

BÖLÜM 21

VESTİBÜLER SCHWANNOM YAKLAŞIM

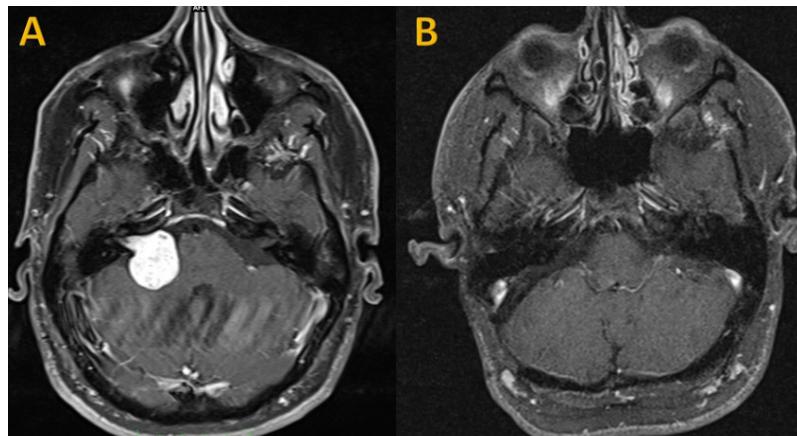


Ahmet Mahmut TEKİN¹

GİRİŞ

Vestibüler schwannomalar (VS) yaklaşık 100.000'de 1 görülerek (1), tüm intrakranial tümörlerin %6-8'ini, serebellopontin köşe (SPK) tümörlerinin ise %80'nini oluşturmaktadır. SPK tümörlerinin en sık rastlanılanı olan VS'lar, vestibülokoklear sinirin schwann hücrelerinden türetilen iyi huylu tümörler olup internal akustik kanal (İAK) içinde kalır veya SPK'ye doğru uzanım gösterirler. Semptomları daha çok posterior fossa yapıları, beyin sapı ve bitişik kraniyal sinirlere bası sonucu ortaya çıkmaktadır (2). Tümör boyutunu İAK dışına yayılım ve beyin sapı kompresyonuna göre sınıflandırmak için yaygın olarak Koos evrelemesi kullanılmaktadır (3). Daha çok tek taraflı ve sporadik olup yaşamın 4. ve 6. dekadalarda arasında görülen VS'lar (4), çift taraflı olduğu zaman Nörofibromatozis tip 2 (NF2) ile ilişkilendirilir (5). Bu tümörlerin saptanması, karekterizasyonun belirlenmesi ve yönetiminde görüntüleme yöntemleri anahtar rol oynamaktadır (6). VS'ların mevcut tedavi seçenekleri arasında cerrahi rezeksiyon, stereotaktik radyocerrahi ve takip yer almaktadır (2). Biyolojik tedaviler umut verici olmakta ve gelecek bilimsel araştırmaları farmakolojik tedavi yöntemlerine yöneltmektedir (7).

¹ Op. Dr., Klinikum Bad Salzungen, Almanya, drtekinahmet@gmail.com



Şekil 4. Sağ SPK'de 3 cm'lik VS'un post-op 3. yilda kontrol MRG'si

Primer cerrahi riskler, tümör boyutu ile doğru orantılı olup çoğu zaman postoperatif işitme ve fasiyal sinir fonksiyonu ile ilgilidir (90,94). Küçük tümörlü (<1.5 cm çapında) hastalarda işitme %40 ila %70 arasında korunurken, kalıcı fasiyal parезi %10'dan daha az görülmektedir (69,94). Büyük tümörlerde (>2,5 cm çapında) ise ameliyat sonrası işitmeyi koruma olasılığı %5'ten az olup kalıcı kısmi veya tam fasiyal sinir felci riski total rezeksiyon sonrası yaklaşık %50'dir (94-96). Ameliyat sonrası rezidüel tümörün büyümeye riski geride kalan hacimle orantılıdır (74). Genel olarak, tümörlerin yaklaşık %30'u subtotal tümör rezeksiyonu sonrasında bir dereceye kadar yeniden büyür ve genellikle radyocerrahi ile tedavi edilir (74,97). Perioperatif inme ve diğer bölgesel kraniyal kalıcı sinir yaralanmaları gibi diğer majör nörovasküler komplikasyonlar ise büyük tümörlerde bile nadirdir (70).

