

Fitting CIC Hearing Aids— Some Practical Pointers

BY GAIL I. GUDMUNDSEN

They're here! Completely-in-the-canal (CIC) hearing aids are rapidly becoming a routine alternative fitting for many of our patients. It was only a year or so ago that we were searching for a generic name for these instruments. Now they are available from a dozen or more different manufacturers. Some good things happen when we use a deep eartip and place the microphone of the hearing aid in the ear canal. Add in cosmetic appeal, and it is easy to see why CIC instruments have people excited.

However, the dispenser has a number of things to consider when selecting and fitting CICs; these include candidacy, impression-taking techniques, verification, and counseling procedures. The Journal will address these and other topics in a special issue this November devoted to CIC hearing aids.

As a warm up for that issue, Gail I. Gudmundsen, MA has joined us on Page Ten this month to answer 20 questions about CIC hearing aids.



Gail, the owner of Advanced Hearing Systems in Elk Grove Village, IL, is nationally recognized for her continued involvement with numerous audiology organizations.

Some of you might also recognize her as the two-eared niece of the famed Dr. Abonso. Over the past few years, she has had extensive experience with CICs, and has personally fitted products from nearly every CIC manufacturer. If you're just getting started with CICs (or even if you're somewhat seasoned), I think you'll find some very useful information in Gail's answers to our Page Ten questions.

*Gus Mueller
Editor, Page Ten*

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What is a CIC?

These are confusing times. For about the last 5 years the literature has been filled with articles about deep-canal fittings and peritympanic fittings. An important distinction is necessary at the outset: CIC stands for completely in the canal, meaning that the visible end of the hearing aid is 1 mm to 2 mm inside the entrance of the ear canal. A deep-canal hearing aid (or earmold) is simply one in which the eartip is placed deep in the ear canal, a technique that has been in practice for decades. A deep-canal fitting can be accomplished with *any* hearing aid or earmold whose eartip extends into the bony portion of the ear canal.

In short, "deep-canal" refers to the place where the instrument ends in the ear canal, not to a particular style of hearing aid. On the other hand, a CIC is a style of hearing aid—one designed to be virtually unnoticeable in the ear canal; in most cases, a CIC hearing aid also has a deeply sealed eartip.

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What are the advantages of CICs?

Beside the obvious cosmetic advantage, there are at least four others: (1) reduction of the occlusion effect, (2) increased undistorted output, (3) increased high-frequency emphasis, and (4) comfort.

An important indirect advantage is that an amplifier-transducer combination that is marginal for high-frequency response and/or undistorted output in an in-the-ear (ITE) hearing aid may provide dramatically improved intelligibility in a CIC application.

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How do CICs reduce the occlusion effect? What about venting?

The minimal venting normally used with CIC hearing aids does not appreciably alter the frequency response, nor does it reduce the occlusion effect. In fact, venting is often not used.

One advantage of *any* deep canal fitting is to reduce the occlusion effect, the "hollow voice" sound that accompanies a shallow seal in the ear canal. When we speak, we produce about 140 dB SPL in the back of the mouth on closed vowels such as /i/ and /u/ (ee and oo). The resulting vibration of the flesh and mandible causes the wall of the ear canal to vibrate. When a shallow seal is used, the trapped sound of the wearer's own voice can produce 100 dB or greater SPL in the ear canal at low frequencies—20 dB to 30 dB more than when the speaker has an open ear.

Zwislocki demonstrated in 1953 that a deeply sealed eartip virtually eliminates the occlusion effect. We don't know exactly how deep is deep, since ear canals differ.¹ But, the occlusion effect is significantly reduced when an earmold or hearing aid is sealed in or near the bony portion of the ear canal, and users are less likely to complain that they sound as if they are "talking in a barrel." Deep insertion also reduces self-masking when the wearer is vocalizing or chewing.

To measure the occlusion effect using real-ear equipment, have the patient speak with the probe microphone in the open ear and then with the hearing aid in place but turned off. (For details of the procedure, check out Mueller, Hawkins, and Northern.² It works.) A quicker way to check for the occlusion effect (you don't need to disable the loudspeaker and get out your sound-level meter) is to listen to the probe-microphone output with a monitor earphone on your real-ear system.

