



• 中医药·中西医结合 •

“通督治郁”针法上调miR-223-3p抑制NLRP3炎症小体 改善脑卒中后抑郁的临床研究*

张静波^{ID}, 胡徽星, 梁发俊, 尹苗苗, 王保国, 章显宝, 郑之俊, 王震^{ID}[△]

安徽中医药大学第二附属医院 脑病六科(合肥 230061)

【摘要】目的 探讨“通督治郁”针法治疗脑卒中后抑郁(post-stroke depression, PSD)的可能作用机制。**方法** 采用随机对照试验,纳入安徽中医药大学第二附属医院脑病六科PSD患者62例,按就诊顺序编号后随机1:1分为对照组(31例)和试验组(31例)。两组均接受基础治疗,对照组予普通针刺,试验组予普通针刺联合“通督治郁”针法,治疗8周。主要结局指标为24项汉密尔顿抑郁量表(HAMD-24)总分;次要指标包括美国国立卫生研究院卒中量表(NIHSS)评分、Barthel指数、外周血单个核细胞miR-223-3p表达量及血清NLRP3、IL-1 β 、IL-18水平。**结果** 治疗后,试验组各项指标较治疗前均改善(均 $P<0.05$),且改善幅度均优于对照组(均 $P<0.05$): HAMD-24总分由(17.87 $\pm$ 3.90)分降至(13.04 $\pm$ 3.55)分; NIHSS评分由(23.29 $\pm$ 6.74)分降至(9.97 $\pm$ 5.81)分; Barthel指数由(32.29 $\pm$ 5.37)分升至(87.13 $\pm$ 6.82)分; miR-223-3p表达由0.29 $\pm$ 0.07升至0.98 $\pm$ 0.21; NLRP3由(65.84 $\pm$ 7.16) ng/L降至(49.56 $\pm$ 4.89) ng/L; IL-1 β 由(43.92 $\pm$ 7.25) pg/mL降至(22.24 $\pm$ 4.76) pg/mL; IL-18由(30.70 $\pm$ 4.13) pg/mL降至(15.40 $\pm$ 3.09) pg/mL。**结论** “通督治郁”针法可改善PSD患者神经功能,其机制可能与上调miR-223-3p表达、抑制NLRP3炎症小体活化、减少IL-1 β 和IL-18等炎症因子释放有关,从而缓解抑郁症状。

【关键词】 miR-223-3p NLRP3 IL-1 β 卒中后抑郁 “通督治郁”针法

Tongdu Zhiyu Acupuncture Improves Post-Stroke Depression by Upregulating miR-223-3p and Inhibiting NLRP3 Inflammasome: A Clinical Study

Zhang Jingbo^{ID}, Hu Huixing, Liang Fajun, Yin Miaomiao, Wang Baoguo, Zhang Xianbao, Zheng Zhijun, Wang Zhen^{ID}[△]. Department of Brain Disease, The Second Affiliated Hospital of Anhui University of Traditional Chinese Medicine, Hefei 230061, China

[△] Corresponding author

This study was supported by the Anhui Provincial Higher Education Scientific Research Project (No. 2024AH050999) and the Anhui Provincial Yangtze River Delta Famous Medical Experts Studio.

[Abstract] Objective To investigate the mechanism of Tongdu Zhiyu acupuncture in the treatment of post-stroke depression (PSD). **Methods** A randomized controlled trial was conducted. Sixty-two PSD patients from the Department of Brain Disease, the Second Affiliated Hospital of Anhui University of Traditional Chinese Medicine were enrolled and randomly assigned in a 1:1 ratio to a control group ($n=31$) or an experimental group ($n=31$). All patients received basic treatment. The control group received ordinary acupuncture, while the experimental group received ordinary acupuncture combined with Tongdu Zhiyu acupuncture. The treatment period was 8 weeks. The primary outcome was the total score on the 24-item Hamilton Depression Scale (HAMD-24). Secondary outcomes included the National Institutes of Health Stroke Scale (NIHSS) score, Barthel index, peripheral blood mononuclear cell miR-223-3p expression, and serum levels of NLRP3, IL-1 β , and IL-18. **Results** After treatment, all indicators in the experimental group improved significantly compared with baseline (all $P<0.05$), and the improvements were significantly greater than those in the control group (all $P<0.05$). The HAMD-24 score decreased from 17.87 $\pm$ 3.90 to 13.04 $\pm$ 3.55; the NIHSS score decreased from 23.29 $\pm$ 6.74 to 9.97 $\pm$ 5.81; the Barthel index increased from 32.29 $\pm$ 5.37 to 87.13 $\pm$ 6.82; miR-223-3p expression increased from 0.29 $\pm$ 0.07 to 0.98 $\pm$ 0.21; serum NLRP3 decreased from (65.84 $\pm$ 7.16) ng/L to (49.56 $\pm$ 4.89) ng/L; IL-1 β decreased from (43.92 $\pm$ 7.25) pg/mL to (22.24 $\pm$ 4.76) pg/mL; and IL-18 decreased from (30.70 $\pm$ 4.13) pg/mL to (15.40 $\pm$ 3.09) pg/mL. **Conclusion** Tongdu Zhiyu acupuncture can improve neurological function in PSD

* 安徽省高等学校科学研究项目(No. 2024AH050999)和安徽省长三角名医工作室(皖中医药发展秘〔2023〕16号)

[△] 通信作者

出版日期: 2026-07-20

patients. Its mechanism may involve upregulating miR-223-3p expression, inhibiting NLRP3 inflammasome activation, and reducing the release of pro-inflammatory cytokines such as IL-1 β and IL-18, thereby alleviating depressive symptoms.

