The Active Earcanal

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Abstract

In the past, the human earcanal has primarily been thought of as a passive conduit for sound. Several studies, reported here, explored evidence of how active the earcanal is. The "active earcanal" is conceptualized and aspects of it are viewed through three timeframes: jaw-induced canal change in seconds/minutes, cerumen production in weeks/months, and aging in years. The influence of each of these aspects on hearing aid performance and resulting patient satisfaction is explored. A new self-assessment tool, a Profile of Hearing Aid Physical Fit, is proposed that focuses on measuring patients' perceptions of those benefits that depend on the interface between earcanal and hearing aid.

Key Words: Cerumen, earcanal, feedback, hearing aid, hearing aid fitting, occlusion, wax

Abbreviations: A:P = anterior:posterior dimension of the earcanal, APHAB = Abbreviated Profile of Hearing Aid Benefit, I:S = inferior:superior dimension of the earcanal, MRI = magnetic resonance imaging, TMJ = temporomandibular joint

The earcanal has long been presumed to be passive. Even though the active mechanisms in the inner ear have been appreciated, and the action of the vibrating tympanic membrane and ossicular chain of the middle ear have been recognized, the outer ear tends to be thought of as a passive conduit for sound. Audiologists are trained to take perfect ear impressions in an early step to defining hearing aids for a patient. Manufacturers are asked to obtain exact duplicates of the perfect impressions in their mold or shell productions. These actions are evidence of, and unconscious reinforcement of, the presumption that the earcanal's essential character is passive.

However, the earcanal is not entirely passive. An understanding of its dynamic nature can affect the level of patient satisfaction with hearing aids.

EARCANAL STUDIED IN THREE TIMEFRAMES

The changing earcanal can be viewed in three time windows: (1) over seconds and minutes as the jaw moves, (2) over weeks and months as cerumen is produced, and (3) over years as the earcanal ages. Each of these timeframes illustrates an aspect of the dynamic nature of the earcanal, and each can be related to patient satisfaction, using hearing aids as the case study.

CHANGES OVER SECONDS AND MINUTES

Two approaches for characterizing the earcanal, magnetic resonance imaging (MRI) and silicone ear impressions, were used to document how changes in jaw position, happening over seconds and minutes, can change the dimensions of the earcanal. MRI was specifically used to view the substructure of the canal as well as the change in that substructure with different jaw positions (Oliveira et al, 1992b). This allowed postulation of a mechanism of changes in substructure to explain changes seen in the earcanal geometry at different jaw positions. Ear impressions were used to study the effects of jaw position on earcanal topography and the related negative consequences of hearing aid feedback and discomfort (Oliveira et al, 1992a; Oliveira, 1995). These studies provide insight into patient satisfaction and the physical fit of all hearing aids, including especially completely-in-the-canal (CIC) hearing aids, the most challenging style for physical fit within the earcanal.

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MRI Studies

The MRI studies to investigate the structure and mechanical changes of the ear canal were conducted in collaboration with the Radiology Department of the University of Minnesota and have been reported previously (Oliveira et al., 1992b, c; Oliveira, 1995). In this work, MRI scans were conducted on subjects whose studied ear canals were filled with tap water containing an MRI enhancer. This made it possible for the first time to visualize, simultaneously, the soft tissue (cartilaginous) around the outer half of the canal, the hard, bony (osseous) tissue around the inner half of the canal, and the actual space of the canal itself. This, in turn, allowed a correlation of changes in jaw position with changes in the ear canal. The enhancer was added to the water because Valvassori (1986) had demonstrated that the air-filled ear canal is very difficult to distinguish from osseous tissue by MRI.

Seven subjects (three male and four female), six with moderate-to-severe sensorineural hearing losses and one with normal hearing, were studied. The imaging used fast scans on a Siemens Magnetom model Sp-63, 1.5 Tesla MRI scanner. Small “field of orbit” coils were used to enhance images. Two jaw positions were usually measured, one closed and one opened.

Because motion by most subjects weakened the resolution, the canal dimensions were generally not quantitatively defined by this technique. In fact, simple silicone impressions were more informative for quantitative measures. However, the MRI data were particularly useful for defining the underlying mechanism of substructure changes that parallel the quantitative changes in the canal with jaw motion. Figure 1 is an orientation to the sectional planes of MRI images that are shown in this paper.

