

Simultaneous Bilateral Cochlear Implant Users - Adults

BINAURAL HEARING SERIES



hearLIFE

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Binaural hearing gives optimal access to sound.

Hearing is normally accomplished with two ears, and the brain is organized to receive and then process sounds from two ears.

The following are the key benefits conferred by binaural hearing:

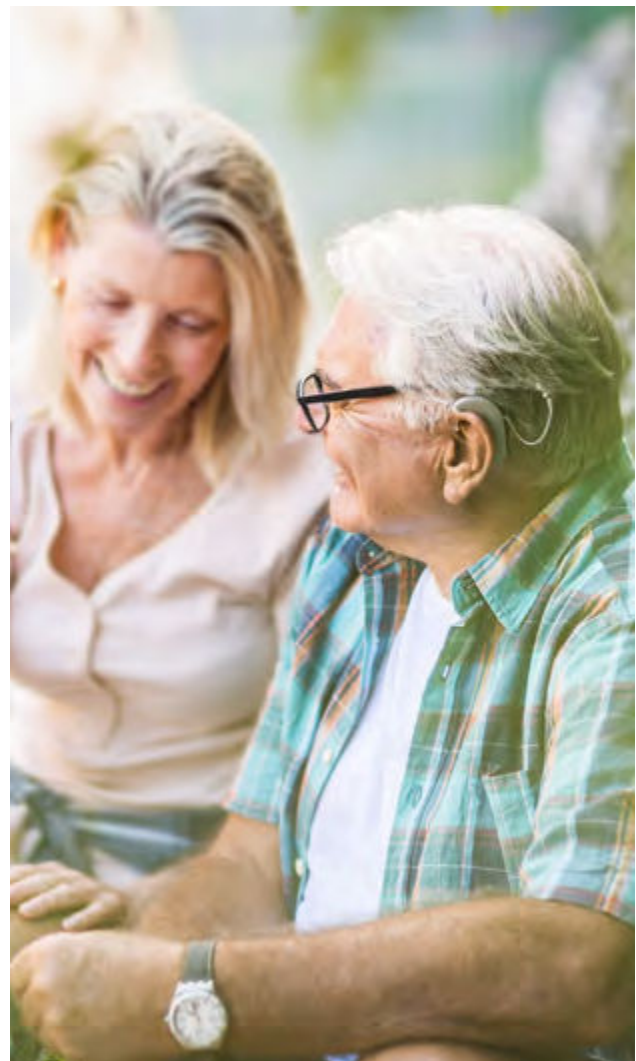
1. Binaural loudness summation and redundancy
 - A sound heard by two ears is usually judged as louder than a sound heard by one.
 - In the bilateral condition there is redundancy of information which assists in speech recognition.
2. Head shadow effect
 - The head acts as an acoustic barrier when sound is presented.
 - Therefore, sound arrives at the two ears in different ways (time and intensity).
3. Binaural squelch effect
 - The central auditory system processes the different stimuli received from each ear and represents it with a higher signal-to-noise ratio by comparing the interaural time and intensity differences.

These benefits result in:

- Localization of sound
- Better understanding of speech in both quiet and noisy situations
- Improved ability to follow conversation
- Reduced listening effort
- Improved feeling of balance

Simultaneous bilateral cochlear implant users are those who use a cochlear implant (CI) on one side and a CI in the other ear and received both implants in one surgery.

Recipients can take advantage of the binaural hearing this condition provides to access the benefits listed.



Rehabilitation aims to maximize the benefits of both devices to allow best outcomes for the user.

Research indicates that adults who receive simultaneous bilateral cochlear implants are able to use binaural processing. Benefits from summation and head shadow appear to develop soon after activation and remain constant. Squelch effect, which is thought to rely on the same binaural cues that give rise to localization, emerge over a longer time period. In one study, squelch effect benefit was evident between the 6-month and 1-year post-activation test intervals.¹ Squelch effect enables the brain to separate a speech signal from background noise and to give it more prominence for speech understanding in the presence of competing sounds. Another study found significant growth of squelch effect between Year 1 and 4 of testing suggesting that binaural processing continues to develop beyond the first year post-implantation.² This was supported by an additional study that demonstrated squelch effect increased over time. Patients who underwent simultaneous bilateral cochlear implantation developed a measurable benefit from the squelch effect after two years in their best performing ear and after three years in both ears. This led the authors to suggest that the brain learns to use interaural differences to segregate sound from noise after simultaneous bilateral cochlear implantation. Better separation of sound from noise improves hearing in noise for bilateral CI users. The increase in the squelch effect suggests that binaural processing continues to adapt in the years following bilateral cochlear implantation.³ Squelch effect has been considered to be a true binaural processing measure.

Additional benefits for simultaneous implantation include an easier adjustment to two devices as both ears are adjusting to new sound processing over the same time period, always having access to sound in case one device is not available (e.g., needing part replacement), and assuring for adults with differences between ears that the ear with better potential is implanted.

