

· 临床研究 ·

不同危险分层的原发性高血压患者球结膜微循环的改变

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【摘要】目的 研究高血压病不同危险分层对原发性高血压患者球结膜微循环形态及功能的影响。**方法** 根据血压水平(1、2、3级)、其他心血管危险因素(年龄、吸烟、血胆固醇、低密度脂蛋白胆固醇、高密度脂蛋白胆固醇、早发心血管家族史、体质指数、高敏C反应蛋白等)、靶器官损害及并发症的情况,对118例高血压病患者进行分层,研究不同危险分层的高血压病患者和同期20例健康志愿者球结膜微循环的变化。**结果** 与健康对照组比较,低危组高血压病患者球结膜微循环改变主要表现为稀疏网格结构、微血管数目减少及细静脉管径变细,两者差异有统计学意义($P < 0.05$)。中危以上(含中危)组高血压病患者球结膜微循环出现形态、流态和袢周状态的明显改变。其形态改变主要为视野清晰度下降、微血管数减少、细动脉及细静脉管径变细、微血管粗细不均增多,并出现网格结构、微血管瘤、囊状扩张及缺血区。其流态改变主要为微血管内血流速度减慢、红细胞聚集。其管周渗出增加、含铁血黄素沉着增多。随着高血压危险分层的增加,球结膜微血管密网格结构比例逐渐增多、微血管数逐渐减少、微血管内血流速度逐渐减慢、红细胞聚集程度逐渐加重,差异有统计学意义($P < 0.05$)。**结论** 高血压病患者出现与危险分层相关的球结膜微循环改变。

【关键词】 球结膜微循环; 高血压; 危险分层

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Alterations of bulbar conjunctival microcirculation in essential hypertension patients with different risk stratification

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【Abstract】 Objective To determine the effect of essential hypertension (EH) with different risk stratification on the morphology and function of bulbar conjunctival microcirculation in EH patients. **Methods** Blood pressure (grades 1, 2, and 3), other cardiovascular risk factors (age, smoking, blood cholesterol, low density lipoprotein cholesterol, high density lipoprotein cholesterol, family history of premature cardiovascular diseases, body mass index, and high sensitivity C reactive protein), and target organ damage and complications were used to stratify 118 EH patients admitted in the hypertension clinic of our hospital from April 2014 to February 2015. Bulbar conjunctival microcirculation was monitored and analyzed in the patients and 20 healthy volunteers in the same period. **Results** Compared with the healthy volunteers, the low-risk patients had statistically sparser grid structure, less microvessels, and thinner venules ($P < 0.05$). While the moderate-, high-, and very high-risk patients displayed obvious changes in morphology, blood flow in microvessels, and surrounding loop state. The morphological changes were mainly characterized by blurred vision, reduced microvessels, thinner arterioles and venules, more microvessels of uneven diameters, grid structure and microaneurysm, cystic dilation and ischemic area. They also showed slowed blood flow velocity, increased erythrocyte aggregation and exudation, and hemosiderin deposition in surrounding loop. With the increase in risk stratification, there were gradually more grid structure density, decreased number of microvessels, reduced blood flow velocity, and enhanced erythrocyte aggregation ($P < 0.05$). **Conclusion** EH patients with different risk stratification show different alterations in bulbar conjunctival microcirculation.

【Key words】 bulbar conjunctival microcirculation; hypertension; risk stratifications

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高血压病是发病率最高的心血管疾病,也是我国脑卒中和冠心病发病及死亡的主要危险因素。我国每年因心血管病死亡300万人,至少50%与高血压有关,其中约70%的脑卒中与高血压病有关^[1]。目前我国高血压患者至少有2亿,其中高血压病患者占多数,而我国高血压病的知晓率、治疗率、控制率均低于发达国家。随着血压升高,靶器官损害和终点事件的危险也随之升高^[2]。尽管不断有新的有效降压药物被发现和应用,但是许多高血压病患者血压并未得到理想控制^[3],而且有些降压治疗后血压达标的高血压病患者其靶器官损害并未减轻。因此,临床上急需探寻新的治疗靶点。近年来,微循环在高血压病特别是靶器官损害防治中的作用越来越受到重视^[4]。阐明高血压病患者不同危险因素分层的微循环变化及其规律将有助于高血压病的防治。本研究分析不同危险分层的高血压病患者球结膜微循环的改变,为评估高血压病的疗效及预后提供参考。

