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Comparison between patient characteristics and cranial MR findings in chronic thinner intoxication

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Abstract Chronic thinner intoxication is one of the most serious social problems among teenagers and young adults in Japan. The purpose of this study was to evaluate clinical characteristics of patients with thinner intoxication who had positive MR findings. During the past 4 years, cranial MR imaging of 85 patients (51 males and 34 females) with chronic thinner intoxication was done at a national psychiatric hospital. The MR imaging was performed on a 1.0-T scanner with use of standard pulse sequences including fluid-attenuated inversion recovery (FLAIR). The established characteristic MR findings of chronic thinner intoxication were observed in 8 of the 85 patients: 4 males and 4 females. The female patients tended toward emaciation and were approximately 5 years younger than the male patients. Six of the 8 patients had severe neurological symptoms such as cerebellar ataxia and decreased visual acuity. In contrast, only 3 of 77 (4%) patients with normal MR findings had mild neurological abnormalities such as tremor. If patients with chronic thinner intoxication have significant neurological symptoms, MR imaging should be performed for evaluation of brain abnormalities. Emaciated female patients may be particularly vulnerable to neurological damage caused by thinner intoxication.

Keywords Thinner abuser · Toluene · Toxic brain damage · White matter degeneration · Magnetic resonance imaging

Introduction

The term “thinner” is used generally herein to refer to organic solvents including pure toluene and lacquer thinner. Cranial MR imaging findings associated with chronic thinner (toluene) intoxication have been reported in neurology and radiology journals [1, 2, 3, 4, 5, 6, 7, 8]. The typical MR features on T2- and proton-density (PD)-weighted images include diffuse white matter hyperintensity of both pyramidal tracts and ponto-cerebellar tracts, hypointense thalami and basal ganglias, and diffuse brain atrophy. To investigate the relation between clinical characteristics and typical MR findings associated with chronic thinner intoxication, we studied the cases of thinner inhalation patients to differentiate between those who showed abnormal MR findings and those who did not. Then we determined differences in clinical characteristics between the two groups to determine any associations between these characteristics and the MR findings.

Materials and methods

Between January 1997 and February 2001, 85 patients suffering from thinner inhalation underwent MR imaging in a national psychiatric hospital. Excluding one patient whose initial inhalation time was not identified, all patients had at least a-3-month history of inhalation. Sixteen of the 85 patients had been inhaling less than 1 year. Fourteen of the 85 patients also abused other drugs such as methamphetamines. Among the male patients (n=51), ages at the time of MR imaging ranged from 13 to 44 years with a

mean age of 24 years. Among the female patients (n=34), ages at the time of MR imaging ranged from 13 to 31 years with a mean age of 18 years. We determined their ages at initial inhalation, duration of inhalation abuse, ages at MR imaging, body weight at the time of MR imaging, combination of other drug abuse, and status of neurological symptoms.

The MR imaging was performed on a 1.0-T scanner (Shimadzu, Magnex XP, Kyoto, Japan) with a quadrature head coil. Sagittal and axial T1-weighted spin-echo (SE) images (TR/TE=325/12 ms and TR/TE=520/12 ms, respectively), axial T2-weighted fast SE images (FSE; TR/TE=4300/110), and axial fast fluid-attenuated inversion recovery (FLAIR) images (TR/TE=6744/1588/110 ms) were obtained. The field of view was 22×22 cm. The section thickness was 6 mm with a 1-mm intersection gap. The imaging matrix was 256×256. The number of excitations was 2 or 4. All of these MR images were reviewed retrospectively and analyzed by an experienced neuroradiologist (A.U.). Questionable hyperintensities in the parietal white matter were regarded as normal.

Clinical characteristics of patients with abnormal MR findings were compared with those of patients with normal MR findings. Statistical analysis was performed using Student's t-test, and a p-value <0.05 was considered significant.

Results

The characteristic cranial MR findings of chronic thinner intoxication were observed in 8 of the 85 patients (4 males and 4 females; Fig. 1; Table 1). Characteristics of clinical data are summarized in Table 2. No significant difference existed between patients with abnormal MR images and patients with normal MR imaging in age of initial inhalation, duration of inhalation, and age at MR imaging. All 16 patients who had been users for under 1 year had normal MR images. Although ages of the initial inhalation were similar, female patients were on average 5 years younger (duration of inhalation was 5 years shorter) than male patients. In female patients body weight of patients with abnormal MR findings was significantly lower than that of patients with normal MR findings (t-test, p<0.05). Nine male patients and 5 female patients also abused other drugs (mainly methamphetamines), and only one of these 14 had abnormal MR findings. In patients with abnormal MR findings, 6 of 8 (75%) had neurological symptoms such as cerebellar

