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Article type : Our Experience

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i. Title

GARDEN TERROR – CASE SERIES OF TWENTY EIGHT SERIOUS EAR INJURIES CAUSED BY YUCCA PLANTS

ii. Running title:

A case series of yucca plant –induced ear injuries

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v. Acknowledgments

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vi. 5 succinct key points

- The majority of injuries from yucca plants involved perforation of the tympanic membrane, but 14% of case were complicated by perilymphatic fistula (PLF).
- Clinician should have a high index of suspicion of traumatic PLF with:
  - perforation of the posterior tympanic membrane and
  - any sensorineural hearing loss or
  - any associated dizziness.
- Clinical testing for PLF (pressure or fistula tests) is often negative.
- Decision to urgently explore the ear suspected to have a traumatic PLF is based more upon history than objective assessment.
- Perilymphatic fistula can mimic classical signs of BPPV, due to pneumolabyrinth.

vii. Main text

Word Count: 1097, including Introduction, Methods, Results and Discussion.

Introduction

The yucca plant (genus *Yucca,* family Asparagaceae, subfamily Agavoideae) is a ubiquitous plant whose long and sharp leaf spines (Fig 1) are accountable for an increasing number of ear injuries presenting to the Emergency Department of our specialised tertiary hospital. Whereas most cases presented as easy-to-diagnose traumatic tympanic membrane perforations (TMP) which healed quickly, 4 cases were complicated by perilymphatic fistula (PLF), and these presented a diagnostic dilemma that resulted in late diagnoses.

Materials and Methods

Ethical considerations

The Human Research and Ethics Committee of the Royal Victorian Eye and Ear Hospital approved this audit and its publication. Patients whose history is identifiable from the description were contacted and have given their consent to publication.

Yucca plant-induced ear injuries presenting to the Emergency Department of the Royal Victorian Eye and Ear Hospital between January 2012 and August 2017 were reviewed. Patients were identified by an electronic search of digital presentation codes.

Results

We report on 28 patients with ear trauma caused by yucca between 2012 and August 2017. In three patients the sole injury was an abrasion of the external ear canal. Twenty-five patients were diagnosed with a TMP. Twenty-one TMPs were uncomplicated, presenting with a conductive hearing loss on audiometry but without dizziness. All healed quickly with resolution of their symptoms.

In 4 cases, the Yucca penetrated both the tympanic membrane and the inner ear, producing a PLF (Table 1). All were vertiginous for 1-3 days after injury but this settled spontaneously, resulting in ongoing non-specific dizziness and unsteadiness. These 4 patients had either a pure sensorineural, or a mixed hearing loss (Figure 2). All 4 had a negative fistula test on presentation, and this led clinicians to consider the risk of PLF to be low. Only one patient underwent an urgent surgical exploration and PLF repair.

Patient 3 presented with a MHL and positive test for posterior benign paroxysmal positional vertigo (BPPV) on the side of injury, with a progressive sensorineural hearing loss and unilateral peripheral vestibular insufficiency *without* pressure sensitivity. Dizziness upon Valsalva appeared 1 month after trauma, which prompted us to image the patient. Pneumolabyrinth was apparent on CT scans of temporal bones, and yet nystagmus was absent on both fistula testing and Valsalva (Figure 3).

Patient 4 first presented 6-weeks post initial trauma, reporting that his primary care doctor diagnosed him as having TMP and referred him for specialist opinion to our hospital. On initial assessment he already had an anacoustic ear with healed eardrum. Notably, his vestibular exam was unremarkable except for positive Dix-Hallpike test on the side of injury. This was treated as a posttraumatic BPPV, as CT of temporal bones did not reveal pneumolabyrinth. Two months later, this patient

developed acute otitis media with TMP, complicated by labyrinthitis and early meningitis. This prompted an urgent examination under anaesthesia.

All 4 cases of PLF underwent surgical exploration and repair as soon as the diagnosis was made. Two patients had a PLF in the round window, and one in the oval window. Patient 4 did not have an active fistula or foreign body found, but round window area was covered by granulations. The hearing remained poor in all patients, with slight improvement postoperatively in 1 case, whereas unsteadiness resolved in all 4 patients.

Discussion

Yucca plants cause a PLF by direct penetration of the inner ear from the needle-like spine of the plant's leaf. This leads to a leakage of labyrinthine fluids causing cochleovestibular symptoms and a loss of inner ear function. The most common sites of PLF are the round and oval windows[1]. These structures are directly in line with the trajectory of Yucca plant leaves when they enter the ear, thus posterior TMP heightens the possibility of PLF.

A traumatic PLF is a surgical emergency[2]. Even if the PLF is repaired, hearing loss may not recover. Timely treatment is associated with some improvement in 13-49% of cases[3,4]. In contrast, the recovery of balance function occurs in 83-94%[5].

Dizziness and/or nystagmus on the fistula test or Valsalva, are the classic clinical signs of a PLF. Here we show that they cannot be relied upon for diagnosis, which supports existing literature. The sensitivity of clinical fistula test ranges from 18% to 37%, with 54% being the best performance when the response is registered with electronystagmography[5]. Similarly, nystagmus is seen in only 50% of cases[6]. Here vestibular symptoms and a sensorineural component to the hearing loss were always present, and these alone should prompt urgent ENT referral for surgical repair[7].

