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Clinical Forum

Detecting and Remediating External Meatal Collapse during Audiologic Assessment

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Abstract

We present a case study in which the jaw/mouth-open procedure during air-conduction testing is employed to both detect and remediate external auditory meatal collapse. A prospective investigation was also conducted to compare the efficacy of the proposed jaw/mouth-open procedure with that of the traditional insert receivers in remediating meatal collapse during audiologic assessment. Meatal collapse was present in 6 of the 136 subjects evaluated. In these 6 subjects, the air-conduction thresholds under supra-aural headphones in the jaw/mouth-open condition were similar to those under insert receivers. We discuss the implications of this finding in clinical settings where insert receivers are not available.

Key Words: Air-conduction testing, audiometric testing, conductive hearing impairment, ear-canal collapse, insert receivers, meatal collapse, otosclerosis

This paper presents an effective test for the detection of meatal collapse. This test can be run moments before audiometry or auditory brainstem response (ABR) testing. Collapse of the external auditory meati (EAM) by the pressure of standard supra-aural headphones has been observed in about 4 percent of the general population (Hildyard and Valentine, 1962), and has been shown to result in artifactual conductive hearing losses of 10 to 50 dB HL (Coles, 1967) if not detected. ABR waveforms have also been delayed by collapsing meati (Hosford-Dunn et al, 1983; Berlin and Hood, 1986; Hall, 1992). Since potentially serious misdiagnoses of conductive and retrocochlear pathology can result from failure to discover meatal collapse, a pretest for detection of the problem, and a procedure to remediate it are essential.

The method offered here involves measuring audiometric threshold by the conventional method and once again with the mouth and jaw in the wide opened position. The procedure is based on observations of Ventry, Chaiklin, and Boyle (1961) tentatively linking jaw movements from talking, yawning, etc., to the "unblocking" of collapsed ear canals in two of their patients. They suggested that it was the pulling forward and downward of the cartilaginous portion of the external ear canal during variable jaw movements that increased the lumen—opening the collapsed meati. This view is supported by dental research, which identified the key role of jaw position in meatal collapse as early as 1920. Wright (1920), for example, reported that one form of hearing loss is caused by misaligned condyles compressing the auditory meati. More recent dental research found that hearing in certain patients was improved significantly by increasing the vertical dimension of the mouth via bridge work (Lantz and Spiegelford, 1981). Conversely, King, Reid, and Belting (1970) found hearing in certain patients to be worsened after

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their teeth were removed. All of these findings agree in specifying a relationship between jaw/mouth opening and hearing sensitivity in cases of collapsing ear canals.

Recently, insert receivers such as the ER-3A have become commercially available, and have been used to alleviate collapsed canals during audiometric assessment. The disadvantage of these receivers is apparent in hearing screening programs because of the cost associated with the replacement of the inserts for each client assessed. In addition, the majority of clinical facilities still prefer to use the traditional TDH-49 headphone with MX/41-AR supra-aural cushion as the industry standard. Some clinical settings use insert receivers only when encountering meatal collapse; however, even here, a method of detecting the problem is lacking.

This study represents an evaluation of the "jaw opening" procedure for the detection and alleviation of meatal collapse. Seven cases are presented. The first is a patient referred for audiologic evaluation prior to a scheduled stapedectomy; the remaining six cases are those who were identified as having collapsing canals by deep insertion of ER-3A insert receivers, in 136 consecutively tested patients.

CASE 1

This 36-year-old female referred herself to the Hofstra Speech and Hearing Center for a second opinion regarding the appropriateness of stapes surgery for hearing impairment. The patient's hearing loss had been followed by her otolaryngologist over the previous 5 years, and she was scheduled to undergo a right-ear stapedectomy. The patient's primary complaints were difficulty in hearing on the telephone and when her five young children were engaged in play activities. Her general medical and otologic history was unremarkable. Otoscopic inspection revealed a normal tympanic membrane and ear canal, bilaterally. Nevertheless, the apertures of the external auditory meati were thin and slit-like.

Figure 1A summarizes the initial pure-tone and bone conduction thresholds for the right ear for this patient. Inspection of this figure reveals that the air-conduction thresholds ranged between 25 and 65 dB HL in the right ear. The bone-conduction thresholds ranged between 0 and 10 dB HL, yielding air-bone gaps between 20 and 40 dB. Suprathreshold speech-recognition ability for monosyllabic PB words presented at 40 dB SL re: SRT was 94 percent in the right ear. The tympanometric peak pressure was within normal limits (±50 daPa; Porter, 1974) in the right ear, as was the right-ear static-acoustic middle-ear admittance (Jerger, 1970), which was at .60 mmho. The retest hearing threshold at 1000 Hz was within 5 dB of the test threshold. These findings were consistent with the diagnosis of otosclerosis.