Some manufacturers include a vent large enough to put the probe tube through or they include a probe tube glued in the vent channel. You can then cut it off when

you've completed the real-ear measurements, leaving a pressure vent. Even if no vent or probe tube is provided, it is often possible to insert a 1-mm probe in the ear canal. The fleshy part of the ear canal will accommodate the probe tip as always. The bony part might present a problem, except manufacturers often reduce the diameter of that portion of the CIC eartip for greater comfort.

4 Is there anything different about the frequency response of CICs?

Absolutely. Deep-canal placement of a hearing aid causes two response changes: increased SPL at the eardrum and increased high-frequency SPL at the microphone input. The result is an increase in *output* of about 4 dB at low frequencies and about 8 dB to 10 dB at 4000 Hz in comparison to an ITE having the same 2-cc coupler specifications. The increase in *gain* is typically 5 dB at low frequencies and 13 dB at 4000 Hz.

Let me explain. The volume of a 2-cc coupler is 2 cc. (Who's buried in Grant's Tomb?) The equivalent volume of the ear is less than 2 cc—about 0.7 cc for ITEs and about 0.25 cc for CICs at 4000 Hz. Because of this reduced volume of air at 4000 Hz, the CIC aid will typically have 9 dB greater undistorted output than an ITE aid, and some 20 dB greater output at the eardrum than measured in a 2-cc coupler.

The increase in *output* comes from the deep placement of the eartip, which leaves only a small volume of air between the eartip and the eardrum. The increase in *gain* comes from the increase in output plus at high frequencies the increase in SPL found at the deep-concha placement of the microphone.

5 So, does this mean that less gain and output are required with CIC hearing aids?

Yes, but. The *patient* will need the same amount of gain and output. However, with a deep placement, less *2-cc coupler* gain and output are required, regardless of the type of hearing aid. An instrument whose 2-cc coupler specifications would be totally inadequate for an ITE hearing aid may well be sufficient for a CIC instrument.

6 This is good news! Then CICs should work for severe hearing losses.

Very good. Gain and output limitations are less than one might think, because the same amplifier-receiver combination will produce 5 dB more output at low frequencies, and 10 dB to 15 dB more at high frequencies. This means that an SSPL-90 output sufficient for a 60-dB high-frequency loss with a typical ITE would be adequate for a 70-dB or 75-dB high-frequency loss with a deep-eartip CIC. Similarly, an ITE 2-cc coupler gain sufficient for a 60-dB high-frequency loss should be adequate for high-frequency losses of 75 dB or more with a CIC fitting.

7 So does this mean that essentially everyone is a candidate for CICs?

Candidacy for any type of amplification is dependent on many things, including degree and slope of hearing loss, lifestyle, and need for special circuitry. CIC candidacy is determined similarly, but with special emphasis on manual dexterity, size and shape of the ear canal, and desire for the cosmetic aspect of "invisibility."

A person with a dexterity problem, a chronic ear condition, drainage, or radical surgical modification of the ear is not a good candidate for a CIC. A remarkable otologic history, abnormal findings on otoscopic examination of the ear canal, and abnormal acoustic immittance measurements are also possible contraindications for CIC use.

8 Will CICs work for precipitous high-frequency losses?

Definitely. Patients whose hearing is normal or near-normal in the low and mid-frequencies, typically require open-

mold or IROS fittings to reduce the occlusion effect and vent the low frequencies. Unfortunately, with open mold fittings, feedback is common when the gain is increased. Because CICs typically require little or no venting and are deeply sealed in the ear canal, the occlusion effect is reduced, and gain can be increased without producing feedback.

An additional advantage with CIC hearing aids is greater high-frequency gain. Remember, we already talked about this. The increased high-frequency emphasis for the same coupler response eases the task of providing adequate gain at 4000 Hz without excess gain at 1000 Hz. In addition, I had success with one patient by using a stepped-response microphone in a CIC.

