

基于脑 fMRI 技术针刺支沟穴特异性及脑网络的研究进展



李晓陵¹, 刘世平², 曹丹娜¹, 刘晓慧², 蔡丽娜², 姜晓旭², 崔璇², 刘潇^{3*}, 王丰^{1*}

作者单位: 1. 黑龙江中医药大学附属第一医院CT磁共振科, 哈尔滨 150040; 2. 黑龙江中医药大学研究生院, 哈尔滨 150040; 3. 黑龙江中医药大学附属第一医院儿科, 哈尔滨 150040

*通信作者: 刘潇, E-mail: liu_xiao@126.com; 王丰, E-mail: wfzmy123@163.com

中图分类号: R445.2; R322.81 文献标识码: A DOI: 10.12015/issn.1674-8034.2021.05.027

本文引用格式: 李晓陵, 刘世平, 曹丹娜, 等. 基于脑 fMRI 技术针刺支沟穴特异性及脑网络的研究进展[J]. 磁共振成像, 2021, 12(5): 110-113.

[摘要] 支沟穴临床疗效显著且应用普遍, 但其针刺作用机制尚不完全清楚, 功能磁共振成像(functional magnetic resonance imaging, fMRI)技术已成为研究针刺作用脑神经机制的重要手段。经过查询、整理应用脑 fMRI 技术研究针刺支沟穴的相关文献得知, 针刺支沟穴特异性激活脑区与主管胃肠道疾病相关脑区结构变化具有高度的一致性, 主治作用与脑肠轴的调节密切相关。针刺支沟穴与假穴、支沟与配穴在脑部激活区并没有明显差异, 但也存在对部分优势脑区的相对倾向性。与针刺前的纯静息态相比, 针刺支沟穴后多个脑区具有时变效应, 针刺后其受试者脑内暂时的动态平衡网络被打破, 额下回与部分脑回间形成了随时间序列变化的功能连接网络。作者通过阐述针刺支沟穴特异性脑激活区及脑网络连接变化情况来更好地指导和服务临床治疗。

[关键词] 针刺; 支沟穴; 功能磁共振成像; 特异性; 脑网络

Research progress on the specificity and brain network of acupuncture at Zhigou acupoint based on brain fMRI technology

LI Xiaoling¹, LIU Shiping², CAO Danna¹, LIU Xiaohui², CAI Lina², JIANG Xiaoxu², CUI Xuan², LIU Xiao^{3*}, WANG Feng^{1*}

¹Department of CT and MRI, the First Affiliated Hospital of Heilongjiang University of Chinese Medicine, Harbin 150040, China;

²Graduate School of Heilongjiang University of Chinese Medicine, Harbin 150040, China; ³Department of Pediatrics, the First Affiliated Hospital of Heilongjiang University of Chinese Medicine, Harbin 150040, China

*Correspondence to: Co corresponding author: Liu X, E-mail: liu_xiao@126.com. Wang F, E-mail: wfzmy123@163.com

Received 26 Jan 2021, Accepted 25 Mar 2021; DOI:10.12015/issn.1674-8034.2021.05.027

ACKNOWLEDGMENTS General Program of National Natural Science Foundation of China (No. 82074537, 81973930). General Program of Heilongjiang Natural Science Foundation (No. LH2020H103, H2016081). Harbin Science and Technology Innovation Talents Excellent Discipline Leader Fund (No. 2016RAXYJ096). Chunhui Plan of Ministry of Education (No. Z2009-1-15030). Harbin Science and Technology Innovation Talents Special Fund Project (No. 2017RAQXJ180).

Cite this article as: Li XL, Liu SP, Cao DN, et al. Research progress on the specificity and brain network of acupuncture at Zhigou acupoint based on brain fMRI technology[J]. Chin J Magn Reson Imaging, 2021, 12(5): 110-113.

