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Chapter 9

Treatment of Partial Deafness: The Polish School in World Science

Henryk Skarżyński and Piotr Henryk Skarżyński

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Abstract

Introduction of the method of treatment of partial deafness with cochlear implants has given many patients the previously inaccessible chance to (re)enter the world of sounds. This method of treatment had been developed and introduced to the world's medicine by H. Skarżyński in 2002, after the extensive research since 1997. This task involved creation of a multispecialty team of experts, development of a special surgical method, and concept of the therapy reflecting on the world largest number of hearing improving surgeries being performed for 13 years averaging 15,000 otosurgical procedures yearly. This chapter introduces the treatment of partial deafness, considered as the Polish School in world science and medicine.

Keywords: partial deafness, partial deafness treatment, otosurgery, cochlear implant, hearing preservation, inner ear structure preservation

1. Introduction

Treatment of partial deafness, both congenital and acquired, with application of cochlear implants is for many patients regardless of their age practically the only chance of entering or returning to the world of sounds. Cochlear implants have been in use for more than 40 years and had been applied in more than 200 thousand people globally. Application of cochlear implants in treatment of classic partial deafness is, on the other hand, the matter of the last 15 or so years. This method of treatment, which is applied to an inner ear which is in a part fully functional and in another part completely deaf, had been introduced to the world medicine by

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Skarżyński in 2002 [1]. This important breakthrough had been preceded by research studies which had been conducted in the Institute of Physiology and Pathology of Hearing since 1997, regarding preservation of even the smallest residual hearing which would then be supplemented with a "new hearing" achieved through a cochlear implant [2–4]. Development of a special surgical method and concept of the therapy had been a great challenge requiring involvement of many specialists: ear surgeons and other physicians, clinical engineers, and many other professionals working in the field of hearing rehabilitation [5, 6]. This treatment method had been applied at the beginning to patients whose preoperative hearing was at the level of residual hearing and since 2002 to those whose hearing in low-frequency ranges was good. In these patients their preoperative hearing levels would enable from 5 to 16% of speech understanding [1]. When this hearing is supplemented with electric stimulation obtained with a cochlear implant, patients can achieve complete speech understanding and free communication with their environment [7, 8]. This had been a groundbreaking approach in science and medicine as it had demonstrated the previously negated feasibility of electric stimulation within the partially functional inner ear [9].

Presentation of this program and a resultant Polish School are a reflection of the largest in the world number of hearing improving surgeries being performed for 13 years—on average 15 thousand otosurgical procedures yearly. Established criteria which an achievement or event should fulfill in order to be considered a school in modern science are commonly known and involve a significant achievement and confirmation of the results and importance of the school through the large clinical material supported by the longitudinal follow-up. A very important, although difficult to achieve, indicator confirming the existence and importance of school's output is the marks of appreciation, awards, citations, and opinions in relevant fields of science. The partial deafness treatment (PDT), considered as the Polish School in world science, meets all the abovementioned criteria and many more.

The step-by-step surgical procedure has been described by Skarżyński et al. in 2010 [7]. Cochlear implantation in the partial deafness treatment is in all patients undergoing this procedure performed in the worse hearing ear. The procedure is performed in all cases using the six-step Skarżyński round window approach for partial deafness treatment with different straight electrodes. It can be a 28 mm, 25 mm, or 24 mm slim straight electrode with different numbers of contacts and diameters 0.3 mm at the tip and 0.6 mm at the proximal end. The surgical steps are in order:

1. Antromastoidotomy
2. Posterior tympanostomy to allow visualization of the round window niche
3. Puncture and incision of the round window membrane
4. Insertion or partial insertion of the electrode array into the scala tympani
5. Electrode fixation in the round window niche
6. Fixation of the device in the bony well

Steroids are administered as a routine in every case: 0.1 mg/kg/day dexamethasone i.v. in two doses per day for 3–4 days.

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2. Results

Program of treatment of deafness combining acoustic hearing with electric hearing obtained through cochlear implantation initiated by H. Skarżyński in 1997 had assembled in the Institute of Physiology and Pathology of Hearing a group of more than 50 specialists: physicians, clinical engineers, psychologists, educators, speech and language therapists, and technicians. They all have contributed to the scientific output of the school with their research, clinical, teaching, and organizational work. Leaders of the Institute's program have authored several hundreds of publications and presentations in collaboration with 52 scientists from all continents from 34 leading countries globally. In the years 2000–2016, the team of the Institute has presented, sometimes with international collaborators, 2135 presentations counting only international and continental series of congresses in otorhinolaryngology, audiology, and related fields in Europe, Asia, Australia, and both Americas and Africa. These presentations included many invited lectures, discussion panels, and expert round tables. Simultaneously the same group has published 1465 papers reporting all aspects related to diagnostics, treatment, and rehabilitation of the partial deafness. Subsequent studies, analyses, and reports of longitudinal follow-up studies are related to the largest in the global medicine group of 317 patients with partial deafness.

