

doi: 10.13241/j.cnki.pmb.2022.16.013

胶质瘤中 CT 联合 MR 动态扫描的诊断价值及其表观弥散系数的定量研究 *

赵智强 刘存存 陈 欢[△] 马景旭 刘 莹

(新疆医科大学第二附属医院医学影像科 新疆 乌鲁木齐 830063)

摘要 目的:探讨胶质瘤中电子计算机断层扫描(CT)联合核磁共振(MR)动态扫描的诊断价值及其表观弥散系数(ADC)定量价值,以促进胶质瘤的有效早期诊断。**方法:**2017年4月到2021年3月选择在本院进行诊治的颅内肿瘤患者68例作为研究对象,所有患者均给予CT联合MR动态扫描,记录ADC值并判断诊断价值。**结果:**在68例患者中,病理诊断为胶质瘤38例(胶质瘤组),非胶质瘤30例(非胶质瘤组)。胶质瘤组的CT出血、水肿、跨中线、界限不清等特征与非胶质瘤组对比差异有统计学意义($P<0.05$)。胶质瘤组多表现为T1WI低信号、T2WI高信号,非胶质瘤组多表现为T1WI等信号或低信号、T2WI高信号,对比差异有统计学意义($P<0.05$)。胶质瘤组的MR ADC_{max}、ADC_{median}、ADC_{min}都低于非胶质瘤组($P<0.05$)。胶质瘤中CT联合MR动态扫描诊断为胶质瘤37例,非胶质瘤31例,CT联合MR动态扫描诊断胶质瘤的敏感性与特异性为97.4%(37/38)和100.0%(30/30)。**结论:**CT联合MR动态扫描诊断胶质瘤具有很好的敏感性与特异性,ADC值能有效反映病灶组织的病理特征,为临床上提供了一种较为安全、有效的胶质瘤影像检查方法。

关键词:电子计算机断层扫描;核磁共振;表观弥散系数;胶质瘤

中图分类号:R739.4;R445 **文献标识码:**A **文章编号:**1673-6273(2022)16-3061-04

The Diagnostic Value of CT Combined with MR Dynamic Scanning in Glioma and the Quantitative Study of Apparent Diffusion Coefficient*

ZHAO Zhi-qiang, LIU Cun-cun, CHEN Huan[△], MA Jing-xu, LIU Ying

(Department of Medical Imaging, Second Affiliated Hospital of Xinjiang Medical University, Urumqi, Xinjiang, 830063, China)

ABSTRACT Objective: To explore the diagnostic valueS of Computed Tomography (CT) combined with Magnetic Resonance(MR) dynamic scanning and the quantitative value of apparent diffusion coefficient (ADC) in the diagnosis of glioma. **Methods:** From April 2017 to March 2021, 68 cases of patients with intracranial tumors who were diagnosed and treated in our hospital were selected as the research objects. All patients were given CT combined with MR dynamic scans, recorded the ADC value and judged the diagnostic value. **Results:** There were 38 cases were pathologically diagnosed as glioma (glioma group), and 30 cases of non-glioma (non-glioma group) in the 68 cases. The CT hemorrhage, edema, cross-midline, boundary, unclear features compared between the glioma group and the non-glioma group were differences ($P<0.05$). The glioma group were mostly showed low signal on T1WI and high signal on T2WI, while the non-glioma group were showed mostly low signal on T1WI or low signal and high signal on T2WI., compared the difference were statistically significant ($P<0.05$). The MR ADC_{max}, ADC_{median} and ADC_{min} of the glioma group were lower than those of the non-glioma group ($P<0.05$). There were 37 cases of glioma were diagnosed by CT combined with MR dynamic scanning, and 31 cases were non-glioma. The sensitivity and specificity of CT combined with MR dynamic scanning in the diagnosis of glioma were 97.4%(37/38) and 100.0%(30/30). **Conclusion:** CT combined with MR dynamic scanning have good sensitivity and specificity in the diagnosis of glioma. ADC value can effectively reflect the pathological characteristics of the lesion tissue, providing safe and effective clinical imaging method for glioma.