Abstract The clinical effect of Zhigou point is remarkable and widely used, but the mechanism of acupuncture action is not completely clear, and functional magnetic resonance imaging (fMRI) technology has become an important means to study the mechanism of acupuncture action of brain nerve. After searching and sorting out the literatures related to acupuncture at Zhigou point by using brain fMRI technology, it is known that the specific activation of the brain area by acupuncture at Zhigou point is highly consistent with the structural changes of the brain area related to the diseases of the gastrointestinal tract, and its function is closely related to the regulation of the brain and intestine axis. There was no significant difference between acupuncture point and sham point in the brain activation area, but there was also a relative tendency to some dominant brain areas. Compared with the pure resting state before acupuncture, multiple brain regions have time-varying effects after acupuncture at Zhigou. After acupuncture, the temporary dynamic equilibrium network in the brain of the subjects was broken, and a functional connection network changing with time series was formed between the inferior frontal gyrus and part of the gyri. The purpose of this paper is to provide better guidance and service for clinical treatment by elaborating the changes of specific brain activation areas and brain network connections of acupuncture at Zhigou points.

Key words acupuncture; Zhigou point; functional magnetic resonance imaging; specificity; brain network

针灸作为祖国传统医学的重要组成部分,其历史悠久、疗效显著。针刺疗法可调达经络气血、通调人体脏腑阴阳,并且操作简便、价格低廉、效速安全,故广受学者关注临床应用普遍^[1-2],但其针刺作用机制尚不完全明确,有待后续科研工作者的努力探寻。古代文献中记载“支沟,上腕三寸,两骨之间陷者中也,为经。”现代针灸学定位是位于前臂背侧,阳池与肘尖

连线上腕背横纹上三寸,尺桡骨之间。三焦通行三气,外能通调腠理,内能畅达三焦,是气机升降的通道,支沟为三焦经之经穴是治疗便秘、顽固性呃逆、带状疱疹、尿潴留等疾病的要穴^[3-6],具有十分重要的研究价值。

功能磁共振成像(functional magnetic resonance imaging, fMRI)作为一种新兴的脑功能成像方法,其血氧水平

收稿日期: 2021-01-26 接受日期: 2021-03-25

基金项目: 国家自然科学基金面上项目(编号:82074537、81973930);黑龙江省自然科学基金项目(编号:LH2020H103、H2016081);哈尔滨市科技创新人才优秀学科带头人基金(编号:2016RAXYJ096);教育部“春晖计划”(编号:Z2009-1-15030);哈尔滨市科技创新人才专项资金项目(编号:2017RAQXJ180)

依赖成像(blood oxygenation level dependent, BOLD)是目前神经影像诊断中应用最普遍的技术方法^[7-8]。其原理是当大脑接收到外部某种刺激时,血液中含氧血红蛋白与去氧血红蛋白数目会发生相应改变,经过计算机的加工处理能将脑组织变化进行即时、可视化的反映^[9],是目前研究针刺作用机理的重要方法^[10-11]。为了进一步探明针刺腧穴的针刺作用机理,国内外学者做了大量实验研究^[12-14],笔者整理了与支沟穴相关的fMRI研究文献,旨在为临床应用针刺疗法提供丰富客观理论依据。

1 针刺支沟穴特异性研究

基于功能磁共振技术的针刺疗法与一般的针刺刺激不同,是具有特殊脑效应机理的针刺技术^[15-17]。针刺支沟穴特异性研究主要包括针刺支沟单穴的研究、针刺支沟穴与非穴的研究、针刺支沟与配穴的研究及针刺支沟穴不同针刺方法的研究。