Figure 2 shows MRI images, 1.1-mm axial sections, taken across the ear canal and intersecting the head of the jawbone. The nose is at the top of the image, the back of the head is at the bottom, and the view is from the base of the skull looking upward. These two figures picture an ear canal (canal space is white), part of the jawbone (bone is black), and the surrounding cartilaginous and bony tissues (in shades of gray and black, respectively). Figure 2A shows the canal when the jaw is closed and Figure 2B shows the canal when the jaw has opened. By qualitatively comparing the width of the white spaces in the two figures, the effect of the jawbone can be clearly seen, pulling forward and stretching the soft cartilaginous tissues in front of the ear canal.

The biomechanics of the jaw help explain what happens to the dimensions of the ear canal as the jaw opens. With the jaw closed, the head of the jaw is resting on a disc in the fossa. Then, as the jaw opens slightly, the head of the jaw pivots. Figures 3A and 3B show this pivoting action.

Figure 2  Axial MRIs of the head: closed jaw and opened jaw. The face is at the top; the back of the head at the bottom. A, closed jaw. The head of the mandible (dark oval above the white space) is proximate to the ear canal (white space, with eardrum at the right end). B, opened jaw. The head of the mandible has moved forward, and the ear canal has been widened by the mandible's pull. (Both are reprinted with permission of Singular Publishing Group.)

Figure 1  Diagram of sectional planes. Axial sections are horizontal. Sagittal sections are vertical, running front to back. These designate the orientation of MRI films. (Reprinted with permission of Singular Publishing Group.)
As the jaw opens wide, (see Fig. 3B), the pivot point literally moves forward toward the front of the head over a protrusion, the articular eminence (Figs. 3A and 3B based on drawings of A. Lucas in Okeson [1985]). To assist in orienting the reader, it is helpful to refer to Figure 4A and 4B. In this figure, the turns of the canal and the anatomic dimensional planes are indicated.

Deeper in the canal at the second turn, the bony region begins in the superior and posterior aspects of the canal (Fig. 5). This is seen clearly in the MRI, sagittal plane, through the earcanal at this location.

At this point in the earcanal, this stabilizing bony region limits the part of the canal that can be changed by the jaw action to the anterior and somewhat inferior aspects of the canal. By about 50 percent of the way into the canal, as in the sagittal plane MRI in Figure 6, the bone (which shows as black) can be seen completely surrounding the canal. At this point, the moving jaw can no longer directly influence the canal. Deeper still, the earcanal continues to be surrounded by bone and uninfluenced by jaw motion to the terminus at the tympanic membrane.
Figure 5  Sagittal MRI of the head at the second bend of the canal. A vertical, front-to-back cross-section of the head about the second turn of the canal shows face at the left with the eye and convolutions of the brain identifiable, back of the head at the right. The bone (very dark) surrounds only the superior (upper) and posterior (back) sides of the canal (oval white space) and the soft cartilaginous tissue (gray) is anterior (front) and somewhat inferior (below) to the canal. Also visible is the dark head of the mandible just in front of the canal. (Reprinted with permission of Singular Publishing Group.)

The tissue in the canal covering the cartilaginous substructure averages 0.5 to 1 mm, while the tissue covering the bony substructure is thinner, about 0.2 mm (Miyamoto and Miyamoto, 1995). This delicate tissue is especially sensitive and is a reason that fitting some patients with hearing aids deep in the canal is challenging.

The overall length of the ear canal correlated with the structural landmarks is represented by the diagram shown in Figure 7. Although the data presented in Figure 7 are from a single individual, MRI data from six additional subjects are qualitatively consistent with this diagram (Oliveira, 1995). Those data also support the conclusion that the most significant changes in ear canal dimension with jaw motion occur between the first and second turns of the canal.

Figure 7  Diagram representing the length and selected anatomic characteristics of the external auditory ear canal. Note that the ear canal becomes completely surrounded by bone at about the 50 percent point. (Reprinted with permission of Singular Publishing Group.)

Ear Impression Studies

Another series of experiments to document the effects of moment-to-moment changes in jaw position was conducted at Purdue University (Oliveira et al, 1992a) and the University of Minnesota (Oliveira, 1995). Unlike MRI studies, which are expensive, these two studies were done using inexpensive impression materials and spacers made of wooden tongue depressors.

Bilateral impressions of the ear canals at the jaw-closed position were taken. Then, repeated pairs of impressions were taken at increasingly wider jaw positions. To standardize the increment by which the spacing increased, a stack of three wooden tongue depressors taped together was added for each new position. At each position, the subject's incisors rested on the spacers during the process of making the impressions. Most mouths are at the wide open position with 18 depressors (approximately 32 mm).