1 对象与方法

1.1 研究对象

本研究收集2014年4月至2015年2月间在解放军总医院高血压门诊就诊的高血压病患者($n=118$)及同期健康志愿者($n=20$)。

1.1.1 入组及排除标准 入组标准如下。(1)参照2010年《中国高血压防治指南》(简称《指南》)^[5]:即在未使用降压药物的静息状态下,非同日3次测量血压,收缩压 ≥ 140 mmHg(1mmHg=0.133kPa)和(或)舒张压 ≥ 90 mmHg。根据血压升高水平,又进一步将高血压分为1级、2级和3级。(2)采用2010年《指南》的分层原则和基本内容,将高血压病患者按心血管风险水平分为低危、中危、高危和极高危4个层次。(3)患者意识清晰,有自理能力,能配合检查。(4)患者及其家属有能力理解知情同意书的相关内容,并同意参与本临床研究和签署知情同意书(本临床研究已通过解放军医学院医学伦理会论证,审批件编号为:伦审科研第S2014-059-02号)。

排除标准:(1)不能停用降压药物2d者;(2)继发性高血压患者;(3)有严重心脏病和心脑血管意外者;(4)有糖尿病、严重肝肾病变者及恶性肿瘤患者;(5)检测部位皮肤病影响微循环检测者;(6)精神病患者及不能从事日常活动者;(7)孕妇

或哺乳期妇女;(8)患者不愿接受随访或研究者,认为不能依从本研究要求的患者。

1.1.2 分组 按上述入组及排除标准,共收集高血压病患者118例,年龄25~75(48.8 ± 13.2)岁,其中男性63例(53.4%),年龄(49.0 ± 13.5)岁;女性55例(46.6%),年龄(48.6 ± 13.3)岁。健康志愿者20例,系经询问病史及查体确定为健康者,年龄26~73(47.6 ± 16.7)岁;其中男性11例(55.0%),年龄(48.1 ± 15.3)岁;女性9例(45.0%),年龄(47.1 ± 14.9)岁。高血压病低危组10例(8.5%),年龄(46.8 ± 13.5)岁,病程(5.3 ± 6.4)年;中危组28例(23.7%),年龄(48.4 ± 13.4)岁,病程(5.9 ± 7.1)年;高危组34例(28.8%),年龄(48.6 ± 13.3)岁,病程(6.0 ± 7.2)年;极高危组46例(39.0%),年龄(49.0 ± 13.5)岁,病程(6.0 ± 7.0)年。

1.2 实验仪器及方法

球结膜微循环观测采用ZL-104型微循环检测仪和微循环图像分析系统(徐州众联医疗器械有限公司)。检查室温度为22℃~25℃,相对湿度约70%。受检者安静休息15~30min后取坐位,检查右眼球结膜微血管。先在低倍($\times 20$)显微镜下观察右眼球结膜微循环清晰度和周围状态,进一步在高倍($\times 50$)显微镜下观察微循环形态和微循环内血液流态。由专人检测及分析,以减少误差,增加数据准确性。

1.3 统计学处理

所有数据均采用SPSS17.0软件进行统计学分析。计量资料采用均数 $\pm$ 标准差($\bar{x} \pm s$)表示,各组间的比较采用单因素方差分析(one-way ANOVA),组间两两比较采用最小显著差异法(least-significant difference, LSD);计数资料比较采用卡方检验。以 $P < 0.05$ 为差异有统计学意义。

2 结果

2.1 各组受试者一般情况比较及球结膜微循环检测指标与血压的相关性分析

2.1.1 各组受试者一般情况比较 与健康对照组比较,各组高血压病患者在性别、年龄和病程方面差异均无统计学意义($P > 0.05$;表1)。

2.1.2 各组受试者体质量指数、血脂、血压的比较 与健康对照组比较,各高血压病组血压均升高,差异有统计学意义($P < 0.05$),且随着高血压危险因素分层的增加,血压升高也越明显。此外,与健

