OPEN ACCESS

# Sudden deafness and tuning fork tests: towards optimal utilisation

Ahmed Bayoumy Bayoumy ,[1] Jacob Alexander de Ru[1,2]

[1]Department of Otorhinolaryngology, Central Military Hospital, Ministry of Defence, Utrecht, The Netherlands
[2]Department of Otorhinolaryngology, UMC Utrecht, Utrecht, The Netherlands

**Correspondence to**
Ahmed Bayoumy Bayoumy, Department of Otorhinolaryngology, Central Military Hospital, Ministry of Defence, Utrecht 3584 EZ, The Netherlands; a.b.bayoumy@amc.uva.nl

Accepted 19 July 2019
Published Online First 23 August 2019



**To cite:** Bayoumy AB, de Ru JA. *Pract Neurol* 2020;**20**:66–68.

## ABSTRACT

The tuning fork tests have been under attack since their first use in clinical examination. However, the tuning fork is small and fits into every white coat, and tuning fork tests for hearing are easy, accurate and inexpensive. They should be used in patients with an acute unilateral hearing loss if an electric audiometer is not available. After more than 100 years, the tuning fork is not obsolete; tuning fork tests are very useful if used correctly and for the appropriate indication.

Idiopathic sudden sensorineural hearing loss is a devastating disease with limited effective treatment. High-dose corticosteroids are the standard treatment[1] and these might be even more effective when combined with hyperbaric oxygen.[2] These treatments need to start as early as possible, since the best results follow a rapid diagnosis.

Thus, general practitioners must refer patients with acute perceptive hearing loss urgently to an Ear, Nose and Throat (ENT) clinic for further diagnosis and treatment. General practitioners can use otoscopy and the tuning fork tests to differentiate between conductive and perceptive hearing loss. The gold standard—audiometric testing with adequate masking—is often not directly available in primary care. However, a tuning fork fits in every white coat, the tests are easy to use, accurate, non-invasive and inexpensive; for acute unilateral hearing loss, they can assist in triage. Moreover, anyone who has forgotten how the tests work can easily experience the effect by occluding one ear canal while holding a tuning fork on the forehead.

Tuning fork tests have been under attack since their first descriptions.[3] And still there are occasional reports citing exceptions to the rule that tuning forks do not lie[4] and the renewed discussion about their usefulness.[5] They are indeed not 100% accurate,[1] and we, like most people, agree that referral for audiometry is the preferred option in the non-acute setting. Their standard use in a neurological setting may lead to 'bad vibrations'.[5] However, most ENT clinicians consider tuning fork testing to be an appropriate and easy-to-use first step in acute situations to distinguish between conductive and perceptive hearing loss.[3 6]

Tuning fork tests were invented at a time when there was neither electric audiometer nor micro-otoscopy. At first, these tests were used for different types of hearing loss to give a 'rough' indication, as the best available diagnostic tool for that moment. Thus, their purpose at that time was—obviously—completely different from current reasons to use tuning fork tests. The foundation of their use—the occlusion effect (bone conduction gain on occlusion of the auditory meatus) and the phenomenon of lateralisation of bone conduction into the occluded ear—were solidly documented by multiple authors with a rather 'universally' reproducible outcome.[3 6]

The most important clinical question nowadays concerns only the accuracy of these tests in diagnosing idiopathic sudden sensorineural hearing loss. In all other situations, it is just one of the tools in the armamentarium but not the sole instrument on which to make radical treatment decisions. As Schmalz, who described the clinical importance of the Weber test, stated: 'the test is especially usable in cases of one sick ear, or at least one more than the other'.[6] In case of idiopathic sudden sensorineural hearing loss, this means that the tuning fork has to be able to differentiate between at least 30 dB sensorineural hearing loss—given the current definition of this condition—and a bone conduction loss.

First, let us put some of the evidence in favour of the tuning fork. There are

not many studies assessing its use, especially for acute hearing loss. In 2013, Shuman *et al*[7] published a research letter on tuning fork testing in idiopathic sudden sensorineural hearing loss. Their audiometric inclusion criteria were a documented pure tone average of at least 50 dB in the affected ear. They found that the Weber test correctly lateralised to the opposite ear in 196 out of 250 patients (78%). Only two cases (1%) incorrectly lateralised, 38 (15%) were heard in the mid-line and 14 (6%) were not heard. The overall sensitivity was 78% in all 250 patients. But, of those 198 patients (79%) who did lateralise, the sensitivity was 99% and the Weber test reliably predicted a sensorineural cause. These results indicate that if there is lateralisation to the normal ear, the Weber test is very useful and reliable for quick referral of patients with suspected acute idiopathic sudden sensorineural hearing loss.

