STANDARDIZATION AND CLINICAL APPLICABILITY OF SENSORI-NEURAL ACUITY LEVEL TEST

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Bone conduction testing is one of the most important tests in hearing evaluation. In the differential diagnosis of hearing impairment the measurement of pure tone bone conduction thresholds is sought as a primary means of establishing the existence and amount of sensori-neural component of the hearing loss. The testing by bone conduction became extensive in clinical procedures after Wheatstone in 1827. Clinical air conduction and Bone conduction thresholds are used primarily to ascertain the presence or absence of an external or middle ear lesion and to determine quantitatively the magnitude of the conductive hearing impairment.

However, as many investigators have mentioned, the reliability of bone conduction testing has been a matter of distrust. The importance of it is evident by the fact that modern surgical techniques and other means of rehabilitation demand an increasing need for its accuracy.

The accuracy is questioned by the following factors:

1. Problem of calibration
2. The static force for coupling the vibration to the skull for B. C. testing.
3. The physical characteristics of bone vibrators (circular space—area of 1.75 cm^2)
4. Negligible interaural attenuation for bone conducted stimuli.

An important requirement with all bone conduction tests is the exclusion of the non-test ear by means of an efficient masking noise, so that all the responses can be, without hesitation, related to the ear under test. But the problem lies in the fact that it is difficult to stimulate one ear without at the same time stimulating the other. Thus, a measure of b. c. of the tested ear may be an indirect measure of the sensitivity of the other ear.

The problem is further complicated by the presence of air-bone gap in the test reducing the maximum masking noise by an amount equal to the air-bone gap. Further, air-bone gap of masked ear makes the problem still more complicated as it increases the minimum masking level by an amount equal to air-bone gap.

Correct evaluation of bone conduction hearing is essential in the diagnosis and classification of hearing disorders since the success of treatment of the hearing handicapped is partially a function of accurate assessment of the cochlear reserve.

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These problems can be overcome if sensori-neural acuity level technique is used instead of conventional method of bone conduction testing. James and Susan Jerger (1955) have critically evaluated sensori-neural acuity level technique and have recommended that the technique should be used as a clinical tool.

The usefulness of SAL test is evident if we consider its merits:

1. The acoustic treatment of the room which is sufficient for A. C. testing is also adequate for B. C. testing.
2. As tones need not be presented through bone conduction vibrator, calibration of b. c. vibrator is no problem.
3. The problem of lateralization does not arise.
4. Problems like when and which ear to mask, how much to mask and how to mask, does not arise.

However this technique is not entirely free from demerits. The SAL has found a varied reception among clinicians (SCHRODER-1963.)

Michael (1963) reported that SAL was a better predictor of the post operative result of stapedectomy than conventional audiometry. Bailey and Martin (1963) reported similar success using spondees rather than pure tones as the SAL signal. BATES and BRAGGS found it very suitable for children who were difficult to be tested by pure tone. Lynn and Pinkey (1962) found the same results when a slight modification was made in the setting up of norms.

Rintelman and Harford have recently reported using the SAL test in the detection of pseudohypocusis in children.

On the other hand serious doubts as to the validity of the SAL test have been raised by Naunton and Fernandaz (1961)

Goldstein and Hayes and Peterson (1962), Tillman (1963), Martin and Bailey (1964), Creston, Marsh and Shutts (1964).

In view of these discrepant reports, to know whether the technique is really very useful an attempt was made to find out if it can be used as a clinical tool.

The purpose of the study was to test the following null hypothesis:

1. SAL values do not differ from bone conduction thresholds for conductive loss cases when SAL norm (1) (threshold of normal subjects in the presence of constant bone conduction noise) is used for calculating SAL values either when narrow band or wide band noise is used.
2. SAL values do not differ from bone conduction thresholds for conductive loss cases when SAL norm (2) (difference in dB between the average threshold is quiet and the average threshold in the presence of the b. c. noise) is used for calculating SAL values either when N. B. or wide band is used.
3. SAL values do not differ from bone conduction thresholds for sensori-neural loss cases when SAL norm (1) is used for calculating SAL values when N. B. or W. B. noise is used.

4. SAL values do not differ from bone conduction thresholds for mixed loss cases when SAL norm (1) is used for calculating SAL values either when N. B. or wide band noise is used.
5. SAL values do not differ from bone conduction thresholds for mixed loss cases when SAL norm (2) is used for calculating SAL values either when N. B. or W. B. noise is used.
6. The A. C. thresholds shift of normals in the presence of constant bone conduction noise (N. B. or W. B.) is not distributed normally.

Procedure

The sensori-neural-acuity level (SAL) test conventional b. c. tests were administered to the normal subjects and to clinical population. SAL data were gathered by using the conventional THD earphones in an acoustically treated room. The data were gathered in quiet, and in the presence of noise both narrow band and wide band. The normal groups served as a criterion group against which the performances of the other groups were evaluated. Both the tests covered the frequency range from 250 to 4 KHz.

