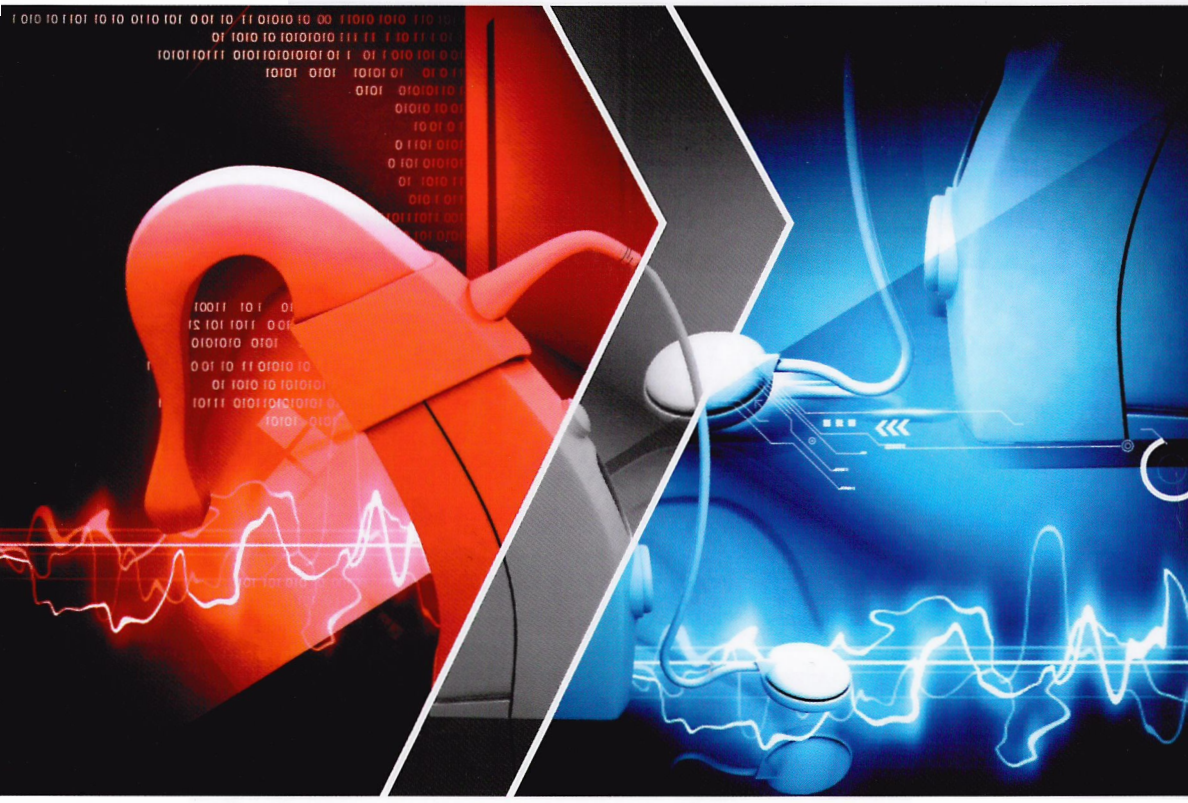
Volume 1 Clinical Protocols and Hearing

Advances in Audiology and Hearing Science



Stavros Hatzopoulos, Editor

Andrea Ciorba and Mark Krumm, Associate Editors

AAP APPLE ACADEMIC PRESS

CRC CRC Press Taylor & Francis Group

ADVANCES IN AUDIOLOGY AND HEARING SCIENCE

VOLUME 1

Clinical Protocols and Hearing Devices

Stavros Hatzopoulos, PhD
Editor

Andrea Ciorba, MD, PhD
Mark Krumm, PhD
Associate Editors

AAP APPLE ACADEMIC PRESS

Apple Academic Press Inc.
4164 Lakeshore Road
Burlington ON L7L 1A4
Canada

Apple Academic Press Inc.
1265 Goldenrod Circle NE
Palm Bay, Florida 32905
USA

Advances in Audiology and Hearing Science, Volume 1: Clinical Protocols and Hearing Devices
International Standard Book Number-13: 978-1-77188-828-8 (Hardcover)
International Standard Book Number-13: 978-0-42929-259-0 (eBook)

Advances in Audiology and Hearing Science, Two Volumes set
International Standard Book Number-13: 978-1-77188-827-1 (Hardcover)
International Standard Book Number-13: 978-0-42929-266-8 (eBook)

Library and Archives Canada Cataloguing in Publication

Title: Advances in audiology and hearing science / edited by Stavros Hatzopoulos, PhD ; editor, Andrea Ciorba, MD PhD, Mark Krumm, PhD, associate editor.

Names: Hatzopoulos, Stavros, editor. | Ciorba, Andrea, editor. | Krumm, Mark, editor.

Description: Includes bibliographical references and indexes. | Contents: Volume 1. Clinical protocols and hearing devices.

Identifiers: Canadiana (print) 20190191961 | Canadiana (ebook) 20190192011 | ISBN 9781771888271 (set ; hardcover) | ISBN 9781771888288 (v. 1 ; hardcover) | ISBN 9780429292668 (set ; eBook) | ISBN 9780429292590 (v. 1 ; eBook)

Subjects: LCSH: Audiology. | LCSH: Hearing. | LCSH: Hearing disorders.

Classification: LCC RF290 .A38 2020 | DDC 617.8—dc23

Library of Congress Cataloging-in-Publication Data

Names: Hatzopoulos, Stavros, editor. | Ciorba, Andrea, editor. | Krumm, Mark, editor.

Title: Advances in audiology and hearing science / edited by Stavros Hatzopoulos, editor; Andrea Ciorba, Mark Krumm, associate editors.

Description: Palm Bay, Florida : Apple Academic Press, [2020] | Includes bibliographical references and index. | Contents: v. 1. Clinical protocols and hearing devices -- v. 2. Otoprotection, regeneration, and telemedicine. | Summary: "With chapters from audiology professionals from around the world, Advances in Audiology and Hearing Science-presented in two volumes-provides an abundance of information on the latest technological and procedural advances in this ever-improving field. Volume 1 primarily focuses on revised clinical protocols and provides information on new research to help guide decisions and criteria regarding diagnosis, management, and treatment of hearing-related issues. Topics include new clinical applications such as auditory steady-state response, wideband acoustic immittance, otoacoustic emissions, frequency following response, noise exposure, genomics and hearing loss, and more. The volume also includes a section on canine audiology, allowing students and professionals a broader exposure to hearing science. Volume 2: Otoprotection, Regeneration, and Telemedicine includes sections with material related to hearing devices, hearing in special populations, such as the children and the elderly, as well chapters on the fast-growing subfields of otoprotection and regeneration, including pharmacologic otoprotection, stem cells, and nanotechnology. Topics include early auditory development in children after cochlear implantation, music therapy, the effect of music on hearing health, and auditory enhancement. Several chapters focus on telemedicine, the remote diagnosis and treatment of patients by means of telecommunications technology. The volumes have been specially authored and organized to function as teaching aids for undergraduate and graduate courses in audiology and speech pathology. The volumes will also be a valuable reference for professions in in audiology, hearing science, neuroscience, and ENT (ear, nose, and throat) and a rich source of information for audiology professionals wishing to keep abreast of what's happening in the audiology and hearing science field"-- Provided by publisher.

