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对比增强高分辨率 MRI 评价大脑中动脉斑块与 脑脊液炎性因子水平的相关性

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摘要 目的: 研究对比增强高分辨磁共振成像(MRI)评价的大脑动脉斑块与脑脊液中炎症因子水平的相关性。**方法:** 选择 2017 年 1 月到 2021 年 6 月在我院接受治疗的脑梗死患者 70 例, 根据其病情分为急性脑梗死组 (ACI)(n=30) 和非急性脑梗死组 (No-ACI)(n=40), 所有患者均行颅脑磁共振检测, 比较两组患者 T1 加权成像(T1WI)、T2 加权成像(T2WI)以及 T1 加权成像增强 (T1WI+E) 斑块信号和强化程度, 并比较两组患者或不同 MRI 表现患者脑脊液人肿瘤坏死因子- α (TNF- α) 和人白介素-6 (IL-6) 水平。**结果:** ACI 组和 No-ACI 组脑梗死患者在 T1WI 和 T2WI 上低信号、等信号和高信号比例无显著差异 ($P>0.05$); 而 ACI 组患者在 T2WI+E 上大脑动脉斑块无强化和轻度强化患者比例显著低于 No-ACI 组患者 ($P<0.05$), 明显强化患者比例显著高于 No-ACI 组患者 ($P<0.05$)。ACI 组患者脑脊液 TNF- α 和 IL-6 水平显著高于 No-ACI 组患者。在 T2WI+E 上, 轻度强化脑梗死患者 TNF- α 和 IL-6 含量显著高于无强化脑梗死患者 ($P<0.05$), 而显著低于明显强化组脑梗死患者 ($P<0.05$)。**结论:** 对比增强高分辨率 MRI 可有效评估大脑动脉斑块特征, 并且大脑动脉斑块强化程度与脑脊液炎症因子水平密切相关。

关键词: 磁共振成像; 动脉斑块; 脑脊液; 炎症因子

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Contrast-enhanced high-resolution MRI to Evaluate the Correlation between Middle Cerebral Artery Plaque and Cerebrospinal Fluid Inflammatory Factors

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ABSTRACT Objective: To study the correlation between cerebral artery plaques evaluated by contrast-enhanced high-resolution magnetic resonance image (MRI) and the levels of inflammatory factors in cerebrospinal fluid. **Methods:** 70 patients with cerebral infarction who were treated in our hospital from January 2017 to June 2021 were selected and divided into acute cerebral infarction group (ACI) (n=30) and non-acute cerebral infarction group (No-ACI) according to their condition (N=40), all patients underwent cranial magnetic resonance detection, and compared the two groups of patients with T1 weighted image (T1 Weighted image, T1WI), T2 weighted image (T2 Weighted image, T2WI) and T1 weighted image enhancement (T1 Weighted image) enhanced, T1WI+E) plaque signal and degree of enhancement, and compare the levels of TNF- α and IL-6 in the cerebrospinal fluid of the two groups of patients or patients with different MRI findings. **Results:** There was no difference in the proportions of low signal, iso-signal and high signal on T1WI and T2WI in patients with cerebral infarction in the ACI group and No-ACI group ($P>0.05$); while in the ACI group, there was no enhancement and mild cerebral artery plaque on T2WI+E. The proportion of patients with high degree of enhancement was lower than that of patients in the No-ACI group ($P<0.05$), and the proportion of patients with enhancement was higher than that of patients in the No-ACI group ($P<0.05$). The levels of TNF- α and IL-6 in the cerebrospinal fluid of the ACI group were higher than those of the No-ACI group. On T2WI+E, the levels of TNF- α and IL-6 in patients with mildly enhanced cerebral infarction were higher than those in patients with non-enhanced cerebral infarction ($P<0.05$), and lower than those in patients with enhanced cerebral infarction ($P<0.05$). **Conclusion:** Contrast-enhanced high-resolution MRI can effectively assess the characteristics of cerebral artery plaque, and the degree of cerebral artery plaque enhancement is closely related to the level of inflammatory factors in cerebral effusion.

