

新型冠状病毒肺炎相关突发性感音神经性耳聋的研究进展

陈玉春^{1,2,3}, 曹竞文^{1,2}, 高春^{2,4}, 郑立婷^{2,3,4}, 卢利霞^{2,3}, 张久聪^{2,3}, 于晓辉^{2,3}

(1. 宁夏医科大学临床医学院, 宁夏 银川 750004; 2. 中国人民解放军联勤保障部队第九四〇医院 消化内科, 甘肃 兰州 730050; 3. 中国人民解放军联勤保障部队九四〇医院基础医学实验室 甘肃省干细胞与基因药物重点实验室, 甘肃 兰州 730050; 4. 甘肃中医药大学第一临床医学院, 甘肃 兰州 730000)

摘 要:新型冠状病毒肺炎(COVID-19)是一种传染性极强、严重危害全球公共卫生的疾病。临床表现主要包括发热、咳嗽、乏力等,随着疫情的发展,COVID-19 患者病程中出现的突发性感音神经性耳聋(SSNHL)越来越多。SSNHL 可以是 COVID-19 患者的后遗症,也有部分患者以 SSNHL 为首发和唯一的症状。该文对 COVID-19 相关 SSNHL 的最新研究进展作一总结,希望有助于后续的相关研究和临床诊治。

关 键 词:突发性感音神经性耳聋;新型冠状病毒肺炎;作用机制
中图分类号:R764. 43⁺1

Research progress of sudden sensorineural hearing loss associated with COVID-19

CHEN Yuchun^{1,2,3}, CAO Jingwen^{1,2}, GAO Chun^{2,4}, ZHENG Liting^{2,3,4}, LU Lixia^{2,3}, ZHANG Jiucong^{2,3}, YU Xiaohui^{2,3}
(1. School of Clinical Medicine, Ningxia Medical University, Yinchuan 750004, China; 2. Department of Gastroenterology, 940th Hospital, PLA Joint Logistic Support Force, Lanzhou 730050 China; 3. Basic Medical Sciences Laboratory of the 940 Hospital, PLA Joint Logistic Support Force, Gansu Provincial Key Laboratory of Stem Cells and Genetic Drugs, Lanzhou 730050 China; 4. the First Clinical College of Medicine, Gansu University of Traditional Chinese Medicine, Lanzhou 730000, China)

Abstract: The novel coronavirus disease 2019 (COVID-19) is a highly contagious disease that seriously endangers global public health. The main clinical manifestations include fever, cough, fatigue, etc. As the epidemic progresses, there are more and more sudden sensorineural hearing loss (SSNHL) in the course of COVID-19 patients. SSNHL can be a sequela of COVID-19 patients. Some patients with COVID-19 also have SSNHL as the first and only symptom. This review summarizes recent advances in COVID-19 related SSNHL research. This article summarizes the latest research progress of SSNHL associated with COVID-19. It is hoped that it will contribute to the subsequent related research and clinical diagnosis and treatment.

Keywords: Sudden sensorineural hearing loss; COVID-19; Mechanism of action

冠状病毒是一类广泛存在且对人及家畜具有严重危害的病原体。新型冠状病毒肺炎(coronavirus disease 2019, COVID-19)是一种由严重急性呼吸综合征冠状病毒 2(severe acute respiratory syndrome coronavirus 2, SARS-CoV-2)引起的以呼吸道症状为

主的疾病。SARS-CoV-2 是冠状病毒家族中的一种单股正链、有包膜的 RNA 病毒,包膜包埋有基质蛋白(M)和刺突蛋白(S)等蛋白^[1]。人群普遍易感,主要通过飞沫、飞沫形成的气溶胶和直接接触传播,具有一定的潜伏期,多为 3 ~ 7 d,最长可达 14 d^[2]。

基金项目:火神山医院科研基金面上项目(HSS-217);甘肃省非感染性肝病临床医学研究中心(21JR7RA017)。
第一作者简介:陈玉春,女,硕士研究生。
通信作者:于晓辉,Email:yuxiaohui528@126.com;卢利霞,Email:nil0718@163.com

