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低温等离子髓核消融术治疗高原地区椎间盘源性下腰痛的疗效及对患者生活质量的影响 *

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摘要 目的：研究低温等离子髓核消融术（LTPNPA）治疗高原地区椎间盘源性下腰痛（DLBP）的疗效及对患者生活质量的影响。**方法**：选择从2015年9月到2017年1月在我院接受治疗的高原地区DLBP患者，随机分为对照组（n=59）和观察组（n=59），对照组患者给予常规腰椎牵引治疗，观察组患者则予以LTPNPA术式治疗，对所有患者进行为期6个月的随访，并对比两组疗效、临床指标（疼痛缓解时间和住院时间）、治疗前后的椎间隙高度R值和Oswestry功能障碍指数（ODI）评分以及不同时期的日常生活能力量表（ADL）评分。**结果**：观察组的优良率是98.31%，高于对照组的88.14%（P<0.05）。观察组的疼痛缓解时间及住院时间均少于对照组（P<0.05）。治疗后两组的ODI评分均低于治疗前，且观察组较对照组偏低（P<0.05）。治疗后两组的椎间隙高度R值相比差异无统计学意义（P>0.05）。治疗后1个月、3个月、6个月两组的ADL评分均高于治疗前，治疗后3个月和6个月高于治疗后1个月，治疗后6个月高于治疗后3个月，且观察组均较对照组偏高（P<0.05）。**结论**：对高原地区DLBP患者应用LTPNPA术式治疗，具有明显疗效，还可提升其生活质量，临床上可考虑在高原地区推广LTPNPA术式，从而使患者获得最佳疗效。

关键词：低温等离子髓核消融术；高原地区；椎间盘源性下腰痛；疗效；生活质量

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Effect of Low Temperature Plasma Nucleus Pulposus Ablation on Discogenic Low Back Pain in Plateau Area and its Influence on Quality of Life*

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ABSTRACT Objective: To study the effect of low temperature plasma nucleus pulposus ablation (LTPNPA) on discogenic low back pain (DLBP) in plateau area and its influence on quality of life. **Methods:** 118 patients with DLBP in plateau area treated in our hospital from September 2015 to January 2017 were selected, they were randomly divided into control group (n=59) and observation group (n=59). The control group was treated with conventional lumbar traction, and the observation group was treated with LTPNPA, all patients were followed up for 6 months, the curative effect, the clinical indicators (pain relief time and hospitalization time), Rvalue of intervertebral space height before and after treatment, oswestry disability index (ODI) score and ability of daily life in different periods of scale (ADL) score between the two groups were compared. **Results:** The excellent and good rate of the observation group was 98.31%, significantly higher than 88.14% of the control group (P<0.05). The pain relief time and hospitalization time of the observation group were significantly less than those of the control group (P<0.05). The ODI scores of the two groups after treatment were significantly lower than before treatment, and the observation group was significantly lower than the control group (P<0.05). There was no significant difference in R value of intervertebral space height between the two groups after treatment (P>0.05). The ADL scores of the two groups at 1 month, 3 months and 6 months after treatment were significantly higher than those before treatment, and which at 3 months and 6 months after treatment were significantly higher than 1 month after treatment, which 6 months after treatment was significantly higher than 3 months after treatment, and the observation group were significantly higher than the control group (P<0.05). **Conclusion:** LTPNPA treatment is an effective method for the treatment of DLBP in plateau area, can improve the quality of life, clinical should consider LTPNPA operation in plateau areas, so that patients can get the best curative effect.

Key words: Low temperature plasma nucleus pulposus ablation; Plateau area; Disc lumbago back pain; Curative effect; Quality of life

