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MRI-DWI 靶向穿刺活检对前列腺癌的诊断效能的初步分析

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[摘要] 目的: 分析磁共振弥散成像(diffusion weighted imaging, DWI)靶向引导前列腺穿刺活检对前列腺癌(prostate cancer, PCa)的诊断效能。方法: 选择2016年9月至2019年9月因不同程度尿路梗阻症状而于我院就诊的可疑PCa患者124例作为研究对象。穿刺前均行DWI检查, 分析图像特征, 以病理结果为“金标准”, 绘制表观扩散系数(apparent diffusion coefficient, ADC)值的ROC曲线, 分析ADC诊断前列腺病变良、恶性的价值。此外比较DWI靶向活检和系统活检在前列腺癌检出率方面的差异。结果: 病理证实56例恶性病变(45.2%), 其余68例为前列腺良性增生(54.8%); DWI下PCa患者ADC值明显低于前列腺增生患者[(0.810±0.091) mm²/s vs (1.499±0.293) mm²/s, $t=16.878$, $P<0.05$]; ROC曲线分析结果显示ADC值诊断前列腺良恶性肿瘤的AUC为0.869, 以ADC值=1.091 mm²/s为界点值评估良恶性肿瘤的敏感性、特异性分别为83.9%, 76.5%; DWI靶向穿刺活检针数显著低于TRUS系统穿刺活检针数, 且DWI靶向穿刺活检阳性针中肿瘤组织占比明显高于TRUS系统穿刺, 差异均具有统计学意义($P<0.05$)。结论: DWI可定性及量化鉴别诊断前列腺良、恶性病变, DWI靶向引导前列腺穿刺活检相较于经典系统穿刺可通过更少的穿刺针数获得相似的肿瘤检出率且阳性针中可提供更多的肿瘤组织。

[关键词] 磁共振弥散成像; 靶向活检; 前列腺穿刺活检; 前列腺癌

A preliminary analysis of the diagnostic efficacy of MRI-DWI targeted puncture biopsy in prostate cancer

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Abstract **Objective:** To analyze the diagnostic efficacy of diffusion weighted imaging (DWI) guided prostate biopsy in prostate cancer (PCa). **Methods:** A total of 124 patients with suspected PCa who were admitted to our hospital for different degrees of urinary tract obstruction from September 2016 to September 2019 were selected as the study subjects. DWI examination was performed before puncture, and image features were analyzed. The ROC curve of the apparent diffusion coefficient (ADC) value was drawn based on the pathological results as the “gold standard” to analyze the value of ADC in the diagnosis of benign and malignant prostate lesions. In addition, differences in the detection rate of prostate cancer between DWI targeted biopsy and systematic biopsy were

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compared. **Results:** Pathology confirmed 56 cases of malignant lesions (45.2%), the remaining 68 cases of benign prostatic hyperplasia (54.8%); ADC value of patients with PCa under DWI was significantly lower than that of patients with BPH [(0.810±0.091) mm²/s vs (1.499±0.293) mm²/s, $t=16.878$, $P<0.05$]; ROC curve analysis showed that the AUC of ADC value in the diagnosis of benign and malignant prostate tumors was 0.869, and the sensitivity and specificity of ADC value =1.091 mm²/s were 83.9% and 76.5%, respectively; The number of DWI targeted biopsy needles was significantly lower than that of TRUS system, and the proportion of tumor tissue in DWI targeted biopsy positive needles was significantly higher than that in TRUS system, with statistically significant differences ($P<0.05$). **Conclusion:** DWI can qualitatively and quantitatively differentiate and diagnose benign and malignant prostate lesions, and DWI targeted prostate biopsy can achieve similar tumor detection rate through fewer puncture needles and provide more tumor tissue in the positive needle compared with the classic system puncture.

