

OSSICULAR CHAIN DISRUPTION DUE TO ROAD TRAFFIC ACCIDENT: CASE REPORT

Mwangi G¹, Macharia I^{1,2}

¹Nairobi ENT Clinic, Nairobi, Kenya

²Department of Otorhinolaryngology, Head and Neck Surgery, School of Medicine, University of Nairobi, Kenya

Address for correspondence: Dr. Grace N. Mwangi, Nairobi ENT Clinic, P.O. Box 29740-00200 Nairobi, Kenya.
Email: dr.gmwangi@gmail.com

ABSTRACT

Road traffic accidents contribute to the majority of temporal bone trauma, with most been unilateral fractures. High index of suspicion is required during initial consultation, since otologic manifestations may not be overt in patients with multiple injuries. We present a case of overlooked temporal bone trauma at the initial stage of management in peripheral unit.

Key words: Temporal bone trauma, Ossicular chain, Hearing loss, Ossiculoplasty

INTRODUCTION

Most temporal bone trauma, up to 40-50% occur secondary to road traffic accidents. Road traffic injuries are the leading cause of death in children and young adults aged 5-29 years¹. Men are three times more affected compared to women. Most are unilateral, with bilateral fractures occurring in 9% - 20% of the cases. Contributing factors locally include; alcohol intoxication, over speeding and lack off safety gear.

Clinical presentation may include facial nerve paralysis, hearing loss and CSF otorrhea. In a patient with multiple injuries, the otological manifestations of temporal bone trauma may be initially overlooked. We report a case of a patient who sustained multiple injuries including temporal bone trauma whose presentation to the otolaryngologist was markedly delayed.

CASE REPORT

We report a case of a 34-year-old male patient who presented in our clinic with right ear itchiness and was overly concerned as it was his only hearing ear. On further enquiry, the patient was involved in a road traffic accident 3 years ago and sustained head injury. He presented with loss of consciousness, left otorrhagia and left reduced hearing. Computed tomography scan of the brain was noted to be normal. No report of any ENT assessment was done. Two months later he noticed ipsilateral facial asymmetry and was reassured in a peripheral unit. There was no report of lacrimation or taste alteration.

On assessment, he had a left sided lower motor neuron facial nerve palsy, House Brackman grade II². Video-otoscopy revealed a left step deformity of the posterosuperior canal wall with a thin and retracted

tympanic membrane. Right ear had some waxy debris deep in the canal which was syringed out.



