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Successful Cochlear Implantation in a Patient With Wolfram Syndrome Type 1: a case report

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Case Report

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Abstract

Background

Wolfram syndrome type 1 (DIDMOAD) is a rare autosomal recessive neurodegenerative disorder characterized by early-onset diabetes mellitus, optic atrophy, and progressive sensorineural hearing loss. Management of profound deafness in these patients is challenging, and outcomes of cochlear implantation remain variable.

Case presentation

We report a 23-year-old Iranian woman with genetically confirmed Wolfram syndrome type 1 who presented with poorly controlled diabetes, progressive visual impairment, and profound bilateral hearing loss refractory to hearing aids. Genetic testing revealed a homozygous frameshift variant in *WFS1*, with both parents identified as heterozygous carriers. The patient underwent cochlear implantation without complications and achieved meaningful functional hearing, with marked improvement in communication and daily auditory perception.

Conclusion

This case demonstrates that cochlear implantation can provide substantial auditory benefit in selected patients with Wolfram syndrome and highlights the importance of early genetic diagnosis and multidisciplinary management.

Introduction

Wolfram syndrome, also known as DIDMOAD (diabetes insipidus, diabetes mellitus, optic atrophy, and deafness), is a rare autosomal recessive neurodegenerative disorder most commonly caused by pathogenic variants in the *WFS1* gene (1, 2). The condition typically presents in childhood with insulin-dependent diabetes mellitus and progressive optic atrophy, followed by multisystem neurologic and sensory deterioration during adolescence and early adulthood (3, 4). Although cochlear implantation outcomes in Wolfram syndrome are variable due to underlying neurodegeneration, selected patients may still achieve meaningful auditory benefit when cochlear nerve integrity is preserved (5–7). Given the rarity of Wolfram syndrome and the limited literature on auditory therapy, especially in Middle Eastern populations, reporting individual cases remains clinically valuable. We present a young woman with genetically confirmed Wolfram syndrome who underwent successful cochlear implantation with significant improvement in auditory perception and communication. This case underscores the importance of early referral, multidisciplinary management, and the role of cochlear implantation in selected patients. This manuscript conforms to the CARE guidelines for the reporting of case reports (8).

Case presentation

A 23-year-old Iranian woman with genetically confirmed Wolfram syndrome type 1 (DIDMOAD) was referred to our endocrinology clinic for poorly controlled diabetes mellitus. She had been diagnosed with

diabetes at the age of two and had gradually developed progressive visual disability as well as severe bilateral sensorineural hearing loss during adolescence. In addition to long-standing diabetes mellitus, the patient had a documented history of central diabetes insipidus (DI) and was receiving desmopressin therapy at the time of presentation, completing the classic DIDMOAD phenotype. At presentation, she reported fatigue, polyuria, and distal paresthesia involving the plantar surface of the feet, suggestive of diabetic neuropathy. She was advised to use hearing aids since previous two years, however recently they were useless.

On admission, laboratory evaluation showed markedly elevated fasting blood glucose (312 mg/dL), HbA1c of 9.5%, and elevated two-hour postprandial glucose (234 mg/dL). Her insulin regimen was therefore adjusted by increasing the basal dose and recalculating pre-meal boluses based on carbohydrate intake. She received advise on glucose monitoring, diet, and foot care, and was scheduled for close endocrinology follow-up.

Although the family initially reported no other affected members, genetic testing showed that both parents were heterozygous carriers of the WFS1 c.547del pathogenic variant, while the proband was homozygous. This finding confirmed the autosomal recessive inheritance pattern, and a pedigree was created to show carrier status within the family (Fig. 1).

Because of her disabling hearing loss and low hearing aids positive effect, the patient was evaluated for cochlear implantation in our ENT department. Pre-operative audiological assessment showed no functional residual hearing, Speech recognition was less than 50 percent

in both ears and no significant benefit from amplification. She was candidate to ipsilateral

cochleal implantation. Temporal bone Computed Tomography (CT) scan was normal. The ENT committee has choose Advanced Bionic HiRes Ultra 3D/ HiFocus SlimJ with Nida CI Q90 Processor to implant.

She was admitted to stabilized general condition and blood sauger pre-operatively and underwent cochlear implantation. The procedure was performed through a standard transmastoid posterior tympanotomy approach. The round window was exposed, and the electrode was smoothly inserted without resistance. Intraoperative neural response and impedance testing showed appropriate function of all sixteen electrodes, and no surgical complications were encountered. Initial device activation occurred three weeks after surgery. Post-operative programming showed stable stimulation thresholds across the array. Electrically-evoked Compound Action Potential

(ECAP) response was present. Neural Response Telemetry (NRT) value correlate with patient

behavioral map. Impedance testing at activation confirmed normal electrical function of all sixteen electrodes, with values remaining stable over subsequent follow-ups (Fig. 2).