Key words: Computed tomography; Nuclear magnetic resonance; Apparent diffusion coefficient; Glioma

Chinese Library Classification(CLC): R739.4; R445 **Document code:** A

Article ID: 1673-6273(2022)16-3061-04

前言

胶质瘤全称为神经胶质瘤,为常见的颅内肿瘤之一,约占

原发中枢神经系统肿瘤的80.0%左右^[1,2]。脑胶质瘤起源于神经间质细胞成分,病理类型包括多形性胶质母细胞瘤、星形细胞瘤、室管膜瘤、少枝胶质细胞瘤等^[3]。胶质瘤的病理特征为复发

* 基金项目:新疆维吾尔自治区卫生健康青年医学科技人才专项科研项目(WJWY-202209)

作者简介:赵智强(1981-),男,本科,主治医师,研究方向:CT MRI 诊断,电话:13579283980, E-mail:zhaozhiqiang81@163.com

[△] 通讯作者:陈欢(1982-),女,本科,主治医师,研究方向:磁共振动态增强-灌注加权成像联合 noddi 技术对脑胶质瘤分级诊断的初步研究,电话:15699107710, E-mail:chenhuan198208@163.com

(收稿日期:2021-11-23 接受日期:2021-12-18)

性高,肿瘤新生血管增殖能力强,早期诊断对改善患者预后具有重要价值^[4]。手术难以全部切除胶质瘤的病灶组织,多数患者在术后易发生复发与转移^[5]。放疗能提高胶质瘤患者的生存率,但该方法需对复发的肿瘤和放射性脑损伤进行鉴别,为此对于诊断要求也较高。电子计算机断层扫描(Computed Tomography, CT)检查可明确胶质瘤的大小、形态、数目、位置以及与邻近脑组织的关系等,但依然存在病灶辨识度不高、显像不清晰等不足^[6]。随着医学技术的发展,当前核磁共振(Magnetic Resonance, MR)已被广泛应用,能清楚显示肿瘤病变和周围结构的关系,也具有空间分辨率高、无电离辐射等优点,特别是 MR 弥散加权成像(Diffusion weighted imaging, DWI)能反映病灶组织中水分子的弥散运动,而水分子运动状态与病灶组织所处的环境、病理改变有关,为此可间接反映病灶组织的病理特点^[7,8]。分子的弥散状态可用表观弥散系数(Apparent diffusion coefficient, ADC)进行量化,通过测量 ADC 值,能有效反映病灶组织的水肿、坏死情况,也是常规 MR 的有效补充^[9-11]。本文具体探讨了胶质瘤中 CT 联合 MR 动态扫描的诊断价值及其 ADC 定量价值,以促进胶质瘤的有效早期诊断。现报道如下。

1 资料与方法

1.1 研究对象

2017 年 4 月到 2021 年 3 月选择在本院进行诊治的颅内肿瘤患者 68 例作为研究对象。

纳入标准:检查前未经任何手术、化疗、放疗及其他抗肿瘤治疗;医院伦理委员会批准了此次研究;临床表现为头晕、头痛、肢体麻木、肌力减低等症状;无 CT 与 MR 检查禁忌症;可以耐受并配合检查;患者知情并同意本研究。

排除标准:妊娠与哺乳期妇女;合并其他部位恶性肿瘤者;影像学图像不清晰者;合并原发性心肝肾异常者。

1.2 CT 联合 MRI 动态扫描方法

所有患者均给予 CT 联合 MRI 动态扫描检查,在 CT 检查中,患者仰卧位平躺于固定底板,采用头颈肩热塑膜低温固定,贴好金属标记点,在面膜上勾画好定位线。使用 GE 公司的双源 CT,扫描范围为全脑,扫描参数:螺旋扫描,螺距 3.0,层厚 2.5 mm,120 kV,180 mAs,扫描后图像进行迭代重建。