Figure 1: Right ear

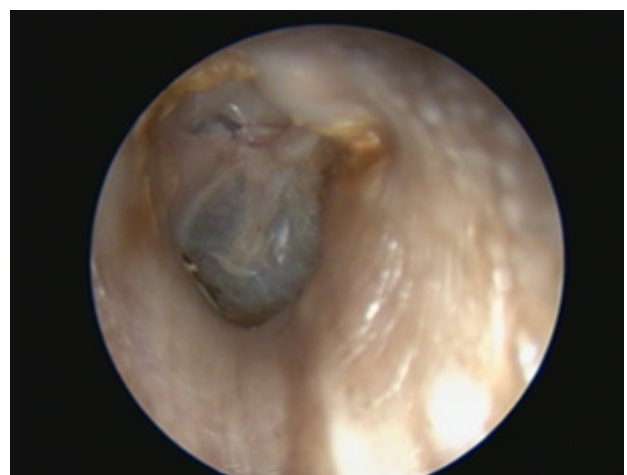


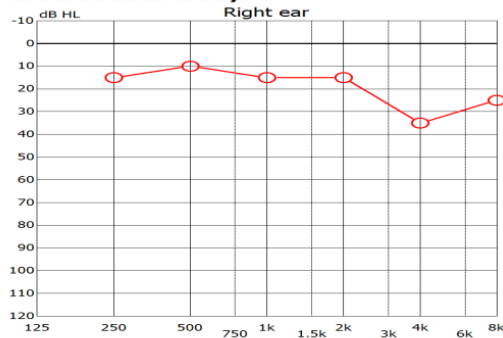
Figure 2: Left ear

Video otoscopic images of the ears

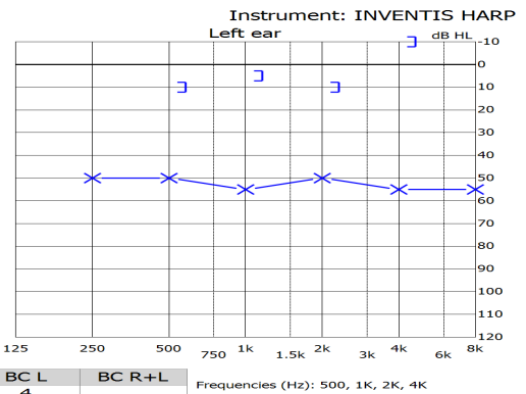
D.E.O, years 34, Born on 1/21/1986

Session date 6/8/2020

Pure tone audiometry



PTA	AC R	AC L	AC R+L	BC R	BC L	BC R+L
	19	52	35.5		4	



Right: Normal Hearing. Left: Moderate Conductive Hearing loss with air bone gap >40dB

Tympanometry

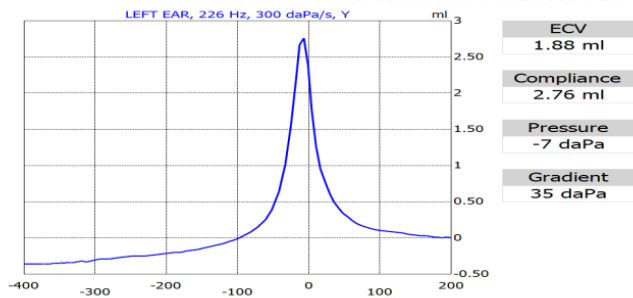
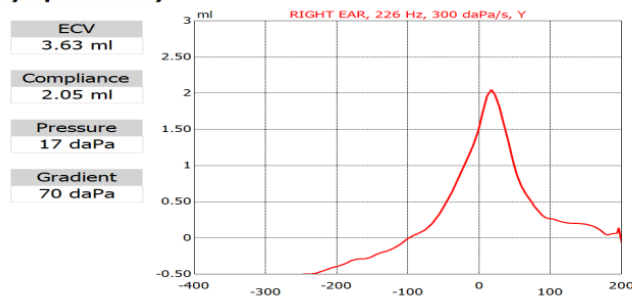


Figure 3: Pre-operative pure tone audiometry and tympanometry findings



Bony fragments within the left middle ear cavity

Figure 4: High resolution CT of temporal bone pre-operative findings

Ossicular discontinuity was thus suspected and patient underwent endoscopic left tympanotomy, middle ear exploration and ossicular chain reconstruction. In view of the Wallerian degeneration of the facial nerve that had occurred, facial nerve exploration was not done.

Salient intra-operative findings included; a fractured incus with the short arm extruded under the canal skin and which was what was responsible for the step deformity on otoscopy. The malleus and remnant incus were fused, with the stapes preserved in its original state.