SARS-CoV-2 感染后的短期和长期影响在不断发生改变,现有研究发现,SSNHL 也是 COVID-19 患者的一种临床表现。所以,当 COVID-19 患者出现突发性感音神经性耳聋(sudden sensorineural hearing loss, SSNHL)时,及时的诊断和治疗对于听力改善和生活质量的提高至关重要。

1 COVID-19 的临床表现

COVID-19 在感染者中没有统一的表现,约 1/3 无任何症状。最常见的症状包括呼吸道症状、乏力、气促、发热、肌肉酸痛、结膜炎、头痛、腹泻等^[3]。重症患者多在发病 1 周后出现呼吸困难和/或低氧血症,严重者可快速进展为急性呼吸窘迫综合征、脓毒症休克、难以纠正的代谢性酸中毒和出凝血功能障碍及多器官功能衰竭等^[4]。目前研究发现,SARS-CoV-2 几乎可以影响机体的每个器官,引起的一些不常见的症状,如引起嗅觉缺失、味觉障碍和面神经麻痹等^[5]。COVID-19 患者在耳鼻咽喉科的表现,主要包括咳嗽、喉咙痛、呼吸困难、嗅觉缺失和味觉障碍等^[6-7]。Gerstacker 等^[8]发现,SSNHL 也是 COVID-19 的一个特征,它可能单独出现或与该疾病的其他症状一起出现。

2 SSNHL

2.1 SSNHL 的特点和治疗

SSNHL 是指突然发生的、原因不明的感音神经性听力损失,患者的听力一般在数分钟或数小时内,少部分患者在 3 d 内下降到最低点^[9],发病率约为每年(5~27)/10 万人^[10]。该病多发生于中年患者,没有显著的性别差异,但近年来发病人群趋于年轻化;首发表现为听力下降,通常伴有耳鸣、眩晕、耳闷胀感等症状^[11]。SSNHL 的治疗方式包括抗炎、抗病毒、血管活性药物和高压氧疗,但是抗病毒和血管活性药物的疗效有限^[12]。目前,口服和静脉注射糖皮质激素为其主要治疗手段,经鼓室内糖皮质激素局部给药可作为全身给药失效后的补救治疗方式,此途径可绕过血液迷路屏障,在内耳中达到较高浓度,从而显著改善听力,这种给药方式也可以减少糖皮质激素的不良反应^[13-14]。高压氧疗可以通过提高局部氧分压,改善血氧状况和微循环来逆转内耳缺氧,主要用于初始糖皮质激素治疗失败后的辅助治疗^[15];最近的研究结果表明,与单纯激素治疗相

比,高压氧疗联合口服或鼓室内皮质类固醇激素可增加 SSNHL 患者的疗效^[16]。SSNHL 为耳鼻咽喉科的一种急症,及时识别和处理可以提高听力恢复和患者的生活质量。

2.2 病毒相关 SSNHL 的作用机制

SSNHL 的病因和病理生理机制尚未完全阐明,局部因素和全身因素均可能引起,常见的病因包括病毒感染、血管性疾病、自身免疫性疾病、传染性疾病、肿瘤等^[17-18];其中,病毒感染是 SSNHL 一个很重要的原因^[19],由病毒引起的 SSNHL 可以是轻度、中度或重度,也可以是单侧或双侧^[8]。目前发现引起 SSNHL 的病毒主要有单纯疱疹病毒、人类免疫缺陷病毒、肝炎病毒、麻疹病毒、风疹病毒、腮腺炎病毒、拉萨病毒和肠道病毒等^[20]。一些文献报道,病毒感染后的直接和间接损伤都会引起 SSNHL,主要与以下 4 个机制相关^[10,21-23]:第一,病毒可以直接侵犯耳蜗神经引起神经炎、侵犯耳蜗和外淋巴组织引起耳蜗炎。第二,病毒感染后引起的交叉反应会导致宿主介导的免疫损伤,从而破坏内毛细胞和 Corti 器等结构。第三,病毒感染通过血凝沉淀、炎症性水肿或诱导高凝状态而导致血管阻塞,耳蜗缺血最终引起听力下降甚至发生耳聋。第四,病毒感染可增加细菌或真菌感染,导致听力丧失。综上所述,病毒通过多种机制最终导致了 SSNHL,由于病毒引起的听力损失大部分在积极治疗后能够恢复正常,所以早期识别和治疗至关重要^[24]。

