FEATURED GRAND ROUNDS

PHILIPPINE JOURNAL OF OTOLARYNGOLOGY-HEAD AND NECK SURGERY VOL. 37 NO. 2 JULY – DECEMBER 2022

Hearing Loss from *S. Suis* Meningitis In A Middle-Aged Couple

Norberto V. Martinez, MD
Michiko S. Hosojima, MD

Department of Otorhinolaryngology
Head and Neck Surgery
St. Luke's Medical Center

Keywords: *streptococcus suis; meningitis; hearing loss*

Streptococcus suis is a bacterial pathogen causing a wide range of infections including meningitis, lung infections, arthritis, sepsis and endocarditis.[1] Over the years, an increasing number of cases have been reported among humans especially in countries in Southeast Asia specifically in Vietnam and Thailand where pig-rearing is common.[2] One of the prominent symptoms of *S. suis* infection is hearing loss that may be present during the onset or a few days after.[1] We report two cases of adult *S. suis* meningitis presenting with bilateral hearing loss.

CASE REPORT

Our first patient was a 57-year-old man who presented with a one day history of generalized weakness initially unaccompanied by any other symptoms. The previous day, he was still able to walk but was generally weak, and preferred to stay in bed. That evening, he developed high grade fever (40ºC) that was temporarily relieved by paracetamol. There were two episodes of vomiting previously ingested food but no headache. By late evening, he was noted to have increased sleeping time, opening eyes spontaneously, responding mostly with yes or no, and following commands but drowsing back to sleep. On the day of admission, he could sustain spontaneous eye opening with no regard and groaned in response to questions without following commands. High grade fever persisted and he was rushed to the Emergency Room. On examination, he was febrile at 40.5ºC, hypertensive at 160/80mmHg, tachycardic at 109 with a Glasgow Coma Scale (GCS) of 9/15 (E4V1M6), and was given O2 support at 1LPM by nasal cannula. He presented with spontaneous eye opening, no regard and did not follow commands. He had meningeal signs- nuchal rigidity but no Kernig's sign. Cranial CT scans showed no acute territorial infarct or intracranial hemorrhage, and a stable chronic lacunar infarct versus prominent perivascular space in the left lentiform nucleus. A COVID rt-PCR test was negative. Complete blood count showed leukocyte count of 5,220/mm3 with 72% neutrophils and a platelet count of 57,800/mm3. Bleeding parameters showed prothrombin time of 14.4 seconds, INR of 1.23 and an elevated PTT of 45.3. He was started on Meropenem and Vancomycin and admitted to the Neurological Critical Care Unit while awaiting clearance for lumbar puncture (being on anti-coagulants).

Our second patient was his wife, a 51-year-old professional singer with no known co-morbidities who was also admitted due to fever and headache. At the time her husband was admitted, she had febrile episodes as high as 40ºC associated with pressure-like headache over both occipital

Correspondence: Dr. Norberto V. Martinez
Department of Otolaryngology- Head and Neck Surgery
St. Luke's Medical Center
Bonifacio Global City, Taguig 1634
Philippines
Phone: (+632) 8723 0101 local 5543
Email: nvmartinez@stlukes.com.ph

The authors declare that this represents original material. that the manuscript has been read and approved by all the authors, that the requirements for authorship have been met by each author, and that each author believes that the manuscript represents honest work.

Disclosures: The authors signed disclosures that there are no financial or other (including personal) relationships, intellectual passion, political or religious beliefs, and institutional affiliations that might lead to a conflict of interest. Reprints will not be available from the author

Presented at the Philippine Society of Otolaryngology - Head and Neck Surgery Virtual Interesting Case Contest. June 23, 2021.

areas (rated PS 7/10) as well as joint pain and nape pain. There were no associated cough, colds, dysuria, otalgia or otorrhea. Paracetamol afforded temporary relief but fever intermittently recurred the next day and she was admitted for further evaluation and management even though her COVID rt-PCR test was negative. On initial examination at the ER, she was still febrile at 38.5C. She was awake, coherent and oriented to 3 spheres. Complete blood count showed leukocytosis, while C Reactive Protein and Erythrocyte Sedimentation Rate were elevated. Magnetic Resonance Imaging (MRI) showed diffuse FLAIR hyperintensities along bilateral cerebral sulci and cerebellar interfoliar spaces with associated leptomeningeal enhancement. There was also enhancement along the ventral surface of the brain stem. A CNS infection was suspected and lumbar puncture was performed. Her CSF showed gram positive cocci in pairs and chains with a possible streptococcus infection, but no fungal elements or acid fast bacilli. Both CSF and blood culture and sensitivity specimens tested positive for *Streptococcus suis* sensitive to Penicillin. She and her husband were started on intravenous Penicillin.

