·男科疾病的诊断与治疗新技术·

高原地区应用可视化精准电生理诊断与治疗佩罗尼氏病

郭　巍，严积雄，张　强，陈琦炜，杨茸茸
(西宁市第一人民医院男科，青海 西宁 810000)

摘　要：【目的】探讨高海拔缺氧地区应用精准电生理诊断与经皮低频电刺激治疗阴茎硬结症的效果及治疗方案。【方法】回顾性分析纳入电生理诊断与治疗阴茎海绵体硬结症患者共 54 例。年龄 20～70 岁，平均(45.5±11.6)岁，病程 2～16 月。治疗前均口服 PDE5i、左卡尼汀口服液、活血化瘀中药等，治疗前停所有口服药物 1 周后进行可视化精准电生理诊断，记录并对比设定治疗前后电生理诊断参数，调整精准电生理相应参数进行经皮低频电刺激治疗，每次 2～3 h、每日 1 次、每疗程 10 次。同时辅助鼻导管吸氧 2～3 h(4 L/min)。电生理诊断与治疗前后应用《疼痛程度数字评估量表》、勃起功能国际问卷-5(IIEF-5)、阴茎弯曲度测量、阴茎彩色多普勒测量斑块面积大小及全身与疾病局部红外热像图温度变化对比评估。【结果】所有患者均顺利完成经皮低频电刺激治疗 2～4 疗程(20～40 次)。疲软/勃起疼痛程度治疗前后均值对比(7.1±1.6 *vs* 2.0±1.0)，差异有统计学意义(P <0.01)；IIEF-5 治疗前后均值对比(8.2±3.2 *vs* 16.0±5.1)，差异有统计学意义(P <0.01)；PCDDU 测量斑块面积治疗前后均值对比 0.23(0.09～0.54)cm^2 *vs* 0.23(0.09～0.54)cm^2，改善值无变化，差异无统计学意义(P = 0.189)；4 例无阴茎弯曲畸形，电刺激治疗前 50 例(92.6%)患者有不同程度的阴茎弯曲畸形，治疗前后对比弯曲角度改善无变化，差异无统计学意义(P >0.05)。可视化精准电生理诊断治疗前后比较 TMT 图提示全身及阴茎、双侧腹股沟区等温度变化>1.5 ℃，属于有效电刺激治疗。随访 3～10 个月无复发硬结、疼痛和阴茎弯曲畸形加重、无 1 例患者需要后续手术。【结论】本研究结果发现可视化电生理诊断情况设定局部与整体相结合治疗参数，通过中医经络穴位、神经肌肉经皮低频电刺激治疗佩罗尼氏病(PD)安全性良好、疗效肯定，特别是在早期阶段对疼痛治疗效果明显，为 PD 治疗开辟了新途径。

关键词：佩罗尼氏病；TMT 图；电生理诊断；经皮低频电刺激
中图分类号：R698.1　　**文献标志码：**A　　**文章编号：**1672-3554(2022)06-0884-08
DOI：10.13471/j.cnki.j.sun.yat-sen.univ(med.sci).2022.0603

Visualized Precise Electro- physiological Diagnosis and Treatment of Peyronie´s Disease in Plateau Areas

GUO Wei, YAN Ji-xiong, ZHANG Qiang, CHEN Qi-wei, YANG Rong-rong
(Andrology department, The first people's Hospital of Xining, Xining 810000, China)
Correspondence to: YANG Rong-rong; E-mail: 9387600547@qq.com

Abstract:【Objective】To investigate the efficacy and treatment options of precise electrophysiological diagnosis combined with percutaneous low-frequency electrical stimulation for penile scleroderma in high-altitude hypoxic areas.【Methods】A total of 54 patients with electrophysiological diagnosis and treatment of corpora cavernosa were included in the retrospective analysis. Their age ranged from 20 to 70 years with a mean of 45.5±11.6 years and disease duration from 2 to 16 months. PDE5i, levocarnitine oral solution, and traditional Chinese medicine for invigorating blood circulation and eliminating stasis were administered orally before treatment. The visual precision electrophysiological diagnosis was performed after discontinuation of all oral drugs for 1 week before treatment. The electrophysiological diagnostic parameters were re-