在 MR 扫描中,选择 Philips 公司生产的 1.5T 核磁共振仪,

患者取仰卧位,双上肢置于身体两旁。T1WI 扫描参数:TR=2045 ms,TE=120 ms,FOV=230×230 mm,矩阵=356×215,层厚=5.5 mm,层间隔=1 mm,层数=21。T2WI 扫描参数:TE=120 ms,TR=9000 ms,FOV=230×230 mm,矩阵=356×215,层厚=5.5 mm,层间隔=1 mm,层数=21。

DWI 扫描采用回波平面成像(Echoplanar imaging, EPI),TR=2150 ms,TE=56 ms;梯度磁场从 x、y、z 轴 3 个方向上施加,b 值=700 s/mm²,矩阵 512×512,FOV=220×220 mm,层厚=3 mm。

1.3 观察指标

1.3.1 CT 参数 避开坏死囊变区域来勾画感兴趣区(Region of interest, ROI),记录病灶部位常规 CT 成像特征,包括 CT 密度、强化、形态等。

1.3.2 记录信号特征 记录两组的常规 MR 信号特征,包括 T1WI 信号、T2WI 信号特征等。1.3.3 记录 ADC 值 将 MI DWI 原始图像传至后处理工作站,每个部位选择 2-3 个感兴趣,并避开出血、血管及坏死区域,生成 ADC 直方图,记录 ADC 最大值(ADCmax)、中位数(ADCmedian)、最小值(ADCmin)等指标,每个部位测量三次取平均值。

1.3.3 联合诊断标准 胶质瘤:病灶存在占位效应,影像学检查显示病灶有进行性增大。非胶质瘤:病灶无变化或逐渐缩小,病灶周围水肿及占位效应逐渐减轻。由影像科有经验(工作经验≥5 年)的神经影像诊断医生 2 名,在不知病理结果的情况下进行诊断,以取得一致意见为准。所有患者给予手术病理检查,以病理检查作为诊断的金标准。

1.4 统计方法

本次研究统计软件为 SPSS22.00,计量数据以均数±标准差表示,计数数据采用百分比、率与例数表示,对比方法为 t 检验、卡方 χ^2 检验分析等,检验水准 $\alpha=0.05$ 。

2 结果

2.1 一般资料对比

在 68 例患者中,病理诊断为胶质瘤 38 例(胶质瘤组),非胶质瘤 30 例(非胶质瘤组)。胶质瘤组的性别、年龄、体重指数、收缩压、舒张压、发病到就诊时间等对比差异无统计学意义($P>0.05$)。见表 1。

表 1 两组一般资料对比

Table 1 Comparison of general data between the two groups

Groups	n	Gender (Male/female)	Age (years)	Body mass index (kg/m ²)	Systolic blood pressure (mmHg)	Diastolic blood pressure (mmHg)	Time from onset to visit (d)
Glioma group	38	20/18	54.92± 3.48	21.48± 1.47	124.11± 10.22	78.13± 5.55	11.83± 1.37
Non-glioma group	30	16/14	54.29± 4.15	21.33± 1.20	124.29± 9.18	78.22± 4.51	11.29± 2.16

2.2 CT 特征对比

胶质瘤组的 CT 出血、水肿、跨中线、界限不清等特征与非胶质瘤组对比有差异($P<0.05$)。见表 2。

2.3 MRI 常规特征对比

胶质瘤组多表现为 T1WI 低信号、T2WI 高信号,非胶质瘤

组多表现为 T1WI 等信号或低信号、T2WI 高信号,对比有差异($P<0.05$)。见表 3。

2.4 ADC 值对比

胶质瘤组的 MR ADCmax、ADCmedian、ADCmin 低于非胶质瘤组($P<0.05$)。见表 4。

表 2 两组 CT 特征对比(n)

Table 2 Comparison of CT features between the two groups (n)

Groups	n	Bleeding	Edema	Across the center line	Boundary is not clear
Glioma group	38	22(57.9%)*	19(50.0%)*	31(81.6%)*	35(92.1%)*
Non-glioma group	30	8(26.7%)	8(26.7%)	13(43.3%)	18(60.0%)

Note: compared with the Non-glioma group, * $P<0.05$.

