

doi: 10.13241/j.cnki.pmb.2023.06.028

彩色多普勒超声联合血清 β_2 -微球蛋白评估血管通路动静脉内瘘的临床价值分析*

宋丽莎¹ 杨伟兵² 薛姗姗² 周敏³ 李毅⁴

(1 西安交通大学医学院附属三二〇一医院超声科 陕西 汉中 723000;

2 西安交通大学第一附属医院超声医学科 陕西 西安 710089; 3 空军军医大学第一附属医院超声科 陕西 西安 710032;

4 西安交通大学医学院附属三二〇一医院肾内科 陕西 汉中 723000)

摘要 目的: 探讨与分析彩色多普勒超声联合血清 β_2 -微球蛋白评估血管通路动静脉内瘘的临床价值。**方法:** 选择 2019 年 1 月-2022 年 6 月在本院进行建立动静脉内瘘的血液透析患者 210 例作为研究对象,所有患者都在造瘘术前 1d、术后 3 个月进行彩色多普勒超声检查与血清 β_2 -MG 检测,判断血管通路状况并进行相关性分析。**结果:** 210 例患者术后 3 个月的内瘘头静脉、桡动脉、内瘘口的内径、血流速度、血流量都明显高于术前 1 d ($P<0.05$)。210 例患者术后 3 个月的血清 β_2 -微球蛋白含量明显低于术前 1 d ($P<0.05$)。210 例患者经过手术判定为动静脉内瘘异常 22 例,占比 10.5%,其中吻合口狭窄 10 例、内瘘头静脉端闭塞 6 例、静脉段血栓 2 例、吻合口血栓 2 例、静脉段狭窄 2 例。Spearsman 分析显示动静脉内瘘异常与内瘘口血流速度、头静脉血流量、桡动脉内径、血清 β_2 -微球蛋白含量存在相关性($P<0.05$)。多因素 logistic 回归分析显示内瘘口血流速度、头静脉血流量、桡动脉内径、血清 β_2 -微球蛋白含量为导致动静脉内瘘异常的重要因素($P<0.05$)。**结论:** 彩色多普勒超声可明确内瘘血流动力学和血管形态的变化,联合血清 β_2 -微球蛋白检测可有效评估动静脉内瘘血管通路状况,监测内瘘使用功能与状态,为改善患者预后提供参考依据。

关键词: 彩色多普勒超声;血管通路;动静脉内瘘; β_2 -微球蛋白

中图分类号: R459.5; R445.1 **文献标识码:** A **文章编号:** 1673-6273(2023)06-1141-04

Clinical Value of Color Doppler Ultrasonography Combined with Serum β_2 -microglobulin in Evaluating Vascular Access Arteriovenous Fistula*

SONG Li-sha¹, YANG Wei-bing², XUE Shan-shan², ZHOU Min³, LI Yi⁴

(1 Department of ultrasonography lab, 3201th Affiliated Hospital, School of Medicine, Xi'an Jiaotong University, Hanzhong, Shaanxi, 723000, China; 2 Department of Ultrasound Medicine, The First Affiliated Hospital of Xi'an Jiaotong University, Xi'an, Shaanxi, 710089, China; 3 Department of ultrasonography lab, The First Affiliated Hospital of Air Force Military Medical University, Xi'an, Shaanxi, 710032, China; 4 Department of Nephrology, 3201th Affiliated Hospital, School of Medicine, Xi'an Jiaotong University, Hanzhong, Shaanxi, 723000, China)

