Case Report

Pediatric otosyphilis—An unusual cause of conductive hearing loss

Zoya Arain, MBBS[a,*], Yasmin Abbas, MBChB MRCS(ENT)[b], Ashok Adams, MRCP FRCR[b]

[a] Darent Valley Hospital, Darenth Wood Rd, Dartford DA2 8DA, UK
[b] Barts Health NHS Trust, The Royal London Hospital, Whitechapel Rd, Whitechapel E1 1BB, UK

ABSTRACT

We present the case of a 5 year old female with a unilateral conductive hearing loss which had a relapsing and remitting course over a 3 year period. An initial noncontrast CT temporal bone study was unremarkable and a diagnosis of otitis media was made in the first instance. However, a second CT temporal bone study performed 3 years later demonstrated bilateral demineralisation of the ossicles and abnormal lucency affecting both the otic capsules. A diagnosis of otosyphilis was proposed on the basis of the imaging features and a prior medical history of previously treated congenital syphilis. With the benefit of hindsight, early pericochlear lucency was identified on the initial CT temporal bone study. There has been a steady rise of syphilis cases since the millennium with resurgence in many high income countries. Otosyphilis has a highly variable clinical presentation and there is limited data to establish the pattern of hearing loss in pediatric patients with a background of congenital otosyphilis. Temporal bone and otic capsule demineralisation carries a broad differential diagnosis including osteogenesis imperfecta, otosclerosis, Paget's disease and radiation related changes. Otosyphilis is a rare but potentially treatable cause of deafness and a high index of suspicion is required to make the diagnosis. In conjunction with a positive syphilis serology, a noncontrast temporal bone CT can aid the diagnosis and expedite the treatment.

Introduction

The WHO have estimated that there are 11 million new syphilis cases per year globally in adults aged 15-49 yrs. [1]. The 2 routes of transmission are through sexual contact or transplacental vertical transmission during pregnancy. The rate of primary and secondary syphilis has increased steadily since the millennium [2], and presents a significant health problem in low income countries. There has been resurgence in high income countries, particularly affecting certain at risk groups such as MSMs [2,3]. The growing number of infected women of reproductive age has led to resurgence of congenital syphilis cases; with many high-risk women not being identified and treated during pregnancy [4].

Table 1 – The stages of syphilis infection.	
Primary	A painless chancre develops at the site of inoculation following a 2-6 week incubation period [9]. The affected sites are usually the anal, genital or oral mucosa, this is frequently accompanied by local lymphadenopathy. After several weeks, there is spontaneous healing of the chancre due to macrophage directed phagocytosis of the treponemes [9,10]. However, some of the treponemes escape and systemically disseminate to multiple organs, which results in the development of chronic disease.
Secondary	This stage follows the multiplication of the disseminated treponemes. This can occur at the same time as, or 6 months following, the appearance of the chancre. It is characterized by systemic symptoms such as headache, malaise, pyrexia, condylomata lata, and a generalized rash affecting the palms or soles [11]. This stage can last between several weeks and months.
Latent	Bacteria is present in body but without associated signs or symptoms.
Tertiary	Can occur years to decades after the primary infection. This stage is rare today due to early treatment with curative antibiotics [9,12]. The treponemes can invade any organ system or tissue [11] and provoke inflammation due to a delayed hypersensitivity response. This can result in cardiovascular syphilis, neurosyphilis or gummatous syphilis. The latter is characterised by the formation of granulomatous lesions (gumma) which are detected predominantly within the skin and bone [11].

Syphilis infection is characterized by active infection, interspersed with periods of latency. Left untreated, syphilis can progress through 4 disease stages, which are outlined in Table 1.

Both acquired and congenital syphilis are known to cause cochleovestibular dysfunction [5]. Sensorineural hearing loss is frequently described in secondary and tertiary syphilis [6,7].

Otosyphilis has a variable clinical presentation and a high index of suspicion is required to make the diagnosis. The Centre for Disease Control recommends a treatment regimen of IV penicillin in order to prevent further disease progression and the development of complications as a result of multisystemic involvement [8].

Late adult presentation of hearing loss, decades after the primary syphilis infection has been documented, however pediatric cases are rare. We report a case of a 5-year-old female with an unusual presentation of unilateral conductive hearing loss, which had a relapsing and remitting presentation over several years. The diagnosis of otosyphilis was proposed by radiological findings on a noncontrast temporal bone CT.

