

doi: 10.13241/j.cnki.pmb.2022.19.011

个体化生物反馈训练联合早期排便功能训练对低位直肠癌保肛术后患者肠道功能、肛肠动力学和生活质量的影响*

李 慧 姚 翠[△] 封益飞 华倩雯 黄 瑞

(江苏省人民医院结直肠外科 江苏 南京 210000)

摘要 目的:探讨个体化生物反馈训练联合早期排便功能训练对低位直肠癌保肛术后患者肠道功能、肛肠动力学和生活质量的影响。**方法:**纳入我院 2018 年 4 月~2021 年 9 月期间收治的 90 例低位直肠癌保肛术患者。按照住院号奇偶数将患者分为对照组(早期排便功能训练,45 例)和研究组(对照组基础上结合个体化生物反馈训练,45 例)。对比两组肠道功能、肛肠动力学和生活质量、肛门失禁情况及控便满意度。**结果:**两组干预后排便受饮食影响、便频便急、排便感觉异常评分均下降,但研究组高于对照组($P<0.05$)。两组干预后健康调查量表简表(SF-36)各维度评分均升高,且研究组高于对照组($P<0.05$)。研究组的肛门失禁例数少于对照组,控便满意度则高于对照组($P<0.05$)。两组干预后肛管静息压、肛管最大收缩压、直肠最大耐受容量均下降,但研究组高于对照组($P<0.05$)。**结论:**个体化生物反馈训练联合早期排便功能训练可促进低位直肠癌保肛术后患者肠道功能恢复,改善肛肠动力学和生活质量,减少肛门失禁情况发生,控便满意度较好。

关键词:低位直肠癌保肛术;早期排便功能训练;个体化生物反馈训练;肛肠动力学;肠道功能;生活质量

中图分类号:R735.37 **文献标识码:**A **文章编号:**1673-6273(2022)19-3660-05

Effects of Individualized Biofeedback Training Combined with Early Defecation Function Training on Intestinal Function, Anorectal Dynamics and Quality of Life in Patients with Low Rectal Cancer after Anus Preserving Surgery*

LI Hui, YAO Cui[△], FENG Yi-fei, HUA Qian-wen, HUANG Rui

(Department of Colorectal Surgery, Jiangsu Provincial People's Hospital, Nanjing, Jiangsu, 210000, China)

ABSTRACT Objective: To investigate the effects of individualized biofeedback training combined with early defecation function training on intestinal function, anorectal dynamics and quality of life in patients with low rectal cancer after anus preserving surgery. **Methods:** 90 patients with low rectal cancer who were treated in our hospital from April 2018 to September 2021 were included. According to the order of admission, the patients were divided into control group (early defecation function training, 45 cases) and study group (based on the control group combined with individualized biofeedback training, 45 cases). The intestinal function, anorectal dynamics and quality of life, anal incontinence and fecal control satisfaction were compared between the two groups. **Results:** After intervention, the scores of defecation affected by diet, frequent and urgent defecation and abnormal defecation sensation in the two groups decreased, but the study group was higher than the control group ($P<0.05$). After intervention, the scores of all dimensions of the short form of health survey scale (SF-36) in the two groups increased, and the study group was higher than the control group ($P<0.05$). The number of cases of anal incontinence in the study group was less than that in the control group, and the fecal control satisfaction was higher than that in the control group ($P<0.05$). After intervention, the resting pressure of anal canal, the maximum systolic pressure of anal canal and the maximum tolerance capacity of rectum decreased in the two groups, but the study group was higher than the control group ($P<0.05$). **Conclusion:** Individualized biofeedback training combined with early defecation function training can promote the recovery of intestinal function, improve anorectal dynamics and quality of life, reduce the occurrence of anal incontinence, and achieve better satisfaction with defecation control.