Identifiers: LCCN 2019043259 (print) | LCCN 2019043260 (ebook) | ISBN 9781771888288 (v. 1 ; hardcover) | ISBN 9781771888295 (v. 2 ; hardcover) | ISBN 9781771888271 (set ; hardcover) | ISBN 9780429292590 (v. 1 ; ebook) | ISBN 9780429292620 (v. 2 ; ebook) | ISBN 9780429292668 (set ; ebook)

Subjects: MESH: Hearing Disorders--diagnosis | Hearing Disorders--therapy | Correction of Hearing Impairment--methods | Hearing Aids | Telemedicine

Classification: LCC RF290 (print) | LCC RF290 (ebook) | NLM WV 270 | DDC 617.8--dc23

LC record available at https://lccn.loc.gov/2019043259

LC ebook record available at https://lccn.loc.gov/2019043260

Apple Academic Press also publishes its books in a variety of electronic formats. Some content that appears in print may not be available in electronic format. For information about Apple Academic Press products, visit our website at **www.appleacademicpress.com** and the CRC Press website at **www.crcpress.com**

How to Access the Multimedia Content of the Book Deposited in the OAE Portal

The various multimedia elements from the Volume 1 and 2 chapters have been deposited in a dedicated section of the Otoacoustic Emissions Portal. The Portal offers a free access of all its contents to all interested users (students and professionals).

The Portal can be accessed at this address: http://www.otoemissions.org and the contents of the book can be accessed at: http://www.otoemissions.org/index.php/en/book-advances-in-audiology.

Figures 1 and 2 show the relative entry pages and the dedicated web page for the "Advances book" so that readers can verify that they have followed the proper links.

Editors Note: Due to copyright issues the content of YouTube links, has not been transferred to the OAE Portal yet, and the links mentioned in the book point to the original material.

Contents

Contributors

Paul Avan
Laboratory of Neurosensory biophysics, UMR INSERM 1107, School of Medicine, University Clermont Auvergne, Clermont-Ferrand, France

Leticia Reis Borges
Braincare Clinic of Audiology, Speech Pathology and Neuropsychology Treatment and Rehabilitation, Campinas, Brazil

Shelly Chadha
Programme for Prevention of Deafness and Hearing Loss, World Health Organization, Geneva, Switzerland

Andrea Ciorba
Clinical Researcher, ENT and Audiology Department, University Hospital of Ferrara, Italy
Email: andrea.ciorba@unife.it

Maria Francisca Colella-Santos
Human Development and Rehabilitation Department, Faculty Medical Sciences, State University of Campinas, Campinas, Brazil

Maria Isabel Ramos do Amaral
Department of Human Development and Rehabilitation/Graduate course in Speech-Language Pathology and Audiology, Faculty of Medical Sciences, State University of Campinas, Brazil (DDHR-FCM/Unicamp)

Christiane Marques do Couto
Department of Human Development and Rehabilitation/Graduate Course in Speech-Language Pathology and Audiology, Faculty of Medical Sciences, State University of Campinas, Brazil (DDHR-FCM/Unicamp)

Schea N. Fissel
School of Health Sciences, Kent State University, USA

Fabrice Giraudet
Laboratory of Neurosensory biophysics, UMR INSERM 1107, School of Medicine, University Clermont Auvergne, Clermont-Ferrand, France

Antoni D. Grzanka
Faculty of Health Sciences, Medical University of Warsaw, Poland

James W. Hall III
Osborne College of Audiology, Salus University Elkins Park, PA, USA
Department of Communicative Disorders, University of Hawaii, Honolulu, HI, USA
Department of Speech-Language Pathology and Audiology, University of Pretoria, Pretoria, South Africa

Richard Harris
Department of Communication Disorders, Brigham Young University, USA

Stavros Hatzopoulos
Clinic of Audiology and ENT, University of Ferrara, Ferrara, Italy

Read more about the chapter authors, starting on page 543.

Lisa Hunter
Center, Cincinnati Children's Hospital Medical Center, University of Cincinnati Academic Health Center, 240 Sabin Way, ML 15008, Cincinnati, OH

W. Wiktor Jedrzejczak
Institute of Physiology and Pathology of Hearing, Warsaw, Poland

Mark Krumm
School of Health Sciences, Kent State University, Kent, USA

Blandine Lourenço
Laboratory of Neurosensory biophysics, UMR INSERM 1107, School of Medicine, University Clermont Auvergne, Clermont-Ferrand, France

Bradley McPherson
Division of Speech and Hearing Sciences, Faculty of Education, University of Hong Kong, Hong Kong, China

David L. McPherson
Neuroscience Center, Brigham Young University, USA
Department of Communication Disorders, Brigham Young University, USA

Thierry Mom
Laboratory of Neurosensory biophysics, UMR INSERM 1107, School of Medicine, University Clermont Auvergne, Clermont-Ferrand, France

Sara Momtaz
Dr. Masoud Motasaddi Zarandy Ear Clinic, Tehran, Iran

Thierry Morlet
Auditory Physiology and Psychoacoutics Laboratory at the Nemours, Alfred I. duPont Hospital for Children, Wilmington, DE, USA

Colleen G. Le Prell
School of Behavioral and Brain Sciences, University of Texas at Dallas, TX, USA

Sávia Leticia Menuzzo Quental
Postgraduate Program in Health, Interdisciplinarity and Rehabilitation, Faculty of Medical Sciences, State University of Campinas, Brazil (FCM/Unicamp)

Jennifer M. Roche
School of Health Sciences, Kent State University, USA

Diane Sabo
Hearing Assessment and Screening for Audiology Systems, Otometrics (a Natus division)

Milaine Dominici Sanfins
Faculty of Medical Sciences, University of Campinas, Campinas, Brazil

Peter M. Scheifele
University of Cincinnati, Cincinnati, OH, USA

Navid Shahnaz
School of Audiology and Speech Sciences, Faculty of Medicine, The University of British Columbia, 2177 Wesbrook Mall, Friedman Building, Vancouver, BC Canada V6T 1Z3

Henryk Skarzynski
Institute of Physiology and Pathology of Hearing, Warsaw, Poland
World Hearing Center, Warsaw, Poland

Piotr Henryk Skarzynski
Institute of Physiology and Pathology of Hearing, Warsaw, Poland
World Hearing Center, Warsaw, Poland
Heart Failure and Cardiac Rehabilitation Department, Medical University of Warsaw, Warsaw, Poland
Institute of Sensory Organs, Warsaw/Kajetany, Poland

Kristine E. Sonstrom
University of Akron & Northeast Ohio Audiology Consortium (NOAC), Akron, OH, USA

David Sorensen
Neuroscience Center, Brigham Young University, USA

Weronika Swierniak
World Hearing Center, Warsaw, Poland

Thalita Ubiali
Child and Adolescent Healthy Program, Faculty of Medical Sciences, State University of Campinas, Campinas, Brazil

CHAPTER 13

Solutions for Partial Deafness

HENRYK SKARZYNSKI[1,2] and PIOTR HENRYK SKARZYNSKI[1,2,3,4*]

[1]*Institute of Physiology and Pathology of Hearing, Warsaw, Poland*

[2]*World Hearing Center, Warsaw, Poland*

[3]*Heart Failure and Cardiac Rehabilitation Department, Medical University of Warsaw, Warsaw, Poland*

[4]*Institute of Sensory Organs, Warsaw/Kajetany, Poland*

[*]*Corresponding author. E-mail: p.skarzynski@ifps.org.pl*

ABSTRACT

The Polish School of Otorynholaryngology has contributed significantly to the world's medical science. The World Hearing Center in Warsaw has presented a significant impact on the development of medical procedures and methods for the treatment and rehabilitation of hearing disorders. In particular, the partial deafness treatment was developed and introduced in 2002 by Professor Henryk Skarzynski, after a series of comprehensive clinical studies which began in 1997. This chapter presents information on (1) the definition and classification of partial deafness and the newest proposed clinical solutions; (2) the six-step Skarzynski surgical technique for cochlear implantation; and (3) the rehabilitation program and the results of clinical studies, conducted at World Hearing Center.

