INTRODUCTION
It is no secret that technology drives the field of medicine. Through this drive, new bonds have been formed among different fields of medicine. A team of George Washington hospital doctors has been united around a new innovation expected to revolutionize a treatment for millions of patients suffering from a hearing disorder.

The Ear
The ear is a highly complex organ that captures, filters, and processes sound. Sound can be heard through 2 mediums: through the air (air conduction) and through the bone (bone conduction), with both working via the principle of sound waves. To fully understand the transmission of sound to the brain, a brief review of the ear anatomy is in order. The ear consists of an inner, middle, and outer section (Figure 1). The ability to hear occurs when sound waves go into the ear canal, causing the tympanic membrane to vibrate. This sets off the malleus, incus, and stapes, ie, the inner ear bones, which amplify the sound waves and cause the fluid inside the scala vestibuli to move. The fluid movement, alongside the cochlear ducts, triggers the nerve impulses that are processed by the brain as sounds via the cochlear nerve. Due to the intricacy and fragile nature of the ear, its functionality may easily become compromised. One common deficiency is single-sided deafness. Single-sided deafness (SSD) affects an estimated 9 million people in the United States. SSD is the absolute or subtotal loss of hearing in one ear. The causes for SSD are sometimes congenital or unknown, but frequently occur due to physical damage to the ear, pressure on the nerve involved in hearing, infections, diseases, tumors, and trauma. SSD is detrimental in that it causes the inability to recognize the direction of sound. The failure to recognize the direction of sound can make everyday tasks, such as walking across the street or even talking to friends, difficult.

A bone-anchored implant transmits sound vibrations to the inner ear where it differentiates sounds.

Two tasks that are particularly difficult include locating the source of sound and hearing in a noisy environment. The sufferers of SSD vary in age and often chose to live their whole life without medical intervention. Until now, if patients chose to opt for treatment, they were limited to having a bone anchorage implant.

Bone Anchor Implants
A bone-anchored hearing system is surgically implanted to help SSD disabilities that are conductive, mixed, or unilateral. A bone-anchored implant transmits sound vibrations to the inner ear where it differentiates sounds. There are 2 common systems for SSD. The first system is the Baha (Cochlear) system; this involves surgically placing an implant behind the ear. This device consists of 3 parts: a titanium implant, an external abutment, and a sound processor. Although both systems can address SSD, many patients find having a screw implanted in the side of the skull, and a bulky apparatus that is visibly attached to the side of the head, objectionable. Suffers of SSD have been looking for a new solution that does not involve surgery.

A New Solution
A new device approaches SSD by addressing the limitations of the existing SSD devices. The new system, called the SoundBite (Sonitus Medical) hearing system, is a nonsurgical intraoral prosthetic device consisting of 2 components; a behind-the-ear (BTE) microphone (Figures 3 and 4a) and a removable in-the-mouth (ITM) hearing device (Figure 4b). SoundBite is meant to restore hearing without surgery for patients who have SSD, conductive, or mixed hearing. The BTE microphone unit is optimized specifically to improve spatial hearing, while the ITM delivers a bone conduction signal directly to the skull via high frequency outputs through the teeth. The BTE microphone unit is a wireless transmitter with a tiny microphone sitting in an open fit dome in the canal of the impaired ear. Placing the microphone in the canal is intended to emphasize on the "natural acoustics" provided by the patient's pinna.

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(Also called the auricle; the visible part of the ear that resides outside of the head.)

Unlike conventional hearing aids, SoundBite uses bone conduction and does not need a working middle or outer ear. By contrast, conventional hearing aids use air conduction to turn up the volume of sound traveling into the ear and require a working middle or outer ear to have any effect.

Comparing Hearing Systems
Overall, the comparisons between the devices are significant. The capabilities of SoundBite as compared to the Baha and Ponto systems are shown in the Table.

<table>
<thead>
<tr>
<th>Device</th>
<th>Surgery</th>
<th>Capping method</th>
<th>Removable by patient</th>
<th>Time between intuation and use</th>
<th>Microphone location</th>
<th>High-frequency capability</th>
<th>Advanced processing features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cochlear Original Baha</td>
<td>Yes</td>
<td>Osseointegrated abutment</td>
<td>No</td>
<td>3 months</td>
<td>Behind the pinna</td>
<td>No (6,000 Hz)</td>
<td>No (minimal)</td>
</tr>
<tr>
<td>Cochlear BP-106 Baha</td>
<td>Yes</td>
<td>Osseointegrated abutment</td>
<td>No</td>
<td>3 months</td>
<td>Behind the pinna</td>
<td>No (7,000 Hz)</td>
<td>Yes</td>
</tr>
<tr>
<td>Oticon Medical Ponto</td>
<td>Yes</td>
<td>Osseointegrated abutment</td>
<td>No</td>
<td>3 months</td>
<td>Behind the pinna</td>
<td>No (8,000 Hz)</td>
<td>Yes</td>
</tr>
<tr>
<td>Oticon Medical Ponto Pro</td>
<td>Yes</td>
<td>Osseointegrated abutment</td>
<td>No</td>
<td>3 months</td>
<td>Behind the pinna</td>
<td>No (8,000 Hz)</td>
<td>Yes</td>
</tr>
<tr>
<td>Sonitus Medical ITM</td>
<td>No</td>
<td>Oral appliance</td>
<td>Yes</td>
<td>2 weeks</td>
<td>In the ear canal</td>
<td>Yes (12,000 Hz)</td>
<td>Yes</td>
</tr>
</tbody>
</table>

SoundBite in the Marketplace
There are currently 12 providers nationwide of the SoundBite preplant implementations. By the end of 2011, increase compared to the common system of Baha, which was only a 20% increase.

Safety Issues
Safety and possible health risks involved in using the SoundBite device can be of concern to many patients. At a result, whenever foreign devices are introduced, it is advantageous to take a critical look at the short- and long-term safety of any products.

The issue of radio wave transmissions interests interfering with the transmision between the BTE and the ITM are negligible. SoundBite uses a system called near field magnetic induction, which transmits the frequency of the BTE to the ITM. SoundBite only gives off 1/10,000 of the power of a cell phone, and is equal to or less than the radiation emitted by a household power outlet. The ITM device can be worn on either side of the molars. If the dentist deems fit to put the ITM device on a certain side, there will be no feedback from the system.

CLOSING COMMENTS
The development of new nonsurgical hearing systems allows the otolaryngologist, audiologist, and dentist to help patients with SSD regain hearing and to enhance their quality of life. The innovation has helped doctors transcend divides between their individual specializations, to offer patients convenient and comprehensive care. Collaborative treatment, such as this, is a sign of a new and evolving trend; we are likely to see more professionals from across the health spectrum joining forces to solve many of the world's medical dilemmas.

Reference

Suggested Readings

Dr. Singer earned his bachelor of science in human development from Vanderbilt University, and his doctor of medical dentistry from the University of Pennsylvania School of Dental Medicine. Dr. Singer holds the title of assistant clinical professor of surgery at the George Washington University Hospital, where he is responsible for emergency facial trauma, and performs surgeries and procedures for special needs patients. Dr. Singer owns DC Smiles in Washington, DC, and NOVA Smiles in Alexandria, Va. He can be reached at novasmiles@yahoo.com.

Disclosure: Dr. Singer reports no disclosures.

TECHNOLOGY

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