Tympanometry, Impedance, and Aural Reflex Testing in a Cleft Palate Population

BRADLEY L. BILLINGS, Ph.D.
L. D. LOWRY, M.D.
Redlands, California 92373

Introduction

Tympanometry, impedance, and aural reflex testing may provide information that is useful in the diagnosis of conductive, cochlear, and retrocochlear sites of lesion (2, 3, 4, 5, 7). Application of these procedures in a cleft palate population with a high incidence of conductive pathologies should be valuable for determining the need for otologic referral, especially when a cleft palate team does not have the services of an otolaryngologist.

Audiologic evaluation is often used in cleft palate clinics as a screening device for otologic abnormalities on the assumption that patients with a conductive hearing loss should be referred for otologic evaluation and/or treatment. The validity of audiologic evaluation as a screening device for otologic abnormalities has been questioned, however, on the basis of data presented by Melnick, Eagles, and Levine (6). They identified many children who evidenced normal hearing in the presence of otologic abnormalities and many others who evidenced significant hearing losses without otologic abnormalities. Therefore, many of the children with otologic abnormalities would not have been referred for otologic care because of normal audiologic results and others without otologic abnormalities would have been unnecessarily referred for otologic care because of abnormal audiologic results.

The data yielded by tympanometry, impedance, and aural reflex testing are, in part, directly dependent on the state of the tympanic membrane and middle ear structures. Therefore, these procedures should provide the audiologist with a valid and easily applied screening device for otologic abnormalities. It was the purpose of this study to investigate the applicability of tympanometry, impedance, and aural reflex testing in a cleft population.
palate population and to assess their validity as a screening device for otologic abnormalities.

**Method and Procedures**

One hundred seven patients seen in the Cleft Palate Clinic at the University of Oklahoma Health Sciences Center served as subjects for this study. The subjects ranged in age from three to thirty years with only three subjects exceeding twenty one years of age. The majority of subjects were in the age range from six to fourteen years. The audiologic evaluation consisted of pure-tone air- and bone-conduction audiometry from 250 to 4000 Hz, bilaterally. Normal hearing was defined when an ear yielded pure-tone thresholds more sensitive than 25 dB HL (1) at all frequencies tested. Tympanometry, impedance, and aural reflex testing was performed with an electroacoustic impedance bridge (Madsen Electromedics Corp., model ZO 70) and a portable audiometer that was used to elicit the aural reflex. Norms for tympanometry, impedance, and aural reflex thresholds were applied to this study as suggested by Jerger (3). Aural reflex thresholds were measured at 500, 1000, 2000, and 4000 Hz, bilaterally. An ear was defined as having an abnormal aural reflex if the reflex could not be elicited at 110 dB HL at two or more of the frequencies tested. Otologic examination of all subjects was performed and abnormalities were noted.

The audiologic, otologic, and tympanometry, impedance, and aural reflex evaluations were performed by different personnel without knowledge of previous results obtained. The otologic evaluation was performed after completion of the audiologic and tympanometry, impedance, and aural reflex evaluations since we were interested in assessing the applicability of these measures when the services of an otolaryngologist were not available. All equipment was calibrated on a weekly basis during the study.

**Results**

One hundred twenty nine of the 214 ears (60%) could not be evaluated for tympanometry, impedance, or aural reflex thresholds. A large number of these ears could not be evaluated because of excessive amounts of cerumen, perforations of the tympanic membrane, or the presence of myringotomy tubes. Only 85 of the 214 ears (40%) were successfully evaluated with the electroacoustic impedance bridge. Of these 85 ears, 53 were otologically normal, 22 were otologically abnormal, and 10 did not receive otologic examination. 17 of the ears were classified otologically abnormal because of tympanic membrane retraction, with or without the presence of fluid in the middle ear. Two of the ears were classified otologically abnormal because of distended tympanic membranes with the presence of fluid and three of the ears were classified abnormal for miscellaneous reasons.

Figure 1 illustrates the results of both the audiologic and the tym-
FIGURE 1. Results of audiologic and tympanometry, impedance, and aural reflex (T, I, AR) evaluations for otologically normal ears (N = 53).

Panometry, impedance, and aural reflex evaluations for the otologically normal ears. 53% of the otologically normal ears yielded normal hearing and normal tympanometry, impedance, and aural reflex thresholds, as would be expected. Results of the audiologic evaluations revealed that 68% of the otologically normal ears yielded normal hearing, as would be expected, while 32% yielded abnormal hearing. Results of the tympanometry, impedance, and aural reflex evaluations revealed that 68% of the otologically normal ears yielded normal tympanometry, impedance, and aural reflex thresholds, as would be expected, while 32% yielded abnormal
Figure 2. Results of audiologic and tympanometry, impedance, and aural reflex (T, I, AR) evaluations for otologically abnormal ears (N = 22).