Keywords diffusion weighted imaging; targeted biopsy; prostate biopsy; prostate cancer

前列腺癌(prostate cancer, PCa)是男性泌尿生殖系统的主要恶性肿瘤之一,近年来我国PCa发病率呈上升趋势,PCa已成为继肺癌后病死率最高的肿瘤之一,严重威胁患者生命安全^[1]。PCa发病初期无典型症状及影像学表现,极易被误诊为良性前列腺增生等,因此关于其早期诊断及评估已成为临床研究的重要方向^[2]。经直肠超声是检查前列腺的常用手段,然其漏诊率超过40%^[3]。近年来随着医学技术的不断发展,磁共振弥散成像(diffusion weighted imaging, DWI)技术可无创性评估活体内组织水分子扩散运动^[4],研究^[5]显示DWI参数表观扩散系数(apparent diffusion coefficient, ADC)值与PCa恶性程度显著相关。基于此本次研究拟分析DWI技术对前列腺良恶性病变的诊断效能,探讨DWI靶向引导前列腺穿刺活检的价值,现将结果报告如下。

1 对象与方法

1.1 对象

选择2016年9月至2019年9月因不同程度尿路梗阻症状而于我院就诊的可疑PCa患者124例作为研究对象。纳入标准^[6-7]: 1)前列腺特异性抗原(prostate specific antigen, PSA) ≥ 4 ng/mL; 2)直肠指检高度疑诊前列腺占位性病变; 3)经直肠超声造影或影像学检查疑诊前列腺占位; 4)均行DWI检查,并在DWI引导下前列腺穿刺活检。排除标准^[6-7]: 1)穿刺活检前接受过新辅助化疗及放疗、化疗者; 2)不耐受穿刺手术者; 3)严重肝、肾及凝血功能异常者; 4)图像质量欠佳或无病理结果者。年龄51~80(67.1±8.4)岁,血清总PSA为4.66~107.91 (24.61±28.43) ng/mL,前列腺体积为

33.1~70.2 (45.6±11.4) mL。本次研究经医院伦理会批准,并已告知患者此次研究的目的与性质并取得其同意。

1.2 仪器与方法

1.2.1 DWI-MRI 检查

选择Siemens 1.5T 磁共振扫描仪,八通道腹部相控阵表面线圈。患者适度充盈膀胱,取仰卧位,以耻骨联合上2 cm为中心扫描,包括T₂WI, T₁WI, DWI扫描,参数如下: T₂WI (TR/TE=4 724 ms/74 ms, 层数20, 层厚5 mm, 层间距1 mm, 视野23 cm × 23 cm, 激励次数1, 矩阵448 mm × 640 mm, 成像时间80 s), DWI (TR/TE=5 600 ms/88 ms, 层厚6 mm, 层间距1.5 mm, 视野2.4 cm × 3.0 cm, b值为800 s/mm², 矩阵192 mm × 320 mm)。扫描结束后自动生成表观扩散系数(apparent diffusion coefficient, ADC)图。设置好感兴趣区(region of interest, ROI),测量相应部位的ADC值,测量3次取均值,发现多个可疑病灶时需取多个病灶ADC值的均值。

1.2.2 DWI 靶向引导前列腺穿刺活检

采用经直肠超声(transrectal ultrasonography, TRUS)引导穿刺,仪器为法国申科Supersonic Imagine超声诊断仪,频率5.0~9.0 MHz腔内端扫描式探头,先行系统活检,根据欧洲泌尿外科学会(European Association of Urology, EAU)指南推荐行四区12针或五区13针穿刺活检。同日根据MRI与DWI图像确定可疑病灶行靶向活检。系统活检及靶向活检由同一位医师完成。穿刺标本依次做好标记后送病理。要求各项常规检查正常的情况下取截石位穿刺,穿刺前灌肠,会阴消毒,局麻下完成。

