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Original article

Technical aids for speech understanding in cochlear implanted adults using cell-phones

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ABSTRACT

Objectives: The present study sought to assess (1) phone use habits and awareness of listening aids in adult cochlear implant bearers, and (2) objective and subjective benefit of listening aids for cell-phone communication.
Material and methods: A questionnaire was sent to 17 cochlear (Cochlear®) implanted adults to assess phone use and awareness of available listening aids. Speech perception without lip-reading was assessed in silence and in noise using Fournier dissyllabic word lists recorded on an iPhone 5C®, with and without listening aids. Subjective benefit was assessed according to listening aid system.
Results: Sixty-five percent of adult cochlear implant bearers regularly used a phone with all kinds of correspondent. Eighty-eight percent phoned only in quiet conditions; 53% did not answer unknown callers; 71% never used listening aids. Speech discrimination scores for disyllabic words recorded on the phone were respectively 69%, 63%, 45% and 16% in quiet and 50, 60 and 70 dB SPL noise. Speech perception in quiet and noise was improved by listening aids; the Roger system was the most beneficial, followed by the FM system, then the inductive system.
Conclusion: Listening aids are effective, but little known by adult cochlear implant bearers.

1. Introduction

Cochlear implantation (CI) is the reference hearing rehabilitation method in children and adults with severe-to-profound bilateral hearing loss. Two years after CI, Shpak et al. [1] reported 71.3% sentence perception in silence, falling to 33.6% in noise (S/N +10 dB).

Telecommunications (Internet, land-lines and cell-phones) are increasingly important in daily life, both occupational and social. Patients with severe-to-profound bilateral hearing loss often use cell-phones for texting (small message service [SMS]). Vocal phone use is reduced in CI patients, at a mean weekly 128 minutes, versus 244 minutes in the general population [2]. Many CI patients find the telephone difficult to use without external aids [3], and this is especially true with cell-phones, due to interference with the cochlear implant and to generally greater noise levels in the situations in which the cell-phone tends to be used.

Some authors have suggested adapting phone settings [4,5]. Manufacturers, aware of the issue, have developed many listening aid techniques, which based on picking up the voice signal at headphone outlet of the phone, to reduce perception of environmental noise. The signal is transmitted from the phone to a receiver worn by the listener:

- the implant processor's microphone, with the audio signal transmitted by circumaural headphones;
- the implant microphone in position "T" to receive the audio signal via a magnetic loop delivered by an inductive earpiece;
- a Phonak® shoe connected to the implant and picking up an FM signal;
- an I-link Bluetooth receiver;
- the Roger system communicating with the implant on a 2.4 GHz frequency, different from the FM system.

These systems are not always known to CI bearers.

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The aim of the present study was to assess:

- phone use in an adult CI population;
- awareness of listening aid systems in an adult CI population;
- the objective benefit of listening aid systems in cell-phone communication;
- subjective benefit in terms of comfort and understanding.

2. Material and methods

Seventeen adult CI (Cochlear®) bearers were included in a single-center prospective descriptive study (in a context of everyday practice, not requiring IRB approval). The processor was a Freedom model in 6 cases, CP810 in 12 cases and CP910 in 1 case. All subjects were being followed by the local CISIC association (Hearing Loss and Cochlear Implant Information Center) of the Haute-Garonne area (France). Fourteen had been implanted in Toulouse, 2 in Montpellier and 1 in Paris. Mean age was 46 years (range, 21–86 years; median, 50 years). Two patients had bilateral implants; 1 of the 15 unilaterally implanted patients had an electroacoustic implant (hearing conservation at a 60 dB HL threshold at 250 and 500 Hz, and profound hearing loss at 1000, 2000 and 4000 Hz), and 2 wore contralateral hearing aids. None showed auditory neuropathy.