Key words: Low rectal cancer after anus preserving surgery; Early defecation function training; Individualized biofeedback training; Anorectal dynamics; Intestinal function; Quality of life

Chinese Library Classification(CLC): R735.37 **Document code:** A

Article ID: 1673-6273(2022)19-3660-05

* 基金项目:江苏省自然科学基金项目(BK20171691)

作者简介:李慧(1994-),女,硕士研究生,从事结直肠癌方向的研究,E-mail: lh1226200279@163.com

[△] 通讯作者:姚翠(1984-),女,硕士,副主任医师,从事肠癌方向的研究,E-mail: 183274236@qq.com

(收稿日期:2022-03-10 接受日期:2022-04-05)

前言

低位直肠癌指的是肿瘤病灶的位置在肛门 5 cm 以内的一类直肠癌疾病,低位直肠癌保肛术是治疗该病的有效术式之一^[1]。但也有不少临床研究显示^[2,3],低位直肠癌保肛术虽然完整地保留了括约肌功能,但在切除肿瘤的过程中,会损伤到人体正常的肠道解剖结构和功能,导致患者术后排便功能受到影响。既往低位直肠癌患者常于术后接受早期排便功能训练,虽可在一定程度上改善排便功能,但效果不显著^[4]。个体化生物反馈训练通过专业的设备搜集患者自身生理活动信息,随后采用生物反馈机制,将这些生理活动信息转变为人们熟悉的视觉或听觉信号,根据这些信息变化患者自行调整生理活动,既往用于胃肠道等疾病中取得了较好的康复效果^[5-7]。本文选择低位直肠癌保肛术患者作为本文观察对象,观察个体化生物反馈训练联合早期排便功能训练在此类患者中的临床应用价值,以期为低位直肠癌保肛术患者的预后改善提供一定参考。

1 资料与方法

1.1 一般资料

纳入我院 2018 年 4 月~2021 年 9 月期间收治的 90 例行低位直肠癌保肛术患者。纳入标准:(1)肿瘤下缘距离齿状线低于 5 cm,经过肠镜或病理学诊断确诊为直肠癌;(2)年龄>18 岁;(3)自愿参加本研究,签署知情同意书;(4)具备手术指征,均成功完成手术。排除标准:(1)存在精神疾病、严重智力障碍、意识障碍、记忆力障碍者;(2)合并严重脏器功能不全者;(3)术前已存在肛裂、肛瘘、脱肛、克罗恩病等疾病者;(4)肿瘤发生远处转移者;(5)术后出现严重并发症者。按照住院号奇偶数将患者分为对照组(n=45)和研究组(n=45),对照组男 26 例,女 19 例,年龄 35~68 岁,平均(52.67±4.52)岁;病理组织学类型:腺癌、未分化癌、黏液腺癌患者分别为 26 例、8 例、11 例。研究组男 29 例,女 16 例,年龄 37~67 岁,平均(53.16±5.29)岁;病理组织学类型:腺癌、未分化癌、黏液腺癌患者分别为 29 例、7 例、9 例。两组患者一般资料对比后,未见统计学差异($P>0.05$)。我院伦理委员会已批准本研究。

1.2 方法

两组低位直肠癌保肛术患者全部接受术后常规处理,包括伤口处理、胃管放置、饮食、生命体征观察、尿管等。对照组在上述基础之上接受早期排便功能训练,术后 4 d,指导患者如何控制大便,术后 7 d,开始接受排便功能训练。具体包括:(1)提肛运动,早晚分别进行 1 组,呼气放松肛门,肛门舒张 3~5 s,吸气时提肛,维持收缩 3~5 s,进行 10 次为 1 组。(2)排便反射训练,进食三餐之后,无论便意是否存在均需按时排便,若出现便意便收缩肛门,每次持续 10 s。(3)坐浴,便后选择 40~50℃的温盐水进行坐浴 15~20 min。(4)排尿中断训练。排尿期间突然中断排尿,之后再继续,连续干预 2 周。研究组则在对照组的基础上结合个体化生物反馈训练,选用美国天柱公司生产的 Orion PC/12mEMG 生物反馈训练系统,制订生物反馈训练剂量为每周 3 次,每次 20 分钟,以 4 周为 1 个周期,进行 3 个周期。训练过程中将纵形的插入式肛管电极置于肛门内直肠下段,粘贴式三导腹前斜肌体表电极置于体表,连接生物反馈仪,让患者观

察肛门收缩过程中压力曲线动态变化过程及肌电变化的波形,并让患者尝试学会比较自身的收缩波形与正常波形的区别,进行收缩锻炼调整,直至患者的收缩排便波形与正常波形相同。

