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3.0T 磁共振扩张量成像对腰椎间盘突出致神经根受压的诊断价值 及其与 Oswestry 功能障碍指数及视觉模拟评分的相关性*

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摘要 目的:研究 3.0T 磁共振扩张量成像(DTI)对腰椎间盘突出致神经根受压的诊断价值及其与 Oswestry 功能障碍指数(ODI)及视觉模拟评分(VAS)的相关性。**方法:**纳入我院从 2017 年 1 月~2019 年 1 月收治的腰椎间盘突出致神经根受压患者 50 例进行研究,记作研究组。另取同期我院收治的单纯腰椎间盘突出患者 50 例作为对照组。两组受试者均接受 DTI 扫描以及 ODI、VAS 评分。比较两组神经根不同层面的各向异性分数(FA)值、弥散系数(ADC)值、ODI、VAS 评分,并作相关性分析。同时,以手术病理诊断为金标准,分析 DTI 诊断腰椎间盘突出致神经根受压的敏感性、特异性、准确度。**结果:**研究组患者神经根近层、中层、远层的 FA 值均显著低于对照组,而 ADC 值均显著高于对照组(均 $P<0.05$)。以手术病理诊断为金标准,DTI 诊断腰椎间盘突出致神经根受压的敏感性为 94.00%、特异性为 96.00%、准确度为 95.00%。研究组 ODI、VAS 评分分别为(43.22±7.25)分、(6.68±1.92)分,相较于对照组的(28.56±6.22)分、(4.02±1.34)分显著更高(均 $P<0.05$)。经 Pearson 相关性分析可得:腰椎间盘突出致神经根受压患者的 FA 值与 ODI、VAS 评分均呈负相关关系(均 $P<0.05$),而 ADC 值与 ODI、VAS 评分无相关性(均 $P>0.05$)。**结论:**DTI 对腰椎间盘突出致神经根受压的诊断价值较高,且 FA 值与 ODI、VAS 均存在明显相关性。临床工作中可能将 DTI 的 FA 值作为量化神经根结构改变的重要参数,值得临床重点关注。

关键词:腰椎间盘突出;神经根受压;磁共振扩张量成像;Oswestry 功能障碍指数;视觉模拟评分

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The Diagnostic Value of 3.0T Magnetic Resonance Dilatation for Nerve Root Compression Caused by Lumbar Disc Herniation and Its Correlation with Oswestry Dysfunction Index and Visual Analogue Score*

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ABSTRACT Objective: To study the diagnostic value of 3.0T magnetic resonance dilatation (DTI) in the diagnosis of nerve root compression caused by lumbar disc herniation and its correlation with Oswestry dysfunction index (ODI) and visual analogue score (VAS). **Methods:** 50 patients with nerve root compression caused by lumbar disc herniation who were admitted to our hospital from January 2017 to January 2019 were included in the study group, which was recorded as the study group. In addition, 50 patients with simple lumbar disc herniation who were admitted to our hospital during the same period were taken as the control group. Subjects in both groups received DTI scanning and ODI and VAS scores. Fractional anisotropy (FA) values, dispersion coefficient (ADC) values, ODI and VAS scores at different levels of nerve roots in the two groups were compared, and the correlations were analyzed. At the same time, the sensitivity, specificity and accuracy of DTI in diagnosing nerve root compression caused by lumbar disc herniation were analyzed by using surgical and pathological diagnosis as the gold standard. **Results:** The FA values of the proximal, middle and distal nerve roots in the study group were significantly lower than those in the control group, while the ADC values were significantly higher than those in the control group (all $P<0.05$). Surgical and pathological diagnosis as the gold standard, the sensitivity of DTI in diagnosing nerve root compression caused by lumbar disc herniation was 94.00%, The specificity was 96.00% and the accuracy was 95.00%. The ODI and VAS scores of the study group were (43.22±7.25) score and (6.68±1.92) score, respectively, which were significantly higher than those of the control group (28.56±6.22) score and (4.02±1.34) score (all $P<0.05$). According to pearson correlation analysis, FA values of patients with lumbar disc herniation and nerve root compression were negatively correlated with ODI and VAS scores (all $P<0.05$), while ADC values were not correlated with ODI and VAS scores (all $P>0.05$). **Conclusion:** DTI has high diagnostic value for nerve root compression caused by lumbar disc herniation, and FA value is significantly correlated with ODI and VAS. In clinical work, FA value of DTI may be

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taken as an important parameter to quantify the changes of nerve root structure, which is worthy of clinical attention.