ABSTRACT Objective: To investigate and analysis the clinical values of color Doppler ultrasonography combined with serum β_2 -microglobulin in evaluating vascular access arteriovenous fistula. **Methods:** From January 2019 to June 2022, A total of 210 cases of hemodialysis patients who underwent arteriovenous fistula establishment in our hospital were selected as the research subjects. Ultrasonography and serum β_2 -MG detection were used to determine the vascular access status and conduct correlation analysis. **Results:** The inner diameter, blood flow velocity and blood flow of the cephalic vein, radial artery and internal fistula in 210 patients at 3 month after operation were higher than those at 1 day before operation ($P<0.05$). The serum β_2 -microglobulin content of 210 patients at 3 month after operation was lower than that at 1 day before operation ($P<0.05$). There were 22 cases were determined to be abnormal arteriovenous fistulas after surgery, accounted for 10.5%, included 10 cases of anastomotic stenosis, 6 cases of occlusion of the venous end of the fistula, 2 cases of venous segment thrombosis, 2 cases of anastomotic thrombus, and venous segment thrombus. Stenosis in 2 cases in the 210 cases. Spearsman analysis showed that the abnormality of arteriovenous fistula was correlated with the blood flow velocity, cephalic vein blood flow, radial artery diameter and serum β_2 -microglobulin content ($P<0.05$). Multivariate logistic regression analysis showed that the blood flow velocity of the internal fistula, the blood flow of the cephalic vein, the diameter of the radial artery, and the content of serum β_2 -microglobulin were the important factors led to the abnormality of the arteriovenous fistula ($P<0.05$). **Conclusion:** Color Doppler ultrasonography can identify the changes of hemodynamics and vascular morphology of internal fistulas, combined with serum β_2 -microglobulin detection can effectively evaluate the vascular access status of arteriovenous fistulas, monitor the function of internal fistulas, and improve the prognosis of patients for reference.

* 基金项目:陕西省卫生健康委科研基金项目(2022D068)

作者简介:宋丽莎(1979-),女,本科,副主任医师,研究方向:从事心血管超声诊断研究工作, E-mail: song125462452@163.com

(收稿日期:2022-08-10 接受日期:2022-08-31)

Key words: Color Doppler ultrasound; Vascular access; Arteriovenous fistula; β 2-microglobulin

Chinese Library Classification(CLC): R459.5; R445.1 **Document code:** A

Article ID:1673-6273(2023)06-1141-04

前言

血液透析是治疗终末期肾脏病患者的重要方法之一,不过在长期透析过程中需建立血管通路,血管通路能否保证足够的血流量是影响透析效果的重要因素^[1,2]。动静脉内瘘是血液透析患者的生命线,也是目前最理想的永久性血管通路,其具有血流量稳定、可反复穿刺、并发症发生率低、使用寿命较长等特点^[3,4]。但是由于各种因素的影响,特别是老年透析患者逐渐增多,动静脉内瘘的建立越来越困难^[5];长期透析可使血液在体外循环,血管局部损伤、炎症和反复接触肝素,可诱发血小板活化,增加了血栓发生的风险^[6,7]。为保证造瘘成功与内瘘的长期使用,对动静脉内瘘的血管通路进行评估具有重要价值^[8,9]。彩色多普勒超声是监测内瘘功能,诊治动静脉内瘘功能障碍的重要手段,也具有无创、可反复使用等多种优点^[10]。 β 2-微球蛋白是反映机体肾功能的重要指标,可比尿素氮、血肌酐更敏感、更准确反映肾小球滤过率^[11,12]。本文具体探讨与分析了彩色多普勒超声联合血清 β 2-微球蛋白评估血管通路动静脉内瘘的临床价值,以减少内瘘失败率及增加内瘘使用寿命。

1 资料与方法

1.1 研究对象

选择2019年1月-2022年6月在本院进行建立动静脉内瘘的血液透析患者210例作为研究对象。

纳入标准:初次血液透析患者,且初次建立动静脉内瘘;造瘘方式均为桡动脉与头静脉吻合;透析时间 ≥ 6 个月;预计生存期 ≥ 3 个月;择期进行造瘘手术;符合终末期肾病的诊断标准;预计生存期 ≥ 3 个月;患者意识形态清晰,自愿参与本研究;年龄20-70岁;本院伦理委员会批准了此次研究。