[Key words] miR-223-3p NLRP3 IL-1 β Post-stroke depression Tongdu Zhiyu acupuncture

脑卒中后抑郁(post-stroke depression, PSD)是脑卒中后最常见的神经精神并发症之一,通常在卒中后早期即可出现,不仅严重阻碍神经功能恢复,还显著增加脑血管事件复发风险,并可能降低患者长期生存率^[1]。流行病学调查显示,PSD在脑卒中患者中的发生率约为25%~80%^[2]。在脑卒中的病理生理进程中,炎症反应贯穿于疾病的起始、进展及并发症发生的全过程,其强度与卒中预后密切相关^[3]。进一步研究表明,炎症机制同样参与抑郁障碍的发病:炎性因子可通过干扰神经递质代谢、损害神经可塑性、影响神经元功能及脑结构重塑等多种途径,促进PSD的发生与发展^[4]。

“通督治郁”针法源自中医经典理论体系,通过刺激特定腧穴,调节阴阳、气血与经络功能,达到改善情志、恢复肢体功能的目的^[5]。临床研究表明,该针法可调节神经递质及神经营养因子水平,从而改善PSD患者的抑郁症状^[6]。近年来,神经炎症在抑郁症发病机制中的作用日益受到关注。NLRP3炎症小体作为先天免疫的关键调控节点,在神经炎症反应中发挥重要作用,抑制其激活已被视为潜在的抗抑郁治疗策略^[7]。研究证实,NLRP3可介导IL-1 β 和IL-18的成熟与释放,驱动炎症级联反应^[8]。miR-223-3p作为一种小分子非编码RNA,在炎症调节中发挥关键作用,能够负向调控NLRP3表达^[9-10]。然而,目前关于“通督治郁”针法治疗PSD的炎症相关机制研究尚不充分。基于此,本研究拟深入探讨“通督治郁”针法调控PSD神经炎症反应的可能作用机制,以期为该针法治疗PSD的理论体系提供进一步的临床证据。

1 资料与方法

1.1 病例选择

本研究前瞻性随机对照研究。选取62例安徽中医药大学第二附属医院脑病六科PSD患者,根据就诊顺序标记序号,然后随机1:1分为对照组($n=31$)、试验组($n=31$)。对照组男女比例为20:11,年龄20~82岁,平均(62.65 ± 15.48)岁;卒中类型:脑梗死26例,脑出血5例。试验组男女比例为21:10,年龄22~79岁,平均(61.74 ± 10.69)岁;卒中类型:脑梗死27例,脑出血4例。两组基线资料差异无统计学意义。本研究样本量估算参考公式:
$$n_1 = \frac{[Z_{\alpha/2} \sqrt{p(1-p)(1+c)/c} + Z_{\beta} \sqrt{p_1(1-p_1) + p_2(1-p_2)/c}]^2}{(p_1 - p_2)^2},$$
其中 n_1 为试验组样本含量。设定检验水准 $\alpha=0.05$,

$\beta=0.10$, $Z_{\alpha/2}=1.96$, $Z_{\beta}=1.28$ 。查阅相关文献^[11],设定试验组 $p_1=0.9$,对照组 $p_2=0.5$, $p=(p_1+p_2)/2=0.70$, c 为两样本含量的比值 $c=n_2/n_1=1$,得出 $n=26$ 。考虑约20%脱落率,计划总入组62例,每组31例。本研究在医学研究登记备案信息系统进行登记备案(备案编号:MR-34-25-077520),并通过安徽中医药大学第二附属医院伦理委员会审批(2025-zjpj-12)。

1.1.1 纳入标准

①符合PSD诊断标准(见1.2);②基础疾病控制平稳,抑郁症状持续至少2周,卒中病程 ≤ 1 年;③24项汉密尔顿抑郁量表(Hamilton Depression Rating Scale, HAMD-24) > 8 分;④既往无抑郁症病史及抗抑郁药治疗史;⑤患者或家属签署知情同意书。

1.1.2 排除标准

①重度痴呆或严重认知障碍;②视觉障碍或交流困难;③重要脏器功能严重障碍;④合并恶性肿瘤;⑤对本研究药物过敏;⑥重度PSD。

1.1.3 脱落标准

①发生严重并发症或不良事件;②自行退出;③依从性差;④失访或死亡。

1.2 诊断标准

脑卒中诊断标准:参照《中国各类主要脑血管病诊断要点》^[12],经影像学检查确诊。

PSD诊断标准:西医标准参照《脑卒中后抑郁临床诊疗指南》^[13];中医辨证参照《中医内科学》(第5版)^[14]及《中医病证诊断疗效标准》^[15],制定标准如下:A.情志不舒、气机郁滞,发生于卒中之后;B.思虑忧郁、胸闷胁胀、精神不振,或暖气、脘痞、善太息,女性月经不调;C.有郁闷、多虑、悲哀、忧愁等情志所伤史;D.经系统检查排除器质性病变。

1.3 研究方法

1.3.1 基础治疗

根据患者基础疾病及个体差异,给予降压、降糖、调脂等常规治疗,避免使用可能影响精神状态的药物,维持生命体征稳定。同时,遵医嘱予以改善脑循环、营养神经等对症支持治疗。在此基础上,所有患者均接受抗抑郁药物治疗:盐酸度洛西汀肠溶胶囊(重庆药友制药有限责任公司,规格:30 mg/粒),每日早餐前口服1粒。