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前言

椎间盘源性下腰痛（disc lumbago back pain，DLBP）在临床上通常是因为腰椎间盘退变及纤维环破裂致使髓核通过破裂

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的纤维环进至椎管，并在局部区域引起自身性免疫炎症反应，形成炎性介质，并在纤维环的后侧亦或是背根神经节区域对外层纤维环中的伤害感受器产生疼痛刺激[1-3]。此种腰痛与普通的腰椎间盘突出型疼痛具有明显的差异，多以持续静态腰痛为主[4]。据统计，DLBP 在全部腰痛当中占比大约 39%，且在高原地区人群中占比较高，这主要是因为高原地区存在较长的寒冷时间，局部区域甚至能持续半年以上，昼夜温差大，长期的低温、低氧和低气压状态易导致机体腰背肌张力的增加，久之易形成 DLBP[5-7]。目前，对于 DLBP 的治疗可选用低温等离子髓核消融术（low temperature plasma nucleus pulposus ablation，LTPNPA），此种术式具有操作简单、创伤小及安全性高等特点，其应用的低温等离子刀头在加热时的温度大约是 70℃，产生的热渗透导致组织坏死的概率较小，仅可对周围 2 mm 区域的组织发挥作用，并仅可改变椎间盘的生化状态，而对脊柱稳定性则无明显影响，疗效较好[8-10]。本文通过分析 LTPNPA 术式对高原地区 DLBP 患者的疗效及生活质量的影响，旨在为临床治疗提供方案和数据支持，现报道如下。

1 资料和方法

1.1 一般资料

选择从 2015 年 9 月到 2017 年 1 月在我院接受治疗的高原地区 DLBP 患者 118 例作为研究对象。纳入标准：(1)所有患者均经 X 线或 CT 等影像学检查确诊；(2) 年龄 >30 岁；(3)患者均对本次研究知情同意，并且签署了同意书。排除标准：(1)有强直性脊柱炎者；(2) 有椎体骨折或椎间盘脱出等病变者；(3)有椎间盘感染者；(4)有手术治疗禁忌证者；(5)有恶性肿瘤者。将患者随机分为对照组(n=59)和观察组(n=59)，其中观察组女 24 例，男 35 例，年龄 33-65 岁，平均(56.47± 2.96)岁；病程 7 个月 -8 年，平均(4.79± 1.29)年。对照组有女 26 例，男 33 例，年龄 34-68 岁，平均(56.50± 2.82)岁；病程 6 个月 -9 年，平均(4.80± 1.31)年。两组一般资料比较差异无统计学意义(P>0.05)，具有可比性。我院的伦理委员会已经批准此次研究。

1.2 研究方法

对照组患者给予常规腰椎牵引治疗，30 min/ 次，1 次 /d，待其症状缓解后可实施腰背肌锻炼，45 min/ 次，1 次 /d，共治疗 3 个月，治疗时需避免负重。观察组患者则予以 LTPNPA 术式治疗，通过购自美国 Arthro care 公司的 2000 controllure 型离子组织气化仪进行操作，取患者的侧卧位，并在透视下实施定位，利用 0.5%的利多卡因(湖南正清制药集团股份有限公司，国药准字：H43021113，规格：20 mL:0.4 g)在距离棘突连线的旁侧 8-10 cm 位置局麻，在与椎间隙平行以及与矢状面呈 45°-55° 角的方向通过 17G 穿刺针行穿刺操作，针头需处于纤维环及髓核的交界处，在透视下确保正位针头处在椎弓根的内侧缘，而侧位针头处在椎间隙后约 1/3-1/4 位置，将针芯移除后往腰椎内置入气化棒，至中点后使气化棒后退，直至穿刺针筒的头部 5 mm 以上位置，在 C 型臂的监视下，调节能量输出至 2 档(即 152 Vrms)，分别使气化棒于 2、4、6、8 及 10 点方向消融。术后要求患者佩戴腰部固定带，仅可进行日常必需性活动，禁止其在 2 周内弯腰、屈曲及提取重物，术后 3 d 可开始锻炼腰背肌，方法同对照组。两组均通过电话随访的方式对患者进行为期 6 个月的随访，期间无脱落病例，随访结束后评价治疗效果。

1.3 观察指标

对比两组疗效、临床指标(疼痛缓解时间和住院时间)、治疗前后的椎间隙高度 R 值和 Oswestry 功能障碍指数(Owestry disability index，ODI)评分[11]以及不同时期的日常生活能力量表(activity of daily living，ADL)评分[12]。其中椎间隙高度 R 值通过 CT 等影像学手段观察计算，即待测椎间隙上下终板的最前缘与最后缘距离之和的平均值；ODI 评分共 10 个问题，每个问题有 0-5 分，ODI 值为实际得分 /50× 100%，分值越高，表示患者的功能障碍也越严重；ADL 评分共 10 个项目，项目分值有 0、5、10、15 分，总分值 100 分，分值越高表示患者的生活质量也越好。

