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功能性核磁共振成像技术对原发性三叉神经痛患者脑功能的评估价值及血清 IL-1 β 、TNF- α 检测的临床意义*

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摘要 目的:研究功能性核磁共振成像(fMRI)技术对原发性三叉神经痛(ITN)患者静息状态下脑功能的评估价值及血清白细胞介素-1 β (IL-1 β)、肿瘤坏死因子- α (TNF- α)检测的临床意义。**方法:**选取2017年2月~2019年2月安徽医科大学附属口腔医院接受诊治的ITN患者共50例进行研究,记为ITN组。另选取同期接受体检的健康人员50例记作健康对照组。两组均于静息状态下行fMRI扫描,比较两组脑区的平均低频振幅率(mfALFF)以及血清IL-1 β 、TNF- α 水平。**结果:**ITN组左侧的枕中回、枕下回、梭状回、距状裂周围皮层、中央旁回、三角部额下回、右侧背外侧额上回以及左小脑脚1区的mfALFF值高于健康对照组(均 $P<0.05$)。ITN组右额上回、右额中回、右额下回、右中央沟盖、右缘上回、右岛盖部额下回、左前扣带回、扣带旁回、左颞极、颞上回脑区的mfALFF值显著低于健康对照组(均 $P<0.05$)。ITN组患者的血清IL-1 β 、TNF- α 水平高于健康对照组(均 $P<0.05$)。**结论:**fMRI对ITN患者静息状态下脑功能的评估价值较高,血清IL-1 β 、TNF- α 水平升高可能与ITN的发病密切相关,可发挥促进疾病发生、发展的作用。

关键词:原发性三叉神经痛;功能性核磁共振成像技术;脑功能评估;白细胞介素-1 β ;肿瘤坏死因子- α

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The Evaluation Value of Functional Magnetic Resonance Imaging in Brain Function of Patients with Idiopathic Trigeminal Neuralgia and the Clinical Significance of Serum IL-1 β and TNF- α Detection*

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ABSTRACT Objective: To study the evaluation value of functional magnetic resonance imaging (fMRI) in brain function of patients with idiopathic trigeminal neuralgia (ITN) and the clinical significance of serum interleukin-1 β (IL-1 β) and tumor necrosis factor- α (TNF- α). **Methods:** A total of 50 patients with ITN who were treated in Stomatological Hospital Affiliated to Anhui Medical University from February 2017 to February 2019 were included in the study and recorded as ITN group. Another 50 healthy patients who received physical examination during the same period were recorded as healthy control group. Both groups were scanned by fMRI at rest. The levels of mean fractional amplitude of low frequency fluctuation (mfALFF), serum IL-1 β and TNF- α in the two groups were compared. **Results:** The levels of mfALFF in the left middle occipital gyrus, inferior occipital gyrus, fusiform gyrus, calcinate fissure surrounding cortex, central paralateral gyrus, triangular inferior frontal gyrus, right dorsolateral superior frontal gyrus and left cerebellar region 1 in the ITN group were higher than those in the healthy control group (all $P<0.05$). In the ITN group, the mfALFF values of right superior temporal gyrus, right middle temporal gyrus, right inferior temporal gyrus, right central sulcus cover, right superior marginal gyrus, right inferior temporal gyrus, left anterior cingulate gyrus, paracingulate gyrus, left temporal polar and superior temporal gyrus were significantly lower than those in the healthy control group (all $P<0.05$). The levels of serum IL-1 β and TNF- α in the ITN group were higher than those in the healthy control group (all $P<0.05$). **Conclusions:** The evaluation value of fMRI at brain function in resting state of patients with ITN is high. The elevated levels of serum IL-1 β and TNF- α may be closely related to the pathogenesis of ITN, and it play a role in promoting the occurrence and development of the disease.