表 3 两组 MRI 常规影像对比(n)

Table 3 Comparison of conventional MRI images between the two groups (n)

Groups	n	T1WI(low signal/equal signal/high signal)	T2WI(low signal/equal signal/high signal)
Glioma group	38	36/1/1*	34/4/0*
Non-glioma group	30	3/14/13	3/3/24

Note: compared with the Non-glioma group, * $P<0.05$.

表 4 两组 MRI ADC 值对比($10^{-3} \text{ mm}^2/\text{s}$, 均数 $\pm$ 标准差)Table 4 Comparison of MRI ADC values between the two groups ($10^{-3} \text{ mm}^2/\text{s}$, mean $\pm$ standard deviation)

Groups	n	ADCmax	ADCmean	ADCmin
Glioma group	38	1.15 $\pm$ 0.24*	0.87 $\pm$ 0.11*	0.64 $\pm$ 0.12*
Non-glioma group	30	2.43 $\pm$ 0.49	1.54 $\pm$ 0.34	0.86 $\pm$ 0.21

Note: compared with the Non-glioma group, * $P<0.05$.

2.5 诊断价值

在 68 例患者中,胶质瘤中 CT 联合 MR 动态扫描诊断为胶质瘤 37 例,非胶质瘤 31 例,CT 联合 MR 动态扫描诊断胶质

瘤的敏感性与特异性为 97.4 % (37/38) 和 100.0 % (30/30)。见表 5。

表 5 CT 联合 MR 动态扫描诊断胶质瘤的敏感性与特异性(n)

Table 5 Sensitivity and specificity of CT combined with MR dynamic scan in diagnosis of glioma (n)

Pathology	Combined diagnosis		Summation
	Glioma	Non-glioma	
Glioma	37	1	38
Non-glioma	0	30	30
Summation	37	31	68

3 讨论

胶质瘤是人体常见肿瘤,也是颅内肿瘤的主要组成部分,病理特点呈多样性,表现为细胞核多形性与有丝分裂活跃性^[12]。由于胶质瘤的不均质性,肿瘤常呈浸润性生长,肿瘤与正常脑组织分界不清,手术很难完全切除病灶而导致对残存的肿瘤无法评估,最终影响患者预后^[13,14]。部分非胶质瘤患者也表现为占位效应、水肿以及病灶强化等,导致临床诊断困难^[15]。

本文通过分组具体探讨了胶质瘤中 CT 联合 MR 动态扫描的诊断价值及其 ADC 定量价值,旨在为胶质瘤的有效早期诊断提供一定的参考。研究结果显示:胶质瘤组的 CT 出血、水肿、跨中线、界限不清等特征与非胶质瘤组对比有差异。这一结果与 Alongi P^[16]的报道具有一致性。从机制上分析,CT 能清楚显示肿瘤病变和周围结构的关系,对软组织特别是肿瘤与组织水肿边界较敏感。但 CT 很难直接反映肿瘤的微血管密度或新