康对照组比较, 高危、极高危组高血压病患者体质指数 (body mass index, BMI) 升高, 差异有统计学意义 ($P < 0.05$); 但各组受试者甘油三酯 (triglycerides, TG) 和总胆固醇 (total cholesterol, TC) 差异无统计学意义 ($P > 0.05$; 表2)。

2.2 球结膜微循环形态的变化

2.2.1 视野清晰度、微血管走行结构的变化 球结膜微循环清晰度分为清晰、不清和模糊3个等级。健康对照组和低危组患者球结膜微循环视野清晰, 差异无统计学意义 ($P > 0.05$)。中危以上 (含中危) 组患者球结膜微循环视野稍差, 与健康对照组比较差异有统计学意义 (均 $P < 0.05$); 且高血压病危险因素分层越高, 球结膜微循环视野清晰度越差 (图1, 表3), 相关分析结果显示, 受试者球结膜微血管清晰度与收缩压呈正相关 ($r = 0.273$, $P < 0.05$)。

球结膜微血管走行分为无网格结构、稀疏网格结构、局部密网格结构及广泛密网格结构4个等级。与健康对照组比较, 高血压病各组患者球结膜微血管均

出现网格结构 ($P < 0.05$); 其中, 低危组球结膜微血管稀疏网格结构比例增加, 与健康对照组比较差异有统计学意义 ($P < 0.05$)。中、高危组球结膜微血管局部密网格结构比例增加, 与健康对照组及低危组比较差异均有统计学意义 (均 $P < 0.05$)。极高危组球结膜微血管广泛密网格结构比例增加, 与其他各组比较, 差异均有统计学意义 (均 $P < 0.05$)。提示高血压病危险因素分层越高, 球结膜微血管网格结构变化越明显 (图2, 表3)。

2.2.2 微血管数、细静脉管径、细动脉管径 与健康对照组比较, 低危组、中危组、高危组和极高危组高血压病患者球结膜微血管数目分别较健康对照组减少28%、37%、33%和41%, 差异有统计学意义 (均 $P < 0.05$); 其中极高危组球结膜微血管数目减少最明显, 与健康对照组及低危组比较差异有统计学意义 (均 $P < 0.05$)。提示高血压病危险因素分层越高, 球结膜微血管数目减少越明显 (图1, 表4)。

表1 各组受试者一般情况比较
Table 1 The general data of subjects in each group

Group	n	Gender		Age (years, $\bar{x} \pm s$)	Course of disease (years, $\bar{x} \pm s$)
		Male [n(%)]	Female [n(%)]		
Healthy control	20	11 (55)	9 (45)	47.6 $\pm$ 16.7	—
Low-risk	10	5 (50)	5 (50)	46.8 $\pm$ 13.4	5.3 $\pm$ 6.4
Moderate-risk	28	16 (57)	12 (43)	48.4 $\pm$ 13.4	5.9 $\pm$ 7.1
High-risk	34	14 (41)	20 (58)	48.6 $\pm$ 13.3	5.9 $\pm$ 7.1
Very high-risk	46	30 (60)	16 (40)	49.0 $\pm$ 13.5	6.0 $\pm$ 7.0

表2 各组受试者体质指数、血脂、血压的比较
Table 2 The BMI, TG, TC and BP of subjects in each group ($\bar{x} \pm s$)

Group	n	BMI (kg/m ²)	TG (mmol/L)	TC (mmol/L)	BP (mmHg)	
					SBP	DBP
Healthy control	20	24.2 $\pm$ 1.6	1.7 $\pm$ 0.8	5.9 $\pm$ 1.10	118 $\pm$ 9	81 $\pm$ 8c
Low-risk	10	25.0 $\pm$ 3.3	1.9 $\pm$ 0.4	4.3 $\pm$ 0.58	152 $\pm$ 7*	97 $\pm$ 3*
Moderate-risk	28	25.9 $\pm$ 3.4	1.7 $\pm$ 1.2	4.5 $\pm$ 0.80	160 $\pm$ 10*	106 $\pm$ 9*
High-risk	34	26.5 $\pm$ 3.3*	1.7 $\pm$ 0.7	4.6 $\pm$ 0.50	172 $\pm$ 16* [#] [△]	107 $\pm$ 20*
Very high-risk	46	27.2 $\pm$ 4.0*	2.5 $\pm$ 2.0	5.3 $\pm$ 1.74	187 $\pm$ 20* [#] [△] [▲]	120 $\pm$ 24* [#] [△] [▲]

