CASE REPORT

Musical-grade tuning forks for emergent audiometric screening

Rodger J McCormick, Mikaela I Poling

Department of Applied Physiology, FSRG deGruyter-McKusick Institute of Health Sciences, Buckhannon, West Virginia, USA

Correspondence to
Mikaela I Poling,
poling_mi@fsrgroup.org

Accepted 21 May 2015

SUMMARY

We discuss our experience using high-quality, musical-grade tuning forks for emergent audiometric screening in a 22-year-old woman with sudden-onset unilateral hearing sensation loss. We present a framework for using this method when proper audiometric equipment is unavailable but where musical-grade tuning forks can be rapidly supplied.

BACKGROUND

Audiometric equipment remains expensive and highly specialised, even with advent of lower cost smartphone app-based alternatives slowly infiltrating the market. Though evaluation of acoustic sensory perception is a critical task in emergency neurological screening, proper equipment may be unavailable in resource-depleted or rural areas, forcing the provider to use crude methods, such as whispered speech. In areas with a musical tradition, musical tuning forks may be available; musical tuning forks are typically of high quality and span a wider frequency range than conventional clinical tuning forks.

CASE PRESENTATION

A 22-year-old white woman with a severe Freeman-Sheldon syndrome (FSS; OMIM 193700) phenotype,¹ presented with severe sudden-onset left-sided hearing loss and no other symptoms or recent illness. Family and personal history was complex, suggesting many worrisome differential diagnoses, including intracranial lesion and cerebrovascular accident. We remained particularly uncertain as to what role, if any, FSS may have had in the patient's present symptom. Otological and neurological examinations were unchanged from previous examination by us 2 weeks prior. Specifically, the patient was afebrile, without focal neurological deficits. External auditory canals were small but patent, without erythema, exudate, or other signs of infection. Tympanic membranes were clear, with some patchy tympanosclerosis from myringotomies in early childhood, and moved normally; there was no sign of effusion, perforation, cholesteatoma or other abnormality.

INVESTIGATIONS

As we are located in a rural area, audiometric equipment was not immediately available, but with a background in music, we elected to request high-quality tuning forks from community musicians, who expeditiously provided them. We were not specific in our request and simply used what was

provided to us. In using the tuning forks, the patient faced away from us and graded her auditory perception in the left ear in comparison to her unaffected right ear on a scale of 1–5, with 0 being undetected and 5 equal to the right ear. On Trial 1, the scale was performed in order; Trial 2 was randomised (table 1).

The tuning forks were held at the standard Rinne distance from the pinnae, and we ensured uniformity of tuning fork activation by using a special mallet provided with the tuning forks, with which we practised before testing. With the tuning forks, we were able to accurately identify the hearing loss pattern as a low frequency loss (table 1), which was subsequently confirmed by formal diagnostic audiometry (figure 1) at a major university tertiary referral centre. With the standard Rinne method using a 256 cps tuning fork, bone conduction was better than air in the left and air better than bone in the right. Weber lateralised to the left ear.

Although we cannot be certain the right ear was completely unaffected at the time of testing, the patient reported no change in hearing sensation and has been previously known to be an accurate historian. Comparison testing, prior to the above-described procedure, seemed to confirm this. We also had previous audiograms from tertiary care university referral centres establishing the patient's baseline hearing, and subsequent audiograms that we compared with our musical tuning fork test showed no right-sided change from baseline and confirmed stability of hearing status in both ears.

Table 1 Audiogram produced from musical tuning forks

Tuning fork frequency (cps or Hz)	Results*	
	Trial 1	Trial 2
128 (C)	4	3
256 (C [#])	3.5	3
293.7 (D)	3	3
349.2 (F)	4	3
370 (F [#])	3	3
466.2 (B ^b)	4.5	4.5
493.9 (B)	4.5	4

While crude, it does show fair agreement between Trial 1 and 2, indicating a pattern of diminished auditory sensory perception at lower frequencies and good sensory perception at the two highest frequencies. Musical notation is retained parenthetically for illustration. More than two trials may have added to the credibility of the method, but this was a very late night emergency clinical assessment. More trials were not deemed clinically necessary, after having a pattern appear with the second trial.

*0, Undetected; 5, =Equal to unaffected ear, 'Very Loud'.