Key words: Idiopathic trigeminal neuralgia; Functional magnetic resonance imaging; Evaluation of brain function; Interleukin-1 β ;

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前言

原发性三叉神经痛(Idiopathic trigeminal neuralgia, ITN)属于临床上较为常见的疾病之一,主要是以三叉神经中某支或多支出现阵发性剧烈疼痛为临床症状表现,且上述疼痛可能历时数秒乃至数十秒,严重影响患者身心健康^[1-3]。迄今为止,关于ITN的具体发病机制以及病因尚未完全明确。影像学结果显示处于任务状态时的ITN患者,其部分脑区存在脑功能活动性异常^[4]。然而,上述方式可能会受情绪、刺激强度、疼痛程度不可控因素的影响,存在一定的局限性,而通过对静息状态下的功能性核磁共振成像(Functional magnetic resonance imaging, fMRI)研究,可有效避免任务状态下fMRI的缺陷^[5]。另有研究发现^[6],在三叉神经痛组织病理中发现半月神经节与感觉根内存在炎症性浸润与脱髓鞘改变,这提示了炎症因子异常表达以及炎症浸润可能在发病过程中起着至关重要的作用。白细胞介素-1 β (Interleukin-1 β , IL-1 β)、肿瘤坏死因子- α (Tumor necrosis factor- α , TNF- α)是临床上应用较为广泛的两种促炎细胞因子,主要参与机体的免疫应答以及调节过程^[7,8]。鉴于此,本研究分析fMRI评估ITN患者静息状态下脑功能的价值及血清IL-1 β 、TNF- α 检测的临床意义,旨在为临床ITN的早期诊断、临床治疗提供参考依据,现作以下报道。

1 资料与方法

1.1 一般资料

选取2017年2月~2019年2月安徽医科大学附属口腔医院接受诊治的ITN患者共50例进行研究,记为ITN组。纳入标准:(1)所有患者既往均无脑梗死病史与精神疾病史;(2)均无金属携带物;(3)无颅脑手术史;(4)年龄 ≥ 18 周岁。排除标准:(1)存在ITN相关手术治疗史者;(2)心、肝、肾等重要脏器功能障碍者;(3)合并严重感染性疾病、自身免疫系统疾病或恶性肿瘤者;(4)正接受其他研究者。其中男性27例,女性23例,年龄22~78岁,平均年龄(56.23 ± 10.73)岁;受教育年限4~18年,平均受教育年限(8.52 ± 3.49)年。另选取同期接受体检的健康人员50例记作健康对照组。其中男性29例,女性21例,年龄23~79岁,平均年龄(56.28 ± 10.75)岁;受教育年限5~18年,平均受教育年限(8.59 ± 3.52)年。两组上述指标比较差异不显著($P > 0.05$)。本研究已获得纳入对象知情同意并签署知情同意协议,并得到安徽医科大学附属口腔医院伦理委员会批准。

1.2 研究方法

(1)两组人员均进行fMRI检查:通过磁共振扫描仪(GE 750W3.0T型)以及头颈联合性线圈(16通道)实施评价,检查时受检者需保持清醒、闭眼以及无特定的思维活动状态。进行T2WI和FALAIR的扫描,功能成像全脑的3D结构成像方式以及血氧水平的依赖性平面回波成像进行处理。参数设置:回波时间为35 ms,重复时间为2000 ms,翻转角度为90°,视野