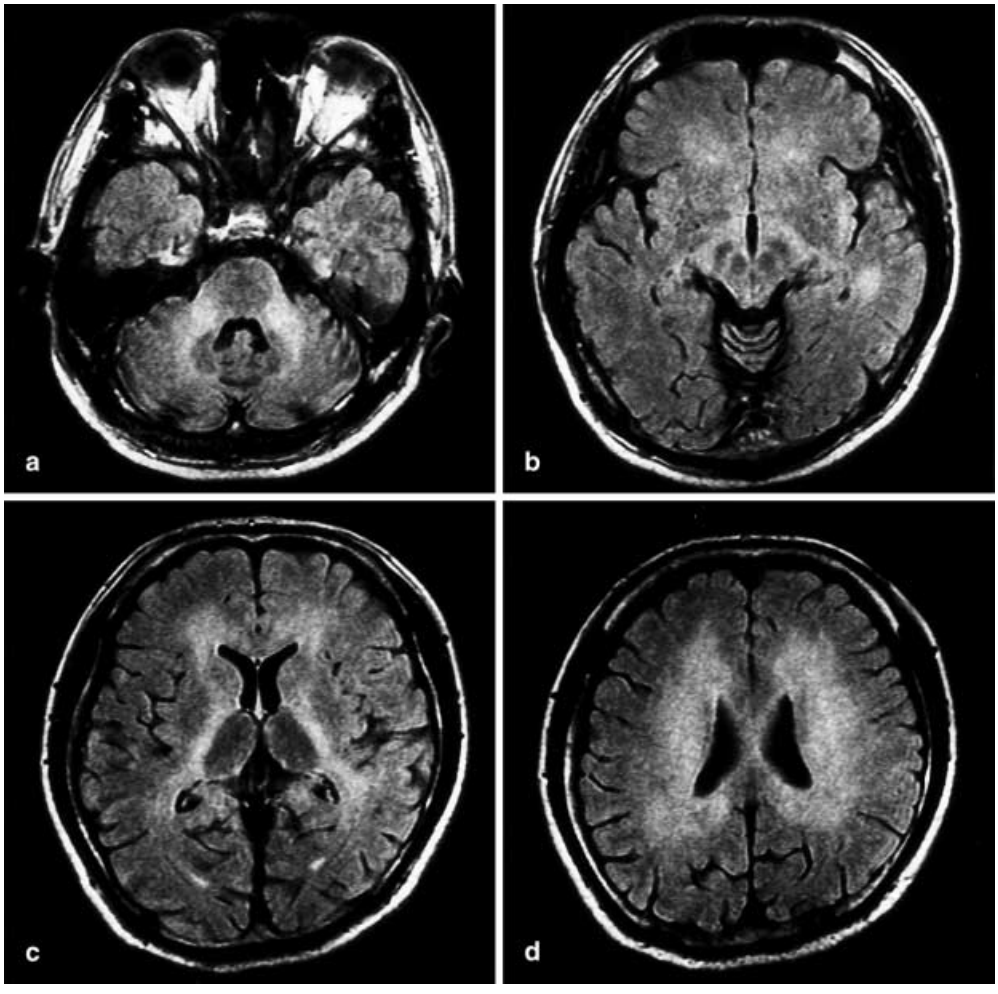

Fig. 1a–d Case 2. A 27-year-old man with a 12-year history of inhalation. Axial fluid-attenuated inversion recovery (FLAIR; TR/TE=6744/1588/110 ms) images show **a** symmetrically hyperintense middle cerebellar peduncles, **b** cerebral peduncles of the midbrain, **c** posterior limbs of the internal capsules, and **d** corona radiata. The subcortical U-fibers are not involved. The bilateral thalami are significantly hypointense (**c**). There are minimal cerebellar and cerebral atrophies (**a**, **d**)

Table 1 Characteristics of patients with thinner intoxication and abnormal MR findings. *FLAIR* fluid-attenuated inversion recovery. *DWMH* diffuse white matter hyperintensity; *HT* hypointense thalami; *BG* basal ganglia

Case no./age (years)/gender	Age at initial inhalation (years)	Duration of inhalation	Body weight[a]	Neurological symptoms	MR imaging findings on FLAIR images
1/20/M	15	5	55	Cerebellar ataxia Decreased visual acuity	DWMH, HT, no atrophy
2/27/M	15	12	74	Gait disturbance Incontinence, tremor	DWMH, HT, minimal atrophy
3/22/M	15	7	64	–	DWMH, HT, BG, mild atrophy
4/25/M	17	8	53	Cerebellar ataxia, tremor	DWMH, HT, BG, minimal atrophy
5/19/F	15	4	46	Dysstasia	DWMH, HT, no atrophy
6/21/F	18	3	44	–	DWMH, HT, BG, minimal atrophy
7/18/F	Unknown[b]	Unknown[b]	30	Decreased visual acuity	DWMH, no atrophy
8/17/F[c]	14	3	37	Decreased visual acuity	DWMH, HT, minimal atrophy

[a] At the MR examination
[b] The initial inhalation time was not identified
[c] This patient was also an abuser of methamphetamine

