

Submission ID #: 71277

Scriptwriter Name: Poornima G

Project Page Link: <https://review.jove.com/account/file-uploader?src=21739533>

Title: Remote Intraoperative Monitoring of Cochlear Implants

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Author Questionnaire

1. We have marked your project as author-provided footage, meaning you film the video yourself and provide JoVE with the footage to edit. JoVE will not send the videographer. Please confirm that this is correct.

☐ Correct

2. Microscopy: Does your protocol require the use of a dissecting or stereomicroscope for performing a complex dissection, microinjection technique, or something similar? **No**

3. Software: Does the part of your protocol being filmed include step-by-step descriptions of software usage? **Yes**

4. Proposed filming date: To help JoVE process and publish your video in a timely manner, please indicate the proposed date that your group will film here: **MM/DD/YYYY**

When you are ready to submit your video files, please contact our Content Manager, [Utkarsh Khare](#).

Current Protocol Length

Number of Steps: 14

Number of Shots: 32 (23 SC)

Interviews

Videographer: Obtain headshots for all authors available at the filming location.

Authors: Please note that **the questions will not appear on screen**. Please answer in **stand-alone full sentence with sufficient context**

Authors: Please provide the presenters' names for the interviews after the shoot

INTRODUCTION:

REQUIRED: Summarize your research focus and the main questions it aims to answer.

- 1.1. **Daniel Polterauer-Neuling:** Our main goal is to show the feasibility and efficiency of remote monitoring for cochlear implantation.
 - 1.1.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

Describe the research gap or limitation in existing methods and how this protocol addresses them.

- 1.2. **Daniel Polterauer-Neuling:** In situ monitoring is time-intensive for the audiologist. This time investment can be reduced by using remote monitoring.
 - 1.2.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

CONCLUSION:

What does this protocol allow researchers to study or measure?

- 1.3. **Pascal Nachtigäller:** Intraoperative monitoring indicates device functionality by checking integrity and connectivity to the auditory system, which is possible remotely.
 - 1.3.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

Describe the most important consideration or challenge when performing this protocol.

- 1.4. **Pascal Nachtigäller:** The most important consideration during the procedure is giving the right instructions to the OR staff and surgeon to facilitate smooth operation.
 - 1.4.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

How can future studies build on this work? Describe the questions or research directions that can be investigated next.

1.5. **Pascal Nachtigäller:** In the future, we will test the feasibility of remote eABR or ANTS measurements.

1.5.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

Videographer: Obtain headshots for all authors available at the filming location.

Title Card

Written informed consent was obtained from the patients to use and publish their data, where applicable

Protocol

NOTE to editor by Utkarsh: rename all videos as per the named given by authors in image form, the image in in document folder. please rename footage according to the image.

Downsize screen capture to 1920 X 1080 for clarity.

2. Preparation for Remote Intraoperative Monitoring by the Audiologist

NOTE: Including the audiologist's perspective is better

Demonstrators: Pascal Nachtigäller and Daniel Polterauer-Neuling

2.1. To begin, obtain the cochlear implant model information from the surgeon and the operating room staff [1]. Note down the details and be ready for intraoperative measurements [2].

2.1.1. WIDE: OR staff asking surgeon, fetching the implant and showing it to surgeon for confirmation

2.1.2. OR staff calling the audiologist and giving out details. Audiologist speaking over the call. **Authors:** Please film the OR staff and the audiologist, both, in separate rooms. We can use split screen to show both to convey the scene

NOTE: Please use split screen to show the operating room staff and the remotely operating audiologist if they have shot as requested

2.2. After the measurement computer is turned on [1], remotely log in to the system [2].

2.2.1. OR staff turning on the measurement computer.

2.2.2. SCREEN: 2026-07-28 10-24-27remotedesktopconnectionstart.

2.3. Open the measurement software, enter the patient details [1] and the implant information [2]. Confirm the connection to the implant before beginning the measurement [2].

