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Letter to the Editor

The facial nerve atrophy with spinal and bulbar muscular atrophy patients (SBMA): Three case reports with 3D fast imaging employing steady-state acquisition (FIESTA)

Dear Editor

1. Introduction

Spinal and bulbar muscular atrophy (SBMA) is an X-linked neuromuscular disease caused by a CAG repeat expansion in the *androgen receptor (AR)* gene [1]. Men afflicted with SBMA develop weakness, atrophy, and fasciculations in the limbs and bulbar muscles during adulthood [2]. In SBMA, facial fasciculations and facial weakness are often prominent. Past SBMA histopathological reports observed that the marked depletion of lower motor neurons (LMNs) through all spinal segments and brainstem motor nuclei – including the facial nerve (FN), but not the third, fourth and sixth cranial nerves – whereas primary sensory neurons were less severely affected [3]. Although weakness and atrophy of the facial muscle is one of the major symptoms of SBMA, no studies have yet focused on the diagnostic value of MRI for the evaluation of the cranial nerves in SBMA patients.

High-resolution MRI of the cranial nerves has allowed examiners to observe cisternal and internal auditory canal segments of cranial nerves in exquisite detail. In particular, balanced steady-state free-precession (SSFP) techniques such as fast imaging employing steady-state acquisition (FIESTA), an SSFP technique with intrinsic flow suppression and high signal-to-noise ratio, allows for the visualization of fine structures including the spatial relationship of the FN and cochlear nerve (CN) from the brain stem to the internal auditory canal [4,5]. Therefore, this study aimed to evaluate whether the FN atrophy observed in three SBMA patients with FIESTA was related to SBMA-induced LMN impairment.

2. Case reports (Table 1)

2.1. Case 1

A 65-year-old hairdresser noticed fine tremor in his hands and finger weakness from his fourth decade of life. Physical examination revealed that he had slight weakness and atrophy of the masseter muscles and marked atrophy of the tongue.

2.2. Case 2

A 67-year-old man had a slowed walking pace and proximal muscle weakness for more than 5 years. He showed muscle weakness and atrophy in the face, tongue and upper and lower limbs.

2.3. Case 3

A 48-year-old man had complained of vague, progressive, mild proximal limb muscle weakness for 5 years. Examination showed mild orbicularis oris weakness.

In all patients, nerve conduction study (NCS) showed mild, axonal-type, peripheral neuropathy, and electromyography (EMG) showed scattered giant motor unit potentials over most muscle groups.

3. MRI data acquisition

All MRI studies were performed with a Signa Excite 3 T scanner (GE Healthcare). Multiplanar reconstruction (MPR) with FIESTA was performed in the parasagittal orientation perpendicular to the long axis of the internal auditory canal (perpendicular to the long axis of the CN).

4. Image evaluations

The MPR images were scrolled through until the level where the facial, cochlear, and vestibular nerves were clearly separated from each other at the mid-point of the internal auditory canal (Fig. 1(A)). At this level, regions of interest (ROI) were drawn along the perimeter of the CNs and FNs (Fig. 1(B)). The ratio of the size of the CN to that of the FN was calculated by dividing the cross-sectional surface area of the CN by that of the ipsilateral facial nerve. The control data obtained from previous reports were compared with our own data [6]. In all patients, the quantitative MRI evaluations were performed before the molecular diagnoses. In comparison with controls [6], patients with SBMA exhibited smaller cross-sectional surface areas of the FN and a larger CN/FN ratio (CFR); however, the CN sizes of the two populations were comparable (Table 1 and Fig. 2).

5. Discussion

We herein described three patients with SBMA who exhibited facial nerve atrophy in the internal auditory canal but relatively preserved CNs. To the best of our knowledge, this report was the first to present abnormal cranial MRI findings that might reflect and correlate with SBMA-induced LMN impairment. Since three patients with SBMA and facial nerve palsy underwent FIESTA 4 weeks before the diagnosis was determined by molecular genetic testing, abnormal findings could be observed early in the disease course. Histopathology demonstrated the loss of motor neurons all throughout the spine, as well as some lower brainstem motor nuclei innervating facial and bulbar musculature, while primary sensory neurons remained preserved [3]. Furthermore, a prior report suggests that the loss of motor neurons is not a retrograde phenomenon but rather a primary neuronal perikaryal event [5]; our early observation of the larger ratio of the cochlear to facial nerve size supports these findings.

3D high-resolution, heavily T2 weighted variable sequences of the fast spin echo (SPACE, Cube, etc.) and gradient echo (true FISP, true SSFP, constructive interference in steady state; CISS, FIESTA, etc.) of

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Table 1
Patient characteristics and FIESTA findings.

		Patients			Normal controls[a] (n = 33, Male = 22)	
		Case 1	Case 2	Case 3	Ave ± SD	Range
Clinical data						
Age, y		65	67	48	47.8 ± 17.1	17–75
Disease duration, y		20	5	5	−	−
Fasciculation		tongue	upper and lower limbs	facial, tongue	−	−
Tendon reflexes		all absent	all absent	normal	−	−
Gynecomastia		+	+	+	−	−
CK, IU/L		748	1187	1011	−	−
CAG repeats		43	45	47	−	−
FIETSA findings						
CN, mm^2	R	1.50	1.57	1.64	1.51 ± 0.35	1.00–2.30
	L	1.87	1.64	1.57	1.53 ± 0.32	1.00–2.50
FN, mm^2	R	0.67	1.12	0.45	1.33 ± 0.41	0.70–2.50
	L	0.30	0.82	0.60	1.27 ± 0.34	0.67–2.30
CFR	R	2.34	1.43	3.64	1.18 + 0.23	0.78–1.71
	L	9.57	3.22	2.62	1.25 ± 0.25	0.85–1.94

Abbreviations: Ave; Average, SD; Standard deviation, CK; Creatine phosphokinase, IU/L; International unit/liter, FIESTA; Fast imaging employing steady-state acquisition, CN; Cochlear nerve, FN; Facial nerve, CFR; Cochlear nerve to facial nerve ratio

[a] Normal controls showed normal MRI findings, and they had no history of facial and vestibular nerve abnormalities or suspected inflammation of the facial nerve.