收稿日期：2022-07-21
基金项目：国家卫健委医药卫生科技发展研究中心科研项目(HDSL20201083)
作者简介：郭巍，主任医师，研究方向：男科与生殖，E-mail：gw13519701641@126.com；杨茸茸，通信作者，E-mail：9387600547@qq.com

corded and contrasted before and after the set-up treatment, and the corresponding parameters for precision electrophysiology were adjusted for percutaneous low-frequency electrical stimulation treatment, 2-3 hours each time, once daily, and 10 times per course. At the same time was administered assisted nasal cannula oxygen inhalation for 2 to 3 hours (4L/min). Before and after electrophysiological diagnosis and treatment were evaluated by using the numeric assessment scale of pain extent, the international index of erectile function score (IIEF-5), penile curvature measurement, color Doppler measurement of plaque areas and comparison of whole body and disease local infrared thermogram temperature changes.【Results】 All patients successfully completed 2-4 sessions of percutaneous low-frequency electrical stimulation (20 sessions to 40 sessions). There was a significant statistical difference ($P < 0.01$) between the mean values before and after treatment for the degree of weakness / erection pain (7.1±1.6 *vs* 2.0±1.0); (8.2±3.2 *vs* 16.0±5.1) before and after IIEF-5 treatment, respectively ($P < 0.01$), Pre- and post-treatment of PCDDU measured mean plaque size was 0.23 (0.09~0.54) cm^2 *vs* 0.23 (0.09~0.54) cm^2, with no statistically different change in improvement value ($P = 0.189$). Four cases had no penile camptodactyly, Before electrical stimulation, 50 (92.6%) patients had different degrees of penile curvature deformity, and there was no change in the improvement of the contrast bending angle before and after treatment ($P >0.05$). The comparison of TMT images before and after treatment with visual precision electrophysiology diagnosis suggested that temperature change >1.5℃ in the whole body and penile and bilateral inguinal regions, etc. could be considered effective electrical stimulation treatment. There were no recurrences of induration, increased pain and penile curvature at 3~10 months follow-up, and no patient required subsequent surgery.【Conclusion】 The results of this study show that visualizing the electrophysiological diagnosis situation to set local and holistic combined treatment parameters, and treating PD by means of percutaneous low-frequency electrical stimulation at meridian and neuromuscular acupoints of traditional Chinese medicine could achieve good safety and efficacy, especially in the early stage, which has a clear effect on pain treatment, thus opening new avenues for PD treatment.

Key words: Peyronie's disease; TMT image; electrophysiological diagnosis; percutaneous low frequency electrical stimulation

[J SUN Yat-sen Univ(Med Sci), 2022, 43(6): 884-891]

佩罗尼氏病(Peyronie's disease, PD)是一种阴茎局部纤维化性结缔组织良性疾病，无序的胶原蛋白和弹性蛋白沉积，导致纤维斑块形成，局限于白膜。目前，它是一种无法治愈、导致约50%的男性勃起阴茎严重弯曲和勃起功能障碍，并不罕见的男科疾病，造成人际关系中的抑郁和焦虑。到今天为止，有效的医疗治疗选择很少，口服和其他病灶内治疗没有可接受的循证医学证据水平，特别是在早期阶段对于PD患者改进治疗方案的需求尚未得到满足。电生理诊断与治疗是基于电生理技术(electrophysiological appropriate techniques, EAT)，通过采集、处理、分析人体电信号，利用电刺激对疾病进行诊断、治疗的一种技术方法[1]。作为一种融合中医理论及现代电生理学的诊断与治疗技术，通过在远红外可视化状态下实现电生理的精准诊断，确定精准电生理治疗参数，用于促进全身与局部血液循环、兴奋神经肌肉组织、疏通经络等治疗。电生理适宜技术简单有效、安全无创，低频电生理技术已在临床广泛应用[2]，特别是在防治女性盆底功能障碍疾病和女性盆底学科建设方面取得了良好的效果[3]。近年来国内也加快应用于男科疾病的诊断与治疗[4]。我院地处海拔近2 300 m，我们应用电生理技术对高海拔地区PD患者精准电生理诊断与经皮低频电刺激治疗，国内外尚未见相关报道。

