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Results from a Pilot Study Using the Nucleus CI24M/SP5 Cochlear Implant System

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Objective: To conduct a pilot study in adults with the Nucleus CI24M/SP5 cochlear implant system.
Patients and Methods: Eight postlingually deafened adults who had received little or no benefit from conventional hearing aids, equipped with the Nucleus CI24M/SP5 cochlear implant system.
Results and Conclusions: The results indicate that most of the subjects were able to perform well in speech recognition tests. The test performances appeared to be strongly affected by the duration of deafness. The speech processor's four user-selectable program memories have been extremely useful for the subjects to evaluate variations to the speech coding strategies in ordinary surroundings outside of the laboratory. The telemetry functions of the new implant provide a set of useful clinical and research tools for gathering greater insights into the in-situ operation of the implant. **Key Words:** Cochlear implant—Nucleus CI24M/SP5 system—Telemetry—Monopolar stimulation.
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The Nucleus CI24M/SP5 cochlear implant system (Cochlear Limited, Sydney, Australia) consists of 1) a titanium-encapsulated receiver/stimulator unit connected to 22 intracochlear electrodes and two extracochlear electrodes, 2) a speech processor based on a custom-designed digital signal processor, and 3) new software for diagnosis and programming.

The CI24M implant is able to deliver biphasic stimulation pulses to any of its electrodes in bipolar or monopolar configuration up to a maximal overall stimulation rate of 15,000 pulses per second, with a maximal stimulation current of 1.8 mA and pulse widths ranging from 25 μs to 13 ms. The implant also accepts two different data transmission protocols. The expanded protocol is equivalent to the transmission protocol used with the current Mini22 implant. The embedded protocol is unique to the new implant, and the high stimulation rate is made possible by this transmission protocol. Charge recovery between stimulation biphasic pulses is achieved by short-circuiting all the stimulating electrodes after presentation of every stimulus. Another unique feature of the CI24M implant is its telemetry capability to measure implant voltages, electrode impedances and neural responses to the electrical stimuli.

The external SP5 speech processor is fully programmable from a personal computer environment using the new DPS7 diagnostic and programming system software featuring a graphical user interface. The SP5 offers four program memories, selectable push-buttons on the front of the processor unit, allowing up to that many program and speech coding strategy variations to be tested and compared by the user in familiar surroundings, outside the clinical or laboratory environment. The flexibility of DSP programming offered by the SP5 allows a large variety of speech processing strategies and sophisticated signal processing algorithms to be implemented.

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AIM OF STUDY

The main aim of this study was to evaluate the speech recognition benefit of the new cochlear implant system. For this study, the SP5 processor used the SPEAK coding strategy as it is implemented for the current Mini22/Spectra22 system. The following were also investigated:

Comparison of the expanded and embedded transmission protocols;
Comparison of bipolar versus monopolar stimulus configurations;
Comparison of the different placements of the extracochlear electrodes;
Evaluation of the diagnostic and programing software;
Evaluation of the telemetry features of the CI24M implant; and
Investigation of any possible side effects and potential hardware problems.

SUBJECTS AND TEST PROTOCOL

Eight postlingually deafened adults who received limited or no benefit from conventional hearing aids participated in the

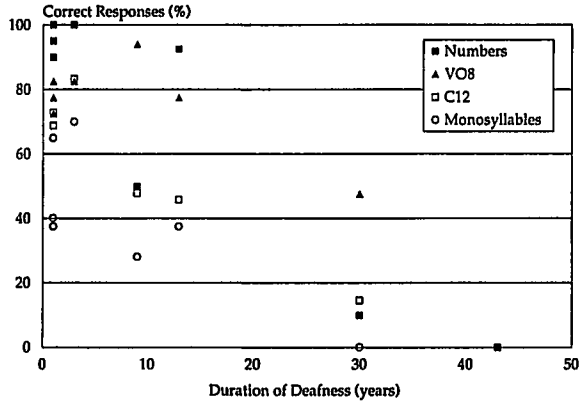

FIG. 1. Summary of 3-month scores for four tests from all participating subjects.

study. All subjects were German speaking, except for one whose primary language was Spanish. The duration of deafness in the implanted ear ranged from 1 year (three subjects) to as long as 43 years (one subject).

The speech recognition test battery in German consisted of two-digit numbers, vowel and consonant logatomes, Freiburger monosyllables, Innsbruck sentences, and Göttingen sentences. The Spanish test material consisted of vowel and consonant logatomes, monosyllables, bisyllables, and CID sentences. The Spanish-speaking subject was also tested with the German two-digit numbers. Speech test results were collected 1 month, 3 months, and 6 months after the implant was switched on.

RESULTS AND DISCUSSION

The speech test results indicated good speech recognition abilities from most of the subjects, comparable to that of users of the Mini22/Spectra22 system (1). Figure 1 shows the 3-month scores for all subjects for the numbers, logatomes, and monosyllables tests, plotted against the duration of deafness. The level of performance appeared to be strongly affected by the duration of deafness in the implanted ear.

No perceptual differences were found between programs using the expanded and embedded transmission protocols. Monopolar stimulus configurations tended to produce lower as well as more uniform threshold and comfortable levels than with bipolar stimulus configuration, consistent with experiences with the Mini20+2 implant. The selection of one or the other extracochlear electrode as the reference electrode in monopolar stimulus configuration had no effect on the resultant speech quality.

Telemetry measurements of the electrode impedances as well as the neural response indicated that the telemetry system is functional and is likely to become a useful research and diagnostic tool.

No adverse side effects were observed with all eight subjects throughout the period of testing.

The SP5 with its four user-selectable program memories proved to be a boon to the subjects, who can now evaluate up to that many different programs under ordinary sound and noise conditions. A number of the subjects reported improved sound quality with the introduction of temporal jitter in the stimulation rate.

CONCLUSION

The results of this study indicate that the Nucleus CI-24M/SP5 cochlear implant system is able to provide good speech recognition comparable to that of existing multichannel implant systems, particularly if the duration of deafness is short. The flexibility of the speech processor and the capabilities of the implant (e.g., higher achievable stimulation rates and telemetry) together provide a very useful clinical and research implant system that can benefit both patients and clinicians greatly.

REFERENCES

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