·临床研究·

高压氧治疗对老年冠心病不稳定型心绞痛患者血脂代谢及血管炎症因子的影响

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【摘 要】 目的 探讨高压氧治疗(HBOT)在缓解老年冠心病不稳定型心绞痛(UA)患者临床症状中的价值,并探讨其对患者外周血D-二聚体(D-D)、血脂代谢及血管炎症因子的影响。**方法** 选择邢台市中心医院2021年6月至2023年12月收治的146例老年冠心病UA患者为研究对象,根据随机数表法将患者分为HBOT组(HBOT+基础治疗,$n=73$)和对照组(基础治疗,$n=73$),两组患者均连续干预15 d。比较两组患者的治疗效果及治疗前后外周血D-D、血脂代谢、血管炎症因子[高敏C反应蛋白(hs-CRP)、血脂蛋白相关磷脂酶A2(Lp-PLA2)、同型半胱氨酸(Hcy)]水平,同时统计两组患者入院第2天及出院前1 d心绞痛发生次数及持续时间。采用SPSS 26.0统计软件进行数据处理,根据数据类型分别采用t检验或χ^2检验进行组间比较。**结果** HBOT组中6例患者因HBOT适应差及高压氧治疗费用问题退出,剩余67例配合完成15 d的治疗;对照组患者均配合完成15 d治疗。治疗后,HBOT组血脂代谢指标TG及血浆D-D水平较同组治疗前下降、HDL-C水平较治疗前升高,且HBOT组血浆D-D水平低于对照组,HDL-C水平高于对照组,差异有统计学意义($P<0.05$);对照组治疗后血脂代谢指标及血浆D-D水平无明显改善,差异无统计学意义($P>0.05$)。治疗后,两组患者血管炎症因子hs-CRP、Lp-PLA2及Hcy水平均较同组治疗前下降;出院前1 d,两组日均心绞痛发作次数及心绞痛持续时间均较同组入院第2天下降;HBOT组治疗后血管炎症因子水平、日均心绞痛发作次数及持续时间均显著低于对照组,差异有统计学意义($P<0.05$)。HBOT组患者治疗有效率显著高于对照组[92.54%(62/67)和80.82%(59/73)],差异有统计学意义($P<0.05$)。**结论** HBOT在减少UA发作次数及心绞痛持续时间中具有良好的功效,除传统作用机制外,HBOT还可能通过减少血管炎症因子释放、改善血脂代谢紊乱及血液高凝状态,发挥治疗效果。

【关键词】 老年人;冠心病;不稳定型心绞痛;高压氧
【中图分类号】 R541.4 **【文献标志码】** A **【DOI】** 10.11915/j.issn.1671-5403.2025.06.093

Influence of hyperbaric oxygen therapy on blood lipid metabolism and vascular inflammatory factors in elderly coronary heart disease patients with unstable angina

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【Abstract】 Objective To explore the value of hyperbaric oxygen therapy (HBOT) on relieving the clinical symptoms in elderly coronary heart disease (CHD) patients with unstable angina (UA), and to investigate its impact on peripheral blood D-dimer (D-D), blood lipid metabolism and vascular inflammatory factors. **Methods** A total of 146 elderly CHD patients with UA admitted to our hospital from June 2021 to December 2023 were recruited and randomly divided into HBOT group (HBOT+ basic treatment, $n=73$) and control group (basic treatment, $n=73$). Both groups of patients were continuously intervened for 15 d. The therapeutic effect, as well as peripheral blood levels of D-D, blood lipids and vascular inflammatory factors [high-sensitivity C-reactive protein (hs-CRP), lipoprotein-associated phospholipase A2 (Lp-PLA2), homocysteine (Hcy)] before and after treatment were determined and compared between two groups. The frequency and duration of angina pectoris on the second day after admission and on the first day before discharge were counted in both groups. SPSS 26.0 was used for data analysis, and t test or χ^2 test was carried out depending on data type. **Results** In the HBOT group, six patients withdrew due to poor adaptation to HBOT treatment and cost of HBOT, and the remaining 67 patients completed 15 d of treatment. All the patients in the control group completed 15 d of treatment. After treatment, the levels of blood lipids, TG and plasma D-D in the HBOT group were decreased than the levels before treatment, while the HDL-C was enhanced than the levels before treatment; the plasma D-D were significantly lower while the HDL-C were significantly higher in the HBOT group than the control group ($P<0.05$). The levels of blood lipid indicators and plasma D-D in the control group were not notably improved after treatment ($P>0.05$). After treatment, the levels of vascular inflammatory factors hs-CRP, Lp-PLA2 and Hcy were decreased in both groups, and the average daily frequency of angina pectoris attacks and duration of angina pectoris in both groups were reduced on the first day before discharge compared with those on the second day after admission. The levels of vascular inflammatory factors and average daily frequency and duration of angina