Key words: Magnetic resonance imaging; Arterial plaque; Cerebrospinal fluid; Inflammatory factor

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前言

颅内动脉疾病,包括脑梗死、脑卒中以及脑出血等都是颅内动脉硬化引起的。脑动脉粥样硬化是以进行性脂质沉积、纤维组织增生和炎性细胞浸润为特征的累及全身大、中型弹性和肌性动脉的慢性疾病在脑供血动脉系统中的表现^[1-3]。研究显示:颅内动脉硬化性疾病的发病率具有明显的年龄、性别和种族差异^[4,5];在中国,路内动脉硬化性疾病发病年龄在40岁以上,并且发病率随年龄增长而增高,以男性患者多见,北方病患比例高于南方^[6,7]。此外,流行病学数据显示:尽管目前缺乏颅内动脉硬化的流行病学资料,但约30%的脑卒中由颅内动脉粥样硬化引起,而脑卒中的发病率高达246.8/10万人,并且死亡率高达114.8/10万人年^[8,9]。研究表明,不稳定的动脉粥样硬化斑块是引起缺血性脑卒中的主要危险因素,所以评估大脑动脉斑块的稳定性不仅可以预防缺血性脑卒中的发生,而且有助于提高缺血性脑卒中的临床治疗疗效^[10,11]。炎症反应已经被证实与动脉粥样硬化斑块不稳定性、以及斑块发生和破裂有关,并且新生血管又会进一步促进斑块内出现和破裂^[12,13]。然而,高分辨率磁共振成像技术只能检测出斑块内出血和破裂,不能显示出斑块内的血管新生,但增强高分辨率磁共振成像技术可以显示出斑块内的血管新生,以此间接评估斑块的稳定性^[14]。本研究通过高分辨率磁共振成像技术对大脑动脉斑块信号和强化程度进行评估,并分析其与患者脑脊液炎症因子的相关性,为临床评估颅内动脉斑块稳定性提供新的参考依据。

1 资料与方法

1.1 一般资料

选择2017年1月到2021年6月在我院接受治疗的脑梗死患者70例,其中男38例,女32例,年龄45-68岁,平均年龄(54.81±10.35)岁,饮酒42例、吸烟39例、合并高血压51例和合并糖尿病29例。根据70例脑梗死患者将其分为急性脑梗死组(ACI组),30例,和非急性脑梗死组(No-ACI组),40例。两

组患者一般资料上比较无显著差异,具有可比性($P>0.05$)。此外,所有参与本次研究的患者或患者家属均对本次研究内容知情,且签订知情同意书。本研究经本院伦理委员会批准。

纳入标准:诊断为脑梗死的患者^[15];资料完整;首次发病且年龄在18岁以上。

排除标准:患有癌症或者存在免疫系统疾病的患者;有严重肝肾功能不全等系统性疾病的患者;严重感染病发患者。

1.2 磁共振成像检测方法^[16]

所有患者行颅脑进行磁共振成像(Magnetic resonance image, MRI)检测,检测仪器为飞利浦1.5T MR检测仪,八通道线圈,3D-TOF MRA图像定位,垂直于动脉狭窄处进行血管壁扫描,包括加黑血技术T1加权成像(T1 Weighted image, T1WI)、T2加权成像(T2 Weighted image, T2WI)以及T1加权成像增强(T1 Weighted image enhanced, T1WI+E)。

1.3 脑脊液炎症因子检测方法

所有患者在行MRI检测后,取脑脊液离心以收集上清,通过人肿瘤坏死因子- α (tumor necrosis factor- α , TNF- α)ELISA检测试剂盒(JL13413,昆明皇宝商贸有限公司)检测脑脊液中TNF- α 含量,通过人白介素-6(Interleukin-6, IL-6)检测试剂盒(PI330,碧云天生物技术有限公司)检测脑脊液中IL-6含量。

1.4 统计学方法

使用SPSS20.0软件对本研究数据进行记录和统计学分析,以百分比(%)表示计数资料,卡方检验比较两组患者计数资料差异;以(均值±标准差)计量资料,t检验比较两组患者计量资料差异,单因素方差分析比较多组间计量资料差异。 $P<0.05$ 表示差异显著具有统计学意义。

2 结果

2.1 两组未增强MRI斑块信号比较

比较两组患者MRI检测T1和T2加权成像大脑中动脉斑块信号,结果显示:两组患者T1WI和T2WI上低信号、等信号和高信号患者比例无显著差异($P>0.05$)。具体如表1和表2所示。

