Using the CAVA Device to Assess Patients with Ménière's Disease

Medical Research Council

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Introduction

- Ménière's disease is a common cause of vertigo.
- Its diagnosis is contentious as there are few definitive and objective tests, and there is an overlap in the symptoms produced by other diseases. Patients are rarely symptomatic when they visit their clinician.

Parameter	Unit of Measurement	Method of Measurement	Description
Attack Frequency	Number	Manual analysis of device data and participant diaries.	Total number of distinct attacks reported during the thirty-day monitoring period.
Nystagmus Duration	Time (hours or minutes)	Manual analysis of device data and participant diaries.	How long nystagmus lasts from the first nystagmus beat until the last. Validated using time and duration of rotary vertigo reported by participant.
Motion Provoked	Binary (yes or no)	Manual analysis of device data.	Whether movement of the head induces nystagmus.
Nystagmus Direction	Direction (Left, right, up, down)	Semi-automatic analysis of device data.	Whether the nystagmus is left or right-beating, and whether this changes temporally.
Slow Phase Velocity	Velocity (deg/sec)	Semi-automatic analysis of device data.	The slope of the slowest phase of the nystagmus beats.
Slow Phase Duration	Time (sec)	Semi-automatic analysis of device data.	The duration of the slow phases of the nystagmus beats.

Table 1: Candidate parameters

- We have developed the CAVA (Continuous Ambulatory Vestibular Assessment) device to monitor eye-movements over thirty days, to record vertigo attacks as they happen.
- Based on preliminary work and our understanding of the distinctive characteristics of Ménière's disease, we formulated a list of candidate parameters with the potential be highly discriminative (Table 1).
- Using data from participants enrolled onto a clinical trial, we undertook proof of concept work to evaluate the suitability of these parameters for patients with Ménière's Disease, Vestibular Migraine and BPPV.

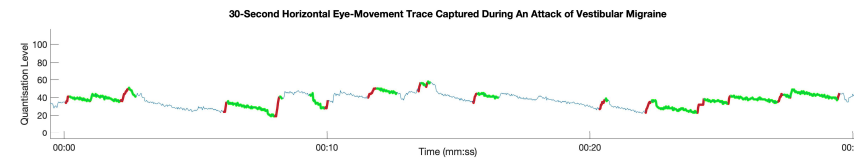## The CAVA Device

Figure 1: The CAVA Device

Results

Figure 2: Nystagmus trace from Vestibular Migraine
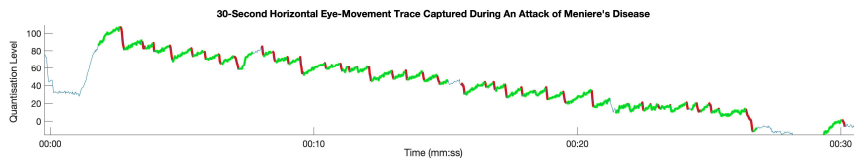

Figure 3: Nystagmus trace from Ménière's Disease

Discussion

- We have provided proof-of-concept data showing that Ménière's disease can be assessed using data captured by the CAVA device.
- A range of parameters can discriminate common causes of dizziness.
- The work was only possible due to the long-term duration of data capture and because patients wore the device during their normal daily activities.
- As this type of data is completely new, it is possible that it could be used to improve existing diagnostic guidelines and could provide insight into other conditions resulting in vertigo.
- Next, we will conduct a multi-centre clinical investigation involving several hundred patients to assess the capabilities of an automated algorithmic approach to diagnosing the causes of dizziness: Ménière's disease, Vestibular migraine, and BPPV.

Disease	Attack Frequency	Nystagmus Duration	Motion Provoked	Nystagmus Direction	Slow Phase Velocity	Slow Phase Duration
Ménière's Disease	1	~3 hours	No	Alternates between left and right-beating. Dominant direction indicates affected ear.	Mean: 9.85 deg/sec 95% CI:s [9.45, 10.21] SE: 0.20 deg/sec	Mean: 0.59 sec 95% CI: [0.57, 0.62] SE: 0.01 sec
Vestibular Migraine	1	~1 hour	No	Left-beating.	Mean: 4.47 deg/sec 95% CI: [3.96, 4.98] SE: 0.26 deg/sec	Mean: 1.33 sec 95% CI: [1.14, 1.52] SE: 0.10 sec
Benign Paroxysmal Positional Vertigo	16	< 1 minute	Yes	Down-beating and ipsitorsional.	Appears as an oscillatory signal rather than jerk-nystagmus.	

Table 2: Parameter measurements from CAVA data