Introducing In-House Integrity Testing into Routine Practice in a Cochlear Implant Clinic

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Introduction

Integrity testing has long been used to assess the function of cochlear implant (CI) devices. Electrode Voltages are measured; differences of amplitude and polarity between electrodes allow faulty electrodes to be identified.

Previous studies and our own data show that voltage patterns are also sensitive to clinical issues, such as:

- **Extra-cochlear position;**
- **Intra-cochlear electrode position anomalies;**
- **Abnormal anatomy;**
- **Ossification/fibrosis.**

Improvements in Evoked Potentials systems mean that Electrode Voltage testing with surface electrodes is now feasible in routine CI clinics. Once started, the system is able to record a series of measurements without further intervention.

REVS testing: Recording of Electrode Voltages on the Skin

You will need an Evoked Potentials (EP) system, preferably with:

- A high sampling rate (≥100 kHz);
- A trigger function;
- Flexible programing, allowing multiple recordings in a series of measurements;
- Automated peak picking.

You will also need the manufacturer's (EP) software to stimulate the CI.

The recordings shown in figure 1 were made with the Surpass system (EMS), and an implant emulator, using data from eight cases (6=normal, 2=abnormal), with amplitudes normalised to 80 current units.

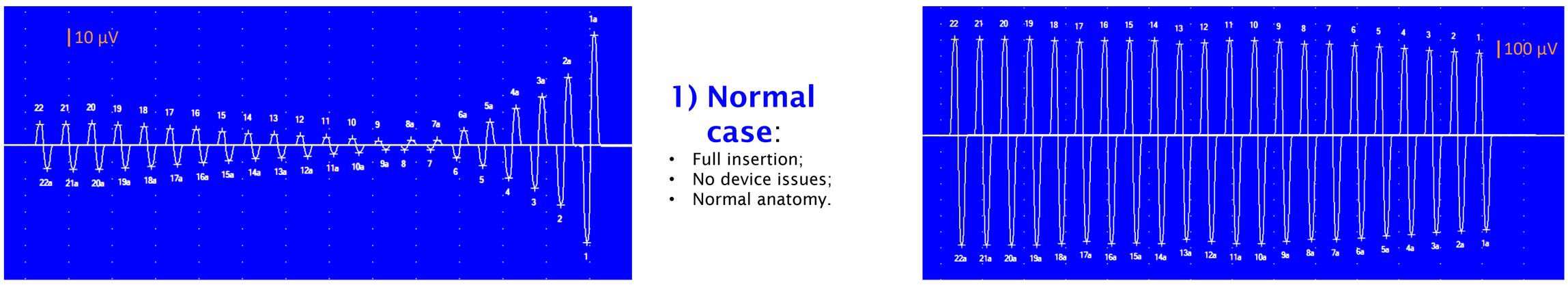
Pulse width=75 µs per phase; number of recordings averaged=128 per active electrode; recording time=1.3 s per electrode in each mode.

Example Traces

Common Ground Mode | **Monopolar Mode**

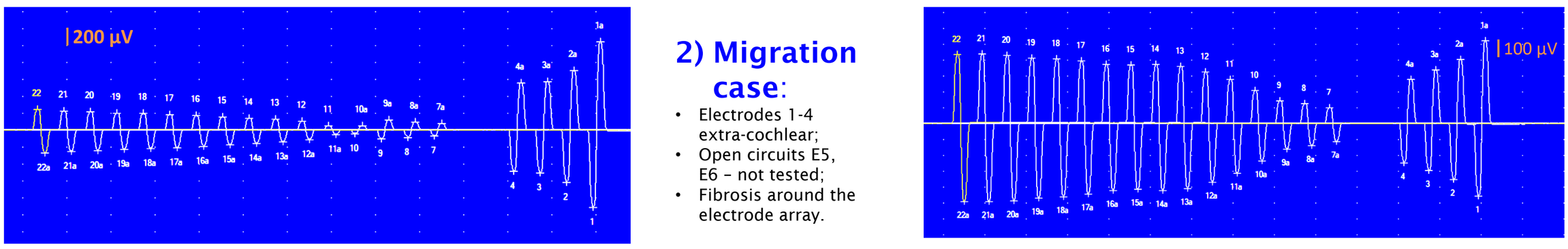
1) Normal case:

- Full insertion;
- No device issues;
- Normal anatomy.



2) Migration case:

- Electrodes 1-4 extra-cochlear;
- Open circuits E5, E6 – not tested;
- Fibrosis around the electrode array.



3) Faulty electrodes:

- Full insertion;
- Partial short circuits (E21, 19, 17, 15, 13);
- Normal anatomy.

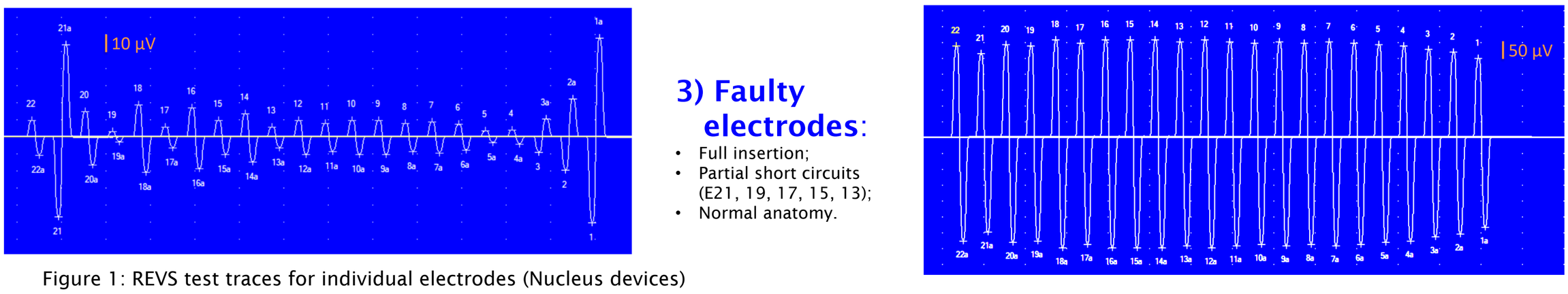


Figure 1: REVS test traces for individual electrodes (Nucleus devices)

Benefits

- Availability, including immediate analysis;
- Reduced need for manufacturers' integrity tests and CT scans;
- Opportunity to record baseline measures;
- Better understanding of voltage anomalies for clinicians;
- Standardised testing for all manufacturers' devices (in time).

Discussion and Conclusions

We are undertaking 'big data analysis' of previous integrity tests with the intention of identifying signatures for different issues. This will facilitate automatic interpretation of REVS test traces, alongside impedance data and 'trans-impedance' data in the future.

In-house integrity testing is feasible in CI clinics, offering clinical data relating to electrode insertion, anatomy and device function.

Auditory Implant Service

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