1.3.2 分组治疗方法

对照组选穴:顶颞前斜线(运动区)、顶颞后斜线(感

觉区)、顶前线(语言区)、肩髃、极泉、尺泽、曲池、气海、血海、委中、梁丘、足三里、三阴交、阴陵泉、丰隆。操作:患者取适当体位,头皮针采用平刺法进针,予平补平泻手法;体针中气海、足三里用补法,血海、三阴交用泻法,其余腧穴均用平补平泻法。得气后留针30 min,治疗期间行针1次。每日治疗1次,每周治疗6 d、休息1 d,共治疗8周。毫针选用华佗牌(规格:0.25 mm×40 mm)。

试验组选穴:在对照组穴位基础上加入“通督治郁”针刺。①主穴:体针:百会、神庭、印堂、人中、神门(双)、内关(双)、合谷(双)、太冲(双)等。②辨证配穴:气虚血瘀证加心俞、脾俞;痰瘀阻络证加中脘、脾俞、膈俞;风痰阻络证加风池、风府;肝肾亏虚证加肾俞、肝俞、太溪。操作:患者取卧位或坐位,常规消毒后进针。百会向印堂方向平刺0.5寸,得气后以80次/min频率捻转2 min;神庭、印堂向鼻尖方向斜刺0.5寸,捻转手法;人中直刺0.2寸,捻转泻法;内关、神门直刺0.5寸,提插捻转补法;合谷、太冲直刺0.5寸,捻转泻法。头皮针与头皮呈30°角进针,运用抽提法刺激。配穴根据患者体型及肌肉厚度决定针刺深度,依穴位特性选用适当补泻手法,每次选取2~3个,交替使用。所有穴位得气后留针30 min,期间行针1次。每日治疗1次,每周治疗6 d、休息1 d,共治疗8周。

1.4 观察指标

主要结局指标:采用HAMD-24^[16]评估患者抑郁程度。该量表涵盖焦虑/躯体化、认知障碍、睡眠障碍、绝望感、体质量变化等7个维度。评分标准:<8分为正常,8~20分为轻度抑郁,21~35分为中度抑郁,>35分为重度抑郁。评分越高,提示抑郁程度越重。

次要结局指标:①美国国立卫生研究院卒中量表(National Institutes of Health Stroke Scale, NIHSS)评分^[17],评估意识水平、凝视、视野、面瘫、上下肢运动、共济失调、感觉、语言、构音障碍及忽视共11项神经功能缺损程度,总分42分,1~4分为轻度,5~15分为中度,16~20分为中重度,21~42分为重度;②Barthel指数^[18],评估日常生活自理能力,包括进食、转移、个人卫生、如厕、沐浴、平地行走(50 m)、上下楼梯、穿衣、大便控制及小便控制共10项,总分100分,得分越高生活自理能力越强;③外周血单个核细胞miR-223-3p表达量测定^[19],于清晨空腹采集患者外周静脉血,分离外周血单个核细胞,采用Trizol法提取总RNA,逆转录为cDNA后进行PCR扩增,反应条件为94℃预变性3~5 min,扩增循环约(35±5)个循环,包括变性、退火及延伸(7~10 min),应用7500实时荧光定量PCR系统检测,以U6为内参,采用2^{-ΔΔCt}法计算相对表达

量,引物序列见表1;④血清NLRP3、IL-1β、IL-18水平测定,分别于治疗前后采集患者空腹外周静脉血,分离血清,采用酶联免疫吸附法(enzyme-linked immunosorbent assay, ELISA)检测,严格按照ELISA试剂盒(上海酶研生物科技有限公司)说明书操作,使用酶标仪测定并分析结果。

表 1 qRT-PCR引物序列
Table 1 qRT-PCR primer sequences

Gene	Primer	Primer sequence
miR-223-3p	Forward	5'-GCGCGTGTGTCAGTTTGTCAAA-3'
	Reverse	5'-AGTGCAGGGTCCGAGGTATT-3'
U6	Forward	5'-CTCGCTTCCGCAGCACA-3'
	Reverse	5'-AACGCTTCACGAATTTGCGT-3'

1.5 统计学方法

采用SPSS 26.0软件进行统计分析。计量资料(年龄、HAMD-24评分等)符合正态分布,以 $\bar{x} \pm s$ 描述,组间资料及治疗前后差值比较采用独立样本t检验;计数资料以例数(%)描述,采用 χ^2 检验。 $P < 0.05$ 为差异有统计学意义。

2 结果

2.1 两组PSD患者治疗前后抑郁程度比较

两组治疗前后HAMD-24评分差值比较,差异有统计学意义($P < 0.05$)。见表2。

表 2 两组治疗前后HAMD-24评分比较 (n=31)

Table 2 Comparison of HAMD-24 scores before and after treatment between the two groups (n = 31)

Group	Time point	HAMD-24 score
Control	Before treatment	18.47 ± 4.33
	After treatment	15.38 ± 3.86
	Intra-group difference	3.09 ± 0.47
Experimental	Before treatment	17.87 ± 3.90
	After treatment	13.04 ± 3.55
	Intra-group difference	4.83 ± 0.35*

HAMD-24: Hamilton Depression Rating Scale. * $P < 0.05$, vs. intra-group difference of the control group.

2.2 两组PSD患者治疗前后神经功能比较

两组治疗前后NIHSS评分差值比较,差异有统计学意义($P < 0.05$)。见表3。

2.3 两组PSD患者治疗前后Barthel指数比较

两组治疗前后Barthel指数差值比较,差异有统计学意义($P < 0.05$)。见表4。

表 3 两组治疗前后NIHSS评分比较 (n=31)

Table 3 Comparison of NIHSS scores before and after treatment between the two groups (n = 31)

Group	Time point	NIHSS score
Control	Before treatment	23.75 ± 6.46
	After treatment	14.35 ± 6.99
	Intra-group difference	9.40 ± 0.53
Experimental	Before treatment	23.29 ± 6.74
	After treatment	9.97 ± 5.81
	Intra-group difference	13.32 ± 0.93*

NIHSS: National Institute of Health Stroke Scale. * $P < 0.05$, vs. intra-group difference of the control group.

