CASE REPORT

Otoscope fogging: examination finding for perforated tympanic membrane

Jason F Naylor

Department of Primary Care,
Irwin Army Community
Hospital, Fort Riley, Kansas,
USA

Correspondence to

Jason F Naylor,
jason.f.naylor.mil@mail.mil

Accepted 13 May 2014

SUMMARY

The author reports a recently recognised physical examination finding, otoscope fogging, for perforated tympanic membrane. Otoscope fogging is defined as condensation forming in the view field of the otoscope while inspecting the ear. In the setting of occult perforation secondary to the inability to visualise the entire tympanic membrane, otoscope fogging may provide the clinician with valuable information since medical management may differ if perforation is present.

BACKGROUND

The prevalence of perforated tympanic membrane (PTM) in the general population is not known. A 2008 prospective study of 1000 randomly selected German adults found the prevalence of chronic PTM to be 0.45%.¹ A cross-sectional study of 4930 South Koreans in the same year calculated the prevalence of PTM to be 1.6%.²

Diagnosis of a PTM is not difficult with otoscopy if it can be visualised. When the examiner cannot see the PTM, though, pneumatic otoscopy and tympanometry may aid in the diagnosis. These devices, however, must be available for use, whereas otoscope fogging does not require additional equipment to aid in the detection of occult PTM. Otoscope fogging is defined as condensation forming in the view field of the otoscope while inspecting the ear, much like one would see if inspecting the nasal cavity while the patient exhales through the nose.

CASE PRESENTATION

Case 1: A 27-year-old Caucasian man presented to an outpatient clinic in the USA with symptoms of acute hearing loss of 1 week duration. He denied all other symptoms, including ear pain, ear discharge, fever/chills/rigors, tinnitus, vertigo, exposure to loud sounds, recent air travel and recent water diving. He reported a history of recurrent otitis media as a child that required bilateral tympanostomy tubes and adenoidectomy. On examination, a central PTM was identified with an airfluid level inferior to it. While inspecting the PTM, the examiner's otoscope fogged as the patient performed the Valsalva manoeuvre. Pneumatic otoscopy and tympanometry were not available for use.

Case 2: Four months later, a 26-year-old Caucasian man presented to the same examiner at the same clinic for follow-up after being treated at a local emergency department for acute dyspnoea. He admitted to smoking one pack of cigarettes a week

for 10 years and a long-standing history of allergic rhinitis. He denied any ear symptoms, including ear pain, ear discharge, loss of hearing and tinnitus. On examination, visualisation of the left TM was partially obstructed by cerumen in the external auditory canal, but the portions seen were normal. However, the examiner's otoscope fogged while the patient performed the Valsalva manoeuvre. Pneumatic otoscopy and tympanometry were not available for use.

TREATMENT

Case 1: The patient was treated for otitis media with perforation with amoxicillin and clavulanate 875 mg orally twice a day for 10 days and referred to an otolaryngologist for audiogram and evaluation of the PTM. The patient did not follow-up with the consultant.

Case 2: The patient was referred to an otolaryngologist for suspected PTM due to the physical examination finding of otoscope fogging. About a month later, the patient was seen by the specialist and found to have a 20% posterosuperior left-sided PTM. The consultant obtained a temporal bone CT and audiogram. The audiogram demonstrated mild sensorineural hearing loss of the affected ear and the CT showed airfluid levels in the left mastoid cells and an abnormal soft tissue density. Owing to employment obligations, the patient elected to be scheduled for tympanomastoidectomy 3 months later.

OUTCOME AND FOLLOW-UP

Case 1: The patient did not return to the clinic for the same or associated symptom.

Case 2: Tympanoplasty was performed without mastoidectomy and ossicular chain reconstruction. The patient's postoperative course was unremarkable, the PTM healed and an audiogram performed 9 months later normalised.

DISCUSSION

The most common causes of PTM are infection, trauma and iatrogenic.^{3–4} PTM is a well-described complication of acute and chronic otitis media.^{5–7} Barotrauma of the middle ear typically results from compression injury, blast exposure, air travel and underwater diving.^{8–9} Forty-eight per cent of the 143 survivors of the 2005 London bombings were found to have PTM.¹⁰ Blunt and penetrating trauma to the head may result in middle ear injury. About 30% of severe head trauma patients and over 50% of basilar skull fractures are associated with PTM, ossicular chain disruption, oval window