13.1 INTRODUCTION

For the last 15 years, partial deafness treatment (PDT) has become a routinely used standardized procedure at the Institute of Physiology and Pathology of Hearing and the World Hearing Center, in Warsaw. This innovative clinical approached has been presented in 2002 by Henryk Skarzynski et al (2003).

The development of a special surgical procedure the various methods of therapy and rehabilitation are the results of a large team of specialists including ear surgeons, clinical engineers, audiologists, speech therapists. psychologists, and other specialists working in the area of hearing. The program of PDT was designed to (1) ensure a comprehensive care; and (2) to achieve the best possible outcomes in the treatment of this group of patients (Skarzynski et al., 2003; Skarzynski et al., 2017). The interesting and challenging aspect of PDT is that partial deafness can be related to different hearing impairments. These hearing complications can be treate with cochlear/middle ear implants or hearing aids.

Initially, PDT treatment was dedicated to patients whose preoperati e hearing was at the level of their residual hearing and since 2002 also for those with normal low-frequency hearing. This concept is based on the benefits of electrical stimulation to the damaged part of the auditory receptor. via cochlear implant's electrodes (Rajan et al., 2017). In this category of patients preoperative, speech understanding ranges from 5 to 16%. After cochlear implantation, it is possible to achieve a complete speech understanding. These satisfactory results were the scientific basis for the first child's cochlear implantation with this type of hearing loss in 2004 (Skarzynski et al., 2007, 2017). For these types of patients it is an opportunity to "return to the complete world of sounds" (Helbig et al., 2016).

13.1.1 CLASSIFICATION OF PARTIAL DEAFNESS TREATMENT

Based on numerous clinical cases, the Skarzynski PDT classification system was developed, which permits the comparison of postoperative results including the degree of hearing preservation and, more importantly, the patient's understanding of speech after treatment (Skarzynski et al., 2012· von Ilberg et al., 2011).

The first presentation of the PDT classification was held in 2009 during the ninth ESPCI conference in Poland. Next year, this scheme was a more comprehensive (Fig. 13.1) (Skarzynski, 2012). In 2014, this classification was updated to include an electro-natural stimulation (ENS) aspect. Currently, the 2014 classification scheme is in use (Fig. 13.2), according to Skarzynski et al. (2014).

Currently, the preoperative part of partial deafness cochlear implantation (PDCI) method includes clinical and audiological assessment to confirm fulfillment of qualification criteria, thresholds of 55 dB HL at 125, 250, and 500 Hz, and thresholds of 70 dB HL or higher at all higher audiometric

frequencies. The subject should obtain limited benefit from the most-optimally fitted hearing amplification, with monosyllable scores in quiet of 55% correct or lower in both ears in the best-aided condition, at 60 dB SPL. The extension of PDT indications created an opportunity for patients with different hearing impairments who obtained no benefit from a hearing aid and did not qualify for standard cochlear implant application (van de Heyning et al., 2013).

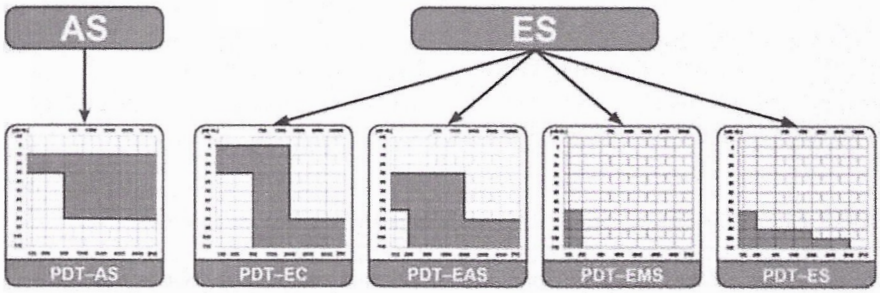


FIGURE 13.1 Previous Partial Deafness Treatment Classification System (2010) which presents different ways of acoustic stimulation (AS) and electric stimulation (ES).
Source: Reprinted with permission from Skarzynski (2012). © Journal of Hearing Science.

TABLE 13.1 Previous Partial Deafness Treatment Classification System.

PDT-AS (A)	*Partial Deafness Treatment-Acoustic Stimulation*	Amplification of acoustic hearing with hearing aids and middle ear implants
PDT-EC (B)	*Partial Deafness Treatment-Electric Complementation*	Electric complementation of existing good low-frequency hearing
PDT-EAS (C)	*Partial Deafness Treatment-Electro-Acoustic Stimulation*	Acoustic amplification by hearing aids of residual hearing at low frequencies and also electric stimulation of other frequencies of the same ear
PDT- EMS (D)	*Partial Deafness Treatment-Electric Modified Stimulation*	Modified electric stimulation uses in cases where pre-operative hearing has been lost without possibility of re-operation
PDT-ES (E)	*Partial Deafness Treatment-Electric Stimulation*	Electric stimulation uses only in cases where residual hearing is non-functional over different frequencies

Source: Based on Skarzynski et al., 2010.

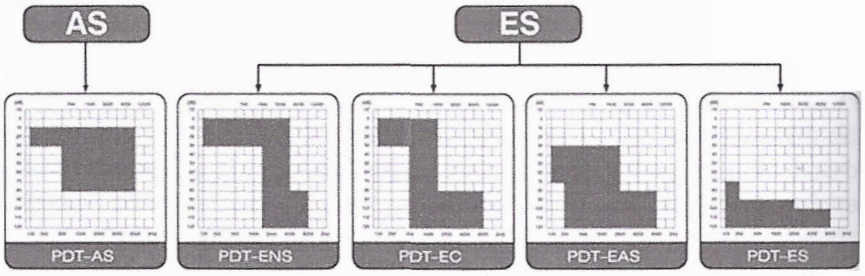


FIGURE 13.2 The newest Partial Deafness Treatment Classification System (2014) which presents different ways of acoustic stimulation (AS) and electric stimulation (ES).

Source: Reprinted with from Skarzynski et al. (2017). © The Author(s). With permission from the Institute of Physiology and Pathology of Hearing.

TABLE 13.2 The newest Partial Deafness Treatment Classification System.

PDT-AS (A)	*Partial Deafness Treatment-Acoustic Stimulation*	Amplification of acoustic hearing with hearing aids and middle ear implants
PDT-ENS (B)	*Partial Deafness Treatment-Electric-Natural Stimulation*	Electric complementation for the effective electric- natural hearing
PDT-EC (C)	*Partial Deafness Treatment-Electric Complementation*	Electric complementation of the preserved hearing only in the low-frequency range up to 500 Hz
PDT- EAS (D)	*Partial Deafness Treatment-Electro-Acoustic Stimulation*	Combination electric and acoustic stimulation with a hearing aid and cochlear implant
PDT-ES (E)	*Partial Deafness Treatment-Electric Stimulation*	Electric stimulation with preservation of the inner ear structure and nonfunctional residual hearing

Source: Based on Skarzynski et al., 2014.

The classification scheme of DT provides the possibility to compare the results of patients with homogenous groups, with regard to the surgical technique, preoperative results and type of electrode.

13.1.2 THE SIX-STEP SKARZYNSKI SURGICAL TECHNIQUE FOR COCHLEAR IMPLANTATION IN THE TREATMENT OF PARTIAL DEAFNESS

Since 2003, the PDT method has been applied to 1562 patients (children and adults) aged from 9 months to 85 years (Skarzynski, 2014).

The cochlear implantation in the PDT treatment is conducted according to the "Six-step Skarzynski Surgical Technique," described by Professor Skarzynski and his team in 2010 (Skarzynski et al., 2010).