SONUÇ

Yayınlanmış veriler, VS cerrahisi konusunda daha deneyimli merkezlerin daha kısa hastanede kalış süresi ve daha düşük maliyetle üstün kısa vadeli sonuçlara sahip olduğunu göstermektedir (98,99).

KAYNAKLAR

1. Propp JM, McCarthy BJ, Davis FG, et al. Descriptive epidemiology of vestibular schwannomas. Neuro Oncol. 2006;8 (1):1-11.
2. Lin EP, Crane BT. The Management and Imaging of Vestibular Schwannomas. American Journal of Neuroradiology. 2017;38 (11):2034-2043. doi:10.3174/ajnr.a5213



3. Koos WT, Day JD, Matula C, et al. Neurotopographic considerations in the microsurgical treatment of small acoustic neurinomas. *J Neurosurg.* 1998;88 (3):506-512.
4. Evans DGR, Moran A, King A, et al. Incidence of Vestibular Schwannoma and Neurofibromatosis 2 in the North West of England over a 10-year Period: Higher Incidence than Previously Thought. *Otology & Neurotology.* 2005;26 (1):93-97. doi:10.1097/00129492-200501000-00016
5. Trofatter JA, MacCollin MM, Rutter JL, et al. A novel moesin-, ezrin-, radixin-like gene is a candidate for the neurofibromatosis 2 tumor suppressor. *Cell.* 1993;75 (4):826.
6. Connor SEJ. Imaging of the Vestibular Schwannoma: Diagnosis, Monitoring, and Treatment Planning. *Neuroimaging Clin N Am.* 2021;31 (4):451-471.
7. Gupta VK, Thakker A, Gupta KK. Vestibular Schwannoma: What We Know and Where We are Heading. *Head Neck Pathol.* 2020;14 (4):1058-1066.
8. Nestor JJ, Korol HW, Nutik SL, et al. The incidence of acoustic neuromas. *Arch Otolaryngol Head Neck Surg.* 1988;114 (6):680.
9. Frohlich AM, Sutherland GR. Epidemiology and clinical features of vestibular schwannoma in Manitoba, Canada. *Can J Neurol Sci.* 1993;20 (2):126-130.
10. Mirz F, Pedersen CB, Fiirgaard B, et al. Incidence and growth pattern of vestibular schwannomas in a Danish county, 1977-98. *Acta Otolaryngol Suppl.* 2000;543:30-33.
11. Reznitsky M, Petersen MMB, West N, et al. Epidemiology Of Vestibular Schwannomas – Prospective 40-Year Data From An Unselected National Cohort. *Clinical Epidemiology.* 2019;11:981-986. doi:10.2147/clep.s218670
12. Stepanidis K, Kessel M, Caye-Thomasen P, et al. Socio-demographic distribution of vestibular schwannomas in Denmark. *Acta Otolaryngol.* 2014;134 (6):551-556.
13. Marinelli JP, Lohse CM, Carlson ML. Incidence of Vestibular Schwannoma over the Past Half-Century: A Population-Based Study of Olmsted County, Minnesota. *Otolaryngol Head Neck Surg.* 2018;159 (4):717-723.
14. Schwartz M, Fisher L. Incidence and clinical characteristics of acoustic neuroma in Beverly Hills. *Skull Base.* 2007;16 (S 1). doi:10.1055/s-2006-958307
15. Evans DG, Raymond FL, Barwell JG, et al. Genetic testing and screening of individuals at risk of NF2. *Clin Genet.* 2012;82 (5):416-424.
16. Pathmanaban ON, Sadler KV, Kamaly-Asl ID, et al. Association of Genetic Predisposition With Solitary Schwannoma or Meningioma in Children and Young Adults. *JAMA Neurol.* 2017;74 (9):1123-1129.
17. Sadler KV, Bowers NL, Hartley C, et al. Sporadic vestibular schwannoma: a molecular testing summary. *Journal of Medical Genetics.* 2021;58 (4):227-233. doi:10.1136/jmedgenet-2020-107022
18. Chen H, Xue L, Wang H, et al. Differential NF2 Gene Status in Sporadic Vestibular Schwannomas and its Prognostic Impact on Tumour Growth Patterns. *Sci Rep.* 2017;7 (1):5470.
19. Sass HCR, Borup R, Alanin M, et al. Gene expression, signal transduction pathways and functional networks associated with growth of sporadic vestibular schwannomas. *J Neurooncol.* 2017;131 (2):283-292.
20. Schneider AB, Ron E, Lubin J, et al. Acoustic neuromas following childhood radiation treatment for benign conditions of the head and neck. *Neuro Oncol.* 2008;10 (1):73-78.
21. Preston DL, Ron E, Yonehara S, et al. Tumors of the nervous system and pituitary gland associated with atomic bomb radiation exposure. *J Natl Cancer Inst.* 2002;94 (20):1555-1563.
22. Yonehara S, Brenner AV, Kishikawa M, et al. Clinical and epidemiologic characteristics of first primary tumors of the central nervous system and related organs among atomic bomb survivors in Hiroshima and Nagasaki, 1958-1995. *Cancer.* 2004;101 (7):1644-1654.



