

A RITE-style mini-BTE as worn on the ear.

the new era of BTEs

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The last several years have seen a resurgence in the popularity of behind-the-ear (BTE) This style of hearing aid was introduced in the mid 1950s, but was slowly supplanted in the marketplace once custom products were introduced in the 1970s. However, the most recent data from the Hearing Industries Association indicates that BTE products make up nearly half of all hearing aids sold. Just three years ago, BTEs only accounted for 25 percent of the marketplace.

Is this just another retro trend? Hardly. Rather, the introduction of dynamic feedback cancellation in hearing aids in late 2001 allowed for the re-examination of the differences between BTE and custom hearing aids. Until the introduction of this technology, the maximum vent possible before feedback did not change dramatically between custom and

BTE products. The best that the professional could hope for was perhaps a 2 mm straight vent. Venting of that size was possible in most custom products, even many CICs. There was no particular advantage to fitting a BTE in terms of the amount of gain possible before feedback. Of course, as we all know, patients with no worse than a mild hearing loss in the low frequencies reported occlusion at a high rate.

When feedback cancellation was introduced, significantly larger vents could be placed in hearing aids without leading to feedback in normal use situations. Vents on the order of 3 to 5 mm became possible from a feedback standpoint, but typically could not be built into the smaller styles of custom products. Venting in excess of 4 mm is often required to eliminate occlusion in some patients. Therefore, the unique ability of BTE products to allow for greater venting rekindled interest in this style.

The hearing aid industry recognized that, since BTEs could now offer a realistic benefit over custom products in terms of venting and occlusion relief, the styling of BTEs needed to be re-examined. It was recognized that acceptance on the part of the consumer may be limited if BTE hearing aids continued to look the way they had for the last several decades. It is well-recognized that stigma is a major contributor to the low penetration rate within the population who could potentially benefit from amplification. Many of these reluctant potential patients have a vision of hearing aids as “beige bananas” hanging behind the ear. Patients who have never worn hearing aids before have no idea what occlusion is all about. Trying to convince these patients to use traditionally styled BTEs because they could offer larger venting and thus minimize occlusion was quickly recognized as an uphill battle. In order to capitalize on the advantage of more open venting, the appearance of BTEs simply had to change. Three issues were addressed: (1) size and shape, (2) coloring and (3) coupling to the ear.

Size and Shape

The last several years have seen the introduction of “mini-BTEs.” The typical BTE hearing aid has a length and width of approximately 35 mm x 15 mm, respectively. As demonstrated in Figure 1, some of the new mini-BTEs can have a physical volume of one-third to one-half that of a traditional device. With the reduction in size and with ever-increasing improvements in digital design and manufacturing techniques, there has been a corresponding reduction in weight. Some of the new mini-BTEs weigh only one-third that of a correspondingly sophisticated full-size BTE. In most cases, this volume and weight reduction comes with no reduction in the sophistication of signal processing. The new mini-BTEs have the capability of offering state-of-the-art versions of adaptive directionality, noise reduction, nonlinear multi-channel signal processing and other approaches that define the very best that digital signal processing offers in hearing aids.

In some cases, the difference between a traditionally styled BTE and a mini is the absence of switches, push buttons or



Figure 1: A RITE-style mini BTE compared to a traditionally styled BTE.

volume controls in the smaller style. The absence of these user controls is only in part due to space requirements. For some manufacturers, it is also a conscious attempt to change what a BTE looks like. A major target audience for this new design is first-time users who may be reluctant to use amplification due to age-related stigma. The lack of user adjustments helps to differentiate the mini style from traditional BTEs. Additionally, many of these patients have milder hearing losses, so the need for multiple programs, T-coils or situational volume adjustments is significantly less. Not only do these patients have less need for user intervention controls, they are likely more reluctant to interact with their hearing aids in public because of lingering stigma-related concerns.

