



## **What is Cochlear Damage?**

The cochlea is a tiny, snail-shaped structure. It is the main organ of hearing and is part of your inner ear. Cochlear Damage means that all or part of your inner ear has been hurt. Damage to the cochlea typically causes permanent hearing loss. This is called sensorineural hearing loss (SNHL). Many things can cause SNHL, or cochlear damage, including loud or extended noise exposure, certain powerful antibiotics, meningitis, Meniere's disease, acoustic tumors, and even the natural decline in age can cause hearing loss. We'll discuss noise-induced hearing loss here as an example, although the cochlear damage that occurs is similar to other types of sensorineural hearing loss.

Noise-induced hearing loss, or NIHL, occurs when your ears are exposed to overly loud sounds. Any sound over 85 decibels is considered to be dangerous to the ears and your hearing. The louder the sound, the shorter the length of time that is considered "safe" exposure. For example, at a loud rock concert, sound may reach 115 decibels, and only a short 15 minutes can cause cochlear damage. In addition, repeated exposure to loud sounds can cause additional cochlear damage. The only way to prevent noise induced hearing loss is to limit exposure to loud sounds and wear ear protection.

## **What happens when cochlear damage occurs?**

Thousands and thousands of tiny nerves called 'hair cells' line the inside of the snail-shaped structure, the cochlea. Each hair cell is responsible for picking up a different sound, sort of like keys on a piano, but on a much more detailed scale. All of the hair cells work in concert to code the incoming sound and send it on to the brain, where sound is heard and understood.

Imagine the tiny hair cells, standing tall and waving back and forth as sound comes into the ear. All of a sudden, an extremely loud sound enters the ear and the cochlea. The hair cells are hit with sound so hard that the hair cells are bent, broken, and in some cases, totally sheared off. Once this cochlear damage occurs, the damage is done. Hair cells in the cochlea are not able to regenerate themselves. Unlike your skin, hair, and many other cells in the body, once cochlear damage occurs, there's no 'growing' back.

## **What do you hear after cochlear damage?**

First of all, you can have varying degrees of cochlear damage. If only a few hair cells are damaged, the result may only be a mild amount of hearing loss. In this case, the hair cells may still be there, but they may require more sound before they are able to move back and forth to send sound up to the brain. Therefore, hearing aids may be sufficient to amplify sound, or make it loud enough to be heard well.

A second example, in which more than a few hair cells are damaged, means that a moderate amount of cochlear damage, or hearing loss, occurs. In this case, many of the hair cells are damaged and some may even be missing, requiring even more sound before they are able to move back and forth to send sound to the brain. A few sounds may be left out of the "concert" altogether, if those hair cells responsible for the sounds are now missing. More powerful hearing aids may be appropriate in this case of cochlear damage. However, even when sound is made loud enough, the sounds may be distorted, because so much cochlear

damage has occurred. This can cause some frustration when trying to hear well in noisy places like restaurants, or in hearing all the details in music. Hearing aids try to compensate for cochlear damage by using techniques for sorting out background noise and providing amplified sound using advanced digital processing.

In a third example, severe cochlear damage occurs. This means that a large portion of the hair cells are damaged or missing completely. Sound coming into the cochlea gets distorted by the hair cells and many sounds are not able to be sent on to the brain since the hair cells are not there anymore. In this case, even powerful hearing aids may be of very limited help. No matter how loud the sounds are made, distortion caused by severe cochlear damage will make hearing aids of limited use. This is where cochlear implants come in.

### **Why are cochlear implants helpful when hearing aids are not?**

Cochlear implants are useful in cases of severe cochlear damage. People who have tried hearing aids with limited success, and have severe to profound sensorineural hearing loss in both ears, may be good candidates for cochlear implants. While hearing aids amplify sounds, if the cochlea is severely damaged and many hair cells are missing, amplified sound won't get past the 'relay station' (i.e. the hair cells in the cochlea), to be sent on to the brain. Cochlear implants replace the function of the hair cells by converting sound into electrical impulses that are relayed to the hearing nerve. Sound is picked up by a microphone worn on the ear. That sound signal is sent into an implant under the skin by using a radio frequency signal. Once the sound signal reached the implant, it is then converted into electrical impulses. By placing a string of electrodes into the cochlea, these electrical impulses relay the sound signal to the hearing nerve, replacing the job that the hair cells would naturally have done. Sound presented through cochlear implants has undergone significant technological advances in recent years and today, people receiving them are benefiting in ways never thought possible twenty years ago.