EDITORIAL
UVODNIK

Faculty of Medicine, University of Novi Sad
Clinical Centre of Vojvodina, Novi Sad
Department of Ear, Nose and Throat Diseases

Editorial
Uvodnik
UDK 616.284-004-089.84(091)

HISTORY OF THE SURGERY FOR OTOSCLEROSIS AND COCHLEAR IMPLANTS

ISTORIJA HIRURGIJE OTOSKLEROZE I KOHLEARNIH IMPLANTA

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Surgery for Otosclerosis

At the turn of the 20th century, stapes surgery, and in general surgery for deafness was condemned by most otologists. A number of chance observations were made which encouraged further attempts to relieve deafness in otosclerosis. In 1897 Karl Adolf Passow made a window in the promontory and covered it with the tympanic membrane. His patient reported a slight improvement in hearing. Charles Ballance wrote about an earlier case in 1919, in which he had discovered a fistula into the lateral semicircular canal during the course of mastoid surgery. He covered it with a skin graft and found to his great satisfaction that not only was the patient free of vertigo but that there was an improvement in hearing as well. George J. Jenkins (1874-1939) from London believed that otosclerosis was caused by hypersecretion of labyrinthine fluids and thus attempted to decompress the labyrinth by making a window into the lateral semicircular canal and covering it with a skin graft.

Gunnar Holmgren started to use the first binocular microscope in 1922 and for the first time he was able to demonstrate the otosclerotic focus fixing the stapes footplate. He recognized that osseous closure of the labyrinthine window was the great stumbling block to permanent hearing improvement. Maurice Sourdille (1885-1961) presented first cases of "tympanolabyrinthopexy". His technique of covering a fistula in the horizontal semicircular canal with a meatal flap attached to the tympanic membrane was initially performed in three stages, later was reduced to two, in order to avoid infection and labyrinthitis.

Julius Lempert [1] was inspired by the technique which he followed closely but he applied the endaural approach in one stage. He called this the "fenestration operation" and published his first successful results in 1938. George Shambaugh Jr. (1903-1999) chose from the outset to use the binocular operating microscope and suction irrigation in order to endochondralize the fenestra and to remove all bone dust particles. These two factors greatly reduced the tendency towards osteogenic closure of the fenestra.

Figure 1. Maurice Sourdille (1885-1961)
Slika 1. *Moris Surdil (1885-1961)*

The fenestration operation was introduced in the pre-antibiotic era and gained in popularity as the operation of choice for otosclerosis until the re-establishment of stapes mobilization at the beginning of the 1950s.

Stapedectomy was reintroduced by Sir Terence Cawthorne (1902-1970) from London in 1947 and

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Figure 2. Samuel Rosen (1897-1981)
Slika 2. *Samjuel Rozen (1897-1981)*

Figure 3. John Shea (born 1924)
Slika 3. *Džon Šej (rođen 1924)*

Gino Cornelli [2] from Milan in 1949; the former covered the oval window with a tympanomeatal flap, which produced little hearing improvement, whilst the latter achieved better hearing results simply by opening the oval window after removal of the stapes. Samuel Rosen [3] (1897-1981) from New York rediscovered stapes mobilization by chance in 1952 when he was palpating the stapes to assess its degree of fixation prior to proceeding to a fenestration operation under local anesthesia. He was surprised by the sudden restoration of the patient's hearing. There was less postoperative vertigo, a normal ear canal and drum and an initial hearing improvement in about 70 per cent of cases. Stapes mobilization rapidly enjoyed worldwide popularity and was an important advance in the surgical treatment of otosclerosis.

Various modifications to the operation were made including the anterior crurotomy mobilization described by Milos Basek [4] from New York and Edmund Prince Fowler [5] in 1956. Two years later, the scene changed again with the re-introduction of stapedectomy by John Shea [6] (born 1924) from Memphis, Tennessee. He removed the whole stapes, covered the open oval window initially with "a thin slice of connective tissue" and replaced the stapes with a nylon replica. He later used a short length (4.5 mm) of fine polythene tubing, placed between the incus and vein, which replaced the connective tissue. John Shea thus established the two important principles: the oval window should be sealed and the ossicular continuity restored.