1.3 观察指标

(1)中文版纪念斯隆-凯特林癌症中心(MSKCC)^[8]肠道功能问卷:治疗前后采用 MSKCC 肠道功能问卷评估患者肠道功能情况,该量表包括排便感觉异常、便频便急、排便受饮食影响,3 个维度共 18 个条目,每个条目计为 1~5 分,除第 4、5、7、11 和 12 个条目为反向计分,其余均为正向计分。总分越高说明患者肠道功能越好。(2)肛肠动力学指标:干预前后采用安徽合肥奥源科技发展有限公司生产的 ZGJ-D3 肛肠压力检测仪检测两组肛管静息压、肛管最大收缩压、直肠最大耐受容量。(3)生活质量各维度评分:干预前后采用健康调查量表简表(SF-36)^[9]评估两组生活质量,SF-36 包括 8 个维度,分别为:生理/社会功能、总体/精神健康、躯体疼痛、生理/情感职能、活力,每个维度各为 100 分,分数越高,生活质量越好。(4)肛门失禁情况及控便满意度:干预后观察患者的肛门失禁情况及患者满意度。肛门失禁评分采用 1975 年 Lane 分类法^[10],按照完全失禁、不能控制稀便和气体、粪便偶染衣裤分为 III 度、II 度、I 度。记录两组控便满意例数。

1.4 统计学方法

采用 SPSS20.0 软件处理数据。所有计量资料经 K-V 检验,符合正态分布的计量资料(SF-36 各维度评分、MSKCC 评分等)用($\bar{x} \pm s$)表示,采用 t 检验;计数资料及等级资料用[n(%)]表示,采用 χ^2 检验或秩和检验。检验标准设置为 $\alpha=0.05$ 。

2 结果

2.1 两组 MSKCC 评分对比

两组干预前排便受饮食影响、便频便急、排便感觉异常评分对比未见明显差异($P>0.05$)。两组干预后排便受饮食影响、便频便急、排便感觉异常评分均下降,但研究组高于对照组($P<0.05$),见表 1。

2.2 两组肛肠动力学指标对比

两组干预前肛管静息压、肛管最大收缩压、直肠最大耐受容量对比未见明显差异($P>0.05$)。两组干预后肛管静息压、肛管最大收缩压、直肠最大耐受容量均下降,但研究组高于对照组($P<0.05$),见表 2。

2.3 两组生活质量评分对比

两组干预前生理/社会功能、总体/精神健康、躯体疼痛、生理/情感职能、活力各维度评分对比未见差异($P>0.05$)。两组干预后生理/社会功能、总体/精神健康、躯体疼痛、生理/情感职能、活力各维度评分均升高,且研究组高于对照组($P<0.05$)。见表 3。

2.4 两组肛门失禁情况及患者满意度对比

研究组的肛门失禁例数少于对照组,控便满意度则高于对照组($P<0.05$)。见表 4。

3 讨论

直肠癌在我国肿瘤发病率居于第 3 位,死亡率居于全国恶性肿瘤第 5 位^[11]。在直肠癌的多种类型中,又以低位直肠癌最

表 1 两组 MSKCC 评分对比($\bar{x} \pm s$, 分)

Table 1 Comparison of MSKCC scores between the two groups($\bar{x} \pm s$, scores)

Groups	Time	Defecation affected by diet	Frequent and urgent defecation	Abnormal defecation sensation
Control group(n=45)	Before intervention	18.16± 1.49	39.79± 5.37	16.20± 2.95
	After intervention	11.32± 1.41	33.56± 4.24	10.08± 2.88
	t	22.367	6.108	9.958
	P	0.000	0.000	0.000
Study group(n=45)	Before intervention	18.29± 1.28	39.15± 6.29	16.94± 3.28
	After intervention	14.58± 1.07*	36.61± 5.35*	13.62± 2.37*
	t	14.918	2.063	5.504
	P	0.000	0.042	0.000

Note: compared with the control group after intervention, *P<0.05.