1　材料与方法

1.1　一般资料

收集了2021年5月~2022年4月本科确诊收治的PD患者54例。年龄20~70岁，平均(45.5±11.6)岁，病程2~16个月，2例曾行“斑块切除+补片修补”术后再发，其余52例为初诊。入组研究患者均得到本人知情同意及医院伦理委员会批准并签订电生理诊断与治疗知情同意书及调查问卷。

1.2　方 法

1.2.1　疲软/勃起疼痛评估　应用《疼痛程度数字

评估量表》,将疼痛程度用0~10个数字依次表示,0表示无疼痛,10表示能够想象的最剧烈疼痛。按照疼痛对应的数字,将疼痛程度分为:①轻度疼痛(1~3),②中度疼痛(4~6),③重度疼痛(7~10)。

1.2.2 勃起功能国际问卷-5评分 应用国际勃起功能评分表-5(International Index of erectile function score,IIEF-5)自测评分;分为轻度ED(12~21分)、中度ED(8~11分)、重度ED(≤7分)。

1.2.3 阴茎弯曲度测量 应用量角器在ICI时阴茎勃起状态下测量阴茎长轴与弯曲轴之间的锐角夹角。

1.2.4 阴茎彩色多普勒超声检查(CDDU)+阴茎海绵体注射血管活性药物试验(ICI) 采用迈瑞-Resona L9型彩色多普勒超声诊断仪,L14-3Ws探头。检查前确保诊室内环境条件适宜,尽可能减少陌生环境给患者带来的焦虑和不安。所有受试者取仰卧位,通过二维超声检查清晰显示阴茎海绵体组织,探查白膜斑块位置、大小及有/无钙化、局部白膜情况。然后阴茎根部适度捆绑,一侧海绵体注射前列地尔10 μg+2 mL生理盐水,1 min后松绑让患者VR眼镜观看性教育影片,10 min内测量PSV、EDV、RI值。诊断标准:阴茎彩色多普勒超声检查(CDDU)+阴茎海绵体注射血管活性药物试验(ICI):10 min内两侧海绵体动脉PSV≥30 cm/s或两侧之和≥50 cm/s、EDV≤5 cm/s、RI≥0.9,出现Ⅲ级以上勃起,持续时间超过30 min为阳性反应。

1.2.5 精准电生理诊断 选用医用红外热成像仪(PRISM 640A/PRISM 384A;佛山市杉山大唐医疗科技有限公司)进行全身扫描取得热像图(TMT图)。根据全身整体及疾病局部热像图,对比设定治疗前后电生理诊断参数调整精准电生理相应治疗参数。有效精准电生理诊断参数为:镇痛:AA3感觉(70 Hz/500 μs);循环:BB9(2 Hz/280 μs);尿道平滑肌EE3(3 Hz/1 500 μs、3 Hz/3 000 μs、6 Hz/3 000 μs);经皮神经电刺激CC19(80 Hz/150 μs);胆经:FF6(50 Hz/300 μs);膀胱经:FF7(61 Hz/300 μs);肾经FF2(11 Hz/300 μs)。

诊断标准:根据疾病局部及全身整体TMT图治疗前后温度变化,>1.5 ℃为有效电刺激治疗。

1.2.6 精准经皮低频电刺激治疗 选用低频神经肌肉治疗仪(BioStim pro;佛山市杉山大唐医疗科技有限公司)。应用调整的诊断参数进行经皮低频电刺激治疗。每次2~3 h、每日一次、每疗程10次。

1.2.7 贴片位置 镇痛:AA3感觉(中极、曲骨+S2~S4);循环:BB9(腹股沟区两侧+阴茎海绵体);尿道平滑肌EE3(中极、曲骨+上、次、中、下髎);经皮神经电刺激CC19(中极、曲骨+环绕阴茎海绵体根部及冠状沟);FF6足少阳胆经(五枢维道+足三里+中溪);FF7足太阳膀胱经(背部脊椎旁开3寸+上、次、中、下髎);肾经FF2(石关、商曲+肾俞+三阴交)。

1.2.8 辅助治疗 经皮低频电刺激同时辅助鼻导管吸氧2~3 h(4 L/min)。

1.3 统计学处理

使用SPSS 20.0软件处理。正态分布的计量数据用均数±标准差($\bar{x} \pm s$)表示,治疗前后比较用配对t检验。偏态分布的计量数据用中位数(下四分位数~上四分位数)[M (P_{25}~P_{75})]表示,治疗前后比较用Wilcoxon配对秩和检验。分类资料用频数和百位数描述。P <0.05为差异有统计学意义。

