Implantable Hearing Aids

For those patients that are hearing impaired but not deaf, the most exciting development in listening assistive devices in the past 20 years is the implantable middle ear hearing device. The advantage of these devices is that they work by vibrating the ossicular chain directly. In this manner they are not dependent on just increasing the sound volume to the ear.

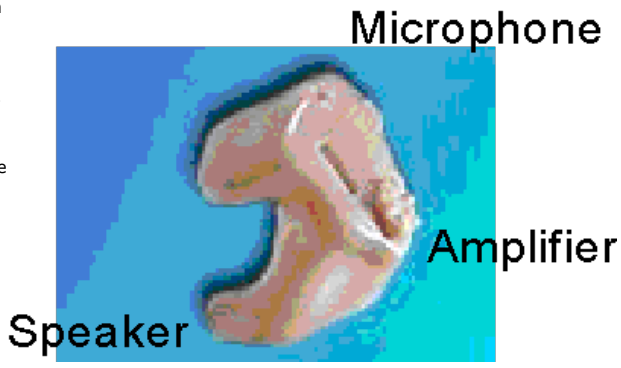

Figure 1. An in the ear canal hearing aid. The essential components of the device are listed including the microphone (which picks up sound), the amplifier (which electronically increases the volume) and the speaker which delivers the sound to the ear canal .

Hearing aids are essentially amplifying devices—they increase the sound volume. Although the electronics has improved in recent years especially with the development of digital aids. However, they all require a small earpiece as a speaker and this is a major drawback because this earpiece/speaker is limited in the quality of sound it can produce. Also because the hearing aid is detecting sound, amplifying the sound and then delivering it to an earpiece/speaker, feedback (or whistling) can be a common problem. Another limitation for some is that hearing aids have to be worn in the ear and can cause problems with ear wax and irritation or even infection of the ear canal.

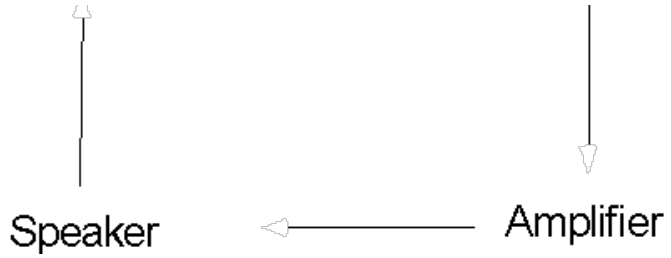

Figure 2. Demonstration of a feedback loop. Sound is detected by the microphone of the hearing aid, then amplified and delivered to the speaker where it produces a louder sound. This louder sound can then be detected once again by the microphone and amplified. Soon this process is repeated over and over and a typical loud high pitched whistling (or feedback) is produced.

Implantable Middle Ear Hearing Devices

There are essentially two implantable middle ear hearing devices on the market now and both work by vibrating the ossicular chain (or middle ear bones) directly. In this way they are taking sound and transforming it to vibrational energy which is delivered directly to the little bones of the middle ear. The advantage is that because they are not delivering sound, they can produce a better quality of hearing. Feedback or whistling is virtually not a problem because there is no feedback loop to be formed.

One of the devices (Symphonix® Soundbridge) is not even worn in the ear but held over the scalp behind the ear eliminating problems with ear wax obstruction and ear canal irritation. The potential disadvantages of the implantable hearing devices is that they require a surgical procedure for placement and they are overall more expensive than conventional hearing aids.

Symphonix® Soundbridge

The first device to achieve FDA approval is the Symphonix® Soundbridge. This device has a floating mass transducer that is positioned onto the incus (2nd ossicle or middle ear bone). An internal receiver wired to the floating mass transducer is then surgically placed under the skin behind the ear. The audio processor which includes the microphone and essential electronics is then fitted over the internal receiver and held in place via a small magnet. No device is worn in the ear canal. Conventional hearing though the ear is still possible in addition to the hearing device.