Micrometer measurements, ±0.1 mm, were made of each impression using a Mitutoyo digital caliper. These measurements were made at
the point of the greatest change in the anterior-posterior (A:P) and in the inferior:superior (I:S) planes between the mouth of the canal and the beginning of the osseous region at the second turn. The percentage of change from the jaw-closed position in the A:P and I:S planes was calculated for each ear as a function of jaw opening, defined in millimeters of jaw spacer.

The data from the Purdue and Minnesota adult subjects (18 earcanals) were pooled and are shown in Figure 8 (Oliveira, 1995). Each data point represents the mean data for a given degree of jaw opening. It would be expected, from the MRI explanation of the mechanism of how the jaw acts on the canal, to see an increasing widening of the canal in the anterior to posterior dimension and not much change in the inferior to superior dimension with increased opening of the jaw. In fact, this is what was observed in the pooled data. The percentage by which the opened-jaw impressions differed from the closed-jaw positions was insignificant in the I:S dimension. The typical adult 10.5 mm I:S dimension is basically unchanged with jaw opening. But in the A:P dimension, the data point for each succeeding position shows a greater percentage of change from the closed jaw than the preceding one. The graph of pooled data shows overall about a 10 percent increase in canal width with the jaw opened wide. This is equivalent to an increase of about 0.7 mm in a typical adult earcanal that has an A:P dimension of about 7.2 mm.

These pooled data are informative for giving general trends in a population of earcanals. Looking specifically at the data from the left and right pairs of ears for six of the subjects in this pooled data provides further information.

Data from the two ears for each of the six subjects are shown in Figures 9, 10, and 12 (Oliveira, 1995). Each pair of graphs presents a direct comparison of the data from the two earcanals of one subject. Data from left and right ears are shown to the left and right, respectively.

Figure 9, for example, illustrates the data from one subject, identified as LD. In both earcanals, the I:S dimensions are essentially constant as the jaw opens, and the A:P dimension of the canal increases with increasing jaw opening. The two earcanals of this subject generally behave symmetrically, that is, the pull of the right and left condyles of the mandible on the soft tissue of the earcanals is roughly balanced.

However, in Figure 10, the data from the subject identified as TD presents a different situation. Although the right ear of this subject shows a relatively small percentage of change in the A:P dimension (~6%), she has a substantial increase (~21%) in the anterior-posterior diameter of her left canal as her jaw opens. An increase this large in the A:P dimension of her canal interfered with the maintenance of a good seal with the hearing aid. Consequently, the hearing aid for that ear was not worn because of extensive feedback. The two earcanals show an interestingly asymmetric behavior when compared, evidence that the mandible of the jawbone is pulling unevenly on the two earcanals (Oliveira, 1995).

This evidence of significant earcanal change can be detected when opened-jaw and closed-jaw impressions are compared visually. Figure 11 shows the actual ear impressions from the subject, TD, whose impressions showed the greatest change upon jaw opening of the six subjects.

The earcanal impressions are viewed from the inferior side. The opened-jaw impressions are on the outside, and the closed impressions are

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Figure 8 Pooled data from 18 ears. The percentage of change (mean ± standard error of the mean) in canal dimension versus jaw opening. The unit for jaw opening is the number of depressors, taped in sets of three, placed between upper and lower jaws. The percentage of change is from closed jaw status. The data points represent mean readings of impressions for each jaw position in the A:P dimension and in the I:S dimension. (Reprinted with permission of Singular Publishing Group.)

Figure 9 Impression data for subject LD. Changes in the left and right earcanals in the A:P and I:S dimensions are illustrated. The x-axis shows the jaw opening in mm. The percentage of change is from the jaw-closed position. (Reprinted with permission of Singular Publishing Group.)
in the center. The left ear is to the left. Comparison of the two left impressions, made with the jaw opened and closed, shows increased dimension on the opened-jaw impression in the area between the first and second bends, relative to that area on the closed-jaw impression.

Finally, in Figure 12, data for all six subjects are arranged according to the degree of symmetry. Symmetry appears to be common in the three subjects to the left. Asymmetry is clear in two of the subjects on the right and is likely in the third one.

The asymmetry between ear canals in the same patient is easily explained when the mechanics seen with the MRIs are considered. The temporomandibular joint (TMJ) is the most

Figure 10  Impression data for subject TD. Changes in the left and right ear canals in the A:P and I:S dimensions are illustrated. The x-axis shows the jaw opening in mm. The percentage of change is from the jaw-closed position. Note in particular the difference between the two ear canals in the A:P dimension. (Reprinted with permission of Singular Publishing Group.)