2 结 果

2.1 54例PD患者一般情况

表1中发病年龄50岁以上15例(27.8%),20~49岁39例(72.2%),年龄(45.5±12.2)岁;合并高血压患者14例(25.9%)、糖尿病患者20例(37.0%)、高脂血症患者49例(90.7%);电刺激治疗前PCDDU+ICI检查合并血管性ED患者44例(81.5%)。

2.2 阴茎疼痛及IIEF-5评分比较情况

表2中54例患者电刺激治疗前均有不同程度疲软/勃起疼痛,感勃起时牵拉不适;电刺激治疗前后对比疲软/勃起疼痛评分均值对比改善值为5.1±0.6,有统计学差异(P<0.01)。54例患者治疗前IIEF-5评分≤21分,电刺激治疗前后均值对比改善值为7.8±1.9,有统计学差异(P<0.01)。

2.3 斑块面积与阴茎弯曲角度变化比较情况

表3中电生理治疗前后对比PCDDU测量斑块面积改善值为0,差异无统计学意义(P>0.05);电刺激治疗前4例无阴茎弯曲畸形,50例(92.6%)患者有不同程度的阴茎弯曲畸形,治疗前后对比弯曲角度无变化,改善的差异无统计学意义(P>0.05)。

2.4 斑块面积与阴茎弯曲角度变化比较情况

表4中观察全身及双侧腹股沟区、盆腔及会阴部、阴茎等靶区域(器官)红外热像图(图1,图2),对比电刺激治疗前后温度变化均>1.5℃,均值对比均有统计学差异(P <0.01)。

表1　54例PD患者的一般情况

Table 1　General conditions of the 54 patients with PD

Variable	Classification	n	Constitute / %
Age	20~	8	14.8
	30~	11	20.4
	40~	20	37.0
	50~	9	16.7
	60~	5	9.3
	70~	1	1.8
Clinical symptoms	Pain	54	100
	Camptodactyly	50	92.6
	AED	44	81.5
Complication	Hypertension	14	66.7
	Diabetes	20	47.6
	Hyperlipidemia	49	90.5

表2　治疗前后改善情况分析

Table 2　Analysis of improvement before and after treatment　($\bar{x} \pm s$)

Variable	n	Before	After	Improved value	$T^{1)}$	P
Weakness / erection pain	54	7.1±1.6	2.0±1.0	5.1±0.6	22.470	0.000[2)]
IIEF-5	54	8.2±3.2	16.0±5.1	7.8±1.9	−19.649	0.000[3)]

IIEF-5=International Index of erectile function score; 1) paired sample t test; 2) compared with pretreatment $P<0.01$; 3) compared with pretreatment $P<0.01$.

表3　治疗前后弯曲畸形角度及斑块面积情况分析(IQR)

Table 3　Bending deformity angle and plaque area before and after treatment(IQR)

Outcome measures	n	Before	After	Improved value	$Z^{1)}$	P
Camptodactyly angle of the penis/°	50	10(5~12)	10(5~12)	0	−1.633	0.102[2)]
Plaque area/cm^2	54	0.23(0.09~0.54)	0.23(0.09~0.54)	0	−1.313	0.189[3)]

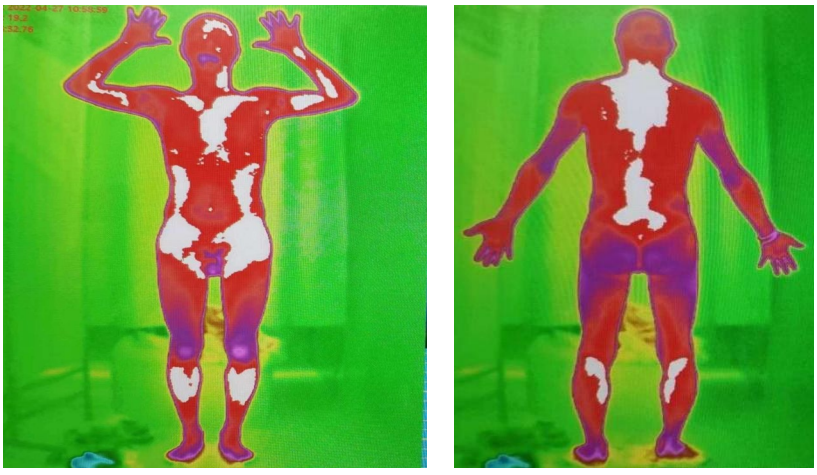
1) paired sample *Wilcoxon* test; 2) compared with pretreatment $P>0.05$; 3) compared with pretreatment $P>0.05$.

