

doi: 10.13241/j.cnki.pmb.2020.23.010

老年肥胖型正常高值血压患者 24h- 动态血压变异特点 及与动脉僵硬度的相关性研究 *

朱颖亮 王 芸 白 宇 仲建刚 张一骄

(南京中医药大学附属医院老年医学科 江苏 南京 210019)

摘要 目的:探讨老年肥胖型正常高值血压患者 24h- 动态血压变异特点及与动脉僵硬度的相关性。**方法:**选择 2018 年 1 月~2020 年 5 月期间在我院住院的老年正常高值血压患者 174 例作为研究对象, 根据腰围分为腹型肥胖组 (n=85) 和非腹型肥胖组 (n=89)。所有受试者监测 24h- 动态血压[包括 24h 平均收缩压(24h-SBP)、白昼平均舒张压(dDBP)、24h 平均舒张压(24h-DBP)、夜间平均收缩压(nSBP)、白昼平均收缩压(dSBP)、夜间平均收缩压(nDBP)、血压变异系数(CV)]和颈- 桡动脉脉搏传导速度(crPWV), 分析 24h- 动态血压变异性、节律性特点和 crPWV 的影响因素。**结果:**腹型肥胖组患者非杓型血压、24h-SBP-CV、24h-DBP-CV、dSBP-CV、nSBP-CV、夜间 SBP 下降率以及 crPWV 均高于非腹型肥胖组 ($P<0.05$), 腹型肥胖组患者动脉僵硬度增高发生率高于非腹型肥胖组患者 ($P<0.05$)。控制混杂因素后, 腹型肥胖组患者腰围与夜间 SBP 下降率($r=0.338$)、24h-SBP-CV($r=0.279$)、24h-DBP-CV($r=0.259$)、dSBP-CV($r=0.208$)、nSBP-CV($r=0.317$)、crPWV($r=0.543$)呈正相关性 ($P<0.05$)。经多元线性回归分析结果显示, 腰围、LDL-C、夜间 SBP 下降率、24h-SBP-CV 和 nSBP-CV 是 crPWV 的重要影响因素 ($P<0.05$)。**结论:**腹部脂肪沉积对老年正常高值血压患者 24h 动态血压变异性、节律性特点和 crPWV 有显著影响, 部分 24h- 动态血压参数与动脉僵硬度有关, 控制腰围对预防动脉硬化有着重要的意义。

关键词:老年; 正常高值血压; 腹型肥胖; 24h- 动态血压; 动脉僵硬度; 靶器官损伤

中图分类号:R589.2;R544;R543.5 **文献标识码:**A **文章编号:**1673-6273(2020)22-4445-05

Characteristics of 24-hour Ambulatory Blood Pressure Variability and Its Correlation Study with Arterial Stiffness in Elderly Obese Patients with High Normal Blood Pressure*

ZHU Ying-liang, WANG Yun, BAI Yu, ZHONG Jian-gang, ZHANG Yi-jiao

(Department of Geriatrics, Affiliated Hospital of Nanjing University of traditional Chinese Medicine, Nanjing, Jiangsu, 210019, China)

ABSTRACT Objective: To investigate the characteristics of 24-hour ambulatory blood pressure variability and its correlation with arterial stiffness in elderly obese patients with high normal blood pressure. **Methods:** 174 elderly patients with normal high-value blood pressure who were hospitalized in our hospital from January 2018 to May 2020 were selected as study subjects, and divided into abdominal obesity group (n=85) and non-abdominal obesity group (n=89) according to the waist circumference. The 24h-ambulatory blood pressure [including 24h systolic blood pressure (24h-SBP), daytime mean diastolic blood pressure (dDBP), 24h systolic blood pressure (24h-DBP), nighttime mean systolic blood pressure (nSBP), daytime mean systolic blood pressure (dSBP), nighttime mean systolic blood pressure (nDBP), blood pressure coefficient of variation (CV)] and carotid-radial pulse wavevelocity (crPWV) in all subjects were monitored. The variability and rhythm of 24-hour ambulatory blood pressure and the influencing factors of crPWV were analyzed. **Results:** The non-dipper blood pressure, 24h-SBP-CV, 24h-DBP-CV, dSBP-CV, nSBP-CV, nighttime SBP decrease rate and crPWV of patients in abdominal obesity group were higher than those in non-abdominal obesity group ($P<0.05$). The incidence of increased arterial stiffness in abdominal obesity group was higher than that in non-abdominal obesity group ($P<0.05$). After controlling for confounding factors, waist circumference of patients in the abdominal obesity group were positively correlated with the nighttime SBP decrease rate ($r=0.338$), 24h-SBP-CV ($r=0.279$), 24h-DBP-CV ($r=0.259$), dSBP-CV ($r=0.208$), nSBP-CV ($r=0.317$) and crPWV ($r=0.543$) ($P<0.05$). The results of multiple linear regression analysis showed that the waist circumference, LDL-C, the decrease rate of nighttime SBP, 24h-SBP-CV and nSBP-CV were the influence factors of crPWV ($P<0.05$). **Conclusion:** Abdominal fat deposition has a significant effect on 24h-ambulatory blood pressure variability and arterial stiffness in elderly patients with normal high-value blood pressure, some parameters of 24h-ambulatory blood pressure are related to arterial stiffness. Waist circumference control is of great significance for preventing atherosclerosis.