Synopsis of key findings

- The majority of injuries from yucca plants involved perforation of the tympanic membrane, and 14% of case were complicated by PFL.
- Clinician should have a high index of suspicion of traumatic PLF with:

    - perforation of the posterior tympanic membrane and
    - any sensorineural hearing loss or
    - any associated dizziness.
- Clinical testing for PLF (pressure or fistula tests) is often negative, so the decision to explore the ear is based more upon history than objective assessment.
- Perilymphatic fistula can mimic classical signs of BPPV, due to pneumolabyrinth.

Comparisons with other studies

Yucca plant injury to the ear is not widely recognised. The only other series reported 3 cases in Israel over 7-year period[8]. We report a larger cohort of patients in shorter timeframe with various significant complications and an unusual disguised presentation of PLF. We suspect that yucca plant ear injury is under-reported. To the best of our knowledge a positive Dix-Hallpike test has not previously been associated with traumatic PLF. BPPV was presumably caused here by air within the labyrinth, and positional nystagmus after yucca injury should heighten concern about a fistula.

Strengths of the study

The size of the cohort, a documented failure of clinical testing to diagnose PLF, and documentation of clinical signs and symptoms found to be associated with fistula. A first-time description of a positive Dix-Hallpike test with pneumolabyrinth.

Clinical applicability of the study

Penetrating injuries of the ear with thin-leafed, spiked domestic plants such as the yucca are particularly likely to cause tympanic membrane perforation, with a high risk of PLF. This appears not to be widely recognised in the medical community and should be better appreciated by ENT surgeons, emergency physicians and primary care practitioners. These colleagues should be aware that dizziness and hearing loss together with a penetrating injury to the ear should raise a high suspicion of PLF, even when classical signs are absent.

viii. References

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ix. Figure legends

Figure 1. Image of the yucca plant.

Figure 2. Case 3. Pure tone audiometry. Note progression of a mixed hearing loss on day 2, to profound hearing loss sensorineural heariing loss 40 days after presentation.

Figure 3. Case 3. Axial and coronal CT scans of patient with right perilymphatic fistula. Arrows point at pneumolabyrinth, seen in both the lateral semicircular canal (31) and the vestibule (54).

Table 1. Perilymphatic fistula cases caused by yucca plant 2012-2017. *MHL* – mixed hearing loss, *PSQ* – posterior-superior quadrant, *PIQ* – posterior-inferior quadrant, *CT* – computer tomography, *EUA* – examination under anaesthesia, *GP* – general practitioner.

PLF #	Presenting complaint post trauma	Initial examination	Cardinal Sx&Sx prompting EUA post observation	Days to EUA
1	Hearing loss Acute vestibular syndrome for 1/7 Otalgia	L) central TMP L) SNHL No spontaneous nystagmus **Negative fistula test** Normal CT brain	Ongoing unsteadiness Progressive SNHL Crackling sounds in L) ear	75
2	Hearing loss Acute vestibular syndrome for 2/7 Otalgia	L) PSQ TMP L) MHL No spontaneous nystagmus **Negative fistula test**	----------	2
3	Hearing loss Acute vestibular syndrome for 3/7 Otalgia	R) PIQ TMP R) MHL No spontaneous nystagmus **Negative fistula test** **R) positive Dix-Hallpike**	Ongoing unsteadiness Progressive SNHL Unilateral peripheral vestibular weakness Vertigo with Valsalva maneourve CT: pneumolabyrinth	40
4	Hearing loss Motion-induced vertigo for 6/52	L) TMP – reported by GP, healed by the time of our review L) SNHL **Negative fistula test** No spontaneous nystagmus Negative HIT test **L) positive Dix-Hallpike test** CT: no pneumolabyrinth	L) AOM with PIQ TMP complicated by labyrinthitis and early meningitis 2/12 post initial presentation	~100

Table 1. PLF cases caused by yucca plant 2012-2017. *MHL* – mixed hearing loss, *PSQ* – posterior-superior quadrant, *PIQ* – posterior-inferior quadrant, *CT* – computer tomography, *EUA* – examination under anaesthesia, *GP* – general practitioner, AOM – acute otitis media.