3 COVID-19 相关 SSNHL

3.1 SARS-CoV-2 通过血管紧张素转化酶 2(angiotensin-converting enzyme 2, ACE2)进入各个器官

首先,Dube 等^[25]发现,SARS-CoV-2 感染与患者嗅觉丧失和视神经炎症有关,这表明 SARS-CoV-2 可能对包括听神经在内的其他脑神经也有类似损伤作用。之后,Mustafa 等^[24]对无症状 SARS-CoV-2 感染患者的听力学进行了检查,发现与未感染者相比,这些患者的高音调阈值显著受损、耳声发射幅度降低,证明 SARS-CoV-2 感染对耳蜗毛细胞功能产生有害影响。目前已有大量文献报道,在 COVID-19 患者和无症状感染者中均出现了 SSNHL^[26-30]。并且发现大多数 COVID-19 相关 SSNHL 病例在 COVID-19 发病后 1 周内出现,双侧病例多于单侧病例^[31-32]。

随着 COVID-19 的暴发,越来越多的研究表明

ACE2 是引起 COVID-19 感染的关键分子^[33-34]。ACE2 是肾素-血管紧张素-醛固酮系统的重要组成部分,广泛表达于人体肺脏、心脏、肾脏、胃肠和肝脏等多个器官中,通常催化血管紧张素 2 的降解,发挥保护心脏、舒张血管、抗增殖和增强缓激肽的活性的作用^[35-36]。Uranaka 等^[37]发现,ACE2 在小鼠的中耳上皮细胞、血管纹和螺旋神经节中有表达。Jeong 等^[38]在人类的咽鼓管、中耳和耳蜗(毛细胞)中也发现了 ACE2。可见,ACE2 广泛存在于包括耳在内的各个器官中。

也有研究表明,SARS-CoV-2 可以附着在血红蛋白的 β 链上,渗透到红细胞内通过血液循环到达全身,使用 ACE2 作为受体进入细胞介导宿主细胞感染,SARS-CoV-2 进入细胞一方面依赖于 S 蛋白与细胞受体的结合,一方面依赖于宿主细胞蛋白酶对 S 蛋白的启动作用^[39-41]。SARS-CoV-2 与 ACE2 结合后降低了 ACE2 受体的活性,从而使得血管紧张素 2 和血管紧张素 1 型受体增加^[42],并且 ACE2 不能抵消 ACE 的促炎和促凝血作用,继而导致严重的炎症和凝血障碍^[43-44]。Frazier 等^[45]发现 SARS-CoV-2 定植于 3 例 COVID-19 阳性死者的中耳和乳突中。一些学者在 COVID-19 患者的脑脊液中也发现了 SARS-CoV-2,脑脊液是与耳蜗外淋巴直接接触的^[46-48]。因此,SARS-CoV-2 可能通过 ACE2 引起全身多器官损伤并且引发 SSNHL。