为24 $\times$ 24 cm²,矩阵为64~64,扫描厚度取3.6 mm,层间距取0.4 mm,扫描层数取38层。通过快速扰相梯度回波序列进行3D解剖图像的扫描和采集,重复时间取8.5 ms,回波时间取3.3 ms,翻转角度为12°,视野取24 $\times$ 24 cm²,矩阵取256 $\times$ 256,扫描厚度取1.2 mm,扫描层数取170层。(2)fMRI图像处理:参照Matlab7.12、Mricro以及SPM12平台上相关数据处理等工具,作出图像DICOM格式变换,得到NIf-TI格式。弃去开始10个时间点的相关数据,并标准化时间与空间。去除头动平移 >2.5 mm以及转动角度 $>2.5^\circ$ 的数据。用4 mm半高全宽高斯作出功能图像的有关空间平滑,经低频滤波处理后,获得频率为0.01~0.08 MHz的数据信号。算出分数低频率的振幅(Fractional amplitude of low frequency fluctuation, fALFF),而后使各体素fALFF值及全脑均值进行相除,最终得到标准化的平均低频振幅率(Mean fractional amplitude of low frequency fluctuation, mfALFF)。(3)标本采集和处理:所有人员于清晨空腹状态下,完成静脉血5 ml的采集,并以3000 r/min转速作出离心10 min的处理,获得上层血清并放置在-80℃的冰箱中保存待检。(4)采用酶联免疫吸附法完成血清IL-1 β 、TNF- α 水平的检测,按照试剂盒说明书(上海酶联生物科技有限公司)进行具体操作。

1.3 统计学方法

以SPSS25.0软件进行统计分析,涉及的计量资料以($\bar{x} \pm s$)表示,并选用t检验。涉及的计数资料以率(%)表示,并选用 χ^2 检验,由蒙特利尔模板(Montreal neurological institute, MNI)坐标呈现差异显著性的脑区。 $P < 0.05$ 表明差异具有统计学意义。

2 结果

2.1 ITN组mfALFF值显著增高脑区

ITN组左侧的枕中回、枕下回、梭状回、距状裂周围皮层、中央旁回、三角部额下回、右侧的背外侧额上回以及左小脑脚1区的mfALFF值高于健康对照组(均 $P < 0.05$)。见表1。

2.2 ITN组mfALFF值显著降低脑区

ITN组右颞上回、右颞中回、右颞下回、右中央沟盖、右缘上回、右岛盖部颞下回、左前扣带回、扣带旁回、左颞极、颞上回脑区的mfALFF值显著低于健康对照组(均 $P < 0.05$)。见表2。

2.3 两组血清IL-1 β 、TNF- α 水平对比

ITN组患者的血清IL-1 β 、TNF- α 水平分别为(40.12 ± 10.07)pg/mL、(38.31 ± 10.90)pg/mL,高于健康对照组的(31.24 ± 11.45)pg/mL、(28.20 ± 12.38)pg/mL(均 $P < 0.05$)。见表3。

3 讨论

既往关于ITN的影像学研究主要集中在三叉神经桥前池段的血管压迫学说,然而该种学说尚且存在不足之处,如关于其病机的探讨未涉及脑桥以后中枢神经系统对痛觉的处理^[9,10]。随着近年来脑结构与fMRI技术的发展,发现了ITN患者多个

脑区结构和功能的异常,涵盖大脑白质微观结构、灰质体积、大脑皮层等。本文选取静息状态下的血氧水平依赖性 fMRI 技术,可按照患者大脑反应区内有关 BOLO 信号的转变,实施脑功能成像。mfALFF 值降低表明神经元的自发性活动受到较大程度抑制,而 mfALFF 值增强的局部脑区则代表该区域内神经元处于自发性的活动增强^[11-13]。另有关于神经性疼痛的研究发现:机体免疫反应在疼痛的发生、发展过程中发挥着至关重要的作

用^[14]。正常状况下,末梢神经中含有多种非神经细胞维持局部的生理平衡以及稳态,这些细胞包括血管内皮细胞、巨噬细胞、纤维细胞等。一旦神经完整性受到破坏以及神经受损,上述细胞可被激活并释放如 IL-6、TNF- α 等炎症因子以及前列腺素和疼痛物质等^[15,16],加之中性粒细胞、T 淋巴细胞以及单核细胞亦参与了机体免疫的反应,继而破坏神经组织,从而产生上述递质。

表 1 ITN 组 mfALFF 值显著增高脑区
Table 1 MfALFF was significantly increased in the ITN group