表 2 两组肛肠动力学指标对比($\bar{x} \pm s$)

Table 2 Comparison of anorectal dynamic indexes between the two groups($\bar{x} \pm s$)

Groups	Time	Resting pressure of anal canal(mmHg)	Maximum systolic pressure of anal canal(mmHg)	Maximum tolerance capacity of rectum(mL)
Control group(n=45)	Before intervention	63.87± 7.34	227.17± 30.19	181.97± 19.16
	After intervention	48.92± 6.52	154.79± 25.22	139.64± 26.23
	t	10.215	12.343	8.742
	P	0.000	0.000	0.000
Study group(n=45)	Before intervention	62.61± 7.36	226.12± 28.24	182.35± 24.22
	After intervention	54.14± 6.28*	187.56± 26.18*	162.38± 27.34*
	t	5.873	6.717	3.668
	P	0.000	0.000	0.000

Note: compared with the control group after intervention, *P<0.05.

表 3 两组生活质量评分对比($\bar{x} \pm s$, 分)

Table 3 Comparison of quality of life scores between the two groups($\bar{x} \pm s$, scores)

Groups	Time	Physiological function	Social function	Physical pain	Overall health	Role-physical	Vitality	Emotional function	Mental health
Control group(n=45)	Before intervention	59.61± 6.08	61.42± 7.19	57.91± 6.12	60.72± 6.69	62.60± 6.11	61.48± 7.22	63.88± 6.15	60.59± 6.36
	After intervention	74.73± 7.12	75.78± 6.23	71.54± 5.09	72.63± 6.21	73.91± 6.14	72.05± 7.24	76.37± 6.08	75.82± 6.46
	t	-10.833	-10.125	-11.486	-8.753	-8.759	-6.935	-9.688	-11.270
	P	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Study group(n=45)	Before intervention	58.41± 6.29	60.79± 6.32	56.82± 6.39	61.06± 7.23	63.59± 7.32	60.48± 7.17	62.79± 7.42	61.48± 7.39
	After intervention	83.06± 7.05*	84.07± 7.19*	80.36± 6.32*	83.41± 7.46*	84.39± 6.47*	72.96± 6.83*	85.17± 6.24*	83.82± 7.86*
	t	-17.502	-16.314	-17.570	-14.432	-14.382	-8.454	-15.485	-13.891
	P	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: compared with the control group after intervention, *P<0.05.

为常见^[12]。外科手术主要用于根治低位直肠癌,可将肿瘤组织切除,但又因肿瘤距离齿状线较近,传统的手术保肛难度较大,

故如何最大程度的保留患者的肛肠功能一直是临床的研究热点之一^[13]。近年来,随着吻合器技术的提高,低位直肠癌保肛术

表 4 两组肛门失禁情况及患者满意度对比 [例(%)]

Table 4 Comparison of anal incontinence and patient satisfaction between the two groups [n(%)]

Groups	Anal incontinence			Fecal control satisfaction
	I degree	II degree	III degree	
Control group(n=45)	4(8.89)	3(6.67)	2(4.44)	31(68.89)
Study group(n=45)	1(2.22)	1(2.22)	0(0.00)	42(93.33)
U/χ^2		5.075		8.775
P		0.024		0.003

成为根治低位直肠癌的主要术式,帮助不少患者避免了终身携带造口袋所带来的不便^[14]。尽管如此,低位直肠癌保肛术仍会导致直肠肛管感觉神经损伤、肛门内括约肌损伤、肛管直肠角改变等生理改变,导致术后患者出现多种肠道症状^[15,16]。以往的研究显示^[17],低位直肠癌保肛术患者中约有 25%~90%的患者可出现大便次数增多、大便不成形、控便能力下降、大便失禁等并发症,严重影响患者的生活质量。目前肠道功能障碍的防治和干预仍处于探索阶段,尚无标准方法。现我国临床多采用早期排便功能训练来改善低位直肠癌保肛术患者的胃肠道功能,但此类训练多集中于改善患者便失禁的症状,而对患者生活质量、控便满意度等方面关注较少^[18]。国外针对低位直肠癌保肛术后肠道功能障碍的康复训练开展较早,不少研究提倡将多种训练方式组合来改善低位直肠癌保肛术后患者的肠道功能障碍^[19,20]。个体化生物反馈训练是根据患者的个人条件,通过电生理仪器将身体生理变化直观呈现给受训者以提高受训者控制身体生理变化能力的训练方式,既往用于排便障碍疾病类患者可获得良好的临床效果^[21,22]。