1.4 疗效评价[7]

优：患者的直腿抬高试验呈阴性，且腰腿痛等症状已消失，可正常工作、生活。良：患者的腰腿痛等症状已消失，但下肢存在轻微麻木感，皮肤感觉呈轻度减退状态。可：患者的腰腿痛等症状已大部分消失，且直腿抬高试验 >60°，基本生活可维持。差：患者的腰腿痛等症状未缓解或加重，且直腿抬高试验≤ 60°，基本生活无法自理。其中优良率 =(优 + 良 + 可)例数 / 总例数× 100%。

1.5 统计学方法

采用 SPSS21.0 进行统计分析，计数资料用率表示，比较行 x^2 检验。计量资料用($\bar{x}$± s)表示，比较行 t 检验。检验标准设置为 α=0.05。

2 结果

2.1 两组患者疗效比较

观察组的优良例数为 58 例，占比 98.31%，高于对照组的 52 例，占比 88.14%，有统计学差异(P<0.05)，见表 1。

表 1 两组患者疗效比较[n(%)]

Table 1 Comparison of curative effect between the two groups[n(%)]

Groups	n	Excellent	Good	Can	Bad	Excellent and good rate
Observation group	59	26(44.07)	28(47.46)	4(6.78)	1(1.69)	58(98.31)
Control group	59	20(33.90)	24(40.68)	8(13.56)	7(11.86)	52(88.14)
x^2						4.827
P						0.028

2.2 两组患者临床指标比较

观察组的疼痛缓解时间及住院时间分别为(5.33± 1.87)d、

(7.94± 1.71)d,少于对照组的(8.98± 1.26)d、(15.03± 2.14)d,有统计学差异(P<0.05)。

2.3 两组治疗前后的椎间隙高度 R 值和 ODI 评分的对比

治疗前两组的椎间隙高度 R 值和 ODI 评分相比，差异均无统计学意义（P>0.05)。治疗后两组的 ODI 评分均低于治疗前,且观察组较对照组偏低,有统计学差异(P<0.05)。治疗后两组的椎间隙高度 R 值与治疗前及组间比较差异均无统计学意义(P>0.05),见表 2。

表 2 两组治疗前后的椎间隙高度 R 值和 ODI 评分的对比($\bar{x}\pm s$)

Table 2 Comparison of R value of intervertebral space height and ODI scores between the two groups before and after treatment($\bar{x}\pm s$)

Groups	n	R value of intervertebral space height(cm)		ODI (scores)	
		Before treatment	After treatment	Before treatment	After treatment
Observation group	59	0.26± 0.02	0.26± 0.01	34.20± 7.68	10.59± 2.35*
Control group	59	0.26± 0.01	0.26± 0.03	35.17± 5.52	23.14± 5.40*
t		0.000	0.000	0.788	16.369
P		1.000	1.000	0.432	0.000

Note: compared with before treatment, *P<0.05.

2.4 两组 ADL 评分的对比

治疗前两组的 ADL 评分相比，差异无统计学意义(P>0.05)。治疗后 1 个月、3 个月、6 个月两组的 ADL 评分均高于治疗前,治疗后 3 个月和 6 个月明显高于治疗后 1 个月,治疗后 6 个月又明显高于治疗后 3 个月，且观察组均高于对照组,有统计学差异(P<0.05),见表 3。

表 3 两组 ADL 评分的对比(分,$\bar{x}\pm s$)

Table 3 Comparison of ADL scores between the two groups(scores, $\bar{x}\pm s$)

Groups	n	Before treatment	1 month after treatment	3 months after treatment	6 months after treatment
Observation group	59	53.27± 3.25	68.49± 2.10*	75.94± 3.06*△	87.12± 5.19*△ #
Control group	59	53.31± 3.18	61.37± 2.18*	66.97± 2.84*△	75.28± 4.30*△ #
t		0.068	18.068	16.504	13.494
P		0.946	0.000	0.000	0.000

Note: compared with before treatment, *P<0.05; compared with 1 month after treatment, △P<0.05; compared with 3 months after treatment, #P<0.05.

