

· 论 著 ·

磁共振扩散加权成像在肝癌经导管动脉化疗栓塞术后随访中的初步临床应用

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[摘要] **目的:**初步探讨磁共振(MR)扩散加权成像(DWI)在肝癌经导管动脉化疗栓塞术(TACE)后随访中应用的可行性和临床价值。**方法:**在 1.5T MR 机上,对 16 例肝癌行 TACE 术后患者分别进行 DWI 检查和 MR 常规平扫(T₁WI 和 T₂WI)。DWI 检查取扩散敏感梯度因子(b 值)为 0 及 500 s/mm²,利用固定参数组合的自旋回波-平面回波(SE-EPI)序列,在各种成像序列上计数新发病灶数目,计算在 DWI 与 T₂WI 上病灶与肝组织之间的对比噪声比(CNR)并予以比较;与 DSA 检查对照,定性评价 DWI 对肿瘤残留或复发活组织的检出能力。**结果:**DWI 共显示肝内新发病灶 46 个,T₂WI 显示 43 个,T₁WI 显示 38 个。DWI 及 T₂WI 序列,新发病灶与肝组织之间的 CNR 差异有统计学意义($P=0.0151$)。行 TACE 术后病灶内部 DWI 信号较复杂,2 例病灶为碘油沉积完整,DSA 检查无肿瘤染色,DWI 为均匀低信号;2 例病灶为碘油沉积但出现局部缺损,DSA 检查可见缺损区肿瘤染色,DWI 图像上碘油沉积区表现为低信号,肿瘤染色区为高信号;12 例病灶 DSA 检查可见无或稍许碘油沉积,造影见大量肿瘤染色,其内有无或轻微染色的缺血、坏死的肿瘤组织,DWI 图像上肿瘤染色区域表现为高信号,缺血坏死区为低或较低信号。**结论:**DWI 是一种敏感的检测肝癌 TACE 术后肝内新发病灶的无创性成像方法,可监测 TACE 术后病灶残留或复发活组织和碘油沉积情况,可以用于肝癌 TACE 术后的临床随访。

[关键词] 肝肿瘤;磁共振扩散加权成像;经导管动脉化疗栓塞术;随访

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Clinical application of diffusion weighted MR imaging in follow-up of patients receiving transcatheter arterial chemoembolization for liver cancer

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[ABSTRACT] **Objective:** To evaluate the feasibility of diffusion-weighted imaging (DWI) application in follow-up of patients receiving transcatheter arterial chemoembolization (TACE) for liver cancer and its clinical value. **Methods:** DWI and routine non-enhanced MRI were performed in 16 liver cancer patients after TACE with the same SE-EPI sequence ($b=500$ s/mm² and 0) on 1.5 T MRI. The numbers of the new lesions detected by DWI, T₁WI and T₂WI were counted. Contrast noise ratios (CNR) between new lesions and liver tissues on DWI and T₂WI were calculated and compared. The efficacy of SWI in diagnosis of residual tumor and recurrent cancer was qualitatively evaluated by comparing with DSA results. **Results:** DWI revealed 46 new lesions, T₂WI revealed 43, and T₁WI revealed 38. There was significant difference in CNR between new lesions and liver tissues on DWI and T₂WI ($P < 0.05$). The signal intensities of liver cancer on DWI were complicated after TACE. Homogeneous accumulation of iodized oil was observed on DSA in 2 of 16 patients with liver cancer after TACE; there was no tumor staining on DSA at the corresponding site of homogeneous hypointensity on DWI. Partial defect of accumulation of iodized oil was noticed in 2 of 16 patients; there was tumor staining on DSA at the corresponding site of hyperintensity on DWI. No or faint accumulation of iodized oil was noticed in 12 patients; there was strong tumor staining at the corresponding site of hyperintensity on DWI; necrosis tumor had no or slight tumor staining on DSA at the corresponding site of hypointensity on DWI. **Conclusion:** Diffusion MRI is a sensitive method for detecting new lesions in patients with liver cancer after TACE, and can be used to monitor residual, recurrent cancer and iodized oil accumulation during follow-up of patients after TACE.