Although the percentages for the results of the audiologic and the tympanometry, impedance, and aural reflex evaluations are equal, many of the subjects yielded normal hearing with abnormal tympanometry, impedance, or aural reflex thresholds or yielded abnormal hearing with normal tympanometry, impedance, and aural reflex thresholds.

Figure 2 illustrates the results of both the audiologic and the tympanometry, impedance, and aural reflex evaluations for the otologically abnormal ears. 68% of the otologically abnormal ears yielded abnormal...
Figure 3. Results of audiologic and tympanometry, impedance, and aural reflex (T, I, AR) evaluations for otologically normal and abnormal ears (N = 75).

Hearing and abnormal tympanometry, impedance, or aural reflex thresholds, as would be expected. Results of the audiologic evaluations revealed that 68% of the otologically abnormal ears yielded abnormal hearing, as would be expected, while 32% yielded normal hearing. Results of the tympanometry, impedance, and aural reflex evaluations revealed that 82% of the otologically abnormal ears yielded abnormal tympanometry, impedance, or aural reflex thresholds, as would be expected, while 18% yielded normal tympanometry, impedance, and aural reflex thresholds.

Figure 3 is a compilation of the data shown in Figures 1 and 2, illustrating the results of the audiologic and the tympanometry, impedance, and aural reflex evaluations for both the otologically normal and the otologically abnormal ears. Otologically normal ears would be expected to yield normal hearing and normal tympanometry, impedance, and aural reflex thresholds while otologically abnormal ears would be expected to yield abnormal
hearing and abnormal tympanometry, impedance, or aural reflex thresholds. Only 57\% of these ears yielded results for the audiologic and the tympanometry, impedance, and aural reflex evaluations that would be expected from the otologic findings. Results of the audiologic evaluations revealed that 68\% of these ears yielded either normal or abnormal hearing as would be expected from the otologic findings, while 32\% yielded audiologic results that would not be expected from the otologic findings. That is, 32\% of these ears yielded either normal hearing with abnormal otologic findings or yielded abnormal hearing with normal otologic findings. Results of the tympanometry, impedance, and aural reflex evaluations revealed that 72\% of these ears yielded either normal or abnormal tympanometry, impedance, and/or aural reflex thresholds as would be expected from the otologic findings, while 28\% yielded tympanometry, impedance, and aural reflex results that would not be expected from the otologic findings. That is, 28\% of these ears yielded either normal tympanometry, impedance, and aural reflex thresholds with abnormal otologic findings or yielded abnormal tympanometry, impedance, or aural reflex thresholds with normal otologic findings.

Discussion

This study was designed to investigate the applicability of tympanometry, impedance, and aural reflex testing in a cleft palate population and to assess their validity as a screening device for otologic abnormalities. Tympanometry, impedance, and aural reflex testing was not successful in 60\% of the ears in this cleft palate population because of the presence of obvious otologic abnormalities such as cerumen, tympanic membrane perforations, or myringotomy tubes. Only 40\% of the ears in this study could be successfully evaluated with the electroacoustic impedance bridge. Therefore, the applicability of tympanometry, impedance, and aural reflex testing was found to be somewhat limited in this population, largely due to the fact that the procedures were attempted on all subjects without prior otologic examination. These procedures would be considerably more effective when applied to selected patients after the otologic evaluation has been completed.

The validity of tympanometry, impedance, and aural reflex testing as a screening device for otologic abnormalities is questionable because 28\% of the ears that were successfully tested in this study yielded results that would not be expected on the basis of the otologic findings. That is, 28\% of the ears yielded either normal tympanometry, impedance, and aural reflex thresholds with abnormal otologic findings, or yielded abnormal tympanometry, impedance, or aural reflex thresholds with normal otologic findings. These results suggest that otologic referrals made only on the basis of tympanometry, impedance, and aural reflex findings will result in a considerable number of unnecessary referrals because of abnormal tympanometry, impedance, or aural reflex thresholds or in a considerable number
of patients with otologic abnormalities who would not be referred because of normal tympanometry, impedance, and aural reflex thresholds.

Although audiologic and tympanometry, impedance, and aural reflex evaluations may assist the physician with his diagnosis, they are not valid screening devices for otologic abnormalities. The only valid procedure for detection of otologic abnormalities is a physical examination of the ears. In view of the high incidence of otologic abnormalities in cleft palate patients, the results of this study emphasize the necessity for cleft palate teams to include an otolaryngologist as an integral member.

Summary

Tympanometry, impedance, and aural reflex testing was attempted in 107 cleft palate patients. 60% of the ears could not be evaluated because of obvious otologic abnormalities, suggesting that these procedures are of limited use without prior otologic examination in a cleft palate population. 28% of the ears that were successfully evaluated showed tympanometry, impedance, or aural reflex results that would not be expected on the basis of the otologic findings, suggesting that these procedures are not valid screening devices for otologic abnormalities.

Reprints: Bradley L. Billings, Ph.D.
Audiology Center of Redlands
242 Cajon Street
Redlands, California 92373

References