Burkey *et al*[8] described 2000 ears of which 201 had conductive hearing loss. The mean conductive hearing loss was 23.1 dB (SD 9.7 dB), and the hearing loss ranged from 10 to 51.7 dB. The 512 Hz Rinne test was correct in 96.6% of all 1799 cases in which there was no conductive hearing loss. This test thus has a high specificity, making it unlikely that the Rinne test will find a conductive hearing loss when there is none. They found a sensitivity of 59.0%, 93.9% and 96.2% in those with conductive hearing losses with an air–bone gap of 10–19, 20–29 and ≥30 dB, respectively. So the greater the loss, the more useful the instrument. When an experienced otologist performed the test, sensitivity rates even reached 100%.

Chole *et al*[9] obtained a sensitivity rate of 78.8% and specificity rate of 71.4% in patients who underwent the Rinne test for conductive hearing loss screening with a 256 Hz tuning fork. The mean air–bone gap was 15.6 dB (SD 10.8). Sensitivity and specificity rates for the 512 Hz tuning fork were 44.8% and 100%, respectively. The mean air–bone gap was 34.5 dB (SD 5.7). The overall accuracy of the 256 Hz tuning fork was 77%, compared with 54.3% for the 512 Hz tuning fork. Despite this, the authors concluded that the 512 Hz tuning fork would be more suitable for screening because of the high number of false positives when using the 256 Hz tuning fork.

Lacovidou *et al*[10] compared the Weber test with the scratch test after tympanomastoid surgery, a situation that simulates an acute conductive hearing loss. For the Weber test they found a sensitivity of 73.2% and a specificity of 100%. Stankiewicz *et al*[11] performed a double-blinded prospective study of 268 ears. The Rinne test was positive in 99% of cases with sensorineural hearing loss. Lateralisation of the Weber test to the good ear occurred in 8 out of 12 patients (67%) with unilateral sensorineural hearing loss. We do not know the extent of hearing loss in this study.

Among patients with an idiopathic sudden sensorineural hearing loss, those needing treatment the most—patients with severe and profound losses—will probably have even higher specificity. Moreover, expert otolaryngologists describing tuning fork tests in idiopathic sudden sensorineural hearing loss clearly favour their use.[12 13]

We have also scrutinised the evidence against the tuning fork to the same degree as adversaries of the tuning fork have examined the evidence in favour. Many of the studies that found low accuracy did not use the tuning fork tests for acute hearing loss, but for many other situations for which audiometry is the gold standard. Some papers described the positive predictive value, but did not describe the types and amount of hearing losses of their patients and subgroups.[7 10 11] The tuning fork was used to differentiate between small conductive and sensorineural losses,[11 14] and tuning fork tests were used in patients with presbycusis and longstanding losses.[7–9 11] Furthermore, the larger studies often screened populations among whom there were few hearing losses.[8 14]

Moreover, the tuning fork was often not used appropriately. If one strikes the tuning fork to make a 'pling' sound, the patient will undoubtedly also hear the sound in the ear contralateral to the conductive hearing loss.[5 7] Is that a faulty lateralisation or just an example of not knowing how to handle the instrument?

It has been said that two groups of people criticise the tuning fork: those who never use it and those who do not know how to use it.[12] There is also a third group: those who do not know *when* to use it. In our opinion, the tuning fork is the best instrument for patients with sudden deafness, apart from an electric audiometer. We think it is far-fetched that while ENT clinicians advise using a tuning fork for this specific indication, colleagues from other specialties suggest that they know better what to use for an ENT diagnosis.[1] The fact that tuning fork tests are leading to bad vibrations concerning hearing loss among general neurologists cannot be extrapolated to their use in a specific situation.

We agree that the tuning fork tests should be part of ENT training in the medical curriculum and that their routine use in neurology can be minimalised. Our neurology colleagues also stated that if it were possible, all the 256 and 512 Hz tuning-forks would be smelted and remade as 128 Hz tuning-forks for the sake of testing the vibration sense. We agree that this makes sense from a neurological point of view. However, ENT clinicians use 512 Hz tuning forks to test hearing and not the vibration sense. At this frequency, the ideal balance between tactile vibration and time of tone decay is obtained, and therefore this tuning fork is preferable to test hearing.[15]

Audiometry is the gold standard in cases of idiopathic sudden sensorineural hearing loss, but this also needs an experienced audiometrist and effective masking. Otherwise the good ear perceives/overhears the bleeps and so the audiogram shows a minor loss


Bayoumy AB, de Ru JA. *Pract Neurol* 2020;**20**:66–68. doi:10.1136/practneurol-2019-002350

on the affected site, in what could be a completely deaf ear. For the same reason, during the Rinne test when the tuning fork is placed at the mastoid—in suspected idiopathic sudden sensorineural hearing loss—it is important to question whether the sound is perceived in the affected or in the good ear.

McGurgan and Nicholl stated that ear wax and otitis media are quite easily recognisable.[5] Since all the ENT physicians that we know have had multiple ceruminosis or otitis media referrals that turned out to have sudden deafness, it is clear that the diagnosis was not as simple as it could and should have been. In the incorrect diagnoses that we have seen ourselves, no tuning fork had been used, while in all cases in our department, the tuning fork did not fail.