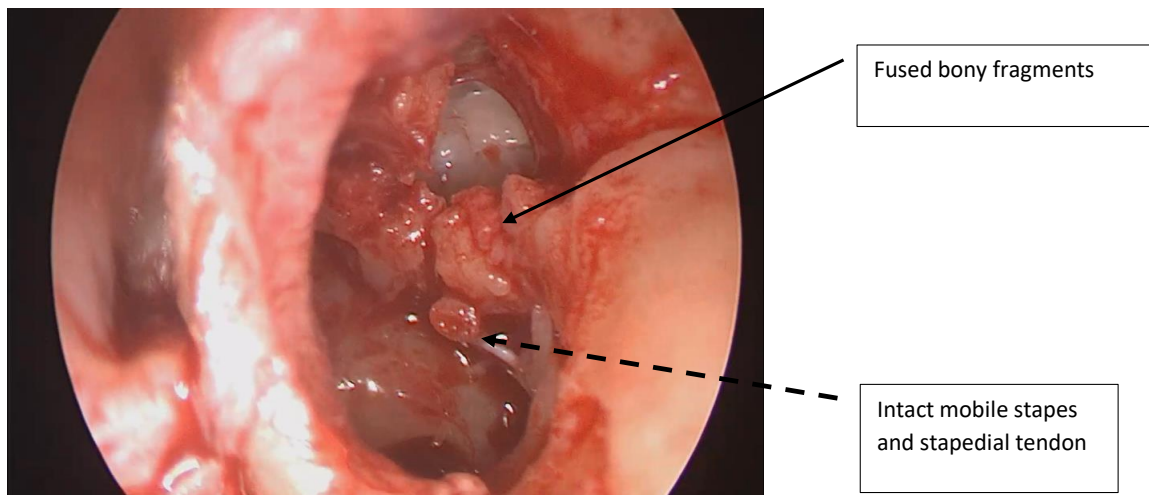


Figure 5: Intra operative findings

The fused bones were curetted out and the short process of the incus used as an inter-positional graft between

the stapes and cartilage graft that was used as a buttress between the stapes and the thin tympanic membrane.

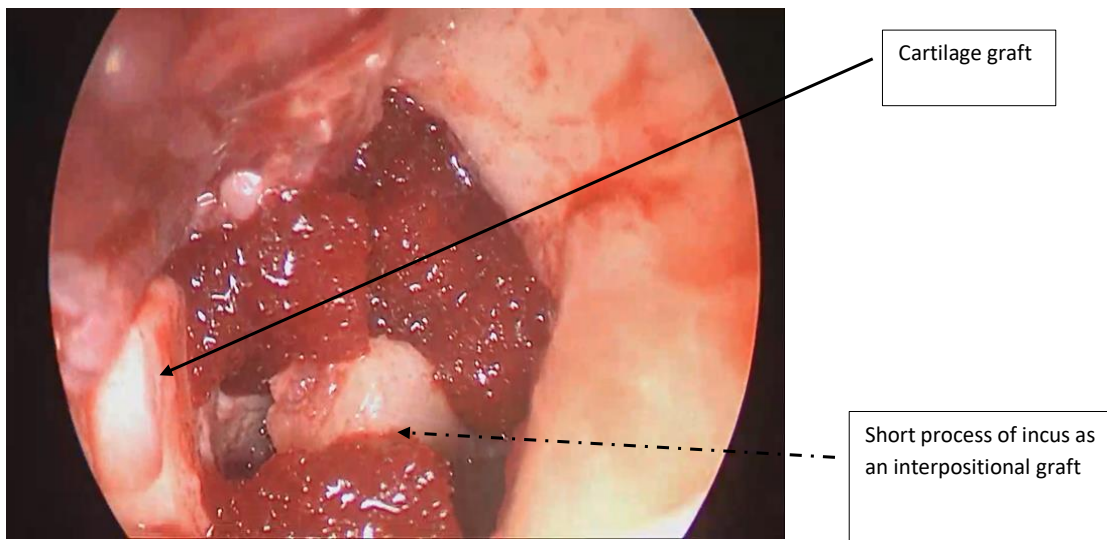
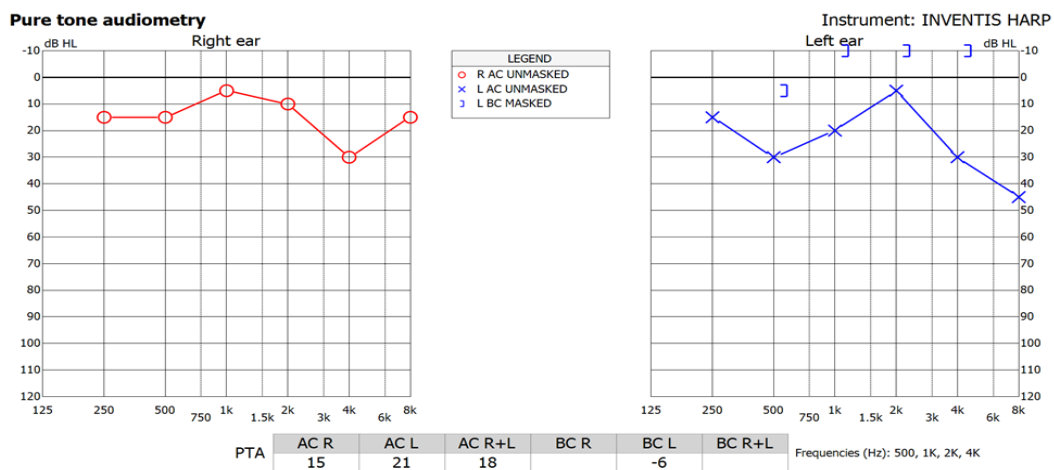