1.3 病理学分析

石蜡块包埋送检标本, 固定后进行HE染色, 明确病理学诊断结果, 常规HE染色不能确诊者需进行免疫组织化学分析协助完成诊断。

1.4 图像质控及诊断标准

避免产生伪像, 严格把控图像质量, 要求所有图像数据采集及判断均经2名高年资超声科及影像科医师独立审核, 结果不一致时讨论后定下结果。

1.5 统计学处理

采用SPSS 21.0统计软件包, 计量资料以均数±标准差($\bar{x} \pm s$)表示行 t 检验, 计数资料以率(%)表示行 χ^2 检验, 以穿刺活检病理结果为“金标准”, 计算DWI诊断价值, 并绘制ADC值的受试者工作特征曲线(receiver operator characteristic curve, ROC)并

计算曲线下面积(AUC), 确定诊断最佳临界值。按 $\alpha=0.05$ 的检验水准, 以 $P<0.05$ 为差异有统计学。

2 结果

2.1 病理检查结果

124例病理证实56例恶性病变(45.2%), 均为前列腺腺癌, Gleason评分6~9(7.4 ± 1.4)分, 血清PSA为(52.4 ± 31.4) ng/mL。其余68例为前列腺良性增生, 其中9例合并急性慢性前列腺炎, 6例合并上皮内瘤变, 2例合并肉芽肿性炎, 血清PSA为(17.4 ± 6.3) ng/mL。

2.2 MRI 图像特征定性评价前列腺良恶性病变

56例恶性病变(前列腺腺癌)T2加权成像可见病灶, DWI可见强信号且ADC值较小(图1, 图2)。

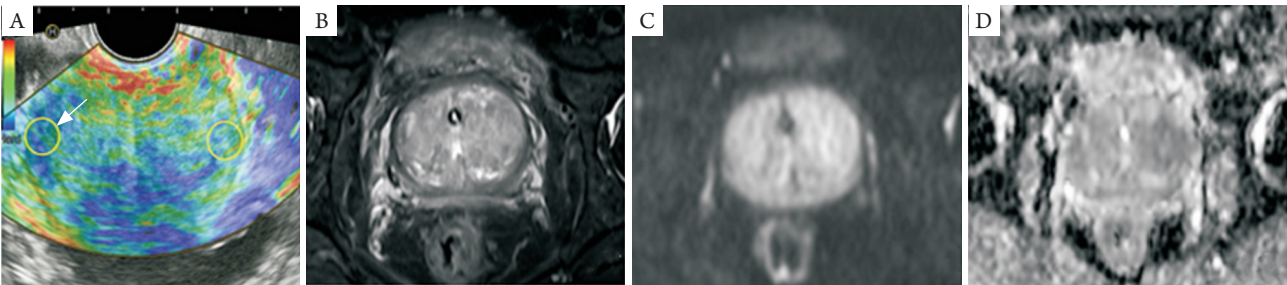


图1穿刺病理证实为前列腺增生患者TRUS图像及MRI图像

Figure 1 TRUS image and MRI image of patients with prostate hyperplasia confirmed by puncture pathology

(A) TRUS下图像, 可见右侧外周带低回声区(箭头); (B) T2加权成像; (C) DWI图; (D) ADC图, ADC值= $1.559 \times 10^{-3} \text{ mm}^2/\text{s}$, 右侧周围带未见异常信号。

(A) Image under TRUS, visible peripheral hypoechoic area (arrow) on the right side; (B) T2-weighted imaging; (C) DWI; (D) ADC value = $1.559 \times 10^{-3} \text{ mm}^2/\text{s}$, no abnormal signals around the right side.