Different slim straight electrodes can be used. It is possible to apply (Skarzynski et al., 2014; Prentiss et al., 2010):

1. PDT-ENS: 16–19 mm,
2. PDT-EC: 20–25 mm,
3. PDT-EAS: 25–28 mm, and
4. PDT-ES: 28–31 mm.

The first step of this procedure is a conservative antro-mastoidectomy with adequate boring in order to insert the electrode array into the mastoid cavity (Fig. 13.3).

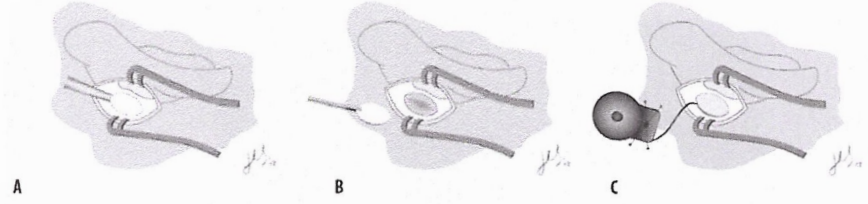


FIGURE 13.3 The first step of procedure: antromastoidotomy.
Source: Skarzynski, 2012.

The second step is a posterior tympanostomy (Fig. 13.4).

The third step is a puncture and incision of the round window membrane (Fig. 13.5).

The fourth step is an insertion or partial insertion of the electrode into the scala tympani (Fig. 13.6).

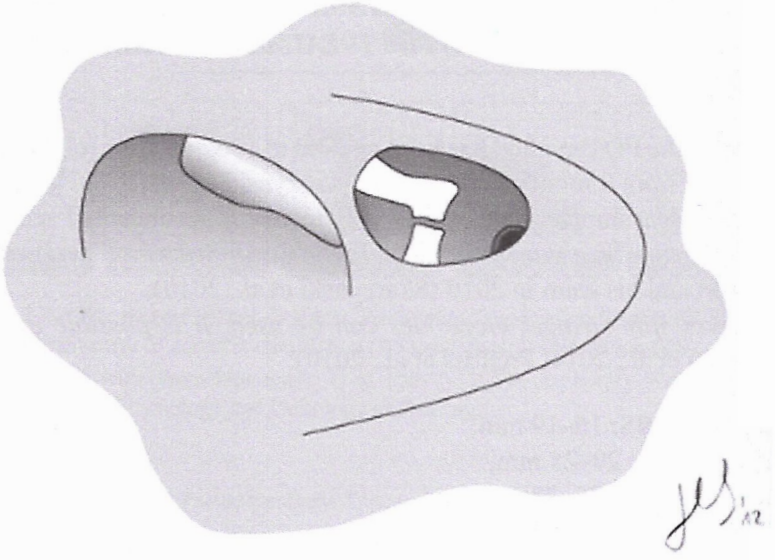


FIGURE 13.4 The second step of procedure posterior tympanotomy with exposure of the round window.
Source: Reprinted with permission from Skarzynski (2012). © Journal of Hearing Science.

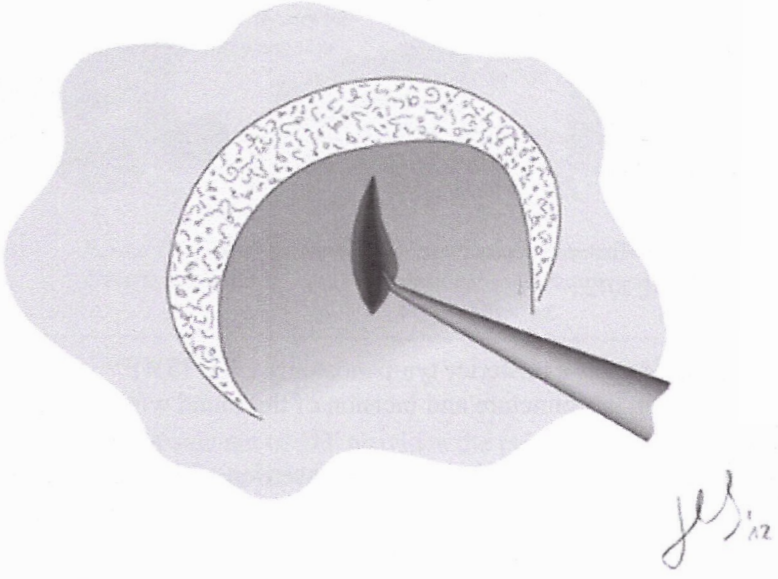


FIGURE 13.5 The third step of procedure: puncture and incision of the round window membrane.
Source: Reprinted with permission from Skarzynski (2012). © Journal of Hearing Science.

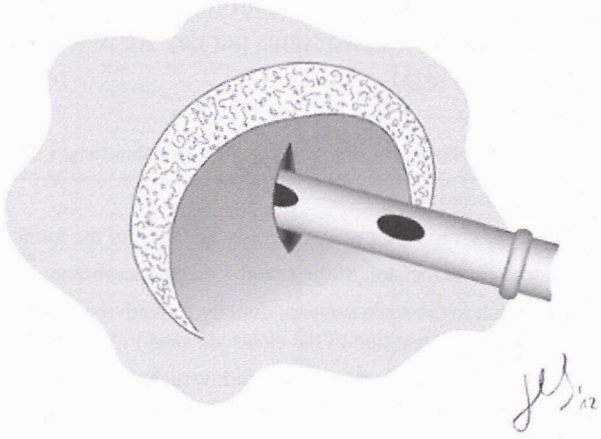


FIGURE 13.6 The fourth step of procedure insertion of the electrode into scala tympani. *Source*: Reprinted with permission from Skarzynski (2012). © Journal of Hearing Science.

The fifth step is the electrode fixation of the round window-niche, with fibrine glue (Fig. 13.7).

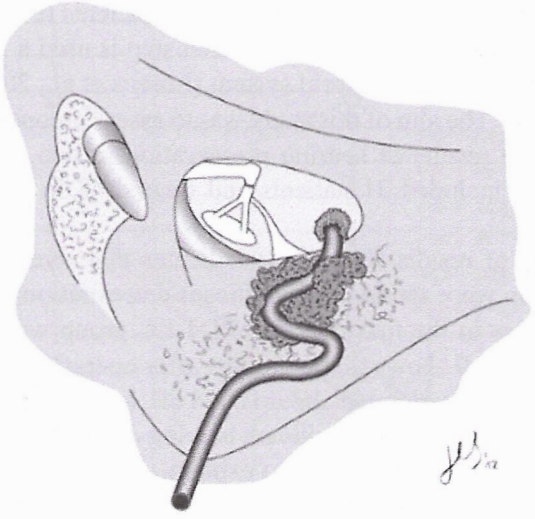


FIGURE 13.7 The fifth step of procedure: sealing and fixing the electrode array. *Source:* Reprinted with permission from Skarzynski (2012). © Journal of Hearing Science.

The sixth step is the fixation of the internal part of the implant in the temporal bone (Skarzynski et al., 2010, 2012; Skarzynski, 2012).

As a routine procedure, steroids are administered in doses calculated as: 0.1/1kg/day *dexamethasone i.v.* two times per day for 3--4 days (Skarzynski et al., 2017; Tables 13.1–13.3).

TABLE 13.3 The Six-Step Skarzynski Surgical Technique (Skarzynski, 2012).

STEP 1	Antromastoidotomy
STEP 2	Posterior tympanotomy to allow visualization of the round window
STEP 3	Puncture and incision of the round window membrane
STEP 4	Approach to the scala tympani directly through the round window membrane (partial insertion of the electrode array)
STEP 5	Electrode fixation in the round window niche with fibrine glue (membrane must be partially uncovered to preserve its mobility)
STEP 6	Fixation of the device in a well in the temporal bone

Source: Reprinted with permission from Skarzynski (2012). © Journal of Hearing Science.