排除标准:妊娠与哺乳期妇女、备孕期妇女;合并高危传染性疾病者;患者存在严重心、脑、肝合并症;合并恶性肿瘤患者;患者有出血性疾病病史;临床资料不全者。

在210例患者中,男110例,女100例;年龄最小22岁,最大69岁,平均年龄 58.71 ± 8.83 岁;平均收缩压(134.87 ± 12.47)mmHg;平均舒张压(84.21 ± 4.18)mmHg;平均体重指数(21.47 ± 2.14)kg/m²;平均透析时间(1.29 ± 0.15)年;原发疾病:慢性肾小球肾炎78例,糖尿病肾病122例,其他10例。

1.2 彩色多普勒超声方法

所有患者都在造瘘术前1d与术后3个月进行彩色多普勒超声检查,采用飞利浦公司的EPIQ 5超声诊断仪EPIQ 5, L12-5探头频率为5.0-7.0 MHz。患者取仰卧位,手心向上并放平伸直,伸直受检测上肢,探头部位在离开吻合口3-4 cm之挠动脉和头静脉所在处。对头静脉、桡动脉、内瘘口的内径及壁厚进行观察,并于横切面上测量吻合口的内径和壁厚,观察血管分布与走向分布状态。观察与记录头静脉、桡动脉、内瘘口的内径、血流速度、血流量。判定动静脉内瘘异常情况,其中异常包括吻合口狭窄、内瘘头静脉端闭塞、静脉段血栓、吻合口血栓、静脉段狭窄等。

1.3 血清 β 2-微球蛋白检测

所有患者在术前1d与术后3个月抽取空腹静脉血2-3 mL,促凝后2000 rpm离心10 min,分离上层血清,采用酶联免疫法检测血清 β 2-微球蛋白含量,检测试剂盒购自南京建成生物技术有限公司。

1.4 统计方法

应用SPSS25.00分析,计量资料结果以均数 $\pm$ 标准差表示(对比为t检验),计数资料用百分率(%)表示,组间比较采用 χ^2 检验,相关性分析采用Spearsman分析与多因素logistic回归分析,检验水准为 $\alpha=0.05$ 。

2 结果

2.1 彩色多普勒超声指标变化对比

210例患者术后3个月的头静脉、桡动脉、内瘘口的内径、血流速度、血流量都明显高于术前1d($P<0.05$)。见表1。

表1 210例患者动静脉内瘘手术前后的彩色多普勒超声指标变化对比(均数)

Table 1 Comparison of color Doppler ultrasound index changes before and after arteriovenous fistula surgery in 210 patients (mean)

Time point	n	Cephalic vein			Radial artery			Internal fistula		
		Bore size (mm)	Blood flow rate (cm/s)	Blood flow (mL/min)	Bore size (mm)	Blood flow rate (cm/s)	Blood flow (mL/min)	Bore size (mm)	Blood flow rate (cm/s)	Blood flow (mL/min)
1d before surgery	210	3.00 $\pm$ 0.21	56.98 $\pm$ 4.01	400.82 $\pm$ 18.39	2.11 $\pm$ 0.18	67.37 $\pm$ 3.25	411.02 $\pm$ 24.02	2.87 $\pm$ 0.33	76.02 $\pm$ 9.11	411.47 $\pm$ 19.72
One month after surgery	210	3.56 $\pm$ 0.25 [#]	76.52 $\pm$ 3.28 [#]	456.02 $\pm$ 21.58 [#]	2.65 $\pm$ 0.22 [#]	82.47 $\pm$ 4.40 [#]	487.09 $\pm$ 34.50 [#]	3.32 $\pm$ 0.23 [#]	93.45 $\pm$ 8.38 [#]	478.98 $\pm$ 20.11 [#]

Note: Compared with the 1 d before surgery, [#] $P<0.05$.