Clinical population consisted of sensori-neural hearing loss, conductive loss and mixed loss cases. Experimental data were gathered for both the ears of each subject.

Equipment

All the experimental data were gathered using Amplivox 103 audiometer. ATDH-39 earphone mounted in an M x 41/AR cushion was utilized to obtain audiometric thresholds in quiet as well as in the presence of the bone conduction noise. The audiometer was calibrated using Bruel and Kjaer equipment. Experimental data were gathered for both the ears of each subject.

Test Procedure

For standardization of norms for the SAL test 100 normal subjects ranging in age from 16 to 30 years with a mean age of 23 years were selected. Each of the pathological groups consisted of 30 cases.

All the normal subjects and the patients were tested under 2 conditions. The first test with the ear-phone on was accomplished in quiet and covered the frequency range from 250 Hz through 4000 Hz. Immediately thereafter a second test was administered covering the frequency range from 250 Hz to 4000 Hz. This latter test was administered in the presence of the bone conducted sensori-neural acuity level noise both narrow band and wide band. The intensity of the bone conduction noise was 60 dB.

In all the subjects, the noise generator was adjusted to produce constant amount of noise across the b.c. vibrator. The acoustic conditions were same for all the three tests.

In addition to the tests described above, b.c. threshold audiogram covering the frequency range from 250 Hz through 4000 Hz was obtained for each subject. During this test the bone vibrator was positioned on the most prominent portion of the mastoid process of the test ear.

Each individual was tested in one session itself. 20 normal subjects were tested four times on different days for checking the reliability of the results for the SAL test.

Analysis and Results

Theoretically SAL and conventional Bone conduction audiometry should be measuring the same thing, and should, therefore, yield identical results. However, the SAL results are affected by variables such as the type of noise used, occlusion effect, the sensori-neural-acuity level norms (average threshold or average threshold shift of normals in presence of noise) etc.

To test the hypothesis (1-6), i.e., to test the significance of difference between the 2 SAL values for N. B. and W. B. and to test the significance of difference between conventional bone conduction thresholds and SAL values in all the 3 pathological groups, Wicoxon-Matched-pairs-signed-Ranks test was used. Both SAL norm (1) and SAL norm (2) were taken into consideration.

Results and Conclusions

1. The values showed significant difference between N. B. and W. B. for both the SAL norms. Results showed no significant difference between right ears. However, the SAL norm values are greater for N. B. than W. B. Also, the SAL norm (1) shows higher values than SAL (2) at all frequencies.

2. Results of the 2 norms (SAL1, SAL_2) for conductive loss groups agreed closely. There was no significant difference between SAL and b.c. when both N. B. and W. B. was used for this group.

3. The sensori-neural group also showed the same results that there was no significant difference between SAL and b.c. when SAL norm (1) and SAL norm (2) are used with N. B. and W. B. noise.

4. Mixed loss group, however, differed from the other two groups. Results showed significant difference between SAL and b.c. when SAL norm (1) was used in presence of both N. B. and W. B. noise.

5. The results showed that there was no significant differences between SAL and b.c. when SAL norm (2) was used with W. B. and N. B. noise in the case of Mixed loss group.

6. When the data were analysed to find out the significant difference between N. B. and W. B. for the three pathological groups using both SAL norm (1) and SAL norm (2), the results showed that there was no significant difference between N. B. and W. B. when SAL norm (1) and SAL norm (2) were used in both conductive and mixed loss groups. The sensori-neural group showed some

discrepancy indicating that there is significant difference between W. B. and N. B. when SAL norm (1) and SAL norm (2) are used.

7. The graphical representation of the distribution of the threshold shifts obtained by the SAL level technique indicates that the threshold shift obtained by this method in 100 normal subjects are normally distributed with, a standard deviation of 6-8 dB.

8. The results of test-retest reliability shows high correlation between the 2 tests for all the frequencies (250-4K) and for both the ears.

9. In the final analysis it can be stated that SAL technique; using SAL norm (2) for wide band and N. B. noise is clinically a useful test for determining 'cochlear reserve'.

Recommendations for further **research**

1. Jerger points out that the discrepancy between SAL results and conventional b.c. results arises in conductive loss cases for lower frequencies because of the fact that the former gives relative bond conduction thresholds whereas the latter gives relative bone conduction thresholds. Further, he suggests that this discrepancy disappears if the bone conduction system is calibrated on occluded normal ears. It would be useful if this aspect is explored.

2. It is reported that masking level difference phenomenon affects the SAL results. This could be explored for applying corrections for masking level difference when SAL technique is to be used clinically.