Key words: Elderly; Normal high-value blood pressure; Abdominal obesity; 24h-ambulatory blood pressure; Arterial stiffness;

* 基金项目:江苏省卫生健康委干部保健科研项目(BJ5022)

作者简介:朱颖亮(1979-),女,硕士,主治医师,研究方向:老年医学,E-mail: zhuylnj@163.com

(收稿日期:2020-05-21 接受日期:2020-06-16)

Target organ lesion

Chinese Library Classification(CLC): R589.2; R544; R543.5 Document code: A

Article ID: 1673-6273(2020)22-4445-05

前言

正常高值血压(120~139/80~89 mmHg)是指从正常血压(<120/80 mmHg)发展至高血压的过渡阶段,也是高血压发生的独立危险因素^[1-3]。尤其是在老年人群中,基础疾病多、机体各项机能逐渐退化,正常高值血压更易进展为高血压,并导致靶器官及代谢损伤。近年来有学者提出,正常高值血压患者由于血液黏度增加,氧化应激反应紊乱,可损伤动脉血管内皮结构和功能,导致血管弹性降低,动脉壁僵硬增加^[4-6],因此血压变异性(BPV)有望成为临床上预测正常高值血压靶器官损害的重要指标。目前临床上关于 BPV 的研究和应用多局限于高血压人群,对于正常高值血压人群血压特点的研究相对较少。陈莲等^[7]学者证实,超重和肥胖可导致正常高值血压患者血压变异性大大增加,并且是正常高值血压向高血压转化的重要危险因素。本研究旨在探讨老年肥胖正常高值血压患者 24h- 动态血压变异特点并分析其与动脉僵硬度的相关性,为 BPV 检测在正常高值血压人群中的开展提供循证医学支持。

1 资料与方法

1.1 一般资料

选择 2018 年 1 月~2020 年 5 月期间在我院住院的老年正常高值血压患者 174 例,其中男性患者 113 例,女性患者 61 例,平均年龄(74.28±9.67)岁。纳入标准:(1)根据《中国高血压防治指南(2018 年修订版)》^[8]的标准,舒张压 80~89 mmHg(1 mmHg=0.133 kPa)和(或)收缩压 120~139 mmHg 且未服用抗高血压药物者诊断为正常高值血压,年龄≥60 岁;(2)根据《中国成年人超重与肥胖症预防与控制指南》^[9],腰围(男)<85 cm 或腰围(女)<80 cm 为非腹型肥胖,腹型肥胖为腰围(女)≥80 cm 或腰围(男)≥85 cm。排除标准:既往有基础心脏病史;动脉硬化检测提示血管完全闭塞者;近 3 个月内出现急性心肌梗死、急性心力衰竭、不稳定性心绞痛等心脏疾病者;急慢性感染、严重肝肾功能障碍、恶性肿瘤、免疫系统疾病者。所有入组对象配合完成动态血压监测和脉搏波传导速度,并自愿签署知情同意书。本研究设计符合《赫尔辛基宣言》。

1.2 方法

1.2.1 血生化检查 上午 8:00~11:00 抽取空腹肘静脉血 5 mL,30 min 内送检,由我院检验科专业医师完成检测,AU5800 型全血生化自动分析仪购于美国贝克曼库尔特公司。检测项目包括:总胆固醇(TC)、低密度脂蛋白(LDL-C)、甘油三酯(TG)、高密度脂蛋白(HDL-C)、血肌酐(SCr)、尿酸、空腹血糖(FPG)、糖化血红蛋白(HbA1c)、天冬氨酸转氨酶(AST)、丙氨酸转氨酶(ALT)。