2.2 血清 β 2-微球蛋白含量变化对比

210例患者术后3个月的血清 β 2-微球蛋白含量明显低于术前1d[(4.34 ± 0.33)mg/LVS(14.82 ± 1.54)mg/L]($t=34.602$,

$P<0.05$)。

2.3 动静脉内瘘异常情况

210例患者经过手术判定为动静脉内瘘异常22例,占比

10.5 %,其中吻合口狭窄 10 例、内瘘头静脉端闭塞 6 例、静脉段血栓 2 例、吻合口血栓 2 例、静脉段狭窄 2 例。

2.4 相关性分析

在 210 例患者中,Spearsman 分析显示动静脉内瘘异常与内瘘口血流速度、头静脉血流量、桡动脉内径、血清 β_2 -微球蛋白含量存在相关性($P<0.05$)。见表 2。

表 2 动静脉内瘘血管通路状况与彩色多普勒超声指标、血清 β_2 -微球蛋白含量的相关性(n=210)

Table 2 Correlation between the vascular access status of the arteriovenous fistula and the color Doppler ultrasound index and the serum 2-microglobulin contents (n=210)

Indexs	Flow velocity at the internal fistula mouth	Head vein blood flow	Internal diameter of radial artery	Serum 2-microglobulin
r	0.644	0.598	0.614	0.599
P	0.000	0.000	0.000	0.000

2.5 影响因素分析

在 210 例患者中,以动静脉内瘘异常作为因变量,以内瘘口血流速度、头静脉血流量、桡动脉内径、血清 β_2 -微球蛋白含

量作为自变量,多因素 logistic 回归分析显示内瘘口血流速度、头静脉血流量、桡动脉内径、血清 β_2 -微球蛋白含量为导致动静脉内瘘异常的重要因素($P<0.05$)。见表 3。

表 3 影响动静脉内瘘血管通路状况的多因素 logistic 回归分析(n=210)

Table 3 Multivariate logistic regression analysis affecting the vascular access status of arteriovenous fistula (n=210)

Indexs	β	SE	Wald	P	OR	95%CI
Flow velocity at the internal fistula mouth	1.832	0.287	22.174	0.000	2.911	1.113-5.036
Head vein blood flow	2.477	0.315	18.636	0.000	3.157	2.099-5.681
Internal diameter of radial artery	3.114	0.222	21.983	0.000	3.004	1.259-6.136
Serum 2-microglobulin content	1.988	0.394	9.777	0.000	1.664	1.102-7.892

3 讨论

动静脉内瘘是指身体邻近的浅表动静脉血管通过手术吻合起来建立的血流通道,绝大多数血液透析患者使用自体动静脉内瘘,其在临床上的应用具有寿命长、手术操作方便、通畅率高、并发症少、医疗费用低等优势^[13,14]。但受多种因素的影响,部分患者可出现自体动静脉内瘘血栓,而造成动静脉内瘘异常。当前研究也认为,动静脉内瘘患者的血管通路的功能可影响整体治疗疗效,早期判定动静脉内瘘的具体情况,能够有效提高血透析治疗质量,改善患者预后^[15,16]。彩色多普勒超声可以明确血管内部以及周围邻近血管的具体情况,可通过观察血管颜色进而判断血流速度、方向的变化^[17]。特别是超声为一种无创性检查方法,患者依从性较高,通过有效早期明确血栓以及狭窄等并发症发生情况,判断血流量情况,提前采取预防措施^[18,19]。

本研究初步结果显示:210 例患者术后 3 个月的头静脉、桡动脉、内瘘口的内径、血流速度、血流量较术前 1 d 高($P<0.05$),表明动静脉内瘘术后患者的血管通路状况明显改善。动静脉术后内瘘需一定时间才能成熟,常规术后检查多采用听诊血管杂音、触摸血管震颤,存在一定的主观性^[20]。采用彩色多普勒超声检查可探查血管通畅程度,在术前评价动、静脉血管,有无动脉硬化、斑块、狭窄、闭塞及变异,血管内径、血流量及通畅情况,术后可为血透 AVF 患者评价吻合区域血管及血流量情况。在术前及术后获得血管内径和血流量具体数值,还可对管腔中是否出现闭塞或狭窄的情况进行探查,对头静脉、桡动脉、内瘘