13.2 COMPARISON OF DATA FROM PDT-EC AND PDT-EAS GROUPS

Difference between PDT-EC and PDT-EAS depends on applying the devices. In partial deafness treatment with an electrical complement (PDT-EC) only the speech processor was used but for group of patients referred for electric and acoustic stimulation (PDT-EAS) the first step is used a hearing aid and the next applying a Duet or Hybrid system (Lorens et al., 2012; Skarzynski et al., 2006, 2007). The aim of this study was to assess preoperative threshold and postoperative results of hearing preservation in two groups. The first group (PDT-EC) included 31 patients and second 43 in years 2002–2012 (Skarzynski, 2012).

The analysis of results (Fig. 13.8) indicates that thresholds during 10 years observation were stable. No significant deterioration of hearing level at low frequencies in the first operated PDT-EC group was observed. The data from Figure 13.9 shows that 6 months after operation the thresholds at the low frequencies deteriorated about 10–25 dB, however the hearing levels above 1000 Hz are on stable. Significant hearing deterioration from 1 month to 6 months after surgery is difficult to explain.

Our observations indicated that 32.5 % of patients reported that the hearing in nonimplanted ear was worsened. The most important results are presented in Figures 13.10 and 13.11 showing that systematic rehabilitation process may impact significant on speech perception. The higher level of results speech perception in quiet and noise were observed in PDT-EC group (Skarzynski, 2012).

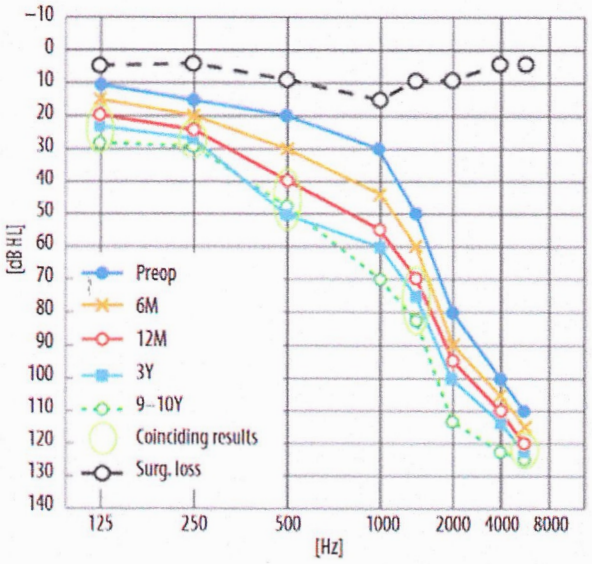


FIGURE 13.8 The comparison of preoperative and postoperative thresholds in PDT-EC group ($n = 31$)—10 years observation.[1]
Source: Reprinted with permission from Skarzynski (2012). © Journal of Hearing Science.

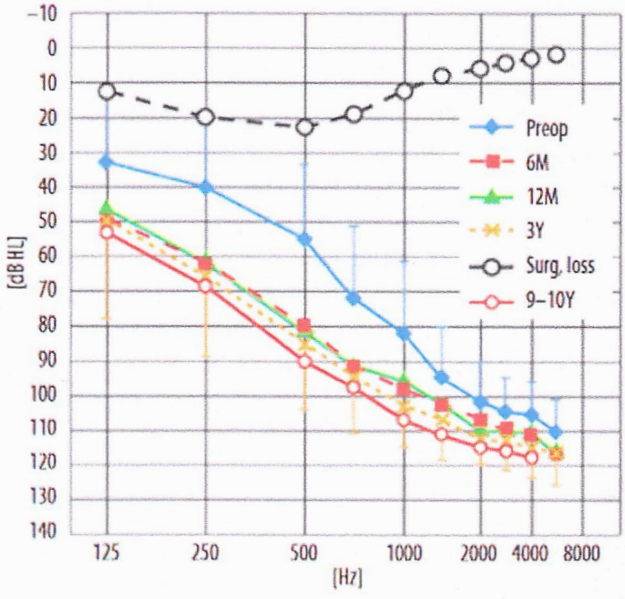


FIGURE 13.9 The comparison of preoperative and postoperative thresholds in PDT-EAS group ($n = 43$)—10 years observation.[1]
Source: Reprinted with permission from Skarzynski (2012). © Journal of Hearing Science.

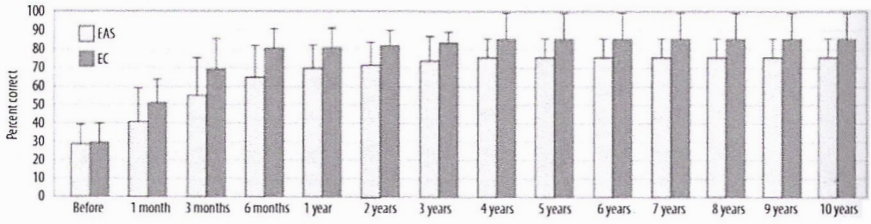


FIGURE 13.10 The results of speech recognition in quiet in a group of patients with PDT-EC and PDT-EAS 10 years observation.[1]
Source: Reprinted with permission from Skarzynski (2012). © Journal of Hearing Science.

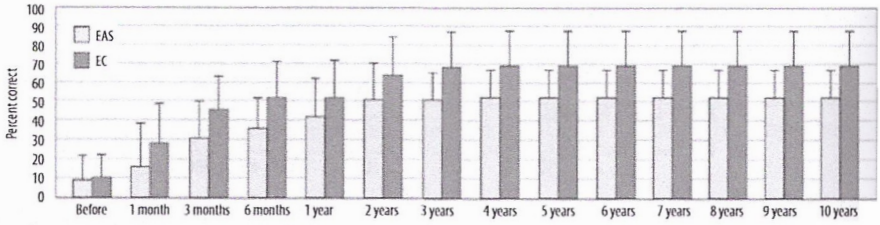


FIGURE 13.11 The results of speech recognition in quiet in a group of patients with PDT-EC and PDT-EAS 10 years observation.[1]
Source: Reprinted with permission from Skarzynski (2012). © Journal of Hearing Science.

13.3 CLINICAL CASES

The basic idea for the PDT treatment at the Institute of Physiology and Pathology of Hearing, and World Hearing Center was the preservation of natural/residual hearing up to 1500 Hz. The following clinical cases were reported in 2014 (case study 2) and in 2015 (case study 1), respectively (Skarzynski et al., 2014, 2015). It is the new perspective of PDT treatment for patients in the senior/elderly group. About 70% of elderly people (>70 years) experience different hearing disorders, which influence their daily activity and communication. Data in the literature show that many patients have a hearing loss at the higher frequencies that is, >1500 Hz (Skarzynski et al., 2017).