23. Blettner M, Schlehofer B, Samkange-Zeeb F, et al. Medical exposure to ionising radiation and the risk of brain tumours: Interphone study group, Germany. *Eur J Cancer*. 2007;43 (13):1990-1998.
24. Christensen HC. Cellular Telephone Use and Risk of Acoustic Neuroma. *American Journal of Epidemiology*. 2004;159 (3):277-283. doi:10.1093/aje/kwh032
25. Ahlbom A, Feychtig M, Green A, et al. Epidemiologic Evidence on Mobile Phones and Tumor Risk. *Epidemiology*. 2009;20 (5):639-652. doi:10.1097/ede.0b013e3181b0927d
26. Takebayashi T, Akiba S, Kikuchi Y, et al. Mobile phone use and acoustic neuroma risk in Japan. *Occup Environ Med*. 2006;63 (12):802-807.
27. Hardell L, Carlberg M, Hansson Mild K. Epidemiological evidence for an association between use of wireless phones and tumor diseases. *Pathophysiology*. 2009;16 (2-3):113-122.
28. Berkowitz O, Iyer AK, Kano H, et al. Epidemiology and Environmental Risk Factors Associated with Vestibular Schwannoma. *World Neurosurg*. 2015;84 (6):1674-1680.
29. Carlson ML, Smadbeck JB, Link MJ, et al. Next Generation Sequencing of Sporadic Vestibular Schwannoma: Necessity of Biallelic NF2 Inactivation and Implications of Accessory Non-NF2 Variants. *Otology & Neurotology*. 2018;39 (9):e860-e871. doi:10.1097/mao.0000000000001932
30. Tamura R. Current Understanding of Neurofibromatosis Type 1, 2, and Schwannomatosis. *Int J Mol Sci*. 2021;22 (11). doi:10.3390/ijms22115850
31. Rouleau GA, Merel P, Lutchman M, et al. Alteration in a new gene encoding a putative membrane-organizing protein causes neuro-fibromatosis type 2. *Nature*. 1993;363 (6429):515-521. doi:10.1038/363515a0
32. Bian LG, Tirakotai W, Sun QF, et al. Molecular genetics alterations and tumor behavior of sporadic vestibular schwannoma from the People's Republic of China. *J Neurooncol*. 2005;73 (3):253-260.
33. Cayé-Thomasen P, Borup R, Stangerup SE, et al. Deregulated genes in sporadic vestibular schwannomas. *Otol Neurotol*. 2010;31 (2):256-266.
34. Aarhus M, Bruland O, Sætran HA, et al. Global gene expression profiling and tissue microarray reveal novel candidate genes and down-regulation of the tumor suppressor gene CAV1 in sporadic vestibular schwannomas. *Neurosurgery*. 2010;67 (4):998-1019.
35. Torres-Martin M, Lassaletta L, San-Roman-Montero J, et al. Microarray analysis of gene expression in vestibular schwannomas reveals SPP1/MET signaling pathway and androgen receptor deregulation. *International Journal of Oncology*. 2013;42 (3):848-862. doi:10.3892/ijo.2013.1798
36. Piotrowski A, Xie J, Liu YF, et al. Germline loss-of-function mutations in LZTR1 predispose to an inherited disorder of multiple schwannomas. *Nature Genetics*. 2014;46 (2):182-187. doi:10.1038/ng.2855
37. Hulsebos TJM, Plomp AS, Wolterman RA, et al. Germline Mutation of INI1/SMARCB1 in Familial Schwannomatosis. *The American Journal of Human Genetics*. 2007;80 (4):805-810. doi:10.1086/513207
38. Smith MJ, Bowers NL, Bulman M, et al. Revisiting neurofibromatosis type 2 diagnostic criteria to exclude LZTR1-related schwannomatosis. *Neurology*. 2017;88 (1):87-92.
39. NIH (2017) *Vestibular Schwannoma (Acoustic Neuroma) and Neurofibromatosis*. (1/01/2022 tarihinde [https://www.nidcd.nih.gov/health/vestibular-schwannoma-acoustic-neuroma-and-neurofibromatosis adresinden ulaşılmıştır](https://www.nidcd.nih.gov/health/vestibular-schwannoma-acoustic-neuroma-and-neurofibromatosis)).
40. Joshi R. Learning from eponyms: Jose Verocay and Verocay bodies, Antoni A and B areas, Nils Antoni and Schwannomas. *Indian Dermatol Online J*. 2012;3 (3):215-219.