Both patients had improvement in headache and nape pain over the next two days. However, they both reported persistent, progressive dizziness and bilateral hearing loss, and showed signs of vestibular dysfunction. The vestibular dysfunction was so severe that both patients were bed-bound and needed assistance in ambulating throughout their hospital stay. Their hearing was described as distorted, with a sensation of being underwater. Hearing tests revealed profound sensorineural hearing loss on the right and moderate sensorineural hearing loss on the left for the husband, and severe sensorineural hearing loss on the right and moderate sensorineural hearing loss on the left, downsloping at 6000 to 8000 Hz in both ears for the wife. Both patients were started on intravenous Dexamethasone, which they completed (together with Penicillin) over the course of 16 days. They were also given Betahistine tablets for dizziness, metoclopramide for nausea and Vitamin B complex. Repeat cranial MRI showed significant interval regression in the diffuse FLAIR hyperintensities and associated leptomeningeal enhancement along bilateral cerebral sulci and cerebellar interfoliar spaces. Repeat lumbar punctures showed no growth of any pathogen and resolution of *S. suis* infection. Serial hearing tests showed stable hearing loss for both patients.

After 2 months from the onset of infection, both patients continued to experience dizziness, vestibular dysfunction and hearing loss. Although both were now able to ambulate, they still needed assistance in daily activities including driving. They still could not tolerate sudden head movements; even nodding and turning the head from side-to-side elicited dizziness. The wife's singing was greatly affected as the right ear had persistent severe hearing loss. Sounds were perceived as distorted, described as 'scratches;' her right ear would hear higher frequencies, while the left ear heard lower frequencies. The perceived imbalance in frequencies posed a challenge to singing the right tune, but she continues to perform and sing professionally despite her hearing condition. She adapted through repetition, practicing until she achieved muscle memory in getting the right tone. They were offered several options for managing the residual symptoms including rehabilitation, hearing aids and early cochlear implantation.

It was subsequently determined that they both ate at a Korean barbecue restaurant days before the onset of symptoms. However, they ordered chicken barbeque and did not eat any pork dishes.

DISCUSSION

Streptococcus suis is a gram positive bacteria isolated from the upper respiratory tract, genitourinary tract and gastrointestinal tract of infected pigs.[1] Though primarily inoculated from the swine population, increased in human transmission and cases have been observed in Asian populations.[2] It is believed that the *S. suis* pathogen may be classified into 35 serotypes, with the type 2 (SS2) mainly implicated for the human *S. suis* infection.[1,2]

Huong *et al.* listed common risk factors for acquiring this infection, including occupational hazard (pig breeders), skin injury exposure, or ingestion of contaminated food.[3] Since both of our patients had no direct contact with pigs/livestock, what was the possible source of bacterial meningitis? A recent study by Nhung *et al.* discussed possible colonization of *S. suis* in poultry flocks, reporting approximately 34% prevalence of the pathogen in chickens.[4] This raises the possibility that poultry may have been one of the reservoirs in our patients' case, having had Korean chicken barbeque for dinner a few days before onset of symptoms. Boonyong *et al.* also mentioned the possibility of cross contamination during meat handling, meat cutting and further processing of different meat products in restaurants,[2] adding another possible explanation for our patients' contamination.