9 Are there correction factors for CICs? And, do I have to abandon all my understanding of RECDs?

Not yet, and no. However, the real-ear gain and output of a CIC will be significantly greater than that of an ITE that measures the same in a 2-cc coupler. In Table 1, line A gives a reasonable estimate of the conversion from 2-cc coupler gain to real-ear insertion gain. Line B gives a reasonable estimate of the conversion from SSPL-90 measured in the 2-cc coupler to SSPL-90 measured at the eardrum. (This difference is called the RECD: real-ear to coupler difference.)³⁻⁵ Keep in mind that no two ears are the same, and that some CIC and many MIC (mostly-in-the-canal) hearing aids don't go as close to the eardrum (deep in the canal) as is assumed here.

10 Is there a greater chance of feedback with CICs?

Yes and no. Yes, sometimes, because the microphone is located down in the ear

Table 1. Real-ear corrections for gain and output

Frequency in Hz	250	500	1000	2000	3000	4000	6000	8000
A GAIN in dB	7.5	7	9	7	10.5	18.3	23	23
B OUTPUT in dB (RECD)	7.5	7.5	10.5	14	18	21	24.5	26.5

canal and a slit leak anywhere is likely to cause feedback. No, if these hearing aids are sealed deeply in the ear canal, because there is usually no venting. Feedback is usually not a problem if you take a good impression.

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Is special training required to fit CICs?

The most important factor in obtaining a properly fitting CIC is to take an accurate impression that extends well beyond the second bend of the ear canal. Fitting CICs may include new ordering and/or verification methods, and determining candidacy involves some factors that do not -1 custom hearing aids. However, fitting CICs is not significantly different from fitting deep-canal earmolds, which experienced dispensers have been doing for years for patients with profound hearing losses.

Taking deep impressions *is not* new. I believe that promoting the concept that a dispenser should receive some type of "certification" before ordering and fitting CIC hearing aids sends the wrong message to prospective patients and to regulatory agencies. To be sure, even the most experienced practitioner must use caution when taking an impression deep in the ear canal. And, for the inexperienced dispenser, instruction is obviously necessary. However, with only one or two exceptions, the current CIC manufacturers do not call for earmold impression procedures that require anything approaching what the term "certification" normally implies.

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What must the dispenser know before taking an impression for a CIC?

You are going to be taking the impression very deep in the ear canal. A long impression, well past the second bend, is essential. The bony portion of the ear canal is tender and the skin in this area is thin, so inform your patient accordingly.

Before you start, make sure the ear is completely free of cerumen. In taking the impression, cotton otoblocks are preferable to foam; I strongly recommend

lubricating the otoblock with oil or glycerin.

As you insert the otoblock with the earlight, stop and observe its path with an otoscope once or twice during the process to ensure proper placement. Before removing the hardened impression, break the seal. The patient can help by moving the jaw, but go slowly to allow the pressure to equalize. Don't pull on the string of the otoblock; the string can actually cut the ear canal if you pull it while removing the impression. Some manufacturers specify the use of a certain type of impression material. Unless you are following a particular protocol, I prefer silicone to powder and liquid, because it is more stable.

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What complications can arise from taking a deep impression? Can you offer any caveats?

Abrasion of the ear canal, discomfort, soreness, redness, hematoma, or bleeding are potential complications. If the ear canal has been abraded or the skin broken during cerumen removal, defer taking the impression. If the ear canal is abnormally shaped or tortuous, the person may not be a good candidate for a CIC. In addition, removing the impression from such a patient's ear may be difficult or even painful.

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Is there a high percentage of remakes with CICs?

Six months ago, the answer was a resounding yes. Now it is maybe. At least one manufacturer has reported that returns for credit were less common for CICs than for canal instruments. Everything has to be done more carefully. Dispensers must take long, full impressions and manufacturers must make shells with extraordinary accuracy. Failure in either case can result in feedback or discomfort or both.

The length of the impression and the diameter of the patient's ear canal will determine if some of the components can be placed side by side or if they must all be constructed in a row. The length of the average adult ear canal is 25 mm. Allowing 2 mm inside the entrance for

the faceplate and 5-mm clearance at the eardrum leaves a maximum of 18 mm for the length of the CIC. Some manufacturers can make them much shorter if that's required for comfort.

I recommend a conservative approach. Make sure to take a full impression that is at least 20 mm in length; otherwise you may end up with an MIC instead of a CIC.