[KEY WORDS] liver neoplasms; diffusion weighted magnetic resonance imaging; transcatheter arterial chemoembolization; follow-up

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肝癌是世界上最常见的恶性肿瘤之一。介入治疗是目前公认的不可切除中、晚期肝癌的主要治疗手段,其中介入栓塞化疗(transarterial chemoem-

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blolization, TACE)是临床肝癌介入治疗的主要方法,它在抑制肿瘤生长、提高患者生存率等方面取得了明显效果。术后随访中及时和准确评价疗效是TACE术取得良好临床疗效的重要保证。目前在临床上主要的随访方式有CT、MRI和PET等。本研究初步探讨磁共振(MR)扩散加权成像(diffusion weighted imaging, DWI)在肝癌患者TACE术后随访中运用的可行性和价值。

1 资料和方法

1.1 病例资料 选择长征医院2007年1月至2007年3月肝癌TACE患者16例,其中男性14例,女性2例,年龄36~78岁,中位年龄59.5岁,包括原发性肝癌15例(所有患者均符合1990年全国肿瘤防治办公室、中国抗癌协会制定的原发性肝癌临床诊断标准^[1]),肺癌肝转移瘤1例(手术病理证实)。其中3例为2次TACE后,5例为3次TACE后,6例为4次TACE后,1例为5次TACE后,1例为7次TACE后。患者本次检查距上次TACE术后45~101 d,平均64.5 d。

1.2 检查方法 GE 1.5T MR成像仪(GE Signa 1.5T HD),8通道相控阵柔软体部线圈。所有患者均作常规轴位T₁WI、T₂WI,冠状面T₂WI和DWI。T₂WI主要成像参数:SSFSE, TR/TE 2 000 ms/130~135 ms,层厚7 mm,间隔0.5 mm,FOV 26~28 cm,矩阵256×256, NEX 2。DWI主要成像参数:ASSET校正,SE-EPI采集,b=0和500 s/mm²,方向ALL, TR/TE 1 500 ms/minimum,层厚7 mm,间隔0.5 mm,FOV 26~28 cm,矩阵256×256, NEX 2,屏气扫描,扫描时间24 s。定位参数均直接复制T₂WI参数,保证图像的一致性。所有图像传输至GE后处理工作站(ADW 4.2),经Functool软件分析。

所有病例均同期行DSA血管造影检查。在Toshiba旋转数字减影血管机引导下,所有患者均经股动脉入路,常规行腹股沟区备皮、消毒、铺巾、局部麻醉穿刺点,以Seldinger改良法穿刺股动脉成功后,顺次置入导引导丝和导管鞘,引入Cook 5F RH管选择腹腔干或肝总动脉造影观察肿瘤染色情况。

1.3 影像学分析 (1)对各序列显示的新发病灶数目进行计数;由两名高年资诊断学主治医师分别对各序列显示的病灶数目进行计数,并对照患者上次TACE术前影像资料(主要是CT图像),确定新发病灶数目。

(2)计算DWI、T₂WI序列中同时能观察到的新

发肿瘤结节与周围肝组织之间的对比信噪比(CNR):测量新发病灶(最大径1~3 cm)的信号值,在不超过病灶范围的前提下,测量时感兴趣区面积尽量大;测量肝组织信号时避开血管与胆管等结构,噪声信号测量时感兴趣区置于图像以外的前或后外侧、无伪影处。对比信噪比计算公式 $CNR = (SI_{tumor} - SI_{liver}) / Noise$, (SI_{tumor}为病灶信号强度,SI_{liver}为肝组织信号强度,Noise为背景噪声标准差)。

