College of Science

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UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

5th March 2013

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 we are continuing to make progress. The number of participants recruited in the project has now reached 97 and we have completed one year of postoperative monitoring for 41 participants. These patients were recruited from those scheduled to undergo middle-ear surgery at Christchurch Hospital or St George's Hospital, Christchurch. The surgeries fall into three categories: i) stapedectomy/stapedotomy; ii) tympanoplasty/myringoplasty; and iii) ossiculoplasty. On these patients, PhD student Melissa Babbage has now conducted over 400 audiograms (measuring air conduction up to 16 kHz) and 400 oVEMP assessments. The assessments were carried out pre-operatively and repeated post-operatively at approximately 1-2 weeks, 1 month, 3 months, 6 months, and 12 months.

The largest amount of data we have so far comes from stapedectomy patients. Due to earthquake-related disruptions, recruitment for the last two categories of surgery will continue for another six months. Preliminary data analyses have produced interesting results supporting our hypotheses regarding the incidence of hearing loss in the extended high-frequency range following middle ear surgery. We have shown that stapedectomy has a very high rate of success when the conventional frequencies are measured, with over 80% of patients showing a mean air-bone gap (measured at 0.5, 1, and 2 kHz) of less than 10 dB at their final assessment. However, over 55% of patients showed an extended high frequency hearing loss at the final assessment, sometimes as high as 30 dB. This data is shown in Figure 1 overleaf.

One question that arises is that if hearing improves in the conventional frequencies, why should we worry about a hearing loss in the extended high-frequency range? Firstly, speech has been shown to contain important spectral content above 8 kHz, and perception of frequencies above 8 kHz is important for speech localisation (front/back, up/down) and speech perception in noise. We are currently gathering psychophysical data to examine this in detail. Secondly, we have demonstrated that measuring extended high frequency thresholds pre- and postoperatively is a more sensitive indicator of operative harm than the conventional lower frequencies. This provides a model that may be used to more closely investigate the efficacy of interventions designed to preserve hearing function, such as intraoperative monitoring, the administration of corticosteroids, or changes in surgical technique. We hope that if such interventions can demonstrate a reduction in the rate of permanent hearing loss in the extended high-frequency range, we may also see a reduction in the smaller group of patients that present with a postoperative hearing loss at conventionally measured frequencies.

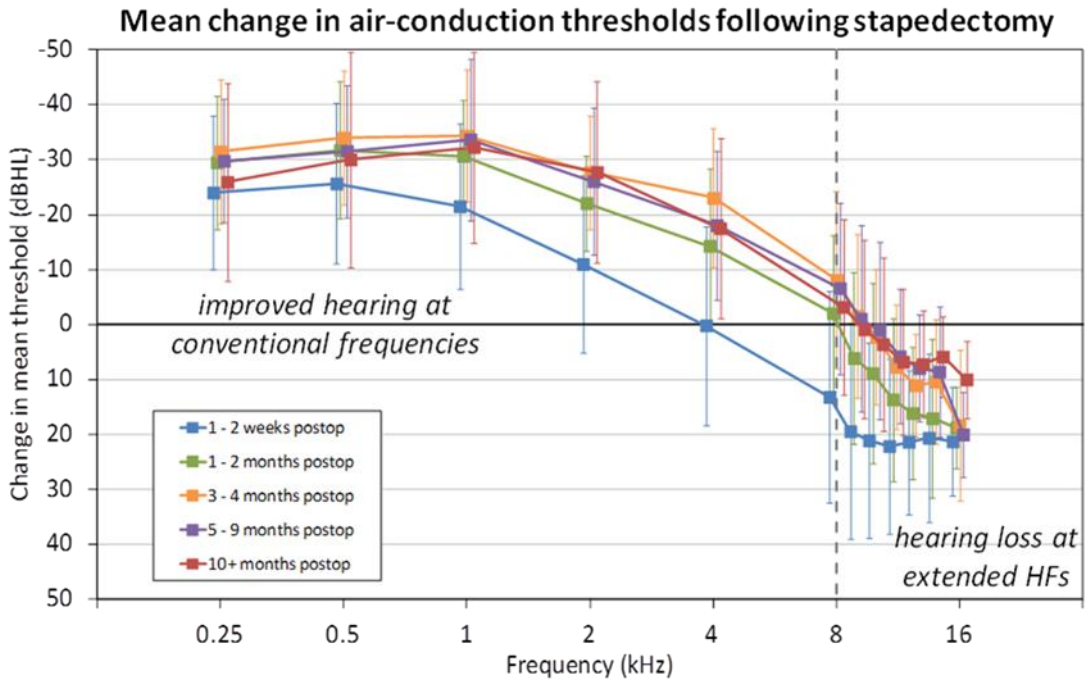

Figure 1: Although stapedectomy resulted in an improvement in hearing at conventionally-measured frequencies, extended high-frequency thresholds worsened (n=29).

We are in the process of obtaining ethical approval for using our intraoperative monitoring system in theatre. The system we have developed is capable of measuring changes in air-bone gaps in real-time (using electrocochleography) during surgery, with the aim of providing information regarding the status of the inner ear early enough to allow the surgical team to modify their procedure. The system has applications not only for middle-ear surgery, but also for cochlear implantation and vestibular schwannoma surgery.

A computer-based audiometer has been developed for testing high-frequency bone-conduction thresholds. This portable system means that results will be comparable when participants are tested at different sites, and will provide the normative data for the bone-conduction component of our intraoperative monitoring system. Work is also underway on establishing the test-retest reliability of the high-frequency bone-conductor when positioned in different locations on the skull, particularly given the restrictions placed on its location during surgery.

We have recently had a paper accepted by the Journal of Neurological Surgery Part B: Skull Base. The Acknowledgements section states “This work was supported by grants from the Oticon Foundation in New Zealand.”. The Foundation was also thanked in the conference presentations made during 2012, and these presentations prominently displayed the Foundation’s logo.

We would like to thank the Oticon Foundation in New Zealand for their support. We will continue to provide updates as our work continues.

Yours sincerely,

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Journal articles accepted:

Babbage MJ, Feldman MB, O'Beirne GA, MacFarlane MR, Bird PA, *in press*. Patterns of hearing loss following retrosigmoid excision of unilateral vestibular schwannoma. Journal of Neurological Surgery Part B: Skull Base.

Conference presentations:

Babbage MJ, O'Beirne GA, Bergin M, Macassey E, Bird PA, 2012. Patterns of extended high frequency hearing loss following middle ear surgery. 65th Annual Scientific Meeting of the New Zealand Society of Otolaryngology Head and Neck Surgery (NZSOHNS), Wellington, New Zealand, 31st October 2012.

Babbage MJ, O'Beirne GA, Bergin M, Macassey E, Bird PA, 2012. Patterns of ultra high-frequency hearing loss following middle ear surgery. The 9th International Conference on Cholesteatoma and Ear Surgery, Nagasaki, Japan, 6th June 2012.