The diagnosis was contradicted, however, by the presence of left contralateral acoustic reflexes obtained with the probe in the right ear, at expected levels (Silman and Gelfand, 1981), consistent with the absence of right-ear conductive pathology. At this point, the hypothesis of a right-ear collapsed canal was generated and repeat right-ear, air-conduction thresholds were obtained, but this time under the jaw/mouth-open condition.

The results of the right ear, air-conduction threshold testing in the jaw/mouth-open condition are shown in Figure 1B. Comparison of the initial (jaw/mouth-closed) and retest (jaw/mouth-open) air-conduction thresholds in Figure 1 reveals threshold shifts of 15 to 30 dB throughout the audiometric range, associated with jaw/mouth opening. These threshold shifts resulted in complete closure of all of the air-bone gaps. The reliability of these improvements in air-conduction thresholds in the jaw/mouth-open

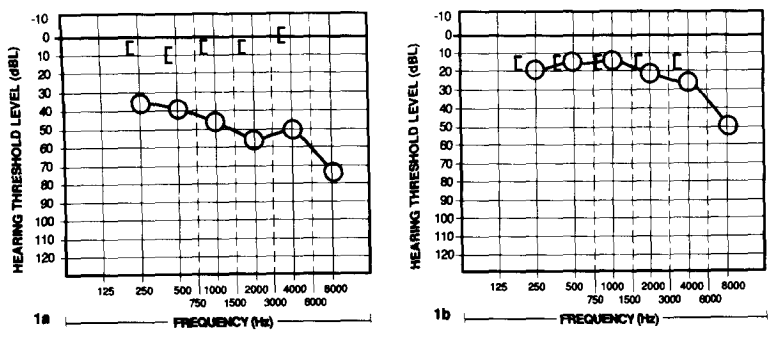

Figure 1 Pure-tone audiogram for the right ear of subject 1: *A*, air-conduction thresholds in the jaw/mouth-closed condition under supra-aural headphones with masked bone-conduction thresholds and *B*, air-conduction thresholds in the jaw/mouth-open condition under supra-aural headphones with masked bone-conduction thresholds. o indicates air conduction; [indicates bone conduction.

versus jaw/mouth-closed condition was established upon 2 repeat trials of air-conduction threshold assessment in the jaw/mouth-closed and then jaw/mouth-open condition. When the otolaryngologist was informed that the right ear, air-bone gaps were associated with a collapsed, right-ear canal rather than a conductive problem associated with a stiffening condition such as otosclerosis, he canceled the surgery.

The thin and slit-like apertures of the external auditory meati along with the complaint of hearing difficulty when the patient's children were playing suggested that a partially collapsed ear canal was present even when headphones were not placed over the ears. The complaint of hearing difficulty over the telephone suggests that greater collapse of the right-ear canal occurred from pressure of the telephone on the ear.

CASES 2 TO 7

Of 136 patients (29–67 years of age) tested for meatal collapse, only 6 were found. The assessment of meatal collapse was made if the following conditions were met: (a) air-bone gaps of at least 15 dB at one or more frequencies (with air-conduction thresholds measured under supra-aural headphones in the jaw/mouth-closed position), and (b) at least 15 dB improvement in air-conduction thresholds with insert receivers in place.

The 6 test cases and the 130 other patients were evaluated in the following order: (a) air-conduction thresholds 250 to 8000 Hz under supra-aural headphones (TDH-49) in the traditional jaw/mouth-closed position, (b) the same, but with jaw/mouth in the open position, (c) bone-conduction thresholds at 250 to 4000 Hz, and then (d) air-conduction thresholds at 250 to 8000 Hz under ER-3A insert receivers. All patients also received traditional speech-recognition threshold and suprathreshold PB-word-recognition tests, as well as acoustic- and pressure-immittance measures, which included contralateral acoustic reflex thresholds. The air-conduction thresholds under ER-3A insert receivers were converted to hearing level (ANSI S3.6–1989).

All testing was carried out in a two-room audiometric suite meeting ANSI S3.1 (1977) standards. Pure-tone and speech testing was done using a GS-10 audiometer. All pure-tone, acoustic-reflex eliciting, and taped signals were routinely calibrated with a sound-level meter (B & K 4150) and coupler (NBS-9A). All six patients were otologically normal, with normal tympanograms, and suprathreshold speech recognition scores at 90 percent or better.