Key words: Lumbar disc herniation; Root compression; Magnetic resonance dilatation imaging; Oswestry dysfunction index; Visual simulation score

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前言

椎间盘突出属于临床较为常见的一种疾病,发病时由于患者脊椎活动受限,从而可能引发神经根受压症状,进而导致放射形疼痛等症状的发生^[1,2]。常规磁共振成像(Magnetic resonance imaging, MRI)可精确发现腰椎间盘突出征象,但无法明确评估受压神经根的损伤程度^[3,4]。相关研究数据显示,采用常规MRI筛查健康和志愿者,腰椎间盘突出检出率可达20%~76%,存在较高的假阳性率,且腰椎间盘突出致神经根受压在常规MRI上的表现和临床神经根受压症状存在一定的相似性,从而导致临床诊断以及治疗缺乏可靠的客观依据^[5,6]。随着近年来影像学技术的飞速发展,磁共振扩张量成像(Diffusion tensor imaging, DTI)基于扩散加权成像发展而来,可从三维立体角度分解、量化弥散的各向异性数据,从而较为精确地显示组织微结构,同时于活体显示纤维束的方向以及完整性^[7,8]。目前,DTI技术在中枢神经系统相关疾病的应用日臻成熟,但在腰椎间盘突出致神经根受压中的应用相关报道并不多见。鉴于此,本文通过研究DTI对腰椎间盘突出致神经根受压的诊断价值及其与Oswestry功能障碍指数(Oswestry disability index, ODI)及视觉模拟评分(Visual analogue scale, VAS)的相关性,旨在为临床诊断提供数据支持,现作以下报道。

1 资料与方法

1.1 一般资料

纳入我院从2017年1月~2019年1月收治的腰椎间盘突出致神经根受压患者50例进行研究,记作研究组,男性患者33例,女性患者17例,年龄23~58岁,平均年龄(42.22±6.22)岁;受压单侧神经局限L5和S1, L5神经根32例, S1神经根18例;受教育程度:初中及以下14例,高中及以上36例。另取同期我院收治的单纯腰椎间盘突出患者50例作为对照组,男性患者30例,女性患者20例,年龄20~60岁,平均年龄(43.16±4.65)岁;受教育程度:初中及以下11例,高中及以上39例。两组上述指标比较,差异不显著($P>0.05$),均衡可比。纳入标准:(1)所有纳入对象均经影像学检查确诊为腰椎间盘突出;(2)年龄在18周岁以上;(3)研究组患者经手术病理诊断确诊为神经根受压;(4)入院前尚未接受相关治疗;(5)无临床病历资料缺失。排除标准:(1)既往有下肢骨或肌肉损伤史、肿瘤史以及腰部或下肢结核者;(2)合并先天性脊柱发育畸形或存在相关影像学检查禁忌症者;(3)意识障碍或伴有精神疾病者;(4)合并严重脏器功能障碍者。纳入对象均在知情同意书上签字,并获批于医院伦理委员会。

1.2 研究方法

(1)DTI检查:使用仪器为Siemens Verio 3.0T MR扫描仪,首先予以常规MR扫描,随后实施DTI和轴位T1-vibe定

位扫描,扫描范围从L3肢体下缘到S1椎体下缘。相关扫描参数如下:TR为7 ms, TE为2.45 ms, FOV为200 mm×200 mm, 层厚取1 mm。其中DTI扫描中心层面和T1-vibe一致, TR为7500 ms, TE为95 ms, FOV为230 mm×230 mm, 层厚取3 mm, b值取0,800 s/mm²。(2)图像分析:借助Siemens工作站Neuro 3D软件实施参数测定以及纤维束示踪成像。DTI参数测定综合T1定位图像,自神经根受压部位到远侧以3 mm为间距。将ROI置于3个不同层面, ROI面积取25~50 mm², 重复测量3次取平均值。(3)所有受试者均接受ODI评分、VAS评分评估:其中ODI评分主要内容包括疼痛程度、自理能力、提物、坐时间、站时间、睡眠、性生活、步行距离、社会功能以及旅游10个条目,每个条目0~5分,总分0~50分,得分越高反映病情越严重^[9]。VAS按照无痛到极痛的程度用0~10分表示,得分越高反映疼痛越剧烈^[10]。

1.3 观察指标

比较两组神经根不同层面的各向异性分数(Fractional anisotropy, FA)值与弥散系数(Dispersion coefficient, ADC)值、ODI、VAS评分。分析DTI诊断腰椎间盘突出致神经根受压的敏感性、特异性、准确度,以及腰椎间盘突出致神经根受压患者的FA值、ADC值与ODI、VAS评分的相关性。