表 4 两组治疗前后Barthel指数比较 (n=31)

Table 4 Comparison of Barthel Index scores before and after treatment between the two groups (n = 31)

Group	Time point	Barthel index
Control	Before treatment	39.35 ± 5.25
	After treatment	71.32 ± 6.53
	Intra-group difference	31.97 ± 1.28
Experimental	Before treatment	39.29 ± 5.37
	After treatment	87.13 ± 6.82
	Intra-group difference	47.84 ± 1.45*

Barthel Index: a scale for assessing activities of daily living. * $P < 0.05$, vs. intra-group difference of the control group.

2.4 两组PSD患者治疗前后miR-223-3p表达量比较

两组治疗前后miR-223-3p表达量差值比较, 差异有统计学意义($P < 0.05$)。见表5。

表 5 两组治疗前后miR-223-3p表达量比较 (n=31)

Table 5 Comparison of miR-223-3p expression before and after treatment between the two groups (n = 31)

Group	Time point	miR-223-3p
Control	Before treatment	0.27 ± 0.05
	After treatment	0.56 ± 0.08
	Intra-group difference	0.29 ± 0.03
Experimental	Before treatment	0.29 ± 0.07
	After treatment	0.98 ± 0.21
	Intra-group difference	0.69 ± 0.14*

* $P < 0.05$, vs. intra-group difference of the control group.

2.5 两组PSD患者治疗前后NLRP3、IL-1β、IL-18水平比较

两组治疗前后NLRP3、IL-1β、IL-18差值比较, 差异均有统计学意义($P < 0.05$)。见表6。

表 6 两组治疗前后NLRP3、IL-1β、IL-18水平比较 (n=31)

Table 6 Comparison of NLRP3, IL-1β, and IL-18 levels before and after treatment between the two groups (n = 31)

Group	Time point	NLRP3/ (ng/L)	IL-1β/ (pg/mL)	IL-18/ (pg/mL)
Control	Before treatment	66.25 ± 7.09	43.44 ± 6.23	31.36 ± 4.27
	After treatment	59.38 ± 6.17	30.91 ± 5.16	22.50 ± 3.57
	Intra-group difference	6.87 ± 0.92	12.53 ± 1.07	8.86 ± 0.70
Experimental	Before treatment	65.84 ± 7.16	43.92 ± 7.25	30.70 ± 4.13
	After treatment	49.56 ± 4.89	22.24 ± 4.76	15.40 ± 3.09
	Intra-group difference	16.28 ± 2.27*	21.68 ± 2.49*	15.30 ± 1.04*

* $P < 0.05$, vs. intra-group difference of the control group.

3 讨论

PSD是脑卒中常见且严重的并发症之一, 其发病率因评估工具、诊断标准及调查时点的不同而有所差异^[20]。PSD不仅严重影响患者神经功能的恢复与日常生活能力, 还显著增加自杀风险, 延长住院时间, 加重家庭与社会的经济负担。因此, 有效防治PSD已成为当前临床研究的热点与难点。目前, 西医治疗PSD主要采用抗抑郁药物, 但存在起效缓慢、不良反应较多、依从性欠佳等问题, 且长期使用可能致疗效下降。中医治疗PSD具有独特优势, 其中针灸因其疗效确切、副作用小等特点, 日益受到临床关注。“通督治郁”针法基于中医理论, 通过针刺督脉及其相关腧穴, 调节人体气血与脏腑功能, 以达到通督醒脑、疏肝理气、解郁安神之效。督脉为“阳脉之海”, 总督一身之阳气, 与脑、心等脏腑功能密切相关, 在调节精神情志活动中发挥重要作用^[21]。近年来研究表明, “通督治郁”针法可改善PSD患者的抑郁症状、神经功能缺损程度及日常生活能力^[22]。本研究将“通督治郁”针法应用于PSD患者, 亦取得了较好的临床疗效。

本研究结果显示, 治疗后对照组与试验组PSD患者的HAMD-24及NIHSS评分均较治疗前显著降低, 且试验组降幅均大于对照组(P 均 < 0.05), 提示试验组患者抑郁症状缓解更明显、神经功能恢复更佳。“通督治郁”针法主穴选取百会、神庭、印堂、人中、神门、内关、合谷、太冲等, 通过刺激督脉及相关腧穴, 可增强大脑神经调节功能, 促进抑郁症状缓解与神经功能恢复^[23]。其中, 百会居巅顶、印堂在前额, 刺激二穴可能通过调控前额叶皮层锥体神经元的兴奋性, 改善抑郁症状与认知功能^[24]; 配合神庭、人中可促进头部气血运行, 充养脑髓, 助神机恢复; 内关为心包经络穴, 通于阴维脉, 针刺可调摄心血、安养心神; 神门为心经原穴, 是宁心安神之要穴; 合谷与太冲上下相配, 可调畅气机、疏肝解郁。此外, 治疗后两组

Barthel指数均较治疗前明显升高,且试验组升高幅度优于对照组(P 均 <0.05),表明“通督治郁”针法在改善PSD患者日常生活能力方面亦具有明显优势。在机制层面,普通针刺可能更多集中于局部症状的缓解,对机体整体调节作用有限;而“通督治郁”针法通过上述穴位的配伍,可振奋督脉阳气、调和阴阳气血、输布津液,发挥防治脑部神志病变的作用^[25];同时,该针法可能通过抑制小胶质细胞过度激活,下调促炎因子水平,减轻神经炎症反应,进而缓解由炎症介导的生理与心理负担,改善抑郁症状及生活能力^[26]。