41. Khrais T, Romano G, Sanna M. Nerve origin of vestibular schwannoma: a prospective study. *J Laryngol Otol.* 2008;122 (2):128-131.
42. Brodhun M, Stahn V, Harder A. Pathogenese und Molekularpathologie des Vestibularisschwannoms. *HNO.* 2017;65 (5):362-372. doi:10.1007/s00106-016-0201-3
43. Matthies C, Samii M. Management of 1000 vestibular schwannomas (acoustic neuromas): clinical presentation. *Neurosurgery.* 1997;40 (1):1-9.
44. Halliday J, Rutherford SA, McCabe MG, et al. An update on the diagnosis and treatment of vestibular schwannoma. *Expert Rev Neurother.* 2018;18 (1):29-39.
45. Carlson ML, Link MJ. Vestibular Schwannomas. *N Engl J Med.* 2021;384 (14):1335-1348.
46. Matthies C, Samii M. Management of 1000 vestibular schwannomas (acoustic neuromas): clinical presentation. *Neurosurgery.* 1997 Jan;40 (1):1-9. doi: 10.1097/00006123-199701000-00001.
47. Carlson ML, Tveiten ØV, Driscoll CL, et al. Long-term dizziness handicap in patients with vestibular schwannoma: a multicenter cross-sectional study. *Otolaryngol Head Neck Surg.* 2014;151 (6):1028-1037.
48. Sweeney AD, Carlson ML, Shepard NT, et al. Congress of Neurological Surgeons Systematic Review and Evidence-Based Guidelines on Otologic and Audiologic Screening for Patients With Vestibular Schwannomas. *Neurosurgery.* 2018;82 (2):E29-E31.
49. Sauvaget E, Kici S, Kania R, et al. Sudden sensorineural hearing loss as a revealing symptom of vestibular schwannoma. *Acta Otolaryngol.* 2005;125 (6):592-595.
50. Harcourt JP, Vijaya-Sekaran S, Loney E, et al. The incidence of symptoms consistent with cerebellopontine angle lesions in a general ENT out-patient clinic. *The Journal of Laryngology & Otology.* 1999;113 (6):518-522. doi:10.1017/s0022215100144391
51. Dunn IF, Bi WL, Mukundan S, et al. Congress of Neurological Surgeons Systematic Review and Evidence-Based Guidelines on the Role of Imaging in the Diagnosis and Management of Patients With Vestibular Schwannomas. *Neurosurgery.* 2018;82 (2):E32-E34. doi:10.1093/neurology/nxy510
52. Kim DH, Do Hyun K, Lee S, et al. Non-contrast Magnetic Resonance Imaging for Diagnosis and Monitoring of Vestibular Schwannomas: A Systematic Review and Meta-analysis. *Otology & Neurotology.* 2019;40 (9):1126-1133. doi:10.1097/mao.0000000000002416
53. Chandrasekhar SS, Tsai Do BS, Schwartz SR, et al. Clinical Practice Guideline: Sudden Hearing Loss (Update). *Otolaryngol Head Neck Surg.* 2019;161 (1_suppl):S1-S45.
54. Waterval J, Kania R, Somers T. EAONO Position Statement on Vestibular Schwannoma: Imaging Assessment. What are the Indications for Performing a Screening MRI Scan for a Potential Vestibular Schwannoma? *J Int Adv Otol.* 2018;14 (1):95-99.
55. Mohyuddin A. Molecular genetic analysis of the NF2 gene in young patients with unilateral vestibular schwannomas. *Journal of Medical Genetics.* 2002;39 (5):315-322. doi:10.1136/jmg.39.5.315
56. Takahashi M, Okudera T, Tomanaga M, et al. Angiographic diagnosis of acoustic neurinomas: analysis of 30 lesions. *Neuroradiology.* 1971;2 (4):191-200.
57. Phelps PD, Lloyd GA. High resolution air CT metatigraphy: the demonstration of normal and abnormal structures in the cerebello-pontine cistern and internal auditory meatus. *Br J Radiol.* 1982;55 (649):19-22.
58. Sriskandan N, Connor SEJ. The role of radiology in the diagnosis and management of vestibular schwannoma. *Clin Radiol.* 2011;66 (4):357-365.
59. Müslüman AM, Akgün C, Tanrıverdi O, et al. Vestibüler Schwannoma. *Türk Nöroşir Derg,* 2016;26 (Ek Sayı 1): 49-60.