BMI: body mass index; TG: triglycerides; TC: total cholesterol; BP: blood pressure; SBP: systolic blood pressure; DBP: diastolic blood pressure. 1mmHg = 0.133kPa. Compared with healthy control group, * $P < 0.05$; compared with low-risk group, # $P < 0.05$; compared with moderate-risk group, [△] $P < 0.05$; compared with high-risk group, [▲] $P < 0.05$

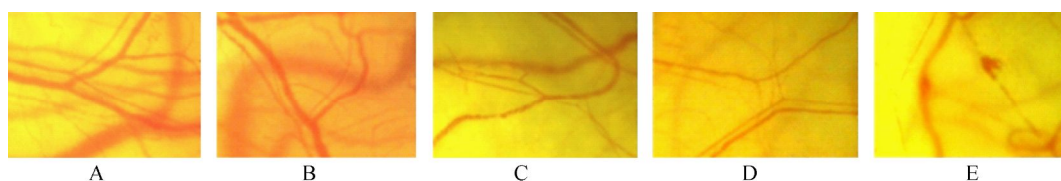


图1 球结膜微循环视野清晰度、微血管数和管径的代表性图

Figure 1 The representative images of clarity, number and diameters of microvessels in the bulbar conjunctival microcirculation ($\times 50$) A: healthy control group; B: low-risk group; C: moderate-risk group; D: high-risk group; E: very high-risk group. The bulbar conjunctival microcirculation of the healthy control group and low-risk group is clear. The number of microvessels is reduced, and the conjunctival microvessel is thinner in the low-risk group. The bulbar conjunctival visions are unclear, the number of microvessels are reduced, and the diameters of arterioles and venules are thinner in the moderate-risk group, the high-risk group and the very high-risk group

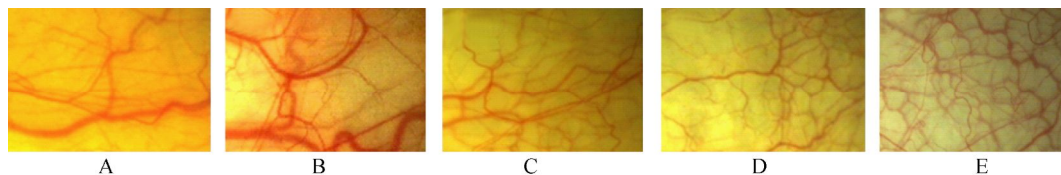


图2 球结膜微循环微血管走行结构的代表性图

Figure 2 The representative figures of the shape structure of the bulbar conjunctival microcirculation ($\times 20$)

A: healthy control group; B: low-risk group; C: moderate-risk group; D: high-risk group; E: very high-risk group. There is no latticework structure in the bulbar conjunctival of healthy control group. The microvessel shape shows sparse latticework structures in the low- and high-risk groups. While, it shows locally dense latticework structures in the moderate-and high-risk groups, and widely dense latticework structure in the very high-risk group

表3 各组受试者球结膜微循环清晰度和网格结构的变化

Table 3 Changes in bulbar conjunctival microcirculation clarity and latticework structure of subjects in each group

Group	n	Clarity			Latticework structure			
		Clear	Unclear	Fuzzy	No latticework	Sparse latticework	Locally dense latticework	Widely dense latticework
Healthy control	20	18 (90)	2 (10)	0 (0)	18 (90)	2 (10)	0 (0)	0 (0)
Low-risk	10	8 (80)	2 (20)	0 (0)	4 (40)*	6 (60)*	0 (0)	0 (0)
Moderate-risk	28	14 (50)*	14 (50)*	0 (0)	9 (32)*	11 (39)	8 (29)* [#]	0 (0)
High-risk	34	16 (47)*	18 (53)*	0 (0)	7 (20)*	11 (32)	14 (42)* [#]	2 (6)
Very high-risk	46	22 (47)*	23 (50)*	1 (3)	12 (26)*	13 (28)	7 (16%)	14 (30)* [#] [△]