Figure 6: Ossicular chain restoration done

The ossicular chain reconstruction restored continuity and improved hearing both clinically and on audiogram.



Right ear normal hearing

Left ear mild conductive hearing loss

Figure 7: Six weeks post-operative pure tone audiometry findings

DISCUSSION

The temporal bone has vital structures that are at risk of injury and include; facial nerve, cranial nerves IX through XI, cochlea, labyrinth, ossicles, tympanic membrane, carotid artery and jugular vein. Its injury can lead to significant morbidity or mortality and knowledge of its pertinent anatomy, pathophysiology of injury and appropriate management strategies are critical³.

Features of temporal bone trauma to look out for include:-

- (i) Evidence of penetrating insult
- (ii) Otorrhoea
- (iii) Battle sign
- (iv) LMN facial nerve paralysis
- (v) Blood in external auditory canal
- (vi) Step deformity along the external auditory canal
- (vii) Haemotympanum
- (viii) Tympanic membrane perforation
- (ix) Tullio's phenomenon

Traditionally, temporal bone fractures were classified as either longitudinal or transverse relative to the plane of the petrous ridge⁴. However, this classification scheme did not provide useful prognostic information with regards to neurological deficits and majority had mixed fractures. An alternative classification based on the involvement of the otic capsule has gained popularity over the years as it gives some reliable prognostic information⁵. This case demonstrates an otic capsule sparing fracture as patient had a conductive hearing loss.

The ossicular chain consists of three bones; the malleus, incus, and stapes joined by two synovial joints, the incudomalleolar and incudostapedial joints. Together, they comprise the primary sound-conduction apparatus to transmit vibratory stimulus from the tympanic membrane to the oval window.

The ossicular chain in addition to conducting sound also amplifies it due to the compound lever effect of the ossicles and their natural resonance. Complete loss of this pathway would result in a conductive hearing loss of 50-60dB⁶. The commonly affected joint is the incudostapedial joint and more often with longitudinal fracture. However it is important to note that dislocation can occur with or without a temporal bone fracture⁷. Other injuries seen include incudomalleolar dislocation, stapediovestibular subluxation, luxation of the incus and incudomalleolar subluxation.

Following trauma, primary investigations are usually performed to rule out a more significant head injury. A CT head will normally be performed, and if a temporal bone fracture is present, it is important to note whether it is otic capsule-sparing or otic capsule-violating, as this is the most reliable predictor of underlying injuries to the middle and inner ear. An audiogram should be obtained as soon as possible to allow for a baseline measurement of hearing loss once the patient is stable. Any conductive hearing loss could be related to either ossicular disruption or hemotympanum, and it is challenging to differentiate between them at this point. Therefore, a repeat audiogram should then be performed at least 6 weeks following the injury by which time any hemotympanum should have resolved. Persistent conductive hearing loss or hearing loss greater than 25dB and an air bone gap present on audiometry of more than 40dB should raise suspicion of ossicular chain discontinuity. If there is a stapes dislocation, mixed hearing loss may be present with or without vertigo. For those with residual conductive hearing loss at 6 weeks post-injury, the likely cause is ossicular chain dislocation. Tympanometry may show increased compliance, suggesting discontinuity of the ossicular chain.