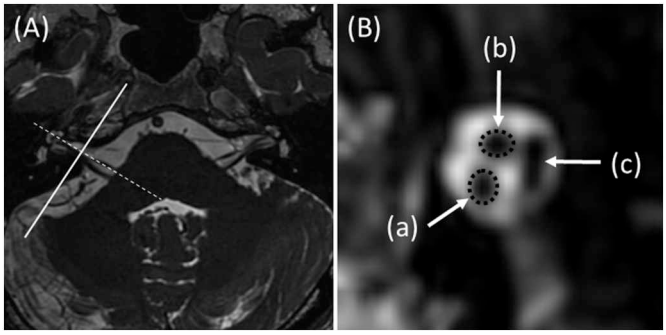

Fig. 1. FIESTA at the level of the internal auditory canal showing the orientation of the parasagittal multiplanar reconstruction (MPR) of the internal auditory canal (A) and the corresponding reconstructed image (B) showing the level of assessment where the three nerves (a; cochlear nerve, b; facial nerve, c; vestibular nerves) are seen separately at the right internal auditory canal (arrows). Freehand region of interests (ROIs) were drawn around the circumference of the cochlear and facial nerve (circled dots).

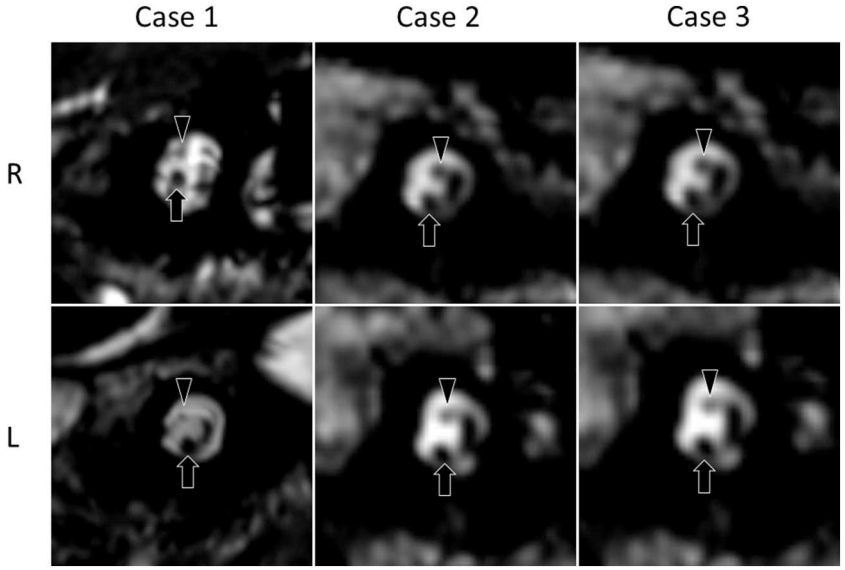

Fig. 2. The three patients with SBMA.
On the parasagittal reconstructed FIESTA, the facial nerve (arrowhead) is less than half the size of the cochlear nerve (arrow) in all cases.

the cerebellopontine angle has been used for the evaluation of various pathologic processes. These are reportedly useful for screening and detailed examinations of the facial and cochlear nerves [6–9]. Naguib et al. reported that the CN size and the cochlear to facial nerve size ratio in patients with acquired long-standing sensorineural hearing loss are significantly smaller than those of normal controls [7].

MRI may be a highly effective and sensitive measure both in the description of facial nerve atrophy in patients with SBMA as well as in the detection of longitudinal changes in disease severity related to the LMSs impairments of SBMA. Our assessment with FIESTA, which can be used to directly evaluate LMNs, has clinical significance in that it may provide a simple, non-invasive, accurate method for detecting LMN impairment. Moreover, in a previous study with normal subjects, the FN size was not found to be affected by sex or age of the subject [10], suggesting that our method can be clinically useful as an objective marker for LMN impairment.

The clinical examinations such as standardized rating scale measurements of bulbar muscle strength (the bulbar rating scale) were not included. Combination of the clinical examinations and the MRI measurements might be an interesting area for further studies. Moreover, only 3 SBMA patients were assessed. Therefore, large multicentric study with patients from various countries are needed to be conducted an extended analysis to a broader cohort.

In summary, our study revealed FN atrophy and small CFR, which could be seen in the early stage of SBMA and reflected directly by LMN impairment.

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Mari Miyata[a,*], Shingo Kakeda[a], Tomoyo Hashimoto[b], Yukunori Korogi[a], Hiroaki Adachi[b]
[a] *Department of Radiology, University of Occupational and Environmental Health, School of Medicine, Kitakyushu, Japan*
[b] *Department of Neurology, University of Occupational and Environmental Health, School of Medicine, Kitakyushu, Japan*
E-mail address: mmiyata-radiology@med.uoeh-u.ac.jp (M. Miyata).

[*] Corresponding author at: Department of Radiology, University of Occupational & Environmental Health, Iseigaoka 1-1, Yahatanishi-ku, Kitakyusyu-shi 807-8555, Japan.