3 讨论

DLBP 是一种顽固型疼痛,在临床上主要是指因椎间盘内部的病变而导致的一类急、慢性的腰部疼痛,如不加以治疗,则可对患者的生活质量产生较为严重的影响。有报道指出,DLBP 的发病机制主要是由椎间盘组织的力学或化学性变化引起,椎间盘在退变过程当中,患者的痛觉神经末梢通常会遭受源自退变组织的机械与化学反应刺激,进而导致其出现腰部疼痛等症状[13,14]。由于 DLBP 的发病位置较为特殊，以往临床上对于 DLBP 患者的治疗主要以牵引和推拿等非手术保守疗法为主,虽然也能获得一定的治疗效果,但不能根本解除患者椎间盘内的髓核病变。LTPNPA 术式是近年来兴起的通过低温等离子消融 DLBP 患者病变椎间盘内髓核的治疗方案,其对患者具有较好的疗效[15-17]。由于高原地区环境较为恶劣,DLBP 患者的发病几率较高，因此本文通过分析应用 LTPNPA 术式治疗高原地区 DLBP 患者的疗效情况,以期为临床治疗方案的选择提供参考思路。

导致高原地区 DLBP 的病因和病理均较为复杂,特别是在高原性低温、低氧和低气压的环境条件下,患者的机体较易受凉,加之组织内长期受缺氧、缺血以及循环障碍的影响,增加了肌肉、关节以及韧带张力,使其腰椎间盘更易受到损伤性病变,最终引起腰痛等症状[18-20]。本研究结果表明,观察组的优良率是98.31%,明显高于对照组的 88.14%,且疼痛缓解时间及住院时间均少于对照组(P<0.05),这提示了应用 LTPNPA 术式能够明显提升高原地区 DLBP 患者的疗效,并可有效促进疼痛症状的缓解,加速其预后康复进程。分析原因,主要与 LTPNPA 术式能较好地改善或解除高原地区 DLBP 患者病变椎间盘的内部结构性异常等因素有关[21,22]。具体而言,LTPNPA 术式主要是通过 40-70℃的低温型等离子刀头对高原地区 DLBP 患者的椎间盘内病变的髓核实施消融,并产生等离子性消融孔道,进而减小了椎间盘的总体积,缓解了神经根或者脊髓的压力,最终改善了患者的疼痛症状,并使其获得较好的疗效。同时,本研究还发现，治疗后两组的椎间隙高度 R 值相比差异无统计学意义(P>0.05),但两组的 ODI 评分均低于治疗前,且观察组低于对照组(P<0.05),这提示了观察组应用的 LTPNPA 术式能够更好地改善患者的腰椎功能,且不会明显影响椎间盘高度。原因主要是与 LTPNPA 术式的作用机制有关[23-25]。此种术式同时存在消融和固化等效应,能够较好地控制患者髓核消融量,如清除 1 cm^3 髓核,即能使 DLBP 患者的病变腰椎获得大幅度减压,且此过程不会损伤椎间盘，因此椎间隙的高度不会发生明显变化,脊柱稳定性也较好,满足人体正常的身体力学所需,最终改善了患者的腰椎功能状态[26-28]。此外,本研究还发现,治疗后 1 个月、3 个月、6 个月两组的 ADL 评分均高于治疗前,治疗后 3 个月和 6 个月明显高于治疗后 1 个月,治疗后 6 个月又明显高

于治疗后 3 个月,且观察组均高于对照组(P<0.05),这提示了经 LTPNPA 术式治疗的观察组术后的生活质量也得到了更加明显的改善。原因考虑是因为 LTPNPA 术式使高原地区 DLBP 患者腰椎间盘的病变区域得以减压,疼痛症状也存在更加有效的改善,患者术后恢复较好,因此其生活质量也明显更高。这在 Chan 等人[29,30]的报道中也有类似的结果能够证实。

综上所述,应用 LTPNPA 术式治疗高原地区 DLBP 患者,能够明显改善其疼痛症状,提升其生活质量,效果较好,临床上可考虑进一步在高原地区推广应用 LTPNPA 术式,从而使 DLBP 患者获得更加科学有效的治疗效果。

参 考 文 献(References)

