San Diego Healthcare System, San Diego, United States, [3]Department of Psychology, UCSD, San Diego, CA, United States, [4]School of Medicine, UCSD, San Diego, CA, United States, [5]Center for Functional MRI, UCSD, San Diego, CA, United States

Synopsis

Alcohol use disorders (AUD) affect about 23% of the adult American population causing cortical degeneration and ultimately affecting cognitive function [1]. Heavy drinking often starts in adolescence, with 32% of high school seniors reporting having gotten drunk in the past month [2]. Previous magnetic resonance imaging (MRI) studies have reported brain white matter degradation in subjects with chronic alcoholism using volumetric imaging and diffusion tensor imaging (DTI) [3,4]. However, white matter microstructure has not previously been examined in youth with AUD. DTI permits in-vivo quantification of the structural integrity of white matter. This study examines the fractional anisotropy (FA) of white matter tracts in the genu, body, and splenium of the corpus callosum in 8 adolescents with AUD and 8 demographically similar control subjects.

Method

Participants were recruited from north San Diego high schools. All participants and parents provided informed consent. Participants were screened for factors that could compromise the interpretation of DTI results or contraindicate MRI, including history of psychopathology or other substance use disorders, medical or neurological problems, use of psychotropic medications, learning disabilities, family history of psychiatric disorders, head injury with loss of consciousness, and presence of metal. Participants represent the community of north San Diego County on demographic factors such as age, gender, ethnicity, and annual household income (Table 1). All participants had been abstinent for at least 5 days at the time of scanning.

Imaging sessions utilized a 1.5 T GE Signa LX MRI scanner, located at the VA San Diego Healthcare System. Nine axial images through the corpus callosum were acquired with a high angular resolution diffusion encoding sequence using spiral acquisition [5,6]. Diffusion was encoded with a SE preparation along 42 diffusion directions with b = 2850 s/mm^2. Image parameters for the DTI sequence were: TE = 103 ms, 64 × 64 image matrix, slice thickness = 3.8mm, FOV = 24 cm^2, TR = 3 sec, and NEX = 5. The images were reconstructed onto a 64×64×9 grid, with an approximate isotropic voxel size of 3.75×3.75×3.8 mm^3. In addition, a spirally acquired high-resolution structural image was acquired in the sagittal plane for spatial normalization and structure localization.

Regions of interest (ROI) were drawn onto each subject's diffusion data set, using the method described by Pfefferbaum and colleagues [3]. Separate ROIs were determined for the genu, body, and the splenium of the corpus callosum by two trained raters who achieved good inter-rater reliability. Average fractional anisotropy (FA) values were extracted for each ROI. ROI selection and FA value extraction were performed in the AFNI suite of programs [7].

Results

One-way ANOVAs compared mean FA values for the genu, body, and splenium in AUD and control teens. FA values in the genu did not significantly differ between groups (0.65 ± 0.07 versus 0.67 ± 0.09, p = .650). However, AUD teens appeared to have lower FA than controls in the splenium (0.79 ± 0.03 versus 0.83 ± 0.04, p = .055), and showed a trend for lower FA in the body of the corpus callosum (0.74 ± 0.03 versus 0.77 ± 0.03, p = .084).

Lower FA values in the body of the corpus callosum were significantly related to longer durations of heavy drinking (r = -.63, p < .01) and more past alcohol withdrawal symptoms (r's = -.50 to -.55, p < .05). Low FA in the splenium significantly correlated with larger quantities of hard alcohol recently consumed (r = -.57, p < .025).

Table 1. **Summary of participant statistics**

	Alcohol Use Disordered	Control
N	8	8
Age	16.9	16.2
% Female	25%	44%
% Caucasian	100%	67%
Parent income	109K/yr	64K/yr
% Family history of alcoholism	63%	67%
WRAT Reading standard score	106.3	104.0
Drinks per month	42.4	2.6

Table 2. Summary of FA, F-statistics, and significance levels for each group and region

		FA	F	p
Genu:	AUD	0.6492	0.215	.650
	Control	0.6677		
Body:	AUD	0.7372	3.464	.084
	Control	0.7687		
Splenium:	AUD	0.7891	4.389	.055
	Control	0.8267		

Conclusion

These results provide in-vivo evidence for subtle abnormalities in white matter microstructure among adolescents with alcohol abuse or dependence. Future works will to use FA in conjunction with fMRI will further elucidate the relationship between white matter microstructure and cognitive changes associated with alcoholism.

References

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