本次研究结果显示,两组干预后肛管最大收缩压、肛管静息压、MSKCC 评分、直肠最大耐受容量均下降,但研究组高于对照组,且研究组的肛门失禁例数少于对照组。说明早期排便功能训练、个体化生物反馈训练联合干预也无法彻底的避免低位直肠癌保肛术后患者肠道功能障碍发生,但可减轻其严重程度,同时可促进肛肠动力学恢复,降低肛门失禁的发生率。生物反馈训练通过不断的强化调整神经反射及中枢植物神经通路,改善直肠感觉功能,进而减轻肠道功能损害^[23,24]。同时,生物反馈训练使患者通过视觉直观感受关于肛肠动力学活动的信息,利于患者术后恢复^[25,26]。癌症作为一种重大疾病,本身对患者的心理造成巨大的创伤,加之手术创伤、术后并发症等会导致患者出现悲观、焦虑,身心的双重创伤导致患者生活质量受到影响^[27,28]。本研究结果发现,联合干预可有效改善低位直肠癌保肛术后患者的生活质量,满意度较好。可能是因为长时间规律的训练能建立肛门括约肌收缩反应,提升结肠容受粪便能力,降低术后并发症发生率,减少因并发症给生活上带来的不适,故而改善其生活质量,提升患者的满意度^[29,30]。值得注意的是,生物反馈训练需坚持训练一段时间后才能见效,患者训练依从性高低对训练效果至关重要。本研究中,所有纳入个体化生物反馈训练的患者配合度较高,可在一定程度上保证效果。

综上所述,早期排便功能训练、个体化生物反馈训练联合干预可有效改善低位直肠癌保肛术后患者肠道功能、肛肠动力学,减少肛门失禁情况发生,提高患者的生活质量,患者控便满

意度较高。

参考文献(References)

- [1] Hoshino N, Hida K, Sakai Y, et al. Nomogram for predicting anastomotic leakage after low anterior resection for rectal cancer[J]. Int J Colorectal Dis, 2018, 33(4): 411-418
- [2] Piozzi GN, Baek SJ, Kwak JM, et al. Anus-Preserving Surgery in Advanced Low-Lying Rectal Cancer: A Perspective on Oncological Safety of Intersphincteric Resection[J]. Cancers (Basel), 2021, 13(19): 4793
- [3] Lee L, Trepanier M, Renaud J, et al. Patients' preferences for sphincter preservation versus abdominoperineal resection for low rectal cancer [J]. Surgery, 2021, 169(3): 623-628
- [4] 许珊珊, 王立平, 回广玲, 等. 早期排、控便功能训练对低位、超低位直肠癌前切除患者排便功能的影响[J]. 中华结直肠疾病电子杂志, 2014, 3(5): 62-64
- [5] Chmielewska D, Stania M, Kucab-Klich K, et al. Electromyographic characteristics of pelvic floor muscles in women with stress urinary incontinence following sEMG-assisted biofeedback training and Pilates exercises[J]. PLoS One, 2019, 14(12): e0225647
- [6] Ussing A, Dahn I, Due U, et al. Efficacy of Supervised Pelvic Floor Muscle Training and Biofeedback vs Attention-Control Treatment in Adults with Fecal Incontinence [J]. Clin Gastroenterol Hepatol, 2019, 17(11): 2253-2261.e4
- [7] Nunes EFC, Sampaio LMM, Biasotto-Gonzalez DA, et al. Biofeedback for pelvic floor muscle training in women with stress urinary incontinence: a systematic review with meta-analysis [J]. Physiotherapy, 2019, 105(1): 10-23
- [8] 侯晓婷, 鹿冬, 路潜, 等. 肠道功能问卷中文版在直肠癌保肛术后患者中的信效度研究[J]. 中华护理杂志, 2014, 49(12): 1453-1458
- [9] Hays RD, Sherbourne CD, Mazel RM. The RAND 36-Item Health Survey 1.0[J]. Health Econ, 1993, 2(3): 217-227
- [10] Lane RH. Clinical application of anorectal physiology[J]. Proc R Soc Med, 1975, 68(1): 28-30
- [11] 钱文彪, 刘丹, 杜雅菊. 肥胖和结直肠癌:流行病学证据和病理生理机制[J]. 胃肠病学和肝病学杂志, 2015, 24(6): 627-630
- [12] 张涵朔, 任镜清, 朱伟聪, 等. 手辅助腹腔镜在肛门全直肠系膜切除手术中低位直肠癌中的应用价值 [J]. 现代生物医学进展, 2021, 21(6): 1169-1173
- [13] Mak JCK, Foo DCC, Wei R, et al. Sphincter-Preserving Surgery for Low Rectal Cancers: Incidence and Risk Factors for Permanent Stoma [J]. World J Surg, 2017, 41(11): 2912-2922
- [14] Klose J, Tarantino I, Kulu Y, et al. Sphincter-Preserving Surgery for