表1 两组T1加权成像斑块信号对比[n(%)]

Table 1 Comparison of plaque signal between two groups of T1-weighted imaging[n(%)]

Groups	n	T1WI		
		Low signal	Equal signal	High signal
ACI group	30	0 (0.00)	15 (50.00)	15 (50.00)
No-ACI group	40	1 (2.50)	23 (57.50)	16 (40.00)

表2 两组T2加权成像斑块信号对比[n(%)]

Table 2 Comparison of plaque signal between two groups of T2-weighted imaging[n(%)]

Groups	n	T2WI		
		Low signal	Equal signal	High signal
ACI group	30	11(30.00)	6(20.00)	13(50.00)
No-ACI group	40	23(62.50)	7(17.50)	10(20.00)

2.2 两组T1WI增强MRI斑块强化程度比较

比较两组患者MRI检测增强T1加权成像大脑中动脉斑

块信号强化程度,结果显示:急性脑梗死组患者在T2WI+E上大脑动脉斑块无强化和轻度强化患者比例显著低于非急性脑

梗死组患者($P<0.05$),而急性脑梗死组患者在 T2WI+E 上大脑 ($P<0.05$)。具体如表 3 所示。
动脉斑块明显强化患者比例显著高于非急性脑梗死组患者

表 3 两组增强 T1 加权成像斑块强化程度对比[n(%)]

Table 3 Comparison of plaque enhancement degree between two groups of enhanced T1-weighted image[n(%)]

Groups	n	T2WI+E		
		No reinforcement	Mild reinforcement	High reinforcement
ACI group	30	5(16.67)*	3(10.00)*	22(73.33)*
No-ACI group	40	25(72.5)	12(20.00)	3(7.50)

Note: Compared with the No-ACI group, * $P<0.05$.

2.3 两组脑脊液炎症因子水平比较

比较两组患者脑脊液中 TNF- α 和 IL-6 含量,结果显示:急

性脑梗死组患者脑脊液中 TNF- α 和 IL-6 含量均显著高于非急性脑梗死患者($P<0.05$)。具体如表 4 所示。

表 4 两组脑脊液 TNF- α 和 IL-6 水平对比(pg/mL, $\bar{x}\pm s$)Table 4 Comparison of the levels of TNF- α and IL-6 in cerebrospinal fluid between the two groups (pg/mL, $\bar{x}\pm s$)

Groups	n	TNF- α	IL-6
ACI group	30	898.65 $\pm$ 102.35	653.28 $\pm$ 95.67
No-ACI group	40	237.12 $\pm$ 39.67*	159.65 $\pm$ 26.38*

Note: Compared with the No-ACI group, * $P<0.05$.

2.4 不同 T1WI 增强 MRI 斑块强化程度患者脑脊液炎症因子水平比较

根据增强 T1 加权成像分析大脑中动脉斑块信号强化程度结果将 70 例脑梗死患者分为无强化组、轻度强化组和明显组,

比较三组间脑梗死患者脑脊液中 TNF- α 和 IL-6 含量,结果显示轻度强化组脑梗死患者 TNF- α 和 IL-6 含量显著高于无强化组脑梗死患者 ($P<0.05$),而显著低于明显强化组脑梗死患者 ($P<0.05$)。具体如表 5 所示。

表 5 不同 T1WI 增强 MRI 斑块强化程度患者脑脊液 TNF- α 和 IL-6 水平对比 (pg/mL, $\bar{x}\pm s$)Table 5 Comparison of TNF- α and IL-6 levels in cerebrospinal fluid of patients with different T1WI-enhanced MRI plaque enhancement (pg/mL, $\bar{x}\pm s$)

Groups	n	TNF- α	IL-6
No reinforcement	30	203.35 $\pm$ 65.82	162.32 $\pm$ 49.65
Mild reinforcement	15	350.36 $\pm$ 123.39*	239.12 $\pm$ 61.28*
High reinforcement	25	1056.21 $\pm$ 252.32**	693.26 $\pm$ 101.38**

Note: Compared with No reinforcement group, * $P<0.05$; Compared with Mild reinforcement group, ** $P<0.05$.