Establishment and development of the Polish School in Otosurgery had several landmark dates and events. In 2000, on congresses in Antwerp [2] and Berlin [3], H. Skarżyński and A. Lorens have presented first reports about the quality of preserved nonfunctional residual hearing. Preservation of even such small level of hearing after cochlear implantation is a significant assistance in the process of hearing and speech rehabilitation. It means also that the structures of the inner ear have been preserved in the unchanged condition, thus that ear could be useable later, when new, innovative, better technologies for improving hearing will be developed and implemented. At the same time, implementation of the partial deafness treatment with a cochlear implant at the present stage of development of technology and medicine still enables sustained development of hearing, speech, and one or even more languages.

The second milestone, related to the typical partial deafness, has been the first surgery in an adult performed by H. Skarżyński in 2002 [1]. That patient had been able preoperatively to perceive sounds well in the low-frequency range up to 500 Hz, with total deafness in all other frequencies. Successful preservation of the low-frequency hearing complemented with electric stimulation for reception of the rest of frequency range provided an incentive for the dynamic development of research and clinical practice in that direction. After 2 years of follow-up of all implanted adult patients, in 2004 H. Skarżyński had performed the first in the world implantation in a child with this type of hearing [10]. Another landmark has been the first in the world presentation in 2009 [11] and publication in 2010 [12] introducing and explaining Skarżyński's concept of treatment in relation to various groups of patients with partial deafness. It involved inclusion of three principal criteria:

a. Application of Skarżyński's surgical method of six steps [13].

b. Selection and implementation of the surgical approach to the inner ear through the round window membrane as the most physiological way of entry to the cochlea.

c. Availability of different types of elastic electrode arrays, including Cochlear CI422 slim straight electrode designed by Skarżyński [14].

Further works on developing the program of treatment of partial deafness had been continued in the Institute of Physiology and Pathology of Hearing simultaneously with different forms of activities aimed at popularizing this method on different continents. Promotion of this treatment method included, of course, presentations on all major global and continental scientific congresses, supplemented by "live" demonstration surgeries performed by H. Skarżyński in Asia, Europe, and America. Simultaneously, for the needs of spreading clinical knowledge and providing an optimal training program, the Institute has started a series of international surgical training workshops called the window approach workshops (WAW). Since the beginning of the WAW program till 2016, there had already been 24 editions, with more than 3500 ear surgeons from all over the world participating. The WAW program includes hands-on training, patient assessment, and demonstration surgeries. Since 2010, the Institute actively participates also in the Live International Otolaryngology Network (LION) yearly global broadcast, with H. Skarżyński presenting surgeries of partial deafness treatment with various types of electrodes and implant systems. These regularly organized live surgical training broadcasts involve demonstrations of surgeries transmitted from several centers from the whole world simultaneously—from Australia, Asia, Europe, and Americas. These broadcasts enjoy always a very wide audience of surgeons and other medical specialists.

Presentation of the Polish School of treatment of partial deafness had been preceded by a huge work and contribution of an international group of leading specialists involved in implementation of the program of treatment of total deafness. The program had been spearheaded by such eminent researchers and surgeons as W. House and T. Balkany in the USA, Ch. Chouard in France, K. Burian in Austria, E. Lehnhardt in Germany, and G. Clark and W. Gibson in Australia. The leader and many members of the team of the Institute of Physiology and Pathology of Hearing had been visiting these leading members of the international community of specialists involved in treatment of total deafness programs. Many of these leaders had participated in conferences organized by the Institute in Poland. Practical preparations for initiation of the program of treatment of deafness in Poland had been initiated by H. Skarżyński with the support of the Foundation of Medical Development "Homo-Homini" in 1991. Following these preparations, first surgeries of treatment of total deafness in Poland had been performed by H. Skarżyński on 16 and 17 July 1992. They had reverberated widely in Polish society and mass media as well as in science and medicine [15, 16]. Further progress of the Polish program of treatment of total deafness has brought about further groundbreaking events and overcoming further barriers and limitation, including the gradual widening of indications for treatment of deafness with cochlear implants. It had been a foundation for the program of treatment of partial deafness. In its initial stage, in the years 2002–2008, the program had involved combining the electric hearing with the preserved natural hearing up to the level of 500 Hz. In following years electrical complementation had been extended to the level of 750 Hz and 1000 Hz. The top achievement had been first in the world publications, in 2014 and 2015, in which Skarżyński et al. had presented the possibility of treatment of partial deafness with preservation of natural hearing up to 1500