生血管的程度,不能准确反应脑肿瘤组织的物质代谢、血管生成等特征,存在一定的诊断不足^[17];胶质瘤组多表现为 T1WI 低信号、T2WI 高信号,而非胶质瘤组多表现为 T1WI 等信号或低信号、T2WI 高信号,对比有差异。表明 MR 对胶质瘤有一定的鉴别诊断价值,但无法进行定量分析。这一结果与 Wu W^[18]的研究结果具有一致性。进一步分析可知:MR 扫描是胶质瘤的诊断手段,胶质瘤的病理特点取决于胶质瘤的临床分期及脑组织成熟度,主要为轴突病变、髓鞘合成延迟以及星形胶质细胞的胶质化改变。而胶质瘤的 MR 影像学特征主要为水肿、占位效应、瘤周水肿、出血坏死、囊实性肿块等,其中以占位效应为主要鉴别点,但很难量化^[19,20];胶质瘤组的 MR ADCmax、ADCmedian、ADCmin 均低于非胶质瘤组。这一结果与 He YX^[21]的研究结果具有一致性。分析其原因可知:MR DWI 为可探测活体组织微观结构的高级磁共振成像技术,反映了人体病理生理状态下各组织成分间水分子交换的功能状况,ADC 值能全面评估

水分子的扩散运动状况^[22]。当质子沿梯度场进行弥散运动时,在回波时间内相位分散不能完全重聚,自旋频率将发生改变,进而导致信号下降^[23,24]。胶质瘤的瘤体可使局部脑组织的水分子扩散能力发生变化,导致 ADC 值降低。同时胶质瘤恶性程度越高,细胞数目将剧增,进而对周围组织产生严重的侵袭性。且同一病灶内可有多个分化级别的胶质瘤细胞,导致水分子扩散能力更加受到限制,最终造成 ADC 值降低^[25];本研究显示:CT 联合 MR 动态扫描诊断胶质瘤的敏感性与特异性为 97.4 % (37/38)和 100.0 % (30/30)。这一结果与 Rani N^[26]的研究结果具有相似性。分析其原因可知:胶质瘤与非胶质瘤患者均可出现肢体运动障碍、头痛、恶心等颅内压增高表现,临床症状基本相似,在临床上鉴别较困难^[27,28]。常规 CT 与 MR 诊断无法进行量化分析,且 MR 图像中所观察到的病灶强化区域并不一定代表病灶瘤恶性程度较高的区域,同样无明显增强的病灶瘤组织也存在较丰富血供的可能^[29]。CT 与 MR 联合使用可提供互补信息,更加精确地判定病灶病理特征,并做出较准确的诊断^[30,31]。本研究也存在一定不足,未纳入拥有正常脑组织的人群,也未进行 CT 定量学分析与影响因素分析,将在后续研究中进行探讨。

综上所述,CT 联合 MR 动态扫描诊断胶质瘤具有很好的敏感性与特异性,ADC 值能有效反映病灶组织的病理特征,为临床上提供了一种安全、有效的胶质瘤影像检查方法。

参考文献(References)

