CASE REPORT

What is the impact of a novel DEPDC5 variant on an infant with focal epilepsy: a case report

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Abstract

Background: Variants in the DEPDC5 have been proved to be main cause of not only various dominant familial focal epilepsies, but also sporadic focal epilepsies. In the present study, a novel variant in DEPDC5 was detected in the patient with focal epilepsy and his healthy father. We aimed to analyze the pathogenic DEPDC5 variant in the small family of three.

Case presentation: A 5-month-old male infant presented with focal epilepsy. Whole exome sequencing identified a novel heterozygous variant c.1696delC (p.Gln566fs) in DEPDC5, confirmed by Sanger sequencing. The variant was inherited from healthy father.

Conclusions: Our study expands the spectrum of DEPDC5 variants. Moreover, We discuss the relation between the low penetrance of DEPDC5 and the relatively high morbidity rate of DEPDC5-related sporadic focal epilepsy. Besides, due to interfamilial phenotypic and genetic heterogeneity, we speculate the prevalence of familial focal epilepsy with variable foci might be underestimated in such small families. We emphasize the importance of gene detection in patients with sporadic epilepsy of unknown etiology, as well as their family members. It can identify causative mutations, thus providing help to clinicians in making a definitive diagnosis.

Keywords: DEPDC5, Focal epilepsy, Whole exome sequencing, FFEVF, Case report

Background

The DEPDC5 (OMIM #614,191) is located on chromosome 22q12.2–12.3. It contains 43 exomes and encodes the disheveled, Egl-10 and pleckstrin domain-containing protein 5 (DEPDC5), a full-length protein composed of 1603 amino acids [1]. DEPDC5 is a part of the GAP Activity Toward Rags 1 complex, which also contains nitrogen permease regulator-like-2 and nitrogen permease regulator-like-3. They work together and regulate mammalian target of rapamycin complex 1 (mTORC1) negatively [2]. The mTORC1 participates in the regulation of neuronal growth, homeostasis and metabolism in neurons. Besides, mTORC1 plays an important role in the development of neurons, such as the differentiation of neurons, synapse formation and neurite outgrowth [3].

To date, variants in the DEPDC5 have been proved to be main cause of various dominant familial focal epilepsies, such as autosomal dominant sleep-related hypermotor epilepsy, familial focal epilepsy with variable foci (FFEFV), familial temporal lobe epilepsy and focal epilepsy caused by various cortical developmental malformations [4]. According to the reports, 13% of familial lateral temporal lobe epilepsies caused by DEPDC5 variants [5]. The DEPDC5 is also related with 13% of autosomal dominant sleep-related hypermotor epilepsies [6].
What’s more, more than 80% FFEVF patients were caused by DEPDC5 variants [4]. Besides, variants in DEPDC5 have been detected in many patients with non-familial focal epilepsies [7]. Here we describe a 5-month-old male infant with focal epilepsy, and discuss what role a novel DEPDC5 variant plays in the small family of three.

**Case presentation**

The male infant was born to healthy non-consanguineous parents. There was no discovered family history of epilepsy or other nervous system diseases. The patient was the only child of his family. He was born at term with no asphyxia after an uneventfully pregnancy. His weight and body length were within the normal range at birth. The neonatal period was unremarkable. And up to now, there has been no problem with the patient’s developmental milestones.

At the age of 5 months, the infant appeared the first afebrile epileptic seizure, which happened when he was sleeping. It lasted for 10 s approximately. And it was characterized by eyes blinking frequently, followed by binocular gaze and the tonic seizure of right upper limb. Asking for past medical history, we found it worth noting that the patient showed short-lasting symptom of blinking about half of a month ago. While, it failed to draw the attention of his parents. Physical examinations and the laboratory examinations showed no abnormality. The blood and urine metabolic screenings were normal as well. The brain magnetic resonance imaging (MRI) showed widened extracerebral space and widening of the beginning of left lateral fissure cistern. A video-electroencephalogram (EEG) revealed epileptiform discharges with spikes and sharp waves over the right frontal area (Fig. 1).

Before the infant received effective treatment, he experienced 9 times focal seizures with similar symptoms. The epileptic seizure usually happened before sleep or during sleeping period. In order to control the epileptic seizure, the patient received a treatment of phenobarbital (5 mg/kg) at first. However, the seizure wasn’t controlled until topiramate was applied. 5 months later, a follow-up review found that epileptic seizure had not occurred to the infant since he discharged from the hospital. And 6 months later, the re-examine of video-EEG showed nothing unusual. The psychomotor development didn’t show retardation or decline. So far, the patient has been seizure-free for 7 months.

We performed whole exome sequencing (WES) to the patient and detected a novel heterozygous variant in DEPDC5 (NM_001242896.1), c.1696delC. The variant was autosomal dominant and could result in a frameshift in translation (p.Gln566fs) and a premature termination codon (PVS1). Besides, it was absent in healthy controls in the 1000 Genomes Project Database [8], the Exome Aggregation Consortium Database [9] or National Heart, Lung, and Blood Institute Exome Sequencing Project [10] (PM2). And it was not recorded in Human Gene Mutation Database [11]. As a result, the variant c.1696delC in DEPDC5 was classified as “likely pathogenic” based on the above evidence according to the 2015 American College of Medical Genetics and Genomics variant classification guidance [12]. The variant was confirmed by Sanger sequencing (the primers used for amplifying were forward 5’—TCTTCAAGGCAGTTCTT—3’ and reverse 5’—AGCAACAAACTTACCCACA—3’) using the DNA of the family members (see Fig. 2). And the result revealed that the variant was inherited from healthy father. The mother didn’t carry this alteration. The pedigree chart in this family is shown in Fig. 3.