Figure 11  Ear impressions from TD. These four ear impressions are the source for the data in Figure 10. From left to right: left ear with jaw opened, left ear with jaw closed, right ear with jaw closed, right ear with jaw opened. The significant difference appears between the first and second turns of the jaw-opened and closed-jaw impressions of the left ear.

Figure 12  Impression data for six hearing-impaired subjects. Dimensional changes in the left and right ear canals, A:P and I:S planes are shown. The jaw opening is in mm. The percentage of change is from the jaw-closed position. The scales for the two dimensions are the same, although the labels are separated. Subjects with symmetrical changes between ears are grouped in the left column. The two subjects with asymmetric, and one subject with possible asymmetric, changes between the ears are grouped in the right column. (Reprinted with permission of Singular Publishing Group.)
complex joint in the body (Okeson, 1985). It is the only compound joint that is directly connected by solid bone to its mirror image, that is, the mandible crosses the midline of the body to connect the two TMJs. If a TMJ wears, asymmetry is a predictable outcome, because a given weakened joint is easily susceptible to further damage. The TMJ and its wear characteristics are complex, and the TMJ affects the earcanal through the mandible. So, notable asymmetry between, and earcanal dimensional change within, the active earcanals of humans should be anticipated with some frequency.

A weakened joint can be thought of as a loose joint, and it is easy to imagine that a loose joint would tend to have a greater distending effect on the A:P plane of the earcanal than a joint held tightly in place.

One quick clinical check for evidence of significant asymmetry between the earcanals is to face the patient and observe the jaw as the patient slowly opens and closes his/her jaw. If the jaw, as it opens, swings off-center from an imaginary midline of the patient's face, instead of straight down, asymmetry is very likely. In fact, further data are being collected to substantiate the preliminary conclusion that the jaw tends to swing away from the ear with the largest change in A:P dimension.

Audiologists will recognize these changes as signals to investigate whether patients may have particularly mobile earcanals and may therefore have the potential for feedback and/or discomfort.

The degree of mobility in earcanals will affect decisions being made about hearing aid style, especially with the more difficult to fit styles, CIC and power in the ear. As clinical experience has shown, one source of patient dissatisfaction—hearing aid feedback—is often a single-sided event. In a mobile earcanal, feedback usually occurs because too large a slit vent is created by a widening canal. Alternatively, jaw motion can extrude the hearing aid out of position, and feedback or sudden loss of gain can occur.

Another source of patient dissatisfaction is discomfort, which is likely if a mobile earcanal presses a hearing aid against the canal wall. Impressions taken at jaw-opened and jaw-closed positions can indicate the extent of a potential problem.

When an audiologist feels that a patient would benefit from having a clearer understanding of what is involved in getting a good physical fit, and perhaps would be better able to cooperate with the process, impressions taken at jaw-closed and opened positions would be a good visual aid. Manufacturers may be able to make a better-fitting earmold or shell for a particularly mobile earcanal if two impressions are taken, one with jaw closed and one with jaw opened wide, showing the degree of flexion possible. An informed patient is more likely to be appreciative of the skill and professionalism of the audiologist and the manufacturer who can solve difficult fitting problems.

CHANGES OVER WEEKS AND MONTHS

The second timeframe is the weeks and months over which earcanals produce and dispose of cerumen. Understanding the nature of cerumen in a patient's earcanal can help with developing a strategy to prevent cerumen from clogging the sound bores and vents of hearing aids. This is important because of the magnitude of the problem, that is, 60 to 80 percent of all hearing aid repairs are caused by cerumen accumulation in the sound bore. Effective management of the cerumen/hearing aid interface has been highly correlated with patient satisfaction.

Cerumen is the product of an active earcanal. It can be broadly characterized as being made up of three different constituents: oils, waxy substances, and dry, flaky skin. Since these substances influence one another, higher or lower ratios of them will have a profound effect on the nature of the canal environment. High levels of oil cause the canal to have easily mobile, soft wax. Low levels of oil and wax, which are natural humectants, cause the canal to have predominantly dry skin flakes. All of these substances migrate along the canal to the outside and are cleared from the ear (i.e., unless a hearing aid blocks the exit).