Middle ear exploration would then be performed under anaesthesia to identify the disrupted ossicular chain and perform ossiculoplasty. The presence of normal or minimally hypertrophied middle ear mucosa, patent eustachian tube orifice and mobile stapes footplate are prerequisites for ossiculoplasty. The materials used in ossiculoplasty can be autografts or homografts or of synthetic materials. The most commonly used autograft material has been the incus body, which is often reshaped to fit between the manubrium of the malleus and the stapes capitulum.

Cartilage ossiculoplasty is suited for atelectatic retraction problems; with no fear of extrusion. Autografts have several disadvantages, including lack of availability in chronically diseased ears, prolonged operative time to obtain and shape the material, resorption and/or loss of rigidity (especially with cartilage), and possible fixation to the walls of the middle ear. The presence of perichondrium with the graft helps to maintain nutrition, stiffness and the ossicular defects, with commendable hearing results. Because of the disadvantages of autograft materials and the potential risk of infection from homograft implants, alloplastic materials are the most commonly used materials for ossicular reconstruction. The synthetic prosthesis fulfilling criteria of biocompatibility gives most advantageous hearing results. Alloplastic materials includes metals

(titanium and gold), plastics (Plastipore, Proplast, Polyethylenes, Polytetrafluoroethylene, or Teflon) and biomaterials (Ceramics and Hydroxyapatite)^{7,8}.

Ossiculoplasty results in hearing improvement in the majority of patients. Following surgery, an average closure of the air-bone gap of 35dB (range 8-60dB) has been reported. Over 70% of patients will have an air-bone gap of less than 20dB, and over 30% of patients will have an air-bone gap of less than 10dB⁹⁻¹¹.

Facial nerve injury is often due to fracture of the temporal bone with resultant compression of the nerve or complete transection. In cases where the nerve injury is incomplete or delayed, prognosis is excellent. When the facial nerve is completely transected, prompt surgical intervention is required for the best cosmetic outcome.

Electrodiagnostic testing, primarily electroneuronography (ENoG) as Fisch popularized, is the most accurate qualitative measurement¹². A favorable prognosis is noted in patients with degeneration of less than 90% within 6 days or less than 95% within 14 days after their injury. Topognostic tests are used to localize the injury site. High Resolution Computed Tomography (HRCT) 1mm thin cuts of temporal bone is a useful diagnostic tool for traumatic facial nerve palsy, as it can visualize the fracture line and its relationship to the Fallopian canal¹³. Magnetic resonance imaging with contrast can reveal inflammatory facial nerve lesions and traumatic nerve injury. Enhancement of the distal intrameatal and labyrinthine segments is specific for facial nerve palsy¹⁴. Patients with total or immediate paralysis as well as those with poor prognostic audiometry results are good candidates for surgical repair while those with delayed onset facial weakness or incomplete facial weakness, conservative management with steroids and vasodilators is recommended. A typical course of high-dose prednisone is 1 mg/kg body weight for up to 10 days followed by a tapering dose regimen. Hematoma and impingement injuries are examples of what would result in a delayed manifestation. In cases of non-recovery or within six months after trauma late surgery may be recommended¹³. The surgical approach depends on the site of the injury to the nerve and hearing status. However, denervated muscle fibers architecture and end plate integrity can be maintained for up to 1 year and after 2 years, irreversible muscle fibrosis occur leading to permanent loss of functional muscle tissue^{15,16}. Sensory function can be recovered even after muscle function is lost because sensory end organs such as Paccinian corpuscles and Merkel cells can last up to 2-3 years¹⁷.