The patients who were Cases 4, 5, 6, and 7 came for routine audiologic assessments as required by their employers. There were no complaints of hearing loss, dizziness, or tinnitus.

Case 2

The patient was a 67-year-old female who came to the Brooklyn College Speech and Hearing Center because of hearing loss.

As seen in Figure 2, Case 2 reveals that initial air-conduction thresholds measured under supra-aural headphones in the jaw/mouth-closed condition represented a moderate to severe hearing impairment ranging from 50 dB HL at 250 Hz to 75 dB HL at 8000 Hz.

When she opened her mouth widely, assuming the jaw/mouth-open position, her air-conduction thresholds can be seen to have improved 20 to 40 dB, completely closing her air-bone gaps. What appeared initially to be a moderately severe mixed hearing loss was revealed to be a mild sensorineural hearing loss. Figure 2 also reveals that for Case 2 hearing as measured under headphones in the jaw/mouth-open condition equalled that measured under insert receivers (± 5 dB).

Case 3

A 68-year-old male was referred to the East Orange VA Hospital because of a hearing loss. The results can be seen in Figure 2, Case 3. Inspection of the threshold curves obtained under the supra-aural headphones and mouth/jaw-closed condition reveals a moderately severe mixed hearing loss ranging from 40 dB HL to 80 dB HL, with air-bone gaps of 20 to 40 dB present at five frequencies. When the patient opened his mouth widely, however, his air-conduction thresholds can be seen to have improved 15 to 20 dB. While the jaw/mouth-opening maneuver narrowed all of the air-bone gaps, it did not completely close them. Gaps of 15 to 20 dB still remained at five frequencies. However, when air-conduction thresholds were measured under insert receivers, they fell within 5 dB of those measured in the jaw/mouth-open condition. This verifies the fact that mouth opening completely alleviated the collapse of the external meatus, and that the remaining air-bone gap was real. True conductive pathology was later confirmed medically.