Many modifications followed, most of them being presented during the International Symposium on Otosclerosis in Detroit in 1960. They were the Gel-

Figure 4. Howard House (1907-2003)
Slika 4. *Hauard Haus (1907-2003)*

foam® wire prosthesis by Howard House [7] (1907-2003) from Los Angeles, the fat wire prosthesis by Harold Schuknecht [8] from Boston, the operation of anterior crurotomy with removal of the footplate and replacement of the posterior crus to rest on a vein graft „interposition“ described by Michel Portmann [9] (born 1926) from Bordeaux, the stainless steel by Manford McGree from Detroit and the Teflon® wire by Frederick R. Guilford [10] from Houston. In 1962 John Shea [11] introduced the idea of making a limited opening in the stapes footplate “stapedotomy“ through which he placed a Teflon® piston prosthesis. Progressively, various types of pistons have been developed by different schools of otologic surgery.

Taking into consideration the history of treatment of otosclerosis at the Department of Ear, Nose and Throat Diseases in Novi Sad, it can be said that fenestration surgery has never been applied as a method of treating otosclerosis. Surgical treatment of otosclerosis at our Department began with stapes mobilization. The first mobilization of the stapes was performed in 1958 by Radivoj Topolac (born 1927). The method of House was applied to perform the first stapedectomy in 1962, and Radivoje Topolac performed the stepedotomy in 1974 [12].

Cochlear Implants

William House's desire to help the profoundly deaf led to his involvement in the early research into cochlear implants. William House was the first to place such an implant inside the cochlea. The concept of electrical stimulation producing hearing sensations in the deaf was not new. Towards the end of the 19th century both Adam Politzer, and Giuseppe Gradenigo were interested in the fact that the passage of an alternating current through electrodes applied around the ear produced sounds. In fact these sound waves were transmitted to the cochlea. By 1930, Ernest Glen Wever and Charles Bray from Princeton observed that an amplified output from an electrode placed intracranially in the acoustic nerve of a cat produced a copy of the speech waveform in both frequency and amplitude.

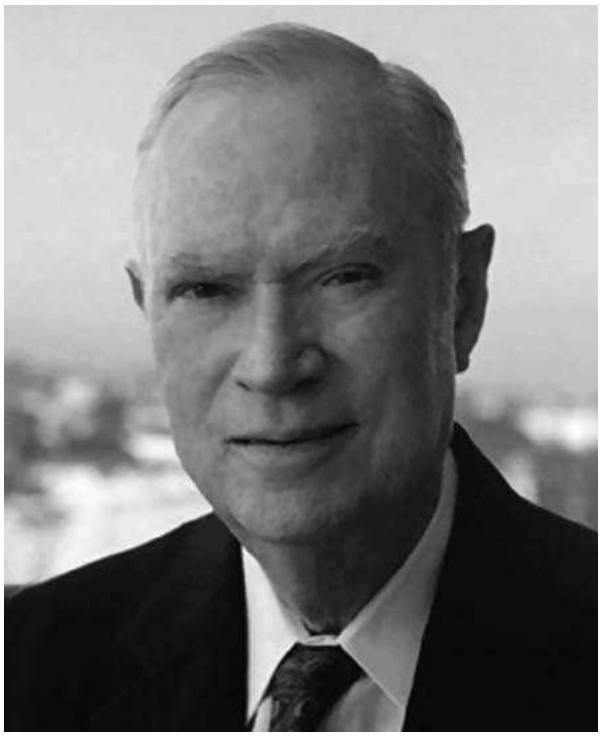

Figure 5. William F. House (1923-2012)
Slika 5. *Vilijam F. Haus (1923-2012)*

A true direct stimulation of the human auditory nerve was perhaps first achieved by Russians Andreef A.M, Gersuni G.V, and Volokhov A.A. [13] in 1934. They placed an electrode near the round window and described various hearing sensations ranging from separate short noises to a smooth buzzing sound. Later, in 1940, the Americans Clark Jones, Smith Stevens (1906-1973) and Moses H. Lurie [14] applied a saline-soaked cotton ball electrode on the round window in nine subjects. The sound of “the chirping cricket“ was described.