[1] Tonosu J, Oka H, Higashikawa A, et al. The associations between magnetic resonance imaging findings and low back pain: A 10-year longitudinal analysis[J]. PLoS One, 2017, 12(11): e0188057

[2] Wiet MG, Piscioneri A, Khan SN, et al. Mast Cell-Intervertebral disc cell interactions regulate inflammation, catabolism and angiogenesis in Discogenic Back Pain[J]. Sci Rep, 2017, 7(1): 12492

[3] Nguyen C, Boutron I, Baron G, et al. Intradiscal Glucocorticoid Injection for Patients With Chronic Low Back Pain Associated With Active Discopathy: A Randomized Trial [J]. Ann Intern Med, 2017, 166 (8): 547-556

[4] Bae J, Lee SM, Lee SH, et al. The Likelihood of Reaching Substantial Clinical Benefit After an Interlaminar Dynamic Spacer for Chronic Low Back Pain: A Clinical and Radiologic Analysis of a Prospective Cohort[J]. World Neurosurg, 2017, 101: 589-598

[5] Arneja AS, Kotowich A, Staley D, et al. Electromagnetic fields in the treatment of chronic lower back pain in patients with degenerative disc disease[J]. Future Sci OA, 2016, 2(1): FSO105

[6] 夏群,梁威.椎间盘源性腰痛的诊治进展[J].天津医药, 2015, 43(11): 1244-1249
Xia Qun, Liang Wei. The diagnosis and therapy of discogenic low back pain[J]. Tianjin Medical Journal, 2015, 43(11): 1244-1249

[7] Todd NV. The surgical treatment of non-specific low back pain [J]. Bone Joint J, 2017, 99-B(8): 1003-1005

[8] Song J, Wang HL, Ma XS, et al. The value of radiographic indexes in the diagnosis of discogenic low back pain: a retrospective analysis of imaging results[J]. Oncotarget, 2017, 8(36): 60558-60567

[9] Kim SH, Lee SH, Kim NH, et al. Clinical Efficacy of Selective Focal Ablation by Navigable Percutaneous Disc Decompression Device in Patients with Cervical Herniated Nucleus Pulposus [J]. Ann Rehabil Med, 2017, 41(1): 80-89

[10] Kuelling FA, Foley KT, Liu JJ, et al. The anabolic effect of plasma-mediated ablation on the intervertebral disc: stimulation of proteoglycan and interleukin-8 production [J]. Spine J, 2014, 14 (10): 2479-2487

[11] Lee CP, Fu TS, Liu CY, et al. Psychometric evaluation of the Oswestry Disability Index in patients with chronic low back pain: factor and Mokken analyses[J]. Health Qual Life Outcomes, 2017, 15(1): 192

[12] Wesolowska K, Czarkowska-Paczek B. Activity of daily living on non-working and working days in Polish urban society[J]. Int J Occup Med Environ Health, 2017, 31(1): 47-54

[13] 刘剑,黄昌林,常祺,等.0 期诊断技术对军事训练所致椎间盘源性下腰痛患者血清 IL-1β,6-keto-PGF1α 及 TNF-α 水平的影响及其意义[J].现代生物医学进展, 2017, 17(9): 1753-1757
Liu Jian, Huang Chang-lin, Chang Qi, et al. A Study on the Effect of Zero-stage Low back Pain Diagnostic Technique on the Serum Levels of IL-1β, 6-keto-PGF1α and TNF-α Discogenic Low Back Pain Induced by Military Training [J]. Progress in Modern Biomedicine, 2017, 17(9): 1753-1757

[14] 宗银东,姜义铁,李林,等.等离子射频联合臭氧髓核成形术治疗顽固性椎间盘源性腰痛的疗效观察[J].蚌埠医学院学报, 2015, 40(9): 1207-1209
Zong Yin-dong, Jiang Yi-tie, Li Lin, et al. The effect of the plasma radiofrequency ablation combined with ozone nucleoplasty in the treatment of intractable discogenic pain [J]. Journal of Bengbu Medical College, 2015, 40(9): 1207-1209

[15] Helm Ii S, Simopoulos TT, Stojanovic M, et al. Effectiveness of Thermal Annular Procedures in Treating Discogenic Low Back Pain [J]. Pain Physician, 2017, 20(6): 447-470

