

BINAURAL AND MONAURAL MEASUREMENT OF THE RECRUITMENT PHENOMENON

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Loudness recruitment phenomenon, by definition, means an abnormally rapid increase of loudness with intensity. The best way of measuring the relation between loudness and intensity in clinical patients, i.e. to show the presence or absence of recruitment, is by means of Fowler's alternate binaural loudness-balance test. Briefly, this test consists of comparing the sensation levels at which a pure tone of the same frequency sounds equally loud in both ears of the patient. The method assumes that one ear has normal, or nearly normal, hearing and that the tone threshold in the bad ear is at least 25 db above that of the good ear.

The test is in principle carried out as follows. The patient listens to short tone impulses via earphones switching the tone from one ear to the other. One begins at the threshold level for the respective ears and increases the sound intensity to the good ear in 20 db steps. At each step a comparison is made of how much one needs to adjust the sound intensity to the bad ear, in order to get it heard equally loud in both ears. The patient must therefore try to remember how the comparison tone sounded in the good ear when it is presented to the bad ear. The patient is allowed to listen several times. The tone can be switched manually between the ears, but it is better if it is done automatically with the aid of an electronic switch. For physiological reasons it is important that the rise-decay time of the tone is short (50 milliseconds) and is identical for both ears. In order to avoid undesirable side-effects from adaptation and auditory fatigue, the tone should be of very short duration (0,3—0,5 sec.). The duration of the interval between successive stimuli to each ear, is of 1,5 seconds.

The adjustment of the tone intensity to the bad ear is made by the examiner, or better still, by the patient himself so that the same degree of loudness is reached in both ears when the tone is alternately compared between the ears.

In this connection one must beware of trying to carry out the sound balancing by comparing the loudness of the tone simultaneously in both ears, instead of alternately. Sustained stimulation or adaptation effect in simultaneous loudness balancing can result in abolition or reversal of loudness recruitment.

The balance test can in principle be carried out at any frequency. It is however usual to use the frequencies of 500, 1000, 2000 and 4000 cps.

When the recruitment phenomenon is present one finds that one may increase the sound intensity considerably more to the healthy or better ear

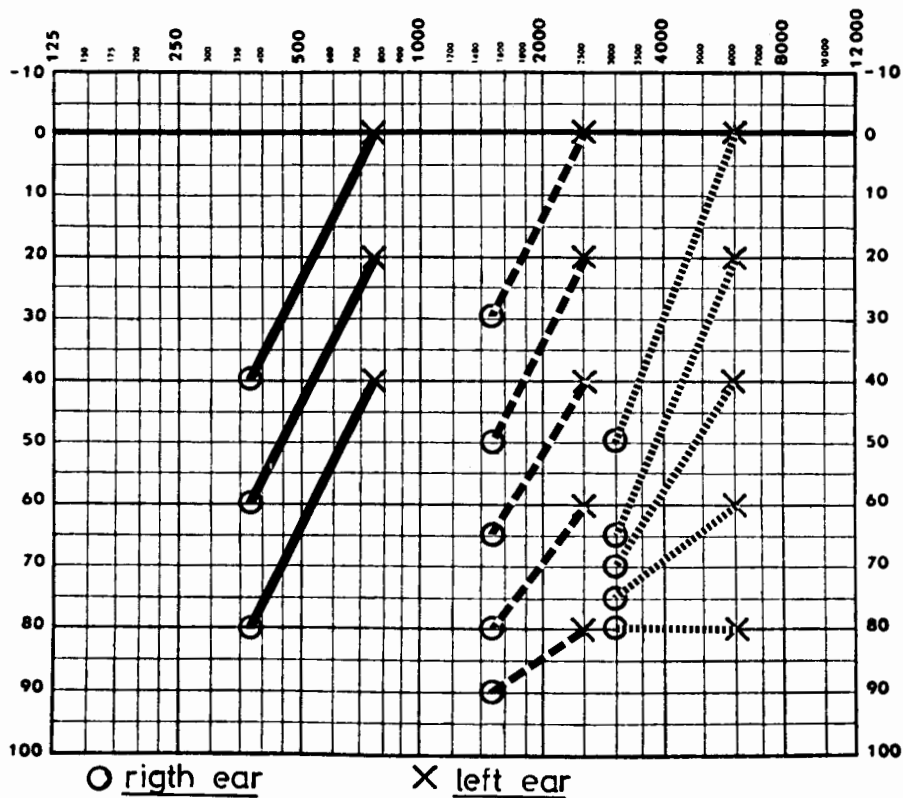


Fig. 1. Results of Fowler's balance test in a case of unilateral sensory-neural loss.

than to the worse ear in order to get the desired loudness balance. The result is registered in a so-called laddergram. It is clear from fig. 1 that a frequency of 500 cps requires the same sensation level in both ears for loudness-balance, which means that there is no recruitment. At 4000 cps equal intensity levels are required for loudness-balance, which means that there is complete recruitment. Partial recruitment is present at 2000 cps.