1.1 针刺支沟单穴的研究

徐莉娜等^[18]学者对比分析针刺健康老年志愿者左侧支沟穴后脑部激活区变化情况发现,针刺支沟特异性激活了左侧颞叶、前侧扣带回及额上回等脑区,这些激活区与功能性肠道疾病的脑部结构改变区域具有一致性^[19]。有研究发现,大多数功能性胃肠道疾病的发病可能是由内脏感觉通道改变引起脑肠轴(GBA)功能失调导致的^[20]。而脑肠轴是存在于大脑和肠道功能系统之间的一个双向应答系统^[21],对机体代谢机制产生重大调控作用和深远影响。许多科学家认为大脑额叶和边缘系统的前扣带回、颞叶与GBA的功能联系紧密,是整合体内脏感觉的脑功能区^[22-23],故针刺支沟穴能够通过激活这些脑功能区来治疗胃肠道相关疾病^[24],也能推测此穴对功能性便秘的治疗可能是通过GBA的功能来起作用。有研究还表明,通过针刺支沟穴治疗便秘不仅即时效应显著,而且疗效与疗程成正比,治疗结束后疗效满意、长远^[25]。韩红艳等^[26]应用fMRI技术从脑能量代谢层面对健康受试者左侧支沟穴分别进行不同时间、区间的针刺刺激后发现,双侧楔前叶、顶下小叶、额中、上回等脑区出现正激活。研究发现楔前叶、顶下小叶和额上、中回与场景回忆、视觉语言等许多高水平认知功能及自我相关信息处理有关^[27-28],针刺支沟穴能使上述脑区出现正激活,故能够治疗由以上脑区功能减弱导致的相关疾病。上述实验结果不仅可以解释针刺支沟穴治疗疾病的机理,而且为临床针刺后留针期间的行针时间点和针刺后效应研究提供一定科学依据。

1.2 针刺支沟穴与非穴的研究

黄泳等^[29]通过观察针刺健康志愿者右侧支沟穴与非穴后脑部特异性激活区情况发现,不管针刺支沟穴还是非穴,其脑部都会表现出针刺刺激对脑区的特异性激活反应,在双侧额叶、基底节和小脑等多个脑区都有不同程度的激活。但也存在差异,主要表现在针刺支沟穴对右侧小脑、右侧枕叶及左侧颞叶激活点数相对较多。而小脑主要管控机体平衡性和调节肌张力、心血管活动,与运动性的学习记忆、语言执行、智力等功能关系密切,颞叶主要参与人体的视、听觉和记忆等功能,并参加情感调节,枕叶与平衡、视觉等功能高度相关^[30]。这也能够表明,相较于非穴而言,针刺支沟穴能够更加有倾向地表现出对上述脑区功能异常相关疾病的特异性,也能作为解释临床针刺支沟穴治疗疾病作用机制依据。

1.3 针刺支沟与配穴的研究

赖新生等^[31]学者分别对健康志愿者右侧支沟穴配伍外关穴和外关单穴进行了针刺研究,针刺后观察脑部激活区发现,两种不同针刺方案均能对双侧大脑额叶、小脑和桥脑等多个脑区有不同程度的激活。但也有一定的趋向性优势,如针刺外关单穴对左侧岛叶和右侧脑桥有比较明显的激活作用,而针刺配穴的显著性激活区域主要在左侧基底节区。这与黄泳等^[29]针刺支沟穴的研究结果相比较可知,针刺支沟配伍外关

组穴和分别针刺支沟、外关单穴在脑部的激活区虽有一定的相同性,但也存在差异,针刺单穴在部分脑区有偏向性和特异性,这与陈俊琦等^[32]的研究结果相通。针刺组穴的脑激活区不是针刺单穴脑激活区的简易叠加,而是重新整合后形成了特定的激活功能区域。这也为针刺单穴脑激活区特异性研究和不同穴位的配伍规律研究提供了理论依据。

1.4 针刺支沟穴不同针刺方法的研究

针刺方法的不同对某些疾病的治疗效果具有差异性。黄泳等^[33]运用fMRI技术并采用Block设计模式对健康志愿者右侧支沟穴分别进行了不同层次针刺研究,实验结果显示,支沟穴皮部浅刺和常规针刺对各脑区的激活没有明显差异,但表现出一定差别趋势,常规针刺脑激活区域相对集中在对侧脑区,并且激活点和强度都相对集中,而皮部浅刺后脑激活区分布较为广泛,激活点相对分散且激活强度较弱。邹燕齐等^[34]对健康志愿者右侧支沟配伍外关穴分别进行皮部浅刺和深部常规针刺后发现,两种不同的刺激方法在脑部的激活区没有显著的差异,但也存在对部分脑区的相对倾向性。上述两种不同针刺方法、层次所产生的不同效应可能与脑部对信号的整合密切相关。

2 针刺支沟穴脑网络研究

基于静息态fMRI技术的功能脑网络研究,为更深入地探究针刺腧穴后大脑内部各功能区之间的动态反应和协调工作机制提供了重要的依据,是目前研究针刺腧穴脑效应的重要方法之一^[35-36]。