1.4 统计学方法

以SPSS20.0软件进行数据分析,通过[n(%)]表示计数资料,予以 χ^2 检验,以($\bar{x} \pm s$)表示计量资料,予以t检验。腰椎间盘突出致神经根受压患者的FA值、ADC值与ODI、VAS评分的关系予以Pearson相关性。 $P<0.05$ 即为差异有统计学意义。

2 结果

2.1 两组神经根不同层面的FA值与ADC值对比

研究组患者神经根近层、中层、远层的FA值均显著低于对照组,而ADC值均显著高于对照组(均 $P<0.05$),见表1。

2.2 DTI诊断腰椎间盘突出致神经根受压的敏感性、特异性、准确度分析

以手术病理诊断为金标准,DTI诊断腰椎间盘突出致神经根受压的敏感性为94.00%、特异性为96.00%、准确度为95.00%,见表2。

2.3 两组ODI、VAS评分对比

研究组ODI、VAS评分分别相较于对照组升高(均 $P<0.05$),见表3。

2.4 腰椎间盘突出致神经根受压患者的FA值、ADC值与ODI、VAS评分的相关性分析

经Pearson相关性分析可得:腰椎间盘突出致神经根受压患者的FA值与ODI、VAS评分均呈负相关关系(均 $P<0.05$),而ADC值与ODI、VAS评分无相关性(均 $P>0.05$),见表4。

表 1 两组神经根不同层面的 FA 值与 ADC 值对比($\bar{x} \pm s$)Table 1 Comparison of FA value and ADC value in different layers of nerve root between two groups($\bar{x} \pm s$)

Groups	n	FA value			ADC value($\times 10^{-3} \text{mm}^2/\text{s}$)		
		Proximal	Middle	Distal	Proximal	Middle	Distal
Study group	50	0.303 $\pm$ 0.021	0.287 $\pm$ 0.025	0.269 $\pm$ 0.020	1.628 $\pm$ 0.200	1.802 $\pm$ 0.225	1.931 $\pm$ 0.210
Control group	50	0.320 $\pm$ 0.017	0.321 $\pm$ 0.021	0.321 $\pm$ 0.021	1.441 $\pm$ 0.202	1.394 $\pm$ 0.185	1.422 $\pm$ 0.176
t	-	2.814	4.657	8.019	2.942	6.264	8.308
P	-	0.008	0.000	0.000	0.006	0.000	0.000

表 2 DTI 诊断腰椎间盘突出致神经根受压的敏感性、特异性、准确度分析

Table 2 Sensitivity, specificity and accuracy of DTI in the diagnosis of nerve root compression caused by lumbar disc herniation

Inspection mode		Surgical and pathological		
		Positive	Negative	Total
DTI	Positive	47	2	49
	Negative	3	48	51
	Total	50	50	100

表 3 两组 ODI、VAS 评分对比(分, $\bar{x} \pm s$)Table 3 Comparison of ODI and VAS scores between the two groups(scores, $\bar{x} \pm s$)

Groups	n	ODI score	VAS score
Study group	50	42.22 $\pm$ 7.25	6.68 $\pm$ 1.92
Control group	50	28.56 $\pm$ 6.22	4.02 $\pm$ 1.34
t	-	10.112	5.081
P	-	0.000	0.000

表 4 腰椎间盘突出致神经根受压患者的 FA 值、ADC 值与 ODI、VAS 评分的相关性分析

Table 4 Correlation Analysis of FA value, ADC value, ODI and VAS score in patients with nerve root

Related indicators	FA value		ADC value	
	r	P	r	P
ODI score	-0.587	0.001	0.318	0.193
VAS score	-0.615	0.000	0.356	0.126

3 讨论

上世纪 30 年代,国外学者提出腰椎间盘突出会引起腰部以及下肢出现放射形疼痛,但关于其具体机制尚未完全明确^[11,12]。随着近年来相关研究的日益深入,越来越多的学者发现受压神经根的变化在疼痛发生的病理过程中起着至关重要的作用^[13,14]。更有临床实验结果表明,受压的腰部神经根可能引发水肿、退髓鞘等改变,甚至会导致受压的整条神经根出现广泛水肿^[15,16]。临床上常规的 MRI 无法显示受压神经根的全貌以及损伤程度,对于多阶段腰椎间盘突出以及巨大的中央型突出亦无法进行精确判断责任神经根,存在一定的局限性^[17-19]。DTI 技术主要是通过抑制血管信号的方式提高周围神经显示效果,从而较为清晰地显示神经纤维走行信息,并通过 FA 值以及 ADC 指量化分析神经内水分子的弥散情况,从而具有一定的评估周围神经胃管结构以及功能潜能^[20-22]。近年来不少研究文献证实,DTI 技术在周围神经系统中的定量评估是可行的^[23,24]。

