Missense mutations in DYT-TOR1A dystonia

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DYT-TOR1A dystonia is caused by dominant mutations in the TOR1A gene, most frequently a heterozygous in-frame deletion in exon 5 (c.904_906delGAG; p.302/303delE). The most frequent phenotype has childhood onset in a limb, spreading to generalized dystonia within a few years. However, also mild focal forms and onset in the cervical and even cranial region have been described. Age at onset varies from 3 to 64 years, and penetrance is only 30%. Other in-frame deletions and point mutations in TOR1A have been associated with dystonia in a limited number of patients. Here, we report 2 new patients with missense mutations in TOR1A.

Patient 1

Patient 1 (IV-1; figure, A) was born from nonconsanguineous Caucasian parents. Focal dystonia started at age 40 years with painful dystonic writer’s cramp affecting the right wrist and finger flexors. She was treated with botulinum toxin injections, but after 10 years, she discontinued treatment because of very mild symptoms. At age 60 years, only increased blink rate was noted. Two of her children were identified with hyperkinetic movements from adolescence (figure, A). A daughter (V-2; figure, A) had an increased blink rate and a mild head tremor. Her son (V-3; figure, A) was treated with botulinum toxin for a dystonic head tremor and mild torticollis. Gene panel sequencing was performed as described previously, revealing a likely pathogenic mutation, c.934A>G; p.R312G in TOR1A (figure, B), which is conserved down to zebrafish (figure, C), has a Combined Annotation Dependent Depletion (cadd.gs.washington.edu) score of 19.5, and is found only once in 246266 alleles (0.0004061%) in the gnomAD database (gnomad.broadinstitute.org). Sanger sequencing revealed segregation of the mutation with the phenotype (figure, A). Using homology modeling, a possible deleterious effect of p.R312G was assessed. The basic torsinA structure should be unaffected by the variant. In the wild type, however, the highly flexible arginine allows R312 to come as close as 2.7 Å to one of the adenosine triphosphate ribose hydroxyls and make hydrogen bonds. In the R312G mutant, this interaction is lost, thus possibly causing protein malfunctioning (figure, D).

Patient 2

Patient 2 (II-1; figure, E) was born from nonconsanguineous Caucasian, healthy parents. Pre- and postnatal periods and psychomotor development were normal. Dystonia started cervically at age 15 years, with phasic torti- and retrocollis, which within 2 years generalized to involve the trunk and upper extremities. Cervical botulinum toxin injections provided some relief until age 23 years. Oral trihexyphenidyl, and levodopa and clonazepam added 2 years later, improved his severe axial dystonia only slightly. At age 26 years, brain and spine MRI and neuropsychological testing were normal. Testing for the classic 3-basepair deletion in TOR1A was negative. He had no impairment of voice, speech, or swallowing, but pathologic face grimacing and moderate...
Of the published missense mutations in TOR1A (mdsgene.org), genetic recurrence has so far only been reported for p.R312G. Most reported patients with TOR1A missense mutations presented with adult onset, including the p.R312G index patient in our study. This may indicate that missense mutations have a less profound effect on torsinA function than the common deletion. However, the phenotypic spectrum of TOR1A mutations is very broad, ranging from nonpenetrance to isolated focal, segmental, or generalized dystonia in carriers of different types of mutations, which is highlighted in our and previous reports.4,7 The causes of this large phenotypic

**Figure** Pedigrees of patient 1 and 2, partial Sanger chromatograms, amino acid conservation, and homology modeling.
variation in TOR1A mutation carriers still largely remain elusive.

Author contributions
Z. Iqbal: bioinformatic analysis and interpretation of data, wet laboratory work, and drafting and revision of the manuscript. J. Koht: ascertaining the patients and clinical data, study concept and design, and drafting and revision of the manuscript. S.P. Henriksen: preparation of the samples for sequencing and arrangement of the samples. C. Cappelletti: wet laboratory work. M.B. Russell: ascertaining the patients. O. Norberto de Souza: homology modeling and drafting the manuscript. L. Pihlstrøm: bioinformatic analysis, interpretation of data, and revision of the manuscript. I.M. Skogseid: ascertaining the patients and clinical data, study concept and design, and drafting and revision of the manuscript. M. Toft: study concept and design, obtained funding, study supervision, and revision of the manuscript.

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Disclosure
Disclosures available: Neurology.org/NG.

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References
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This information is current as of June 6, 2019
In the article "Missense mutations in DYT-TOR1A dystonia" by Iqbal et al., first published online June 6, 2019, the genotype under patient IV-1 in panel A of the figure should have read “M/-.” Additionally, the third label in the second row of panel A in the same figure should read “II-3.” The editorial office regrets the errors.

REFERENCE