收稿日期: 2024-06-19; **接受日期**: 2024-07-31
基金项目: 邢台市重点研发计划自筹项目(2023ZC098)
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pectoris attacks were significantly lower in the HBOT group than the control group after treatment ($P<0.05$). The effective rate of treatment was significantly higher in the HBOT group than the control group [92.54% (62/67) *vs* 80.82% (59/73), $P<0.05$]. **Conclusion** HBOT has good efficacy in reducing the frequency of angina pectoris attacks and the duration of angina pectoris. Besides the traditional mechanism, HBOT may also play a therapeutic effect by reducing the releases of vascular inflammatory factors and improving the lipid metabolism disorder and hypercoagulable state.

【Key words】 aged; coronary heart disease; unstable angina; hyperbaric oxygen

This work was supported by the Self-Funded Project of Key Research and Development Plan of Xingtai (2023ZC098).

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心绞痛是冠心病的常见临床症状,其中不稳定型心绞痛(unstable angina,UA)是一种介于稳定型心绞痛与心肌梗死之间的阶段,极易进展为心肌梗死,相比于稳定型心绞痛,UA患者预后更差。内科用药治疗及冠状动脉介入术(percutaneous coronary intervention,PCI)是治疗UA的主要方式,但长期服药易产生副作用,而PCI属于有创治疗,部分患者不能接受[1]。如何提高UA治疗的安全性及有效性一直是临床研究的热点。高压氧治疗(hyperbaric oxygen therapy,HBOT)是指在高压环境下呼吸纯氧或高浓度氧,多用于一氧化碳中毒迟发性脑损伤、突发性耳聋、缺血缺氧性脑损伤等,其具有操作简单、无创等优势[2]。自1973年起,高压氧(hyperbaric oxygen,HBO)即被逐渐应用于冠心病的治疗,但其在治疗UA中的具体时机及疗程并无明确规定。本研究对老年冠心病合并UA患者进行为期15 d的基础治疗与HBOT,观察HBOT是否影响患者血管炎症因子、脂质代谢及凝血状态,探讨HBOT治疗UA的疗效及可能机制。

1 对象与方法

1.1 研究对象

选择邢台市中心医院2021年6月至2023年12月收治的146例老年UA患者为研究对象。根据随机数表法将患者分为HBOT组(73例)及对照组(73例)。纳入标准:年龄≥60岁;符合《2020年美国不稳定型心绞痛与非ST段抬高心肌梗死治疗指南》[3]中相关诊断标准;可配合完成相关研究。排除标准:参与研究前1个月内发生急性冠脉综合征;参与研究前2周内行心脏介入术或心脏搭桥术;伴活动性出血及出血性疾病,重症肺部感染或严重肺大泡,未经处理的气胸、纵膈气肿,伴2度及以上房室间传导阻滞,严重高血压,重度心率失常,合并癫痫、上呼吸道感染等HBOT禁忌证。本研究通过医院医学伦理委员会批准(批号:20200781),参与者均知情且签署知情同意书。HBOT组中有6例患者因HBOT治疗适应差及高压氧治疗费用问题退出,剩余67例配合完成15 d治疗。对照组患者均配合完成15 d治疗。两组患者基线资料比较,差异无统计学意义($P>0.05$;表1),具有可比性。

1.2 方法

1.2.1 样本量计算 本研究的主要观察指标为冠心病心绞痛疗效,运用疗效指标分别计算样本量,运用均数配对检验计算公式,即 $N=\left[\frac{(Z_{\alpha/2}+Z_{\beta})\delta}{\partial}\right]^2$,$\alpha=0.05$,$\beta=0.10$,根据疗效指标计算最大样本量,计算结果为130例,考虑到失访及实际情况将样本量扩大至146例。