- [1] Flores-Toro J A, Luo D, Gopinath A, et al. CCR2 inhibition reduces tumor myeloid cells and unmasks a checkpoint inhibitor effect to slow progression of resistant murine gliomas[J]. *Proc Natl Acad Sci U S A*, 2020, 117(2): 1129-1138
- [2] Ghasemi D R, Sill M, Okonechnikov K, et al. MYCN amplification drives an aggressive form of spinal ependymoma [J]. *Acta Neuropathol*, 2019, 138(6): 1075-1089
- [3] Goryawala M, Saraf-Lavi E, Nagornaya N, et al. The Association between Whole-Brain MR Spectroscopy and IDH Mutation Status in Gliomas[J]. *J Neuroimaging*, 2020, 30(1): 58-64
- [4] Harutyunyan A S, Krug B, Chen H, et al. H3K27M induces defective chromatin spread of PRC2-mediated repressive H3K27me2/me3 and is essential for glioma tumorigenesis [J]. *Nat Commun*, 2019, 10(1): 1262-1268
- [5] Aliotta E. Molecular Subtype Classification in Lower-Grade Glioma with Accelerated DTI [J]. *AJNR Am J Neuroradiol*, 2019, 40 (9): 1458-1463
- [6] Bohner G, Siebert E, Brenner W, et al. Long-term neurocognitive and other side effects of radiotherapy, with or without chemotherapy, for glioma[J]. *Sci Rep*, 2019, 8(8): 13047
- [7] Breckwoldt M O, Bode J, Sahn F, et al. Correlated MRI and Ultramicroscopy (MR-UM) of Brain Tumors Reveals Vast Heterogeneity of Tumor Infiltration and Neoangiogenesis in Preclinical Models and Human Disease[J]. *Magn Reson Med*, 2018, 12(9): 1004
- [8] Dou W, Lin C E, Ding H, et al. Chemical exchange saturation transfer magnetic resonance imaging and its main and potential applications in pre-clinical and clinical studies[J]. *AJNR Am J Neuroradiol*, 2019, 9(10): 1747-1766
- [9] Hwang I. Dynamic Contrast-Enhanced MR Imaging of Nonenhancing T2 High-Signal-Intensity Lesions in Baseline and Posttreatment Glioblastoma: Temporal Change and Prognostic Value [J]. *NMR Biomed*, 2020, 41(1): 49-56
- [10] Jiang S, Eberhart C G, Lim M, et al. Identifying Recurrent Malignant Glioma after Treatment Using Amide Proton Transfer-Weighted MR Imaging: A Validation Study with Image-Guided Stereotactic Biopsy [J]. *Acta Neuropathol*, 2019, 25(2): 552-561
- [11] Law I, Albert N L, Arbizu J, et al. Joint EANM/EANO/RANO practice guidelines/SNMMI procedure standards for imaging of gliomas using PET with radiolabelled amino acids and [(18)F]FDG: version 1.0[J]. *Eur J Nucl Med Mol Imaging*, 2019, 46(3): 540-557
- [12] Lohmeier J. Quantitative biparametric analysis of hybrid (18)F-FET PET/MR-neuroimaging for differentiation between treatment response and recurrent glioma[J]. *Radiology*, 2019, 9(1): 14603
- [13] Maudsley A A. Lesion segmentation for MR spectroscopic imaging using the convolution difference method[J]. *AJNR Am J Neuroradiol*, 2019, 81(3): 1499-1510
- [14] Mitchell D A, Harrison J K, Magin R L, et al. Capturing complexity of the diffusion-weighted MR signal decay[J]. *Proc Natl Acad Sci U S A*, 2019, 56(3): 110-118
- [15] Ohno M, Matsuzaki J, Kawauchi J, et al. Assessment of the Diagnostic Utility of Serum MicroRNA Classification in Patients With Diffuse Glioma[J]. *JAMA Netw Open*, 2019, 2(12): e1916953
- [16] Alongi P, Vetrano IG, Fiasconaro E, et al. Choline-PET/CT in the Differential Diagnosis Between Cystic Glioblastoma and Intracranial Hemorrhage[J]. *Curr Radiopharm*, 2019, 12(1): 88-92
- [17] He X, Liu M, Zhang M, et al. A novel three-dimensional template combined with MR-guided 125I brachytherapy for recurrent glioblastoma[J]. *Radiat Oncol*, 2020, 15(1): 146
- [18] Wu W, Li J, Ye J, et al. Differentiation of Glioma Mimicking Encephalitis and Encephalitis Using Multiparametric MR-Based Deep Learning[J]. *Front Oncol*, 2021, 15(11): 639062
- [19] Stichel D, Schrimpf D, Coras R, et al. Hyperpolarized Pyruvate MR Spectroscopy Depicts Glycolytic Inhibition in a Mouse Model of Glioma[J]. *Acta Neuropathol*, 2019, 293(1): 168-173
- [20] Suero Molina E, Schipmann S, Stummer W. Maximizing safe resections: the roles of 5-aminolevulinic acid and intraoperative MR imaging in glioma surgery-review of the literature [J]. *Neurosurg Rev*, 2019, 42(2): 197-208
- [21] He YX, Qu CX, He YY, et al. Conventional MR and DW imaging findings of cerebellar primary CNS lymphoma: comparison with high-grade glioma[J]. *Sci Rep*, 2020, 10(1): 10007
- [22] Tsiouris S, Bougias C, Fotopoulos A. Principles and current trends in the correlative evaluation of glioma with advanced MRI techniques and PET[J]. *Hell J Nucl Med*, 2019, 22(3): 206-219
- [23] Wefers A K. Isomorphic diffuse glioma is a morphologically and molecularly distinct tumour entity with recurrent gene fusions of MYBL1 or MYB and a benign disease course[J]. *Nat Commun*, 2020, 13(1): 193-209
- [24] Behr S C, Villanueva-Meyer J E, Li Y, et al. Targeting iron metabolism in high-grade glioma with 68Ga-citrate PET/MR[J]. *Neurooncol Adv*, 2018, 3(21): 789-793
- [25] Laws M T. Noninvasive quantification of SIRT1 expression-activity and pharmacologic inhibition in a rat model of intracerebral glioma using 2-[(18)F]BzAHA PET/CT/MRI[J]. *BMC Med Imaging*, 2020, 2(1): 6