Given the possible exposure, how could the bacterial pathogen have caused the meningeal symptoms and hearing loss? Auger and Gottschalk in 2017 explained that the pathogen is believed to penetrate mucosal barriers eventually passing through the bloodstream which then leads to eventual dissemination to different organs and the blood brain barrier.[5] They further discussed that the H factor (one of its several virulence factors) has the ability to avoid "opsonophagocytosis" and in turn increases its binding to host cells.[5] The capability and virulence factor of the bacterium explains its clinical manifestations. As with other cases of bacterial central nervous system infection, our patients presented with fever, changes in sensorium, and meningeal symptoms. What is interesting in both cases is the presentation of severe dizziness

and hearing loss. In a span of 5 days, both our patients had persistent and progressive hearing loss in both ears. This corresponds to common clinical features which includes fever, meningitis, headache, dizziness, and hearing loss.[6] According to Wertheim *et al.*, symptoms typically occur within 2-5 days from initial exposure.[6] Moreover, Huh *et al.* said that around 2/3 of *S. suis* meningitis patients may present with hearing loss with a guarded prognosis for recovery.[1] Tan *et al.* indicated that the hearing loss is often bilateral, profound, sensorineural and likely permanent.[7] As seen in our cases, vestibular dysfunction also accompanies the hearing loss.

Because the *S. suis* pathogen is able to cross the bloodstream and blood brain barrier through its virulence factors,[5] infection through the blood brain barrier then enables the bacterium to also affect the cochlea. Huh *et al.* in 2011 explained that the bacterium crosses the cochlear aqueduct then migrates to the perilymph.[1] Tan *et al.* further explain that the presence of the pathogen in the perilymphatic spaces causes a cascading inflammatory response, in turn creating an osteoid matrix and fibrosis, which then eventually leads to labyrinthitis ossificans.[7]

Similar to other bacterial meningitis cases, timely diagnosis and early initiation of antibiotic therapy is recommended. Penicillin G was started immediately upon diagnosis through lumbar puncture and blood culture of both patients. The recommended dose for Penicillin G is 24 million units over 24 hours for at least 10 days[6] which both patients were able to complete during their hospital admission. We have mentioned that the bacterium causes an inflammatory response triggering the cascading effect leading to labyrinthitis ossificans. Over the years, there have been differing opinions regarding the role of corticosteroids in hearing loss management. Brouwer *et al.* concluded that the overall effect of corticosteroids in reducing hearing loss in adult bacterial meningitis patients is not as well established as in the pediatric population.[8] However, a more recent study by Rayanakorn *et al.* in 2018 supported the use of corticosteroids as an adjunct to antibiotic therapy, reducing complications and hearing loss.[9] Dexamethasone, compared to other corticosteroids, has a higher biological half-life, greater anti-inflammatory property, and lower molecular weight and high liposolubility.[10,11] Hence at the time of referral of our patients, adjunct use of Dexamethasone was started immediately along with serial monitoring of hearing level through audiometry. Over the course of two weeks, we saw improvement in the hearing thresholds of both patients. Imaging also showed significant regression of hyperintensities and leptomeningeal enhancement after treatment. Subjectively, both patients reported general improvement of hearing and tinnitus as well as dizziness. Vestibular rehabilitation was then recommended by the team to address the vertigo and gait instability caused by the infection. For the professional singer, a series of audiometric and vestibular function tests can monitor progress, and options for hearing devices such as hearing aids may be considered to amplify sounds and frequencies that are affected.[12] Newer hearing aids feature directional microphones, wind noise elimination and binaural coupling.[12] Early assessment may help in determining the role of cochlear implants, as infections spread to the inner ear structures rapidly and may occur within hours of the diagnosis of meningitis.[13]

Currently, no prophylactic treatment is available for *S. suis* pathogens. Avoidance of transmission is vital to the prevention of spread to public consumers. We recommend raising public awareness through campaigns and educating high risk populations (such as hog farm workers) in the use of personal protective equipment. Safety protocols for restaurants should also be established especially for handling different meat products to avoid cross-contamination.