表4　治疗前后温度变化情况分析

Table 4　Analysis of temperature changes before and after treatment　($\bar{x} \pm s$,℃)

Target organ	n	Before	After	Improved value	$T^{1)}$	P
Pelvic and perineal region	54	34.3±1.1	26.6±1.4	7.7±0.3	31.809	0.000[2)]
Inguinal area bilaterally	54	34.5±1.0	25.6±1.1	8.9±0.1	52.251	0.000[3)]
Penile root	54	33.9±1.5	27.3±1.4	6.7±0.1	34.447	0.000[4)]

1) paired sample t test; 2) compared with pretreatment $P<0.01$; 3) compared with pretreatment $P<0.01$; 4) compared with pretreatment $P<0.01$.



① Localized punctate hyperthermic area at the base of the penis with poor local circulation, temperature was 32.67 ℃ before treatment; ② Bilateral inguinal areas showed funnel-shaped hyperthermic areas, poor circulation in inguinal areas, and pre-treatment temperature (34.04 ℃ on the left and 34.18℃ on the right); ③ The acupoints, such as local irregular mass like hyperthermic areas in the shape region of kidney meridian and poorly blocked blood stasis in meridians (Shen Yu, Yu Zhong, Shen Yin), were obvious, and the temperature before treatment was 34.6 ℃; ④ Bilateral bile ducts showed symmetrical flaky hyperthermic areas on the course of meridians, which were blocked by meridians, especially at acupoints such as Jing Men, Wu Shu and Ju Liao, and the temperature before treatment (33.84 ℃ on the left side, 33. 97 ℃ on the right side); ⑤ The areas of the vagus meridians of the lower legs were blocked with poor circulation (the acupoints of Sanyinjiao and Yinglingquan, etc.) and the temperature was 34.31 ℃ on the left side and 33.84 ℃ on the right side before treatment; ⑥ The dorsal bladder was patchy with irregular hyperthermic regions along the Meridian's walking area, and the meridians were congested poorly (the acupoints of Damao, Fengmen, Shentang, Shenyu, and Pangguang Yu were the main points), with a temperature of 34.09 ℃ before treatment.

图1 电刺激治疗前全身与疾病局部TMT图及电生理诊断、温度(正背面)

Fig. 1 TMT images, electrophysiological diagnosis, and temperature (front, back) of whole body versus local diseased area before electrical stimulation treatment

3 讨论

PD目前广泛接受的病因是性交过程中勃起阴茎的重复创伤,是一个异常的伤口愈合过程,它是对白膜多层炎症的反应[5]。发病年龄多在55~65岁。患病率随着年龄和勃起功能障碍(ED)的增加可高达20.3%[6-7]。El-Sakka等[8]最近的调查:接受PD筛查的勃起功能障碍(ED)患者中,PD的患病率高达8%;此外,ED和PD的危险因素之间存在显著相关性,PD与年龄、肥胖、吸烟、持续时间和每天吸烟次数之间存在显著相关性;血脂异常、心理障碍和至少存在一个危险因素与PD显著相关;El-Sakka等[9]另一项研究发现糖尿病控制不良和PD之间有显著相关性与我们表1中研究发现的PD与糖尿病、高血压、血脂异常等代谢性疾病高度相关性一致;表1中我们研究发现不同之处在于PD的发病年龄呈年轻化趋势,PD前ED的患病率高,IIEF-5评分均≤21分,PCDDU+ICI检查合并血管性ED患者44例(81.5%),可能与低氧引起缺氧性ED更易造成阴茎勃起不全而多次导致阴茎白膜损伤相关,也与纳入研究的样本数及年龄范围局限相关,随着PD的进展ED程度加重,但还需进一步分层对比研究。