口内血流通过的情况进行有效判定,明确内膜增厚程度,从而为指导临床治疗提供参考^[21,22]。

动静脉内瘘血栓的形成机制比较复杂,涉及的病因包括患者一般情况、炎症、内瘘位置选择、内瘘、透析、凝血纤溶、高甲状旁腺激素血症、脂代谢、矿物代谢等^[23]。本研究显示 210 例患者术后 3 个月的血清 β_2 -微球蛋白含量明显低于术前 1 d ($P<0.05$),表明动静脉内瘘术后患者的 β_2 -微球蛋白含量明降低,肾功能有所恢复。头静脉-桡动脉内瘘具有可利用的穿刺部位长、对血流动力学影响小、对日常生活影响小、抗感染能力强、等优点,成为血液透析患者建立血管通路的重要方法。但很多血液透析患者的血管顺应性下降、动脉硬化发生率高,血管弹性差,常导致造瘘失败^[24]。 β_2 -微球蛋白是人类白细胞抗原(HLA) I 类抗原的轻链,是由淋巴细胞、血小板、多形核白细胞产生的一种低分子量血清球蛋白。当机体血清 β_2 -微球蛋白上升时,可间接反映机体肾小球滤过功能受损。特别是当机体肾小管对 β_2 -微球蛋白重吸收障碍,也会造成血液中 β_2 -微球蛋白表达升高^[25]。

动静脉内瘘对患者机体造成的伤害较小。但传统术前检查仅限于触摸动脉搏动、近肘部绑上止血带观察静脉充盈情况,无法明确相关血管的血流速度与通畅情况。超声对内瘘血流量检测有重要作用,其认为动静脉内瘘是血流量在 430 mL/min 左右,能有效降低并发症的发生,也能满足血透采血的要求^[26,27]。并且彩色多普勒超声可以明确血透析患者人工动静脉内瘘等异常,可高效快速地掌握患者的病情,且具有较高的检测准确率^[28]。本研究显示 210 例患者经过手术判定为动静脉内瘘异常

22 例,占比 10.5%,其中吻合口狭窄 10 例、内瘘头静脉端闭塞 6 例、静脉段血栓 2 例、吻合口血栓 2 例、静脉段狭窄 2 例;Spearsman 分析显示动静脉内瘘异常与内瘘口血流速度、头静脉血流量、桡动脉内径、血清 β_2 -微球蛋白含量存在相关性 ($P<0.05$);多因素 logistic 回归分析显示内瘘口血流速度、头静脉血流量、桡动脉内径、血清 β_2 -微球蛋白含量为导致动静脉内瘘异常的重要因素 ($P<0.05$),表明彩色多普勒超声联合血清 β_2 -微球蛋白评估血管通路动静脉内瘘具有重要的价值。并且彩色多普勒超声可清晰显示血管的走形、斑块、内径、动脉内膜厚度等情况,能直观评价血流状态,可对血管的血流动力学准确评价,有助于选择合适的吻合血管,提高内瘘手术成功率^[29,30]。不过本研究未进行长时间的随访分析,调查病例数量较少,使将在后续研究中扩大样本进行探讨。

总之,彩色多普勒超声可明确内瘘血流动力学和血管形态的变化,联合血清 β_2 -微球蛋白检测可有效评估动静脉内瘘血管通路状况,监测内瘘使用功能,为改善患者预后提供参考。

参考文献(References)