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Hz [17, 18]. In clinical practice this approach is an opportunity created by modern science and medicine for patients with this type of hearing impairment at any age, but the most important is the opportunity for people in advanced age. In the group of people over 70 years, as many as ¾ have different kinds of hearing impairment negatively impacting their ability to communicate with their environment. In a global scale, there are tens of millions of people suffering from the typical partial deafness above 1500 Hz. They are not deaf. In diagnostic studies conducted in conditions of silence, their speech understanding may reach the level of 40–60%. In the standardized conditions of hearing testing in noise, which better mirrors the situations of everyday functioning, their levels of speech understanding drop to 11–22%. It is a cause of their gradual isolation from the society, withdrawal from active participation in social life. In a growing proportion these patients develop deep depression. If we consider that this senior group of citizens grows steadily in line with increasing life expectancy in the developed countries, it is not difficult to arrive at the conclusion that partial deafness today is an important social problem.

3. Summary

At the turn of the twenty first century, the problem of preservation of the nonfunctional residual hearing and thus preservation of the intact inner ear structure had been addressed by several research teams in the world. The trend started by the team of the Institute of Physiology and Pathology of Hearing, especially first results from children and adults published since 2000, had brought about the realization that an intact inner ear might in future be useful when novel, yet unknown techniques for preservation/restoration of good hearing at any age become available. Particularly noteworthy are in this context studies of the research groups from Frankfurt, von Ilberg et al. [19]; Iowa City, Gantz [20]; Kansas City, Staecker [21]; Vienna, Baumgartner et al. [22]; Melbourne, Briggs [23]; Antwerp, Van de Heyning et al. [22, 24]; and Matsumoto, Usami et al. [25]. Until present day these centers have developed various programs of partial deafness treatment with residual hearing up to 250 and 500 Hz in adults and make preparations for conducting similar surgeries in children. Present indications for acoustic and electric stimulation of the damaged inner ear have been included in the newest concept published by Skarżyński et al. in 2014 [17], presented in **Figure 1**.

A crucial issue in development of the Polish School in modern science had been the search for standardized method of assessment of the results of therapy achieved by different research groups in various groups of patients different with regard to their size and qualities. On the initiative of Skarżyński and the team of the Institute of Physiology and Pathology of Hearing, a global HearRing group had initiated the works that resulted in developing the first scientific scale which was published in 2012 by Skarżyński et al. [26]. This scale enables archiving and comparing the results of growing groups of patients provided with cochlear implants. Participation of several tens of prominent researchers from the whole world in development of this scale was not only helpful in its elaboration; it facilitates its steady popularization in modern science and medicine [27].

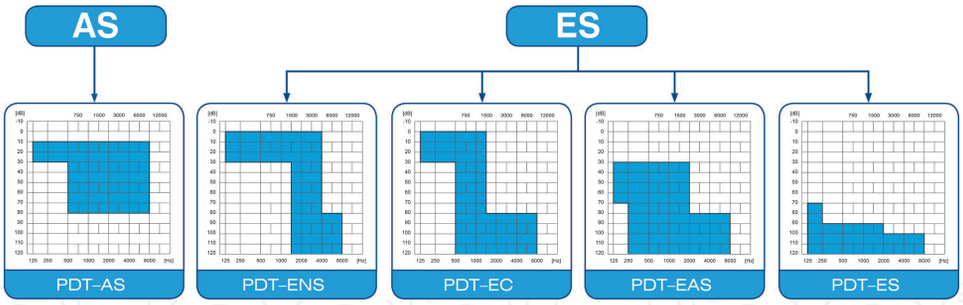


Figure 1. The newest concept of complementation of damaged hearing in indicated ranges: (a) acoustic complementation with hearing aids and middle ear implants (acoustic stimulation, AS), (b) electric support for the effective electric-natural hearing (partial deafness treatment-electronatural stimulation, PDT-ENS), (c) electric complementation of the preserved hearing only in the low-frequency range up to 500 Hz (partial deafness treatment-electric complement, PDT-EC), (d) combined electric and acoustic stimulation with a hearing aid and cochlear implant (partial deafness treatment-electro-acoustic stimulation, PDT-EAS), and (e) only electric stimulation with preservation of the inner ear structure and nonfunctional residual hearing (partial deafness treatment-electric stimulation, PDT-ES).