3.2 COVID-19 相关 SSNHL 的发病机制和治疗

COVID-19 相关 SSNHL 的患者以听力损失为主要症状,伴随症状为耳鸣、眩晕和耳痛^[49]。其发病机制尚不完全清楚,目前研究发现可能与以下几种机制有关。第一,ACE2 在大脑、延髓和颞叶中含量丰富,SARS-CoV-2 与 ACE2 结合后会引发炎症反应和某些细胞因子的释放,如肿瘤坏死因子- α (tumor necrosis factor- α , TNF- α)、白细胞介素(interleukin, IL)-1 和 IL-6 等,从而严重影响听觉中枢,导致听力损伤。这种炎症反应既可能由病毒直接引起的,也可能免疫介导的^[50-51]。第二,SARS-CoV-2 感染会使红细胞脱氧,引起听力中枢缺氧而导致永久性耳聋^[49]。第三,与其他病毒相似,由于 SARS-CoV-2 能导致凝血功能障碍和微血管中血栓形成,从而引起颞叶、听神经或耳蜗听觉中枢的缺血性损伤,最终导致 SSNHL^[52-55]。早期就有研究表明^[56],迷路内出血是 SSNHL 的原因之一,这与 Chern 等^[21]报道的 1 例因迷路内出血而致双侧 SSNHL 的 COVID-19 病例相符合。

目前关于 COVID-19 相关 SSNHL 的报道越来越多。与不进行干预的对照组相比,早期(在症状出现后 7 d 内)使用糖皮质激素治疗可显著提高听力恢复率^[10],并且这种结果不受耳聋持续时间、单双侧和严重程度的影响^[57]。所以,发生 SSNHL 的 COVID-19 患者应尽快接受评估和治疗^[58]。同其他病毒所致的 SSNHL 相似,糖皮质激素仍是其首选的治疗药物。然而,由于糖皮质激素会促进感染,COVID-19 患者免疫力低,全身静脉给药需要谨慎,经鼓室内糖皮质激素局部治疗为更好的选择^[59]。

4 小结与展望

COVID-19 患者的临床表现通常以呼吸系统症状为主,但是,SSNHL 等非特异性症状可能是 COVID-19 患者的唯一表现,因此,识别 COVID-19 患者的这种非特异性表现对于尽早隔离、预防传播和启动治疗至关重要。另外,在新冠大流行期间,当怀疑 COVID-19 患者伴有听力下降等症状时,应当尽快进行听力测试,早期干预对于 COVID-19 相关 SSNHL 尤为重要。由于 SSNHL 是 COVID-19 患者的后遗症之一,永久性耳聋的可能性不容忽视,对于 SARS-CoV-2 感染后康复的患者,我们应跟踪调查听力情况,这项工作可以促使康复患者更好地融入社会,恢复正常生活。COVID-19 相关 SSNHL 的发生机制尚不完全清楚,未来还需进行大规模、多中心的病理生理学和预防等方面的研究。

参考文献:

- [1] 王建云,王永军,周莹荃,等. 儿童新型冠状病毒肺炎 1 例病例报告[J]. 中国循证儿科杂志,2020,15(1):42-44.
- [2] Rubin EJ, Baden LR, Morrissey S, et al. Medical Journals and the 2019-nCoV Outbreak[J]. N Engl J Med, 2020, 382(9):866.
- [3] Vallamkonda J, John A, Wani WY, et al. SARS-CoV-2 pathophysiology and assessment of coronaviruses in CNS diseases with a focus on therapeutic targets[J]. Biochim Biophys Acta Mol Basis Dis, 2020, 1866(10):165889.
- [4] 新型冠状病毒肺炎诊疗方案(试行第九版)[J]. 心肺血管病杂志,2022,41(5):449-457.
- [5] Mao L, Jin H, Wang M, et al. Neurologic Manifestations of Hospitalized Patients With Coronavirus Disease 2019 in Wuhan, China[J]. JAMA Neurol, 2020, 77(6):683-690.
- [6] Krajewska J, Krajewski W, Zub K, et al. COVID-19 in otolaryngologist practice: a review of current knowledge[J]. Eur Arch Otorhinolaryngol, 2020, 277(7):1885-1897.
- [7] Vaira LA, Salzano G, Deiana G, et al. Anosmia and Ageusia;