Compared with healthy control group, * $P < 0.05$; compared with low-risk group, [#] $P < 0.05$; compared with moderate-risk group, [△] $P < 0.05$; compared with high-risk group, [▲] $P < 0.05$

表4 各组受试者微血管数、细静脉及细动脉管径的变化

Table 4 Changes in the number of microvessels and the diameter of arteriole and venule of subjects in each group

Group	n			
		Number of microvessels	Diameter of venule (μm)	Diameter of arteriole (μm)
Healthy control	20	8.0 $\pm$ 1.0	27.8 $\pm$ 4.1	10.3 $\pm$ 2.0
Low-risk	10	5.7 $\pm$ 1.0*	22.7 $\pm$ 4.3*	9.0 $\pm$ 1.1
Moderate-risk	28	5.0 $\pm$ 1.7*	21.0 $\pm$ 3.4*	8.2 $\pm$ 2.3*
High-risk	34	5.3 $\pm$ 1.1*	21.1 $\pm$ 5.0*	8.5 $\pm$ 1.9*
Very high-risk	46	4.7 $\pm$ 0.9* [#]	20.3 $\pm$ 4.1*	7.8 $\pm$ 1.2*

Compared with healthy control group, * $P < 0.05$; compared with low-risk group, [#] $P < 0.05$

与健康对照组比较, 低危、中危、高危和极高危组高血压病患者球结膜细静脉管径分别减少19%、25%、24%和27%, 差异有统计学意义 (均 $P < 0.05$)。且随着高血压危险分层的增高, 球结膜微血管细静脉管径出现逐渐变细的趋势 ($P > 0.05$; 图1, 表4)。

与健康对照组比较, 中危、高危和极高危组高血压病患者球结膜细动脉管径分别减少20%、18%和24%, 差异有统计学意义 (均 $P < 0.05$; 图1, 表4)。

2.2.3 微血管瘤、囊状扩张、缺血区、粗细不均的变化 与健康对照组比较, 高血压病低危、中危组患者出现球结膜微血管瘤的比率差异无统计学意义 ($P > 0.05$)。高危、极高危组球结膜微血管出现微血管瘤的比率显著增加, 与健康对照组和低危组比较差异有统计学意义 (均 $P < 0.05$)。提示高血压病危险因素分层越高, 越易出现球结膜微血管瘤 (图3, 表5)。

与健康对照组比较, 高血压病低危组患者出现球结膜微血管囊状扩张的比率差异无统计学意义 ($P > 0.05$)。中危以上 (含中危) 组球结膜微血管出现囊状扩张的比

率显著增加, 与健康对照组比较差异有统计学意义 (均 $P < 0.05$)。提示高血压病危险因素分层越高, 越易出现球结膜微血管囊状扩张 (表5)。

在球结膜微血管缺血区的检查中我们发现, 与健康对照组及低危组比较, 只有极高危组患者球结膜微血管缺血区的比率明显增加, 且差异有统计学意义 ($P < 0.05$)。余各组之间及与健康对照组比较, 差异均无统计学意义 ($P > 0.05$; 表5)。

与健康对照组比较, 高血压病各组患者球结膜微血管粗细不均的数量均增多, 低危、中危组、高危和极高危组高血压病患者球结膜微血管粗细不均分别增加30%、60%、56%和59%, 差异有统计学意义 (均 $P < 0.05$; 图4, 表5)。相关分析结果显示, 受试者收缩压与微血管粗细不均呈正相关 ($r = 0.194$, $P < 0.05$)。