2.1. Assessment of phone use by CI subjects

Patients filled out a dedicated closed-question telephone use questionnaire: frequency of use, type of contacts (familiar or not personally known), land-line or cell-phone, acoustic environment of the calls, and reaction to a call with unknown caller ID. Table 1 shows these 5 questions (1–5) of the questionnaire.

Table 1
Assessment of phone use by cochlear implant bearers (questions 1 to 5) and of their awareness of listening aids (questions 6 to 10).

	Questions	Possible responses
1	Do you phone…?	Never/only when strictly necessary/from time to time/regularly/very often
2	Do you phone…?	Only to people who are close and familiar (family, childhood friends)/only to people who are aware of your disability/to anyone you have already had dealings with, even if they are not aware of your disability (anyone but strangers)/to anyone
3	Do you phone…?	Only with your land-line and/or cell-phone adapted to your hearing/on any type of phone available
4	Do you phone…?	Only in silence and alone/sometimes with several people talking beside you/in bars or restaurants with a little background noise/in noisy bars or restaurants/in the street or on public transport
5	What do you do when you get a call showing unknown caller ID?	Spontaneously answer/hesitate, then pluck up the courage to answer/definitively do not answer
6	Do you know the T-coil (hearing loop)?	Yes/no
7	If you know the T-coil, do you use it?	Yes/no
8	Have you ever used the inductive system?	Yes/no
9	Have you ever used the FM system?	Yes/no
10	Have you ever used the Roger system?	Yes/no

2.2. Assessment of CI bearers' awareness of telephone listening aids

The questionnaire assessed CI bearers' awareness of the existence of the magnetic "hearing loops" and other listening aid technologies, knowledge of how they work, and use of them (or not). This part of the questionnaire corresponds to questions 6 to 10 in Table 1 (closed-questions).

2.3. Objective assessment of speech perception by telephone in CI bearers with and without listening aids

Speech perception without lip-reading was assessed in silence using Fournier dissyllabic word lists recorded on a cell-phone, by a speech-therapist whose voice was not familiar to the subject, played back at maximum volume. The cell-phone was an Apple® iPhone 5C. Assessment was repeated in 50, 60 and 70 dB SPL cocktail-party noise.

The acoustic message was delivered, under the 4 conditions (silence, and 50, 60 and 70 dB SPL noise) firstly via the cell-phone alone; secondly via the cell-phone combined with circumaural headphones with the ear-shell situated at the entry of the implant microphone (Philips® SHB 5600 BK/10 headphone); thirdly, via the cell-phone combined with an inductive system; fourthly, via the cell-phone combined with a Phonak® SmartLink+ FM frequency-modulated system connected up to a MicroLink Freedom or ML14i receiver; or fifthly, via the cell-phone combined with a Phonak® Roger Pen system, worn around the neck, and Roger 14 receiver.

Speech perception scores were compared on non-parametric tests (StatView software, Abacus®; significance threshold, $P < 0.05$).

2.4. Subjective assessment of listening comfort according to listening aid system

Under each of the above 5 communication conditions, subjects made a phone call to a familiar correspondent, in silence and then in the 3 conditions of background noise. At the end of each call, subjects assessed listening comfort on a 0–10 scale, with 10 representing excellent listening comfort.

3. Results

3.1. Assessment of phone use by CI subjects

Sixty-five percent of CI bearers used the phone regularly, with all kinds of correspondents, 23% occasionally, with familiar correspondents, and 12% only in case of necessity. Eighty-eight percent phoned only in calm surroundings, including 47% who phoned only when strictly alone, while 12% phoned in public spaces. Fifty-three percent did not pick up incoming calls displaying an unknown caller ID, 35% hesitated, and 12% answered whatever the number displayed.

3.2. Assessment of CI bearers' awareness of telephone listening aids

A large majority of patients (71%) had never used phone listening aids. All had received information about the telecoil, but only 35% used it on a daily basis, and 53% reported crackling as a source of discomfort when using it. Sixty-three percent had the technical possibility of setting a listening aid system, but only 30% had received the information that would allow them to do so.