表1 两组患者基线资料比较

Table 1 Comparison of baseline data between two groups

Item	HBOT group ($n=67$)	Control group ($n=73$)	t/χ^2	P value
Age (years, $\bar{x}\pm s$)	68.59±6.37	69.14±7.03	0.484	0.629
Gender [n(%)]			0.344	0.558
Male	40(59.70)	40(54.79)		
Female	27(40.30)	33(45.21)		
Duration of coronary heart disease (years, $\bar{x}\pm s$)	5.63±1.15	5.71±1.23	0.397	0.692
CCS angina grading [n(%)]			0.099	0.992
Ⅰ	13(19.40)	13(17.81)		
Ⅱ	34(50.74)	37(50.68)		
Ⅲ	10(14.93)	11(15.07)		
Ⅳ	10(14.93)	12(16.44)		
BMI [n(%)]			0.761	0.684
<18.5 kg/m^2	10(14.93)	15(20.55)		
18.5-23.9 kg/m^2	30(44.77)	31(42.46)		
>23.9 kg/m^2	27(40.30)	27(36.99)		
Diabetes mellitus [n(%)]	33(49.25)	33(45.21)	0.230	0.632
Hypertension [n(%)]	39(58.21)	43(58.90)	0.007	0.934
Previous stroke [n(%)]	18(26.87)	18(24.66)	0.089	0.765

HBOT: hyperbaric oxygen therapy; CCS: chronic coronary syndrome; BMI: body mass index.

1.2.2 治疗方法 对照组患者接受基础治疗，HBOT 组在此基础上联合 HBOT 治疗。(1)基础治疗。阿司匹林肠溶片(云鹏医药集团有限公司，国药准字：H34021567)100 mg/次，1 次/d；硫酸氢氯吡格雷片(吉林省博大伟业制药有限公司，国药准字 H20203667)75 mg/次，1 次/d；磺达肝癸钠(江苏恒瑞医药股份有限公司，国药准字 H20183122)0.5 ml/次，1 次/d；单硝酸异山梨酯缓释片(广东隆信制药有限公司，国药准字 H20000258)，40 mg/次，1 次/d；琥珀酸美托洛尔(重庆药友制药有限责任公司，国药准字 H20243118)47.5 mg/次，1 次/d；阿托伐他汀钙片(浙江海正药业股份有限公司，国药准字 H20213110)，10 mg/次，1 次/d。同时给予注射用药：前列地尔注射液(哈药集团生物工程有限公司，国药准字 H20094203)10 g、马来酸桂哌齐特(齐鲁制药有限公司，国药准字 H20153126)320 mg、丹参酮ⅡA 磺酸钠注射液(上海上药第一生化药业有限公司，国药准字 H31022558)80 mg、磷酸肌酸钠注射液(海南卓泰制药有限公司，国药准字 H20193288)1 g 等静脉滴注，1 次/d。(2)HBOT 干预。HBOT 干预前，首先评估患者血压、心率、血气分析、心肌酶、肌钙蛋白 T、胸部 CT 等检查结果，排除 HBO 治疗禁忌证。采用医用高压氧舱(常州市武进华兴医疗器械有限公司，苏械注准 20182081501)进行治疗，10 min 内加压 0.16 MPa，患者经面罩吸入 100% 氧气 1 h，后在 10 min 内减压至正常压力，1 次/d。基础治疗及 HBOT 均连续干预 15 d。

1.2.3 观察指标 (1)疗效。参照文献[4]相关内容分为显效、有效及无效。显效：静息心电图恢复正常，同等强度的劳动不引起心绞痛或减少>80%；有效：低压 ST 段回升≥0.05 mV，倒置 T 波变浅≥50% 或由平坦转为直立，同等强度劳动心绞痛发作次数减少 50%~80%；无效：静息心电图无改变，同等强度劳累其心绞痛发作次数减少<50%。(2)血生化指标。分别于治疗前后(治疗前 2 d 内及治疗结束后 2 d 内)采集患者外周空腹静脉血 6 ml，检测血浆 D-二聚体(D-dimer，D-D)、血脂代谢指标[总胆固醇(total cholesterol，TC)、三油甘脂(triglycerides，TG)、高密度脂蛋白胆固醇(high-density lipoprotein cholesterol，HDL-C)、低密度脂蛋白胆固醇(low-density lipoprotein cholesterol，LDL-C)]及血管炎症因子[包括高敏 C 反应蛋白(high-sensitivity C-reactive protein，hs-CRP)、血脂蛋白相关磷脂酶 A2(lipoprotein-associated phospholipase A2，Lp-PLA2)、同型半胱氨酸(homocysteine，Hcy)]水平。其中血浆 D-D 采用血凝仪(Backman 公司)检测，hs-CRP、血脂代谢指标采用全自动生化分析仪(Olympus-AU640)检测，采用酶联免疫吸附法检测 Hcy 水平，试剂盒购自上海纪宁生物，双抗体夹心法检测血清 Lp-PLA2 水平，试剂盒购自天津康尔克生物科技有限公司。(3)心绞痛发作情况。分别于入院第 2 d 天及出院前 1 d，通过 24 h 动态心电图统计其日心绞痛发作次数及持续时间。