1.2.2 脉搏传导速度检测 采用 Complior 脉搏波形分析系统(法国 Artech-Medical 公司)检测受试者颈动脉和桡动脉的脉搏波与心电图的时间延迟,测量胸骨上切迹至传感器所在的颈动脉和桡动脉的距离之和,计算颈-桡动脉脉搏传导速度

(crPWV)。根据欧洲高血压防治指南规定,crPWV≥12 m/s 则为动脉僵硬度增高,否则为动脉僵硬度正常。

1.2.3 24h- 动态血压监测 受试者左上臂佩戴 ABPM-05 动态血压监测仪(美国美林医疗公司)监测 24h- 昼夜动态血压,每次测量均保持静息状态。6:00am-22:00pm 期间,每隔 20 min 测一次白昼血压,22:00pm- 次日 6:00am 期间,每 30 min 测一次夜间血压,若受试者无效测压次数>20%,则测量重新开始。记录 24h 平均收缩压(24h-SBP)、24h 平均舒张压(24h-DBP)、白昼平均舒张压(dDBP)、夜间平均收缩压(nSBP)、白昼平均收缩压(dSBP)、夜间平均收缩压(nDBP)、血压变异系数(CV),CV= 血压均值标准差/血压均值×100%,并记录非杓型高血压、24h-SBP-CV、24h-DBP-CV、dSBP-CV、dDBP-CV、nSBP-CV、nDBP-CV、夜间 SBP 下降率及夜间 DBP 下降率。

1.3 统计学处理

采用 SPSS 24.0 统计软件分析数据。正态分布的计量资料采用($\bar{x} \pm s$)表示,采用单因素方差分析或 t 检验;采用例数(构成比)表示计数资料,采用 χ^2 检验。连续变量控制混杂因素后进行偏相关性分析。采用逐步回归法筛选变量,以多元线性回归分析 24h 血压昼夜变异性对动脉僵硬度的影响。所有显著性检验均为双侧检验, $P < 0.05$ 为差异有统计学意义。

2 结果

2.1 两组受试者一般资料比较

174 例老年正常高值血压人群中,根据腰围分组,其中 85 例患者属于腹型肥胖者,作为腹型肥胖组,其余 89 例患者属于非腹型肥胖者,作为非腹型肥胖组。腹型肥胖组患者体重、腰围、体重指数、饮酒史比例、TC 和 LDL-C 水平高于非腹型肥胖组患者,差异有统计学意义($P < 0.05$)。两组患者年龄、性别构成、身高、吸烟史比例、诊室收缩压、诊室舒张压、FPG、HbA1c、SCr、尿酸、AST、ALT、TG、HDL-C 水平比较,差异无统计学意义($P > 0.05$)。见表 1。

2.2 两组受试者 24h- 动态血压监测结果

腹型肥胖组和非腹型肥胖组老年正常高值血压患者 24h 平均血压(24h-SBP、24h-DBP)、白昼平均血压(dSBP、dDBP)和夜间平均血压(nSBP、nDBP)比较,差异无统计学意义($P > 0.05$)。见表 2。

2.3 两组组受试者 24h- 动态血压变异性及节律性特点

腹型肥胖组患者非杓型血压、24h-SBP-CV、24h-DBP-CV、dSBP-CV、nSBP-CV、夜间 SBP 下降率均高于非腹型肥胖组,差异有统计学意义($P < 0.05$),而两组 dDBP-CV、nDBP-CV、夜间 DBP 下降率比较未见显著性差异($P > 0.05$)。见表 3。

2.4 两组受试者动脉硬化指标比较

腹型肥胖组和非腹型肥胖组患者 crPWV 分别为(12.38±1.29)m/s 和(10.78±1.33)m/s,经 t 检验,差异有统计学意义($t=8.050, P=0.000$),腹型肥胖组患者 crPWV 高于非腹型肥胖组。另外,腹型肥胖组有 67 例(78.82%)患者动脉僵硬度增高,

非腹型肥胖组有 22 例(24.73%)患者动脉僵硬度增高,腹型肥胖组患者动脉僵硬度增高发生率高于非腹型肥胖组患者,差异有统计学意义($\chi^2=50.935, P=0.000$)。

2.5 腹型肥胖组患者腰围与 24h-动态血压变异性、动脉硬化指标的相关性分析

控制患者腰围、体重、体重指数、饮酒史等混杂因素后,腹型肥胖组患者腰围与夜间 SBP 下降率、24h-SBP-CV、24h-DBP-CV、dSBP-CV、nSBP-CV、crPWV 呈正相关性($P<0.05$)。见表 4。