额下回作为主管运动语言的中枢之一,不仅对新旧知识进行整合,而且对语言语义加工处理,是调节高级认知功能的重要区域^[37-38]。韩红艳等^[39]以额下回为感兴趣区种子点深入探讨针刺支沟穴对健康受试者脑网络功能连接时变效应差异特征,研究发现与针刺支沟前的纯静息态相比,针刺后受试者脑内暂时的动态平衡网络被打破,额中、下回、小脑后叶等脑功能区与额下回之间形成了随时间序列变化的功能连接网络,结合支沟穴的功效和额下回的功能,推测上述脑网络的形成可能是临床针刺支沟穴治疗语言及思维等高级认知功能障碍的中枢效应机制。另一项研究以左、右侧旁中央小叶为种子点,探讨针刺左支沟穴前后脑网络连接时变效应差异,结论表明,与针刺前的纯静息态相比,双侧小脑后叶、额下回与顶上、下小叶等脑区会与两侧旁中央小叶之间形成随时间序列变化的功能连接脑网络^[40]。结合支沟穴的主治作用^[41]和这些脑区的功能^[42-45],上述结论可能是临床针刺该穴治疗胃肠道疾病、下肢感觉和运动障碍疾病的中枢机制。

3 小结

针刺支沟穴特异性激活脑区与主管胃肠道疾病相关脑区结构变化具有高度的一致性,并且针刺该穴对胃肠道疾病的治疗作用很可能与脑肠轴的调节作用密切相关;针刺支沟与非穴后脑激活区存在对部分优势脑区的相对倾向性,这可能与经络腧穴的“循经传感”和主治功效密切相关;针刺支沟配穴和不同针刺方法可产生新的趋向性脑激活区,为临床针灸治疗某些疾病提供可视化理论依据,因病邪多具有相兼性、复杂性,并且人体各脏腑是相互关联、协调统一的,故临床治疗也要注重穴位配伍关系并结合不同针刺方法。脑网络的研究可以动态可视化的观察针刺前后各脑区间的差异及脑网络连接时效变化特征,能更深入的探究针刺腧穴脑效应机制,故日后应该更加注重这方面的研究。

4 问题与展望

支沟穴具有取穴简单方便、疗效显著、针刺安全性高等优点,引起了国内外学者的广泛关注,取得了突破性的进展和丰硕成果。但也存在一些问题:首先,因不同受试者个人心理生理存在差异且受实验环境等因素的影响,会对其实验结果造

成一定的干扰,所以在实验前应对受试者进行严格限定和统一,尽量排除上述无关因素造成的干扰,使其实验的模式统一化、结果准确化。其次,实验对象主要为健康受试者,对其他优势病种的研究较少,以后应该重视对特定疾病人群的研究,包括对其特定病种针刺单穴与配穴对比研究及针刺前后对比的研究。最后,目前对于针刺引起脑网络连接变化的研究较少,而人体作为一个高度复杂、协调统一的整体我们更应该注重整体脑网络之间的相互影响。

随着fMRI技术不断革新与进展,该技术在研究针刺作用机制方面的应用越来越广泛且成熟,为解释针刺作用机制找到了突破口并且为其深入研究开辟了新道路^[46]。我们想要全面、深层次地应用fMRI技术探究针刺腧穴作用机制,就应严格规范实验方案及步骤,尽可能排除干扰因素,以临床治疗疾病为出发点,将脑功能成像结果与多学科有效结合。有学者研究发现,针刺会使机体的代谢功能产生相应变化,可以从宏观整体和微观分子水平来阐释针刺作用机制,使其研究更加全面透彻^[47-48]。为了更进一步探究针刺作用下fMRI信号的变化及针刺对脑部神经信息传递产生的影响,我们需采用多种模式、从不同的角度出发、多系统的协作研究印证。大样本优势病种的针刺经络腧穴特异性研究与针刺过程中脑功能的动态时变效应研究将是未来研究的重点方向。

作者利益冲突声明:全体作者均声明无利益冲突。

参考文献[References]