A final argument summarizing the position of the international scientific community toward strengthening of the Polish School is personal citations and awards and distinctions bestowed for these achievements by the various international scientific and expert groups. Erixon et al. in the Ear and Hearing, which has one of the highest Impact Factor journals in this field, have written in 2015: "Skarzynski et al. (2012) called the first group electrical complement patients and the second group electro-acoustic stimulation patients" [28]. Von Ilberg with an international group of collaborators in a multicenter study published in the Audiology and Neurotology in 2011 [19] has mentioned: "The most expanded indication for electro-acoustic stimulation (EAS) has been reported by the Warsaw group, who implanted candidates with markedly better acoustic hearing in the frequencies between 125 and 500 Hz. Some of the recipients showed extremely sloping audiograms, using the natural preserved acoustic LFH, without the need of any additional acoustic amplification." The same paper mentions further "a small number of studies reporting on children fitted with EAS have recently been published by Skarzynski et al." In its summary it says "Skarzynski and his group have demonstrated convincing results in their first studies on children" and further "however, Skarzynski stressed that this kind of surgery on children should not be attempted without significant successful experience with adults" and still further "by introducing this method, it became possible to improve hearing preservation, with rates going up to 95–100% in most EAS candidates." Guimares et al. in the Brazilian Journal of Otorhinolaryngology in 2015 have said: "Some classifications for hearing preservation have been proposed to assess the degree of preservation of residual hearing, and the most commonly employed is that proposed by Skarzynski (…)" [29].

It should be underlined that the real effects of the Polish School are shown by the increasing abilities of Polish patients in their sustained development of hearing, speech, learning of languages, and development of artistic potential—vocal and musical. The best example of this success is their achievements demonstrated during the first International Music Festival "Beats of Cochlea" [30].

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From among nearly two hundred distinctions and awards won by H. Skarżyński and his team in Poland and internationally in relation to the implementation and promotion of the Polish School, three awards are particularly noteworthy. The first is the '21st Century Award—chief award in the global competition "21st Century Achievement Award Winners" in the category "Healthcare" for the System of Remote Fitting and Rehabilitation in Washington in 2010, in relation to the development and implementation of the telemedical care for patients with partial deafness. The second is the golden medal in the global Prix Galien competition—the first award considered as "Oscar" or "Nobel" of the medical world, awarded for creation of the first "National Network of Teleaudiology" for patients after cochlear implantation, in Monte Carlo in 2014. The third personal distinction of the international community has been the highest citation for H. Skarżyński, as one of the four scientists from the whole world, for his contribution to the development of science and medicine and providing the optimal possibilities of communication of the modern societies. This award has been given to H. Skarżyński in recognition of his leadership and inspirational example for the international society through establishment of the internationally known medical center dedicated to the surgical treatment of hearing disorders and tireless advocacy for people with hearing disorders all over the world.

4. Conclusions

1. The principal idea of the Polish School in the international medical science is a demonstration of the full advantages of patients with partial deafness, preservation of the unchanged structures of the inner ear allowing unlimited development of hearing, speech, and language and chances for application of new future technologies.
2. The perspectives of popularizing of the Polish School in global medical science create a real chance of help for tens of millions of people, particularly in the advanced age.

Glossary

Six-step Skarżyński procedure—surgical procedure of cochlear implantation developed by Skarżyński H. [7] for hearing preservation combining the atraumatic round window electrode insertion with different straight electrodes.

HearRing preservation classification—the first scientific scale which enables comparing the rate of hearing preservation after cochlear implantation developed by the HearRing group published in 2012 by H. Skarżyński et al. [26].

Partial deafness (PD)—a condition where patient has in one ear normal low-frequency hearing but no hearing in the high-frequency range; hearing loss occurs in at least one frequency critical to speech understanding.

Partial deafness treatment—management of partial deafness (PD) consisting in preservation of preoperative hearing through minimally traumatic surgical implantation procedure along with the use of different means of acoustic and electric stimulation.

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