- [1] Zu Y, Lu X, Yu Q, et al. Higher Postdialysis Lactic Acid Is Associated with Postdialysis Fatigue in Maintenance of Hemodialysis Patients[J]. Blood Purif, 2020, 49(5): 535-541
- [2] Zununi Vahed S, Ahmadian E, et al. The Impact of Intravenous Iron Supplementation on Hematinic Parameters and Erythropoietin Requirements in Hemodialysis Patients [J]. Adv Ther, 2021, 38(8): 4413-4424
- [3] Zonnebeld N, Tordoir JHM, van Loon MM, et al. Pre-operative Patient Specific Flow Predictions to Improve Haemodialysis Arteriovenous Fistula Maturation (Shunt Simulation Study): A Randomised Controlled Trial[J]. Eur J Vasc Endovasc Surg, 2020, 60(1): 98-106
- [4] Živković V, Cvetković D, Nikolić S. Exsanguination from arteriovenous fistula: anything is possible! [J]. Forensic Sci Med Pathol, 2020, 16(2): 381-382
- [5] Zouaghi MK, Lammouchi MA, Hassan M, et al. Determinants of patency of arteriovenous fistula in hemodialysis patients [J]. Saudi J Kidney Dis Transpl, 2018, 29(3): 615-622
- [6] Zhu ZR, Zou L, Xing Y, et al. Predictors of primary patency after percutaneous balloon angioplasty for stenosis of Brescia-Cimino hemodialysis arteriovenous fistula [J]. Br J Radiol, 2020, 93(1109): 20190505
- [7] Zhou Y. Effects of High Flux Hemodialysis Combined with L-Carnitine on Microinflammation and Arteriovenous Fistula in Maintenance Hemodialysis Patients [J]. Evid Based Complement Alternat Med, 2022, 15(8): 6964127
- [8] Ziętek ZM. Anatomical traps for arteriovenous fistula creation [J]. Folia Morphol (Warsz), 2021, 80(2): 467-470
- [9] Zhu Y, Xiong J, Liu F, et al. Splenic Arteriovenous Fistula Accompanied by Splenic Artery Aneurysm Associated with Acute-onset Portal Hypertension and Gastrointestinal Bleeding: Case Report and Literature Review[J]. Ann Vasc Surg, 2022, 78(5): 378.e17-378.e22
- [10] Yun SS, Mok S, Park SC, et al. Efficacy of blood flow measurement using intraoperative color flow Doppler ultrasound as a predictor of autologous arteriovenous fistula maturation[J]. Nephrol, 2018, 31(6): 975-983
- [11] 李隽,李海燕. 动静脉内瘘和透析导管对老年透析患者透析充分性、微炎症状态和肾性贫血的影响[J]. 中国中西医结合肾病杂志, 2020, 21(2): 3
- [12] Yu J, Liu Z, Shen B, et al. Intradialytic Hypotension as an Independent Risk Factor for Long-Term Mortality in Maintaining Hemodialysis Patients: A 5-Year Follow-Up Cohort Study [J]. Blood Purif, 2018, 45(4): 320-326
- [13] Zhou M, Chen G, Feng L, et al. Effects of ultrasound-guided percutaneous transluminal angioplasty for stenosis of arteriovenous fistula used for hemodialysis and related factors influencing patency [J]. Ann Ital Chir, 2020, 91(5): 55-60
- [14] Zhou F, Cui Y, Zhao Q, et al. Hypertension Caused by Renal Arteriovenous Fistula with Multiple Renal Artery Aneurysms[J]. Ann Vasc Surg, 2021, 70(8): 565.e11-565.e13
- [15] Zhao Y, Yang L, Mai H, et al. The Effect of Arteriovenous Fistula on Hard Endpoints Should be Observed Prospectively in Both CKD and Non-CKD Patients[J]. Am J Hypertens, 2019, 32(10): e1
- [16] Zhao C, Zuckerman ST, Cai C, et al. Periadventitial Delivery of Simvastatin-Loaded Microparticles Attenuate Venous Neointimal Hyperplasia Associated With Arteriovenous Fistula [J]. J Am Heart Assoc, 2020, 9(24): e018418
- [17] Ren C, Chen J, Wang Y, et al. Application of ultrasonography in monitoring the complications of autologous arteriovenous fistula in hemodialysis patients[J]. Medicine (Baltimore), 2018, 97(44): e12994
- [18] Middleton WD, Robinson KA. Analysis and Classification of Postcatheterization Femoral Arteriovenous Fistulas Based on Color Doppler Examinations[J]. J Ultrasound Med, 2022, 41(1): 207-216
- [19] Meola M, Marciello A, Di Salle G, et al. Ultrasound evaluation of access complications: Thrombosis, aneurysms, pseudoaneurysms and infections[J]. J Vasc Access, 2021, 22(1_suppl):71-83
- [20] Zhang Y, Thamer M, Lee T, et al. Racial Disparities in Arteriovenous Fistula Use Among Hemodialysis Patients: The Role of Surgeon Supply[J]. Kidney Int Rep, 2022, 7(7): 1575-1584
- [21] Zierler RE, Leotta DF, Sansom K, et al. Analysis of Factors Influencing Accuracy of Volume Flow Measurement in Dialysis Access Fistulas Based on Duplex Ultrasound Simulation [J]. Vasc Endovascular Surg, 2019, 53(7): 529-535
- [22] Zamboli P, Fiorini F, D'Amelio A, et al. Color Doppler ultrasound and arteriovenous fistulas for hemodialysis [J]. J Ultrasound, 2014, 17(4): 253-63
- [23] Yuan H, Sun J, Zhou Z, et al. Diagnosis and treatment of acquired arteriovenous fistula after lower extremity deep vein thrombosis[J]. Int Angiol, 2019, 38(1): 10-16
- [24] 王娅敏,温怡,刘智美,等. 维持性血液透析患者不同自体动静脉内瘘术式对透析效能、管路通畅率、炎症因子指标及并发症的影响[J]. 实用医院临床杂志, 2021, 18(3): 3
- [25] Yamamoto S. Molecular mechanisms underlying uremic toxin-related systemic disorders in chronic kidney disease: focused on β_2 -microglobulin-related amyloidosis and indoxyl sulfate-induced atherosclerosis-Oshima Award Address 2016 [J]. Clin Exp Nephrol, 2019, 23(2): 151-157