Items	Voxel	Z	P	Peak MNI coordinates			BA partition
				X	Y	Z	
Left middle occipital gyrus	52	4.14	0.000	-24	-85	10	18
		3.64	0.000	-31	-84	20	
		3.11	0.000	-30	-76	16	
Left inferior occipital gyrus	22	3.59	0.000	-32	-88	-3	20
	22	3.22	0.000	-32	-79	-6	
	11	3.20	0.000	-24	-87	-9	
Left fusiform gyrus	12	2.92	0.000	-29	-40	-18	36
Left calcarine fissure	20	3.52	0.000	-6	-100	3	-
surrounding cortex		3.28	0.000	-3	-94	8	-
Left central paralateral gyrus	13	3.34	0.000	-10	-31	70	-
Left triangular inferior frontal gyrus	17	4.19	0.000	-58	24	18	47
Right dorsolateral superior frontal gyrus	11	3.40	0.000	18	40	34	8
Left cerebellar region 1	30	3.52	0.000	-40	-79	-27	2

Note: BA: Bloodman Division.

表 2 ITN 组 mfALFF 值显著降低脑区
Table 2 mfALFF decreased significantly in the ITN group

Items	Voxel	Z	P	Peak MNI coordinates			BA partition
				X	Y	Z	
Right superior temporal gyrus	34	3.21	0.000	52	3	-9	22
	55	3.40	0.000	60	-23	14	
	14	3.67	0.000	62	-30	-17	
	15	4.13	0.000	49	-57	12	21
Right middle temporal gyrus	19	2.50	0.005	51	-66	12	
		3.08	0.001	60	-40	-7	
Right inferior temporal gyrus	11	2.57	0.006	47	-31	-24	20
Right central sulcus cover	33	2.40	0.000	52	9	0	-
Right superior marginal gyrus	12	3.30	0.000	62	-23	33	39
Right inferior temporal gyrus		2.69	0.000	54	16	6	-
Left anterior cingulate gyrus, paracingulate gyrus	18	3.32	0.000	0	47	-3	33
Left temporal pole, superior temporal gyrus	13	3.01	0.001	-48	13	-9	38

Note: BA: Bloodman Division.

表3 两组血清 IL-1 β 、TNF- α 水平对比($\bar{x} \pm s$)
Table 3 Comparison of levels of serum il-1 β and TNF- α between the two groups($\bar{x} \pm s$)

Groups	n	IL-1 β (pg/mL)	TNF- α (pg/mL)
ITN group	50	40.12 $\pm$ 10.07	38.31 $\pm$ 10.90
Healthy control group	50	31.24 $\pm$ 11.45	28.20 $\pm$ 12.38
t	-	4.118	4.334
P	-	0.000	0.000

本文结果显示,ITN 组左侧的枕中回、枕下回、梭状回、距状裂周围皮层、中央旁回、三角部额下回、右侧背外侧额上回以及左小脑脚 1 区的 mfALFF 值高于健康对照组,反映出患者在静息状态下,具有自发性的脑活动,可能与疼痛调节亦或是多感觉的整合相关。分析原因,笔者认为枕叶与语言、动作感觉、视觉处理以及抽象概念相关,因受试者基本处于闭眼状态,出现视觉刺激的可能性不高,其中枕中回、枕下回的 mfALFF 水平增高,反映了患者存在自发脑活动。而梭状回处于大脑视觉联合皮层的中底部,主要是在视觉认知中发挥重要作用,其水平的上升体现了神经元活性的变强,并可能和长期疼痛密切相关。Ter Minassian A 等人^[17]研究结果显示:被检者左侧梭状回具有较为明显的异常性活动,并与疼痛反应级别之间有着负相关,这表明了左侧梭状回若处于急性的疼痛反应时具有重要作用。距状裂周围皮层位于枕叶内,其 mfALFF 值的增高可能原因与枕叶情况相似,但关于其具体原因仍需深入探索。ITN 患者常会发生的自发型电击样疼痛可能会导致有关调控脑区结构中的病理异常,其中额叶属于大脑疼痛网络中重要组成部分之一,介导痛觉信息的调节、传导,因此 ITN 患者的右侧背外侧额上回的 mfALFF 值明显异常^[18-20]。ITN 组右额上回、右额中回、右额下回、右中央沟盖、右缘上回、右岛盖部额下回,左前扣带回、扣带旁回,左颞极、颞上回脑区的 mfALFF 值显著低于健康对照组,提示患者的脑区正常的脑功能发生了异常,可能与情绪感知有关,长期的疼痛导致患者产生焦虑、不安等负性情绪,颞叶、中央沟盖等可能参与了其中评估^[21-23]。