2.6 腹型肥胖组患者 crPWV 影响因素的多元线性回归分析

以 crPWV 作为因变量,将腰围、体重、体重指数、饮酒史、TC、LDL-C、夜间 SBP 下降率、24h-SBP-CV、nSBP-CV 纳入逐步回归分析方程,结果显示腰围、LDL-C、夜间 SBP 下降率、24h-SBP-CV 和 nSBP-CV 是 crPWV 的重要影响因素($P<0.05$)。见表 5。

3 讨论

高血压是引起脑卒中、心肌梗死、心力衰竭以及微血管病

表 1 腹型肥胖组和非腹型肥胖组受试者一般资料比较

Table 1 Comparison of general data of subjects in abdominal obesity group and non-abdominal obesity group

Items	Abdominal obesity group (n=85)	Non-abdominal obesity group (n=89)	t/ χ^2	P
Age(years)	73.14±9.15	75.37±10.04	1.529	0.128
Male(n, %)	60(70.59)	53(59.55)	2.327	0.127
Height(cm)	173.48±9.32	175.10±7.68	1.254	0.212
Waist(cm)	89.38±10.46	75.43±5.32	11.162	<0.001
Weight(kg)	89.73±21.65	73.54±14.51	5.814	<0.001
Body mass index(kg/m ²)	28.45±3.57	26.76±2.35	3.704	<0.001
Smoking history(n, %)	24(28.24)	19(21.35)	1.108	0.293
Drinking history(n, %)	39(45.88)	22(24.72)	8.553	<0.001
Office systolic blood pressure(mmHg)	131.41±5.60	130.65±5.48	0.905	0.367
Office diastolic blood pressure(mmHg)	86.18±2.96	85.91±2.62	0.638	0.524
FPG(mmol/L)	5.62±0.65	5.58±0.57	0.432	0.666
HbA1c(%)	6.08±0.69	5.91±0.62	1.711	0.089
SCr(mmol/L)	73.24±24.59	67.85±21.24	1.549	0.123
Serum uric acid(μ mol/L)	283.35±56.45	272.58±51.64	1.314	0.191
AST(U/L)	22.14±5.10	21.89±4.75	0.335	0.738
ALT(U/L)	18.92±4.53	17.65±4.50	1.855	0.065
TC(mmol/L)	5.59±1.08	4.97±0.92	4.083	<0.001
TG(mmol/L)	1.47±0.40	1.42±0.39	0.835	0.405
HDL-C(mmol/L)	1.32±0.28	1.38±0.32	1.314	0.191
LDL-C(mmol/L)	3.16±0.82	2.69±0.74	3.973	<0.001

表 2 死亡组与存活组血清 Trx1、FGL2 表达水平对比($\bar{x}\pm s$)

Table 2 Comparison of serum Trx1 and FGL2 expression levels between death group and survival group($\bar{x}\pm s$)

Items	Abdominal obesity group (n=85)	Non-abdominal obesity group (n=89)	t	P
24h-SBP(mmHg)	131.48±7.59	129.34±7.20	1.909	0.058
24h-DBP(mmHg)	85.43±5.47	83.96±5.29	1.802	0.073
dSBP(mmHg)	127.65±5.49	126.38±5.23	1.563	0.120
dDBP(mmHg)	82.57±5.82	83.24±4.95	0.819	0.414
nSBP(mmHg)	135.62±7.33	133.70±7.19	1.744	0.083
nDBP(mmHg)	87.18±6.91	85.31±6.32	1.864	0.064

表 3 腹型肥胖组和非腹型肥胖组受试者 24h- 动态血压变异性及节律性特点($\bar{x}\pm s$)

Table 3 24-hour ambulatory blood pressure variability and rhythm characteristics of subjects in abdominal obesity group and non abdominal obesity group($\bar{x}\pm s$)

Items	Abdominal obesity group (n=85)	Non-abdominal obesity group (n=89)	t	P
Non-dipper blood pressure(n, %)	40(47.06)	13(14.61)	21.616	<0.001
24h-SBP-CV(%)	10.35±4.10	7.48±2.29	5.734	<0.001
24h-DBP-CV(%)	9.57±5.38	7.36±3.13	4.837	<0.001
dSBP-CV(%)	9.93±5.16	7.82±3.94	3.040	0.003
dDBP-CV(%)	12.05±3.98	11.03±4.38	1.605	0.110
nSBP-CV(%)	11.46±4.73	8.87±3.20	4.248	<0.001
nDBP-CV(%)	13.15±4.29	12.32±3.47	1.406	0.162
Nighttime SBP decrease rate(%)	3.34±2.27	1.45±2.10	5.704	<0.001
Nighttime DBP decrease rate(%)	1.85±2.32	1.42±1.78	1.375	0.171