2.3.1. SCREEN: 2026-07-28 10-24-27createpatientinmaestro. 00:00-00:05 and 00:12-00:16

2.3.2. SCREEN: 2026-07-28 10-24-27createpatientinmaestro 00:28-00:34 and 00:36-00:40.

2.3.3. SCREEN: 2026-07-28 10-36-32measruingIFT+ESRT+autoART+ART. 00:54-01:01

3. Intraoperative Cochlear Implant Monitoring

3.1. Measure the impedances, note them, and inform the surgeon of the values [1].

3.1.1. SCREEN: 2026-07-28 10-36-32measruingIFT+ESRT+autoART+ART. 01:06-01:09 and 01:15-01:19

3.2. Review the stimulation current-induced non-stimulating electrode voltages for anomalies related to the electrode placement, including possible tip fold-overs [1].

3.2.1. SCREEN: 2026-07-28 10-36-32measruingIFT+ESRT+autoART+ART. 01:19-01:23.
Video editor: Zoom into the graph and the values below

3.3. After the impedance measurements, confirm whether the electrically evoked stapedial reflex is indicated based on anatomical factors and prior operations [1].

3.3.1. SCREEN: 2026-07-28 10-36-32measruingIFT+ESRT+autoART+ART. 01:26-01:44.
Video editor: Zoom into the graphs and the values below on top left

3.4. If the electrically evoked stapedial reflex measurement is indicated, measure the reflex [1] and, if time allows, measure its threshold [2].

Video editor: Zoom into the graphs and the values below on top left

3.4.1. SCREEN: 2026-07-28 10-36-32measruingIFT+ESRT+autoART+ART 3:40-03:50 and to 5:15.

3.4.2. SCREEN: 2026-07-28 10-36-32measruingIFT+ESRT+autoART+ART 05:08-5:14.

3.5. Measure at least one of each of the apical, medial, and basal electrodes, including the ones near the beginning and the end of the array [3].

3.5.1. SCREEN: 2026-07-28 10-36-32measruingIFT+ESRT+autoART+ART 05:14-05:19

Video editor: Zoom into the graphs and the values below on top left

3.6. Next, ask the surgeon to visually inspect whether the stapedial reflex is triggered [1] and provide oral feedback [2].

3.6.1. Surgeon visually inspecting whether the stapedial reflex is triggered.

3.6.2. Surgeon providing oral feedback.

- 3.7. If the reflexes are absent for selected electrodes, especially the most basal electrodes, ask the surgeon to confirm whether the electrode array is fully inserted and adjust it if required [1].

3.7.1. Surgeon checking the electrode array position and adjusting it.

4. ECAP Recording and Data Saving

- 4.1. Record the electrically evoked compound action potentials, or ECAP [1], using the recommended parameters [2].

4.1.1. SCREEN: 2026-07-28 10-36-32measruingIFT+ESRT+autoART+ART 05:21-05:30.

4.1.2. LAB MEDIA: Table 1 *Video editor: Crop and show the rows having "ECAP" only*

- 4.2. Use automatic measurements for routine cases [1].

4.2.1. SCREEN: 2026-07-28 10-36-32measruingIFT+ESRT+autoART+ART 5:56-5:58 and 08:02-08:04.

- 4.3. If the responses are difficult to evaluate or further assessment is needed, repeat the measurement manually [1].

4.3.1. SCREEN: 2026-07-28 10-36-32measruingIFT+ESRT+autoART+ART 8:25-8:32 and 13:40-13:42 .

- 4.4. Finally, save the data to the connected database and shut down the computer [1].