- [11] 刘瀚旻, 马融. 儿童肺炎支原体肺炎中西医结合诊治专家共识 (2017 年制定)[J]. 中国实用儿科杂志, 2017, 32(12): 881-885
- [12] 余蓉, 梁美婷, 曹正, 等. 肺炎支原体肺炎伴喘息儿童血清 25(OH) D₃、Th17/Treg 表达水平与肺功能的关系[J]. 现代生物医学进展, 2020, 20(14): 2723-2727
- [13] Pánisová E, Unger WWJ, Berger C, et al. Mycoplasmapneumoniae-Specific IFN- γ -Producing CD4⁺ Effector-Memory T Cells Correlate with Pulmonary Disease[J]. Am J Respir Cell Mol Biol, 2021, 64(1): 143-146
- [14] Luo Y, Li C, Zhou Z, et al. Biological functions of IL-17-producing cells in mycoplasma respiratory infection[J]. Immunology, 2021, 164(2): 223-230
- [15] Martínez-Calle M, Parra-Ortiz E, Cruz A, et al. Towards the Molecular Mechanism of Pulmonary Surfactant Protein SP-B: At the Crossroad of Membrane Permeability and Interfacial Lipid Transfer [J]. J Mol Biol, 2021, 433(3): 166749
- [16] Kishore U, Bulla R, Madan T. Editorial: Odyssey of Surfactant Proteins SP-A and SP-D: Innate Immune Surveillance Molecules [J]. Front Immunol, 2020, 11(11): 394
- [17] Pilecki B, Wulf-Johansson H, Støttrup C, et al. Surfactant Protein D Deficiency Aggravates Cigarette Smoke-Induced Lung Inflammation by Upregulation of Ceramide Synthesis [J]. Front Immunol, 2018, 9(18): 3013
- [18] Li D, Pan L, Zhang X, et al. Lower Oligomeric Form of Surfactant Protein D in Murine Acute Lung Injury Induces M1 Subtype Macrophages Through Calreticulin/p38 MAPK Signaling Pathway[J]. Front Immunol, 2021, 12(16): 687506
- [19] Cao ZQ, Yu X, Leng P. Research progress on the role of gal-3 in cardio/cerebrovascular diseases[J]. Biomed Pharmacother, 2021, 133(7): 111066
- [20] Mammen MJ, Ali J, Aurora A, et al. IL-17 Is a Key Regulator of Mucin-Galectin-3 Interactions in Asthma[J]. Int J Cell Biol, 2021, 21(9): 9997625
- [21] 赵茜叶, 侍苏杰, 孙大权, 等. 难治性肺炎支原体肺炎患儿支气管肺泡灌洗液中半乳凝素 -3 水平与细胞免疫的相关性[J]. 中国当代儿科杂志, 2019, 21(2): 150-154
- [22] Lu HY, Shih CM, Huang CY, et al. Galectin-3 Modulates Macrophage Activation and Contributes Smooth Muscle Cells Apoptosis in Abdominal Aortic Aneurysm Pathogenesis [J]. Int J Mol Sci, 2020, 21(21): 8257
- [23] Tana FL, Guimarães ES, Cerqueira DM, et al. Galectin-3 regulates proinflammatory cytokine function and favours Brucella abortus chronic replication in macrophages and mice [J]. Cell Microbiol, 2021, 23(10): e13375
- [24] Niu Y, Lin J, Li C, et al. Galectin-3 plays an important pro-inflammatory role in A. fumigatus keratitis by recruiting neutrophils and activating p38 in neutrophils [J]. Int Immunopharmacol, 2021, 97(8): 107706