本文结果发现:研究组患者神经根近层、中层、远层的 FA 值均显著低于对照组,而 ADC 值均显著高于对照组。与此同时,以手术病理诊断为金标准,DTI 诊断腰椎间盘突出致神经根受压的敏感性、特异性、准确度均达到 90%以上,提示了 DTI 诊断腰椎间盘突出致神经根受压的价值较高。其中陈镜聪等人的研究结果表明^[25]:腰椎间盘突出引起腰骶神经根压迫症患者的患侧神经根 FA 值显著低于健侧,而 ADC 值显著高于健侧。究其原因,DTI 的 ADC 值于 FA 值均可有效反映组织结构的变化情况,其中 ADC 值主要是用以反映水分子弥散速度,FA 值则反映水分子运动方向,高 FA 值反映了组织内水分子的运动各向异性^[26,27]。因此,DTI 可有效诊断腰椎间盘突出致神经根受压,同时可准确反映神经根水肿以及脱髓鞘等神经损伤变化。此外,经 Pearson 相关性分析可得:腰椎间盘突出致神经根受压患者的 FA 值与 ODI、VAS 评分均呈负相关关系,而 ADC 值与 ODI、VAS 评分无相关性。这在崔婷婷等人的研究结果中得以证实^[28]:腰椎间盘突出致神经根受压患者患侧 FA 值和 ODI、

VAS 评分均呈负相关,这提示了 FA 值可能成为量化受压神经根结构改变的重要参数,可作为评估患者病情严重程度的潜在指标。分析原因,FA 值的降低可在一定程度上反映组织破坏、脱髓鞘变和轴突缺损的发生,由此可见,FA 值的下降幅度越大,患者临床症状表现越严重,相应的神经根损伤程度亦相对较重,从而使得 ODI、VAS 评分升高。而受压神经根 ADC 值的变化可能受水肿以及炎性反应所影响,患者临床各病理阶段均可能是导致 ADC 值存在差异的原因。

综上所述,DTI 应用于腰椎间盘突出致神经根受压中的诊断价值较高,其中 FA 值与 ODI、VAS 均存在明显相关性。DTI 的 FA 值具有作为量化神经根结构改变重要参数的潜能,值得临床重点关注。

参考文献(References)