1.3 统计学处理

采用 SPSS 26.0 统计软件进行数据处理。计量资料以均数±标准差($\bar{x}\pm s$)表示，组间比较采用 t 检验。计数资料以例数(百分率)表示，组间比较采用 χ^2 检验。$P<0.05$ 为差异有统计学意义。

2 结 果

2.1 两组患者治疗前后血脂代谢及血浆 D-D 水平

治疗后，HBOT 组血脂代谢指标 TG 及血浆 D-D 水平较同组治疗前下降，HDL-C 水平较治疗前升高；治疗后 HBOT 组血浆 D-D 水平低于对照组，HDL-C 水平高于对照组，差异有统计学意义($P<0.05$)；对照组治疗前后血脂代谢指标及血浆 D-D 水平比较，差异无统计学意义($P>0.05$；表 2)。

2.2 两组患者治疗前后血管炎症因子水平

治疗后，两组患者血管炎症因子 hs-CRP、Lp-PLA2 及 Hcy 水平均较同组治疗前下降；HBOT 组上述指标均低于对照组，差异均有统计学意义($P<0.05$；表 3)。

2.3 两组患者治疗前后心绞痛发作次数及持续时间

治疗后，HBOT 组及对照组患者日均心绞痛发作次数均较同组治疗前下降[HBOT 组：(1.01±0.26)和(5.69±1.68)次，$P<0.001$；对照组：(2.43±0.39)和(5.73±1.74)次，$P<0.001$]。治疗后，HBOT 组及对照组心绞痛持续时间也较同组治疗前下降[HBOT 组：(1.43±0.39)和(7.15±1.63)min，$P<0.001$；对照组：(2.21±0.43)和(7.23±1.53)min，$P<0.001$]，且 HBOT 组治疗后日均心绞痛发作次数及持续时间低于对照组($P<0.001$)，差异均有统计学意义。

表2 两组患者治疗前后血脂代谢及血浆D-D水平比较

Table 2 Comparison of blood lipid metabolism and plasma D-D before and after treatment between two groups ($\bar{x}\pm s$)

Group	n	TC(mmol/L)		TG(mmol/L)		HDL-C(mmol/L)		LDL-C(mmol/L)		D-D(μg/L)	
		Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
HBOT	67	5.19±1.15	5.07±1.05	1.64±0.24	1.57±0.31*	1.43±0.29	1.56±0.24*	3.82±0.69	3.54±0.71	356.48±43.69	297.45±50.31*
Control	73	5.17±1.27	5.21±1.09	1.65±0.33	1.59±0.25	1.44±0.26	1.45±0.19	3.89±0.73	3.74±0.68	361.04±44.98	362.19±41.09
t		0.097	0.773	0.203	0.422	0.215	3.019	0.582	1.702	0.607	8.367
P value		0.923	0.441	0.839	0.674	0.830	0.003	0.562	0.091	0.545	<0.001

D-D: D-dimer; HBOT: hyperbaric oxygen therapy; TC: total cholesterol; TG: triglycerides; HDL-C: high-density lipoprotein cholesterol; LDL-C: low-density lipoprotein cholesterol. Compared with the same group before treatment, *P<0.05.

表3 两组患者治疗前后血管炎症因子水平比较

Table 3 Comparison of vascular inflammatory factors before and after treatment between two groups ($\bar{x}\pm s$)

Group	n	hs-CRP(mg/L)		Lp-PLA2(ng/ml)		Hcy(μmol/L)	
		Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
HBOT	67	7.46±1.46	4.03±0.85*	205.49±36.98	126.79±40.36*	16.78±3.45	11.36±3.37*
Control	73	7.63±1.73	5.64±0.94*	201.17±46.15	169.84±44.06*	16.31±3.69	14.84±3.54*
t		0.625	10.596	0.608	6.011	0.777	5.945
P value		0.533	<0.001	0.544	<0.001	0.439	<0.001

HBOT: hyperbaric oxygen therapy; hs-CRP: high-sensitivity C-reactive protein; Lp-PLA2: lipoprotein-associated phospholipase A2; Hcy: homocysteine. Compared with the same group before treatment, *P<0.05.