After nine months, the patient was satisfied and experienced progressive improvement in auditory perception. Although exact audiometric thresholds varied across visits, she repeatedly achieved meaningful access to conversational-level speech. Qualitatively, she reported being able to detect everyday environmental sounds, recognize familiar voices, and communicate effectively in quiet settings, abilities that were absent prior to implantation. The Cochlear Implant Quality of Life questionnaire (CIQOL-10) was administered to further assess postoperative outcomes.

The patient continues multidisciplinary follow-up. Endocrinology manages her diabetes and neuropathic symptoms, ophthalmology monitors progressive optic atrophy, and audiology provides ongoing device programming and auditory rehabilitation. Speech therapy sessions focus on improving speech perception and communication strategies.

Genetic counseling was provided to the patient and her family regarding the autosomal recessive inheritance pattern and future reproductive considerations. Despite the progressive neurodegenerative nature of Wolfram syndrome, cochlear implantation in this case restored functional hearing and substantially improved the patient's communication abilities and overall quality of life.

Discussion

This case represents a classic phenotype of WS1, supported by molecular confirmation of a homozygous *WFS1* frameshift variant. Identification of heterozygous carrier status in both parents and construction of a pedigree further reinforce the autosomal recessive inheritance pattern. Studies across the WS1 range highlight substantial phenotypic variability among individuals with *WFS1* mutations, with ophthalmic, neurologic, and psychiatric manifestations differing significantly even among related carriers (9). These findings are consistent with our patient's combination of progressive visual decline, severe auditory dysfunction, and long-standing metabolic disease.

From an audiologic and otologic perspective, the successful cochlear implantation in our patient is clinically meaningful. Several recent reports describe that, despite the neurodegenerative nature of Wolfram syndrome, some patients can achieve substantial hearing improvement after cochlear implantation. For instance, Lim et al. (5) documented that individuals with profound hearing loss due to *WFS1* variants may still achieve functional speech understanding when pre-operative neural integrity is maintained. Similarly, another reports (6, 7) showed positive auditory outcomes following implantation, noting that postoperative improvements depend on residual cochlear nerve function and central auditory pathway integrity. These observations correspond with our patient's postoperative functional gains, supporting the notion that cochlear implantation should not be dismissed only on the basis of the fundamental neurodegenerative disorder.

Comparative analysis with other published cases reveals additional fine distinctions. Some authors have reported atypical retinal findings, including vitelliform-like deposits and macular changes (10, 11) suggesting that visual involvement in WS1 continues above isolated optic atrophy. understanding of these wide retinal patterns may improve ophthalmologic surveillance strategies. Li et al. (12) described a

familial or “Wolfram-like” presentation, demonstrating that genotype-phenotype relation is variable and highlighting the importance of detailed family studies and genetic counseling in each case, an approach applied in our evaluation through carrier testing and pedigree construction. Recent neuroimaging studies have also highlighted characteristic structural changes in WS1, including brainstem and cerebellar atrophy, hypothalamic involvement, and white-matter abnormalities (5, 13). These findings provide insight into the neurologic and behavioral symptoms frequently observed in these patients. Although wide neuroimaging was not performed at the time of this report, longitudinal neurologic monitoring remains necessary to assess potential progression of neurodegeneration.

This case report is limited by its single patient design, restricting generalizability. Long-term follow-up is required to evaluate the stability of auditory improvement and the progression of visual and neurologic decline, which are known to follow a progressive course in Wolfram (DIDMOAD) syndrome (14). Although molecular diagnosis was confirmed, the genotype-phenotype relation of the WFS1 variant (c.547del) remains incompletely understood, highlighting the challenge of allelic heterogeneity in Wolfram syndrome (15). Broader family studies and longitudinal phenotyping may help understanding this relationship.

Evaluating young patients with early-onset diabetes and visual or auditory abnormalities, as early genetic testing enables accurate diagnosis and informed counseling. Cochlear implantation may provide meaningful benefit even in progressive neurodegenerative conditions, and candidacy should be based on functional auditory potential rather than diagnosis alone. Importantly, awareness of the multisystem involvement of DIDMOAD is essential for surgeons, since unrecognized endocrine and airway abnormalities may significantly increase perioperative risk. Long-term follow-up and comprehensive genotype-phenotype data may further improve prognostication and multidisciplinary treatment planning.

Conclusion

This case highlights the critical importance of a multidisciplinary, surgically informed approach in managing Wolfram syndrome. It also demonstrates that cochlear implantation can significantly improve auditory function and quality of life, with the patient reporting meaningful improvements in communication, environmental sound awareness, and daily activities following the procedure.