- 2021, 61(3): 299-323
- [6] 李玉轩. 太原杏花岭区文化旅游开发的空间格局与行动战略研究[J]. 生产力研究, 2012, 13(9): 117-119
- [7] 赵辨. 中国临床皮肤病学 [M]. 南京: 江苏科学技术出版社, 2010: 672
- [8] LeWitt TM, Kundu RV. Vitiligo [J]. JAMA Dermatol, 2021, 157(9): 1136
- [9] Bergqvist C, Ezzedine K. Vitiligo: A focus on pathogenesis and its therapeutic implications[J]. J Dermatol, 2021, 48(3): 252-270
- [10] Marchioro HZ, Silva de Castro CC, Fava VM, et al. Update on the pathogenesis of vitiligo[J]. An Bras Dermatol, 2022, 97(4): 478-490
- [11] Boniface K, Seneschal J, Picardo M, et al. Vitiligo: Focus on Clinical Aspects, Immunopathogenesis, and Therapy [J]. Clin Rev Allergy Immunol, 2018, 54(1): 52-67
- [12] 王晓艳, 王婷琳, 周城, 等. 中国六省市白癜风流行病学调查[J]. 中华皮肤科杂志, 2010, 43(7): 463-466
- [13] 裴广德, 杜金锋, 黄英, 等. 河南省焦作地区白癜风流行病学调查[J]. 实用皮肤病学杂志, 2011, 4(1): 19-21
- [14] Abdel-Malek ZA, Jordan C, Ho T, et al. The enigma and challenges of vitiligo pathophysiology and treatment[J]. Pigment Cell Melanoma Res, 2020, 33(6): 778-787
- [15] 王禹毅, 王小琴. 白癜风与自身免疫性共病[J]. 重庆医学, 2022, 51(11): 1973-1976
- [16] 柏志芳, 刘霞, 宗淑芳, 等. 毫火针联合补肾活血方对寻常型白癜风患者外周血炎症因子和免疫指标的影响[J]. 现代生物医学进展, 2021, 21(4): 702-705
- [17] Okamura K, Garber M, Harris JE. Gaining Insight into Vitiligo Genetics through the Lens of a Large Epidemiologic Study[J]. J Invest Dermatol, 2021, 141(4): 718-721
- [18] Roberts GHL, Paul S, Yorgov D, et al. Family Clustering of Autoimmune Vitiligo Results Principally from Polygenic Inheritance of Common Risk Alleles[J]. Am J Hum Genet, 2019, 105(2): 364-372
- [19] Kussainova A, Kassym L, Akhmetova A, et al. Vitiligo and anxiety: A systematic review and meta-analysis [J]. PLoS One, 2020, 15(11): e0241445
- [20] Vallerand IA, Lewinson RT, Parsons LM, et al. Vitiligo and major depressive disorder: A bidirectional population-based cohort study[J]. J Am Acad Dermatol, 2019, 80(5): 1371-1379
- [21] Falk-Mahapatra R, Gollnick SO. Photodynamic Therapy and Immunity: An Update[J]. Photochem Photobiol, 2020, 96(3): 550-559
- [22] Baykal Selçuk L, Katkat E, Aksu Arica D, et al. Sun-protection habits and knowledge of patients with vitiligo [J]. Acta Dermatovenereol Alp Pannonica Adriat, 2020, 29(1): 7-10
- [23] 韩宪伟, 李铁男, 张涛. 白癜风发病影响因素的 Logistic 回归分析[J]. 中华中医药杂志, 2019, 34(2): 811-814
- [24] Ghosh S. Chemical Vitiligo: A Subset of Vitiligo [J]. Indian J Dermatol, 2020, 65(6): 443-449
- [25] Shakhbazova A, Wu H, Chambers CJ, et al. A Systematic Review of Nutrition, Supplement, and Herbal-Based Adjunctive Therapies for Vitiligo[J]. J Altern Complement Med, 2021, 27(4): 294-311
- [26] Wu X, Jin S, Yang Y, et al. Altered expression of ferroptosis markers and iron metabolism reveals a potential role of ferroptosis in vitiligo [J]. Pigment Cell Melanoma Res, 2022, 35(3): 328-341
- [27] 康安静, 苏宝山, 徐汉卿. 氧自由基及微量元素在白癜风黑素细胞凋亡中作用的研究[J]. 中华临床医药杂志, 2002, 3(18): 4-6
- [28] 黄珂珂, 邢梦, 蒯仂, 等. 白癜风与表观遗传学相关研究及展望[J]. 世界临床药物, 2020, 41(1): 64-68
- [29] 刘江波, 张学军. 白癜风相关环境因素研究回顾[J]. 国际皮肤性病杂志, 2007, 33(4): 219-221
- [30] 辛宁, 康晓静. 白癜风的 HLA 等位基因遗传学研究进展 [J]. 现代生物医学进展, 2010, 10(12): 2385-2387