The Symphonix® Soundbridge works as follows: Sound is picked up or received by a small microphone in the external audio processor. Electronics and programming transforms this sound to a signal which is delivered though the skin to the implanted receiver. Wiring (the conductor link) then carries this information to the floating mass transducer.
Because the floating mass transducer is implanted on the incus, the middle ear bones are directly stimulated and this energy is delivered into the inner ear. Within the inner ear, these vibrations are interpreted as sound by the cochlea which is then

carried by the auditory nerve to the brain.

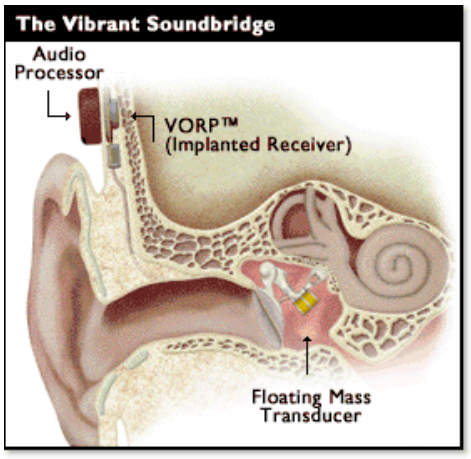

Figure 3. Schematic drawing of the Symphonix® Soundbridge middle ear hearing device. The audio processor has a microphone that picks up the sound and then transforms it to an electrical signal which is carried to the implanted receiver (of the VORP) beneath the skin. The implanted receiver is wired to the floating mass transducer which vibrates the middle ear bones directly. These vibrations are carried directly into the inner ear where they are transformed to nerve impulses to be carried by the auditory nerve to the brain.

The device that is actually worn is the audio processor. It is placed behind the ear where it can be easily covered by hair. The device is relatively small; about the diameter of a quarter and about 3/8 of an inch thick. A primary advantage of the device is that there is nothing in the external ear.

Figure 4. The external audio processor for the Symphonix® Soundbridge device.

The primary advantage reported by patients wearing this device is a vast improvement in the quality of the sound they hear. Many people find they can effectively use their device in the presence of background noise such as a cocktail party or noisy restaurant whereas before they used to remove their hearing aids in such situations as the distraction was unbearable and the hearing aids were then essentially useless. Because the electronics are external, any change or upgrade in electronics or programming is easily performed simply by changing the external audio processor. No additional surgery is necessary.

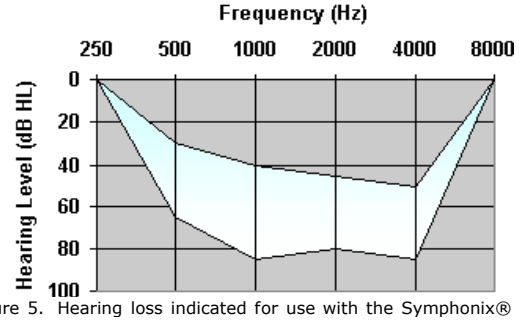

Figure 5. Hearing loss indicated for use with the Symphonix® Soundbridge device.

To implant the device does require an outpatient surgical procedure. It is slightly more than a routine mastoidectomy. This involves general anesthesia. Electrodes are placed for EMG facial nerve monitoring. An incision is made behind the ear. The mastoid bone is partially opened with a surgical drill. A small window is created in the facial recess to gain access to the middle ear. Within the middle ear the floating mass transducer is positioned onto the incus. Additionally a seat is created for the internal receiver behind the mastoid. The wound is closed with stitches and a dressing is placed.

Candidates for the procedure should have no history of chronic middle ear infections. They should have normal middle ear infection. Their hearing should be in the range of at least a 20 to 50 dB downsloping sensorineural hearing loss or greater. Speech recognition should be greater than 50%. Patients should have realistic expectations and motivations and usually this means that they have tried or used a hearing aid in the past. It is best to talk to your doctor and/or audiologist about the indications and procedure in detail.