13.3.1 CASE 1

16-year-old adolescent patient. The pre-operative result of pure tone audiometry presented a good hearing in the range of frequencies 125–1500 Hz

[1]Figures 13.8–13.11 were published in *J. Hear. Sci.* (2012 Vol. 2. No 2). With the editor's agreement, these figures have been used here.

and deafness at other (Fig. 13.12). *In order to restore hearing cochlear implanted was performed at high frequencies, while preserving low and mid frequency acoustic hearing in the implanted ear. It is described as ENS of the inner ear.*

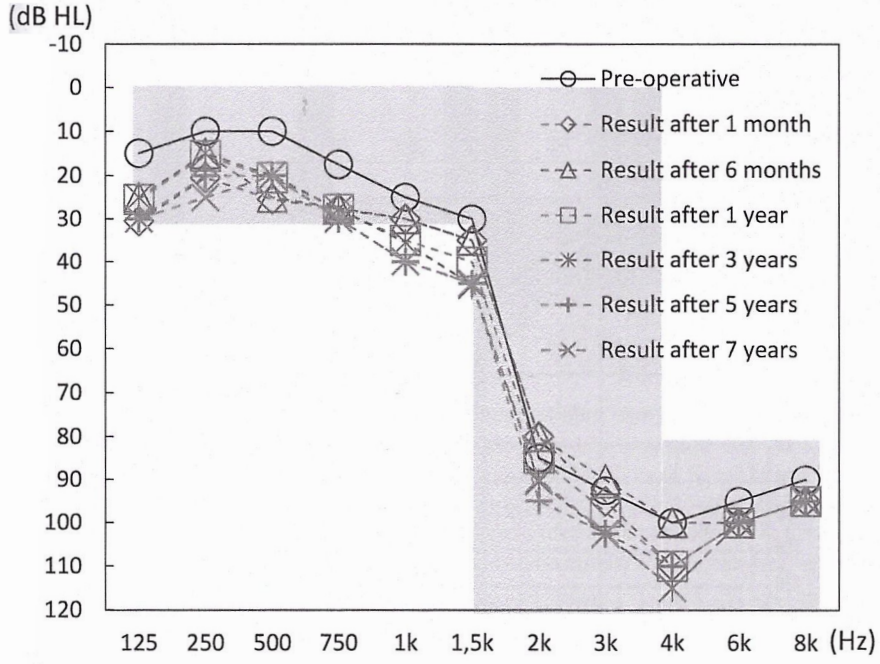


FIGURE 13.12 The result of pure tone audiometry—case study 2.

13.3.1.1 THE RESULTS OF MONOSYLLABIC WORD TEST (THE PRUSZEWICZ MONOSYLLABIC WORD TEST)

A large increase in the speech understanding in quiet and noise was observed. The pre-operative measurement of speech understanding in quiet was 65% (unaided), however after six months it was about 80% and after 1 year, 90%. Furthermore, a 7-year observation demonstrated that the result was quite stable (above 90%).

Changes were also observed in the speech understanding scores in noise. The pre-operative score of speech understanding in noise was 30% (unaided), 6 months later was 55% and after one year reached 60%. The ENS data, after 7 years, showed that speech understanding in noise was 75%.

13.3.2 CASE 2

75-year-old patient with good hearing in the range of frequencies 125–1500 Hz and deafness at other. The result of pure tone audiometry presented a good hearing in the range of frequencies 125–1500 Hz and deafness at other (Fig. 13.13). *The cochlear implantation was used to restore hearing at high frequencies, while preserving low and mid frequency acoustic hearing in the implanted ear. This is described as ENS of the inner ear.*

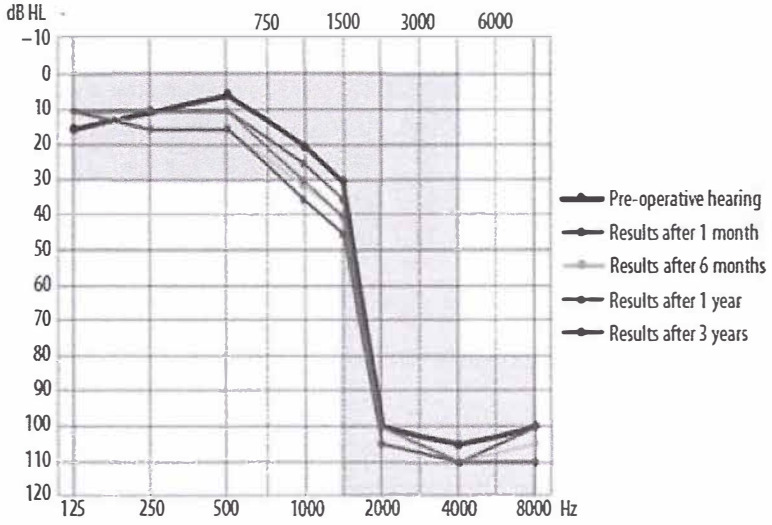


FIGURE 13.13 The result of pure tone audiometry—case study 2.
Source: Reprinted with permission from Skarzynski, Lorens, and Skarzynski (2014). © Journal of Hearing Science.

13.4 REHABILITATION PROCESS OF THE PATIENTS POSTIMPLANTATION

Implantation is the first stage in the treatment of partial deafness. It is important to continue with a rehabilitation process under the guidance of a speech therapist. Our research shows that a properly selected program of speech rehabilitation has a significant impact on speech understanding and can show optimal results in a relatively short time (Fig. 13.14). In the Institute of Physiology and Pathology of Hearing and at the World Hearing Center a unique program has been organized, to optimally match the needs of this group of patients (Pankowska et al., 2012, 2015).

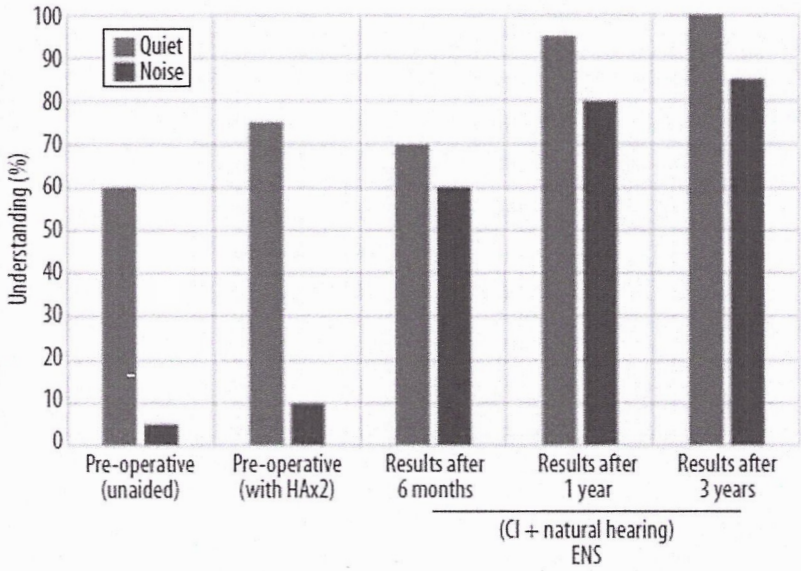


FIGURE 13.14 Case study 2: the result of monosyllabic word test. (a) Speech understanding in quiet. (b) Speech understanding in noise. The data from these two clinical cases, showed that the low and mid frequency hearing (up to 1500 Hz) can be preserved by using the round window surgical approach. These patients needed a restoration of their hearing at the higher frequencies. The cochlear implantation presented a major challenge to the surgeon, as it was necessary to preserve the pre-operative low and middle frequencies hearing levels.

Source: Reprinted with permission from Skarzynski, Lorens, and Skarzynski (2014). © Journal of Hearing Science.