表 4 腹型肥胖组患者腰围与 24h 昼夜血压变异性、动脉硬化指标的相关性

Table 4 Correlation between waist circumference and 24-hour circadian blood pressure variability and arteriosclerosis indexes in abdominal obesity group

Items	r	P
Nighttime SBP decrease rate	0.338	<0.001
24h-SBP-CV	0.279	<0.001
24h-DBP-CV	0.259	<0.001
dSBP-CV	0.208	0.013
nSBP-CV	0.317	<0.001
crPWV	0.543	<0.001

表 5 腹型肥胖组患者 crPWV 影响因素的多元线性回归分析

Table 5 Multiple linear regression analysis of influencing factors of crPWV in abdominal obesity group

Items	Unstandardized Coefficients		Standard coefficient β	t	P
	β	Standard error			
Constant	-2.778	0.463	-	-2.336	<0.001
Waist circumference	0.003	0.001	0.012	9.845	<0.001
LDL-C	0.117	0.019	0.186	2.163	0.027
Nighttime SBP decrease rate	0.962	0.278	1.213	5.425	<0.001
24h-SBP-CV	0.369	0.105	0.442	5.781	<0.001
nSBP-CV	0.571	0.214	0.697	5.148	<0.001

变的重要危险因素之一^[10,11],由于发病机制复杂且尚不明确,我国目前高血压整体知晓率、治疗率、控制率仍处于较低水平^[12]。流行病学调查显示,正常高值血压患者 4 年内进展为高血压的风险超过 50%,而且处于正常高值血压阶段的人群普遍存在相应靶器官损伤情况^[13]。因此自 2017 年起,国外众多临床指南逐渐更新了高血压的定义,将 130~140 mmHg/80~90 mmHg 者也纳入了高血压人群,以期提高对高血压防治工作的积极性^[14-16]。目前国内最新颁布的《中国高血压防治指南(2018 年修订版)》^[8]依然沿用之前的高血压标准,但是临床上仍然需要将正常高值血压患者作为重点防治对象,进行必要的非药物治疗和

密切监测血压变化。尤其是对于老年人群,多伴有其他基础疾病,且以单纯收缩性高血压最为常见,因此更易发生靶器官损伤。

2015 年黄锐等^[17]学者采用分层多级随机抽样方法对 5912 例 60 岁以上老年人群进行正常高值血压问卷调查和血压检查,结果发现正常高值血压的发病率约为 40%,其中体重指数是正常高值血压发生的独立危险因素。此外,丁亚楠等^[18]学者也证实腰围是正常高值血压的重要独立危险因素之一。本研究共纳入 174 例老年正常高值血压患者,其中 85 例患者为腹型肥胖组,其余 89 例患者腰围小于阈值,为非腹型肥胖。腹型肥胖组和非腹型肥胖组患者血压变异性存在一定的差异,腹型肥

胖组患者中非杓型血压、24h-SBP-CV、24h-DBP-CV、dS-BP-CV、nSBP-CV、夜间SBP下降率均高于非腹型肥胖组。既往Faramawi等^[19]学者就曾证实,腰围与短时血压变异性呈正相关关系,不仅如此,陈浩嘉等^[20]学者通过对开滦研究队列人群进行统计学分析发现,随着腰围增加,长时血压变异性也显著升高,因此腹型肥胖也是长时血压变异性的独立危险因素。在本研究中排除混杂因素后通过偏相关性分析发现,腰围与腹型肥胖组患者夜间SBP下降率、24h-SBP-CV、24h-DBP-CV、dS-BP-CV、nSBP-CV呈正相关性,说明老年腹型肥胖正常高值血压患者24h血压昼夜变异性较非腹型肥胖患者更明显,推测可能的原因:腹型肥胖者可能交感神经兴奋过度,从而减退血管压力反射敏感性,进一步造成血管变异性增加^[21-23]。因此在对高血压高危人群进行筛查时,腰围比体质指数更为重要,建议控制腹型肥胖人群比例可能对于高血压的防治意义更为重大。

