Dorothy Wolff: A Pioneer in Otopathology

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Abstract

Dorothy Wolff, PhD, was an inspirational anatomist, pathologist, auditory physiologist, and surgical innovator. Though little known, she worked throughout the mid-20th century in the midst of a revolution in otologic surgery, influencing well-known otologists such as Julius Lempert, MD, Phillip E. Meltzer, MD, and Richard Bellucci, MD. Wolff’s seminal work included pathologic studies of the operated human ear, which provided the anatomic basis for effective modern techniques of surgical hearing rehabilitation. Wolff also developed and refined multiple animal models of otologic pathologies that are still in use today. As an independent, innovative, and ambitious scientist, Dorothy Wolff succeeded in pioneering surgical otopathology to the benefit of us all.

Keywords

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Beginning with the first mention of the cochlea by Empedocles in 400 BC, countless men and women have contributed to our collective understanding of human peripheral auditory anatomy and physiology.¹ Greek and Italian scientists during the 1500s described ossicular structure and function,¹ and Adam Politzer ushered in the modern era of otologic study by establishing robust otopathologic techniques that permitted him to describe numerous otologic conditions, including otosclerosis.²,³ These otopathologic developments permitted surgeons to begin operating with the expressed purpose of hearing improvement by the mid-20th century; however, the pathologic study of the operated ear was still severely underdeveloped. As such, it was difficult to understand how best to improve on the emerging surgical techniques.

Dorothy Wolff, PhD, was a dedicated and illuminating scientific figure whose work in otopathology represents a singular contribution that accelerated the development of effective, safe, and modern techniques for surgical hearing rehabilitation. At the peak of her career, she ran the research laboratory at Julius Lempert’s Endaural Hospital in New York, where she helped him perfect the single-stage fenestration procedure for the treatment of otosclerosis. Over the course of her 40-year scientific career, Wolff elucidated mechanisms of osseous change within the temporal bone; she developed a novel animal model to study fixation of the stapes footplate; and she established effective otopathologic techniques to evaluate the auditory system across multiple animal models, including amphibians, birds, felines, and primates.⁴-⁶ Her seminal work in otopathology was the prerequisite for subsequent developments in the field of surgical otology, specifically related to the treatment of otosclerosis (Figure 1).

Indeed, if Julius Lempert, MD, is to be remembered as the father of modern otology, Dorothy Wolff, PhD, may well be the lesser-known mother of modern otopathology.

Wolff’s first major scientific contribution was a book entitled Histopathology of the Ear, Nose and Throat, which was published in 1947 with coauthor Andrew A. Eggston, MD.⁴ A tome, it quickly became the definitive reference for head and neck histopathologic anatomy. The book contains over a thousand pages of detailed anatomic descriptions, figures, and photographs. It is an epic work that served as the reference anatomic text for a generation of medical students, but despite the success of her book, Dorothy Wolff, PhD, remains a largely unknown and underappreciated figure in the history of modern otolaryngology.

Little information is available about Wolff’s early life. Born in 1895, she grew up in Shippensburg, a small town in central Pennsylvania, and later attended Smith College, an all-women’s institution in western Massachusetts.⁷ A

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college reunion book from 1923 illuminated her skill and dedication to sketching, a talent that was undoubtedly critical for her future anatomic renderings. She first became interested in otology in the mid-1920s, when she worked as a research assistant in the otology department at Johns Hopkins Medical School. Thereafter, Wolff continued her formal education at the University of Michigan, Ann Arbor, earning a master’s degree in anatomy from the medical school in 1928.

Wolff was eager to continue her academic work and entered a PhD program through the Department of Anatomy at Washington University in St Louis. As a doctoral candidate, she focused on the development of the auditory system and analyzed over 60 pairs of human temporal bone specimens spanning in age from 6 months of fetal development to late adulthood. Her detailed work aimed to expand our knowledge of the timing and process of embryonic development of the middle and inner ear. Wolff was a dedicated and hardworking student. At the time, the method that Wolff described to reconstruct and analyze the temporal bone required the use of wax blocks that were poured out, carved by hand, and stacked up on top of one another (Figure 2). This work was not only time intensive but also highly temperamental. Wolff worked before air conditioners were universally available, and the consistency of the wax models depended on the weather and ambient temperature. Each specimen must have taken weeks to complete, something that, today, can be achieved in mere hours with the

Figure 1. Photograph of Dr. Wolff at her microscope. (Courtesy of Smith College Archives, Smith College.)