The first auditory implantation was performed by André Djourno [15] (1904-1996) and Charles Eyriès (1908-1996) in France in 1957. They inserted a single copper wire near a small segment of cranial nerve VIII in a 50-year old man who was totally deaf. It enabled him to perceive speech rhythm. This report stimulated others and in particular two groups in the United States of America; William House and the Doyle brothers in Los Angeles, and Blair Simmons (1930-1998) and Robert White in Stanford.

In 1961 William House [16] with John Doyle implanted two patients with a single gold electrode placed in the scala tympani. One of these was later replaced with a multiple electrode system. Blair Simmons [17] implanted a six-electrode device in 1964 and found that the patient was able to hear a wide range of sounds. The patient suffered an unforeseen complication of loss of vision due to retinitis pigmentosa, which greatly affected his progress as he was unable to speech-read. Caution was advised by the leading otologists of the day and further clinical work was completely stopped for several years. In 1969 William House [18] again implanted another patient, this time with a six-electrode system developed by his new collaborator Jack Urban. The success with this case led to further implants and the technique became established as a means of alleviating total deafness.

Robert Schindler [19] (born 1943), Michael Merzenich (born 1942), and Robert Michelson (1914-1997) from San Francisco, Claude Henri Chouard [20) from France, Paul Banfai [21] from Germany and Kurt Burian [22] from Austria began clinical work in the 1970s. In Australia Graeme Milbourne Clark [23] (born 1935) used a prototype ten-electrode system in 1978 which, although initially complex, was the first commercialized im-

plant. Ellis Doueck [24] and his group in London pioneered the extracochlear implant in 1977.

Cochlear implants are now produced commercially and nationally approved for clinical use. William House was the first to use a cochlear implant in a prelingually deaf child in 1980.

Cochlear implants are now established as being beneficial to the totally postlingually deaf adult and multichannel implants are superior to those with a single channel. The benefits for the prelingually deaf child are still being fully evaluated. The success of a cochlear implant depends on a fully developed team of otologist, audiology technicians and scientists and teachers of the deaf and, above all, a willing patient.

Yearlong activities had preceded the first cochlear implant surgery performed at the Center for Cochlear Implantation of the Department of Ear, Nose and Throat Diseases, Clinical Center of Vojvodina in 2002, laying the groundwork for its further activities. The first successful cochlear implantation in Serbia was performed at our Center.

The first modern cochlear implant, Nucleus R 24, was placed on November 20, 2002 in a female patient with postlingual hearing impairment (patient I. J., age 40). The surgery was performed by J. Jori, J. G. Kiss from the Ear, Nose and Throat Clinic Szeged, Hungary and Dankuc D. [25] from the Department of Ear, Nose and Throat Diseases in Novi Sad.

Subsequently, Dankuc D, assisted by J. Jori, performed the first implantation of an artificial inner ear in Serbia – a cochlear implant Nucleus R 24. Ever since, the cochlear implant surgery in Novi Sad has been exclusively performed by an experienced team led by Komazec Z. [26], Dankuc D, Vlaški Lj, Lemajić Komazec S, specialized surdopedagogists Nedeljkov S, Sokolovac I, and Vajs O. as well as engineers Mendrei T, and Mrđanov V.

Bone Anchored Hearing Aid

During the 19th century and beginning of the 20th century, various teeth-bone conduction devices were produced; however, they were unsuccessful. The development of the carbon microphone and the magnetic receiver at the beginning of the 1920s enabled the construction of the bone conduction vibrator. In the 1950s the first commercialized bone conduction spectacles were produced by different companies. To enhance the transmission of sound, some of which was lost in the soft tissue, the idea of implanting the vibrator percutaneously into the mastoid bone was pioneered by Per-Ingvar Branemark (born 1929) and Anders Tjellström [27] (born 1937) from Goteborg, Sweden using the principle of osseointegration. In 1977, they implanted the first Baha® (bone anchored hearing aid). In 1981 and in the same spirit, Jack Hought, from Oklahoma City, developed a fully implantable bone conduction device, without much success. By the 1990s the Baha® had become used worldwide.

Figure 6. Anders Tjellström (born 1937)
Slika 6. *Anders Ćelstrem (rođen 1937)*

References

1. Lempert J. Imrovement of hearing in cases of otosclerosis: new one-stage surgical technique. Arch Otolaryngol. 1938; 28:42-97.