Case report

A 5-year-old female presented with left sided otalgia and hearing loss which was referred for further investigation. Her past medical history included premature birth at 31 weeks, congenitally acquired syphilis and recurrent episodes of tonsillitis. Her right-sided hearing was unremarkable, however she had a mild conductive hearing loss on her left. On otoscopy, retraction of the left tympanic membrane was observed with a cyst visualised in the posterior half. A temporal bone CT was requested to assess for middle ear disease and reported as normal.

At follow up 3 months later, the left sided hearing loss was persistent. The tympanic membrane retraction had further worsened however there was no clinical evidence of a cholesteatoma. Grade III tonsils were noted and anterior rhinoscopy demonstrated good airflow bilaterally. A mild left sided conductive hearing loss down to 30 dB was identified on

pure tone audiogram, with a flat tympanogram (suggestive of a middle ear effusion). The contralateral ear was unaffected.

After 6 months the patient reported the onset of left sided tinnitus. The retraction of her tympanic membrane was stable and hearing tests demonstrated normal low and mid frequencies on the left with a slight dip at 8 kHz. However, the hearing in her left ear deteriorated further over the following 6 months and the patient presented with bilateral suppurative otitis media and flat tympanograms. She was consequently listed for grommet insertion. However, at her 6 month follow up appointment, the otitis media had completely resolved and hearing assessment was normal. On examination the left sided tympanic membrane retraction persisted. The patient underwent a second CT temporal bone study that demonstrated gross abnormality of the petrous temporal bone structures bilaterally with widespread lucency of the bony labyrinth surrounding the cochlea, vestibule, and semicircular canals (Fig. 2). With the benefit of hindsight, pericochlear lucency could also be identified on the CT acquired 3 years previously (Fig. 1). Marked demineralisation of the ossicular chains was noted bilaterally. The imaging appearances were pathognomic for otosyphilis and this was further supported by the history of congenital syphilis infection. Osteogenesis imperfecta was suggested as a potential differential diagnosis based on the radiological features although there were no clinical features to support this.

Discussion

There has been a resurgence of syphilis in several high income countries including North America, China, Australia, and Western Europe [11].

Infection by the parasite Treponema pallidum occurs through sexual contact or by transplacental vertical transmission during pregnancy. Treatment outcomes for syphilitic hearing loss are variable and there is little robust evidence for optimal management given the absence of randomised control trials in this patient group. The Centre for Disease Control recommends a 2 week regimen of IV penicillin for cases of neurosyphilis [8]. The intravenous route is thought
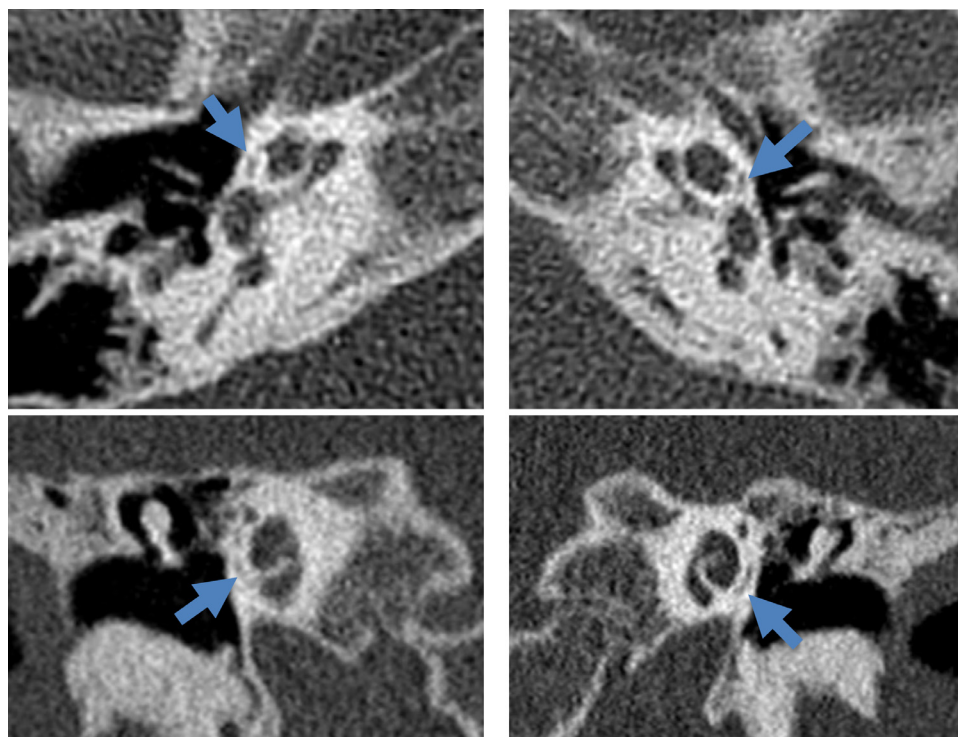
Fig. 1 – Axial and coronal reformats from a temporal bone CT study performed 3 years earlier. There is subtle pericochlear lucency noted bilaterally (blue arrows) (Color version of figure is available online.)