Lue等[5]描述PD临床表现为早期(急性期)为疼痛、斑块和阴茎弯曲畸形三联征,晚期(慢性期)为斑块(钙化或骨化)、阴茎弯曲畸形和ED三联征。Gelbard等[10]报道PD的自然病程和预后:13%的患者PD有一定的缓解,47%的患者没有变化,40%的患者逐渐进展。

尽管PD已经存在了250多年,目前其发病机制尚不确定。与PD相关的异常可归因于白膜的独特解剖结构。长时间的炎症反应,以及微妙的胶原纤维网络和弹性纤维的降解失衡,最终的结果是胶原纤维的过度产生。PD的早期(急性期),炎症限制在局部致密的组织层间,炎症和水肿会刺激神经末梢,产生疼痛(有或无勃起),当炎症反应成熟或被困的神经纤维死亡时,疼痛可能会减轻。我们的研究中所有患者均有不同程度的疲软/勃起的疼

① The localized punctate hyperthermic area at the base of the penis resolved, the local circulation improved, and the temperature was 30.81 ℃ after treatment; ② The hyperthermic area of strip in bilateral inguinal area was significantly improved, the circulation of inguinal area was improved, and the temperature before treatment (30.63 ℃, right 30.70 ℃); ③ Hyperthermia of the local irregular cluster-like febrile area in the shape region of the kidney meridian subsided, the meridian was clear, and the temperature was 30.03 ℃ after treatment; ④ Hyperthermia in most of the symmetrical flaky areas in the spreading pattern of bilateral biliary meridian subsided, the meridians were more unobtructed than before, and the temperature after treatment was (30.01 ℃ on the left side and 30.1 ℃ on the right side); ⑤ The unobstructed circulation in the vagal meridian area of both lower legs was restored, and the temperature was 29.87 ℃ on the left side and 29. 98 ℃ on the right side after treatment; ⑥ The dorsal bladder showed clear regression of patchy irregular hyperthermic areas in the passage area of meridians, and the meridians were significantly more unobstructed than before and the temperature was 28.21 ℃ after treatment.

图2　电刺激治疗后全身与疾病局部TMT图及电生理诊断、温度(正背面)

Fig. 2　TMT images, electrophysiological diagnosis, and temperature (front, back) of whole body versus diseased local area after electrical stimulation treatment

痛，口服非甾体类药物(塞来昔布胶囊)效果差，国外Torres等[11]研究电刺激可通过改善循环，诱导多巴胺表达，抑制炎性细胞因子的产生等机制发挥抗炎作用；国内张翼等[1]、迟戈等[12]也研究发现低频电流有促进局部血液和淋巴循环作用；国外Han[13]研究表明电刺激通过机体释放内源性镇痛物质实现镇痛效果。我们表2中的研究报告同样运用经皮(经经络穴位、经神经肌肉)低频电刺激治疗，镇痛效果非常明显，可能与电刺激治疗可改善阴茎局部血液循环、减弱炎症反应程度、缩短炎症时间、减轻局部神经损害、局部镇痛显著相关。

在慢性阶段，纤维化开始，Akkus等[14]研究表明：炎症细胞的聚集和细胞外基质(胶原蛋白、弹性蛋白等)在白膜多层结构中的沉积是诱导PD的关键因素。El-Sakka等[15-17]多项研究认为TGF-β1是一种影响细胞外基质沉积和诱导白膜纤维化的细胞因子，也是慢性纤维化疾病的一个原因。近期有学者从PD患者切除的斑块中分离出PD成纤维细胞与PD患者的白膜未受影响区域的成纤维细胞或健康患者的白膜成纤维细胞进行比较研究得出在TGF-β1刺激下细胞外基质的产生，最重要的是成纤维细胞转化为肌成纤维细胞[18-20]。电刺激可通过改善循环，增加血管通透性，促进正常愈合结局[21-22]。Vernet等[23]研究认为，NO降低ROS活性，导致肌成纤维细胞凋亡，并抑制胶原合成。国内Liu等[24]近期研究报道电刺激可导致阴茎海绵状平滑肌中NO和cGMP的形成，为治疗ED的新方法。