Figure 2. Model made from hand-carved wax blocks of serial sections through the human temporal bone. Individual wax blocks were (A and B) poured out and carved by hand and then (C) stacked vertically to reconstruct the temporal bone in 3 dimensions. This manual method was used prior to the development of computer-aided reconstruction. (Republished from Wolff D. Auditory mechanism of the late fetus. In: Anatomy. St Louis, MO: Washington University; 1933.)
use of digital software. Despite these challenges, her significant effort paid off as she completed her doctorate thesis in 1933, entitled "Auditory Mechanism of the Late Fetus." With this work, she elucidated important factors about the development of the temporal bone, including that (1) mesenchymal tissue is present in the middle ear throughout the first year of life; (2) the final conformation of the middle ear is obtained by rotation, not resorption, of bone; and (3) multiple apertures in the facial canal are present throughout early infancy, providing a developmental, instead of pathologic, explanation for temporary facial paralysis associated with otitis media in newborns. These and other findings instantly established her as a new authority in the field of human otopathology.

After graduating with a doctorate in anatomy, Wolff remained at Washington University, where she quickly advanced to become an assistant professor of applied anatomy in otolaryngology. At the time, her success as a woman in academics was rare. Within the Department of Medicine at Washington University alone, there were only 5 female members out of over 120 total faculty. Unfortunately, her research was curtailed at the university in the early 1940s due to complications with funding during World War II. Eager to continue her work, Wolff relocated to New York City in 1942 to begin working on her anatomic textbook with Andrew Eggston, MD, a pathologist at the Manhattan Eye, Ear, and Throat Hospital. It was here that she first came in contact with her soon-to-be close friend and colleague, Dr Julius Lempert. She describes their first meeting: "Late one night the house phone rang (I later learned that Dr Lempert was a night hawk). I answered the phone. ‘Dr Dorothy Wolff?' ‘Yes.' ‘Thank God I have found you; I’ve been all over this town looking for you. I want to talk to you. May I come up?'" That night the two bonded over their dedication to studying auditory physiology and quickly began a collaboration that would last over a decade. Together they would establish the otopathologic rationale for surgical success in fenestration surgery.

Thereafter, Wolff worked out of a small room in Lempert’s Endaural Hospital on East 74th Street. The Lempert hospital contained clinic space, operating rooms, a small inpatient unit, a temporal bone laboratory, and Wolff’s research laboratory. She would frequently joke that her office was so small that she had to consider the size of her technician so that they could both simultaneously fit into the room. Lempert, credited for popularizing the single-stage fenestration procedure, maintained a busy surgical practice at the hospital, which provided ample material for their research in the form of hundreds of human ossicles resected during surgery. The collaboration between Wolff and Lempert allowed the two to make novel, detailed observations on vascular and osseous changes in patients with otosclerosis. The pair went on to publish multiple papers and attend national and international meetings to discuss the origin and progression of otosclerosis. Their combined work was highlighted at the 1949 American
Medical Association Meeting, where they were awarded the Gold Medal in original investigations for their description and refinement of the fenestration procedure (Figure 5).14 Wolff and Lempert quickly formed a close relationship that was driven by their mutual dedication to the field of otology. Wolff would say of Lempert, “Neither of us had any sense of time; the work came first. I respected and admired him. We were friends until his death.”11 A mutual understanding of the obstacles facing stigmatized groups in academics may have also influenced their relationship. Wolff was a pioneering woman in academics but with few female counterparts. Lempert was the son of a Jewish immigrant and was largely unrecognized by the academic medical community in his early career. Regardless, Lempert saw Wolff as an entrusted companion and confidant. She frequently traveled alone to meetings to present their combined work. For example, she spent several weeks in South America to present their fenestration work on a tour of the continent’s hospitals.11 However, Wolff’s gender remained limiting and prevented her from achieving equal status to the male clinicians and researchers of her day. Lempert was known for his social dinners and parties, and although Wolff was frequently invited, her invitations would depend on the attendance of Mrs. Lempert and the wives of other physicians.11

