# Otologics Active Middle Ear Implants

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**KEYWORDS**

• Middle ear transducer • Carina • Active middle ear prosthesis • Cochlear
• Otologics

**KEY POINTS**

- Active middle ear implants increase our rehabilitation armamentarium available in situations in which traditional amplification is not adequate.
- The adoption of traditional amplification remains a problem for a variety of reasons.
- Use of an implantable middle ear prosthesis requires a major commitment from the patients, families, surgeon, audiologist, and educator, particularly if and when future candidacy expands to include the young pediatric age range.
- The reliability of implantable devices has greatly improved with newer generations of the implants, but failures do still occur.
- The best results are achieved in settings with trained surgeons, audiologists, and educators working together with implant patients.

**A video of Otologics surgery accompanies this article at http://www.oto.theclinics.com/**

## INTRODUCTION

The World Health Organization estimates that approximately 600 million people are affected with hearing loss worldwide. Of these, 250 million suffer from moderate to severe hearing losses. In the United States, 28 million Americans have hearing loss severe enough to impact communications. The magnitude of the problem worldwide is overwhelming in how one begins to rehabilitate these hard-of-hearing and deaf individuals.

Traditional hearing aids have seen major advances in recent years, both in fidelity of sound and cosmetic appearance. Although most of the hard-of-hearing population could benefit from traditional amplification, only 15% to 20 % actually use these

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devices. Even in the severely affected group with marked compromise of communication skills, only 55% use hearing aids.[1,2] All health care workers are familiar with the many rationales for not wearing amplification devices.[3] Aesthetic appearance, cost, discomfort in wearing, restriction in activities, quality of sound, and medical conditions (such as canal deformity, chronic external otitis, and chronic middle ear disease) are common complaints from our patients. This lack of adoption of even new hearing aid technology has encouraged manufacturers to develop a new line of technology that is implantable to alleviate these common problems.

The active middle ear prostheses use semi-implantable and fully implantable technology to stimulate the inner ear. In the past decade, rapid advances have been made in the field; these are available in the market place for patients with mild to severe hearing losses. Implantable devices fall into 4 general categories: acoustic osseointegrated prostheses, active middle ear prostheses, cochlear implants, and auditory brainstem implants, along with hybrid devices. This article centers on the semi-implantable and fully implantable Otologics LLC devices, now Cochlear Corporation (Sydney, Australia) active middle ear prostheses.

## REQUIREMENT FOR ACTIVE MIDDLE EAR PROSTHESES

Semi-implantable and fully implantable active middle ear prostheses all require common components: a sensory pick up mechanism, processing electronics, a power source, communication system, and a stimulator. The approach has varied with companies, but the needs remain the same. Although technology in implantable devices has made major strides, challenges remain in developing microphone technology, a translating stimulator, and an implantable power source.

In semi-implantable devices, the microphone, processing electronics, and power source can all be maintained externally with information and power being delivered transcutaneously via a telecommunication coil or magnetic induction. In these devices, many of the technological problems have been solved; the results rely more on signal processing than microphone and battery technology.

In fully implantable devices, these challenges have slowed down the introduction of this technology into the hard-of-hearing patient population. The development of a fully implantable microphone has been one of the major stumbling blocks in all implantable hearing devices. A microphone must be sensitive to ambient sounds, ignoring biologic noises while implanted under a layer of skin and subcutaneous tissue. Adding 6 mm of soft tissue over a microphone decreases its effectiveness by tenfold, thus requiring an enlargement of the microphone system by tenfold. The sensitivity to biological noises and skull vibrations, as during voicing or chewing, is increased 100 fold under 6 mm of soft tissue. Thus, some cushioning of the microphone is required to temper the biological sounds.

Battery technology has made major advances in the past decade. The power source needs to be capable of delivering at least 16 hours of device use without recharging to be an effective amplifier for patients. It should be safe and provide sufficient power for all operating conditions over the life of the implant. It is now feasible to have a small battery sufficient to drive active middle ear prostheses for 24 plus hours between charges. Larger batteries similar to cardiac pacemaker technology can last 5 to 7 years without recharging before requiring replacement.

Electrodes in cochlear implants have now been implanted in patients with devices lasting for several decades. This development is a relatively straightforward technological development when compared with an active middle ear prosthesis. Stimulating the intact inner ear requires a translating system that converts sound energy