to be more effective in reaching treponemocidal levels in the cerebrospinal fluid (CSF) [13–16]. Several studies have additionally supplemented this with a corticosteroid for otosyphilis [16,17]. Bradshaw et al. undertook a small retrospective study using 7 confirmed adult otosyphilis cases. There was a subjective hearing improvement in 67% of those receiving treatment 1 month after the onset of hearing loss [18]. Gleich et al. conducted a prospective cohort study involving 18 adult patients with cochleovestibular dysfunction and positive syphilis serology, treated with the IV antibiotics and steroids. The median age was 53 and symptoms were present between 2 weeks and 20 years. 31% achieved an improved speech recognition threshold by 15 dB [5]. It was found that patients with hearing loss greater than 5 years did not respond [5] and generally a younger age was associated with a better prognosis [5]. However there is a paucity of data evaluating treatment outcomes in pediatric patients specifically.

A systematic review by Chau et al. identified a lack of longitudinal audiometric follow-up data for patients previously either fully or partially treated for congenital syphilitic infection [19]. Only one study reported audiological data for a cohort of infants with a serologically confirmed diagnosis of congenital syphilis [20]. Although none of the 75 neonates had evidence of hearing impairment at birth, no audiological follow up was performed to assess the delayed onset of hearing loss in children treated for congenital syphilis.

Hearing loss secondary to congenital syphilis is typically sensorineural and bilateral in nature and can present suddenly [21]. The current case was atypical in that the patient had presented with conductive hearing loss with a fluctuating and variable course over several years.

The most common cause of conductive hearing loss in the pediatric population is otitis media, and our patient developed this which acted as a complicating factor.

Salomone et al. discuss a case of delayed diagnosis of juvenile otosclerosis after the conductive hearing loss in a young child was found to be refractory to grommet insertion [22].

In the present case, the diagnosis of otosyphilis was proposed by the radiological findings of the temporal bone CT. The patient was otherwise systemically asymptomatic without other stigmata of a syphilis infection. The clinical and audiological findings were nonspecific. Interestingly, bilateral radiological findings were demonstrated despite generally unilateral symptoms and puretone audiogram abnormalities; the reason for this is unclear. Kivekas et al. (2014) describe a case of a 75-year-old female who developed a bilateral sensorineural hearing loss. A temporal bone CT study demonstrated bilateral demineralisation of the otic capsules without associated ossicular chain involvement [23]. The development of conductive hearing loss, as seen in our case, is considered secondary to the development of osteitic lesions of the ossicles which results in fixation of the incus or malleus to the lateral wall of the atic [21,24–26].