While Wolff worked with Lempert, issues with the fenestration procedure, including bone regeneration and closure of the fenestra, motivated her to pursue a short-term research position at the Massachusetts Eye and Ear Infirmary in Boston. For 2 years, Wolff worked with the otologist Dr Philip E. Meltzer to study the mechanism of bone regeneration in a rhesus monkey model. Meltzer performed the fenestration procedure on the animals, while Wolff analyzed and interpreted the specimens.12 She pioneered the techniques necessary to effectively analyze simian temporal bones, which allowed thorough interpretation of the consequences of various surgical techniques. While their work did not solve issues associated with the fenestration procedure, they did elucidate important aspects of osseous regeneration following damage of the otic capsule that contribute to our current understanding of new bone formation within the middle and inner ear.6

In the 1950s, with the introduction of stapes mobilization, Wolff recognized the advantages of stapes surgery over fenestration procedures and appropriately shifted her focus to studying surgical outcomes following stapedectomy. Julius Lempert, however, never adopted stapes surgery, and Wolff necessarily moved on from his research laboratory to pursue the next phase of her career. She worked with Richard Bellucci, MD, of New York City to develop an animal model to study otosclerosis.5 Until that time, studies of otosclerosis were limited to human cadaveric specimens, as an animal model of stapes fixation had not been previously developed.5 Wolff and Bellucci would change that by recapitulating histopathologic changes seen in otosclerosis in a feline model using an electrocautery needle to induce stapes fixation (Figure 6).5 This revolutionary model accelerated research into the pathology and treatment of otosclerosis and allowed Wolff and Bellucci to elucidate consequences of novel otologic techniques.5 They discovered a high rate of local tissue response and refixation of the stapes following the mobilization procedure and described pathologic intralabyrinthine changes following stapedectomy.15,16 Wolff continued to work with Dr Bellucci well into her 70s, and she briefly overlapped with Dr Harold Schuknecht of the Massachusetts Eye and Ear Infirmary near the end of
her professional career. Although not explicitly mentioned in Schuknecht’s textbook *Pathology of the Ear*, Wolff’s work was clearly appreciated as references to her publications fill the sections related to otosclerosis and surgical otopathology.17 Thereafter, Wolff’s work tapered off until her last publication, in August 1970.18

While explicit descriptions of Wolff’s home life are limited, records indicate that she resided with her mother and younger sister for most of her life.9,11 The absence of any mention of her father adds to an interpretation of her family dynamics, wherein Wolff likely took on the responsibilities as a primary provider. These obligations may have influenced Wolff’s decision to pursue an academic career and to break out of the traditional female role. Wolff’s career began to wind down in the 1970s; however, given her lifelong dedication to research, she appeared to remain involved in academics through the last decade of her life. In fact, a letter thanking Michael Glasscock, MD, for a lecture series in 1977 documents her continuous thirst for knowledge and interest in the field of otology.11 In January 1980, Dr Dorothy Wolff passed away at 85 years of age.9

Dorothy Wolff was an inspirational anatomist, pathologist, auditory physiologist, and surgical innovator. She was a woman generations ahead of her time. Wolff’s passion for the field of otology dominated her professional life. As a single woman without children, she dedicated her career to furthering otopathologic techniques and contributed greatly to our understanding of middle ear disease and its effective treatments. As a truly curious and dedicated scientist, her enthusiasm for research is best demonstrated in one of her manuscripts on the life of Alfonso Corti, a pioneer in inner ear histology. She proposed, “Americans should establish the custom of observing memorial days in honor of great scientists of the past so that our younger generations would learn about and appreciate the contributions of distinguished men [or women] of previous generations.”19 While we may not be able to set aside a memorial day to remember Dr Dorothy Wolff, we should insist on celebrating her as an inspirational woman and superb translational scientist.

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