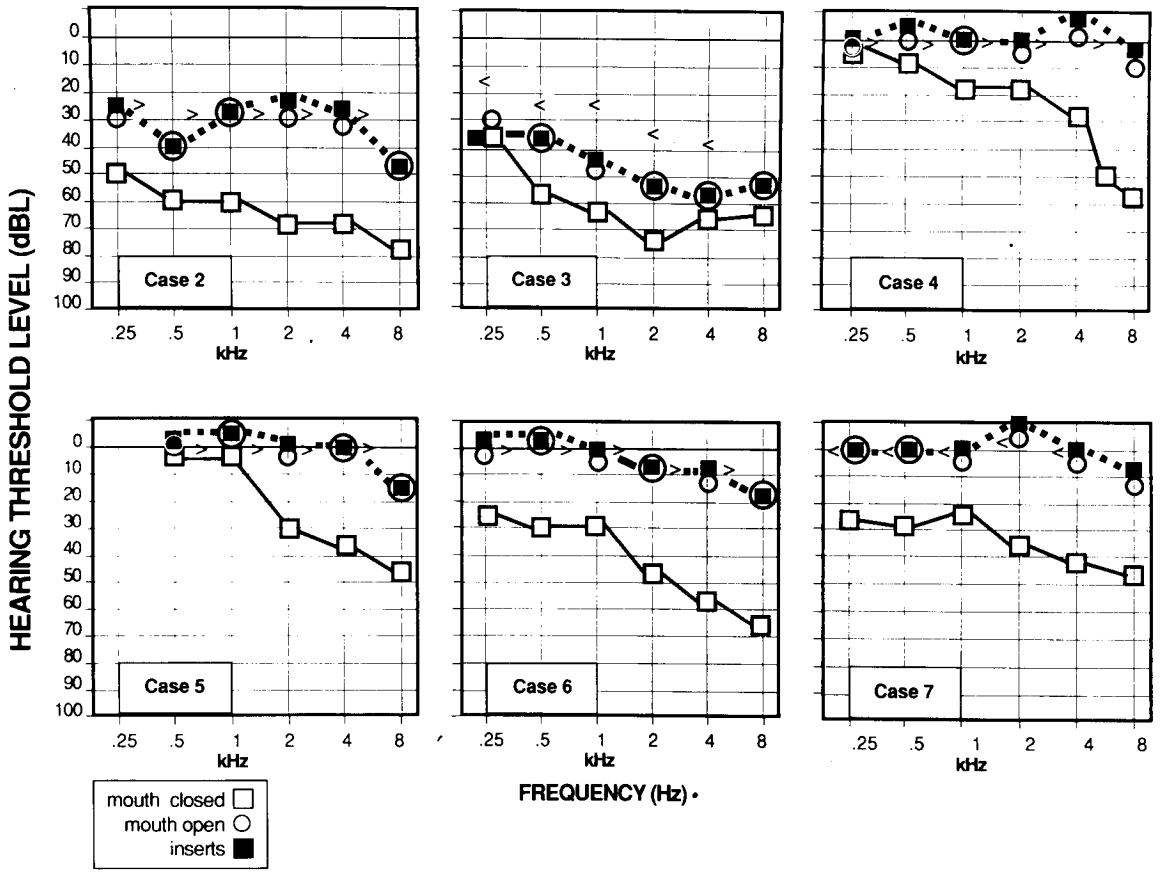

Figure 2 Audiometric results for each of six subjects with meatal collapse. Bone-conduction thresholds, air-conduction thresholds under supra-aural headphones in the jaw/mouth-closed condition ❑, air-conduction thresholds under insert receivers ■, and air-conduction thresholds under supra-aural headphones in the jaw/mouth-open condition ○ are shown.

Case 4

Case 4 was a 61-year-old male evaluated audiologically at the East Orange VA. As Figure 2, Case 4 shows, the initial data as measured under supra-aural headphones in the jaw/mouth-closed condition indicate the presence of a mildly sloping conductive hearing loss with air-conduction thresholds ranging from 0 to 60 dB HL. Bone conduction was about 0 dB HL across the test range. As the Figure reveals, however, jaw/mouth-opening resulted in a 10 to 45 dB improvement in air-conduction thresholds, thereby completely closing all of the air-bone gaps. Again, insert receiver thresholds came within 5 dB of those measured under the jaw/mouth-open condition.

Case 5

The patient was a male, 61 years of age, tested at the Brooklyn College Speech and Hearing Center. As Figure 2, Case 5 shows, the initial audiogram obtained under supra-aural headphones in the jaw/mouth-closed condition depicts a conductive hearing loss of 30 to 45 dB HL from 2 to 8 kHz.

Bone conduction was about 0 dB HL throughout the auditory test range. Here, the mouth-opening maneuver can be seen to have resulted in alleviating the hearing loss completely. Air-bone gaps were closed, and as expected, air-conduction thresholds obtained later under the insert receivers equalled those measured under the supra-aural jaw/mouth-open condition.

Case 6

A 31-year-old female was referred by her employer to the Brooklyn College Speech and Hearing Center for a routine hearing evaluation. Her hearing thresholds are shown in Figure 2, Case 6. Under the supra-aural jaw/mouth-closed condition, the results reveal a mild-to-moderate conductive hearing impairment of 30 to 65 dB HL, with bone thresholds at about 0 to

10 dB HL. When retested with her mouth opened widely, her air-conduction thresholds can be seen to have improved approximately 25 to 55 dB. This completely closed her air-bone gaps. Insert receiver thresholds came within 5 dB of the jaw/mouth-open results.

Case 7

The patient was a 38-year-old female with slit-like EAM apertures who was tested audiologically as part of a comprehensive physical examination. As Figure 2, Case 7 shows, the audiogram obtained under supra-aural headphones in the jaw/mouth-closed condition reveals a mild-to-moderate conductive hearing loss with bone-conduction sensitivity at about 0 dB HL. When the patient assumed the jaw/mouth-open position, however, her hearing loss disappeared. Her jaw/mouth-open and her bone-conduction thresholds were all within 5 dB of her insert receiver thresholds.

DISCUSSION

As the results of the study indicated, a simple jaw/mouth-opening maneuver identified meatal collapse as accurately as did deep insertion of ER-3A insert receivers. Both methods agreed with earlier reports finding meatal collapse in about 4 percent of the general population. Furthermore, the similarity of the air-conduction thresholds obtained under supra-aural headphones in the jaw/mouth-open condition and those obtained in the insert-receiver condition in the 6 patients found to have meatal collapse of 136 patients tested suggest that remediation of meatal collapse using the jaw/mouth-opening maneuver is essentially as effective as using insert receivers for measurement of air-conduction thresholds.

When insert receivers are unavailable or when mass audiometric screenings using supra-aural headphones are done, audiologists can routinely screen for meatal collapse at 4000 Hz by determining whether the air-conduction threshold in the jaw/mouth-open condition is better by 15 dB or more than that in the jaw/mouth-closed condition. If meatal collapse is present, the air-conduction thresholds recorded on the audiogram should be based on the jaw/mouth-open rather than jaw/mouth-closed procedure.

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