Histopathological changes within the temporal bones are identical for congenital and acquired syphilis [21,27]. In milder cases, connective tissue infiltration is observed which leads to an inflammatory fibrosis [27].However, in more severe cases, an obliterative endarteritis and mononuclear infiltration
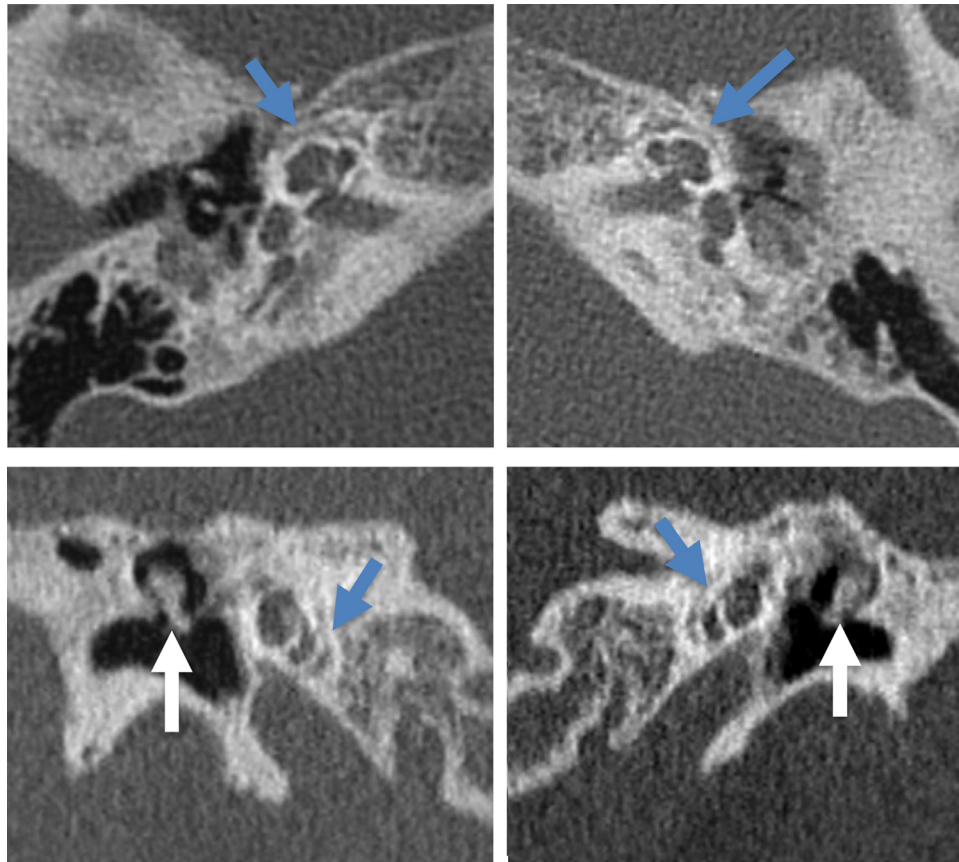
Fig. 2 – Axial and coronal reformats from a temporal bone CT that demonstrate abnormal and widespread pericochlear lucency affecting the otic capsule bilaterally (blue arrows). There is marked demineralisation of the ossicular chains that was not evident on the prior CT study (white arrows on the current study and compare to Fig. 1) (Color version of figure is available online.)

compromises the blood supply and leads to tissue necrosis [27]. Mayer and Fraser identified foreign giant cells within tissue samples which were associated with regions of bone resorption [25]. The bony resorption in the otic capsule was especially pronounced around the semicircular canals [25]. Cochlear hydrops has been identified within the membraneous labyrinth, however the mechanism for this is contentious [28].

The radiographic findings reflect the underlying histopathological process with an irregular permeative lucency within the otic capsule resulting from demineralisation that extends to the margin of the membranous labyrinth. This 'moth eaten' appearance is pathognomic for otosyphilis. [29]. The same process can extend to involve the ossicular chain resulting in lucencies within the malleus and incus [29]. The differential diagnosis for the radiological findings of bilateral otic capsule demineralisation includes osteogenesis imperfecta, otosclerosis, and Paget's disease [30]. Radiation related change is another increasingly recognised cause of temporal bone demineralisation [31].

Osteogenesis imperfecta is a genetic disorder of collagen synthesis. The clinical phenotype includes blue sclera, abnormal dentition and ligamentous laxity in addition to hearing loss [32]. The imaging findings are similar to those of otosyphilis [30] and otosclerosis [33] but are often more exten-

sive. There is proliferation of thickened demineralised bone surrounding the otic capsule [32] with extension into the labyrinth [32]. There may be an associated conductive hearing loss component due to fixation of the stapes footplate or atrophic changes to the long process of the incus [32].

Otosclerosis or otospongiosis is a disorder with a complex genetic and environmental aetiology that results in the abnormal bone remodelling, resorption, new bone deposition and vascular proliferation [34]. Symptoms commonly affect patients in their 20s-40s. There is female gender predominance and most cases are bilateral [35].

The 2 main subtypes are fenestral and cochlear. With fenestral disease, the fisula ante fenestram is the region most commonly involved. This is an important differentiator from otosyphilis which spares the fisula ante fenestram [36]. The pathology may also extend to involve the otic capsule, round window niche and footplate of the stapes [34] which frequently results in progressive conductive hearing loss. The early stages of the disease are characterized by demineralisation anteromedial to the oval window which reflects underlying spongiotic bone resorption. Eventually this can progress to proliferation of demineralised bone which results in narrowing of the oval window, fixation of the stapes footplate and possible obliteration of the round window niche [33]. The ossicular chain can be involved with the formation of a web of

bone between the incus or malleus and the wall of the atic [37].

Cochlear otosclerosis is less common than, but will always co-exist with the fenestral subtype [35].

It is characterised by demineralised spongiotic vascular bone around the coclear capsule which can additionally extend to surround the vestibule, semicircular canals and internal auditory canal.