- [1] Inoue T. Pure Conus Medullaris Syndrome without Lower Extremity Involvement Caused by Intradural Disc Herniation at L1/2: A Case Report[J]. Spine Surg Relat Res, 2018, 3(4): 392-395
- [2] Kim JH, Lee J, Lee WJ, et al. Efficacy of automated percutaneous lumbar discectomy for lumbar disc herniation in young male soldiers [J]. Medicine (Baltimore), 2019, 98(46): 18044-18045
- [3] Uçkun ÖM, Alagöz F, Polat Ö, et al. Urgent operation improves weakness in cauda equina syndrome due to lumbar disc herniation[J]. Turk J Phys Med Rehabil, 2019, 65(3): 222-227
- [4] 闵朋, 杨锐. 磁共振扩散张量成像在评价脊神经根病变中的作用[J]. 中国临床研究, 2018, 31(2): 252-255
- [5] 罗树彬, 肖文丰, 黄莹, 等. MR 扩散张量成像对腰椎间盘突出手术治疗的诊断价值[J]. 实用放射学杂志, 2019, 35(2): 249-252
- [6] Meng C, Li Y, Wang S, et al. Application of a modified optical fiber in targeted percutaneous laser discectomy of lumbar disc herniation: A retrospective study [J]. Exp Ther Med, 2019, 18(5): 3552-3562
- [7] Cho PG, Ji GY, Yoon YS, et al. Clinical Effectiveness of Percutaneous Epidural Neuroplasty According to the Type of Single-Level Lumbar Disc Herniation: A 12-Month Follow-Up Study [J]. J Korean Neurosurg Soc, 2019, 62(6): 681-690
- [8] Wang Q, Zhang H, Zhang J, et al. The relationship of the shear wave elastography findings of patients with unilateral lumbar disc herniation and clinical characteristics[J]. BMC Musculoskelet Disord, 2019, 20(1): 438-439
- [9] Hwang UJ, Kwon OY, Jung SH, et al. Predictors of pain intensity and Oswestry Disability Index in prolonged standing service workers with nonspecific chronic low back pain subclassified as active extension pattern[J]. Musculoskelet Sci Pract, 2019, 22(36): 58-64
- [10] 郑华伟, 刘刚, 何述明, 等. 不同切除方式治疗腰椎间盘突出症的对照研究[J]. 西南国防医药, 2019, 29(9): 948-950
- [11] Zhang J, Zhang F, Xiao F, et al. Quantitative Evaluation of the Compressed L5 and S1 Nerve Roots in Unilateral Lumbar Disc Herniation by Using Diffusion Tensor Imaging [J]. Clin Neuroradiol, 2018, 28(4): 529-537
- [12] Koksai V, Koc RK. Microsurgery versus Medical Treatment for Neuropathic Pain Caused by Foraminal Extraforaminal Lumbar Disc Herniation: An Observational Study[J]. Turk Neurosurg, 2019, 29(6): 915-926
- [13] Chu ECP, Chan AKC, Lin AFC. Pitting oedema in a polio survivor with lumbar radiculopathy complicated disc herniation [J]. J Family Med Prim Care, 2019, 8(5): 1765-1768
- [14] 江帆, 龙耀斌, 许建文, 等. 腰椎旁神经阻滞联合超短波对腰椎间盘突出症患者疼痛及腰背肌生物力学性能的影响[J]. 现代生物医学进展, 2017, 17(27): 5298-5301, 5326
- [15] Ishibashi K, Oshima Y, Inoue H, et al. A less invasive surgery using a full-endoscopic system for L5 nerve root compression caused by lumbar foraminal stenosis[J]. J Spine Surg, 2018, 4(3): 594-601
- [16] Stein AA, Vrionis F, Espinosa PS, et al. Report of an Isolated L5 Radiculopathy Caused by an L2-3 Disc Herniation and Review of the Literature[J]. Cureus, 2018, 10(4): 2552-2553
- [17] 吴杏, 胡久益, 王小双, 等. FA 值、ADC 值与腰骶丛脊神经根受压程度的相关性研究[J]. 临床放射学杂志, 2017, 36(5): 710-713
- [18] 钱海峰, 吴晓, 徐万里, 等. 3.0T 磁共振扩散张量成像在腰椎间盘突出诊治中的应用[J]. 浙江医学, 2016, 38(4): 260-263
- [19] 刘建航, 刘昊, 陈道云, 等. 磁共振弥散张量成像技术在临床疾病诊治过程中更多的优势和价值[J]. 中国组织工程研究, 2019, 23(8): 1241-1247
- [20] Leal PRL, Roch J, Hermier M, et al. Diffusion tensor imaging abnormalities of the trigeminal nerve root in patients with classical trigeminal neuralgia: a pre- and postoperative comparative study 4 years after microvascular decompression [J]. Acta Neurochir (Wien), 2019, 161(7): 1415-1425
- [21] Liu J, Zhu J, Yuan F, et al. Abnormal brain white matter in patients with right trigeminal neuralgia: a diffusion tensor imaging study [J]. J Headache Pain, 2018, 19(1): 46-48
- [22] Wang X, Wang H, Sun C, et al. Analysis of radiological parameters associated with decreased fractional anisotropy values on diffusion tensor imaging in patients with lumbar spinal stenosis[J]. Eur Spine J, 2019, 28(6): 1397-1405
- [23] Chai W, You C, Zhang W, et al. Diffusion tensor imaging of microstructural alterations in the trigeminal nerve due to neurovascular contact/compression[J]. Acta Neurochir (Wien), 2019, 161(7): 1407-1413
- [24] Lee YL, Chen ST, Yang JT, et al. Diffusivity parameters of diffusion tensor imaging and apparent diffusion coefficient as imaging markers for predicting the treatment response of patients with trigeminal neuralgia[J]. J Neurosurg, 2019, 13(17): 1-7
- [25] 陈镜聪, 黄柏锋, 刘锦文, 等. DTI 在腰椎间盘突出引起腰骶神经根压迫症中的应用[J]. 深圳中西医结合杂志, 2019, 29(9): 20-21
- [26] He A, Wang WZ, Qiao PF, et al. Quantitative Evaluation of Compressed L4-5 and S1 Nerve Roots of Lumbar Disc Herniation Patients by Diffusion Tensor Imaging and Fiber Tractography [J]. World Neurosurg, 2018, 12(115): e45-e52
- [27] Eguchi Y, Kanamoto H, Oikawa Y, et al. Recent advances in magnetic resonance neuroimaging of lumbar nerve to clinical applications: A review of clinical studies utilizing Diffusion Tensor Imaging and Diffusion-weighted magnetic resonance neurography [J]. Spine Surg Relat Res, 2017, 1(2): 61-71
- [28] 崔婷婷, 李松柏. 腰椎间盘突出症患者受压神经根 DTI 与临床表现的相关性[J]. 中国医学影像技术, 2017, 33(12): 1869-1873