[16] Akeda K, Ohishi K, Masuda K, et al. Intradiscal Injection of Autologous Platelet-Rich Plasma Releasate to Treat Discogenic Low Back Pain: A Preliminary Clinical Trial [J]. Asian Spine J, 2017, 11 (3): 380-389

[17] 齐峰,何鹏宇.应用低温等离子髓核消融术治疗椎间盘源性下腰痛的疗效观察[J].临床和实验医学杂志, 2015, 14(7): 587-590
Qi Feng, He Peng-yu. Study on application of low temperature plasma nucleus pulposus ablation in treatment of discogenic low back pain [J]. Journal of Clinical and Experimental Medicine, 2015, 14 (7): 587-590

[18] Sharma A, Sargar K, Salter A. Temporal Evolution of Disc in Young Patients with Low Back Pain and Stress Reaction in Lumbar Vertebrae[J]. AJNR Am J Neuroradiol, 2017, 38(8): 1647-1652

[19] Bhangare KP, Kaye AD, Knezevic NN, et al. An Analysis of New Approaches and Drug Formulations for Treatment of Chronic Low Back Pain[J]. Anesthesiol Clin, 2017, 35(2): 341-350

[20] Chun SW, Lim CY, Kim K, et al. The relationships between low back pain and lumbar lordosis: a systematic review and meta-analysis [J]. Spine J, 2017, 17(8): 1180-1191

[21] Simson KJ, Miller CT, Ford J, et al. Optimising conservative management of chronic low back pain: study protocol for a randomised controlled trial[J]. Trials, 2017, 18(1): 184

[22] 何鹏宇,张素杰,齐峰,等.低温等离子髓核消融术配合腰椎牵引治疗椎间盘源性腰痛临床研究 [J]. 临床和实验医学杂志, 2016, 15 (14): 1417-1419
He Peng-yu, Zhang Su-jie, Qi Feng, et al. A clinical study on low temperature plasma nucleus pulpous ablation combined with lumbar traction in treatment of disc lumbago back pain[J]. Journal of Clinical and Experimental Medicine, 2016, 15(14): 1417-1419

[23] Lee JH, Lee SH. Clinical Efficacy of Percutaneous Endoscopic Lumbar Annuloplasty and Nucleoplasty forTreatment of Patients with Discogenic Low Back Pain[J]. Pain Med, 2016, 17(4): 650-657

[24] Oba H, Takahashi J, Tsutsumimoto T, et al. Predictors of improvement in low back pain after lumbar decompression surgery: Prospective study of 140 patients[J]. J Orthop Sci, 2017, 22(4): 641-646

(下转第 3763 页)

lase-L1, and S100B Concentrations in Patients with Traumatic Brain Injury[J]. J Neurotrauma, 2017, 34(11): 1957-1971

[18] Erdem AF, Sahin YN, Dogan N, et al. Effects of sevoflurane and propofol on S100β and neuron-specific enolase protein levels during cardiopulmonary bypass[J]. Niger J Clin Pract, 2016, 19(2): 278-283

[19] Rodríguez-Rodríguez A, Egea-Guerrero JJ, Gordillo-Escobar E, et al. S100B and Neuron-Specific Enolase as mortality predictors in patients with severe traumatic brain injury [J]. Neurol Res, 2016, 38(2): 130-137

[20] 贺光宏,李杰华,许涛,等.右美托咪定对创伤性颅脑损伤患者术后脑氧代谢及认知功能影响分析[J].中国医学前沿杂志(电子版), 2017, 9(8): 46-50
He Guang-hong, Li Jie-hua, Xu Tao, et al. Effects of Dexmedetomidine on postoperative cerebral oxygen metabolism and cognitive function inpatients with traumatic brain injury [J]. Chinese Journal of the Frontiers of Medical Science (Electronic Version), 2017, 9(8): 46-50

[21] Xu L, Li B, Yang C, et al. Clinical research on postoperative efficacy and related factors of early simulation hyperbaric oxygen therapy for severe craniocerebral injury[J]. Pak J Pharm Sci, 2016, 29(1 Suppl): 273-280