此外,本研究除了证实老年腹型肥胖正常高值血压患者血压变异性较非腹型肥胖者更显著外,动脉硬化指标crPWV也显著高于非腹型肥胖者,说明正常高值血压已存在动脉血管功能和结构异常,血管弹性降低,动脉僵硬增加。其可能的原因:腹型肥胖者体内腹部脂肪组织堆积过剩,通过释放大炎症因子,导致血管内皮细胞损伤,从而增加动脉血管的僵硬^[24-26],而且经多元线性回归分析显示,腰围、LDL-C、夜间SBP下降率、24h-SBP-CV和nSBP-CV都与crPWV息息相关。Vlachopoulos等^[27]学者通过大样本荟萃分析证实,PWV是未来心脑血管事件尤其是动脉粥样硬化、脑卒中等最重要的风险评估因子之一。因此血压变异性与动脉僵硬相互促进,互为因果,是导致老年腹型肥胖正常高值血压者进展为高血压以及发生靶器官损伤的重要机制^[28-30]。

综上所述,老年腹型肥胖正常高值血压者血压变异性较非腹型肥胖者更明显,易导致血管壁弹性降低,动脉僵硬增加。因此控制腰围有助于促进生理性血压节律恢复,减少发生的心脑血管事件,有利于预防靶器官损害。

参考文献(References)

- [1] Hannah-Shmouni F, Gubbi S, Spence JD, et al. Resistant Hypertension: A Clinical Perspective [J]. *Endocrinol Metab Clin North Am*, 2019, 48(4): 811-828
- [2] Afzal MR, Savona S, Mohamed O, et al. Hypertension and Arrhythmias[J]. *Heart Fail Clin*, 2019, 15(4): 543-550
- [3] Chernova I, Krishnan N. Resistant Hypertension Updated Guidelines [J]. *Curr Cardiol Rep*, 2019, 21(10): 117
- [4] Touyz RM, Rios FJ, Alves-Lopes R, et al. Oxidative Stress: A Unifying Paradigm in Hypertension[J]. *Can J Cardiol*, 2020, 36(5): 659-670
- [5] Czigler A, Toth L, Szarka N, et al. Hypertension Exacerbates Cerebrovascular Oxidative Stress Induced by Mild Traumatic Brain Injury: Protective Effects of the Mitochondria-Targeted Antioxidative Peptide SS-31[J]. *J Neurotrauma*, 2019, 36(23): 3309-3315
- [6] Dikalov SI, Dikalova AE. Crosstalk Between Mitochondrial Hyperacetylation and Oxidative Stress in Vascular Dysfunction and Hypertension[J]. *Antioxid Redox Signal*, 2019, 31(10): 710-721
- [7] 陈莲. 高血压前期体检人群24h动态血压监测血压水平与体质指数的关系[J]. *医学综述*, 2016, 22(7): 1362-1365
- [8] 中国高血压防治指南修订委员会, 高血压联盟(中国), 中华医学会