3 讨论

有效评估大脑动脉粥样硬化斑块的稳定性不仅有助于预防脑卒中的发生,而且对卒中发生后的临床治疗与预后具有重要的参考价值。常规磁共振成像技术虽然可以显示血管内狭窄程度,却不能将血管内的斑块以及血管壁的特征显示出来。高分辨率磁共振成像(High Resolution Magnetic Resonance Imaging, HRMRI)是一种相较于普通磁共振成像技术磁场更强大的磁共振成像技术,其成像的分辨率更高,主要应用于血管壁检查,可确定血管壁斑块的具体位置,了解血管斑块是否稳定,是否有新生小血管形成及对血管的重新塑造,可较好的指导介入治疗,降低手术风险^[17,18];还可对脑血管病因做鉴别诊断,如血管炎、脑血管后部收缩、可逆性脑血管后部收缩综合征、烟雾病及烟雾综合征等疾病鉴别提供较好的影像病理学帮助^[19,20]。

本研究通过高分辨率磁共振成像技术对急性脑梗死和非

急性脑梗死患者进行颅脑动脉检测,结果显示两组脑梗死患者在 T1WI 和 T2WI 上低信号、等信号和高信号比例无显著差异,而在增强 T1WI 上斑块强化程度存在明显差异,这一结果表明增强高分辨率磁共振成像技术可区分脑梗死患者斑块强化程度。这一结果与 Scheffler M 等人^[21]的研究一致,即急性脑梗死患者和非急性脑梗死患者经高分辨率 MRI 检测在 T1WI 和 T2WI 上大脑动脉斑块信号无显著差异,而增强 T1WI 上斑块强化程度差异显著。进一步分析可知:高分辨率 MRI 可以有效的将血管壁、斑块特征显示出来,但其却不能很好的显示出斑块内血管新生的情况,而新生血管由于血管壁较薄而进一步引起脂质和炎症因子的聚集而引起斑块不稳定^[22,23]。而增强高分辨率 MRI 可以利用新生血管壁较薄的特征,利用造影剂的增强效果而强化斑块,进而可以达到间接评估斑块稳定性的作用^[24,25]。

动脉粥样硬化是动脉管壁上沉积了一层脂类,使动脉弹性减低、管腔变窄的病变。因此,过去一直认为动脉硬化斑块的形

成,是来源于血液中的脂肪。然而,近期研究发现,动脉硬化斑块是来自血管壁的死细胞,这些死细胞是由病毒、细菌和颗粒物引起的炎症反应所引起的凋亡或坏死,最终被免疫系统降解,从而出现了“细胞碎片”附着,导致动脉内壁增厚,最终形成越来越大的斑块^[26,27]。因此,炎症反应在动脉斑块的形成、稳定性以及斑块破裂过程中均发挥重要的作用。本文比较急性脑梗死和非急性脑梗死患者脑脊液炎症因子水平发现,急性脑梗死患者脑脊液 TNF- α 和 IL-6 水平均显著高于非急性脑梗死患者,这表明颅内动脉斑块的稳定性越差脑脊液炎症水平越高。这一结果与张海鹰等人^[28]以及 Zhou D 等人^[29]研究结果一致,即血清炎症因子与患者动脉粥样硬化斑块性质有着明显关系,炎症反应越强烈,斑块越不稳定。进一步分析可知:目前的研究将动脉粥样硬化疾病划归为炎症性疾病的范畴,免疫抑制剂和抗炎药物被广泛的应用于动脉粥样硬化性疾病的治疗,其可有效的维持动脉斑块的稳定性和进一步发展^[30]。

此外,本研究还发现在增强高分辨 MRI 检测上,轻度强化组脑梗死患者 TNF- α 和 IL-6 含量显著高于无强化组脑梗死患者,而显著低于明显强化组脑梗死患者。该结果与 Zhang B 等人^[31]研究结果一致。分析可知:炎症细胞浸润到斑块中不仅增加了斑块的体积,而且炎症引起的细胞损伤会引起金属蛋白酶的释放,而金属蛋白酶的释放会导致斑块纤维帽进一步薄化,这样造影剂就会更加容易的进入到斑块内,表现为强化程度增加^[32]。但需要注意的是,本次研究纳入的临床样本量较低,纳入病患疾病类型单一,所以研究结论尚需大样本量临床数据进一步验证。