[22] Pacchioni A, Versaci F, Mugnolo A, et al. Risk of brain injury during diagnostic coronary angiography: comparison between right and left radial approach[J]. Int J Cardiol, 2013, 167(6): 3021-3026

[23] Armstead WM, Riley J, Vavilala MS. Sex and Age Differences in Epinephrine Mechanisms and Outcomes after Brain Injury [J]. J Neurotrauma, 2017, 34(8): 1666-1675

[24] Li CH, Chen DP, Yang J. Enteral Nutritional Support in Patients with Head Injuries After Craniocerebral Surgery[J]. Turk Neurosurg, 2015, 25(6): 873-876

[25] 凌文娟,沈志强,曹冰,等.右美托咪定对重型颅脑损伤患者术后持续镇静的效果及脑组织的保护作用[J].现代生物医学进展, 2016, 16(18): 3533-3536
Ling Wen-juan, Shen Zhi-qiang, Cao Bin, et al. Continuous Sedation and Brain Protective Effect of Dexmedetomidine on Severe Craniocerebral Injury Patients after Operation [J]. Progress in Modern Biomedicine, 2016, 16(18): 3533-3536

[26] Endesfelder S, Makki H, Von Haefen C, et al. Neuroprotective effects of dexmedetomidine against hyperoxia-induced injury in the developing rat brain[J]. PLoS One, 2017, 12(2): e0171498

[27] Pajoumand M, Kufera JA, Bonds BW, et al. Dexmedetomidine as an adjunct for sedation in patients with traumatic brain injury[J]. J Trauma Acute Care Surg, 2016, 81(2): 345-351

[28] Wang X, Ji J, Fen L, et al. Effects of dexmedetomidine on cerebral blood flow in critically ill patients with or without traumatic brain injury: a prospective controlled trial [J]. Brain Inj, 2013, 27(13-14): 1617-1622

[29] Xiong B, Shi QQ, Miao CH. Dexmedetomidine renders a brain protection on hippocampal formation through inhibition of nNOS-NO signalling in endotoxin-induced shock rats [J]. Brain Inj, 2014, 28(7): 1003-1008

[30] Ren X, Ma H, Zuo Z. Dexmedetomidine Postconditioning Reduces Brain Injury after Brain Hypoxia-Ischemia in Neonatal Rats[J]. J Neuroimmune Pharmacol, 2016, 11(2): 238-247

(上接第 3753 页)

[25] 卢政好,苏小桃,欧军,等.经皮靶点穿刺臭氧注射术治疗伴有纤维环后方高信号的腰椎间盘突出症[J].现代生物医学进展, 2017, 17(22): 4268-4272
Lu Zheng-hao, Su Xiao-tao, Ou Jun, et al. Treatment of Targeted Percutanous Ozone Ablation on Lumbar Disc Herniation with High Intensity Zone in Lumbar Disc Annulus Fibrosus [J]. Progress in Modern Biomedicine, 2017, 17(22): 4268-4272

[26] Zhang L, Ding XL, Zhao XL, et al. Fluoroscopy-guided Bipolar Radiofrequency Thermocoagulation Treatment for Discogenic Low Back Pain[J]. Chin Med J (Engl), 2016, 129(19): 2313-2318

[27] Manchikanti L, Pampati V, Benyamin RM, et al. Cost Utility Analysis of Lumbar Interlaminar Epidural Injections in the Treatment of Lumbar Disc Herniation, Central Spinal Stenosis, and Axial or Discogenic Low Back Pain[J]. Pain Physician, 2017, 20(4): 219-228

[28] Helm Ii S, Simopoulos TT, Stojanovic M, et al. Effectiveness of Thermal Annular Procedures in Treating Discogenic Low Back Pain [J]. Pain Physician, 2017, 20(6): 447-470

[29] Chan AYP, Ford JJ, Surkitt LD, et al. Individualised functional restoration plus guideline-based advice vs advice alone for non-reducible discogenic low back pain:a randomised controlled trial [J]. Physiotherapy, 2017, 103(2): 121-130

[30] Zhang X, Hao J, Hu Z, et al. Clinical Evaluation and Magnetic Resonance Imaging Assessment of Intradiscal Methylene Blue Injection for the Treatment of Discogenic Low Back Pain [J]. Pain Physician, 2016, 19(8): E1189-E1195