60. Duvoisin B, Fernandes J, Doyon D, et al. Magnetic resonance findings in 92 acoustic neuromas. *European Journal of Radiology*. 1991;13 (2):96-102. doi:10.1016/0720-048x (91)90088-d
61. Gomez-Brouchet A, Delisle MB, Cognard C, et al. Vestibular schwannomas: correlations between magnetic resonance imaging and histopathologic appearance. *Otol Neurotol*. 2001;22 (1):79-86.
62. Inoue Y, Ogawa K, Momoshima S, et al. The diagnostic significance of the 3D-reconstructed MRI in vestibular schwannoma surgery: prediction of tumor origin. *Eur Arch Otorhinolaryngol*. 2002;259 (2):73-76.
63. Tos M, Thomsen J. Proposal of classification of tumour size in acoustic neurinoma surgery. In: Tos M, Thomsen J (eds). *Acoustic Neuroma, Proceedings of the First International Conference on Acoustic Neuroma*. Amsterdam: Kugler Publications, 1992: 133-137
64. Yaşargil MG: Acoustic neurinomas. In: *Microneurosurgery*. New York: George Thieme Verlag, 1996: (4), 100-119
65. Sekiya T, Hatayama T, Shimamura N, et al. A comprehensive classification system of vestibular schwannomas. *J Clin Neurosci*. 2000;7 (2):129-133.
66. Samii M, Matthies C, Tatagiba M. Management of vestibular schwannomas (acoustic neuromas): auditory and facial nerve function after resection of 120 vestibular schwannomas in patients with neurofibromatosis 2. *Neurosurgery*. 1997;40 (4):696-705; discussion 705-706.
67. Samii M, Matthies C. Management of 1000 vestibular schwannomas (acoustic neuromas): hearing function in 1000 tumor resections. *Neurosurgery*. 1997;40 (2):248-260.
68. Rosahl S, Bohr C, Lell M, et al. Diagnostik und Therapie des Vestibularisschwannoms – eine interdisziplinäre Herausforderung. *Laryngo-Rhino-Otologie*. 2017;96 (S 01):S152-S182. doi:10.1055/s-0042-122386
69. Ansari SF, Terry C, Cohen-Gadol AA. Surgery for vestibular schwannomas: a systematic review of complications by approach. *Neurosurg Focus*. 2012;33 (3):E14.
70. Mahboubi H, Ahmed OH, Yau AY, et al. Complications of Surgery for Sporadic Vestibular Schwannoma. *Otolaryngology-Head and Neck Surgery*. 2014;150 (2):275-281. doi:10.1177/0194599813512106
71. Van Gompel JJ, Agazzi S, Carlson ML, et al. Congress of Neurological Surgeons Systematic Review and Evidence-Based Guidelines on Emerging Therapies for the Treatment of Patients With Vestibular Schwannomas. *Neurosurgery*. 2018;82 (2):E52-E54.
72. Gauden A, Weir P, Hawthorne G, et al. Systematic review of quality of life in the management of vestibular schwannoma. *Journal of Clinical Neuroscience*. 2011;18 (12):1573-1584. doi:10.1016/j.jocn.2011.05.009
73. Muzevic D, Legcovic J, Splavski B, et al. Stereotactic radiotherapy for vestibular schwannoma. *Cochrane Database Syst Rev*. 2014; (12):CD009897.
74. Carlson ML, Link MJ, Driscoll CLW, et al. Working Toward Consensus on Sporadic Vestibular Schwannoma Care: A Modified Delphi Study. *Otology & Neurotology*. 2020;41 (10):e1360-e1371. doi:10.1097/mao.0000000000002917
75. Carlson ML, Glasgow AE, Grosshardt BR, et al. Does where you live influence how your vestibular schwannoma is managed? Examining geographical differences in vestibular schwannoma treatment across the United States. *Journal of Neuro-Oncology*. 2016;129 (2):269-279. doi:10.1007/s11060-016-2170-5
76. Carlson ML, Tveiten ØV, Lund-Johansen M, et al. Patient Motivation and Long-Term Satisfaction with Treatment Choice in Vestibular Schwannoma. *World Neurosurgery*. 2018;114:e1245-e1252. doi:10.1016/j.wneu.2018.03.182