- 心血管病分会中国医师协会高血压专业委员会, 等. 中国高血压防治指南(2018年修订版)[J]. *中国心血管杂志*, 2019, 24(1): 24-56
- [9] 陈春明, 孔灵芝. 中国成年人超重与肥胖症预防与控制指南[M]. 北京: 人民卫生出版社, 2006: 3-4
- [10] 解晓江, 李长青, 李菲, 等. 高血压患者饮食习惯、传统制剂服用现状调查及其影响因素分析 [J]. *现代生物医学进展*, 2020, 20(3): 582-587, 573
- [11] Brahmabhatt Y, Gupta M, Hamrahian S. Hypertension in Premenopausal and Postmenopausal Women[J]. *Curr Hypertens Rep*, 2019, 21(10): 74
- [12] 吴琦欣, 史明标, 邓燕, 等. 我国成人高血压流行病学分布特征研究进展[J]. *现代预防医学*, 2019, 46(23): 4238-4242
- [13] 汪宏莉, 韩延柏, 陈涛, 等. 老年人高血压风险预测肥胖指标筛选 [J]. *中国公共卫生*, 2020, 36(1): 105-109
- [14] Seccia TM, Caroccia B, Maiolino G, et al. Arterial Hypertension, Aldosterone, and Atrial Fibrillation[J]. *Curr Hypertens Rep*, 2019, 21(12): 94
- [15] Delivanis DA, Vassiliadi DA, Tsarakakis S. Adrenal Imaging in Patients with Endocrine Hypertension [J]. *Endocrinol Metab Clin North Am*, 2019, 48(4): 667-680
- [16] Mills KT, Stefanescu A, He J. The global epidemiology of hypertension[J]. *Nat Rev Nephrol*, 2020, 16(4): 223-237
- [17] 黄锐, 黄从新, 谢文杰, 等. 湖北省老年高血压前期的患病情况及相关危险因素分析[J]. *广西医学*, 2015, 37(9): 1249-1252
- [18] 丁亚楠, 吴雷, 耿国英, 等. 郑州市居民高血压前期的患病率及其危险因素分析 [J]. *中西医结合心脑血管病杂志*, 2019, 17(14): 2135-2139
- [19] Faramawi MF, Delongchamp R, Said Q, et al. High-normal blood pressure is associated with visit-to-visit blood pressure variability in the US adults[J]. *Blood Press*, 2017, 26(1): 18-23
- [20] 陈浩嘉, 张芮英, 陈泽凯, 等. 腰围与长时血压变异性的关系[J]. *中华高血压杂志*, 2019, 27(2): 156-161
- [21] Drivsholm A, Lund MAV, Hedley PL, et al. Associations between thyroid-stimulating hormone, blood pressure and adiponectin are attenuated in children and adolescents with overweight or obesity[J]. *J Pediatr Endocrinol Metab*, 2019, 32(12): 1351-1358
- [22] Dong Y, Jan C, Zou Z, et al. Effect of Overweight and Obesity on High Blood Pressure in Chinese Children and Adolescents[J]. *Obesity (Silver Spring)*, 2019, 27(9): 1503-1512
- [23] Dempsey AA, Parraga G, Altamirano-Diaz L, et al. Increased blood pressure is associated with increased carotid artery intima-media thickness in children with repaired coarctation of the aorta [J]. *J Hypertens*, 2019, 37(8): 1689-1698
- [24] Fu Q. Sex differences in sympathetic activity in obesity and its related hypertension[J]. *Ann N Y Acad Sci*, 2019, 1454(1): 31-41
- [25] Zhao Y, Qin P, Sun H, et al. Metabolically healthy general and abdominal obesity are associated with increased risk of hypertension [J]. *Br J Nutr*, 2020, 123(5): 583-591
- [26] Chen SH, Chen SC, Lai YP, et al. Abdominal obesity and hypertension are correlated with health-related quality of life in Taiwanese adults with metabolic syndrome [J]. *BMJ Open Diabetes Res Care*, 2020, 8(1): e000947