- [1] Yan CQ, Huo JW, Wang X, et al. Different degree centrality changes in the brain after acupuncture on contralateral or ipsilateral point in patients with chronic shoulder pain: a resting-state fMRI study[J]. *Neural Plast*, 2020, 2020: 5701042. DOI:10.1155/2020/5701042.
- [2] Li Y, Xiong C, Zeng Y, et al. Acupuncture treatment of lung-spleen qi deficiency in stable chronic obstructive pulmonary disease: a randomized, open-label, controlled trial[J]. *Tradit Chin Med*, 2019, 39(6): 885-891.
- [3] Li XB. Clinical research progress of acupuncture in the treatment of constipation[J]. *Clin J Tradit Chin Med*, 2018, 30(11): 2149-2153. DOI: 10.16448/j.cjctcm.2018.0661.
- [4] Wang XC, Lu XZ. Clinical observation of Zhigou acupoint in the treatment of intractable hiccup[J]. *Chin Urban Rural Enterprise Health*, 2018, 33(7): 148-149. DOI:10.16286/j.1003-5052.2018.07.067.
- [5] Ma KL, Wang JQ, Lv Jingshan "Zhigou, Yanglingquan" combined with local acupoints for the treatment of 27 cases of snake string sores in the ribs[J]. *Chin Med Res*, 2017, 30(12): 57-59. DOI:10.3969/j.issn.1001-6910.2017.12.25.
- [6] Deng XH. Clinical application of Zhigou acupoint[J]. *Asia-Pacific Tradit Med*, 2017, 13(4): 72-74. DOI:10.11954/ytctyy.201704028.
- [7] Sun L, Chen YY, Fang JL, et al. Correlation between blood oxygen level dependent fMRI signal and GABA content in anterior cingulate cortex after acupuncture of Hegu (LI4)[J]. *Zhen Ci Yan Jiu*, 2019, 44(12): 878-883. DOI:10.13702/j.1000-0607.190597.
- [8] Steiner AR, Rousseau-Blass F, Schroeter A, et al. Systematic review: anaesthetic protocols and management as confounders in rodent blood oxygen level dependent functional magnetic resonance imaging (BOLD fMRI) -part a: effects of changes in physiological parameters[J]. *Front Neurosci*, 2020, 14: 577119. DOI:10.3389/fnins.2020.577119. eCollection 2020.
- [9] Li A, Li XL, Zhang F, et al. A functional magnetic resonance imaging study of the neuronal specificity of an point: acupuncture at Rangu (KI 2) and its sham point[J]. *Intern Med*, 2016, 46(8): 973-977. DOI: 10.1111/imj.13154.
- [10] Li A, Wang YH, Zhang F, et al. Acupuncture for gender differences and similarities in cerebral activity of health volunteers: a pilot fMRI study[J]. *Medicine (Baltimore)*, 2018, 97(50): e13655. DOI:10.1097/MD.0000000000000013655.
- [11] Yu SW, Lin SH, Tsai CC, et al. Acupuncture effect and mechanism for treating pain in patients with Parkinson's disease[J]. *Front Neurol*, 2019, 10: 1114. DOI:10.3389/fneur.2019.01114.
- [12] Cai RL, Shen GM, Wang H, et al. Brain functional connectivity network studies of acupuncture: a systematic review on resting-state fMRI[J]. *Integr Med*, 2018, 16(1): 26-33. DOI: 10.1016/j. joim. 2017. 12.002.