2.3 球结膜微循环血液流态的变化

2.3.1 血流速度 与健康对照组比较, 高血压病低

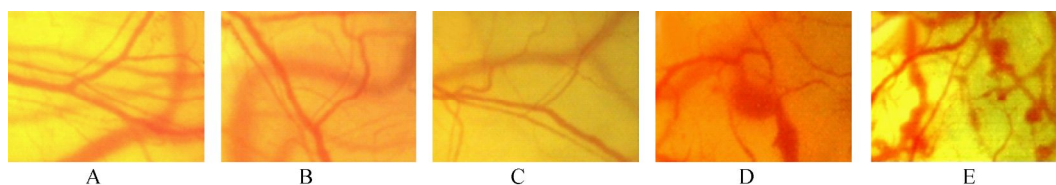


图3 球结膜微血管瘤的代表性图

Figure 3 The representative images of microangioma in the bulbar conjunctiva ($\times 50$)

A: healthy control group; B: low-risk group; C: moderate-risk group; D: high-risk group; E: very high-risk group. There is no microangioma in the bulbar conjunctiva of the healthy control group, the low-risk group and the moderate risk group. While microangiomas are prone to appear in the bulbar conjunctiva of high- and very high- risk groups

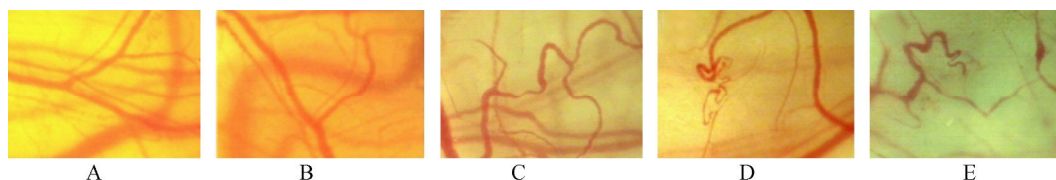


图4 球结膜微血管粗细不均的代表性图

Figure 4 The representative images of microvessels in the bulbar conjunctiva ($\times 50$)

A: healthy control group; B: low-risk group; C: moderate-risk group; D: high-risk group; E: very high-risk group. The microvessels shows uniform thickness in the healthy control group, while, they show uneven thickness in the low-, moderate-, high- and very high-risk groups

表5 各组受试者微血管瘤、囊状扩张、缺血区及微血管粗细不均数量的变化

Table 5 Changes in capillary hemangioma, cystically dilated, ischemic region and number of microvessels with uneven diameters from subjects in each group

Group	n	Microangioma [n(%)]	Cystically dilated [n(%)]	Ischemic region [n(%)]	Number of microvessels with uneven diameters ($\bar{x} \pm s$)
Healthy control	20	0 (0)	1 (5)	0 (0)	1.1 ± 0.8
Low-risk	10	0 (0)	2 (20)	0 (0)	$1.6 \pm 1.2^*$
Moderate-risk	28	2 (8)	17 (58)*	5 (18)	$2.8 \pm 0.8^*$
High-risk	34	8 (24)*#	22 (64)*#	4 (12)	$2.5 \pm 0.9^*$
Very high-risk	46	9 (23)*#	31 (68)*#	13 (29)*#	$2.7 \pm 1.1^*$

Compared with healthy control group, * $P < 0.05$; compared with low-risk group, # $P < 0.05$

危组患者球结膜微血管内血流速度差异无统计学意义 ($P > 0.05$)。中危以上 (含中危) 组患者球结膜微血管内血流速度减慢, 中危、高危和极高危组高血压病患者球结膜微血管内血流速度分别较健康对照组受试者低20%、24%和30% (均 $P < 0.05$) , 且与低危组比较差异亦有统计学意义 ($P < 0.05$) ; 其中极高危组球结膜微血管内血流速度最慢, 与中危及高危组比较差异有统计学意义 ($P < 0.05$) 。提示高血压病危险分层越高, 球结膜微血管内血流速度减慢越明显 (表6)。相关分析结果显示, 受试者收缩压与微血管内血流速度呈负相关^[5,7] ($r = -0.195$, $P < 0.05$) 。