Bilateral implantation whether simultaneous or sequential has been reported to provide benefits beyond localization and listening in quiet and noise. Recipients have reported better sound quality and clarity, more acoustical balance, greater ease in following group conversations, and less fatigue at the end of the day.⁴ Quality of life improvements have also been noted. One study found positive changes in the quality of life domains of speech production, emotion, cognition, and pain.⁵ Specifically for adults, another study found further advantage from bilateral implantation in the areas of hearing difficulty and social restriction.⁶ Bilateral cochlear implantation is now considered acceptable medical practice. For children and adults who are candidates for CI in both ears, it is clear from the literature that they perform better with two cochlear implants rather than one, and bilateral cochlear implants are strongly endorsed.⁷

Rehabilitation

Relearning to listen, interpret, and process the new sounds starts once an adult receives simultaneous bilateral cochlear implants. Rehabilitation is important to facilitate adjustment to the new technology and improvement of listening skills. To reach full potential, it is highly recommended that the adult participates in rehabilitation. Research has shown positive benefits for adults who spend time on focused auditory practice. Examples of areas of benefit are speech reception, music appreciation, and cognition. Recipients demonstrated improved speech perception of trained words when embedded within a sentence.⁸ Musical training requires higher perceptual demands which may “fine-tune” the auditory system. This can then generalize to skills such as phonological processing, verbal memory, learning mechanisms for language, and lower perceptual thresholds for complex auditory input.⁹ Auditory training activities that incorporate listening and cognitive tasks have been shown to improve skills. As noted in one study, auditory therapy resulted in generalized improvements in measures of self-reported hearing, competing speech, and complex cognitive tasks.¹⁰ It can be concluded that adult cochlear implant recipients benefit from active participation in aural rehabilitation.

MED-EL has resources that may be helpful in providing information to adult recipients who are starting out or continuing their journey to better hearing. *Hear Your Best: A Guide to Cochlear Implant Rehabilitation* introduces the topic of rehabilitation and what it means. *Hear Today* is an informative booklet or app that provides useful information on how to start the rehabilitation process. It includes practical activities to develop listening skills in real life situations. Resources that review specific topics include [Smart Tips for Cochlear Implant Users](#) which covers rehabilitation and tips on living and hearing with cochlear implants in everyday situations. [Telephone Training Tips](#) provides suggestions for using the telephone, and [Music Tips for Adults](#) discusses ways to gain better access to music and develop music appreciation. Check out the [MED-EL Blog](#) post about one adult's experience with cochlear implants and music.

The two key aims of rehabilitation are to develop optimal communication skills and to enhance the benefits of binaural hearing. Following cochlear implantation, there are six core aspects of rehabilitation when working with adults.

1. Pre-implant counselling. This is important for all potential recipients of a cochlear implant. All typical counselling aspects should be covered, such as risks of surgery and need for ongoing rehabilitation. Important additional considerations for the bilateral condition should be discussed.

- a. The expectation that both devices will need to be worn during all waking hours.
- b. Expected benefits of each device. During pre-implant evaluations, each ear will have been tested separately. For many adults, the configuration of the hearing loss, aetiology, and expected outcomes will be similar for both ears. For others there may be a difference. The recipient will need to understand that one ear may be considerably more dominant than the other.

The Expectations Questionnaire for Adults (EQA) may be helpful in pre-implant counselling discussions.

2. Ongoing assessment and monitoring. Evaluating the recipient's CI use is important to support best outcomes. Assessment and monitoring of detection and speech perception provides valuable information regarding the adult's auditory skills. It is beneficial to assess these two skills with each CI alone as well as together. Assessment should include the [Ling Six Sound Test](#) and speech discrimination tasks. Informal speech discrimination tasks can include sets of words that differ by vowel only or by one consonant only. Discussion of daily listening abilities and challenges will allow realistic therapy goals to be set collaboratively with the recipient. If a significant discrepancy in skills is noted between ears, additional specific listening activities are recommended for the poorer ear. The [Hearing Implant Sound Quality Index¹⁹ \(HISQUI¹⁹\)](#) is a validated questionnaire that provides a way to measure how CI recipients perceive the quality of the sound in everyday listening situations.

3. Auditory training. Analytic exercises are those that focus on the elements of speech to improve a recipient's ability to identify the various sounds of speech. Synthetic exercises focus on the understanding of the overall meaning of discourse. Use of materials which are tailored to the interests of the recipient will support motivation. See resources for therapy under *MED-EL Resources to Support Rehabilitation*.

4. Development of binaural benefit. Sound localization and improved listening in noise are significant benefits of binaural hearing.¹¹ In a rehabilitation programme, it is beneficial to include activities which focus on development of these two skills.