On CT, this corresponds to a 'double ring' of demineralisation around the cochlear [35], in addition to findings of fenestral otosclerosis.

Paget's disease is characterised by excessive bone turnover due to osteoclastic resorption followed by osteoclastic repair [38]. Normal bone is replaced by abnormal lamellar bone which is soft and porous, deforming under stress and therefore susceptible to fracture. When the temporal bone is involved, the most common symptom is bilateral sensorineural hearing loss, and possibly also tinnitus and headache [38]. Conductive hearing loss component may also be present due to fixation of the stapes footplate [38]. During the early stage of the disease, well-defined lytic lesions are demonstrated in the skull. Demineralisation begins at the petrous apices of the temporal bones (due to greater marrow deposition) which progresses inferiorly and laterally [38]. Bony resorption starts at the peripheral aspect of the otic capsule and extends centrally [38]. The intermediate and later stages of Paget's disease involve bony sclerosis and expansion, and are therefore more readily distinguishable from otosyphilis.

The temporal bone is frequently included within the radiation field during the treatment of head and neck cancer. Clinical symptoms can present 3 months to 40 years from the date of the initial treatment [31]. The pathophysiology involves an oblierative endarteritis and periarteritis which causes avascular necrosis [39]. Histologically, there is death of osteocytes, increased osteolysis and fibrosis in the region of the dead bone with loss of marrow [40]. On CT, mild cases of osteoradionecrosis involve bony erosion around the external auditory canal and mastoid opacification [31].

Summary

Syphilis is a rare but increasingly prevalent cause of hearing loss. Otosyphilis has a highly variable clinical presentation with limited available long term data to establish the pattern of hearing loss in pediatric patients with a background of congenital otosyphilis. In conjunction with positive serology, non-contrast temporal bone CT imaging can aid diagnosis and expedite treatment.

REFERENCES

[1] Schmid G, Samuelson J, Rowley JT. Prevalence and incidence of selected sexually transmitted infections. Geneva, Switzerland: World Health Organization; 2011.

[2] Patton ME, Su JR, Nelson R, Weinstock H. Primary and secondary syphilis—United States, 2005–2013. Morb Mortal Wkly Rep. 2014;63(18):402.

[3] European Centre for Disease Prevention and Control. Annual epidemiological report 2014 - sexually transmitted infections, including HIV and blood-borne viruses. Stockholm: ECDC; 2015. https://www.ecdc.europa.eu/en/publications-data/sexually-transmitted-infections-including-hiv-and-blood-borne-viruses-annual#no-link.

[4] Simms I, Broutet N. Congenital syphilis re-emerging. J der Deutschen Dermatologischen Gesellschaft 2008;6(4):269–72.

[5] Gleich LL, Linstrom CJ, Kimmelman CP. Otosyphilis: a diagnostic and therapeutic dilemma. Laryngoscope 1992;102(11):1255–9.

[6] Dobbin JM, Perkins JH. Otosyphilis and hearing loss: response to penicillin and steroid therapy. Laryngoscope 1983;93(12):1540–3.

[7] Hughes GB, Rutherford I. Predictive value of serologic tests for syphilis in otology. Ann Otolo Rhinol Laryngol 1986;95(3):250–9.

[8] Workowski KA, Bolan GA. Sexually transmitted diseases treatment guidelines, 2015. MMWR. Recommendations and reports: Morbidity and mortality weekly report. Recomm Rep 2015;64(RR-03):1.

[9] LaFond RE, Lukehart SA. Biological basis for syphilis. Clin Microbiol Rev 2006;19(1):29–49.

[10] Ho EL, Lukehart SA. Syphilis: using modern approaches to understand an old disease. J Clin Invest 2011;121(12):4584–92.

[11] Stamm LV. Syphilis: re-emergence of an old foe. Microb Cell 2016;3(9):363.

[12] Stamm LV. Syphilis: antibiotic treatment and resistance. Epidemiol Infect 2015;143(8):1567–74.

[13] Yoder FW. Penicillin treatment of neurosyphilis: are recommended dosages sufficient? JAMA 1975;232(3):270–1.

[14] Mohr JA, Griffiths W, Jackson R, Saadah H, Bird P, Riddle J. Neurosyphilis and penicillin levels in cerebrospinal fluid. JAMA 1976;236(19):2208–9.

[15] Dunlop EM, Al-Egaily SS, Houang ET. Penicillin levels in blood and CSF achieved by treatment of syphilis. JAMA 1979;241(23):2538–40.