此外,ITN 组患者的血清 IL-1 β 、TNF- α 水平相较健康对照组升高(均 $P < 0.05$),与黄珊珊等人^[24]的研究结果相似,提示了 ITN 患者血清 IL-1 β 、TNF- α 水平存在明显的高表达,且上述因子的表达异常可能参与了疾病的发生、发展过程^[25-27]。究其原因,作者认为 IL-1 β 、TNF- α 可通过对细胞膜上的钙离子与钠离子通道起到激活作用,继而促使多种疼痛物质的产生,进一步提高神经细胞的兴奋性,从而使得上述通道的传导性处于不断增加趋势,最终诱发疼痛的产生^[28-30]。

综上所述,fMRI 应用于 ITN 患者静息状态下脑功能的评估价值较高,且患者的多个脑区易发生 mfALFF 值升高或降低,表明在静息状态时,上述脑区的活动变化可能和疼痛调节或(和)感觉整合密切相关。此外,血清 IL-1 β 、TNF- α 表达异常增高可能与 ITN 的发病密切相关,发挥促进疾病发生、发展的作用。

参考文献(References)

[1] Shrivastava A, Mohammed N, Hung YC, et al. Impact of Integral Dose on the Maintenance of Pain Relief in Patients with Idiopathic Trigem-

inal Neuralgia Treated with Upfront Gamma Knife Radiosurgery[J]. World Neurosurg, 2019, 1878(19): 31432-31439

[2] Moore D, Chong MS, Shetty A, et al. A systematic review of rescue analgesic strategies in acute exacerbations of primary trigeminal neuralgia[J]. Br J Anaesth, 2019, 123(2): e385-e396

[3] Jia Y, Pan Y, Ren H, et al. Effectiveness and Safety of High-Voltage Pulsed Radiofrequency to Treat Patients with Primary Trigeminal Neuralgia: A Multicenter, Randomized, Double-Blind, Controlled Study Protocol[J]. Pain Physician, 2018, 21(5): 469-481

[4] 徐斌,张勇,陈尼卡,等. 磁共振体层血管成像在阿霉素治疗三叉神经痛应用研究[J].海南医学院学报, 2016, 22(11): 1182-1184

[5] 崔曼曼,王霁蕾,肖芳莉,等. fMRI 技术在探索原发性三叉神经痛患者静息态下脑功能变化的研究[J].安徽医科大学学报, 2017, 52(7): 1029-1032

[6] Prakash S, Rathore C. Two Cases of Hemicrania Continua-Trigeminal Neuralgia Syndrome: Expanding the Spectrum of Trigeminal Autonomic Cephalalgia-Tic (TAC-TIC) Syndrome[J]. Headache, 2017, 57(3): 472-477

[7] 马腾飞,王霁蕾,黄姗姗,等. 经眶下孔注射相关炎症因子制造大鼠三叉神经痛模型的实验研究 [J]. 安徽医科大学学报, 2015, 23(6): 753-756