CrossMark

To cite: Naylor JF. *BMJ Case Rep* Published online: [please include Day Month Year] doi:10.1136/bcr-2013-200707

rupture and/ or facial nerve injury.^{11–14} PTM was the most common injury found in those suffering minor otological trauma (incidence of 33.6%) in a 2007 retrospective study spanning 28 years in the USA.¹⁵ Iatrogenic causes of PTM include irrigation, instrumentation and sequela of tympanostomy tubes.¹⁶ A 2010 retrospective study in the UK reported that 9% of patients had PTM after removal of the tympanostomy tubes.¹⁷ PTM, regardless of the aetiology, is associated with the formation of cholesteatoma.¹⁸

PTMs require special consideration for medical management. Irrigation of cerumen and non-organic foreign bodies is contraindicated if PTM is possible in order to prevent contamination of the middle ear.¹⁹ Ototoxic medications should be limited to those that are not ototoxic.^{19–20} Perforations greater than 40% of the surface area of the TM, centrally located, or involving its annulus should be referred to an otolaryngologist for tympanoplasty consideration since the spontaneous healing rates are significantly lower.^{9–21–23} Superoposterior PTM should prompt the clinician to consider cholesteatoma.^{5–24} Traumatic PTMs with potential ossicular chain disruption, oval window rupture or evidence of facial nerve injury should undergo emergent audiometry and evaluation by an otolaryngologist.¹⁴

In general, diagnosis of a PTM is not difficult with otoscopy. There are, however, instances where identification of the perforation may not be possible due to incomplete visualisation of the TM. This may result from several conditions: partial obstruction by cerumen, foreign body, skin mass, exostosis, etc within the external auditory canal; the natural curvature of the external auditory canal; and difficulty in properly positioning the patient (eg, trauma patient in a cervical collar recumbent on a gurney). In these instances, indirect methods of detecting PTM may be useful for the clinician.

Pneumatic otoscopy and tympanometry may aid in the diagnosis of occult PTM. Both methods require the availability of special equipment and pneumatic otoscopy necessitates some visualisation of the TM. Perforation is indicated with pneumatic otoscopy when the TM is immobile without evidence of middle ear effusion and on tympanometry with a flat type B tympanogram.²⁵ Several studies have evaluated both methods in the paediatric population, particularly in the setting of otitis media with effusion; however, none of these studies directly tested the device for detection of isolated PTM.^{26–30} As a result, the effectiveness of pneumatic otoscopy and tympanometry for diagnosing PTM only is not fully described. Therefore, it may benefit providers to have a physical examination finding for PTM.

Otoscope fogging is defined as condensation forming in the view field of the otoscope while inspecting the ear. This finding should only be observed if humidified, warmed air moves from the nasopharynx to the middle ear and the middle ear communicates with the external ear. One of the physiological functions of the nose is to warm and humidify inspired air for the lower respiratory tract.^{31–32} Air inhaled through the nose may be directed into the middle ear by opening of the Eustachian tubes.^{33–34} This warmed and humidified air is trapped in the middle ear by an intact tympanic membrane.^{35–36} With PTM, though, this air is free to exit into the external ear and cause condensation of instrumentation by virtue of the relative differences in air temperature and humidity.³⁷ Since air must pass through the Eustachian tube, this sign may not be seen in paediatric patients due to their developing anatomy and in any patient who is unable to perform the Valsalva manoeuvre.^{38–41}

A search of the medical literature did not reveal any previous description of otoscope fogging; however, fogging of

otoendoscopes in the setting of PTM has been documented. Telemedicine services use video otoendoscopes to enable distant consultants to view the TM and other anatomy in order to assist in the management of otic symptoms. PTM is a known impediment to this process: ‘a perforation with moisture can interfere with visualisation of the tympanic membrane through fogging the lens’.⁴² Although not stated elsewhere in the literature, it seems reasonable to conclude that fogging of otoendoscopes when PTM is present lends support to the same occurrence in otoscopes despite the differences between the two devices.

Testing for otoscope fogging does not require additional equipment and is easy to perform. It may be the only indirect test for PTM available to providers located in smaller outpatient clinics, abroad on humanitarian missions and deployed with military forces. Detection of PTM leads to closer follow-up, changes medication use and increases referral rates. Otoscope fogging is not described in the medical literature and physical examination texts. Consequently, the reproducibility, accuracy, sensitivity and specificity of this examination finding are unknown. Future studies should include a large number of participants and clinicians to determine these parameters and inter-observational rates.

Learning points

- ▶ Fogging of the otoscope may indicate a perforated tympanic membrane.
- ▶ Irrigation and ototoxic, ototoxic medications are contraindicated in the setting of a perforation.
- ▶ Perforations larger than 40%, centrally located or involving the annulus may require tympanoplasty.