Abbreviations

WS1
Wolfram Syndrome type 1
DIDMOAD
Diabetes Insipidus, Diabetes Mellitus, Optic Atrophy, and Deafness
WFS1
Wolfram Syndrome 1 gene
DM

Diabetes Mellitus
DI
Diabetes Insipidus
ENT
Ear, Nose, and Throat
CT
Computed Tomography
HbA1c
Hemoglobin A1c
ECAP
Electrically-evoked Compound Action Potential
NRT
Neural Response Telemetry
CI
Cochlear Implant
CIQOL-10
Cochlear Implant Quality of Life – 10 item questionnaire

Declarations

Ethics approval

Ethics approval was not required for this case report in accordance with local and institutional guidelines. Written informed consent was obtained from the patient for participation and publication of this case report.

Consent for publication

Written informed consent was obtained from the patient for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

Availability of data and material

The datasets generated and/or analyzed during the current study are not publicly available due to patient privacy and confidentiality concerns but are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Author contributions

MHT wrote the original draft; TZ collected the data. NAS, FS and SM were the patient's doctors. All authors have read and approved the final version of the manuscript.

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Figures

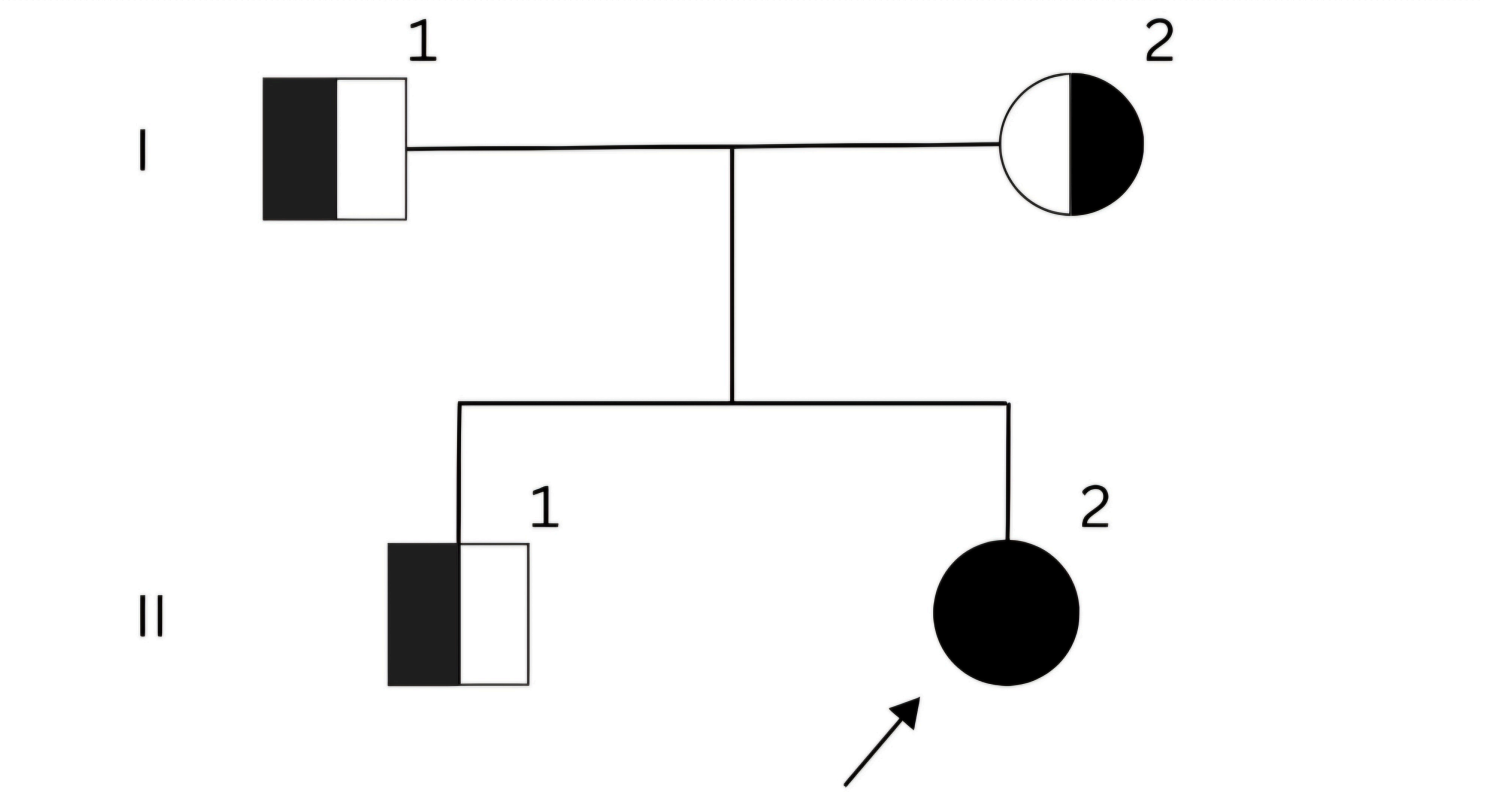


Figure 1

Pedigree of the family demonstrating segregation of the WFS1 c.547del variant. Half filled symbols (individuals I 1, I 2, and II 1) indicate heterozygous carriers of the WFS1 c.547del variant. The fully filled circle with an arrow (individual II 2) denotes the affected proband who is homozygous for the WFS1 c.547del variant.