[8] 王江峰,刘金道,张婉,等. 舒脑欣滴丸联合腺苷钴胺治疗三叉神经痛的临床研究[J].现代药物与临床, 2019, 34(3): 621-626

[9] Steiner TJ, Jensen R, Katsarava Z, et al. Aids to management of headache disorders in primary care (2nd edition): on behalf of the European Headache Federation and Lifting The Burden: the Global Campaign against Headache[J]. J Headache Pain, 2019, 20(1): 57

[10] Xiong NX, Zhou X, Yang B, et al. Preoperative MRI Evaluation of Relationship between Trigeminal Nerve and Superior Petrosal Vein: Its Role in Treating Trigeminal Neuralgia [J]. J Neurol Surg A Cent Eur Neurosurg, 2019, 80(3): 213-219

[11] Bendtsen L, Zakrzewska JM, Abbott J, et al. European Academy of Neurology guideline on trigeminal neuralgia [J]. Eur J Neurol, 2019, 26(6): 831-849

[12] 侯前梅,吴艳,宋丽,等. 原发性三叉神经痛的 MRI 研究进展[J].中国疼痛医学杂志, 2017, 23(10): 764-767

[13] 庞惠泽,范国光. 原发性三叉神经痛形态学及功能改变的 MRI 研究现状与进展[J].国际医学放射学杂志, 2018, 41(1): 35-38

[14] 朱洪宽,张顺吉,陈永伦,等. DSA 引导射频热凝联合血府逐瘀方治疗原发性三叉神经痛疗效及对血浆 β -内啡肽及 P 物质的影响[J].现代中西医结合杂志, 2017, 26(27): 3020-3022

[15] 周俊英,牛智领. 奥卡西平联合小剂量巴氯芬治疗三叉神经痛的疗效评价[J]. 中西医结合心脑血管病杂志, 2019, 17(8): 1254-1256

- [16] 赵永宏, 蔡其刚, 翁维, 等. 原发性三叉神经痛三叉神经根部病因观察[J]. 中国耳鼻咽喉颅底外科杂志, 2015, 21(6): 486-488
- [17] Ter Minassian A, Ricalens E, Humbert S, et al. Dissociating anticipation from perception: Acute pain activates default mode network[J]. Hum Brain Mapp, 2013, 34(9): 2228-2243
- [18] Tanaka T, Shiiba S, Yoshino N, et al. Predicting the therapeutic effect of carbamazepine in trigeminal neuralgia by analysis of neurovascular compression utilizing magnetic resonance cisternography [J]. Int J Oral Maxillofac Surg, 2019, 48(4): 480-487
- [19] Singh S, Roy H, Singh GP, et al. Early postoperative carbamazepine-induced tetany in a patient with trigeminal neuralgia [J]. J Anaesthesiol Clin Pharmacol, 2018, 34(3): 405-406
- [20] 刘坤, 郭锦华, 王丽娟, 等. 高频电针联合卡马西平治疗三叉神经痛 32 例临床观察[J]. 江苏中医药, 2016, 48(5): 68-69
- [21] 徐一凡, 徐武, 陈维涛, 等. 微血管减压术在三叉神经痛患者中的应用及预后分析[J]. 现代生物医学进展, 2018, 18(21): 4087-4090
- [22] Puri N, Rathore A, Dharmdeep G, et al. A Clinical Study on Comparative Evaluation of the Effectiveness of Carbamazepine and Combination of Carbamazepine with Baclofen or Capsaicin in the Management of Trigeminal Neuralgia[J]. Niger J Surg, 2018, 24(2): 95-99
- [23] Chen Y, Xiang CQ, Liu WF, et al. Application of amplitude of low frequency fluctuation to altered spontaneous neuronal activity in classical trigeminal neuralgia patients: A resting state functional MRI study[J]. Mol Med Rep, 2019, 20(2): 1707-1715
- [24] 黄姗姗, 徐文华, 马腾飞, 等. 三叉神经痛患者部分促炎因子水平变化及意义[J]. 安徽医科大学学报, 2015, 50(5): 711-712
- [25] Moon HC, Park CA, Jeon YJ, et al. 7 Tesla magnetic resonance imaging of caudal anterior cingulate and posterior cingulate cortex atrophy in patients with trigeminal neuralgia [J]. Magn Reson Imaging, 2018, 9(51): 144-150
- [26] Ruiz-Juretschke F, González-Quarante LH, García-Leal R, et al. Neurovascular relations of the trigeminal nerve in asymptomatic individuals studied with high-resolution three-dimensional magnetic resonance imaging[J]. Anat Rec (Hoboken), 2019, 302(4): 639-645
- [27] Giacobbo Scavo C, Roperto R, Cacciotti G, et al. Cystic progression of a cavernous malformation at the level of the trigeminal root entry zone presenting with sudden onset of trigeminal neuralgia [J]. J Craniofac Surg, 2018, 29(8): 728-730
- [28] Yang D, Shen J, Xia X, et al. Preoperative evaluation of neurovascular relationship in trigeminal neuralgia by three-dimensional fast low angle shot (3D-FLASH) and three-dimensional constructive interference in steady-state (3D-CISS) MRI sequence[J]. Br J Radiol, 2018, 91(1085): 20170557-20170558
- [29] Brinzeu A, Dumot C, Sindou M, et al. Role of the petrous ridge and angulation of the trigeminal nerve in the pathogenesis of trigeminal neuralgia, with implications for microvascular decompression[J]. Acta Neurochir (Wien), 2018, 160(5): 971-976
- [30] Wang Y, Zhang Y, Zhang J, et al. Structural and functional abnormalities of the insular cortex in trigeminal neuralgia: a multimodal magnetic resonance imaging analysis[J]. Pain, 2018, 159(3): 507-514

