College of Science

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UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

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The Secretary
The Oticon Foundation in New Zealand
142 Lambton Quay
P O Box 9128
Wellington, New Zealand

Dear Ms Pullar,

PROGRESS REPORT: Improvement of intraoperative hearing assessment and prevention of inner ear damage in humans

I am pleased to report that although we have incurred significant earthquake-related disruption over the past 12 months, we are still making progress.

As we mentioned in our July update, physical access to the Christchurch Hospital, St George's Hospital, and the University of Canterbury campus was restricted for several months following the February earthquake. These access restrictions caused postponement or cancellation of a large number of elective surgeries, and greatly reduced the rate at which new participants were able to enter our study. The ability to obtain follow-up data from our enrolled participants was also impeded by a) the closure of the University of Canterbury Speech and Hearing Clinic; b) the cancellation of outpatient appointments at Christchurch Hospital; and c) the migration of residents from the Canterbury region. These factors meant the recruitment phase of the study had to be extended to achieve the required participant numbers. Progress on the intra-operative monitoring phase of the study has subsequently also been delayed.

Despite this, PhD student Melissa Babbage has managed to obtain around 260 extended high-frequency audiograms and 95 tap oVEMP (ocular vestibular-evoked myogenic potential) recordings from over 75 patients undergoing middle-ear surgery. Detailed analyses are currently being performed to determine whether any hearing loss identified is transient or permanent, and how audiometric thresholds change over the course of the first postoperative year for each type of surgery (whether it is myringoplasty, tympanoplasty, ossiculoplasty, stapedectomy/stapedotomy, or mastoidectomy). Our collaborators, Professor Jennifer Brown of the University of Canterbury and Associate Professor Timothy Robinson of the University of Wyoming, are currently assisting us with developing our statistical methodology.

The pattern of post-surgical change in hearing threshold that is of most interest to us is the closure of a low-frequency air-bone gap accompanied by acquired sensorineural hearing loss at higher frequencies. This is visible as a worsening of bone-conduction thresholds at 4 kHz, but many patients also display a worsening of extended high-frequency air conduction thresholds at 8 kHz and above. Without the ability to measure bone-conduction thresholds at these frequencies, it is difficult to determine whether these changes are sensorineural or conductive in nature.

To address this problem, a commercially available bone-conduction transducer (shown below) with a frequency range of 250 Hz – 16 kHz has been adapted for use in audiometric testing. We have gathered normative high-frequency bone-conduction data from around 30 normal-hearing

participants using this lightweight device. This has enabled us to determine a biological calibration for the device so that we can establish bone-conduction thresholds at frequencies between 6 kHz and 16 kHz in our patients, thereby determining whether a post-operative change in high-frequency hearing is conductive or sensorineural in origin.

In order to determine the optimal placement for the bone conductor, we have assessed three candidate head placements (mastoid, zygomatic process, and forehead) in terms of test-retest reliability, maximum output levels, and participant comfort. We are also establishing effective contralateral masking techniques for these measurements.

Figure 1: The bone-conduction transducer in its unmodified state (left) and after being adapted for audiometric use (right).

In our last report we mentioned that we were studying ways in which the test-retest reliability of the oVEMP measures could also be improved. Because our primary oVEMP measure is an amplitude ratio (e.g. right vs left), our results are somewhat vulnerable to changes in electrode placement and impedance. We have recently been using electronystagmography to measure vertical saccades in our patients prior to measuring oVEMPs using those same electrode positions. We are hopeful that this will reduce the variability of this measure.

The reliability of extended high-frequency air-conduction testing has recently been called into question by some researchers. We too have noticed spurious supra-threshold tones that have been audible to some participants during high frequency testing – particularly those with good low-frequency hearing. We are in the process of carrying out detailed electrical measurements of these artefacts and the conditions under which they occur. Once the properties of these artefacts have been defined we aim to develop high-frequency audiometric testing protocols that will ensure data is not contaminated by participants responding to unwanted noise. These protocols will be relevant to any clinical situation in which high-frequency audiometry is performed.

These reliability studies are an essential step to enable us to use each of these measurement techniques with confidence as we move on to the intervention stage of our study.

We would like to thank the Oticon Foundation in New Zealand for their continued support.

Yours sincerely,

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