我们表3的研究通过经皮低频电刺激治疗前后对比在阴茎斑块面积及弯曲畸形角度变化上，虽然没有统计学差异，但至少阻碍了向恶化的进一步进展，表2中还表现出勃起功能有明显的提高，且随访3～10个月无复发硬结、疼痛和阴茎弯曲畸形加重、无1例患者需要后续手术。表4中我们观察全身及双侧腹股沟区、盆腔及会阴部、阴茎等靶区

域(器官)局部红外热像图(TMT图1-2)温度变化对比均值均>1.5 ℃,属于有效的电刺激治疗。分析原因可能是与:①通过电刺激诱导TGF-β1生成,调节TGF-β信号通路协同其他生长因子对肌成纤维细胞形成和凋亡发挥作用,影响愈合的结局相关,但是缺乏电刺激治疗前后斑块病理组织学及细胞分子学验证;②早期阶段通过电刺激治疗改善了局部血液循环、减轻了炎症反应为后期抑制PD中胶原的产生、TGF-β1过表达及ED的发生或加重奠定了有效的治疗基础高度相关;③电刺激治疗改善了阴茎海绵体缺氧状态及增加海绵体内压力,改善了阴茎海绵体平滑肌细胞功能和结构,从而缓解了阴茎海绵体纤维化进程相关;④经皮低频电刺激配合中医全身经络穴位机制,改善睡眠质量、调节自身免疫状态,抑制纤维化调控基因表达相关。

总之,我院地处中高原地区,处于低氧状态,缺氧导致血管内皮细胞损害、NOS活性下降、NO生成减少、ROS活性增强、ED的患病率高且年轻化、有可能阴茎白膜损害后TGF-β1上调等问题,故PD的患病年龄有年轻化趋势,低氧状态下对PD的治疗存在困难,我们研究认为在PD的早期阶段经皮(经穴位、经神经肌肉)低频电刺激治疗同时辅助高流量吸氧改善局部血液循环、改善病变局部缺氧、调节免疫状态从而提高iNOS及eNOS的活性(与口服PDE5i类同)、降低ROS活性的损害、减轻长时间炎症反应及炎症细胞的聚集、抑制PD中胶原的产生、调节纤维化调控基因表达,缓解疲软/勃起时疼痛、改善阴茎勃起功能、阻碍阴茎海绵体斑块及弯曲畸形的进展,治疗效果明显,维持时间较长。但后续需要大样本数、延长随访时间及病理组织学与细胞分子学的进一步验证。

参考文献

[1] 张翼,燕铁斌,庄甲举,等译. 临床电生理治疗学(3版)[M]. 北京: 人民军医出版社, 2011.
Zhang Y, Yan TB, Zhuang JJ, et al. Translation. Clinical electrophysiology (third edition) [M]. Lippincott Williams & Wilkins, 2011.

[2] Wang Z, Chen Y, Chen C, et al. Pain management of surgical abortion using transcutaneous acupoint electrical stimulation: an orthogonal prospective study[J]. J Obstet Gynaecol Res, 2018, 44(7): 1235-1242.

[3] Reis BM, da Silva JB, Rocha APR.et al. Intravaginal electrical stimulation associated with pelvic floor muscle training for women with stress urinary incon-tinence: study protocol for a randomized controlled trial with economic evaluation [J]. Trials, 2021, 22(1):823.

[4] 邓春华, 商学军, 王忠, 等. 电生理适宜技术在男科疾病诊疗中的应用中国专家共识[J]. 中华男科学杂志, 2022, 8(4):366-377.
Deng CH, Shang XJ, Wang Z, et al. Chinese expert consensus on the application of electrophysiological techniques in the diagnosis and treatment of andrology diseases[J]. Natl J Andr, 2022, 8(4): 366-377.

[5] Lue TF. Peyronie's disease: an anatomically-based hypothesis and beyond[J]. Int J Impotence Res, 2002, 14(5): 411-413.

[6] Mulhall JP, Creech SD, Boorjian SA, et al. Subjective and objective analysis of the prevalence of Peyronie's disease in a population of men presenting for prostate cancer screening[J]. J Urol, 2004, 171(6 Pt 1): 2350-2353.

[7] Al-Thakafifi S, Al-Hathal N. Peyronie's disease: a literature review on epidemiology, genetics, pathophysiology, diagnosis and work-up[J]. Transl Androl Urol, 2016, 5(3): 280-289.