综上所述:对比增强高分辨率 MRI 可有效评估大脑动脉斑块特征,并且大脑动脉斑块强化程度与脑积液炎症因子水平密切相关。

参考文献(References)

- [1] Gustavsson AM, van Westen D, Stomrud E, et al. Midlife Atherosclerosis and Development of Alzheimer or Vascular Dementia [J]. *Ann Neurol*, 2020, 87(1): 52-62
- [2] Zhang S, Wang N, Chen L, et al. Serum Aldosterone Is Associated with Cerebral Artery Atherosclerosis and Calcification [J]. *J Stroke Cerebrovasc Dis*, 2019, 28(3): 523-530
- [3] Simonetto M, Infante M, Sacco RL, et al. A Novel Anti-Inflammatory Role of Omega-3 PUFAs in Prevention and Treatment of Atherosclerosis and Vascular Cognitive Impairment and Dementia [J]. *Nutrients*, 2019, 11(10): 2279
- [4] Del Brutto OH, Mera RM, Del Brutto VJ, et al. Cerebral small vessel disease score and atherosclerosis burden - A population study in community-dwelling older adults [J]. *Clin Neurol Neurosurg*, 2020, 194 (3): 105795
- [5] Chen X, Lu D, Guo N, et al. Left ventricular ejection fraction and right atrial diameter are associated with deep regional CBF in arteriosclerotic cerebral small vessel disease[J]. *BMC Neurol*, 2021, 21(1): 67
- [6] Zhou F, Tang J, Li P, et al. Distribution of cerebral artery stenosis and risk factors in ethnic Zhuang and Han patients with ischemic stroke in Guangxi province [J]. *Ann Palliat Med*, 2020, 9(2): 256-263
- [7] Zhang K, Jiang Y, Wang Y, et al. Associations of Arterial Stiffness and Carotid Atherosclerosis with Cerebral Small Vessel Disease in a Rural Community-Based Population[J]. *J Atheroscler Thromb*, 2020, 27 (9): 922-933
- [8] Song XW, Wei CM, Xu WD, et al. Prevalence and predictors of intraplaque hemorrhage in stroke patients with intracranial atherosclerosis[J]. *Natl Med J China*, 2020, 100(33): 2622-2627
- [9] Ameriso SF, Amarenco P, Pearce LA, et al. Intracranial and systemic atherosclerosis in the NAVIGATE ESUS trial: Recurrent stroke risk and response to antithrombotic therapy [J]. *J Stroke Cerebrovasc Dis*, 2020, 29(8): 104936
- [10] Song X, Zhao X, Liebeskind DS, et al. Incremental value of plaque enhancement in predicting stroke recurrence in symptomatic intracranial atherosclerosis [J]. *Neuroradiology*, 2020, 62(9): 1123-1131
- [11] Ran Y, Wang Y, Zhu M, et al. Higher Plaque Burden of Middle Cerebral Artery Is Associated With Recurrent Ischemic Stroke: A Quantitative Magnetic Resonance Imaging Study [J]. *Stroke*, 2020, 51(2): 659-662
- [12] Back M, Yurdagul A Jr, Tabas I, et al. Inflammation and its resolution in atherosclerosis: mediators and therapeutic opportunities [J]. *Nat Rev Cardiol*, 2019, 16(7): 389-406
- [13] Ameli R, Eker O, Sigovan M, et al. Multifocal arterial wall contrast enhancement in ischemic stroke: A mirror of systemic inflammatory response in acute stroke [J]. *Rev Neurol (Paris)*, 2020, 176 (3): 194-199
- [14] Calcagno C, Pérez-Medina C, Mulder WJM, et al. Whole-Body Atherosclerosis Imaging by Positron Emission Tomography/Magnetic Resonance Imaging: From Mice to Nonhuman Primates [J]. *Arterioscler Thromb Vasc Biol*, 2020, 40(5): 1123-1134
- [15] Bao L, Zhang S, Gong X, et al. Trousseau Syndrome Related Cerebral Infarction: Clinical Manifestations, Laboratory Findings and Radiological Features[J]. *J Stroke Cerebrovasc Dis*, 2020, 29(9): 104891
- [16] Baik M, Kim KM, Oh CM, et al. Cerebral Infarction Observed on Brain MRI in Unconscious Out-of-Hospital Cardiac Arrest Survivors: A Pilot Study[J]. *Neurocrit Care*, 2021, 34(1): 248-258
- [17] Scheffler M, Pellaton A, Boto J, et al. Hemorrhagic Plaques in Mild Carotid Stenosis: The Risk of Stroke [J]. *Can J Neurol Sci*, 2021, 48 (2): 218-225
- [18] Mukherjee D, Antar V, Soylemez B, et al. High-resolution diffusion tensor magnetic resonance imaging of the brainstem safe entry zones [J]. *Neurosurg Rev*, 2020, 43(1): 153-167
- [19] Sui B, Gao P. High-resolution vessel wall magnetic resonance imaging of carotid and intracranial vessels [J]. *Acta Radiol*, 2019, 60(10): 1329-1340
- [20] Shi Z, Li J, Zhao M, Peng W, et al. Quantitative Histogram Analysis on Intracranial Atherosclerotic Plaques: A High-Resolution Magnetic Resonance Imaging Study [J]. *Stroke*, 2020, 51(7): 2161-2169
- [21] Wu Y, Wu F, Liu Y, et al. High-Resolution Magnetic Resonance Imaging of Cervicocranial Artery Dissection: Imaging Features Associated With Stroke[J]. *Stroke*, 2019, 50(11): 3101-3107
- [22] Cho SJ, Jung SC, Suh CH, et al. High-resolution magnetic resonance imaging of intracranial vessel walls: Comparison of 3D T1-weighted turbo spin echo with or without DANTE or iMSDE [J]. *PLoS One*, 2019, 14(8): e0220603