- Common Findings in COVID-19 Patients [J]. *Laryngoscope*, 2020, 130(7):1787.
- [8] Gerstaecker K, Speck I, Riemann S, et al. Deafness after COVID-19? [J]. *Hno*, 2021, 69(Suppl 2):92–95.
 - [9] 严斌, 童小燕. 突发性耳聋患者预后的影响因素分析[J]. *实用临床医药杂志*, 2020, 24(6):83–85, 89.
 - [10] Chandrasekhar SS, Tsai Do BS, Schwartz SR, et al. Clinical practice guideline: Sudden hearing loss (Update) [J]. *Otolaryngol Head Neck Surg*, 2019, 161(1_suppl):S1–S45.
 - [11] 周恩, 刘斌, 赵鹏, 等. 低频型突聋伴耳闷胀感患者耳闷胀感特征及与突聋的关系[J]. *中华耳科学杂志*, 2017, 15(2):201–206.
 - [12] Schreiber BE, Agrup C, Haskard DO, et al. Sudden sensorineural hearing loss[J]. *Lancet*, 2010, 375(9721):1203–1211.
 - [13] Bird PA, Begg EJ, Zhang M, et al. Intratympanic versus intravenous delivery of methylprednisolone to cochlear perilymph [J]. *Otol Neurotol*, 2007, 28(8):1124–1130.
 - [14] Marx M, Younes E, Chandrasekhar SS, et al. International consensus (ICON) on treatment of sudden sensorineural hearing loss [J]. *Eur Ann Otorhinolaryngol Head Neck Dis*, 2018, 135(1s):S23–S28.
 - [15] Wang Y, Gao Y, Wang B, et al. Efficacy and prognostic factors of combined hyperbaric oxygen therapy in patients with idiopathic sudden sensorineural hearing loss [J]. *Am J Audiol*, 2019, 28(1):95–100.
 - [16] Olex-Zarychta D. Hyperbaric oxygenation as adjunctive therapy in the treatment of sudden sensorineural hearing loss [J]. *Int J Mol Sci*, 2020, 21(22):8588.
 - [17] Young YH. Contemporary review of the causes and differential diagnosis of sudden sensorineural hearing loss [J]. *Int J Audiol*, 2020, 59(4):243–253.
 - [18] 李哲, 蔡克万, 王政林. 血栓通注射液联合巴曲酶治疗突发性耳聋合并代谢综合征的临床观察[J]. *中国耳鼻咽喉颅底外科杂志*, 2021, 27(5):589–593.
 - [19] Cohen BE, Durstenfeld A, Roehm PC. Viral causes of hearing loss: a review for hearing health professionals [J]. *Trends Hear*, 2014, 18:1–17.
 - [20] Mateer EJ, Huang C, Shehu NY, et al. Lassa fever-induced sensorineural hearing loss: A neglected public health and social burden [J]. *PLoS Negl Trop Dis*, 2018, 12(2):e0006187.
 - [21] Chern A, Famuyide AO, Moonis G, et al. Bilateral sudden sensorineural hearing loss and intralabyrinthine hemorrhage in a patient with COVID-19 [J]. *Otol Neurotol*, 2021, 42(1):e10–e14.
 - [22] Wilson WR. The relationship of the herpesvirus family to sudden hearing loss: a prospective clinical study and literature review [J]. *Laryngoscope*, 1986, 96(8):870–877.
 - [23] Aslan M, Çiçek MT. Can isolated sudden sensorineural hearing loss (SSNHL) and idiopathic acute facial paralysis (Bell's palsy) be symptoms of COVID-19? [J]. *Am J Otolaryngol*, 2021, 42(5):103129.
 - [24] Mustafa MWM. Audiological profile of asymptomatic Covid-19 PCR-positive cases [J]. *Am J Otolaryngol*, 2020, 41(3):102483.