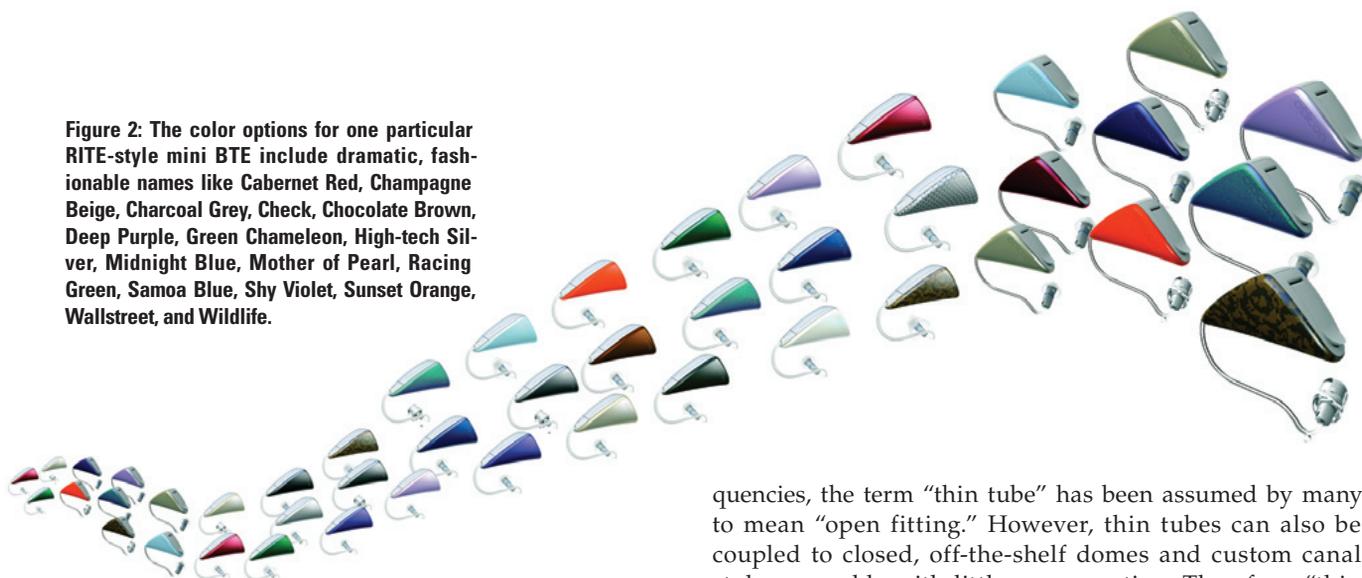
Not all of the new mini-BTEs are lacking external controls. Some do offer the ability for the patient to make changes in settings. Importantly, some do offer T-coils. These products are nice options for patients who respond well to the smaller size and weight of these new devices but still have the need for manual intervention. It is possible that, in some cases, the desire to offer the patient manual adjustments is based not on the patient's request, but on the clinical philosophy of the professional fitting the product. Regardless, it is advantageous to have the option of user control on some models.

Coloring

Some of the new mini-BTEs have been produced in nontraditional hearing aid colors. BTEs for adults have almost always used hair-tone or skin-tone colors in order to decrease visibility. Dramatic color options have been offered in BTEs for a number of years but usually have been used by children as a fashion statement. Some manufacturers, again in an attempt to differentiate the new mini-BTEs from traditional hearing aids, have offered “fashion” colors. Figure 2 demonstrates the range of options for one of these products in the marketplace. The colors and the names (for example, Wall Street, Racing Green, Cabernet Red) have been specifically chosen to break away from our old notions of the way a hearing aid is supposed to look.

Given the size of many of the new mini-BTEs, they can be worn discreetly behind the ear. Many times, the selection of a

Figure 2: The color options for one particular RITE-style mini BTE include dramatic, fashionable names like Cabernet Red, Champagne Beige, Charcoal Grey, Check, Chocolate Brown, Deep Purple, Green Chameleon, High-tech Silver, Midnight Blue, Mother of Pearl, Racing Green, Samoa Blue, Shy Violet, Sunset Orange, Wallstreet, and Wildlife.



unique color option seems to be based on the user's desire to wear something fashionable, even though it is not typically seen by the general public. Even if the patient chooses a skin or hair-tone color in a mini-BTE, the mere presence of other dramatic colors in the product line may help to distinguish the product from more traditional hearing aids.

Coupling to the Ear

In an attempt to improve the cosmetics of BTEs, most manufacturers now offer thin tubes as an alternative to traditional ear hooks and ear molds. These thin tubes are made of a matte finish material and are typically connected to an off-the-shelf dome or other retention device inside the ear canal. The combined effect of no ear hook, a non-reflective, smaller tube and no ear mold significantly decreases how noticeable the hearing aid is. The initial versions of some of the most popular mini-BTEs were designed for new users with mild, high-frequency hearing loss. These patients did not need amplification in the lower frequencies. Therefore, thin tubes were often fit to non-occluding, off-the-shelf domes designed to hold the medial termination of the thin tube in place in the ear canal. This coupling option offers the combined advantages of both improved cosmetics and also very large venting. Both advantages have proven to be important for the reluctant first-time user of amplification.