2.3.2 红细胞聚集程度 球结膜微血管内红细胞聚集程度分为无、轻度、中度和重度4个等级。与健康对照组比较, 高血压病低危组患者球结膜微血管内红细胞聚集程度的差异无统计学意义 ($P > 0.05$) 。中危组患者球结膜微血管内红细胞轻度聚集的比率显著增加, 与健康对照组、高危组、极高危组比较差异有统计学意义 (均 $P < 0.05$) 。高危、极高危组患者球结膜微血管内红细胞中度聚集的比率增加, 与健康对照组及低危组比较差异有统计学意义 (均 $P < 0.05$) 。提示

高血压病危险分层越高, 球结膜微血管内红细胞聚集程度越严重 (表6) 。相关分析结果显示, 受试者收缩压与微血管内红细胞聚集程度呈正相关 ($r = 0.218$, $P < 0.05$) 。

2.4 球结膜微血管周围情况

2.4.1 渗出或水肿 与健康对照组比较, 高血压病各组患者球结膜微血管周围渗出灶的数量差异有统计学意义 (均 $P < 0.05$) ; 且随着高血压危险分层的增高, 球结膜微血管周围渗出灶出现逐渐增多的趋势 ($P > 0.05$) 。提示高血压病危险分层越高, 球结膜微血管周围渗出灶越多 (图1, 表7) 。

2.4.2 含铁血黄素沉着和周围出血 与健康对照组比较, 高血压病各组甲襞微血管周围出血发生率差异无统计学意义 ($P > 0.05$) 。健康对照组未见铁血黄素沉着, 低危组高血压病患者球结膜微血管周围含铁血黄素沉着出现率为40% (4/10) , 与健康对照组比较差异无统计学意义 ($P > 0.05$) 。中危组、高危组和极高危组高血压病患者球结膜微血管周围含铁血黄素沉着出现率分别为61% (17/28) 、71% (24/34) 、74% (34/46) , 与健康对照组比较差异有统计学意

义 (均 $P < 0.05$) ; 且随着高血压危险分层的增高, 球结膜微血管周围含铁血黄素沉着出现逐渐增多的趋势 ($P > 0.05$; 图5)。相关分析结果显示, 受试者含铁血黄素沉着与收缩压 ($r = 0.199, P < 0.05$) 和舒张压 ($r = 0.192, P < 0.05$) 均呈正相关。

3 讨论

近年来, 高血压病发病的微血管损伤机制备受关注。微血管内皮细胞是生成、释放血管活性物质的主要部位, 高血压病时内皮细胞功能紊乱可以影响活性物质产生, 进而加重微循环结构及功能损伤^[7-10], 导致微血管功能和结构性数目减少、微血管重塑, 从而影响靶器官组织血液供应, 是高血压病靶器官损伤的主要机制, 也是高血压病早期预警、病情和疗效评估的客观指标之一^[13]。

球结膜微血管呈平面分布于球结膜表面, 来源于颈内动脉分支的眼动脉, 其变化在一定程度上间接反映颅内微循环状态, 是体表唯一可以进行无创性观测细动脉、毛细血管和细静脉等微循环全部区段的部位, 微循环的结构和功能状态反映了高血压

对靶器官损伤的程度^[14]。国外学者发现高血压病的重要特征是微血管数目减少^[11,15,16], 并认为微血管数目减少在高血压发生时就已经存在。Cheng等^[13]认为在高血压病早期, 微血管数目减少是功能性的, 是血管收缩所致的无灌注现象。而后期才出现结构性的微血管数目减少, 也是高血压导致靶器官损害的第一步。国内也有研究报道, 高血压病患者微血管变化主要表现为: 微血管数目减少、粗细不均、管径变细、出现缺血区、囊状扩张及微血管瘤^[17,18]。但高血压的预后不仅与血压升高有关, 还与心血管危险因素 (年龄、吸烟、血胆固醇、低密度脂蛋白胆固醇、高密度脂蛋白胆固醇、早发心血管家族史、体质指数、高敏C反应蛋白等) 及靶器官损伤程度有关, 因此, 现在主张对高血压病患者做心血管危险分层来指导高血压临床治疗及判断预后。通过阅读文献资料, 尚未见到依据危险因素分层观察高血压病患者球结膜微循环的改变的报道。本研究首次根据心血管危险分层来总结高血压病患者微循环的改变, 我们研究发现, 低危组高血压病患者即出现球结膜微血管数目减少、稀疏网格结构比例增