CONCLUSION

Temporal bone trauma can be overlooked in majority of multi trauma patients. High index of suspicion would ensure early diagnosis, prompt management and hence decreased morbidity or mortality. Ossiculoplasty results in hearing improvement in the majority of patients. The case by case selective approach in selection of ossiculoplasty technique would seem logical and optimum since there are varieties of ossiculoplasty techniques that exist. Outcome depends on the experience of the surgeon, graft material availability and instrumentation.

REFERENCES

1. WHO factsheet on road traffic accidents reviewed in February 2020. <https://www.who.int/news-room/fact-sheets/detail/road-traffic-injuries>. Accessed 26th November, 2020.
2. House JW, Brackmann DE. Facial nerve grading system. *Otolaryngol Head Neck Surg.* 1985; **93**(2):146-147.
3. Diaz RC, Cervenka B, Brodie HA. Treatment of temporal bone fractures. *J Neurol Surg Skull Base.* 2016; **77**(5):419-429.
4. Ulrich K. *Acta Otolaryngol.* 1926; **6**(Suppl):1-150.
5. Kelly KE, Tami TA. Temporal bone and skull base trauma. In: Jackler RK, Brackmann DE, eds. *Neurology*. St. Louis: Mosby year book 1994:1127-1155.
6. Merchant SN, Ravicz ME, Puria S, *et al.* Analysis of middle ear mechanics and application to diseased and reconstructed ears. *Am J Otol.* 1997; **18**(2):139-154.
7. Martin AD, Harner SG, Stephen G. Ossicular reconstruction with titanium prosthesis. *Laryngoscope.* 2004; **114**:61-64.
8. Iurato S, *et al.* Hearing results of ossiculoplasty in Austin-Kartush group A patients. *Otol Neurotol.* 2001; **22**:140-144.
9. Delrue S, Verhaert N, *et al.* Surgical management and hearing outcome of traumatic ossicular injuries. *J Int Adv Otol.* 2016; **12**(3):231-236.
10. Yetiser S, Hidir Y, *et al.* Traumatic ossicular dislocations: etiology and management. *Am J Otolaryngol.* 2008; **29**(1):31-36.
11. Basson OJ, van Lierop AC. Conductive hearing loss after head trauma: review of ossicular pathology, management and outcomes. *J Laryngol Otol.* 2009; **123**(2):177-181.
12. Fisch U. Diagnostic studies on idiopathic facial palsy. In: Shambaugh GI, Shea JJ, eds. *Proceedings of the Fifth International Workshop on Middle Ear Microsurgery and Fluctuant hearing Loss*. Huntsville, Ala: Strode, 1974: 219-224.

13. Darrouzet V, Duclos JY, *et al.* Management of facial paralysis resulting from temporal bone fractures: our experience in 115 cases. *Otolaryngol Head Neck Surg.* 2001; **125**:77–84.
14. Kinoshita T, Ishii K, *et al.* Facial nerve palsy: Evaluation by contrast-enhanced MR imaging. *Clin Radiol.* 2001; **56**:926–932.
15. Dahlin LB. Nerve injury and repair: from molecule to man. In: Slutsky DJ, Hentz VR, editors. *Peripheral nerve surgery: practical applications in the upper extremity.* Churchill Livingstone, Elsevier; Philadelphia: 2006. pp. 1–22.
16. Noaman HH, Shiha AE, Bahm J. Oberlin's ulnar nerve transfer to the biceps motor nerve in obstetric brachial plexus palsy: Indications, and good and bad results. *Microsurgery.* 2004; **24**(3):182–187.
17. Tsao B, Boulis N, Bethoux F, *et al.* Bradley's Neurology in Clinical Practice. 6th ed. 2012. Trauma of the Nervous System, Peripheral Nerve Trauma. pp. 984–1001.