 - [25] Dubé M, Le Coupanec A, Wong AHM, et al. Axonal transport enables neuron-to-neuron propagation of human coronavirus OC43 [J]. *J Virol*, 2018, 92(17):e00404–00418.
 - [26] Koumpa FS, Forde CT, Manjaly JG. Sudden irreversible hearing loss post COVID-19 [J]. *BMJ Case Rep*, 2020, 13(11):e238419.
 - [27] Pokharel S, Tamang S, Pokharel S, et al. Sudden sensorineural hearing loss in a post-COVID-19 patient [J]. *Clin Case Rep*, 2021, 9(10):e04956.
 - [28] Ricciardiello F, Pisani D, Viola P, et al. Sudden sensorineural hearing loss in mild COVID-19: Case series and analysis of the literature [J]. *Audiol Res*, 2021, 11(3):313–326.
 - [29] Edwards M, Muzaffar J, Naik P, et al. Catastrophic bilateral sudden sensorineural hearing loss following COVID-19 [J]. *BMJ Case Rep*, 2021, 14(6):e243157.
 - [30] Fancello V, Fancello G, Hatzopoulos S, et al. Sensorineural hearing loss post-COVID-19 infection: An update [J]. *Audiol Res*, 2022, 12(3):307–315.
 - [31] Yaseen NK, Al-Ani RM, Ali Rashid R. COVID-19-related sudden sensorineural hearing loss [J]. *Qatar Med J*, 2021, 2021(3):58.
 - [32] Lang B, Hintze J, Conlon B. Coronavirus disease 2019 and sudden sensorineural hearing loss [J]. *J Laryngol Otol*, 2020, 136(9):823–826.
 - [33] Ejaz H, Alsrhani A, Zafar A, et al. COVID-19 and comorbidities: Deleterious impact on infected patients [J]. *J Infect Public Health*, 2020, 13(12):1833–1839.
 - [34] Yesudhas D, Srivastava A, Gromiha MM. COVID-19 outbreak: history, mechanism, transmission, structural studies and therapeutics [J]. *Infection*, 2021, 49(2):199–213.
 - [35] South AM, Diz DI, Chappell MC. COVID-19, ACE2, and the cardiovascular consequences [J]. *Am J Physiol Heart Circ Physiol*, 2020, 318(5):H1084–H1090.
 - [36] Camiolo M, Gauthier M, Kaminski N, et al. Expression of SARS-CoV-2 receptor ACE2 and coincident host response signature varies by asthma inflammatory phenotype [J]. *J Allergy Clin Immunol*, 2020, 146(2):315–324.
 - [37] Uranaka T, Kashio A, Ueha R, et al. Expression of ACE2, TMPRSS2, and furin in mouse ear tissue, and the implications for SARS-CoV-2 infection [J]. *Laryngoscope*, 2021, 131(6):e2013–e2017.
 - [38] Jeong M, Ocwieja KE, Han D, et al. Direct SARS-CoV-2 infection of the human inner ear may underlie COVID-19-associated audio-vestibular dysfunction [J]. *Commun Med (Lond)*, 2021, 1(1):44.
 - [39] Shovlin CL, Vizcaychipi MP. Vascular inflammation and endothelial injury in SARS-CoV-2 infection: The overlooked regulatory cascades implicated by the ACE2 gene cluster [J]. *QJM*, 2020, hcaa241.
 - [40] Ullah H, Ullah A, Gul A, et al. Novel coronavirus 2019 (COVID-19) pandemic outbreak: A comprehensive review of the current lit-