PSD不仅损害患者的神经系统功能与认知能力,还增加卒中复发风险,延缓康复进程。研究显示^[27],慢性炎症在抑郁症、情感障碍等精神疾病的发生发展中起关键作用。炎症介质可通过干扰神经递质代谢、改变神经信号传导,诱发或加重抑郁;同时,小胶质细胞的过度激活也与焦虑、抑郁症状密切相关。近年来,随着分子生物学技术的发展,miRNA在脑卒中发病机制中的作用日益受到关注。miRNA作为非编码RNA,可通过靶向炎症通路中的关键分子影响疾病进程。一项多中心研究显示^[28],在863个miRNA中,62个在至少6种疾病(如肺癌、胰腺炎、多发性硬化症)中表达下调,其中hsa-miR-320d在11种疾病中一致下调,提示miRNA可能通过共性炎症通路参与多种疾病的发生。此外,循环miRNA因其稳定性高,已在癌症、心血管疾病及代谢性疾病中被视为潜在生物标志物,如miR-21在乳腺癌、结肠癌及系统性硬化症中均存在表达异常^[29]。因此,miRNA有望成为炎症性疾病的潜在治疗靶点。在Chen等^[30]的研究中,miR-223-3p参与调控趋化因子信号传导等多种炎症反应过程,并在抑制NLRP3炎症小体激活中发挥重要作用。在免疫反应中,miR-223-3p具有负向调节功能,可抑制中性粒细胞、巨噬细胞等免疫细胞的过度激活^[31]。NLRP3炎症小体是一种多蛋白复合物,其激活通常由病原相关分子模式(PAMPs)或损伤相关分子模式(DAMPs)触发,通过诱导NLRP3构象改变及寡聚化,形成ASC寡聚体,进而激活半胱氨酸蛋白酶-1(caspase-1),催化促炎细胞因子IL-1 β 和IL-18的成熟与释放^[32]。在抑郁症患者中,上述细胞因子不仅可损害神经元功能,还可激活小胶质细胞,长期神经炎症状态与抑郁症状的持续密切相关^[33]。王水轮等^[34]研究发现,抑郁症患者NLRP3炎症小体水平随病情加重而持续升高。既往研究表明^[35],针灸可通过改善神经系统自我调节功能,上调miR-223-3p表达,而miR-223-3p又可抑制NLRP3表达及其炎症小体激活。本研究结果显示,试验组患者治疗后miR-223-3p表达量明显高于对照

组,且NLRP3、IL-1 β 、IL-18水平均较治疗前明显降低,提示“通督治郁”针法可显著减轻PSD患者的神经炎症反应,改善抑郁症状、神经功能及日常生活能力。其机制可能是,“通督治郁”针法通过针刺百会、神庭等督脉经穴抑制TLR4/NF- κ B炎症信号通路,解除对miR-223-3p的转录抑制,使其表达上调;而上调后的miR-223-3p通过与NLRP3 mRNA的3'-UTR区特异性结合,在转录后水平抑制NLRP3蛋白的翻译,从而阻断NLRP3炎症小体的组装与活化,减少下游IL-1 β 、IL-18等促炎因子的释放,并减轻氧化应激损伤,最终实现对海马神经元的保护作用 and 抗抑郁效应^[36-37]。

综上所述,“通督治郁”针法可改善PSD患者的神经功能,上调miR-223-3p表达,抑制NLRP3炎症小体活化,减少IL-1 β 、IL-18等炎症因子的释放,从而缓解抑郁症状。但本研究样本量较小,可能存在一定的抽样误差,后续研究需进一步扩大样本量,并开展多中心、大样本的随机对照试验,以验证本研究结论,完善实验设计。

* * *

作者贡献声明 张静波负责论文构思、数据审编、经费获取、验证、初稿写作和审读与编辑写作,胡徽星和尹苗苗负责正式分析和资源提供,梁发俊负责调查研究和资源提供,王保国负责可视化,章显宝负责研究方法和资源提供,郑之俊负责正式分析和初稿写作,王震负责项目管理和监督指导。所有作者已经同意将文章提交给本刊,且对将要发表的版本进行最终定稿,并同意对工作的所有方面负责。

Author Contribution Zhang Jingbo is responsible for conceptualization, data curation, funding acquisition, validation, writing--original draft, and writing--review and editing. Hu Huixing and Yin Miaomiao are responsible for formal analysis and resources. Liang Fajun is responsible for investigation and resources. Wang Baoguo is responsible for visualization. Zhang Xianbao is responsible for methodology and resources. Zheng Zhijun is responsible for formal analysis and writing--original draft. Wang Zhen is responsible for project administration and supervision. All authors consented to the submission of the article to the Journal. All authors approved the final version to be published and agreed to take responsibility for all aspects of the work.

利益冲突 所有作者均声明不存在利益冲突

Declaration of Conflicting Interests All authors declare no competing interests.

参 考 文 献

- [1] 张杰,何福培,林蓓蕾,等.脑卒中高危人群抑郁症状潜在类别分析及影响因素研究[J].现代预防医学,2024,51(19):3643. DOI: 10.20043/j.cnki.MPM.202405386.
Zhang J, He F P, Lin B L, et al. Analysis of potential categories of depression symptoms and influencing factors in high-risk stroke populations[J]. Mod Prev Med, 2024, 51(19): 3643. DOI: 10.20043/j.cnki.MPM.202405386.
- [2] 郝清波,刘香银.淀粉样蛋白A1位点rs12218基因多态性与急性缺血性脑卒中后抑郁易感性及影响因素分析[J].南昌大学学报(医学版),2022,62(3):29. DOI: 10.13764/j.cnki.ncdm.2022.03.005.