77. Tos M, Stangerup SE, Cayé-Thomasen P, et al. What Is the Real Incidence of Vestibular Schwannoma? *Archives of Otolaryngology–Head & Neck Surgery*. 2004;130 (2):216. doi:10.1001/archotol.130.2.216
78. Lees KA, Tombers NM, Link MJ, et al. Natural History of Sporadic Vestibular Schwannoma: A Volumetric Study of Tumor Growth. *Otolaryngology–Head and Neck Surgery*. 2018;159 (3):535-542. doi:10.1177/0194599818770413
79. Reznitsky M, Petersen MMB, West N, et al. The natural history of vestibular schwannoma growth—prospective 40-year data from an unselected national cohort. *Neuro-Oncology*. 2021;23 (5):827-836. doi:10.1093/neuonc/noaa230
80. Hunter JB, Francis DO, O'Connell BP, et al. Single Institutional Experience With Observing 564 Vestibular Schwannomas: Factors Associated With Tumor Growth. *Otol Neurotol*. 2016;37 (10):1630-1636.
81. Macielak RJ, Patel NS, Lees KA, et al. Delayed Tumor Growth in Vestibular Schwannoma: An Argument for Lifelong Surveillance. *Otology & Neurotology*. 2019;40 (9):1224-1229. doi:10.1097/mao.0000000000002337
82. Bakkouri WE, Kania RE, Guichard JP, et al. Conservative management of 386 cases of unilateral vestibular schwannoma: tumor growth and consequences for treatment. *J Neurosurg*. 2009;110 (4):662-669.
83. Patel NS, Huang AE, Dowling EM, et al. The Influence of Vestibular Schwannoma Tumor Volume and Growth on Hearing Loss. *Otolaryngology–Head and Neck Surgery*. 2020;162 (4):530-537. doi:10.1177/0194599819900396
84. Bailo M, Boari N, Franzin A, et al. Gamma Knife Radiosurgery as Primary Treatment for Large Vestibular Schwannomas: Clinical Results at Long-Term Follow-Up in a Series of 59 Patients. *World Neurosurgery*. 2016;95:487-501. doi:10.1016/j.wneu.2016.07.117
85. Breshears JD, Chang J, Molinaro AM, et al. Temporal Dynamics of Pseudoprogression After Gamma Knife Radiosurgery for Vestibular Schwannomas—A Retrospective Volumetric Study. *Neurosurgery*. 2019;84 (1):123-131. doi:10.1093/neuros/nyy019
86. Johnson S, Kano H, Faramand A, et al. Long term results of primary radiosurgery for vestibular schwannomas. *Journal of Neuro-Oncology*. 2019;145 (2):247-255. doi:10.1007/s11060-019-03290-0
87. Iorio-Morin C, Liscak R, Vladýka V, et al. Repeat Stereotactic Radiosurgery for Progressive or Recurrent Vestibular Schwannomas. *Neurosurgery*. 2019;85 (4):535-542. doi:10.1093/neuros/nyy416
88. Balossier A, Régis J, Reyns N, et al. Repeat stereotactic radiosurgery for progressive vestibular schwannomas after previous radiosurgery: a systematic review and meta-analysis. *Neurosurg Rev*. 2021;44 (6):3177-3188.
89. Neff BA, Carlson ML, O'Byrne MM, et al. Trigeminal neuralgia and neuropathy in large sporadic vestibular schwannomas. *J Neurosurg*. 2017;127 (5):992-999.
90. Hadjipanayis CG, Carlson ML, Link MJ, et al. Congress of Neurological Surgeons Systematic Review and Evidence-Based Guidelines on Surgical Resection for the Treatment of Patients With Vestibular Schwannomas. *Neurosurgery*. 2018;82 (2):E40-E43.
91. Bennett M, Haynes DS. Surgical approaches and complications in the removal of vestibular schwannomas. 2007. *Neurosurg Clin N Am*. 2008;19 (2):331-343.
92. Samii M, Matthies C. Management of 1000 vestibular schwannomas (acoustic neuromas): surgical management and results with an emphasis on complications and how to avoid them. *Neurosurgery*. 1997;40 (1):11-21.