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How can I make adjustments? Do CICs have remote controls?

With the exception of one brand, all CICs have only one control—a screw-set volume control. This makes the frequent adjustments often required of linear hearing aids impossible. A level-dependent wide-dynamic-range compression circuit may be the circuit of choice for many losses, because the wearer does not have to make adjustments for changes in loudness. This is desirable, because the wearer cannot adjust CIC instruments without removing them and using a screwdriver. Programmers and remote controls are planned for future-generation CIC aids.

Many wearers find less need to adjust a CIC volume control than an ITE volume control, but this *is not* because less gain and output are needed with CICs, as is commonly believed. The requirements for real-ear gain and output are determined by the hearing loss, not by the type of hearing aid. The main reasons that fewer adjustments are required with CIC hearing aids is that they typically provide increased high-frequency emphasis (which may have been inadequate on previous ITEs) and that they often produce increased undistorted high-frequency output at the eardrum. The proper amount of high-frequency emphasis allows good intelligibility to be obtained at a lower volume-control setting, thereby reducing the likelihood of discomfort.

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Are CICs comfortable?

Usually. If not, remakes are necessary. Many experienced hearing aid users find that CICs are the most comfortable hearing aids they have ever worn. Remember, however, the bony portion of the ear canal is tender. Although deeply

sealed CICs do not present a significant problem, some new and even experienced users must adopt a wearing schedule to let their ear canals adapt gradually to CIC use. This process does not usually take long if the fit is good, but counseling is required to allay apprehension.

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Why are some faceplates brown?

Many CICs come with a brown-tinted faceplate, on the theory that if the faceplate is deep in the ear canal, a dark color will make it less visible. Some pseudo-CIC hearing aids protrude out of the ear canal; in such cases, it is debatable whether a beige or brown faceplate is less visible. Check to see which faceplates are standard and which are optional.

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How many companies manufacture CICs? Are they all about the same?

About a dozen companies have officially introduced their CICs, but many more are studying them at this time. I have personally dispensed CICs from nine companies. Not surprisingly, faceplates, canal lengths, visibility, and circuitry all differ among manufacturers. I am convinced that user acceptance of CIC hearing aids depends in part on circuitry; I personally recommend level-dependent wide-dynamic-range (TILL) responses in nearly all the CICs I fit.

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Do you recommend using any special counseling techniques with CIC patients?

Honest information is always the most powerful counseling tool. While discussing amplification options, I present all types of hearing aids and discuss the appropriateness of each for the particular patient. Even when patients are not candidates, I still show them CICs, because a well-informed patient is your best referral source. If someone is a good candidate for CICs, I discuss the advantages of deep-canal fittings, the importance of good dexterity, and the possible limitations of circuitry.

I openly discuss the longevity of the product and describe both positive and negative experiences. I tell them the McCollom rule (promulgated by Herb McCollom, a long-time dispensing audiologist in Lancaster, PA): The smaller the hearing aids, the more they cost, the more often they break down, and the more batteries they use.

This information seldom deters patients from choosing CICs, and, because of its obvious candor, it helps break down barriers. After discussing options, I make recommendations: "My first choice for you is..., my second choice..., etc. If marginal candidates are eager to try this technology, I encourage them to do so. We often learn a great deal by trying a particular approach, even when apparent good sense or limited past experience may suggest otherwise.

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Why all the excitement over CICs now? This is the year of customer satisfaction. Do you think people really want CICs?

We dispense CICs now because we can. Progress in signal-processing circuitry and the miniaturization of components have made it possible to achieve high fidelity and small size. And, the fact remains that stigma is still one of the primary reasons why people do not purchase hearing aids.

Formal market research is now being conducted to determine to what extent the visibility factor influences purchase decisions, but the cosmetic appeal of CICs is undeniable. The acoustic advantages of deep canal placement are also well established. Completely-in-the canal hearing aids are not appropriate for everyone, but the availability of this type of instrument may make a critical difference in an individual's decision to try amplification for the first time, or try again if a previous attempt was unsuccessful for cosmetic or acoustic reasons. These are exciting times in our profession.

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