The audiologist can determine the nature of a patient's cerumen. Clues can sometimes be detected on the patient's face. Noticeable oiliness at the base of the nose may indicate oily cerumen. It can be verified by examining the earcanal with a video otoscope, which will show globules of oil in the canal. Very dry facial skin may indicate dry, flaky cerumen. Flakes of skin can usually be observed in the concha or on the bottom of the canal. If neither of the other two types is clearly evident, then the cerumen is judged to be of the waxy type. This is the most common. Managing the cerumen/hearing aid interface wisely begins with the assessment of cerumen type.

Several kinds of patient-managed cerumen guards have been developed to increase hearing
aid reliability. One is a disposable, adhesive cerumen guard made of an acoustically transparent foam filter with medically approved tape and adhesive securing it over the sound bore and vent. When the guard becomes soiled or the edges lift or shift, the patient removes the guard and applies a fresh one.

We have conducted research into the reported variability of the guards' durations across a population of patients. Over 130 patients responded to a survey concerning the average number of days over which they are able to receive benefit from using the adhesive cerumen guard. These data are plotted as a histogram in Figure 13. Results covered a wide range from 1 to 2 days to more than 14 days of use, with a concentration of patients falling between 3 and 8 days.

Different ear canal environments interact very differently with the adhesive cerumen guards, depending on which substance predominates: oil, wax, or flaky skin. Considering that, the guard can be seen as a "litmus-like" indicator of the general type of cerumen that patients' canals generate.

Oily ear canals would result in the shortest guard durability because of oil's ability to soften the adhesion of the guard in approximately 1 to 4 days. An environment of dry, flaky skin would extend the longevity of an adhesive-based guard. Then the reasons for changing the guard become factors like soiled appearance after 10 or more days of use. Waxy canals, the most common type, fall between these two extremes. The dip in the histogram at about 11 days represents the cross-over from patients with predominantly waxy canals to patients with predominantly dry, flaky canals.

Hearing aid reliability directly impacts patient satisfaction. This insight was confirmed by probing more deeply into how cerumen control with guards relates to the actual reliability of patients' hearing aids. A paired comparison was made for each survey respondent who was a user of the guards for 8 or more months (N = 82). Events of repair or cleaning were tabulated for 8 months before use and after use of the guard. The requisite repair/cleaning history was culled from patient charts by an independent investigator.

While a retrospective study is never entirely satisfactory, it did show some clear results. When the reliability of the aids before and after guard use were compared, a two and a half to three-fold improvement in reliability was seen, as shown in Figure 14.

The survey respondents were also asked to rate their satisfaction with their hearing aids.
during the times before and after protecting them with the guard. This was done by ranking on a 5-point scale of "strongly disagree, somewhat disagree, neutral, somewhat agree, strongly agree" the statement, "I am more satisfied with my hearing aid." As shown in Figure 15, more than 69 percent of the subjects responded that they were "somewhat" or "strongly" more satisfied with their hearing aids when they were protected from cerumen infiltration. Judging by a comparison of Figures 14 and 15, patient satisfaction clearly relates to improved reliability by overcoming the negative effects on hearing aids of the active earcanal’s cerumen production over weeks and months. While these data were measured with a patient-managed, adhesive-based guard, any effective patient-managed guard would be expected to yield similar beneficial results, increasing patient satisfaction with their more reliable hearing aids.

**CHANGES OVER YEARS**

The final timeframe is in terms of years. The effects of aging earcanal presents additional challenges to patient satisfaction.

Some of the effects of aging seen in the earcanal are a drier canal, loss of elasticity, diminished fat pad, increased skin fragility, general sagging, and, in males, some increased earcanal hair. Aging earcanals often have reduced glandular activity. Those that earlier had exuded waxy or oily cerumen and expelled it readily may now produce a more dry, flaky type of cerumen and have diminished motility.

To understand the loss of elasticity common in the aged earcanal, the audiologist can, with one hand, pull up a fold of skin on the back of the other hand and then release it. Generally, the skin will drop back down, or even spring back down. But many older patients, if they did this, would have the skin “tented up” for hours. Many older patients have simply lost the elasticity of their skin. The skin in the earcanal would, in all likelihood, be somewhat similarly affected.

It is also common for older ears to have a diminished fat pad cushioning the skin of the canal. In canals of younger hearing aid wearers, the fat pad under the skin can provide some cushion, especially needed when motion of the jawbone changes the shape of an earcanal holding a hearing aid. But with older patients wearing hearing aids, when the fat pad diminishes with age, the lack of cushion means that the hearing aid is pressing the skin, which may have poor circulation, against the cartilage. This may explain the evidences of bruising seen in earcanals of certain aged patients. In someone with a very dynamic earcanal, the loss of the fat pad can lead to discomfort and/or feedback, and even to rejecting the use of the hearing aid.