表6 各组受试者球结膜微循环血液流态的变化
Table 6 Changes in blood flow in bulbar conjunctival microcirculation of subjects in each group

Group	n	Velocity of blood flow ($\mu\text{m/s}$, $\bar{x} \pm s$)	Erythrocyte aggregation degree [n(%)]			
			No	Mild	Moderate	Severe
Healthy control	20	549.6 $\pm$ 54.2	16(80)	4 (20)	0 (0)	0 (0)
Low-risk	10	542.4 $\pm$ 61.5	7 (70)	3 (30)	0 (0)	0 (0)
Moderate-risk	28	442.9 $\pm$ 60.4 [#]	1 (3) [#]	23 (82) [*]	4 (15)	0 (0)
High-risk	34	421.0 $\pm$ 79.1 [#]	5 (15) [#]	13 (38) [△]	16 (47) [#]	0 (0)
Very high-risk	46	386.3 $\pm$ 86.8 ^{#△▲}	6 (13) [#]	17 (37) [△]	19 (43) [#]	3 (7)

Compared with healthy control group, ^{*} $P < 0.05$; compared with low-risk group, [#] $P < 0.05$; compared with moderate-risk group, [△] $P < 0.05$; compared with high-risk group, [▲] $P < 0.05$

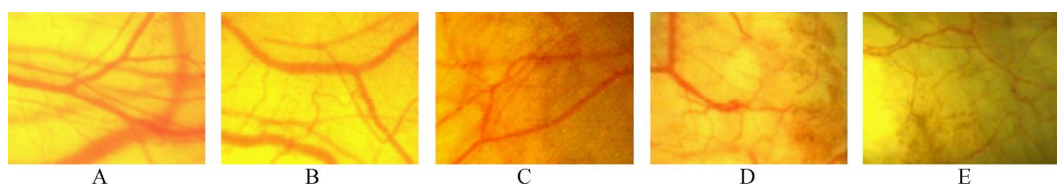


图5 球结膜微血管周围含铁血黄素沉着的代表性图

Figure 5 The representative images of hemosiderosis around the microvessels in the bulbar conjunctiva ($\times 50$)

A: healthy control group; B: low-risk group; C: moderate-risk group; D: high-risk group; E: very high-risk group. There is no hemosiderosis around the microvessels in the bulbar conjunctiva of control group, while it appears in the moderate-, high- and very high-risk groups

表7 各组受试者球结膜微血管周围情况的变化
Table 7 Changes of the surrounding of bulbar conjunctival microvessels of subjects in each group [n(%)]

Group	n	Exudation or edema			
		No	1-2	> 3	Widely
Healthy control	20	19 (95)	1 (5)	0 (0)	0 (0)
Low-risk	10	2 (20) [*]	5 (50)	3 (30)	0 (0)
Moderate-risk	28	9 (32) [*]	10 (36)	8 (28)	1 (4)
High-risk	34	10 (29) [*]	14 (41) [*]	8 (24)	2 (6)
Very high-risk	46	7 (15) [*]	23 (50) [*]	13 (28)	3 (7)

Compared with healthy control group, ^{*} $P < 0.05$

多及细静脉管径变细。中危以上(含中危)组高血压病患者球结膜微循环出现视野清晰度稍差、微血管数减少、细动脉及细静脉管径变细、微血管粗细不均增多,并出现网格结构、微血管瘤、囊状扩张及缺血区等形态改变;并出现血流速度减慢、红细胞不同程度聚集等流态改变和渗出增加、含铁血黄素沉着增多等袢周改变。而且随着高血压危险分层的增加,球结膜微血管密网格结构比率逐渐增多、微血管数目逐渐减少、微血管内血流速度逐渐减慢、红细胞聚集程度逐渐加重,差异有统计学意义($P < 0.05$)。上述结果表明,球结膜微循环的改变与高血压病的危险因素分层存在相关性,改善微循环应该成为高血压病治疗的靶点之一。

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