- [13] Zhe L, Tie L, Peng Y, et al. The therapeutic effects of percutaneous kyphoplasty on osteoporotic vertebral compression fractures with or without intravertebral cleft[J]. *Int Orthop*, 2018, 35(7): 1-7
- [14] Yu W, Xiao X, Zhang J, et al. Cement Distribution Patterns in Osteoporotic Vertebral Compression Fractures with Intravertebral Cleft: Effect on Therapeutic Efficacy [J]. *World Neurosurg*, 2018, 18(27): 365-379
- [15] Todd A, Kleimeyer JP, Woodall JR, et al. Improved biomechanics of two alternative kyphoplasty cementation methods limit vertebral recollapse: Biomechanics of Alternative Kyphoplasty Methods [J]. *J Orthop Res*, 2018, 36(27): 36-48
- [16] Wang Y, Jia G, Song J, et al. Comparative Efficacy of Alendronate upon Vertebral Bone Mineral Density and Fracture Rates in East Asians Versus Non-East Asians with Postmenopausal Osteoporosis: A Systematic Review and Meta-Analysis[J]. *Horm Metab Res*, 2018, 50(10): 738-746
- [17] 中华医学会骨质疏松和骨矿盐疾病分会. 原发性骨质疏松症诊疗指南(2017)[J]. *中国骨质疏松杂志*, 2019, 25(3): 281-309
- [18] Raj-Koziak D, Gos, El z bieta, Ś wierniak, Weronika, et al. Relationship Between Tinnitus Loudness Measure by Visual Analogue Scale and Psychoacoustic Matching of Tinnitus Loudness [J]. *Otol Neurotol*, 2019, 40(1): 16-21
- [19] Yu W, Liang D, Yao Z, et al. Risk factors for recollapse of the augmented vertebrae after percutaneous vertebroplasty for osteoporotic vertebral fractures with intravertebral vacuum cleft [J]. *Med*, 2017, 96(2): e5675
- [20] Zhang ZF, Huang H, Chen S, et al. Comparison of high- and low-viscosity cement in the treatment of vertebral compression fractures[J]. *Med*, 2018, 97(12): e0184
- [21] Jin-Sung P, Jaedong, Yonggu L, et al. Intra-cardiac Embolism of a Large Bone Cement Material after Percutaneous Vertebroplasty Removed through a Combination of an Endovascular Procedure and an Inferior Vena Cava Exploration: a Case Report [J]. *J Korean Med Sci*, 2018, 33(19): e141
- [22] Li X, Lu Y, Lin X. Refracture of osteoporotic vertebral body after treatment by balloon kyphoplasty: Three cases report [J]. *Bull Sch Med Univ Md*, 2017, 96(49): e8961
- [23] Svensson HK, Olsson LE, Hansson T, et al. The effects of person-centered or other supportive interventions in older women with osteoporotic vertebral compression fractures-a systematic review of the literature[J]. *Osteoporos Int*, 2017, 28(12): 2521-2540
- [24] Sun HB, Jing XS, Liu YZ, et al. The Optimal Volume Fraction in Percutaneous Vertebroplasty Evaluated by Pain Relief, Cement Dispersion, and Cement Leakage: A Prospective Cohort Study of 130 Patients with Painful Osteoporotic Vertebral Compression Fracture in the Thoracolumbar Vertebra [J]. *World Neurosurg*, 2018, 114: e677-e688
- [25] 陈继良, 许庆山, 王旭, 等. 经皮椎体成形术治疗骨质疏松性椎体压缩性骨折伴椎体内裂隙样变的疗效观察[J]. *中国微创外科杂志*, 2018, 18(2): 138-142
- [26] Liu T, Li Z, Su Q, et al. Cement leakage in osteoporotic vertebral compression fractures with cortical defect using high-viscosity bone cement during unilateral percutaneous kyphoplasty surgery [J]. *Med*, 2017, 96(25): e7216
- [27] Zhu J, Zhang K, Luo K, et al. Mineralized Collagen Modified Polymethyl Methacrylate Bone Cement for Osteoporotic Compression Vertebral Fracture at 1-Year Follow-up[J]. *Spine*, 2019, 44(23): 2337-2347
- [28] Han D, Chen W. Rs6815464 Polymorphism and Osteoporotic Vertebral Compression Fracture Risk[J]. *Gene*, 2020, 746: e144650
- [29] Back Pain Inducing Test, a Novel and Sensitive Screening Test for Painful Osteoporotic Vertebral Fractures: A Prospective Clinical Study[J]. *J Bone Miner Res*, 2020, 35(3): 488-497
- [30] 李继凯. 经皮椎体成形术治疗伴或不伴真空裂隙征的骨质疏松性椎体骨折的临床对照研究[D]. 山西医科大学, 2016
- [31] Wang WF, Lin CW, Xie CN, et al. The association between sarcopenia and osteoporotic vertebral compression refractures [J]. *Osteoporos Int*, 2019, 30(12): 2459-2467
- [32] D. C. Noriega, F. Rodriguez-Monsalve, R. Ramajo, et al. Long-term safety and clinical performance of kyphoplasty and SpineJack procedures in the treatment of osteoporotic vertebral compression fractures: a pilot, monocentric, investigator-initiated study [J]. *Osteoporos Int*, 2019, 28(30): 637-645
- [33] 蒋小军, 王辉. 经皮椎体成形术(PVP)治疗伴与不伴裂隙样变椎体压缩骨折疗效观察[J]. *颈腰痛杂志*, 2015, 36(5): 389-391

(上接第 4449 页)

- [27] Vlachopoulos C, Aznaouridis K, Stefanadis C, et al. Prediction of Cardiovascular Events and All-Cause Mortality With Arterial Stiffness: A Systematic Review and Meta-Analysis [J]. *J Am Coll Cardiol*, 2010, 55(13): 1318-1327
- [28] Shirasawa T, Ochiai H, Yoshimoto T, et al. Associations between normal weight central obesity and cardiovascular disease risk factors in Japanese middle-aged adults: a cross-sectional study [J]. *J Health Popul Nutr*, 2019, 38(1): 46
- [29] Lin YA, Chen YJ, Tsao YC, et al. Relationship between obesity indices and hypertension among middle-aged and elderly populations in Taiwan: a community-based, cross-sectional study [J]. *BMJ Open*, 2019, 9(10): e031660
- [30] Dwivedi AK, Dubey P, Cistola DP, et al. Association Between Obesity and Cardiovascular Outcomes: Updated Evidence from Meta-analysis Studies[J]. *Curr Cardiol Rep*, 2020, 22(4): 25