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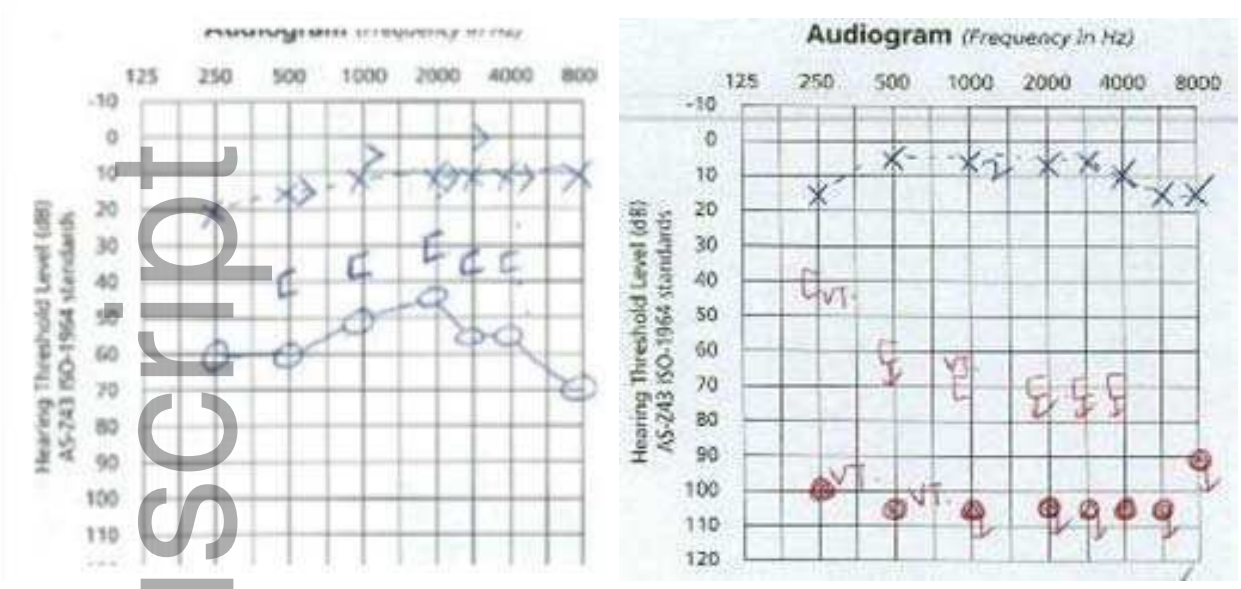

Figure 2. Case 3. Pure tone audiometry.

Note progression of a mixed hearing loss on day 2, to profound hearing loss sensorineural hearing loss 40 days after presentation.

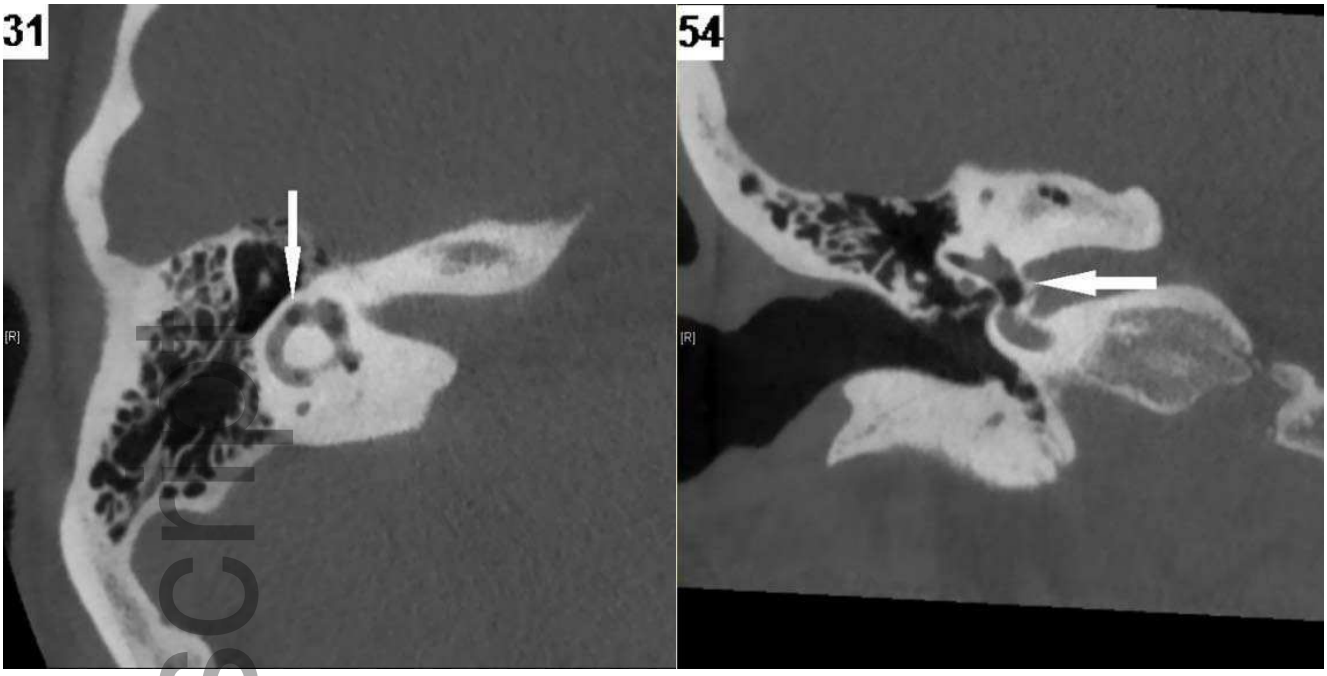

Figure 3. Case 3. Axial and coronal CT scans of patient with right PLF. Arrows point at pneumolabyrinth, seen in both the lateral semicircular canal (scan 31) and the vestibule (scan 54).