- erature[J]. *Vacunas*, 2021, 22(2):106–113.
- [41] Hoffmann M, Kleine-Weber H, Schroeder S, et al. SARS-CoV-2 cell entry depends on ACE2 and TMPRSS2 and is blocked by a clinically proven protease inhibitor[J]. *Cell*, 2020, 181(2):271–280. e278.
- [42] Zmora P, Moldenhauer AS, Hofmann-Winkler H, et al. TMPRSS2 isoform 1 activates respiratory viruses and is expressed in viral target cells[J]. *PLoS One*, 2015, 10(9):e0138380.
- [43] Abassi Z, Higazi AAR, Kinaneh S, et al. ACE2, COVID-19 infection, inflammation, and coagulopathy: Missing pieces in the puzzle[J]. *Front Physiol*, 2020, 11:574753.
- [44] Verdecchia P, Cavallini C, Spanevello A, et al. The pivotal link between ACE2 deficiency and SARS-CoV-2 infection[J]. *Eur J Intern Med*, 2020, 76:14–20.
- [45] Frazier KM, Hooper JE, Mostafa HH, et al. SARS-CoV-2 Virus Isolated From the Mastoid and Middle Ear: Implications for COVID-19 Precautions During Ear Surgery [J]. *JAMA Otolaryngol Head Neck Surg*, 2020, 146(10):964–966.
- [46] Natoli S, Oliveira V, Calabresi P, et al. Does SARS-Cov-2 invade the brain? Translational lessons from animal models[J]. *Eur J Neurol*, 2020, 27(9):1764–1773.
- [47] Zhang W, Xu L, Luo T, et al. The etiology of Bell’s palsy: a review[J]. *J Neurol*, 2020, 267(7):1896–1905.
- [48] Pool C, King TS, Pradhan S, et al. Sudden sensorineural hearing loss and coronavirus disease 2019[J]. *J Laryngol Otol*, 2022, 136(9):823–826.
- [49] Saniasiaya J. Hearing Loss in SARS-CoV-2: What do we know? [J]. *Ear Nose Throat J*, 2021, 100(2_suppl):152s–154s.
- [50] Krasniqi S, Daci A. Role of the angiotensin pathway and its target therapy in epilepsy management[J]. *Int J Mol Sci*, 2019, 20(3):726.
- [51] Ogier M, Andéol G, Sagui E, et al. How to detect and track chronic neurologic sequelae of COVID-19? Use of auditory brainstem responses and neuroimaging for long-term patient follow-up[J]. *Brain Behav Immun Health*, 2020, 5:100081.
- [52] Cure E, Cumhuri Cure M. Comment on “Hearing loss and COVID-19: A note”[J]. *Am J Otolaryngol*, 2020, 41(4):102513.
- [53] Harenberg J, Jonas JB, Trecca EMC. A liaison between sudden sensorineural hearing loss and SARS-CoV-2 infection[J]. *Thromb Haemost*, 2020, 120(9):1237–1239.
- [54] Varga Z, Flammer AJ, Steiger P, et al. Endothelial cell infection and endotheliitis in COVID-19[J]. *Lancet*, 2020, 395(10234):1417–1418.
- [55] Levi M, Thachil J, Iba T, et al. Coagulation abnormalities and thrombosis in patients with COVID-19 [J]. *Lancet Haematol*, 2020, 7(6):e438–e440.
- [56] Vakkalanka S, Ey E, Goldenberg RA. Inner ear hemorrhage and sudden sensorineural hearing loss[J]. *Am J Otol*, 2000, 21(5):764–765.
- [57] Shilo S, Ungar OJ, Handzel O, et al. Telemedicine for patients with unilateral sudden hearing loss in the COVID-19 era[J]. *JAMA Otolaryngol Head Neck Surg*, 2022, 148(2):166–172.
- [58] Little C, Cosetti MK. In response to the challenges of pharmacotherapy of SARS-CoV-2 infection in patients with sudden sensorineural hearing loss due to COVID-19[J]. *Laryngoscope*, 2021, 131(7):E2336.
- [59] Tsuda T, Hanada Y, Wada K, et al. Efficacy of intratympanic glucocorticoid steroid administration therapy as an initial treatment for idiopathic sudden sensorineural hearing loss during the COVID-19 pandemic[J]. *Ear Nose Throat J*, 2021;1455613211032534.

(收稿日期:2022–10–29)

本文引用格式:陈玉春,曹竞文,高春,等. 新型冠状病毒肺炎相关突发性感音神经性耳聋的研究进展[J]. 中国耳鼻咽喉颅底外科杂志, 2023, 29(5):104–108. DOI:10.11798/j.issn.1007–1520.202322453

Cite this article as:CHEN Yuchun, CAO Jingwen, GAO Chun, et al. Research progress of sudden sensorineural hearing loss associated with COVID-19[J]. *Chin J Otorhinolaryngol Skull Base Surg*, 2023, 29(5):104–108. DOI:10.11798/j.issn.1007–1520.202322453