- Hao Q B, Liu X Y. Association of rs12218 polymorphism in amyloid A1 gene with susceptibility to depression after acute ischemic stroke and its influencing factors[J]. *Acta Acad Med Jiangxi*, 2022, 62(3): 29. DOI: 10.13764/j.cnki.ncdm.2022.03.005.
- [3] 马维丽, 王恩石, 高戴娜, 等. 预后营养指数和炎症指标与卒中后抑郁的相关性分析[J]. *遵义医科大学学报*, 2025, 48(3): 280.
- Ma W L, Wang E S, Gao D N, *et al.* Analysis of prognostic nutritional index and inflammatory indicators in relation to poststroke depression[J]. *J Zunyi Med Univ*, 2025, 48(3): 280.
- [4] Fan Q, Liu Y, Sheng L, *et al.* Chaihu-Shugan-San inhibits neuroinflammation in the treatment of post-stroke depression through the JAK/STAT3-GSK3 β /PTEN/Akt pathway[J/OL]. *Biomed Pharmacother*, 2023, 160: 114385. <https://doi.org/10.1016/j.biopha.2023.114385>.
- [5] 郑全成, 张宇, 曾令慧, 等. 通督治郁针法联合头针疗法治疗卒中后抑郁的疗效及对血清 5-HT 和 BDNF 水平影响[J]. *针灸临床杂志*, 2021, 37(9): 25. DOI: 10.19917/j.cnki.1005-0779.021177.
- Zheng Q C, Zhang Y, Zeng L H, *et al.* Efficacy of Tongdu Zhiyu acupuncture combined with scalp acupuncture in treating post-stroke depression and its effects on serum 5-HT and BDNF levels[J]. *J Clin Acupunct Moxibustion*, 2021, 37(9): 25. DOI: 10.19917/j.cnki.1005-0779.021177.
- [6] 王保国, 肖伟, 王震, 等. "通督治郁"针法治疗脑卒中后抑郁对临床症状及血清 5-HT、NE、DA 的影响[J]. *中华中医药学刊*, 2023, 41(3): 190. DOI: 10.13193/j.issn.1673-7717.2023.03.041.
- Wang B G, Xiao W, Wang Z, *et al.* Effects of "Tongdu Zhiyu" acupuncture on clinical symptoms and serum 5-HT, NE, DA in patients with post-stroke depression[J]. *Chin Arch Tradit Chin Med*, 2023, 41(3): 190. DOI: 10.13193/j.issn.1673-7717.2023.03.041.
- [7] Li S, Sun Y, Song M, *et al.* NLRP3/caspase-1/GSDMD-mediated pyroptosis exerts a crucial role in astrocyte pathological injury in mouse model of depression[J/OL]. *JCI Insight*, 2021, 6(23): e146852. <https://insight.jci.org/articles/view/146852>. DOI: 10.1172/jci.insight.146852.
- [8] Gao Z, Lv H, Wang Y, *et al.* TET2 deficiency promotes anxiety and depression-like behaviors by activating NLRP3/IL-1 β pathway in microglia of allergic rhinitis mice[J/OL]. *Mol Med*, 2023, 29(1): 160. <https://doi.org/10.1186/s10020-023-00753-3>.
- [9] Tian J, Zhou D, Xiang L, *et al.* MiR-223-3p inhibits inflammation and pyroptosis in monosodium urate-induced rats and fibroblast-like synoviocytes by targeting NLRP3[J]. *Clin Exp Immunol*, 2021, 204(3): 396. DOI: 10.1111/cei.13586.
- [10] Tang H, Lin Y, Huang L, *et al.* MiR-223-3p regulates autophagy and inflammation by targeting ATG16L1 in Fusarium solani-induced keratitis[J/OL]. *Invest Ophthalmol Vis Sci*, 2022, 63(1): 41. <https://doi.org/10.1167/iov.63.1.41>.
- [11] 李宏毅, 张敏, 何治. 认知行为干预联合针刺治疗老年脑卒中后抑郁的效果及对患者血清 BDNF、Hcy、CRP 水平的影响[J]. *中国老年学杂志*, 2025, 45(18): 4473-4477. DOI: 10.3969/j.issn.1005-9202.2025.18.033.
- [12] 中华医学会神经病学分会, 中华医学会神经病学分会脑血管病学组. 中国各类主要脑血管病诊断要点 2019[J]. *中华神经科杂志*, 2019, 52(9): 710. DOI: 10.3760/cma.j.issn.1006-7876.2019.09.003.
- Chinese Society of Neurology, Chinese Stroke Society. Diagnostic criteria of cerebrovascular diseases in China (version 2019)[J]. *Chin J Neurol*, 2019, 52(9): 710. DOI: 10.3760/cma.j.issn.1006-7876.2019.09.003.
- [13] 河南省卒中学会卒中后心理与情感障碍分会, 河南省医师协会精神科分会, 河南省心理卫生协会. 脑卒中后抑郁临床诊疗指南[J]. *临床心身疾病杂志*, 2020, 26(3): 后插 1. DOI: 10.3969/j.issn.1672-187X.2020.03.054.
- Henan Stroke Association Psychological and Emotional Disorders Branch after Stroke, Henan Medical Association Psychiatric Branch, Henan Mental Health Association. Clinical diagnosis and treatment guidelines for post-stroke depression[J]. *J Clin Psychosom Dis*, 2020, 26(3): Suppl. 1. DOI: 10.3969/j.issn.1672-187X.2020.03.054.
- [14] 勉华, 石岩. 中医内科学[M]. 5 版. 北京: 中国中医药出版社, 2021: 148-151.