(上接第 1144 页)

- [26] Zonnebeld N, Huberts W, van Loon MM, et al. Natural Vascular Remodelling After Arteriovenous Fistula Creation in Dialysis Patients With and Without Previous Ipsilateral Vascular Access[J]. Eur J Vasc Endovasc Surg, 2020, 59(2): 277-287
- [27] Zonnebeld N, Maas TMG, Huberts W, et al. Pre-operative Duplex Ultrasonography in Arteriovenous Fistula Creation: Intra- and Inter-observer Agreement[J]. Eur J Vasc Endovasc Surg, 2017, 54(5): 613-619
- [28] Zhu X, Gong X, Zhang B, et al. Application of Transcranial Color-coded Duplex Sonography in the Diagnosis and Management of Straight Sinus Thrombosis With Dural Arteriovenous Fistulae: A Case Report[J]. Neurologist, 2020, 25(6): 180-186
- [29] Yun SS, Mok S, Park SC, et al. Efficacy of blood flow measurement using intraoperative color flow Doppler ultrasound as a predictor of autologous arteriovenous fistula maturation [J]. Ther Apher Dial, 2022, 15(8): 1744-1749
- [30] Wang H, Su LH, Li ZL, et al. The value of color doppler ultrasonography in the diagnosis of endograft infections following endovascular aneurysm repair [J]. Natl Med J China, 2022, 102(1): 67-72