CrossMark

To cite: McCormick RJ, Poling MI. *BMJ Case Rep* Published online: [please include Day Month Year] doi:10.1136/bcr-2015-210662

Figure 1 Audiogram produced by formal audiometry at a major university referral centre. While obviously more detailed, notice concordance with initial screening test using musical tuning forks.

TREATMENT

After otorhinolaryngology consultation, oral antibiotic (amoxicillin) and corticosteroid (dexamethasone) therapy was initiated empirically until the patient could arrive at the major university tertiary referral centre for further testing, at which time they decided to stop therapy based on negative findings of an anatomic pathology.

OUTCOME AND FOLLOW-UP

Four to 6 weeks after initial presentation, the patient reported some brief episodic vertigo. High-resolution CT and MRI with intravenous contrast ruled out an anatomic pathology, and the patient remained without a diagnosis. Three months from initial presentation, hearing suddenly and spontaneously returned to about 90% of preloss sensation. At 6 years' follow-up, there was no recurrence or other otological or acoustic problem. We felt the sudden unilateral hearing loss represented a viral infection.

DISCUSSION

While use of musical tuning forks is not ideal and may not always be an option, it may well add useful clinical data, provided it does not delay formal testing and referral, if indicated. In the experience with our patient, referral was not delayed, and evaluation performed with the musical tuning forks added valuable clinical data. With assistance from the musicians, we hope

to conduct randomised studies to better evaluate and validate the method described.

Patient's perspective

With experiencing so many physical limitations already because of FSS and with having endured so many failed attempts to correct some of these problems, losing my hearing was utterly terrifying—the last straw. My hearing has always been exceptionally good. From my perspective, I can't really think of a worse thing that could happen to me, short of a locked-in type condition, like ALS. It made me feel very good that some type of thorough, objective assessment could be done, even without having an audiometer available. The testing itself felt very similar to a routine optometric evaluation for corrective lenses. It gave me great comfort and reassurance that something was being done. I wasn't having to wait. I felt confirmed to see actual results and receive an immediate explanation about what they showed, no matter how limiting they were. I could see something about what was going on with me. That was really as important from a psychological perspective to me as it was from a medical standpoint to my doctors.

Learning points

- ▶ Musical-grade tuning forks are typically manufactured to more exacting specifications than medical-grade tuning forks, which makes musical tuning forks an ideal emergency audiometric screening adjunct.
- ▶ Tuning fork screening should be accomplished in a very objective way, using a system similar to the one we have presented, to avoid bias and allow monitoring over time, if that is needed later.
- ▶ Use of musical-grade tuning forks should not extend the time to formal audiometric testing.
- ▶ The psychological benefits to a patient to be able to begin objective testing for an acute, worrisome auditory complaint in the absence of proper audiometric equipment, may be as crucial as or more so than any physiological insight gained.

Acknowledgements The authors would like to thank Mr Mark Lynch, Dr Joseph B Reed and Mrs Judy Knorr, who graciously loaned their very fine tuning forks and activator mallet that were used in the testing of our patient. The authors also thank Dr Reed for assistance with securing urgent otorhinolaryngological consultation for our patient. Finally, the authors thank Mrs CM Poling for helpful review of the manuscript.

Contributors RJM was the primary originator and designer of the method described, and MIP, who primarily drafted the contemporaneous testing report and manuscript, also participated in analysis and interpretation of the findings. Both critically revised the manuscript for intellectual content and style and approved the final version.

Competing interests None declared.

Patient consent Obtained.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCE

- 1 Stevenson DA, Carey JC, Palumbos J, *et al*. Clinical characteristics and natural history of Freeman-Sheldon syndrome. *Pediatrics* 2006;117:754–62.

Copyright 2015 BMJ Publishing Group. All rights reserved. For permission to reuse any of this content visit <http://group.bmj.com/group/rights-licensing/permissions>.
BMJ Case Report Fellows may re-use this article for personal use and teaching without any further permission.

Become a Fellow of BMJ Case Reports today and you can:

- ▶ Submit as many cases as you like
- ▶ Enjoy fast sympathetic peer review and rapid publication of accepted articles
- ▶ Access all the published articles
- ▶ Re-use any of the published material for personal use and teaching without further permission

For information on Institutional Fellowships contact consortiasales@bmjgroup.com

Visit casereports.bmj.com for more articles like this and to become a Fellow