(上接第 2196 页)

- [21] Fu-Man Du, Hong-Yu, Kuang Bin, et al. Associations Between Thyroid Hormones Within the Euthyroid Range and Indices of Obesity in Obese Chinese Women of Reproductive Age[J]. Metabolic syndrome and related disorders, 2019, 17(8): 416-422
- [22] GuoHua, Feng ChuanYuan, Kang Jing, et al. Neuroendocrine abnormalities associated with untreated first episode patients with major depressive disorder and bipolar disorder[J]. Psychoneuroendocrinology, 2019, 107: 119-123
- [23] Okan Dikker, Murat Akarsu. Evaluation of serum galectin-3 concentrations in patients with hypothyroidism [J]. Scandinavian journal of clinical and laboratory investigation, 2019, 79(5): 354-358
- [24] G Balercia, M Bonomi, V A Giagulli, et al. Thyroid function in Klinefelter syndrome: a multicentre study from KING group[J]. Journal of endocrinological investigation, 2019, 42(10): 1199-1204
- [25] K Atalay, F G Savur, A Kirgiz, et al. Serum levels of thyroid hormone, vitamin D, vitamin B12, folic acid, C-reactive protein, and hemoglobin in Pseudoexfoliation and primary open angle Glaucoma [J]. Journal francais d'ophtalmologie, 2019, 42(7): 730-738
- [26] Sayid Shafi, Zuhur, Gulsah, et al. External Validation of the GREAT Score in Turkish Patients with Graves' Hyperthyroidism Treated with the Titration Regimen Method of Antithyroid Drugs: A Multicenter Study[J]. Hormoneset metabolisme, 2019, 51(10): 627-633
- [27] Danchen, Wang Songlin, Yu Chaochao, et al. Reference intervals for thyroid-stimulating hormone, free thyroxine, and free triiodothyronine in elderly Chinese persons [J]. Clinical chemistry and laboratory medicine, 2019, 57(7): 1044-1052
- [28] Xiaoyan, Guo Xinyan, Chen Ce, et al. Hyperinsulinemia and thyroid peroxidase antibody in Chinese patients with papillary thyroid cancer [J]. Endocrine journal, 2019, 66(8): 731-737