- [15] 李国锐. 《中医病证诊断疗效标准》出台[J]. *标准化信息*, 1995(2): 5.
- [16] Fava G A, Kellner R, Munari F, *et al.* The Hamilton Depression Rating Scale in normals and depressives[J]. *Acta Psychiatr Scand*, 1982, 66(1): 26. DOI: 10.1111/j.1600-0447.1982.tb00911.x.
- [17] 孙伟平. NIHSS 评分[C]//广东省医学会第十八次神经病学学术会议暨第八届粤港澳神经病学学术会议论文集. 广州: 广东省医学会, 2016: 141.
- [18] Mahoney F I, Barthel D W. Functional evaluation: the Barthel index[J]. *Md State Med J*, 1965, 14: 61.
- [19] 孙艳强, 李虹良, 陈康雪, 等. GAS5 作为 miR-223-3p 的 ceRNA 介导 U87 细胞的焦亡抑制脑胶质细胞的增殖, 槲皮素可以增强 GAS5 的作用[J]. *中国药学(英文版)*, 2024, 33(3): 230. DOI: 10.5246/jcps.2024.03.018.
- Sun Y Q, Li H L, Chen K X, *et al.* GAS5, as the ceRNA of miR-223-3p, mediates pyroptosis and inhibits the proliferation of brain glial cells U87, and quercetin can enhance its effect[J]. *J Chin Pharm Sci*, 2024, 33(3): 230. DOI: 10.5246/jcps.2024.03.018.
- [20] 赵雨蕾, 蒋蓉, 余艳, 等. 基于机器学习的卒中后抑郁风险预测模型研究进展[J]. *实用医院临床杂志*, 2022, 19(5): 191. DOI: 10.3969/j.issn.1672-6170.2022.05.055.
- Zhao Y L, Jiang R, Yu Y, *et al.* Research progress of risk prediction model for post-stroke depression based on machine learning[J]. *Pract J Clin Med*, 2022, 19(5): 191. DOI: 10.3969/j.issn.1672-6170.2022.05.055.
- [21] 沈亚亭, 白秀, 王明威, 等. 特色针法治疗卒中后抑郁的实践与机制研究进展[J]. *世界中医药*, 2022, 17(2): 276. DOI: 10.3969/j.issn.1673-7202.2022.02.025.
- Shen Y T, Bai X, Wang M W, *et al.* Practice and mechanism study on the characteristic acupuncture treatment of post-stroke depression[J]. *World Chin Med*, 2022, 17(2): 276. DOI: 10.3969/j.issn.1673-7202.2022.02.025.
- [22] 李晓雷, 王秋妍, 刘洋, 等. 头针联合通督治郁针法对脑卒中后抑郁(痰瘀互结证)患者抑郁症状及血清脑源性神经营养因子、神经生长因子水平的影响[J]. *海南医学*, 2025, 36(6): 794. DOI: 10.3969/j.issn.1003-6350.2025.06.007.
- Li X L, Wang Q Y, Liu Y, *et al.* Effects of scalp acupuncture combined with Tongdu Zhiyu acupuncture on depressive symptoms and serum levels of BDNF and NGF in patients with post-stroke depression (phlegm and blood stasis syndrome)[J]. *Hainan Med J*, 2025, 36(6): 794. DOI: 10.3969/j.issn.1003-6350.2025.06.007.
- [23] 杨育林, 郭悦宝, 闫兵, 等. 杨卓欣调任通督针法治疗产后抑郁的思路探析[J]. *西部中医药*, 2023, 36(6): 32. DOI: 10.12174/j.issn.2096-9600.2023.06.08.
- Yang Y L, Guo Y B, Yan B, *et al.* Analysis of Yang Zhuoxin's academic thought on treating postpartum depression with Tiaooren Tongdu acupuncture[J]. *West J Tradit Chin Med*, 2023, 36(6): 32. DOI: 10.12174/j.issn.2096-9600.2023.06.08.
- [24] 张家豪. 电针百会印堂改善 CUMS 小鼠 mPFC 锥体神经元兴奋的兴奋性和钾离子通道电流的研究[D]. 济南: 山东中医药大学, 2024.
- [25] 颜克华, 任润雪, 范文涛, 等. 针刺治疗脑卒中后抑郁选穴配伍规律分析[J]. *中西医结合心脑血管病杂志*, 2023, 21(3): 421. DOI: 10.12102/j.issn.1672-1349.2023.03.006.
- Yan K H, Ren R X, Fan W T, *et al.* Analysis of acupoint selection and compatibility rules in acupuncture treatment of post-stroke depression[J]. *Chin J Integr Med Cardio-Cerebrovasc Dis*, 2023, 21(3): 421. DOI: 10.12102/j.issn.1672-1349.2023.03.006.
- [26] 季武, 王震, 胡忠萍, 等. "通督治郁"针刺法对卒中后抑郁患者汉密尔顿抑郁量表各项评分的影响[J]. *实用临床医药杂志*, 2024, 28(8): 109. DOI: 10.7619/jcmp.20234238.
- Ji W, Wang Z, Hu Z P, *et al.* The effects of "Tongdu Zhiyu" acupuncture on the scores of the Hamilton Depression Scale in patients with post-stroke depression[J]. *J Clin Med Pract*, 2024, 28(8): 109. DOI: 10.7619/jcmp.20234238.
- [27] Liu Y, Gao S S, Zhao Z H, *et al.* Effects of fluoxetine on the activity of NOD-like receptor family 3 inflammasome in peripheral blood and hippocampal region of mice with chronic unpredictable mild stress-induced depression[J]. *Chin J Psychiatry*, 2022, 55(6): 445. DOI: 10.3760/cma.j.cn113661-20220407-00090.
- [28] Mohanraj L, Carter C, Liu J, *et al.* MicroRNA profiles in hematopoietic stem cell transplant recipients[J]. *Biol Res Nurs*, 2024, 26(4): 559. DOI: 10.1177/10998004241256874.