- [13] Liu L, Chen S, Zeng D, et al. Cerebral activation effects of acupuncture at Yanglingquan(GB34) point acquired using resting-state fMRI[J]. *Comput Med Imaging Graph*, 2018, 67: 55-58. DOI:10.1016/j.compmedimag. 2018.04.004.
- [14] Chen SQ, Cai DC, Chen JX, et al. Altered brain regional homogeneity following contralateral acupuncture at quchi (LI 11) and Zusanli (ST 36) in ischemic stroke patients with left hemiplegia: an fMRI study[J]. *Integr Med*, 2020, 26(1): 20-25. DOI:10.1007/s11655-019-3079-6.
- [15] Ang L, Yu HW, Fan Z, et al. Acupuncture for gender differences and similarities in cerebral activity of health volunteers: a pilot fMRI study[J]. *Medicine (Baltimore)*, 2018,97(50): e13655. DOI:10.1097/MD.00000000000013655.
- [16] Maeda Y, Kim H, Kettner N, et al. Rewiring the primary somatosensory cortex in carpal tunnel syndrome with acupuncture[J]. *Brain*, 2017, 140(4): 914. DOI:10.1093/brain/awx015.
- [17] Ning Y, Liu X, Yao H, et al. The fMRI study for acupuncture on shift work sleep disorder: Study protocol for a randomized controlled neuroimaging trial[J]. *Medicine (Baltimore)*, 2020, 99(36): e22068. DOI:10.1097/MD.00000000000022068.
- [18] Xu LN, Ren AX, Li Y, et al. Study on the central response characteristics of functional magnetic resonance imaging in elderly patients with acupuncture at Zhigou acupoint[J]. *Geriatrics Health Care*, 2018, 24(2): 164-166, 170.
- [19] Zhao LL, Zhang Y. The mechanism of brain structure and function change and the research of magnetic resonance imaging in patients with irritable bowel syndrome[J]. *J Gastroenterol Hepatol*, 2015, 24(12): 1514-1516. DOI:10.3969/j.issn.1006-5709.2015.012.029.
- [20] Zhao XS, Lv Y, Zhang B, et al. Study on the epidemiology and multi-locus sequence typing of methicillin-resistant *Staphylococcus aureus* in elderly[J]. *Chin J Nosocomiol*, 2017, 27(23): 5296-5299. DOI:10.11816/cn.ni.2017-171907.
- [21] Zhu DM, Yang Y, Jiang XF, et al. Surveillance of bacterial resistance in Shanghai in 2011[J]. *Chin J Infect Chemother*, 2012, 12(6): 401-411.
- [22] Liu QZ, Zhou TL, Li C, et al. Study on genotyping of an outbreak strain of methicillin-resistant *Staphylococcus aureus*[J]. *Chin J Nosocomiol*, 2006, 16(10): 1086-1088.
- [23] Chen YH, Luo JQ, Guan YQ, et al. Investigation and countermeasures of the outbreak of suspected MRSA nosocomial infection in clean intensive care unit[J]. *China Modern Med J*, 2019, 21(2): 31-34. DOI: 10.3969/j.issn.1672-9463.2019.02.008.
- [24] Yin P, Gao NY, Zheng HM, et al. A randomized controlled study of "Lijiaotongfu" acupuncture in the treatment of functional constipation[J]. *Shanghai J of Acupuncture Moxibust*, 2019, 38(12): 1320-1325. DOI:10.13460/j.issn.1005-0957.2019.12.1320.
- [25] Zhang ZL, Ji XQ, Zhao SH, et al. Multi-center randomized controlled study on electroacupuncture at Zhigou acupoint in the treatment of constipation[J]. *Chin Acupunct Moxibust*, 2007(7): 475-478.