Competing interests None.

Patient consent Obtained.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

- 1 Kaftan H. Prevalence of chronic tympanic membrane perforation in the adult population. *HNO* 2008;56:145–50.
- 2 Cho YS, Choi SH, Park KH, et al. Prevalence of otolaryngologic diseases in South Korea: data from the Korea National Health and Nutrition Examination Survey 2008. *Clin Exp Otorhinolaryngol* 2010;3:183–93.
- 3 Isaacson B. Hearing loss. *Med Clin North Am* 2010;94:973–88.
- 4 O’Handley JG, Tobin EJ, Shah AR. Otorhinolaryngology. In: Rakel RE, Rakel DP, eds. *Textbook of family medicine*. 8th edn. Philadelphia: Saunders, 2011:300–42.
- 5 Chole RA, Sudhoff HH. Chronic otitis media, mastoiditis, and petrositis. In: Flint PW, Haughey BH, Lund VJ, Niparko JK, Richardson MA, Robbins KT, Thomas JR, eds. *Cummings otolaryngology: head & neck surgery*. 5th edn. Philadelphia: Mosby, 2010:1963–78.
- 6 Kerschner JE. Otitis media. In: Kliegman RM, Stanton BF, St Geme JW, Schor NF, Behrman RM, eds. *Nelson textbook of pediatrics*. 19th edn. Philadelphia: Saunders, 2011:2199–213.
- 7 Casselbrant ML, Mandel EM. Acute otitis media and otitis media with effusion. In: Kliegman RM, Stanton BF, St Geme JW, Schor NF, Behrman RM, eds. *Nelson textbook of pediatrics*. 19th edn. Philadelphia: Saunders, 2011:2761–77.
- 8 Mirza S, Richardson H. Otic barotrauma from air travel. *J Laryngol Otol* 2005;119:366–70.
- 9 Lou ZC, Lou ZH, Zhang QP. Traumatic tympanic membrane perforations: a study of etiology and factors affecting outcome. *Am J Otolaryngol* 2012;33:549–55.
- 10 Radford P, Patel HD, Hamilton N, et al. Tympanic membrane rupture in the survivors of the July 7, 2005, London bombings. *Otolaryngol Head Neck Surg* 2011;145:806–12.
- 11 Ort S, Beus K, Isaacson J. Pediatric temporal bone fractures in a rural population. *Otolaryngol Head Neck Surg* 2004;131:433–7.