- 研究[J]. 中华物理医学与康复杂志, 2003, 25(3): 151-154
- [13] Faiz KW. VAS--visual analog scale [J]. Tidsskr Nor Laege foren, 2014, 134(3): 323
- [14] Okazaki T, Nakagawa H, Mure H, et al. Microdiscectomy and Foraminotomy in Cervical Spondylotic Myelopathy and Radiculopathy[J]. Neurol Med Chir (Tokyo), 2018, 58(11): 468-476
- [15] 杨旭, 张志利, 徐幼苗, 等. 双脉冲射频抑制神经根型颈椎病患者围手术期炎症因子释放的价值[J]. 现代生物医学进展, 2020, 20(12): 2355-2358
- [16] Dai W, Wang X, Xie R, et al. Baduanjin exercise for cervical spondylotic radiculopathy: A protocol for systematic review and meta-analysis[J]. Medicine (Baltimore), 2020, 99(18): e0037s
- [17] Bai LL, Wang WT, Wang JF, et al. Anterior Cervical Discectomy and Fusion Combined with Foraminotomy Assisted by High-Definition 3-Dimensional Exoscope in the Treatment of Cervical Spondylotic Radiculopathy Secondary to Bony Foraminal Stenosis[J]. Orthop Surg, 2021, 13(8): 2318-2326
- [18] 李建飞, 李倩, 李佳璐, 等. 悬吊推拿运动治疗颈型颈椎病的持续疗效[J]. 中国康复理论与实践, 2021, 27(7): 834-839
- [19] 龙水文, 李晋玉, 郑晨颖, 等. 脊髓型颈椎病术后脊髓神经功能康复中医治疗研究进展 [J]. 中国中医药信息杂志, 2021, 28(7): 137-140
- [20] 邓娇, 李晗, 陈赞琪, 等. 项痹病(神经根型颈椎病)中医康复诊疗方案疗效分析[J]. 颈腰痛杂志, 2021, 42(2): 199-202
- [21] 魏戌, 方圣杰, 孙凯, 等. 神经根型颈椎病中医证候研究进展[J]. 南京中医药大学学报, 2021, 37(4): 632-636
- [22] 李文浩, 牛逸群, 谭明生. 基于数据挖掘法探讨中医药治疗脊髓型颈椎病的用药规律[J]. 中医正骨, 2021, 33(1): 22-26, 33
- [23] 陈松, 金麒麟, 陈博来. 龙虎交战针法联合腰背部肌肉拉伸练习治疗腰椎间盘突出症临床效果观察 [J]. 临床误诊误治, 2021, 34(10): 99-103
- [24] 邓秀敏, 刘世巍, 雷佳, 等. 龙虎交战针法治疗痛性糖尿病周围神经病变:随机对照研究[J]. 中国针灸, 2021, 41(1): 23-26, 35
- [25] 洪秋阳, 王世广, 刘音, 等. 龙虎交战针法治疗腰椎间盘突出症急性期临床研究[J]. 中国中医急症, 2021, 30(5): 819-821, 828
- [26] 张永臣, 贾红玲, 张春晓. 龙虎交战针法治疗痛证及其机理研究[J]. 长春中医药大学学报, 2012, 28(6): 1039-1041
- [27] 任景, 李涛, 李博. 龙虎交战针法联合温针灸治疗寒湿瘀阻型坐骨神经痛的疗效及对血清 IL-6、IL-1 β 、TNF- α 水平影响 [J]. 四川中医, 2021, 39(7): 179-181
- [28] 成旭辉. 龙虎交战针法配合温针灸治疗腰椎间盘突出症 [J]. 针灸临床杂志, 2010, 26(10): 38-39
- [29] Nakajima M, Inoue M, Itoi M, et al. Clinical effect of acupuncture on cervical spondylotic radiculopathy: results of a case series [J]. Acupunct Med, 2013, 31(4): 364-367
- [30] 温雁云, 袁宜勤, 赵锋, 等. 龙虎交战针法对非特异性下背痛患者血浆 P 物质的影响[J]. 湖南中医药大学学报, 2012, 32(9): 67-69
- [31] 张永臣. 龙虎交战针法对腰椎间盘突出症患者 IgG、IgM 和补体 C3 的影响[J]. 针灸临床杂志, 2008, 24(11): 4-5