[8] El-Sakka AI. Prevalence of Peyronie's disease among patients with erectile dysfunction[J]. Eur Urol, 2006, 49(3): 564-569.

[9] El-Sakka AI, Tayeb KA. Peyronie's disease in diabetic patients being screened for erectile dysfunction[J]. J Urol, 2005, 174(3): 1026-1030.

[10] Gelbard MK, Dorey F, James K. The natural history of Peyronie's disease[J]. J Urol, 1990, 144(6): 1376-1379.

[11] Torres-Rosas R, Yehia G, Pea G, et al. Dopamine mediates vagal modulation of the immune system by electroacupuncture [J]. Nat Med, 2014, 20(3): 291-295.

[12] 迟戈, 马艳彬, 李非, 等. 中低频电疗法的临床应用[J]. 中国医疗器械信息, 2010,16(11): 26-27; +72.

Chi G, Ma YB, Li F, et al. Clinical application of low and medi-um frequency electrotherapy[J]. Med dev infor Chin, 2010, 16(11): 26-27;+72.

[13] Han JS. Acupuncture: neuropeptide release produced by electrical stimulation of different frequencies[J]. Trends Neurosci, 2003, 26(1): 17-22.

[14] Akkus E, Carrier S, Baba K, et al. Structural alterations in the tunica albuginea of the penis: impact of Peyronie's disease, ageing and impotence[J]. Br J Urol, 1997, 79(1): 47-53.

[15] El-Sakka AI, Hassan MU, Nunes L, et al. Histological and ultrastructural alterations in an animal model of Peyronie's disease[J]. Br J Urol, 1998, 81(3): 445-452.

[16] El-Sakka AI, Hassoba HM, Pillarisetty RJ, et al. Peyronie's disease is associated with an increase in transforming growth factor beta protein expression[J]. J Urol, 1997, 158(4): 1391-1394.

[17] El-Sakka AI, Hassoba HM, Chui RM, et al. An animal model of Peyronie's-like condition associated with an increase of transforming growth factor beta mRNA and protein expression[J]. J Urol, 1997, 158(6): 2284-2290.

[18] Mateus M, Ilg MM, Stebbeds WJ, et al. Understanding the role of adenosine receptors in the myofifibroblast transformation in Peyronie's disease[J]. J Sex Med, 2018, 15:947-957.

[19] Ilg MM, Mateus M, Stebbeds WJ, et al. Antififibrotic synergy between phosphodiesterase type 5 inhibitors and selective oestrogen receptor modulators in Peyronie's disease models[J]. Eur Urol, 2019, 75: 329-340.

[20] Milenkovic U, Ilg MM, Zuccato C, et al. Simvastatin and the rho-kinase inhibitor Y-27632 prevent myofifibroblast transformation in Peyronie's diseaseederived fifibroblasts via inhibition of YAP/TAZ nuclear translocation[J]. BJU Int, 2019, 123:703-715.

[21] 刘晓丹，冯洁玲，王嘉敏，等.盆底神经肌肉电刺激治疗对中重度宫腔粘连术后子宫内膜修复的疗效评估[J].中山大学学报(医学科学版)，2022，43(1)：140-145.
Liu XD, Feng JL, Wang JM, et al. Effect of pelvic floor neuromuscular electrical stimulation on endometrial repair after the surgery of moderate to severe intrauterine adhesion[J]. J Sun Yat-sen Univ (Med Sci), 2022, 43(1): 140-145.

[22] Sundaram PM, Rangharajan KK, Akbari E, et al. Direct current electric field regulates endothelial permeability under physiologically relevant fluid forces in a microfluidic vessel bifurcation model[J]. Lab Chip, 2021, 21(2): 319-330.

[23] Vernet D, Ferrini MG, Valente E, et al. Effect of nitric oxide on the differentiation of fibroblasts into myofibroblasts in the Peyronie's fibrotic plaque and in its rat model[J]. Nitric Oxide, 2002, 7(4): 262-276.

[24] Liu K, Wang Z, Liu Y, et al. An electrophysiological technique to accurately diagnose and treat erectile dysfunction[J]. J Vis Exp, 2022, doi:10.3791/63851.

(编辑　孙慧兰)