Since the first thin tube fittings were performed on patients with normal or near-normal hearing in the low fre-

quencies, the term "thin tube" has been assumed by many to mean "open fitting." However, thin tubes can also be coupled to closed, off-the-shelf domes and custom canal style ear molds with little or no venting. Therefore, "thin tube" and "open fitting" are not necessarily the same thing. When thin tubes are coupled to more closed canal options, the potential for better gain in the low frequencies exists. However the hearing aid circuitry must be able to produce a broadband response. Not all mini-BTEs are designed to fit a broad range of hearing losses. It is important that the professional understands the range of hearing losses that are appropriate for the particular make and model of mini-BTE that is being used. Figure 3 shows a custom canal style ear mold connected to a mini-BTE. The ear mold in this figure does not have enough venting to qualify as an open fit. In this case, this hearing aid and ear mold combination is appropriate for someone with more than a mild hearing loss in the low frequencies.

RITE Design

An additional design improvement has occurred over the last few years: the receiver-in-the-ear or RITE style. Compared to a traditional BTE or even most mini-BTEs, the RITE design moves the receiver from the body of the hearing aid into the ear canal. The tube connecting the body of the hearing aid to the receiver is no longer a hollow thin tube, but rather a thin insulated wire that provides the electrical signal to the receiver. The insulation used in the RITE design is also of a matte finish, ensuring the same cosmetic benefits of thin tubes.

The major benefit of the RITE design is a smoother response in the high frequencies. In the traditional BTE design,

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the sound is directed down a long narrow tube which will inherently create resonant peaks and troughs especially in the higher frequencies. By moving the sound source into the ear canal, the need for a long narrow acoustic pathway is eliminated. A smoother response usually results in higher ratings of sound quality. Although the resonant peaks can be corrected electronically in a hearing aid, most devices do not have the narrow frequency resolution necessary to smooth out these irregularities without making compromises. Any residual “peaky-ness” can make the hearing aid more prone to feedback.

Advantages of BTEs

With the resurgence in the popularity of BTEs, it is useful to revisit the benefits of this style.

- As stated previously, the BTE style combined with digital feedback cancellation can allow for larger venting for most patients. The larger the venting, the higher the acceptance rate due to improvements in sound quality and reduction in occlusion.

- With the smaller size and focus on styling, the new mini-BTEs can offer improved cosmetics, especially when connected to thin tubes or when implemented as a RITE design.



Figure 3: A custom canal-style mold connected to a RITE-style mini BTE.

- By eliminating the need to fit circuitry into a custom-made hearing aid shell, production consistency is improved. No matter how careful the technician is, when partially unprotected circuitry, microphones, loud-

speakers and the associated connection wiring need to be individually fitted into the smallest possible space, errors can be made. When the same circuitry is being fit to a consistently sized hearing aid case, the result is expected to be more easy to replicate.

- Compared to the smaller-sized custom products, directional microphones can be placed at an advantageous position and spacing. Many of the smaller models of custom products do not even offer directionality as an option. There is yet to be

a widespread directional solution for CIC products. It is important to note that for effective directionality to be realized, the microphones in BTEs need to be aligned in a horizontal plane above the ear. This requirement is not met by some mini-BTEs that are designed to wrap tightly around the back of the pinna.

- BTEs are far less dependent on the size and shape of the ear canal to achieve a cosmetically acceptable result. Many cosmetically conscious patients who desire a deeply fit CIC to minimize noticeability are disappointed when the hearing aids must sit partially in the concha bowl due to a small ear canal. Few adults have ear canals that are so small that an acceptable dome or canal mold cannot be found.

The Future

It is hard to tell where the percentage of BTE fittings will stabilize. By now, all of the major manufacturers offer thin tubes and most offer mini-BTEs. Most manufacturers develop new hearing aid circuitry so that it can fit into smaller custom products. Therefore, fitting advanced signal processing into mini-BTEs is achieved without much difficulty. The size of future mini-BTEs will likely be driven by the inclusion or exclusion of options such as switches, T-coils, VCWs and, eventually, wireless connectivity. There is still a natural place for custom products, driven by both the professionals' and patients' preferences. Some professionals simply prefer custom products over BTEs and vice versa. The same goes for patients: some simply prefer the cosmetics and practicalities of handling custom products.

The new attention to styling concerns with BTEs will likely continue for some time into the future as more and more innovative approaches are offered. Care must be taken to ensure that styling concerns do not threaten functionality, but that is not likely. Some of the most interesting hearing aid designs in the market also offer some of the most sophisticated technologies. We are likely to see an extended era of both excellent form and excellent function. **\$**

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