(3)观察DSA造影图像,分析病灶内部碘化油沉积情况,肿瘤血供、肿瘤染色和肿瘤坏死情况,并与DWI图像相对照,分析碘化油沉积区、肿瘤坏死区和肿瘤复发/残留区等在DWI图像上的信号特点。

1.4 统计学处理 用非参数统计方法Wilcoxon秩和检验比较DWI、T₂WI显示病灶的对比噪声比的差异。统计软件为SAS 9.1.3版。

2 结果

2.1 各序列检测肝癌TACE术后肝内新发病灶的数目 新发病灶在T₁WI表现为低信号,T₂WI和DWI上均为高信号或较高信号,部分小病灶(<1.0 cm)在T₂WI信号相对较低,极易漏检或不能显示。本组病例中,T₁WI发现新发病灶38个,T₂WI发现43个,DWI显示46个。见图1。

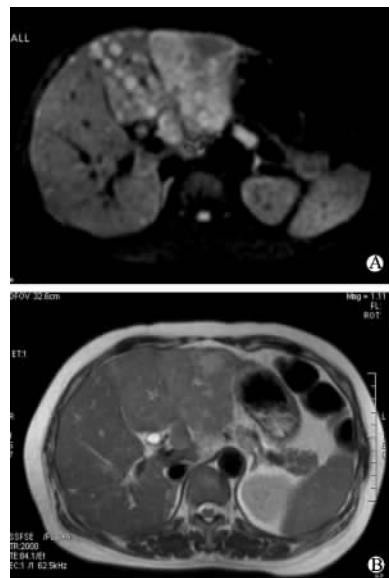


图1 肝癌TACE术后MRI随访中DWI和T₂WI图像比较

Fig 1 MR diffusion-weighted image and T₂-weighted image in follow-up of patients with liver cancer after TACE

A 52-year-old female patient with liver cancer in the left lobe received TACE twice. DWI(A) showed several nodules with higher CNR compared with T₂WI(B), suggesting recurrent viable tumor

2.2 DWI与T₂WI检测肝癌TACE术后肝内新发病灶的CNR比较 本组共测量16个最大径范围在1~3 cm的新发病灶DWI和T₂WI的CNR(表1)。

表1 肝癌TACE术后新发病灶T₂WI和DWI的CNR比较

Tab 1 Comparison of CNR between new lesions and liver tissues on diffusion-weighted and T₂-weighted images

No.	CNR DWI	CNR T ₂ WI
1	82.00	70.85
2	73.84	61.01
3	68.84	43.75
4	65.31	43.17
5	58.70	36.58
6	57.42	33.63
7	46.19	29.89
8	43.47	28.82
9	42.99	24.14
10	39.58	24.13
11	36.91	23.20
12	30.04	22.24
13	29.76	17.33
14	25.70	10.82
15	24.85	9.87
16	22.78	9.51

The value of CNRs on diffusion-weighted images was significantly higher than the value of CNRs on T₂-weighted images of new lesions (nonparametric statistics, a Wilcoxon rank sum test was used, $S=329.000, Z=2.43094, P=0.0151$)

采用非参数统计方法成组设计资料两样本Wilcoxon秩和检验,正态近似法结果为 $S=329.000, Z=2.43094, P=0.0151$,两者差异有统计学意义,可以认为新发病灶DWI成像具有更好的信噪比。

2.3 TACE术后病灶的造影特点和DWI信号特征 本组资料中,16例患者共分析TACE术后病灶16个。其中2例病灶CT平扫示碘油沉积良好、完整,DSA造影未见明显肿瘤染色,DWI上表现为圆形或类圆形均匀一致低信号灶(图2);2例病灶碘油沉积,但内部碘油较松散、沉积灶欠光整,DSA造影可见碘油沉积灶周边部局部出现肿瘤染色,在DWI上病灶碘油沉积区表现为低信号,但低信号灶形态不完整,局部周边可见不规则高信号改变(图3);9例患者病灶DSA检查见散在分布不规则小点状或小片状碘油沉积灶,造影见肿瘤染色明显,尤其是肿瘤周边部,在DWI上主要是大片高信号,其内可见散在碘油沉积区呈小点、片状低信号;3例病灶DSA下未见明显残留的碘油沉积,造影见大量肿瘤染色,病变中央部可见不规则形或稍许染色区,代表肿瘤缺血、坏死区,DWI病灶主要为圆形、类圆形或不规则形高信号,内部可见不规则形、边界移行的高低或较低信号区域,与DSA下肿瘤缺血、坏死区相对应(图4)。