Too often otolaryngologists are faced with this unnecessary delay. So, we believe that every otolaryngologist would prefer to see an emergency referral of suspected idiopathic sudden sensorineural hearing loss if tuning fork tests suggest this—even if the patient turns out to have conductive loss—rather than the other way around. Therefore, we do encourage general practitioners and neurologists to use tuning fork tests in cases of acute hearing loss. The Weber test, performed first, will lateralise to the good ear in cases of severe and profound idiopathic sudden sensorineural hearing loss. If the Weber test lateralises to the affected ear, the Rinne test will confirm the conductive hearing loss with very high specificity.

## CONCLUSION

After more than 100 years, the use of the tuning fork is not obsolete; it is a very useful tool if used correctly and for the appropriate indication.

## SUGGESTIONS FOR FURTHER READING

1. Huizing EH. The early descriptions of the so-called tuning fork tests of Weber and Rinne. I. The “Weber test” and its first description by Schmalz. *ORL J Otorhinolaryngol Relat Spec* 1973; 35: 278–282. DOI: 10.1159/000275130.
2. Huizing EH. The early descriptions of the so-called tuning-fork tests of Weber, Rinne, Schwabach, and Bing. II. The “Rinne Test” and its first description by Polansky. *ORL J Otorhinolaryngol Relat Spec* 1975; 37: 88–91. DOI: 10.1159/000275210.

### Key points

- General practitioners can use otoscopy and the tuning fork tests to differentiate between conductive and sensorineural hearing loss.
- Tuning fork tests remain useful and are used in daily ENT practice.
- Tuning fork tests can be used in the quick assessment and triage of idiopathic sudden sensorineural hearing loss, a condition that needs immediate treatment.
- A third group of criticasters are those who do not know when to use the tuning fork test: they pick up the *bad vibrations* only.

**Contributors** AB and JA: writing manuscript.

**Funding** The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

**Competing interests** None declared.

**Patient consent for publication** Not required.

**Provenance and peer review** Not commissioned; externally peer reviewed by David Nicholl, Birmingham, UK.



**ORCID iD**

Ahmed Bayoumy Bayoumy http://orcid.org/0000-0002-5302-9312

## REFERENCES

1 Fishman JM, Cullen L. Investigating sudden hearing loss in adults. *BMJ* 2018;7:k4347.
2 Bayoumy AB, de Ru JA. The use of hyperbaric oxygen therapy in acute hearing loss: a narrative review. *Eur Arch Otorhinolaryngol* 2019;276:1859–80.
3 Huizing EH. The early descriptions of the so-called tuning fork tests of Weber and Rinne. I. The "Weber test" and its first description by Schmalz. *ORL J Otorhinolaryngol Relat Spec* 1973;35:278–82.
4 McBride P. The Tuning-Fork in diagnosis of lesions of the internal ear. *Br Med J* 1886;1:688–9.
5 McGurgan IJ, Nicholl DJ. Weber's and Rinne's tests: bad vibrations? *Pract Neurol* 2017;17:323–4.
6 Feldmann H. [History of the tuning fork. II: Evolution of the classical experiments by Weber, Rinne and Schwabach]. *Laryngorhinootologie* 1997;76:318–26.
7 Shuman AG, Li X, Halpin CF, *et al*. Tuning fork testing in sudden sensorineural hearing loss. *JAMA Intern Med* 2013;173:706–7.
8 Burkey JM, Lippy WH, Schuring AG, *et al*. Clinical utility of the 512-Hz Rinne tuning fork test. *Am J Otol* 1998;19:59–62.
9 Chole RA, Cook GB. The Rinne test for conductive deafness. A critical reappraisal. *Arch Otolaryngol Head Neck Surg* 1988;114:399–403.
10 Iacovidou A, Giblett N, Doshi J, *et al*. How reliable is the "scratch test" versus the Weber test after tympanomastoid surgery? *Otol Neurotol* 2014;35:762–3.
11 Stankiewicz JA, Mowry HJ. Clinical accuracy of tuning fork tests. *Laryngoscope* 1979;89:1956–63.
12 Doyle PJ, Anderson DW, Pijl S. The tuning fork--an essential instrument in otologic practice. *J Otolaryngol* 1984;13:83–6.
13 Verburg AFEA, Alkhateeb WHFW, Merkus P. [Acute perceptive hearing loss. Importance of tuning fork test in primary care]. *Ned Tijdschr Geneeskd* 2011;155:A2460.

14 Haapaniemi JJ, Suonpää JT, Salmivalli AJ, *et al*. C1-tuning fork tests in school-aged children. *Auris Nasus Larynx* 1996;23:26–32.

15 Wahid NWB, Attia M. Weber test, 2019. Available: https://www.ncbi.nlm.nih.gov/books/NBK526135/ [Accessed 9 Jul 2019].