- [26] Han HY, Wang KK, Wang WX, et al. Effects of acupuncture on the fMRI time-varying effect of resting state in healthy human brain[J]. *J Beijing University Chin Med*, 2018, 41(06): 508-515.
韩红艳, 王柯柯, 王文献, 等. 针刺支沟穴对健康人脑内静息态 fALFF 时变效应的影响[J]. *北京中医药大学学报*, 2018, 41(06): 508-515.
- [27] Song JT, Tao L, Qian ZY, et al. Research on the differences of brain between the sexes based on the fMRI and DTI of resting state[J]. *J Biomed Engin Res*, 2014, 33(4): 211.
宋建太, 陶玲, 钱志余, 等. 基于静息态 fMRI 和 DTI 的大脑性别差异性研究[J]. *生物医学工程研究*, 2014, 33(4): 211-215+220.
- [28] Feng ZZ, Tu J. Dendrolateral and ventromedial prefrontal cortex neural circuits in depression[J]. *J Third Military Med University*, 2011, 33(22): 2327.
冯正直, 涂静. 背外侧-腹内侧前额叶皮层神经回路异常介导抑郁的研究进展[J]. *第三军医大学学报*, 2011, 33(22): 2327.
- [29] Huang Y, Li GL, Lai XS, et al. Comparison of functional magnetic resonance imaging in different brain regions activated by acupuncture at Zhigou and non acupoints[J]. *J Chengdu University Tradit Chin Med*, 2009, 32(1): 3-6.
黄泳, 李赣龙, 赖新生, 等. 针刺支沟穴与非穴激活不同脑区的功能磁共振成像比较[J]. *成都中医药大学学报*, 2009, 32(1): 3-6.
- [30] Tang CM. Neuropsychology[M]. Beijing: People's Military Medical Press, 2004: 92-101.
汤慈美. 神经心理学[M]. 北京: 人民军医出版社, 2004: 92-101.
- [31] Lai XS, Peng LM, Huang Y, et al. Comparison of fMRI brain functional imaging between acupuncture at Waiguan and Waiguan combined with Zhigou[J]. *J Guiyang University Tradit Chin Med*, 2009, 31(05): 9-12.
赖新生, 彭玲梅, 黄泳, 等. 针刺外关穴与外关配伍支沟穴 fMRI 脑功能成像比较[J]. *贵阳中医学院学报*, 2009, 31(05): 9-12.
- [32] Chen JQ, Huang Y, Zou YQ, et al. Comparative study on fMRI brain functional imaging of acupuncture at Waiguan and Waiguan combined with Neiguan[J]. *Liaoning J Tradit Chin Med*, 2010, 37(6): 1127-1129.
陈俊琦, 黄泳, 邹燕齐, 等. 针刺外关穴与外关配伍内关穴的 fMRI 脑功能成像比较研究[J]. *辽宁中医杂志*, 2010, 37(6): 1127-1129.
- [33] Huang Y, Li XX, Lai XS, et al. Comparison of functional magnetic resonance imaging between superficial needling at Zhigou point and conventional needling[J]. *Hebei Tradit Chin Med*, 2009, 31(2): 254-256.
黄泳, 李小溪, 赖新生, 等. 支沟穴皮部浅刺与常规针刺功能性磁共振脑功能成像比较[J]. *河北中医*, 2009, 31(2): 254-256.
- [34] Zou YQ, Huang Y, Lai XS, et al. FMRI comparative study on the activation of brain regions by Waiguan combined with Zhigou superficial needling and conventional needling[J]. *J Yunnan University Tradit Chin Med*, 2008, 31(6): 44-47.
邹燕齐, 黄泳, 赖新生, 等. 外关穴配伍支沟穴皮部浅刺和常规针刺激活脑区的 fMRI 比较研究[J]. *云南中医学院学报*, 2008, 31(6): 44-47.
- [35] Han X, Jin H, Li K, et al. Acupuncture modulates disrupted whole-brain network after ischemic stroke: evidence based on graph theory analysis[J]. *Neural Plast*, 2020, 2020: 8838498. DOI: 10.1155/2020/8838498.
- [36] Fan DQ, Zhao HC, Sheng J, et al. Electroacupuncture modulates resting-state functional connectivity in the default mode network for healthy older adults[J]. *J Geriatr Psychiatry Neurol*, 2020, 33(2): 85-92. DOI:10.1177/0891988719868304.
- [37] Li Y, Mo L, Shi DP, et al. FMRI study on cognitive processing of Chinese metaphorical sentences with different properties[J]. *J Zhejiang University*, 2016, 46(6): 33-45. DOI:10.3785/j.issn.1008-942X.CN33-6000/C.2016.04.051.