4.4.1. SCREEN: 2026-07-28 10-36shutdowndisconnectFromRemote.

Results

5. Results

- 5.1. Measurements were recorded for 87 operations [1], 80 of which were performed remotely [2] and 7 in situ [3].
 - 5.1.1. LAB MEDIA: Figure 6. *Video editor: Please highlight the full bar labeled "total"*
 - 5.1.2. LAB MEDIA: Figure 6. *Video editor: Please highlight the dark green 'remote' portion of the bar labeled "total"*
 - 5.1.3. LAB MEDIA: Figure 6. *Video editor: Please highlight the light green 'in-situ' portion of the bar labeled "total"*
- 5.2. The impedances were the most common measurement and were performed every time [1]. Electrocochleography was the least frequent measurement [2].
 - 5.2.1. LAB MEDIA: Figure 6. *Video editor: Highlight the bar labelled Imp.*
 - 5.2.2. LAB MEDIA: Figure 6. *Video editor: Highlight the bar labelled ECochG.*
- 5.3. Using this protocol, a normal stimulation current-induced non-stimulating electrode voltage result was observed in a case [1]. In another case, a characteristic off-diagonal pattern of tip fold-over was detected [2].
 - 5.3.1. LAB MEDIA: Figure 5A.
 - 5.3.2. LAB MEDIA: Figure 5B.
- 5.4. Remote measurements reduced the median time spent by the audiologist from 29.03 minutes in situ [1] to around 8 minutes remotely [2].
 - 5.4.1. LAB MEDIA: Figure 7. *Video editor: Highlight the Standard in-situ plot.*
 - 5.4.2. LAB MEDIA: Figure 7. *Video editor: Highlight the Standard remote plot.*
- 5.5. When electrocochleography was performed, remote measurements reduced the median time spent by the audiologist from 48.63 minutes in situ [1] to about 27.75 minutes remotely [2].
 - 5.5.1. LAB MEDIA: Figure 7. *Video editor: Highlight the ECochG in-situ plot.*
 - 5.5.2. LAB MEDIA: Figure 7. *Video editor: Highlight the Standard remote plot.*

1. Cochlear
Pronunciation link: <https://www.merriam-webster.com/dictionary/cochlear>
IPA: /'kɑ:kliə/, /'kookliə/
Phonetic Spelling: kaak·lee·ur / kohk·lee·ur
2. Audiologist
Pronunciation link: <https://www.merriam-webster.com/dictionary/audiology>
IPA: /,ɔ:di'ɑ:lədʒɪst/
Phonetic Spelling: aw·dee·aa·luh·jist
3. Intraoperative
Pronunciation link: No confirmed link found
IPA: /,ɪntrə'ɑ:pərətɪv/
Phonetic Spelling: in·truh·aa·puh·ruh·tiv
4. Impedances
Pronunciation link: No confirmed link found
IPA: /ɪm'pi:dənsɪz/
Phonetic Spelling: im·pee·duhn·siz
5. Stimulation
Pronunciation link: <https://www.merriam-webster.com/dictionary/stimulation>
IPA: /,stɪmjə'leɪʃən/
Phonetic Spelling: stim·yuh·lay·shuhn
6. Electrode
Pronunciation link: <https://www.merriam-webster.com/dictionary/electrode>
IPA: /ɪ'lektroʊd/
Phonetic Spelling: ih·lek·trohd
7. Anomalies
Pronunciation link: <https://www.merriam-webster.com/dictionary/anomaly>
IPA: /ə'nɑ:məliz/
Phonetic Spelling: uh·naa·muh·leez
8. Stapedial
Pronunciation link: <https://www.howtopronounce.com/stapedial>
IPA: /stə'pi:diəl/
Phonetic Spelling: stuh·pee·dee·uhl
9. Anatomical
Pronunciation link: <https://www.merriam-webster.com/dictionary/anatomical>
IPA: /,ænə'tɑ:mɪkəl/
Phonetic Spelling: an·uh·taa·mi·kuhl
10. Apical
Pronunciation link: <https://www.merriam-webster.com/dictionary/apical>
IPA: /'eɪpɪkəl/, /'æpɪkəl/
Phonetic Spelling: ay·pi·kuhl / ap·i·kuhl
11. Medial
Pronunciation link: <https://www.merriam-webster.com/dictionary/medial>

IPA: /'mi:diəl/

Phonetic Spelling: mee·dee·uhl

12. Basal

Pronunciation link: <https://www.merriam-webster.com/dictionary/basal>

IPA: /'beɪsəl/, /'beɪzəl/

Phonetic Spelling: bay·suhl / bay·zuhl

13. Electrically

Pronunciation link: <https://www.merriam-webster.com/dictionary/electrically>

IPA: /ɪ'lektrɪkli/

Phonetic Spelling: ih·lek·trik·lee

14. Reflex

Pronunciation link: <https://www.merriam-webster.com/dictionary/reflex>

IPA: /'ri: flɛks/

Phonetic Spelling: ree·fleks

15. ECAP

Pronunciation link: No confirmed link found

IPA: /'i:kæp/

Phonetic Spelling: ee·kap

16. Electrocochleography

Pronunciation link: No confirmed link found

IPA: /ɪ lektroʊ kə:kli'ɑ:grəfi/

Phonetic Spelling: ih·lek·troh·kaak·lee·aa·gruh·fee