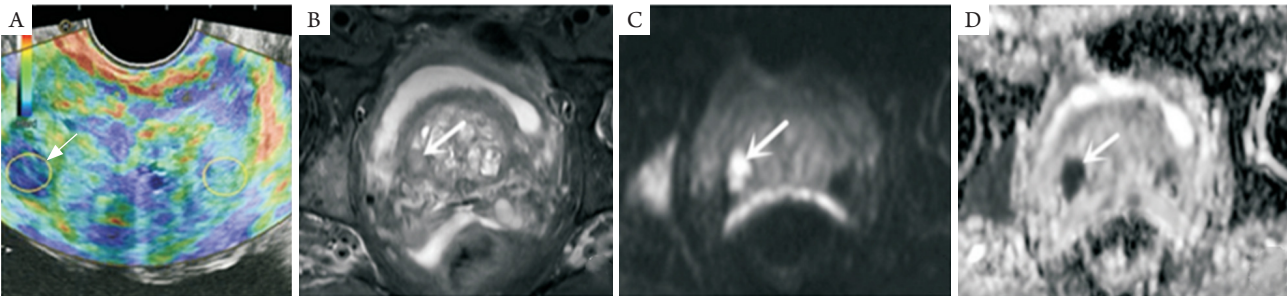


图2穿刺病理证实为PCa患者TRUS图像及MRI图像

Figure 2 TRUS images and MRI images of PCa patients confirmed by puncture pathology

(A) TRUS下图像, 可见右侧周围带低回声区(箭头); (B) T2加权成像, 病灶可见; (C) DWI显示右侧周围带信号强; (D) ADC图显示右侧边缘结节信号弱, ADC值= $0.812 \times 10^{-3} \text{ mm}^2/\text{s}$ 。

(A) Image under TRUS, low echoic area (arrow) around the right side can be seen; (B) T2-weighted imaging, lesions can be seen; (C) DWI shows strong peripheral signal on the right side; (D) ADC shows weak signal on the right edge nodules, ADC value = $0.812 \times 10^{-3} \text{ mm}^2/\text{s}$.

2.3 DWI 量化诊断 PCa 的 ROC 曲线分析

DWI下PCa患者ADC值明显低于前列腺增生患者 $[(0.810 \pm 0.091) \text{ mm}^2/\text{s} \text{ vs } (1.499 \pm 0.293) \text{ mm}^2/\text{s}, t=16.878, P<0.05]$ 。以ADC值作为检验变量, 以病理诊断作为状态变量(恶性=1, 良性=0), 得出ADC值诊断前列腺良恶性肿瘤的AUC为0.869, 以ADC值 $=1.091 \text{ mm}^2/\text{s}$ 为界点值评估良恶性肿瘤的敏感性、特异性分别为83.9%、76.5%(表1, 图3)。

表1 ADC值诊断PCa的价值

Table 1 Value of ADC value in PCa diagnosis

ADC值	病理结果		合计
	+	-	
+	47	16	63
-	9	52	61
合计	56	68	124

ADC值取 $1.091 \text{ mm}^2/\text{s}$ 。

ADC value $=1.091 \text{ mm}^2/\text{s}$ 。

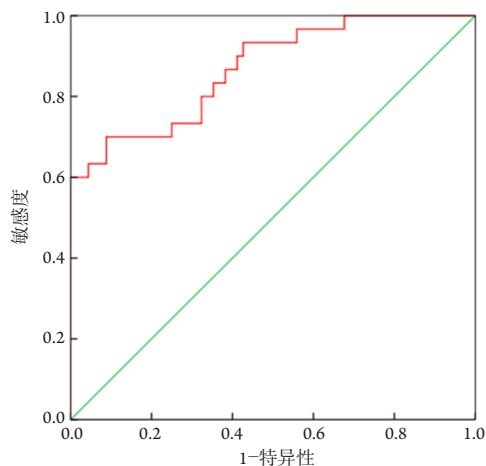


图3 ADC值诊断PCa的ROC曲线分析

Figure 3 ROC curve analysis of ADC value in PCa diagnosis

2.4 TRUS 系统穿刺与 DWI 靶向引导穿刺法 PCa 情况比较

DWI靶向穿刺活检针数显著少于TRUS系统穿刺活检针数, 且DWI靶向穿刺活检阳性针中肿瘤组织占比明显高于TRUS系统穿刺, 差异均具有统计学意义($P<0.05$, 表2)。