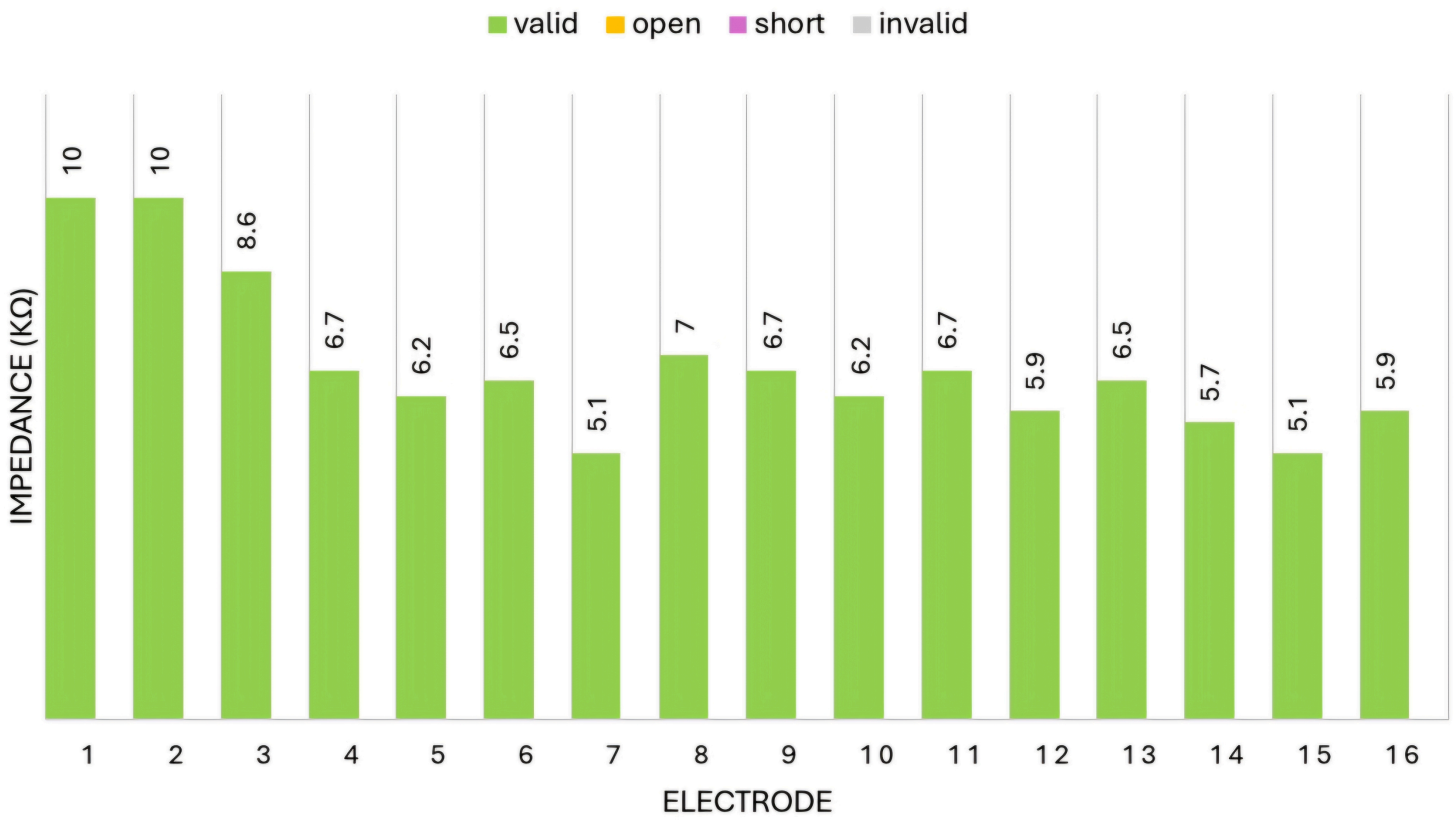


Figure 2

Electrode impedance values were classified as follows: valid (approximately 5–10 kΩ), indicating adequate electrode–tissue contact; short (<1 kΩ), suggestive of electrical short circuiting; open (>20 kΩ), indicating circuit discontinuity; and invalid, referring to values outside the reliable operating range of the recording system. In our patient, all electrode impedance values were within the valid (5–10 kΩ) range, with no electrodes classified as short, open, or invalid.

Supplementary Files

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