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Supporting Data

Additional Supporting Information may be found in the online version of this article at the publisher's web-site.

Magnetic Resonance Imaging–Guided Focused Ultrasound Thalamotomy in Spinocerebellar Ataxia Type 12

Spinocerebellar ataxias (SCAs) are progressive, neurodegenerative disorders generally associated with a variety of symptoms. The SCA12 is typically associated with action tremor of the upper extremity, and symptomatic treatment is challenging.[1]

Stereotactic neurosurgery is performed to treat severe, therapy-refractory tremor, mainly in essential tremor and Parkinson's tremor. In addition, transcranial high-intensity magnetic resonance–guided focused ultrasound (MRgFUS) is a new technique for interventional neuromodulation. Tremor reduction is achieved through targeted thermal lesion of the Nucleus ventralis intermedius (VIM) of the thalamus or the cerebello-thalamo-cortical tract (CTT).[2]

Single case reports previously demonstrated the effective use of DBS for the treatment of tremor or dystonia in SCAs.[3,4] However, to our knowledge, no patient with SCA12 has been treated with MRgFUS so far.

Herein, we report on a patient suffering from SCA12 with severe, therapy-refractory tremor and favorable outcome after lesioning the CTT by MRgFUS.

A 60-year-old man with severe action tremor of the upper extremity and positive family history (Supporting Information Fig. S1) was diagnosed with SCA12 in 2014 after genetic analysis, which demonstrated a CAG repeat expansion in the PPP2R2B gene of 15/58. After written informed consent, unilateral treatment with MRgFUS was performed targeting the CTT using 3-T diffusion tensor imaging as described previously[5] (Supporting Information Fig. S2). A total of five ablative sonications (peak temperature > 56°C) at two locations (first: 1 mm superior to AC-PC plane, 14 mm lateral to midline, 25% of the AC-PC distance anterior to PC; second: 0.5 mm laterally and 0.5 mm anteriorly in relation to the first target) were performed. A near-total tremor reduction in the right arm was obtained. Within the first days after treatment, gait disturbances occurred but resolved completely within 3 months. The Supporting Information Videos S3–S6 show the tremor before and 3, 90, and 320 days after MRgFUS. On the Fahn-Tolosa-Marin Tremor Scale, tremor score improved from 90/260 to 51/260 after 3 days and remained stable after 11 months (47/260). On the Scale for the Assessment and Rating of Ataxia, no worsening of ataxia was apparent (21.5/40 at baseline, 20/40 after 11 months) (Fig. 1A, Supporting Information Fig. S7A–C).

Using a triaxial accelerometer (SOMNOwatch plus; SOMNOmedics, Randersacker, Germany), tremor was recorded and Fourier transformed (Software DOMINO light; SOMNOmedics). After MRgFUS, a significant reduction of tremor power was observed in the right upper extremity (Supporting Information Table S8, Fig. 1B). The analysis of diffusion tensor imaging indicated a reduction of the fiber tract streamline count from 4039 before to 569 after MRgFUS.

Unilateral thalamotomy using MRgFUS appears to provide a safe and efficient means for tremor reduction in SCA12. Comparably with stereotactic treatments in essential tremor, the VIM or CTT can serve as an appropriate target for tremor reduction in cerebellar degeneration; moreover, no persistent worsening of ataxia or disruption of microstructural integrity in other regions than the CTT-related regions was observed within 11 months of follow-up. This is consistent with previous reports in patients with SCA receiving deep brain stimulation of the VIM.[3,4,6]

In conclusion, we consider MRgFUS a promising, incisionless alternative to treat severe action tremor also in rare diseases, such as SCA12.

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Data Availability Statement

Data available on request from the authors.

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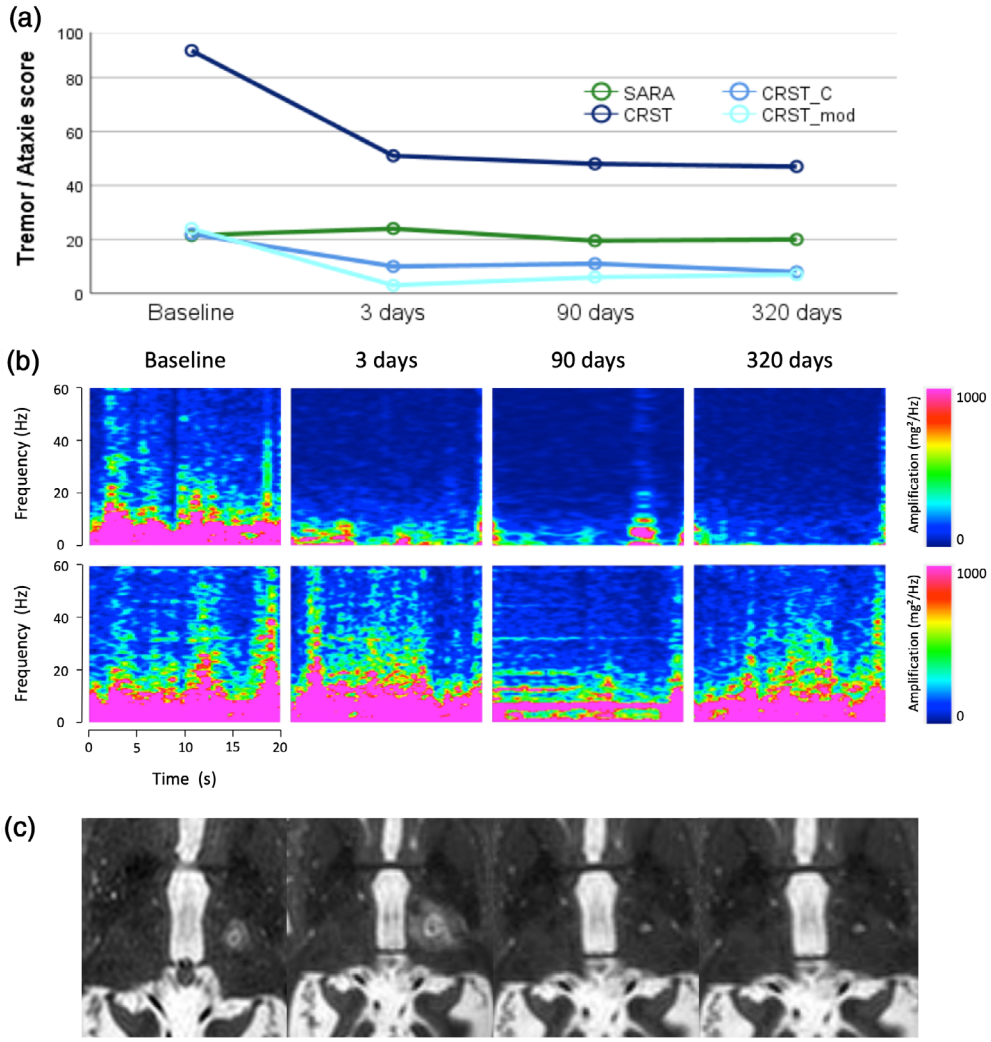

FIG. 1. (**a**) Results for *CRST* (Fahn-Tolosa-Marin Tremor Scale), *CRST_mod* (modified handscore), *CRST_C* (disability), and *SARA* (Scale for the Assessment and Rating of Ataxia) score. (**b**) Standard spectral analysis: time-frequency power spectra in action condition of the right (upper panel) and left upper extremity (lower panel) at four time points. (**c**) T2-weighted magnetic resonance imaging at four time points.

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Supporting Data

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