REFERENCES

1. Huh HJ, Park K-J, Jang J-H, Lee M, Lee JH, Ahn YH, et al. Streptococcus suis meningitis with bilateral sensorineural hearing loss. *Korean J Lab Med.* 2011 Jul;31(3):205–11. DOI: 10.3343/kjlm.2011.31.3.205; PubMed PMID: 21779197; PubMed Central PMCID: PMC3129354.
2. Boonyong N, Kaewmongkol S, Khunbutsri D, Satchasataporn K, Meekhanon N. Contamination of Streptococcus suis in pork and edible pig organs in central Thailand. *Vet World.* 2019 Jan;12(1):165–169. DOI: 10.14202/vetworld.2019.165-169; PubMed PMID: 30936671; PubMed Central PMCID: PMC6431799.
3. Huong VTL, Ha N, Huy NT, Horby P, Nghia HDT, Thiem VD, et al. Epidemiology, clinical manifestations, and outcomes of Streptococcus suis infection in humans. *Emerg Infect Dis.* 2014 Jul;20(7):1105–14. DOI: 10.3201/eid2007.131594; PubMed PMID: 24959701; PubMed Central PMCID: PMC4073838.
4. Nhung NT, Yen NTP, Cuong N, Kiet BT, Hien VB, Campbell J, et al. Carriage of the zoonotic organism Streptococcus suis in chicken flocks in Vietnam. *Zoonoses Public Health.* 2020 Dec; 67(8):843–8. DOI: 10.1111/zph.12711; PubMed PMID: 32342661.
5. Auger JP, Gottschalk M. The Streptococcus suis factor H-binding protein: A key to unlocking the blood-brain barrier and access the central nervous system? *Virulence.* 2017 Oct 3;8(7):1081-1084. DOI: 10.1080/21505594.2017.1342027; PubMed PMID: 28622084; PubMed Central PMCID: PMC5711356.
6. Wertheim HFL, Nghia HDT, Taylor W, Schultsz C. *Streptococcus suis:* an emerging human pathogen, *Clin Infect Dis*. 2009 Mar 1;48(5):617–25. DOI: 10.1086/596763; PubMed PMID: 19191650.
7. Tan JH, Yeh BI, Seet CSR. Deafness due to haemorrhagic labyrinthitis and a review of relapses in Streptococcus suis meningitis. *Singapore Med J.* 2010 Feb;51(2):e30-3. PubMed PMID: 20358139
8. Brouwer MC, McIntyre P, Prasad K, van de Beek D. Corticosteroids for acute bacterial meningitis. *Cochrane Database Syst Rev*. 2015 Sep 12;2015(9):CD004405. DOI: 10.1002/14651858.CD004405.pub5; PubMed PMID: 26362566; PubMed Central PMCID: PMC6491272.
9. Rayanakorn A, Katip W, Goh BH, Oberdorfer P, Lee LH. A risk scoring system for predicting Streptococcus suis hearing loss: A 13-year retrospective cohort study. *PLoS One*. 2020 Feb 4;15(2):e0228488; DOI: 10.1371/journal.pone.0228488. PubMed PMID: 32017787; PubMed Central PMCID: PMC6999904.
10. Leung MA, Flaherty A, Zhang JA, Hara J, Barber W, Burgess L. Sudden sensorineural hearing loss: primary care update. *Hawaii J Med Public Health*. 2016 Jun; 75(6):172-4. PubMed PMID: 27413627; PubMed Central PMCID: PMC4928516.
11. Chandrasekhar SS, Rubinstein RY, Kwartler JA, Gatz M, Connelly PE, Huang E, et al. Dexamethasone pharmacokinetics in the inner ear: comparison of route of administration and use of facilitating agents. *Otolaryngol Head Neck Surg.* 2000 Apr;122(4):521-8. DOI: 10.1067/mhn.2000.102578; PubMed PMID: 10740171.
12. Hoppe U, Hesse G. Hearing aids: indications, technology, adaptation, and quality control. *GMS Curr Top Otorhinolaryngol Head Neck Surg*. 2017 Dec 18;16: Doc08. DOI: 10.3205/cto000147; PubMed PMID: 29279726; PubMed Central PMCID: PMC5738937.
13. Orzan E, Muzzi E, Caregnato I, Cossu P, Marchi R, Ghiselli S. Uncommon post-meningitis hearing threshold improvement: a case report. *J Int Adv Otol*. 2018 Dec;14(3): 484-487. DOI: 10.5152/iao.2018.4993; PubMed PMID: 30411708; PubMed Central PMCID: PMC6354543.