(上接第 2878 页)

- [23] Wüst RCI, Calcagno C, Daal MRR, et al. Emerging Magnetic Resonance Imaging Techniques for Atherosclerosis Imaging [J]. Arterioscler Thromb Vasc Biol, 2019, 39(5): 841-849
- [24] Vranic JE, Hartman JB, Mossa-Basha M. High-Resolution Magnetic Resonance Vessel Wall Imaging for the Evaluation of Intracranial Vascular Pathology [J]. Neuroimaging Clin N Am, 2021, 31 (2): 223-233
- [25] Xu M, He XY, Huang P. The Relationship between the Mean Platelet Volume and Carotid Atherosclerosis and Prognosis in Patients with Acute Cerebral Infarction[J]. Biomed Res Int, 2020, 30(1): 6685740
- [26] Zhao Y, Qu H, Wang Y, et al. Small rodent models of atherosclerosis [J]. Biomed Pharmacother, 2020, 129(2): 110426
- [27] 瞿媛, 顾宁. 微小 RNA 在动脉粥样硬化易损斑块中的研究进展 [J]. 中国动脉硬化杂志, 2020, 28(6): 548-552
- [28] 张海鹰, 高原. 急性脑梗死患者血清炎症因子与颈动脉粥样硬化斑块性质的关系[J]. 中国现代药物应用, 2019, 13(4): 24-25
- [29] Zhou D, Xie L, Wang Y, et al. Clinical Efficacy of Tonic Traditional Chinese Medicine Injection on Acute Cerebral Infarction: A Bayesian Network Meta-Analysis [J]. Evid Based Complement Alternat Med, 2020, 23(2): 831-835
- [30] Ruparelina N, Choudhury R. Inflammation and atherosclerosis: what is on the horizon?[J]. Heart, 2020, 106(1): 80-85
- [31] Zhang B, Di X, Song Y, Li B. Effect of Ultramicro Superparamagnetic Iron Oxide Nanoparticles on Cerebral Infarction in Mice[J]. J Nanosci Nanotechnol, 2020, 20(12): 7305-7310
- [32] Ruiz-León AM, Lapuente M, Estruch R, et al. Clinical Advances in Immunonutrition and Atherosclerosis: A Review [J]. Front Immunol, 2019, 10(1): 837