[16] Hendershot EL. Luetic deafness. Laryngoscope 1973;83(6):865–70.

[17] Wong RT, Lepore ML, Burch GR, Henderson RL. Luetic hearing loss. Laryngoscope 1977;87(10):1765–9.

[18] Bradshaw D, Pallawela S, Nelson M, Scott C, Day S. Otosyphilis: missed opportunities for early treatment? Sex Transm Infect 2012;88(8):573.

[19] Chau J, Atashband S, Chang E, Westerberg BD, Kozak FK. A systematic review of pediatric sensorineural hearing loss in congenital syphilis. Int J Pediatr Otorhinolaryngol 2009;73(6):787–92.

[20] Gleich LL, Urbina M, Pincus RL. Asymptomatic congenital syphilis and auditory brainstem response. Int J Pediatr Otorhinolaryngol 1994;30(1):11–13.

[21] Darmstadt GL, Harris JP. Luetic hearing loss: clinical presentation, diagnosis, and treatment. Am J Otolaryngol 1989;10(6):410–21.

[22] Salomone R, Riskalla PE, de Oliveira Vicente A, Boccalini MC, Chaves AG, Lopes R, et al. Pediatric otosclerosis: case report and literature review. Braz J otorhinolaryngol 2008;74(2):303–6.

[23] Kivekäs I, Vasama JP, Hakomäki J. Bilateral temporal bone otosyphilis. Otol Neurotol 2014;35(2):e90–1.

[24] Becker GD. Late syphilitic hearing loss: a diagnostic and therapeutic dilemma. Laryngoscope 1979;89(8):1273–88.

[25] Mayer O, Fraser JS. Pathological changes in the ear in late congenital syphilis. J Laryngol Otol 1936;51(11):683–714.

[26] Belal A Jr, Linthicum FH Jr. Pathology of congenital syphilitic labyrinthitis. Am J Otolaryngol 1980;1(2):109–18.

[27] Karmody CS, Schuknecht HF. Deafness in congenital syphilis. Arch Otolaryngol 1966;83(1):18–27.

[28] Miller ME, Makary C, Lopez IA, Ishiyama A. Endolymphatic hydrops in otologic syphilis: a temporal bone study. Otol Neurotol 2010;31(4):681–6.

[29] Swartz JD, Harnsberger HR. Imaging of the temporal bone. The otic capsule and otodystrophies. Swartz JD, Harnsberger HR, editors. 3rd ed.. New York: Thieme; 1997.

[30] Sonne JE, Zeifer B, Linstrom C. Manifestations of otosyphilis as visualized with computed tomography. Otol Neurotol 2002;23(5):806–7.

[31] Ahmed S, Gupta N, Hamilton JD, Garden AS, Gidley PW, Ginsberg LE. CT findings in temporal bone osteoradionecrosis. J Comput Assist Tomogr 2014;38(5):662.

[32] Alkadhi H, Rissmann D, Kollias SS. Osteogenesis imperfecta of the temporal bone: CT and MR imaging in Van der Hoeve-de Kleyn syndrome. Am J Neuroradiol 2004;25(6):1106–9.

[33] Andreu-Arasa VC, Sung EK, Fujita A, Saito N, Sakai O. Otosclerosis and dysplasias of the temporal bone. Neuroimaging Clin 2019;29(1):29–47.

[34] Quesnel AM, Ishai R, McKenna MJ. Otosclerosis: temporal bone pathology. Otolaryngol Clin North Am 2018;51(2):291–303.

[35] Purohit B, Hermans R. Imaging in otosclerosis: a pictorial review. Insights Imaging 2014;5(2):245–52.

[36] Ogungbemi A, Dudau C, Morley S, Beale T. Computed tomography features of luetic osteitis (otosyphilis) of the temporal bone. J Laryngol Otol 2014;128(2):185–8.

[37] Sakai O, Curtin HD, Hasso AN, Swartz JD. Otosclerosis and dysplasias of the temporal bone. 4th ed. Head and neck imaging, 1256. St. Louis: Mosby; 2003. p. 1339.

[38] Hullar TE, Lustig LR. Paget's disease and fibrous dysplasia. Otolaryngol Clin North Am 2003;36(4):707–32.

[39] Eiving J. Radiation osteitis. Acta Radiol 1926;6(1–6):399–412.

[40] Schuknecht HF, Karmody CS. Radionecrosis of the temporal bone. Laryngoscope 1966;76(8):1416–28.