- a. Sound localization skills develop over time and require practise. Information and tips on how to develop these skills can be found in [Sound Localisation](#) and on the [MED-EL Blog](#).
- b. Practising already mastered listening activities in the presence of background noise will help the adult listen and understand in situations of competing noise. Global language skills, attention, and memory influence listening-in-noise performance. Start with low intensity background noise. Suggested background noise to add from easiest to hardest are:
 - Steady state noise (e.g., white noise), other noise unrelated to spoken language (e.g., orchestral music)
 - Multi-speaker babble (individual speakers indistinguishable)
 - Speaker babble with highlighted salient spoken phrases

Monitor carefully the level of background noise presented. It is suggested that activities start at +15 dB signal-to-noise ratio progressing to louder background noise levels as confidence grows and performance improves. Activities carried out in background noise are challenging for recipients. Keep activities brief (10 to 20 minutes).

5. Communication therapy. This includes understanding how to improve the listening environment, using clarification strategies, and communication partner training to support more successful communication in daily life. For information on strategies visit the [MED-EL Blog](#) to read a post about how to use communication strategies.

6. Ongoing expectations counselling. This is important to support recipients in adjusting to their CIs and to support them in maintaining high but realistic expectations for progress.



MED-EL Resources to Support Rehabilitation

MED-EL Rehabilitation Online Resources

Visit the [MED-EL Blog](#) for further information on sound localization, auditory training, and communication strategies including how to improve the listening environment, use clarification strategies, and communication partner training.

The MED-EL Blog 5-part series [Rehab For Adults: Auditory Training With Your Cochlear Implant](#) provides more information and resources for auditory training.

[Smart Tips for Cochlear Implant Users](#) covers rehabilitation and tips on living and hearing with cochlear implants in everyday situations.

[Telephone Training Tips](#) for Adults provides suggestions for using the telephone.

[Music Tips for Adults](#) discusses ways to gain better access to music and develop music appreciation.

[Hearing Implant Sound Quality Index¹⁹ \(HISQUI¹⁹\)](#) is a validated questionnaire that provides a way to measure how CI recipients perceive the quality of the sound in everyday listening situations.

[Sound Localisation](#) provides information and tips on how to develop these skills.

[Bilateral Cochlear Implantation](#) provides information about the benefits of bilateral cochlear implantation.

Additional MED-EL Rehabilitation Resources

Contact your [MED-EL representative](#) or the MED-EL Rehabilitation Department at rehabilitation@medel.com to obtain copies of any of the mentioned resources.

Hear at Home provides exercises for auditory training designed for use at home with family or in therapy. The exercises provide the speaker with detailed instructions on how to present the materials and can be adapted according to the abilities of the recipient.

Listen Up! / Listening Up! CD 1 Listening Training for Beginners provides independent practice for a recipient to listen and identify words and sentences.

Listen Up! / Listening Up! CD 2 Listening Training for Advanced Listeners provides independent practice for a recipient to listen and identify information presented in sentences and short stories.

Listen Up! / Listening Up! CD 3 Music Training for Beginners provides independent practice for a recipient to listen and identify loud/soft sounds, high/low pitch, short/long sounds, melodies, rhythms, instruments, and musical excerpts.

Hear Today allows clinicians to evaluate recipients' current level of functioning with their CI. It also provides recipients with tips to improve their listening skills in everyday situations. *Hear Today* is also available as an app.

Hear Your Best: A Guide to Cochlear Implant Rehabilitation introduces the topic of rehabilitation and what it means.

Expectations Questionnaire for Adults (EQA) may be helpful in pre-implant counselling discussions.

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MED-EL Offices Worldwide

AMERICAS

Argentina

medel@medel.com.ar

Canada

officecanada@medel.com

Colombia

office-colombia@medel.com

Mexico

office-mexico@medel.com

United States

implants@medelus.com

ASIA PACIFIC

Australia

office@medel.com.au

China

office@medel.net.cn

Hong Kong

office@hk.medel.com

India

implants@medel.in

Indonesia

office@id.medel.com

Japan

office-japan@medel.com

Malaysia

office@my.medel.com

Philippines

office@ph.medel.com

Singapore

office@sg.medel.com

South Korea

office@kr.medel.com

Thailand

office@th.medel.com

Vietnam

office@vn.medel.com

EMEA

Austria

office@at.medel.com

Belgium

office@be.medel.com

Finland

office@fi.medel.com

France

office@fr.medel.com

Germany

office@medel.de

Italy

ufficio.italia@medel.com

Portugal

office@pt.medel.com

Spain

office@es.medel.com

South Africa

customerserviceZA@medel.com

United Arab Emirates

office@ae.medel.com

United Kingdom

customerservices@medel.co.uk

MED-EL Medical Electronics
Fürstenweg 77a | 6020 Innsbruck, Austria | office@medel.com

medel.com