- 12 Lee D, Honrado C, Har-El G, *et al*. Pediatric temporal bone fractures. *Laryngoscope* 1998;108:816–21.
- 13 Zimmerman WD, Ganzel TM, Windmill IM, *et al*. Peripheral hearing loss following head trauma in children. *Laryngoscope* 1993;103:87–91.
- 14 Evans AK, Handler SD. Evaluation and management of middle ear trauma. In: Basow DS, ed. *UpToDate*. Massachusetts: Wolters Kluwer, 2012.
- 15 Conoyer JM. Otolgic surgery following ear trauma. *Otolaryngol Head Neck Surg* 2007;137:757–61.
- 16 Schmiemann G, Kruschinski C. Complication rate of out-patient removal of ear wax: systematic review of the literature. *HNO* 2009;57:713–18.
- 17 Daudia A, Yelavich S, Dawes PJ. Long-term middle-ear ventilation with subannular tubes. *J Laryngol Otol* 2010;124:945–9.
- 18 Louw L. Acquired cholesteatoma pathogenesis: stepwise explanations. *J Laryngol Otol* 2010;124:587–93.
- 19 House JC, Lee DJ. Topical therapies of external ear disorders. In: Flint PW, Haughey BH, Lund VJ, Niparko JK, Richardson MA, Robbins KT, Thomas JR, eds. *Cummings otolaryngology: head & neck surgery*. 5th edn. Philadelphia: Mosby, 2010:1950–62.
- 20 Marais J, Rutka JA. Ototoxicity and topical eardrops. *Clin Otolaryngol Allied Sci* 1998;23:360–7.
- 21 Ritenour AE, Wickley A, Ritenour JS, *et al*. Tympanic membrane perforation and hearing loss from blast overpressure in Operation Enduring Freedom and Operation Iraqi Freedom wounded. *J Trauma* 2008;64:S174–8.
- 22 Orji FT, Agu CC. Determinants of spontaneous healing in traumatic perforations of the tympanic membrane. *Clin Otolaryngol* 2008;33:420–6.
- 23 Lou ZC, Tang YM, Yang J. A prospective study evaluating spontaneous healing of aetiology, size and type-different groups of traumatic tympanic membrane perforation. *Clin Otolaryngol* 2011;36:450–60.
- 24 Chang P, Kim S. Cholesteatoma—diagnosing the unsafe ear. *Aust Fam Physician* 2008;37:631–8.
- 25 Gunasekera H, O'Connor TE, Vijayasekaran S, *et al*. Primary care management of otitis media among Australian children. *Med J Aust* 2009;191(9 Suppl):S55–9.
- 26 Rogers DJ, Boseley ME, Adams MT, *et al*. Prospective comparison of handheld pneumatic otoscopy, binocular microscopy, and tympanometry in identifying middle ear effusions in children. *Int J Pediatr Otorhinolaryngol* 2010;74:1140–3.
- 27 Nienhuys TG, Boswell JB, McConnel FB. Middle ear measures as predictors of hearing loss in Australian aboriginal schoolchildren. *Int J Pediatr Otorhinolaryngol* 1994;30:15–27.
- 28 Onusko E. Tympanometry. *Am Fam Physician* 2004;70:1713–20.
- 29 Palmu AA, Syrjanen R. Diagnostic value of tympanometry using subject-specific normative values. *Int J Pediatr Otorhinolaryngol* 2005;69:965–71.
- 30 Watters GW, Jones JE, Freeland AP. The predictive value of tympanometry in the diagnosis of middle ear effusion. *Clin Otolaryngol Allied Sci* 1997;22:343–5.
- 31 Eccles R. Anatomy and physiology of the nose and control of nasal air flow. In: Adkinson NF, Bochner BS, Busse WW, Holgate ST, Lemanske RF, Simons FE, eds. *Middleton's allergy: principles and practice*. 7th edn. Philadelphia: Mosby, 2009:702.
- 32 Schulze A. Respiratory gas conditioning and humidification. *Clin Perinatol* 2007;34:19–33.
- 33 Van Hosen KB, Bird NH. Diving medicine. In: Auerbach PS, ed. *Auerbach: wilderness medicine*. 6th edn. Philadelphia: Mosby, 2012:1529–30.
- 34 Brenner W, Bohuslayzki KH, Kroker B, *et al*. Ventilation scintigraphy of the middle ear. *J Nucl Med* 1997;38:66–70.
- 35 Couch ME. History, examination, and the preoperative evaluation. In: Flint PW, Haughey BH, Lund VJ, Niparko JK, Richardson MA, Robbins KT, Thomas JR, eds. *Cummings otolaryngology: head & neck surgery*. 5th edn. Philadelphia: Mosby, 2010:97.
- 36 Moon RE, Camporesi EM. Clinical care in extreme environments: at high and low pressure and in space. In: Miller RD, Eriksson LI, Fleischer LA, Weiner-Kronish JP, Young WL, eds. *Miller's anesthesia*. 7th edn. Maryland Heights: Churchill Livingstone, 2009:2500.
- 37 Lawrentschuk N. Laparoscopic lens fogging: a review of etiology and methods to maintain a clear visual field. *J Endourol* 2010;24:905–13.
- 38 O'Reilly RC, Sando I. Anatomy and physiology of the Eustachian tube. In: Flint PW, Haughey BH, Lund VJ, Niparko JK, Richardson MA, Robbins KT, Thomas JR, eds. *Cummings otolaryngology: head & neck surgery*. 5th edn. Philadelphia: Mosby, 2010:97.
- 39 Klein JR. Children in the wilderness. In: Auerbach PS, ed. *Auerbach: wilderness medicine*. 6th edn. Philadelphia: Mosby, 2012:1968.
- 40 Morrissey T, Lissoway JB. Ear emergencies. In: Adams JG, Barton ED, Collings JL, DeBlieux PM, Gisondi MA, Nadel ES, eds. *Adams: emergency medicine*. 2nd edn. Philadelphia: Saunders, 2012:228.
- 41 Pfaff JA, Moore GP. Otolaryngology. In: Marx JA, Hockberger RS, Walls RM, Adams JG, Barsan WG, Birn MH, *et al*, eds. *Marx: Rosen's emergency medicine*. 7th edn. Philadelphia: Mosby, 2009:877.
- 42 Arriaga M, Nuss D, Arriaga RY. Neurotology telemedicine consultation. *Otolaryngol Clin N Am* 2011;44:1235–50.

Copyright 2014 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