Generally, the problems of understanding and speech perception are presented in the majority of adult patients with partial deafness. The difficulties encountered by these patients include limited possibilities in the differentiation of sounds; lack of sound recognition in quiet and noise; erroneous recognition of similar words; and various articulation problems. It is important to organize the rehabilitation sessions in such a way as to integrate the perception of natural sounds with the perception of electric sounds. Hearing rehabilitation is a planned therapeutic process using language material such as: phrases, sentences, words, monosyllables, and phones. It needs to be emphasized that the rehabilitation process should be conducted in two ways: in a natural environment to the patients and also in cooperation with a specialist who organizes and creates the special program of rehabilitation session, based on an orderly and well-fitting auditory training suited to the patient's needs. The program of

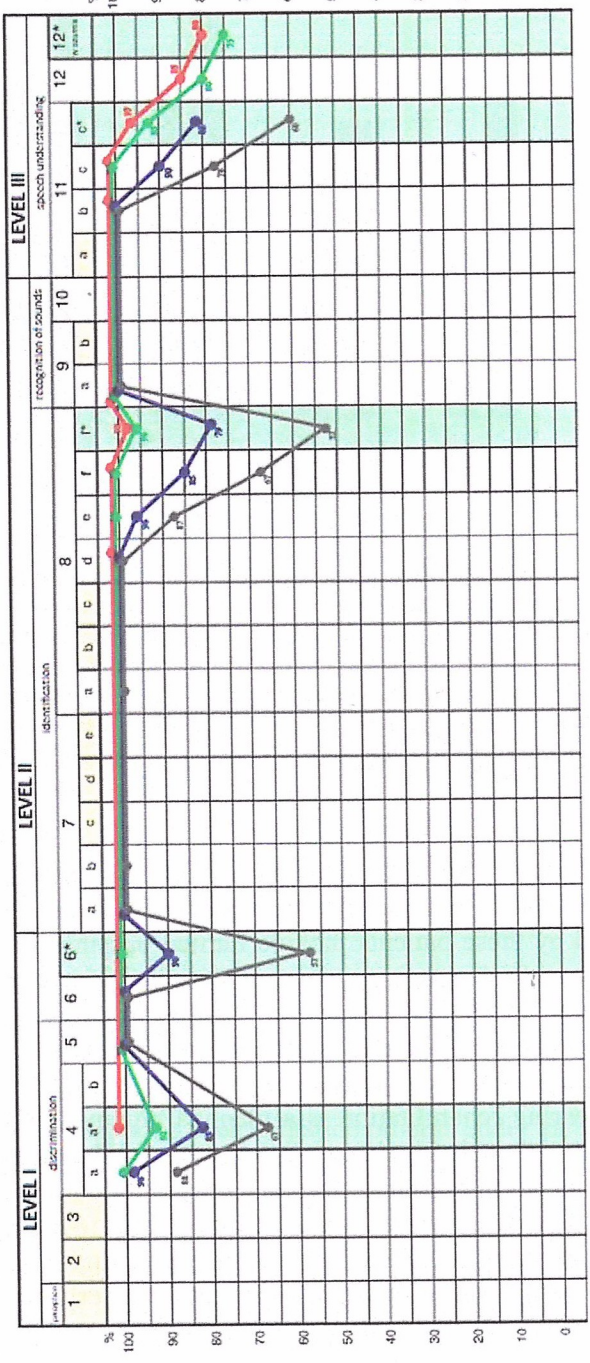


FIGURE 13.15 Profile of patient's hearing skills.
Source: Reprinted with permission from Pankowska et al., 2012a. © Nowa Audiofonologia.

auditory training includes exercises which pertains perception, discrimination, recognition of sounds, and speech understanding. The connection of difficult and simple tasks impact on patient's motivation and shows progress in rehabilitation. It is very important indication for speech therapists (Pankowska et al., 2012).

Rehabilitation process is shared on three levels (Geremek-Samsonowicz, 2012):

1) first level: *basic*—detection and discrimination of sounds;
2) second level: *simple conversation*—recognition of sounds, especially sounds of speech; and
3) third level: speech understanding in natural environment.

In order to assess the results of rehabilitation is applied packet of test tasks and the next step is elaborated the *Profile of Patient's Hearing Skills* (Fig. 13.15). This method provides information and allows setting the new targets in the rehabilitation process (Pankowska et al., 2012).

It is recommended that postoperative treatment of patients with partial deafness should base on auditory training which is directed on identification and perception of sounds on moderate and higher frequencies (Solnica et al., 2012).

In the period of digitization, it is important to create and develop methods for patients based on teleinformatic and telemedicine. The services should be top-class, *readily available,* easy to access, and responsive to the needs of patients. Since the beginning of the 21st century, in the Institute of Physiology and Pathology, World Hearing Center's team is leading a modern telemedicine program in Poland (Wasowski et al., 2012). National Network of Teleaudiology (NNT) is easy accessible telehealth applications for patients after cochlear implantation. Also, telerehabilitation is a new form of treatment in group of patients with partial deafness. This program is dedicated for children and adults and also for specialists in Poland (Solnica et al., 2012). Figures 13.16 and 13.17 depict the actual conditions during a Telerehabilitation session.

Types of consultations in telerehabilitation program (Pankowska et al., 2012):

1) individual consultations;
2) intervention consultations;
3) consultation including examinations and telefitting; and
4) group consultations.

FIGURE 13.16 The telerehabilitation session conducted by a qualified speech therapist from the Institute of Physiology and Pathology of Hearing, World Hearing Center. This process based on collaborate the main center (World Hearing Center) and other institutions, participating to National Network of Telemedicine. The rehabilitation program is individually created for patient's needs, especially by the speech therapists. Patients may decide which form of rehabilitation they prefer after cochlear implantation.
Source: Reprinted with permission from the the Institute of Physiology and Pathology of Hearing, World Hearing Center.

FIGURE 13.17 Speech therapists and psychologist who observe the rehabilitation process conducting by local therapists in institution participating in NNT. The aim of this observation is providing advices and exchange of experience.
Source: Reprinted with permission from the the Institute of Physiology and Pathology of Hearing, World Hearing Center.

Our observations show that this method is as effective as a standard model which is conducted in the Institute. Telerehabilitation allows substantial saving of time of experienced specialists, and in this way, may lead to the reduction of cost. Advantages of the standard telemedicine mode are: saving of time, money, and effort for the patient, better access to specialists, educational value for less advanced team (Wasowski et al., 2010; Kruszynska et al., 2016).

13.5 CONCLUSION

The Polish School of PDT plays a key role in development otosurgery. Many years of experience show that was appropriated expanding the inclusion criteria for cochlear implantations because grows number of patients with this type of hearing loss. It is a chance for patients in every age with a different type of hearing deterioration (Obszanska, 2014). It needs to be highlighted it is the idea proposed by Professor Skarzynski and team from the Institute of Physiology and Pathology of Hearing connecting holistic medicine approach. Not only surgical aspect was proposed but a special rehabilitation program (including auditory training and psychological care).

Conducted the first operation with PTD-ENS was the milestone in world science. It was a new point of view in treatment people about 70 years old whose have a hearing loss above 1500 Hz. Elderly people may feel difficulties with speech understanding which can lead to isolation and development of mental problems such as depressive symptoms, higher level of anxiety, feeling lonely. Furthermore, the results of study conducted by Ciesla et al. (2016) shows that this group of patients declared higher level of depression and anxiety. Quality of life was assessed to using questionnaire methods indicated decrease health-related quality of life. The study by Kobosko et al. (2017) demonstrated that subjective and objective assessment of benefits after cochlear implantation in group of patients with partial deafness may be different. Authors indicate clinical professionals should precisely analyze differences in subjective and objective results. The basis of nonconsistent can be determined by psychological factors. It is important to assess patient's motivation which effect on attending in rehabilitation process.

The program of PDT is a chance for all people, especially elderly patients, to experience greater satisfaction in daily activities and interpersonal relations. This method of treatment enables to return to the world of sounds and experience full of life satisfaction. Furthermore, elaboration

of six steps by Professor Skarzynski and classification of PDT enable to compare results and experience between the various medical centers. Consequently, it encourages standardization of knowledge in the world and elaboration general procedures in otolaryngology. This is being made through the development of technique. Sustainable development of knowledge about audiology and engineering contribute to create innovative solutions and devices. Collaborate with specialist from others areas contribute to make the highest quality of service and generation the best solutions. Achievement of full patient's satisfaction is the result of self and specialist work. Cochlear implantation is the first stage of complex process, however full of success requires active engagement and patient's motivation during rehabilitation process.

