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1.1
Keynote Lecture

Overview and recent advances in bone conduction physiology

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During the mid 18th century it was found that sound could be transmitted through solids and in the 19th century it was generally accepted that a person can perceive sound by bone conduction. Since then, the research community has tried to understand its fundamental mechanisms. Although the knowledge about bone conduction physiology continuously increases, all mechanisms involved are still not completely understood. The current status of bone conduction physiology including some recent advances will be presented. By the use of human temporal bone specimen models together with live humans, intact human cadavers, and isolated human cadaver heads, the sound in the ear canal, the vibration of the middle ear ossicles, oval and round window, and basilar membrane were investigated while applying vibration stimulation mimicking bone conduction excitation. Results from these investigations have shown that as long as the ear canal is open, the ear canal sound pressure is not a dominant contributor to perception of bone conduction sound. With an occluded ear canal the ear canal sound pressure becomes dominant at frequencies below 1 to 2 kHz; the occlusion effect depends on both the position of the occlusion in the ear canal itself and on the stimulation position. The inertia of the middle ear ossicles seems to contribute to the bone conducted sound around and slightly above the resonance frequency of the ossicles (around 1.5 kHz). At low and high frequencies, the stimulation of the basilar membrane with bone conduction excitation is most probably not through the oval window; inertia of the fluid dominates at the low frequencies while a combination of fluid inertia and compressional and expansion of the cochlear space can produce the response at the high frequencies. Vibration analysis as well as tone cancellation experiments indicate that the internal structures of the inner ear produces no important response for bone conduction hearing. The sound wave transmission in the skull base differs from the cranial vault and the transcranial transmission is practically one for frequencies below 1 kHz while it decreases with around 10-20 dB/decade at higher frequencies. These presented results influence methodology for hearing threshold testing with bone conduction stimulation as well as usage of bone conduction hearing aids.