Another change noted with aging is that the pull of gravity over many years and the reduced elasticity in body tissues may result in canal sagging. This includes the cartilage-supporting earcanals and can lead to the partial or complete collapse of the earcanal. Finally, in the aging earcanal, there can be increased hair growth, especially in some males.

These characteristics of changes with age, naturally, have several consequences. The advantage of lower production of waxy cerumen is offset by loss of elasticity, canal sagging, and increased hair growth, which contribute to impaction, increasingly so with age, by making it more difficult for the earcanal to dispose of what it produces.

Cerumen impaction is defined as 75 percent of the tympanic membrane obscured when viewed with an otoscope. In one study of 634 non-hearing aid wearers in the general adult population (Fig. 16), cerumen impaction was evident in approximately 25 percent of subjects between 55 and 74 years of age. In those 75 to 85 years of age, the percentage with cerumen impaction increased to 42 percent (Gleitman et al, 1993).

![Figure 16 Prevalence of cerumen impaction in the general adult population. The percentage of each age group with sufficient cerumen impaction (significant obscuring of 75% of the eardrum) in a study of 634 adult subjects is shown. For each age group, the number of subjects showing impaction out of the age group's total is in parentheses.](image-url)
For patients wearing hearing aids, the dry, flaky type of cerumen increases the chances of hearing aid failures caused by intermittence. Dry skin flakes infiltrate the receiver port. When the skin flakes absorb moisture, they swell, blocking the receiver tube. Then, when the hearing aid sits in the dry environment outside the ear canal, the flakes dry and shrivel and the receiver tube becomes only partly blocked, allowing sound through again. The alternation between these states can cause the hearing aid to perform intermittently. A practical clinical clue to this problem is when a patient reports that the hearing aid quits about 2 hours into the day—adequate time for the canal, humid from the patient’s showering, to expand the dry skin flakes.

The absence of skin elasticity and fat pad and the presence of ear canal hair in males make it more difficult to achieve and maintain a good seal between the hearing aid and ear canal. This results in increased chances of feedback and discomfort, issues that reduce patient satisfaction. These factors, when added to the dynamism of ear canals, can present special challenges in making a good-fitting earmold or shell. The effect of aging thus presents additional challenges to patient satisfaction.

SUMMARY

The ear canal changes over seconds as the jaw moves, changes over weeks as cerumen is produced, and changes over the years with age. Studies reported here can contribute to increased patient satisfaction with hearing aids.

Changes in the ear canal can occur in seconds as the jaw moves. The mechanistic effects on the ear canal of motion in the TMJ became evident through MRI. The head of the mandible was shown ultimately to pull on the anterior, soft tissue of the ear canal as the jaw opens, sometimes distorting the shape of the ear canal sufficiently to disrupt a good seal between hearing aid and ear canal. The bony region that limits flexion appears initially near the second bend in the canal, in the superior and posterior quadrants, gradually extending to the inferior and anterior sectors. At about 50 percent of the way, the whole ear canal is surrounded by bone that continues to the tympanic membrane.

Measurements of impressions, taken at several degrees of jaw openness, confirmed the effect of jaw motion. Also seen was evidence that distortion of the ear canal can happen differently in the two canals of the same patient, occasionally requiring that the audiologist address the needs of the two canals differently. Two simple techniques—observing whether the jaw swings off midline as it opens and comparing jaw-opened and jaw-closed impressions—can provide the evidence needed to assess the situation. Jaw-motion-induced changes in the ear canal can affect comfort, feedback, and selection of hearing aid style.

Over weeks and months, ear canals produce cerumen, differently in different people. Good cerumen management takes cerumen types into account to prevent infiltration of the receiver port, cerumen impaction, intermittent hearing aid performance, and, most important to patient satisfaction, to improve reliability and prevent repairs.

Over the years, changes in the ear canal that challenge patient satisfaction include more difficulty in clearing out cerumen, loss of the fat pad cushion, loss of the tissue strength that supports the canal, and loss of sturdiness and elasticity in the skin.

Patient satisfaction with hearing aids requires incorporating management of the effects of jaw motion, cerumen production, and aging into good audiolgic practice.

Acknowledgment. This work was supported in part by Small Business Innovative Research grant #1-R43-DC01583-01 from the National Institute on Deafness and Communications, National Institutes of Health.

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