Fibromuscular dysplasia (FMD) is a non-inflammatory and non-atherosclerotic disease of unknown cause which affects the small- and medium-sized arteries. The most commonly involved blood vessels are the renal and cervicocephalic arteries. If the disease involves the cervicocephalic arteries, it can cause abnormalities, including carotid and vertebral artery stenosis, arterial dissection, and aneurysm formation [1-3].

FMD is definitively diagnosed by imaging studies such as computed tomographic angiography (CTA), magnetic resonance angiography (MRA), and digital subtraction angiography (DSA) [2]. High-resolution magnetic resonance imaging (HR-MRI) techniques have recently been in-
troduced to clinical practice, and provide a high value for the etiological diagnosis of intracranial arterial diseases [4-7]. Here, we report patients diagnosed with cervico-cephalic FMD who underwent HR-MRI. To our knowledge, this is the first case report of HR-MRI in a patient with intracranial FMD.

**CASE REPORTS**

**Case 1**

A 60-year-old previously healthy woman was admitted with short-term vertigo lasting a few seconds. Vertigo was aggravated by positional changes and improved with bed rest. Initial neurological examination results were normal. She was diagnosed with benign paroxysmal positional vertigo as the cause of symptoms. Brain CTA showed multiple stenoses and dilatations with a string-of-beads appearance in the left internal carotid artery (ICA) (Fig. 1A). The patient was admitted to our hospital for DSA. In the left common carotid artery angiogram, vessel tortuosity and a string of beads were observed from the left petrous portion to the ICA bifurcation, a typical luminal feature of FMD (Fig. 1B). Aorta angiography revealed normal renal arteries bilaterally (Fig. 1C). HR-MRI revealed concentric wall thickening and saccular enhancement with dystrophic calcification (arrows).

![Fig. 1.](image1) (A) Brain computed tomographic angiography showing multiple stenosis and dilatation in the left internal carotid artery (arrow). (B) Digital subtraction angiography (DSA) shows vessel tortuosity and string-of-beads sign from the left petrous portion to the internal carotid artery bifurcation. (C) DSA showing bilateral normal renal artery at the renal-level aortogram.

![Fig. 2.](image2) High-resolution magnetic resonance imaging showing concentric wall thickening and saccular enhancement with dystrophic calcification (arrows).
concentric wall thickening and saccular enhancement with
dystrophic calcification in the distal segment of the left ICA
(Fig. 2). Aspirin was prescribed at discharge, and she had no
symptoms for up to 6 months after discharge.

Case 2
A 42-year-old, previously healthy woman visited our hospital
with headache and shoulder pain. Initial neurological exam-
ation results were normal. She underwent brain MRI and
MRA to rule out secondary headache. MRA of the brain further
revealed dilatation and tortuosity of the right ICA (Fig. 3A). HR-
MRI was performed for further evaluation, and aortic CTA was
performed to identify any renal artery involvement. No steno-
sis or aneurysmal dilatation was observed in the renal arter-
ies (Fig. 3B). HR-MRI revealed diffuse wall thickening but no
enhancement in the right ICA from the petrous portion to the
distal communicating segment (Fig. 3C, D).

Written informed consents by the patients were waived due
to retrospective nature of our study.

DISCUSSION

Intracranial arteries are involved in 7% to 20% of cases of cer-
vicoencephalic FMD [8]. Most cervico-encephalic FMD are lo-
ated in the ICA, most commonly in the middle or distal seg-
ments. Vertebral artery involvement is less frequent and gen-
erally co-exists with carotid lesions. In addition, 50% of pa-
tients with carotid artery lesions have renal artery disease [9].

Our patient presented with headaches and vertigo. In the
United States registry for FMD, 60% of patients experienced
significant headache [10]. Pulsatile tinnitus is another com-
mon symptom of FMD. Dizziness may occur in one quarter of
the patients, but true vertigo is uncommon in FMD. The most
disruptive sequelae of cerebrovascular FMD include transient
ischemic attack, stroke, subarachnoid hemorrhage, and cer-
vical artery dissection, which have been reported in 13%,
10%, 1.1%, and 12% of patients, respectively [10]. Severe ste-
nosis producing cerebral hypoperfusion, thromboembolism,
dissection, and aneurysmal rupture could be mechanisms of
focal neurological events. Treatment of FMD patients de-

deps on the particular neurological symptoms and compli-
cations [8]. In this study, patients asymptomatic, and there
were no vascular complications such as dissection and aneu-
rysmp.

The pathological classification of FMD is based on the dom-
inant vessel wall layer, intima, media, and adventitia. Among
the three pathological FMD types, the media type is the most
common, accounting for more than 85% of cases [1,10,11].
Medial fibroplasia shows multifocal stenosis, termed the
’string-of-beads; appearance, while intimal fibroplasia shows
focal stenosis [3]. The cases presented in this report were
classified as having media-type FMD involving intracranial
ICA. Medial FMD presents as alternating areas of thinned me-
dia and thickened fibromuscular ridges in which the arterial
muscle is replaced by fibroplasia with loose collagen [11].

In this series, HR-MRI of the first case showed concentric
wall thickening and saccular enhancement, whereas the other case showed no enhancement. The clinical implications of vascular enhancement in FMD remain unclear. In cases with carotid web, also known as carotid intimal variant FMD, previous studies have shown that HR-MRI reveals protrusion with enhancement along the posterior margin of carotid bulb [12]. HR-MRI feature of concentric wall thickening may be related to the pathological features of thickened fibromuscular ridges. In addition, the HR-MRI findings of concentric enhancement with wall thickening in our case were similar to those of patients with symptomatic moyamoya disease [6]. Therefore, diffuse concentric enhancement within vessels could represent hyperproliferation of the vessel wall components and may be related to symptomatology in FMD. Further studies are needed to determine whether HR-MRI can provide information about the natural course of FMD.

In conclusion, HR-MRI can be used to directly visualize vessel walls. As the natural course of this disease varies among patients with FMD despite similarities in luminal features, further studies with HR-MRI are needed to test the diagnostic and prognostic role of HR-MRI in patients with FMD.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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