- [29] 黄赛赛, 王丹丹, 张卓亚, 等. 系统性硬化症患者血浆7种miRNA水平与脏器累及和临床指标的相关性[J]. *临床检验杂志*, 2021, 39(5): 358. DOI: [10.13602/j.cnki.jcls.2021.05.09](https://doi.org/10.13602/j.cnki.jcls.2021.05.09).
- Huang S S, Wang D D, Zhang Z Y, *et al*. Correlation between plasma levels of seven miRNAs and organ involvement and clinical indicators in patients with systemic sclerosis[J]. *Chin J Clin Lab Sci*, 2021, 39(5): 358. DOI: [10.13602/j.cnki.jcls.2021.05.09](https://doi.org/10.13602/j.cnki.jcls.2021.05.09).
- [30] Chen X, Yang S, Long X, *et al*. Polysaccharide of *Atractylodes macrocephala* Koidz alleviate LPS-induced inflammatory liver injury by reducing pyroptosis of macrophage via regulating LncRNA GAS5/miR-223-3p/NLRP3 axis[J/OL]. *Front Pharmacol*, 2025, 16: 1593689. <https://doi.org/10.3389/fphar.2025.1593689>.
- [31] Zhang M, Lan H, Peng S, *et al*. MiR-223-3p attenuates radiation-induced inflammatory response and inhibits the activation of NLRP3 inflammasome in macrophages[J/OL]. *Int Immunopharmacol*, 2023, 122: 110616. <https://doi.org/10.1016/j.intimp.2023.110616>.
- [32] Blevins H M, Xu Y, Biby S, *et al*. The NLRP3 inflammasome pathway: a review of mechanisms and inhibitors for the treatment of inflammatory diseases[J/OL]. *Front Aging Neurosci*, 2022, 14: 879021. <https://doi.org/10.3389/fnagi.2022.879021>.
- [33] Zhou L, Zhang J, Han X, *et al*. CysLT2R antagonist HAMI 3379 ameliorates post-stroke depression through NLRP3 inflammasome/pyroptosis pathway in gerbils[J/OL]. *Brain Sci*, 2022, 12(8): 976. <https://doi.org/10.3390/brainsci12080976>.
- [34] 王水轮, 黄凌志, 姜振东. 抑郁症患者GDNF和NLRP3炎症小体表达水平及相关性[J]. *热带医学杂志*, 2022, 22(2): 246.
- Wang S L, Huang L Z, Jiang Z D. Expression levels and correlation of GDNF and NLRP3 inflammasome in patients with depression[J]. *J Trop Med*, 2022, 22(2): 246.
- [35] Niu X, Song H, Xiao X, *et al*. Tectoridin alleviates lipopolysaccharide-induced inflammation via inhibiting TLR4-NF- κ B/NLRP3 signaling in vivo and in vitro[J]. *Immunopharmacol Immunotoxicol*, 2022, 44(5): 641. DOI: [10.1080/08923973.2022.2065651](https://doi.org/10.1080/08923973.2022.2065651).
- [36] 王紫燕, 杨卓欣, 黄杏贤, 等. 基于NLRP3信号通路探讨调任通督针法对多囊卵巢综合征大鼠激素失衡和胰岛素抵抗的影响[J]. *广州中医药大学学报*, 2024, 41(12): 3243.
- Wang Z Y, Yang Z X, Huang X X, *et al*. Exploration of the effect of Tiaoren Tongdu acupuncture on hormonal imbalance and insulin resistance in rats with polycystic ovary syndrome based on the NLRP3 signaling pathway[J]. *J Guangzhou Univ Tradit Chin Med*, 2024, 41(12): 3243.
- [37] 姜硕, 王梦楠, 赵慧颖, 等. cGAS/STING通过NLRP3炎症小体调控人肺微血管内皮细胞炎症的作用机制[J/OL]. *中华重症医学电子杂志*, 2021, 7(3): 233. <https://doi.org/10.3877/cma.j.issn.2096-1537.2021.03.007>.
- Jiang S, Wang M N, Zhao H Y, *et al*. cGAS/STING regulates inflammation of human pulmonary microvascular endothelial cells via NLRP3 inflammasome[J/OL]. *Chin J Crit Care Intensive Care Med (Electron Ed)*, 2021, 7(3): 233. <https://doi.org/10.3877/cma.j.issn.2096-1537.2021.03.007>.

(2025-06-25收稿, 2026-01-26修回)

编辑 刘 华



开放获取 本文使用遵循知识共享署名—非商业性使用4.0国际许可协议(CC BY-NC 4.0), 详细信息请访问

<https://creativecommons.org/licenses/by-nc/4.0/>。

OPEN ACCESS This article is licensed for use under Creative Commons Attribution-NonCommercial 4.0 International license (CC BY-NC 4.0). For more information, visit <https://creativecommons.org/licenses/by-nc/4.0/>.

© 2026《四川大学学报(医学版)》编辑部

Editorial Office of *Journal of Sichuan University (Medical Sciences)*