QUESTIONS

1. Describe the first step of surgical technique proposed by Professor Skarzynski.
2. Explain the term PDT-ENS.
3. Describe the rehabilitation process after implantation.
4. What are advantages in using telemedicine during diagnostic and rehabilitation process?
5. Who has created the first classification of PDT?
6. What are advantages in using the classification of PDT?

KEYWORDS

- **surgical technique**
- **telemedicine**
- **partial deafness treatment**
- **rehabilitation**
- **cochlear implant**
- **cochlear implantation**

REFERENCES

Ciesla, K.; Lewandowska, M.; Skarzynski, H. Health-related Quality of Life and Mental Distress in Patients with Partial Deafness: Preliminary Findings. *Eur. Arch.Oto-Rhino-Laryngol.* **2016,** *273*, 767–776.

Geremek-Samsonowicz, A. Rehabilitation of Patients after Cochlear Implantation over the Course of 20 Years of Experience. *Nowa Audiofonol.* **2012,** *1* (3), 30–34 (article in Polish).

Helbig, S.; Adel, Y.; Rader, T.; Stover, T.; Baumann, U. Long-term Hearing Preservation Outcomes after Cochlear Implantation for Electric-Acoustic-Stimulation. *Otol. Neurotol.* **2016,** *37* (9), e353–e359.

Kobosko, J.; Pankowska, A.; Olszewski, Ł.; Geremek-Samsonowicz, A.; Skarzynski, H. Subjective and Objective Assessment of Cochlear Implant Benefit in Adults with the Prelingual Onset Partial Deafness. *Nowa Audiofonol.* **2017,** *6* (4), 31–42 (article in Polish).

Lorens, A.; Zgoda, M.; Skarzynski, H. A New Audio Processor for Combined Electric and Acoustic Stimulation for the Treatment of Partial Deafness. *Acta Otolaryngol.* **2012,** *132* (7):739–750.

Obszanska, A. Life Experience of a Partial Before and After Partial Deafness Treatment (PDT)- Case Study. *Nowa Audiofonol.* **2014,** *3* (3), 39–47 (article in Polish).

Pankowska, A.; Geremek- Samsonowicz, A.; Skarzynski, H. Cochlear Implants in Partial Deafness. Tasks and Forms of Rehabilitation of Children. In *Speech-language Therapy for the Deaf, Theory and Praxis*; Ewa Muzyka-Furtak, Ed., Harmonia Universalis Gdańsk, 2015; pp. 329–342 (article in Polish).

Pankowska, A.; Solnica, J.; Skarzynski, H. Application of Modified Auditory Skill Profile in Observation of Hearing Rehabilitation Effect of Adults Partially Deaf Patients Who Use Cochlear Implant Systems. *Nowa Audiofon.* **2012a,** *1* (1), 38–45 (article in Polish).

Pankowska, A.; Solnica, J.; Skarzynski, H. Telerehabilitation- A New Form of Help to Patients Who are Using the Cochlear Implant under the Postoperative Care. *Nowa Audiofon.* **2012b,** *1* (3), 35–38 (article in Polish).

Prentiss, S.; Sykes, K.; Staecker, H. Partial Deafness Cochlear Implantation at The University of Kansas: Technique and Outcomes. *J. Am. Acad. Audiol.* **2010,** *21* (3), 197 203.

Rajan, G.; Tavora-Vieira, D.; Baumgartner, W.-D.; Godey, B.; Muller, J. et al. Hearing Preservation Cochlear Implantation in Children: The HEARRING Group Consensus and Practice Guide. *Cochlear Implant. Int.* **2017,** *19* (1), 1–13.

Skarzynski, H. Long-Term Results of Partial Deafness Treatment. *Cochlear Implants Int.* **2014,** *15* (S1), 21–23.

Skarzynski, H. Ten Years Experience with a New Strategy of Partial Deafness Treatment. *J. Hear. Sci.* **2012,** *2* (2), 11–18.

Skarzynski, H.; Lorens, A.; Dziendziel, B.; Skarzynski, P. H. Expanding Pediatric Cochlear Implant Candidacy: A Case Study of Electro-Natural Stimulation (ENS) in Partial Deafness Treatment. *Int. J. Pediatr. Otorhinolaryngol.* **2015,** *79* (11), 1896–900.

Skarzynski, H.; Lorens, A.; Matusiak, M.; Porowski, M.; Skarzynski, P. H.; James, C. J. Cochlear Implantation with the Nucleus Slim Straight Electrode in Subjects with Residual Low-frequency Hearing. *Ear Hear.* **2014,** *35* (2), e33–e43.

Skarzynski, H.; Lorens, A.; Piotrowska, A.; Anderson I. Partial Deafness Cochlear Implantation in Children. *J. Pediatr. Otorhinolaryngol.* **2007,** *71* (9), 1407–1413.

Skarzynski, H.; Lorens, A.; Piotrowska, A.; Anderson, I. Partial Deafness Coechlear Implantation Provides Benefit to a New Population of Individuals with Hearing Loss. *Acta Otolaryngol.* **2006,** *126*, 934–940.

Skarzynski, H.; Lorens, A.; Piotrowska, A.; Skarzynski, P. H. Hearing Preservation in Partial Deafness Treatment. *Med. Sci. Monit.* **2010,** *16* (11), CR555–562.

Skarzynski, H.; Lorens, A.; Piotrowska, A. A New Method of Partial Deafness Treatment. *Med. Sci. Monit.* **2003,** *9* (4), CS 26–30.

Skarzynski, H.; Lorens, A. Partial Deafness Treatment. *Cochlear Implant Int.* **2010,** *11* (Suppl. 1), 29–41.

Skarzynski, H.; Lorens, A.; Skarzynski, P. H. Electro-Natural Stimulation (ENS) in Partial Deafness Treatment: A Case Study. *J. Hear. Sci.* **2014,** (4), CS67–71.

Skarzynski, H.; Skarzynski, P. H. Treatment of Partial Deafness: The Polish School in World Science. In *Advances in Clinical Audiology*; INTECH, 2017. https://www.intechopen.com/books/advances-in-clinical-audiology/treatment-of-partial-deafness-the-polish-school-in-world-science

Skarzynski H.; van de Heyning P.; Agrawal S.; Arauz S. L.; Atlas M.; et al. Towards A Consensus on a Hearing Preservation Classification System. *J. Hear. Sci.* **2012,** *2* (2), SR95–SR96.

Solnica, J.; Kobosko, J.; Pankowska, A.; Zgoda, M.; Skarzynski, H. Effectiveness Of The Auditory Training in Patients with the Partial Deafness after Cochlear Implantation in the Assessment Oof Patients and Speech Therapists. *Nowa Audiofonol.* **2012,** *1* (1), 31–37 (article in Polish).

Van de Heyning, P.; Adunka, O.; Arauz, S. L.; Atlas, M.; Baumgartner, W. D. et al. Standards of Practice in the Field of Hearing Implants. *Cochlear Implants Int.* **2013,** *14* (suppl. 2), S1–S5.

von Ilberg, C. A.; Baumann, U.; Kiefer, J.; Tillein, J.; Adunka, O. F. Electro-Acoustic Stimulation of the Auditory System: A Review of the First Decade. *Audiol. Neurootol.* **2011,** *16* (suppl. 2), 1–30.

Walkowski, A.; Skarzynski, H.; Lorens, A.; Obrycka, A.; Walkowiak, A. et al. The Telefitting Method Used in the National Network of Teleaudiology: Assessment of Quality and Cost Effectiveness. *J. Hear. Sci.* **2012,** *2* (2), 81–85.

Wasowski, A.; Skarzynski, P. H.; Lorens, A.; Obrycka, A.; Walkowiak, A. et al. Remote Fitting of Cochlear Implant System. *Cochlear Implants Int.* **2010,** *11* (1), 489–492.