2.4 两组患者治疗效果

HBOT组显效30例(44.78%),有效32例(47.76%),无效5例(7.46%),总有效率为92.54%(62/67);对照组显效23例(31.51),有效36例(49.32%),无效14例(19.18%),总有效率为80.82%(59/73),HBOT组总有效率显著高于对照组,差异有统计学意义($\chi^2=4.088$,P<0.05)。

3 讨 论

冠状动脉供血不足,心肌缺血缺氧是导致UA的重要原因之一,而HBOT可增加血氧含量,改善心肌缺血缺氧状态,缓解患者临床症状[5]。本研究结果显示,在常规抗血小板、抗凝、抗缺血治疗的基础上联合15 d的HBOT可进一步提高老年冠心病UA患者治疗有效率,减少心绞痛发作次数及心绞痛持续时间,提示联合HBOT在UA中具有良好的应用价值,与叶单单等[6]研究结论相似。

探讨HBOT在改善UA中的相关作用机制,可为HBOT在UA中应用提供有力支持。大量研究证实,HBOT可提高物理氧溶解量,增强血氧张力,改变正常气压下传统氧离供氧方式,可增强心肌血氧弥散与心肌供氧量,进而减少心肌损伤,是HBOT改善心绞痛的主要作用机制[7-9]。此外,还有研究表示,在高压状态下,心肌组织内血氧弥散速度加快,可快速改善心肌缺氧状态,在短时间内缓解心绞痛症状[10]。此外,HBOT还可刺激外周动脉压力感受器、反射性兴奋迷走神经以及化学感受器等,进而减缓心率,降低心肌收缩压,减轻心脏负担,缓解心绞痛[11]。

从UA发病机制中探讨HBOT在改善患者临床症状中的潜在机制具有可行性。易损斑块破裂继发血栓形成是诱发UA的重要原因,而炎症因子可活化血栓,促进血栓形成,因此炎症反应在UA发病中起着至关重要的作用。本研究将可能参与UA炎症反应的相关指标Lp-PLA2、hs-CRP及Hcy作为观察指标,其中Lp-PLA2主要由动脉粥样硬化斑块中炎症细胞合成,外周血循环系统中的Lp-PLA2可黏附在LDL-C上并随之转运至血管内膜,并通过水解氧化的LDL-C产生多种促炎症递质,进而激活炎症反应,促进血栓形成及斑块破裂,导致UA[12]。hs-CRP是反映机体炎症反应的敏感指标,有研究显示,血管内皮病灶内有大量hs-CRP沉积,且CRP水平与薄纤维帽数量相关[13]。Hcy则可引起血管内皮细胞功能障碍,促进血管平滑肌增殖,降低血管内皮功能,破坏纤维蛋白溶解,促进血栓形成,增加UA发生风险[14]。本研究中,联合HBOT干预后,HBOT组患者以上指标均低于对照组,提示HBOT还可从缓解炎症的角度改善UA病情。这可能与HBOT能促进侧支循环的建立、进而改善血管内皮供氧功能状态,促进血管内皮功能恢复、减轻炎症反应相关[15]。

血脂代谢异常是导致冠心病、引起心绞痛的重

要原因[16]。有研究发现,HBOT 能改善患者血脂紊乱现状,调节患者血液黏稠度[17]。本研究结果显示,联合 HBOT 能有效改善老年 UA 患者血脂代谢指标 TG、HDL-C 及血浆 D-D 水平,与上述研究结论相似。证实 HBOT 还可通过改善患者血脂代谢及血液高凝状态治疗 UA。

综上所述,HBOT 在减少 UA 发作次数及心绞痛持续时间中具有良好的效果,除传统作用机制外,HBOT 还可能通过减少血管炎症因子释放、改善血脂代谢紊乱与血液高凝状态发挥治疗效果。但本研究所纳入的样本量不高,为增强 HBOT 在临床中的实用性依据,可进一步增加研究样本量进行深入研究。

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(编辑: 郑真真)