- Low Rectal Cancer: Do We Overshoot the Mark? [J]. *J Gastrointest Surg*, 2017, 21(5): 885-891
- [15] Partl R, Magyar M, Hassler E, et al. Clinical parameters predictive for sphincter-preserving surgery and prognostic outcome in patients with locally advanced low rectal cancer [J]. *Radiat Oncol*, 2020, 15(1): 99
- [16] Denost Q, Moreau JB, Vendrely V, et al. Intersphincteric resection for low rectal cancer: the risk is functional rather than oncological. A 25-year experience from Bordeaux [J]. *Colorectal Dis*, 2020, 22(11): 1603-1613
- [17] 齐晟, 何智勇, 李承刚, 等. 经肛门结肠直肠套入式吻合对腹腔镜低位直肠癌保肛术患者肠道功能的影响分析 [J]. *结直肠肛门外科*, 2019, 25(1): 65-69
- [18] 卞凤丽, 黄云娟, 杨芳, 等. 坐位排便肠道康复训练对急性心肌梗死急诊 PCI 术后患者早期排便及心脏功能的影响 [J]. *中国急救复苏与灾害医学杂志*, 2021, 16(11): 1287-1290
- [19] Sakr A, Sauri F, Alessa M, et al. Assessment and management of low anterior resection syndrome after sphincter preserving surgery for rectal cancer [J]. *Chin Med J (Engl)*, 2020, 133(15): 1824-1833
- [20] Haas S, Faaborg P, Liao D, et al. Anal sphincter dysfunction in patients treated with primary radiotherapy for anal cancer: a study with the functional lumen imaging probe [J]. *Acta Oncol*, 2018, 57(4): 465-472
- [21] Chiarioni G, Heymen S, Whitehead WE. Biofeedback therapy for dyssynergic defecation [J]. *World J Gastroenterol*, 2006, 12 (44): 7069-7074
- [22] Talebi A, Alimadadi E, Akbari A, et al. Improvement of Patient Satisfaction and Anorectal Manometry Parameters After Biofeedback Therapy in Patients with Different Types of Dyssynergic Defecation [J]. *Appl Psychophysiol Biofeedback*, 2020, 45(4): 267-274
- [23] Moore D, Young CJ. A systematic review and meta-analysis of biofeedback therapy for dyssynergic defaecation in adults [J]. *Tech Coloproctol*, 2020, 24(9): 909-918
- [24] 鲍俊涛, 张书峰, 王晓晖, 等. 改良股薄肌移植联合生物反馈对肌源性肛门失禁患儿肛门节制的疗效 [J]. *广东医学*, 2014, 35(3): 430-432
- [25] 盖娟娟, 范小华, 曾科学. 盆底生物电反馈治疗在低位直肠癌保肛术后排便重建的作用 [J]. *结直肠肛门外科*, 2015, 21(5): 310-313
- [26] Janka A, Adler C, Brunner B, et al. Biofeedback Training in Crisis Managers: A Randomized Controlled Trial [J]. *Appl Psychophysiol Biofeedback*, 2017, 42(2): 117-125
- [27] 宋建宁, 王俭, 李铁军, 等. 保肛术与腹会阴联合直肠癌根治造瘘术治疗老年低位直肠癌的效果及对生活质量的影响比较 [J]. *中国老年学杂志*, 2018, 38(24): 5984-5986
- [28] 王晓艳, 应仙华, 吴淑英. 生物反馈疗法联合电刺激治疗产妇产后盆底功能障碍性疾病的临床疗效及影响因素分析 [J]. *中国妇幼保健*, 2020, 35(24): 4667-4671
- [29] 赵加应, 殷琛庆, 陈文杰, 等. 针灸联合生物反馈治疗直肠癌保肛术后排便失禁的效果 [J]. *中国康复理论与实践*, 2020, 26(6): 715-724
- [30] Kizakevich PN, Eckhoff RP, Lewis GF, et al. Biofeedback-Assisted Resilience Training for Traumatic and Operational Stress: Preliminary Analysis of a Self-Delivered Digital Health Methodology [J]. *JMIR Mhealth Uhealth*, 2019, 7(9): e12590
- (上接第 3624 页)
- [16] Jiang J, Dai J, Cui H. Vitexin reverses the autophagy dysfunction to attenuate MCAO-induced cerebral ischemic stroke via mTOR/Ulk1 pathway [J]. *Biomed Pharmacother*, 2018, 99: 583-590