表2 TRUS系统穿刺与DWI靶向引导穿刺的PCa情况比较

Table 2 Comparison of PCa in TRUS systematic puncture and DWI targeted puncture

指标	DWI靶向引导 穿刺法	TRUS系统 穿刺	P
穿刺针数	2.5 ± 0.9	11.3 ± 2.5	<0.001
阳性针中肿瘤 组织比例	44.3%	32.1%	<0.001

3 讨论

近年来我国PCa的发病率呈逐年上升趋势, 临床高效鉴别前列腺疾病的良、恶性意义重大。TRUS是筛查PCa的常用方法, 然而因个体存在差异, TRUS直接区分良、恶性结节难度较大, 有些恶性病变在TRUS下并不能被发现, 临床误诊率高^[8-9]。穿刺活检是前列腺结节良、恶性确诊的主要手段^[10]。目前公认的术前定性诊断PCa的“金标准”为经典的TRUS引导下的前列腺系统穿刺活检^[11], 然而通常穿刺针数在10针以上, 极大地增大了穿刺并发症的发生率, 即便是通过超声发现低回声结节进行靶向穿刺也并不能提高PCa的检出率^[12]。因此如何保证前列腺病变诊断的准确率的情况下降低穿刺对患者损伤, 提高穿刺活检阳性率是临床研究的热点问题。

DWI技术是20世纪90年代初中期发展起来的MRI新技术, 可检测活体组织内水分子扩散运动的无创手段, 通过机体内水分扩散快慢检测病变^[13]。前列腺疾病具有复杂病理形态及多种组织学变异, 正常或良性增生的前列腺腺体和腺管结构丰富, 水分子运动自由性较高, 弥散不受限制, ADC值较高, 而恶性病变明显使水分子扩散受阻, ADC值减小, 主要是因为肿瘤浸润生长及增殖导致该区域组织细胞排列紧密而影响水分子扩散^[14]。因此近年来有学者^[15]将其应用于PCa的诊断。本研究除比较前列腺疾病良、恶性DWI下ADC值的差异, 更重要的是通过绘制ADC值的ROC曲线创新性地量化指出ADC鉴别前列腺良恶性病变的最佳临界值为 $1.091 \text{ mm}^2/\text{s}$, 此时AUC为0.869, 敏感性为83.9%, 提示DWI不仅能够可视化地鉴别PCa, 而且通过ADC值还可量化反映前列腺组织病变的信息, 且对诊断前列腺疾病良、恶性病变具有较高

的价值, 不过也应指出DWI量化鉴别PCa的特异性未超过80%, 提示前列腺钙化、合并炎症、病灶部位及大小等可能对诊断结果造成一定的影响, 这就要求临床对一些复杂病变, 需通过超声结合DWI以提高对可疑病灶的诊断^[16-17]。

靶向穿刺通过实时检测或图像引导穿刺活检, 是近年来受欢迎的新型穿刺手法。DWI靶向引导穿刺活检是将穿刺前的MRI, DWI图像与穿刺相融合, 利用MRI, DWI图像定位靶病灶进行穿刺活检^[18]。研究结果显示相较于传统穿刺, DWI靶向穿刺明显减少了穿刺活检针数且穿刺活检阳性针中肿瘤组织占比明显提高, 提示DWI靶向穿刺过程中病灶位置实时可见, 靶向穿刺定位准确, 这有助于减少穿刺术后并发症的发生, 安全性更高。当然靶向穿刺对穿刺医师阅读图像的能力提出了更高的要求, 且存在的缺点是不能准确地定位较大体积前列腺内的较小病灶^[18]。

综上所述, DWI可定性及量化鉴别诊断前列腺良、恶性病变, 其中ADC值对PCa的诊断效能较高。DWI靶向引导前列腺穿刺活检相较于经典系统穿刺可通过更少的穿刺针数获得相似的肿瘤检出率且阳性针中可提供更多的肿瘤组织供病理医师判读。

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