- [25] 乔敏, 李姗姗, 刘荣梅, 等. CC 趋化因子和 CXC 趋化因子及其受体在结核分枝杆菌感染免疫应答中作用的研究进展[J]. 细胞与分子免疫学杂志, 2021, 37(4): 373-377
- [26] Li M, Sun X, Zhao J, et al. CCL5 deficiency promotes liver repair by improving inflammation resolution and liver regeneration through M2 macrophage polarization[J]. Cell Mol Immunol, 2020, 17(7): 753-764
- [27] Zhou Z, Zhu Y, Gao G, et al. Long noncoding RNA SNHG16 targets miR-146a-5p/CCL5 to regulate LPS-induced WI-38 cell apoptosis and inflammation in acute pneumonia [J]. Life Sci, 2019, 228(1): 189-197
- [28] Liu F, Zhao Y, Lu J, et al. Hyperoside inhibits proinflammatory cytokines in human lung epithelial cells infected with Mycoplasma pneumoniae[J]. Mol Cell Biochem, 2019, 453(1-2): 179-186
- [29] Zeng Z, Lan T, Wei Y, et al. CCL5/CCR5 axis in human diseases and related treatments[J]. Genes Dis, 2022, 9(1): 12-27
- [30] Xia L, Zhu X, Zhang L, et al. EZH2 enhances expression of CCL5 to promote recruitment of macrophages and invasion in lung cancer[J]. Biotechnol Appl Biochem, 2020, 67(6): 1011-1019
- (上接第 3064 页)
- [26] Rani N, Singh B, Kumar N, et al. Differentiation of Recurrent/Residual Glioma From Radiation Necrosis Using Semi Quantitative 99mTc MDM (Bis-Methionine-DTPA) Brain SPECT/CT and Dynamic Susceptibility Contrast-Enhanced MR Perfusion: A Comparative Study [J]. Clin Nucl Med, 2018, 43(3): e74-e81
- [27] Tseng C L, Stewart J, Whitfield G, et al. Glioma consensus contouring recommendations from a MR-Linac International Consortium Research Group and evaluation of a CT-MRI and MRI-only workflow [J]. J Neurooncol, 2020, 149(2): 305-314
- [28] Abdalla G, Hammam A, Anjari M, et al. Glioma surveillance imaging: current strategies, shortcomings, challenges and outlook [J]. BJR Open, 2020, 2(1): 20200009
- [29] Andronesi O C, Mandal A S, Romero-Garcia R, et al. Genetic, cellular, and connectomic characterization of the brain regions commonly plagued by glioma[J]. Radiology, 2020, 143(11): 3294-3307
- [30] Benzakoun J, Robert C, Legrand L, et al. Anatomical and functional MR imaging to define tumoral boundaries and characterize lesions in neuro-oncology[J]. Cancer Radiother, 2020, 24(5): 453-462
- [31] Bohner G, Siebert E, Brenner W, et al. JAM-A Acts via C/EBP- α to Promote Claudin-5 Expression and Enhance Endothelial Barrier Function[J]. Sci Rep, 2020, 12(8): 1056-1073