- [17] 董六一, 邵旭, 江勤, 等. 牡荆素对大鼠实验性心肌缺血损伤的保护作用及其机制 [J]. *中草药*, 2011, 42(7): 1378-1383
- [18] 巩固, 袁利邦, 黄怡, 等. LRG 在脂多糖预处理诱导大鼠脑保护效应中的作用研究 [J]. *实用医学杂志*, 2012, 28(2): 187-189
- [19] 郑思敏, 李思远, 牛晓丽, 等. 多黏菌素 B 对大鼠全脑缺血再灌注时脂多糖所致损伤的保护作用及机制 [J]. *贵州医科大学学报*, 2021, 46(9): 1011-1017
- [20] Lima LKF, Pereira SKS, Junior R, et al. A brief review on the neuro-protective mechanisms of vitexin [J]. *Biomed Res Int*, 2018, 2018: 4785089
- [21] Gaikwad SM, Heneka MT. Studying M1 and M2 states in adult microglia [J]. *Methods Mol Biol*, 2013, 1041: 185-197
- [22] Martinez FO, Gordon S. The M1 and M2 paradigm of macrophage activation: time for reassessment [J]. *F1000Prime Rep*, 2014, 6: 13
- [23] Chhor V, Le Charpentier T, Lebon S, et al. Characterization of phenotype markers and neurotoxic potential of polarised primary microglia in vitro [J]. *Brain Behav Immun*, 2013, 32: 70-85
- [24] Mikita T, Campbell D, Wu P, et al. Requirements for interleukin-4-induced gene expression and functional characterization of Stat6 [J]. *Mol Cell Biol*, 1996, 16(10): 5811-5820
- [25] Mantovani A, Sica A, Sozzani S, et al. The chemokine system in diverse forms of macrophage activation and polarization [J]. *Trends Immunol*, 2004, 25(12): 677-686
- [26] Yahaya MAF, Bakar ARA, Stanslas J, et al. Insights from molecular docking and molecular dynamics on the potential of vitexin as an antagonist candidate against lipopolysaccharide (LPS) for microglial activation in neuroinflammation [J]. *BMC Biotechnol*, 2021, 21(1): 38
- [27] Lu YC, Yeh WC, Ohashi PS. LPS/TLR4 signal transduction pathway [J]. *Cytokine*, 2008, 42(2): 145-151
- [28] Ain QU, Batool M, Choi S. TLR4-targeting therapeutics: structural basis and computer-aided drug discovery approaches [J]. *Molecules*, 2020, 25(3): 627
- [29] Švajger U, Brus B, Turk S, et al. Novel toll-like receptor 4 (TLR4) antagonists identified by structure- and ligand-based virtual screening [J]. *Eur J Med Chem*, 2013, 70: 393-399
- [30] Napetschnig J, Wu H. Molecular basis of NF- κ B signaling [J]. *Annu Rev Biophys*, 2013, 42: 443-468
- [31] Kawai T, Akira S. Signaling to NF-kappaB by Toll-like receptors [J]. *Trends Mol Med*, 2007, 13(11): 460-469
- [32] Tam WF, Sen R. IkappaB family members function by different mechanisms [J]. *J Biol Chem*, 2001, 276(11): 7701-7704
- [33] Duan S, Du X, Chen S, et al. Effect of vitexin on alleviating liver inflammation in a dextran sulfate sodium (DSS)-induced colitis model [J]. *Biomed Pharmacother*, 2020, 121: 109683
- [34] Li C, Chen Y, Yuan X, et al. Vitexin ameliorates chronic stress plus high fat diet-induced nonalcoholic fatty liver disease by inhibiting inflammation [J]. *Eur J Pharmacol*, 2020, 882: 173264