There is a certain lack of agreement as to whether the intensity should be varied on the good or the bad ear. In practice it does not seem to matter which one does. The patients often find it easier to adjust the intensity to the bad ear, at least if recruitment is present.

The balance test can be carried out with the majority of commercial tone-audiometers. The test demands however that the audiometer can deliver short tones of the same frequency but of different sensation levels to each ear. If such an instrument is not available, two audiometers can be used. Jerger recommends carrying out the test with the help of a speech audiometer having two channels, one of which is connected with a Békésy audiometer.

The alternating tones pass through the speech audiometer where the test levels are set on the attenuators. The output from one channel is set to the desired sensation level for the good ear, and sent directly to one earphone. The output from the other channel is sent through the Békésy audiometer to the other earphone. The patient uses the Békésy intensity control to get the two tones equally loud. In that way the patient traces out on an audiogram blank the sensation level required for the bad ear, to match a given sensation level in the good ear. If the intensity is fixed as described on the good ear, it is necessary to have an attenuator in 2 db steps for regulating the adjustment to the bad ear. If the tone audiometer has only 5 db steps it is as a rule, easier to carry out the test in reverse i.e. by having the sound intensity fixed on the bad ear and letting the patient adjust his good ear until he has equal loudness in both ears. According to Jerger, it is sufficient to fix the sound intensity for the bad ear with two adjustments: sensation levels of 20 and 40 db.

In bilateral sensory-neural hearing loss, in which the higher frequencies are more severely impaired than the lower ones, it is possible to carry out a monaural loudness-balance test. According to Reger, who first suggested this test, the loudness at the impaired frequencies is compared with the loudness of the normal frequencies at threshold and at set intervals above threshold. The equal loudness curves of the normal ear are already established experimentally.

The result of the patients attempts to match the loudness of tones of various frequencies to the loudness of e.g. 500 cps tone are compared with the equal loudness curves. When divergencies occur, recruitment is present.

In practice it is often difficult to carry out this test, because of the difficulty for the patient to compare the loudness of two tones with different frequencies. In cases of binaural hearing impairment we prefer instead the stapedius-reflex test to show recruitment. It is carried out in about the same manner as that which will be described later by dr Terkildsen. One investigates whether the stapedius-reflex of the damaged ear can be released at the same intensity level as that of a patient with normal hearing. If this is the case, it points to the presence of recruitment.

MESURES BINAURICULAIRE ET MONO-AURICULAIRE DU RECRUTEMENT

La definition du recrutement phénomène est la renforcement anormale de la sensation sonore en relation sur l'intensité.

La meilleur façon de mesurer la cohésion entre la sensation sonore et l'intensité dans le cas d'un assourdissement monaural est le test de balance de Fowler. Ce test base sur la comparaison des niveaux du son au dessus du seuil d'audibilité minimum pour les oreilles respectives qui donnent la même sensation sonore sur la même fréquence (c.a.d. on cherche le niveau d'égalisation entre les oreilles).

Le sujet entend un son d'une durée de 0,3—0,5 sec. par alternance tantôt à droite et tantôt à gauche. Le testeur cherche d'abord le seuil minimum

des oreilles et après il augmente l'intensité du son de 20 db à l'oreille avec le meilleur seuil et modifie l'intensité du son dans l'autre oreille jusqu'à obtention de l'égalisation. Après il fait la comparaison entre les deux niveaux d'intensité pour voir combien il est nécessaire d'augmenter l'intensité dans l'oreille malade pour obtenir l'égalisation du son. C'est préférable d'employer pour ce test les fréquences de 500, 1000, 2000 et 4000 Hz.

Lorsque la surdité est bilatérale, Reger a proposé d'effectuer le test de balance de Fowler sur la même oreille, entre deux fréquences inégalement atteintes. C'est en pratique très difficile pour le sujet de comparer les niveaux d'intensité, du fait de la différence de hauteur des deux sons.

Pour obtenir des résultats plus certains c'est à recommander d'employer le réflexe du muscle de l'étrier d'après Metz. C'est une méthode objective. Le Docteur Terkildsen donne des détails là-dessus dans ses publications. Le principe de cette méthode est d'examiner la possibilité de produire le réflexe stapédial à l'oreille malade avec le même niveau d'intensité du son qui produit ce réflexe dans l'oreille normale. Quand il est possible de produire un réflexe stapédial dans l'oreille malade dans ces circonstances on soupçonne la présence du recrutement.

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