93. Ahmad RARL, Sivalingam S, Topsakal V, et al. Rate of recurrent vestibular schwannoma after total removal via different surgical approaches. *Ann Otol Rhinol Laryngol.* 2012;121 (3):156-161.
94. Preet K, Ong V, Sheppard JP, et al. Postoperative Hearing Preservation in Patients Undergoing Retrosigmoid Craniotomy for Resection of Vestibular Schwannomas: A Systematic Review of 2034 Patients. *Neurosurgery.* Published online 2019. doi:10.1093/neuro/nyz147
95. Grinblat G, Dandinarasaiah M, Braverman I, et al. "Large and giant vestibular schwannomas: overall outcomes and the factors influencing facial nerve function." *Neurosurgical Review.* 2021;44 (4):2119-2131. doi:10.1007/s10143-020-01380-6
96. Gurgel RK, Dogru S, Amdur RL, et al. Facial nerve outcomes after surgery for large vestibular schwannomas: do surgical approach and extent of resection matter? *Neurosurgical Focus.* 2012;33 (3):E16. doi:10.3171/2012.7.focus12199
97. Romiyo P, Ng E, Dejam D, et al. Radiosurgery treatment is associated with improved facial nerve preservation versus repeat resection in recurrent vestibular schwannomas. *Acta Neurochir.* 2019;161 (7):1449-1456.
98. Barker FG, Carter BS, Ojemann RG, et al. Surgical Excision of Acoustic Neuroma: Patient Outcome and Provider Caseload. *The Laryngoscope.* 2003;113 (8):1332-1343. doi:10.1097/00005537-200308000-00013
99. Hatch JL, Bauschard MJ, Nguyen SA, et al. Does Hospital Volume Affect Outcomes in Patients Undergoing Vestibular Schwannoma Surgery? *Otology & Neurotology.* 2018;39 (4):481-487. doi:10.1097/mao.0000000000001718