Table 2 Characteristics of patients with or without abnormal MR findings

	Male patients		Female patients	
	Abnormal MR findings (*n*=4)	Normal MR findings (*n*=47)	Abnormal MR findings (*n*=4)	Normal MR findings (*n*=30)
Mean age at MRI	24±2.7	23±7.5	19±1.5	17±3.7
Mean age of initial inhalation	16±0.9	15±1.2	16±1.7	15±2.0
Mean duration of inhalation (years)	8.0±2.5	7.1±1.2	3.3±0.5	2.3±3.0
Body weight	62±8.3	61±11.0	39±6.3[a]	52±10.0*
Neurological symptoms (+)	3 of 4	2 of 47	3 of 4	1 of 30
Other drug abuse[a]	0 of 4	9 of 47	1 of 4	4 of 30

Data are expressed as mean±SD
*$p<0.05$ (Student's *t*-test)
[a] Mainly abuse of methamphetamines

ataxia and decreased visual acuity. In contrast, only 3 of 77 (4%) patients with normal MR findings had mild neurological abnormalities such as tremor.

Initially, we planned to investigate differences in kind of thinner (pure toluene, lacquer thinner, or others), dose of thinner, and frequency of inhalation; however, we could not determine these data because the patients were not always questioned about such information during their evaluation and treatment. In addition, many of them were apathetic and mentally impaired, and thus unresponsive to questions that were asked.

Discussion

Chronic thinner intoxication is one of the most serious social problems among teenagers and young adults in Japan. During and immediately after inhalation of thinner, most patients have hallucinations and delusions. Many patients are caught while under the influence of thinner and are sent to psychiatric hospitals for withdrawal treatment. After discharge from hospitals, however, some resume the practice of inhaling thinner.

Cranial MR imaging findings of chronic thinner intoxication are well known. In our series, FLAIR images were obtained instead of PD-weighted images which have been more commonly used, and similar but more obvious abnormalities were found on FLAIR images than on T2-weighted images. To our knowledge, this is the first report of findings of FLAIR images in patients with chronic thinner intoxication. White matter hyperintensity is considered to represent damage to myelin (demyelination or myelin pallor) and gliosis [8]. The thalamic and basal ganglionic hypointensities are due to iron deposition or partitioning of toluene into the lipid membranes of cells in cerebral tissue [5, 6]. Diffuse brain atrophy including cerebellum and corpus callosum may be secondary results of brain damage.

Yamanouchi et al. [8] reported the cases of 7 patients with abnormal MR findings among 20 patients with chronic thinner intoxication who had inhaled for at least 1 year. In our series, however, these abnormal MR features were observed in only 9.4% (8 of 85) of patients. When our 16 patients whose inhalation history was under 1 year were excluded, the abnormal rate in our study became 11.6% (8 of 69). We compared the clinical char-

acteristics of our patients who had abnormal MR findings with those of patients without MR abnormalities. Although the reason why the abnormal rate of our series was lower than that of previous study was not clear, our patients may have been relatively infrequent abusers. In general, the combination of daily dose and frequency of inhalation seems to have an effect on degree of brain damage, and in Japan, the majority of the patients inhalate pure toluene; however, we could not determine dose of thinner, frequency of inhalation, and kind of thinner. According to Yamanouchi et al. [8], diffuse white matter change with brain atrophy was seen in patients who had abused mainly lacquer thinner, and patients with restricted white matter change and intermediate white matter change had abused mainly pure toluene. Age at initial inhalation, duration of inhalation, and age at MR imaging were similar in both our groups. The finding that female patients had an average 5-year shorter history of inhalation than male patients indicates that female patients may be more vulnerable than male patients to thinner intoxication. Chronic thinner abusers tend to be emaciated, especially female patients. We routinely measured body weight of patients at the time of MR imaging. Female patients with abnormal MR findings were more emaciated than were female patients without MR abnormalities. In thinner abusers in general, daily dose of thinner correlated with decrease in volume of food intake. Moreover, thinner is well known to have an affinity for lipids; thus, when thinner abusers are emaciated, the implication is that they are susceptible to thinner penetration of the myelin sheath, and that this penetration would be associated with white matter degeneration. The combination of thinner abuse with abuse of other drugs, such as methamphetamines, was not a factor associated with MR abnormalities. Presence of neurological symptoms, including cerebellar ataxia and decreased visual acuity, was the most important clinical feature of patients with MR abnormalities; therefore, if chronic thinner abusers have neurological symptoms, cranial MR imaging should be performed for the evaluation of brain damage. Conversely, if patients have no definite neurological symptoms, MR imaging may not be useful. Filley et al. [2] reported a correlation between degree of white matter abnormality and dementia in chronic toluene abusers. In our series we did not evaluate mental function because most of the thinner abusers were apathetic and mentally impaired to various degrees.

Conclusion

Our present data show two useful connections: one between the presence of clinical neurological symptoms and chronic thinner intoxication; and the other between the tendency toward emaciation and the female gender. Thus, MR imaging may only be useful for evaluating brain abnormalities in chronic abusers who also have neurological symptoms. Additionally, female patients who are underweight and in danger of emaciation should be carefully evaluated since they may be more vulnerable to brain damage than are patients with a relatively normal weight.

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