Background

Auditory Neuropathy (AN) refers to the impairment of listening ability caused by disordered conduction in the auditory nerve with relatively preserved outer hair cell function and cochlear amplification. One of the few conditions that affects the auditory nerve is a neurodegenerative disease called Friedreich's Ataxia (FRDA). FRDA is the most frequent autosomal recessive inherited ataxia caused by mutations in the FXN gene. Cardinal features of FRDA are ataxia of both trunk and limbs along with cerebellar dysfunction and cochlear amplification. One of the few conditions that affects the auditory nerve is a neurodegenerative disease called Friedreich's Ataxia (FRDA). FRDA is the most frequent autosomal recessive inherited ataxia caused by mutations in the FXN gene. Friedrich's Ataxia is a rare genetic disorder characterized by progressive degeneration of the spinal cord, cerebellum, and peripheral nerves. The mean numbers of GAA repeats on the intron 1 of the FXN gene underwent: GAA1, GAA2, GAA3, GAA4, and GAA5. The number of GAA repeats ranged from 100 to 1200. The mean numbers of GAA repeats on the intron 1 of the FXN gene underwent: GAA1, GAA2, GAA3, GAA4, and GAA5. The number of GAA repeats ranged from 100 to 1200.

Methods

Fifteen patients with genetically confirmed FRDA who were homozygous for GAA expansions in intron 1 of the FXN gene underwent:

1. Pure-tone audiometry
2. Otoacoustic Emissions
3. Auditory Brainstem Responses

Auditory processing evaluation:

1. Gaps in Noise Test (GIN)
2. Listening in Spatialized Noise-Sentences Test (LISN-S)

Patient-reported hearing difficulties

1. The Speech, Spatial, and Qualities of Hearing (SSQ) questionnaire

Age at assessment ranged from 17 years to 48 years (30.8±9.9 years). The number of GAA repeats ranged from 100 to 1200. The mean numbers of GAA repeats on the smaller and the larger alleles were 614±257 and 825±218, respectively. Patients were classified into three groups, those with GAA1 repeats over 700, those between 500 and 700, and those with repeats under 500 (Dürr et al., 1996).

Results

Hearing assessment of five FRDA patients with GAA1 repeats less than 500 revealed no/mild hearing impairment. Mild/moderate hearing impairment was observed in 10 patients with GAA1 repeat lengths of more than 500. Auditory spatial processing disorder is present in 90% of our FRDA patients, making it impossible for them to focus selectively on sounds coming from one direction while supressing sounds coming from other directions. Deficits in temporal resolution, which is inability to follow rapid changes in a sound, existed in more than 80% of our patients. In a scale questionnaire, SSQ, we received reports of functional hearing difficulties, concerning speech, spatial and hearing quality in a range of complex listening situations that are part of daily living, from most of our FRDA patients. The presence and robustness of otoacoustic emissions suggested intact peripheral hearing in all of our FRDA patients.

Discussion

We conducted baseline audiological and auditory processing assessment on 15 genetically confirmed FRDA patients. We observed binaural impaired speech perception in 14 out of 15 FRDA patients. However, severity of spatial processing impairment was in varying degrees and strongly associated only with the repeat length of GAA1. Worse talker advantage was observed in FRDA individuals whose GAA1 repeat length exceeded 700. This may reflect frequency discrimination deficits in that talker advantage is dependent on the pitch and timbre characteristics of the speaker (Glyde et al., 2013). The findings of our study suggest that temporal distortion is mainly observed in FRDA individuals with the GAA1 more than 500. All patients whose GAA1 was more than 500 reported gross functional deficits in a variety of complex listening situations typical of those encountered in everyday life (evident on the speech, spatial and qualities of hearing scale questionnaire). In summary, the findings of our study suggest more severe temporal resolution and more degraded neural sound conduction leading to more problems with speech perception and spatial processing in those patients with the GAA more than 500.

References


Acknowledgement

We acknowledge the financial support of the Department of Health and the National Institute for Health Research (NIHR) Biomedical Research Centre based at the University College London Hospitals and the National Institute for Health Research. We would like to thank our patients and colleagues at the Ataxia and Neurology Department of the University College London Hospitals for their encouragement and support.