李莹, 莫雷, 史大鹏, 等. 不同性质汉语隐喻句认知加工的 fMRI 研究[J]. *浙江大学学报*, 2016, 46(6): 33-45. DOI: 10.3785/j.issn.1008-942X.CN33-6000/C.2016.04.051.
- [38] Benedek M, Jauk E, Fink A, et al. To create or to recall? Neural mechanisms underlying the generation of creative new ideas[J]. *Neuroimage*, 2014, 88(100): 125-33. DOI:10.1016/j.neuroimage.2013.11.021.
- [39] Han HY, Zhang C, Hu YC, et al. Different effects of acupuncture at Zhigou on the time-varying effect of functional connectivity network with inferior frontal gyrus as seed point in healthy human brain[J]. *Chin J Basic Med Tradit Chin Med*, 2019, 25(4): 535-538, 555.
韩红艳, 张驰, 胡逸聪, 等. 针刺支沟穴对健康人脑内以额下回为种子点功能连接网络时变效应的差异影响[J]. *中国中医基础医学杂志*, 2019, 25(04): 535-538+555.
- [40] Han HY, Duan XH, Wang KK, et al. Time varying effects of lpcg and rpcg as seed points in healthy human brain before and after acupuncture at Zhigou[J]. *J Beijing University Tradit Chin Med*, 2019, 42(4): 325-331. DOI:10.3969/j.issn.1006-2157.2019.04.010.
韩红艳, 段晓茜, 王柯柯, 等. 针刺支沟穴前后健康人脑内以 LPCG、RPCG 为种子点功能连接网络时变效应的差异[J]. *北京中医药大学学报*, 2019, 42(04): 325-331. DOI:10.3969/j.issn.1006-2157.2019.04.010.
- [41] Ma SR, Zhang YW, Zhao CX. Talking about health care and recuperation of hand Shaoyang Sanjiao meridian: the tenth of twelve meridians and health care series[J]. *Life world*, 2019(11): 40-47.
马淑然, 张雨微, 赵春秀. 漫谈手少阳三焦经的保健与调养: 十二经脉与养生保健系列之十[J]. *生命世界*, 2019(11): 40-47.
- [42] Habas C, Kamdar N, Nguyen D, et al. Distinct cerebellar contributions to intrinsic connectivity networks[J]. *J Neurosci*, 2009, 29(26): 8586-94. DOI:10.1523/JNEUROSCI.1868-09.2009.
- [43] Davis SW, Dennis NA, Daselaar SM, et al. Que PASA? The posterior-anterior shift in aging[J]. *Cereb Cortex*, 2008, 18(5): 1201-1219. DOI:10.1093/cercor/bhm155.
- [44] Gollan JK, Buchanan A, Connolly M, et al. Differences in the neural correlates of affective responses in de pressed and healthy women[J]. *Psychiatry Res*, 2015, 234(3): 336-345. DOI:10.1016/j.psychres.2015.10.006.
- [45] Liang X, Zou Q, He Y, et al. Topologically reorganized connectivity architecture of default-mode, executive-control, and salience networks across working memory task loads[J]. *Cereb Cortex*, 2016, 26(4): 1501-1511. DOI:10.1093/cercor/bhu316.
- [46] Wang Q, Zhang Y, Liu YS, et al. Effect of acupuncture at Xuanzhong on brain functional imaging in patients with cervical spondylosis[J]. *Asia Pacific Tradit Med*, 2018, 14(11): 171-173. DOI:10.11954/ytcty.201811065.
王琼, 张英, 刘雨生, 等. 针刺悬钟穴对颈椎病患者脑功能成像影响研究[J]. *亚太传统医药*, 2018, 14(11): 171-173. DOI:10.11954/ytcty.201811065.
- [47] Ju L, Wen Y, Yin J, et al. Metabonomic study of the effects of different acupuncture directions on therapeutic efficacy[J]. *Chromatogr B Analyt Technol Biomed Life Sci*, 2016, 1009-1010: 87-95. DOI:10.1016/j.jchromb.2015.12.006.
- [48] Zhong H, Shao XN, Hu SN, et al. Research progress on Mechanism of acupuncture based on metabonomics[J]. *World Chin Med*, 2019, 14(3): 542-547. DOI:10.3969/j.issn.1673-7202.2019.03.006.
钟欢, 邵湘宁, 胡舒宁, 等. 基于代谢组学的针灸作用机制研究进展[J]. *世界中医药*, 2019, 14(3): 542-547. DOI: 10.3969/j.issn.1673-7202.2019.03.006.



《磁共振成像》杂志
官方网站

办精品期刊 促学科发展 惠百姓健康

打造世界一流的磁共振媒体