2. Cornelli G. Tecnica e resultati della apertura del vestibulo labirintico attraverso la finestra ovale nella terapia della otosclerosi. Revista L'Ospedale Maggiore. 1949;2:55-62.

3. Rosen S. Palpation of stapes for fixation. Arch Otolaryngol 1952;56:610-5.

4. Bazek M, Fowler EP. Jr. Anatomical factors in stapes mobilization operations. Arch Otolaryngol. 1956;63:589.

5. Fowler E. Anterior crurotomy. Arch Otolaryngol. 1956; 46:319-88.

6. Shea J. Fenestration of the oval window. Ann Otol Rhinol Laryngol. 1958;67:932-51.

7. House HP. Experiences with stapes surgery. In: Schuknecht H. Otosclerosis. International. Symposium, Detroit 1960. Boston: Little Brown; 1962. p. 447-56.

8. Schuknecht HF, Oleksiuk S. The metal prosthesis for stapes ankylosis. Arch Otolaryngol. 1960;71:287-95.

9. Portmann M. Interposition: surgical procedure for stapes ankylosis. In: Schuknecht H. Otosclerosis. Internationl. Symposium, Dtroit 1960. Boston: Little Brown; 1962. p. 429-45.

10. Guilford FR. Experiences in the surgery of otosclerosis. In: Schuknecht H. Otosclerosis. Internationl. Symposium, Detroit 1960. Boston: Little Brown; 1962. p. 523-41.

11. Shea J, Sanabria F, Smyth G. Teflon piston operation for otosclerosis. Arch Otolaryngol. 1962;76:516-21.

12. Dankuc D, Pejakovic N, Komazec Z, Vlaski Lj. Functional hearing results in patients with otosclerosis before and after stapedotomy. Med Pregl. 2012;65(1-2):54-8.

13. Andreef AM, Gersini GV, Volokhov AA. Electrical stimulation of the hearing organ. J Physiol. (USSR). 1934;17:546-59.

14. Jones RC, Stevens SS, Lurie MH. Three mechanisms of hearing by electrical stimulation. J Acoust Soc Am. 1940;12:181-90.

15. Djourno A, Eyries C, Vallancien B. De l'excitation électrique du nerf cochléaire chez l'homme, par induction à distance, à l'aide d'un micro-bobinage inclus à demeure. CR Soc Biol (Paris). 1957;151:423-5.

16. House LR. Cochlear implant: the beginning. Laryngoscope. 1987;97:996-7.

17. Simmons FB. Electrical stimulation of the auditory nerve in man. Arch Otolaryngol. 1966;84:2-54.

18. House W. Cochlear implants. Ann Otol Rhinol Laryngol. 1976;85(Suppl 27):1-93.

19. Michelson RP. The results of electrical stimulation of the cochleain human sensory deafness. Ann Otol Rhinol Laryngol. 1971;80:914-9.

20. Chouard CH, Mac Leod P. Implantation of multiple electrodes for rehabilitation of total deafness: preliminary report. Laryngoscope. 1976:86:1743-51.

21. Banfai P. Zugangswege für das Cochlear Implant. HNO 1978;26(3):85-9.

22. Burian K. Klinische Erfahrungen mit der Elektrostimuation des Hörorgans. Arch Otorhinolaryngol. 1979:223(1):139-66.

23. Clark GE, Pyman BC, Bailey QR. The surgery for mulitelectrode cochlear implantations. J Laryngol Otol. 1979:93:215-23.

24. Doueck E. A new approach to the cochlear implant. Proc R Soc Med. 1977;70(6):379-83.

25. Dankuc D. Kohlearni implant. Med Pregl. 2005;58(7-8):329-32.

26. Komazec Z, Dankuc D, Vlaški Lj, Lemajić-Komazec S, Nedeljkov S, Sokolovac I. Kohlearna implantacija na Klinici za bolesti uva, grla i nosa Kliničkog centra Vojvodine. Med Pregl. 2007;60(11-12):643-8.

27. Tjellström A, Lindsröm J, Hallen O, Albrektsson T, Branemark PI. Osseointegrated titanium implant in the temporal bone. Am J Otol. 1981;2:304-10.

Rad je primljen 28. II 2015.
Prihvaćen za štampu 28. II 2015.
BIBLID.0025-8105:(2015):LXVIII:5-6:151-155.