**Discussion and conclusions**

DEPDC5 variants have been demonstrated to be the most common cause of familial focal epilepsies. While in clinical work, most patients have no family history of epilepsy. In 2017, a study reported that 2 in 220 (0.9%) patients with sporadic non-lesiona focal epilepsy, had disease-causing variants in the DEPDC5 [7]. It suggested DEPDC5 also have a significant effect on sporadic focal epilepsy.
epilepsy. FFEVF, proved mainly caused by DEPDC5 variants, is a type of autosomal dominant epilepsy. It is characterized by an obvious intrafamilial variation that focal seizures happen in different cortical regions within the family members. Seizure type varies considerably between individuals, rather than showing phenotypic homogeneity [13]. Because of its interfamilial phenotypic and genetic heterogeneity, we speculate that the prevalence of FFEVF might be underestimated in small families. Interestingly, in the case we reported, the infant’s variant was inherited from his healthy father who carries the same variant as the infant. In addition to considering that variable expressivity could be caused by the combination of genetic, environmental, and lifestyle factors, this is accordant with the low penetrance (45–67%) which has been reported in previous studies [7]. Besides, viewing Table 1 which shows clinical expressions of various focal epilepsies caused by DEPDC5 variants as well as that of proband, it is impossible to exclude the possibility of FFEVF. Though this family is so small that we can’t diagnose the epilepsy as FFEVF clinically yet. In view of this situation, the misdiagnosed families may contribute to the relatively high morbidity rate of sporadic focal epilepsy. To some degree, it can explain why DEPDC5 variants account for nearly 1% of patients with sporadic focal epilepsy. It suggests that gene detection is necessary for the patients with sporadic epilepsy of unknown etiology, as well as their family members. The identification of DEPDC5 variants in these small families enables the possibility of molecular diagnosis with FFEVF. In the

Fig. 2 Sanger sequencing confirmed the DEPDC5 (c. 1696delC) variant. Both the proband and his father father carried the heterozygous variant. The nucleotide deletion was marked with a dark box in the reverse sequencing

Fig. 3 Pedigree chart in this family. The father (II) was healthy (marked as a dark dot in a blank background) even though he carried the heterozygous variant c.1696delC in DEPDC5. The proband (III, pointed out by the arrow) inherited the variant from his father and developed the corresponding disease (marked as dark)
Table 1 Clinical expressions of various focal epilepsies caused by DEPDC5 variants

|                      | ADSHE [6] (ADNLE) | ADEAF [5] (ADLTE) | FFEVF [4] | Proband’s epilepsy               |
|----------------------|-------------------|------------------|-----------|----------------------------------|
| **Average age at onset** | Childhood (8-12 years) | Adolescence-Adult (16.24 years) | Infancy-Adult (3 months-40 years) | 5 months |
| **Site of onset**     | Frontal lobe      | Lateral temporal lobe | Individuation, intrafamilial variation | Right frontal lobe |
| **Features of seizures** | Sleep-related motor seizures | With auditory auras and symptoms | Individuation, intrafamilial variation | Binocular gaze, tonic seizure of right upper limb |
| **Brain MRI**         | Generally normal  | Lateral temporal epileptiform discharges | Individuation, intrafamilial variation | Unremarkable |
| **EEG**               | Frontal epileptiform discharges | Lateral temporal epileptiform discharges | | Right frontal epileptiform discharges |

**ADSHE** Autosomal dominant sleep-related hypermotor epilepsy, **ADNLE** Autosomal dominant nocturnal frontal lobe epilepsy, **ADEAF** Autosomal dominant epilepsy with auditory features, **ADLTE** Autosomal dominant lateral temporal lobe epilepsy

In conclusion, we found a novel heterozygous variant in DEPDC5, c.1696delC (p.Gln566fs) in a family of three. The variant spectrum of DEPDC5 is expanded. Due to interfamilial phenotypic and genetic heterogeneity, the prevalence of FFEVF might be underestimated in such small families. Considering the existence of an unaffected carrier, FFEVF is possible to be diagnosed clinically. In clinical practice, gene detection can provide support to a definitive diagnosis and it is necessary for the patients with sporadic epilepsy of unknown etiology, as well as their family members.

**Abbreviations**
DEPDC5: Disheveled, Egl-10 and pleckstrin domain-containing protein 5; mTORC1: Mammalian target of rapamycin complex 1; FFEVF: Familial focal epilepsy with variable foci; MRI: Magnetic resonance imaging; EEG: Electroencephalogram; WES: Whole exome sequencing; FCD: Focal cortical dysplasia.

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**Authors’ contributions**
CG, XL and LP participated in the conception of the study and writing of the manuscript. JM made substantial contributions to the the acquisition, analysis and interpretation of EEG data. CG, XL, LP, XZ and JS performed the experiments. JS, DL and CC analyzed the experimental results. JM and CC revised the manuscript and CC submitted the manuscript. All of the authors read and approved the final manuscript.
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Availability of data and materials
The datasets used and/or analysed during the current study are available in ClinVar, accession number is SCV002025780.

Declarations

Ethics approval and consent to participate
Written informed consent was obtained from all family members and the study was approved by the ethics committee of Tianjin Children’s Hospital (Tianjin, China).

Consent for publication
Written informed consent was obtained from the patient’s parents for publication.

Competing interests
The authors declare that they have no competing interests.

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