图2 肝癌TACE术后碘油沉积完整病灶的DWI、DSA和CT图像特征

Fig 2 DWI, DSA and non-contrast CT image features of homogeneous accumulation of iodized oil within lesion after TACE

A 38-year-old man with liver cancer in the right lobe received TACE twice. Three months after TACE, homogeneous hypointensity within tumor was seen on DWI(A). DSA(B) and non-contrast CT(C) showed homogeneous accumulation of iodized oil within tumor, with no tumor staining

3 讨论

TACE是治疗肝癌尤其是原发性肝癌的重要临床方法,通过TACE术为部分不能手术切除的患者赢得了手术切除的机会,同时TACE在延长中晚期肝癌的生存时间和改善生活质量上也发挥着巨大的

作用。大量的研究表明,肝癌有丰富的侧支循环,这是肝癌容易复发的重要原因^[2],在临床上,一般患者都需要接受数次TACE术,在治疗随访过程中,及时准确评价疗效是临床取得满意疗效的保证。目前临床上主要运用CT、MRI和PET(PET/CT)等^[3-5]。CT是首选的随访方式。通过CT平扫和增

强检查,可以观察碘化油栓塞后的药物沉积状况,通过增强检查可以较准确计数病灶数目、评价病灶的

活性组织,同时也可通过 CTA 技术进行肿瘤供血血管的显示,对手术有指导意义^[6-7]。

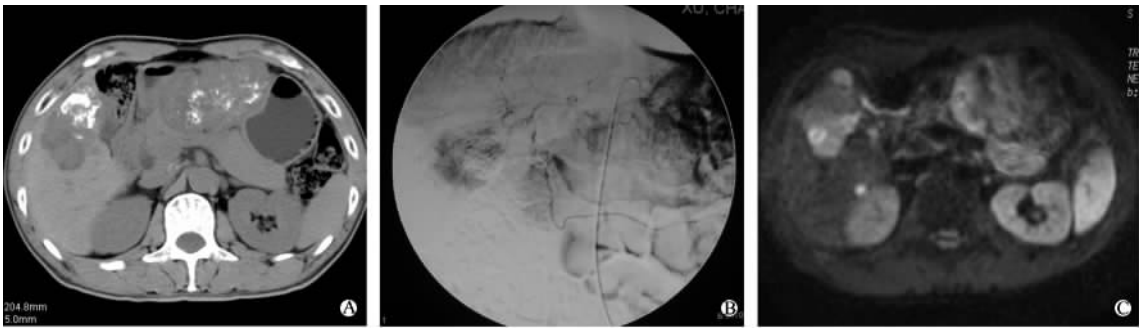


图 3 肝癌 TACE 术后碘油沉积不完整病灶的 CT、DSA 和 DWI 图像特征

Fig 3 DWI, DSA and non-contrast CT image features of partial defect in accumulation of iodized oil within lesion after TACE

A 49-year-old man with liver cancer in the right lobe received 3 times of TACE. CT(A) and DSA(B) showed partial defect in accumulation of iodized oil 14 weeks after TACE. The region of iodized oil accumulation showed no tumor staining on DSA and hypointensity on DWI(C). DSA also showed tumor staining corresponding site of hyperintensity on DWI around tumor, suggesting recurrent viable tumor; therefore, TACE was repeated

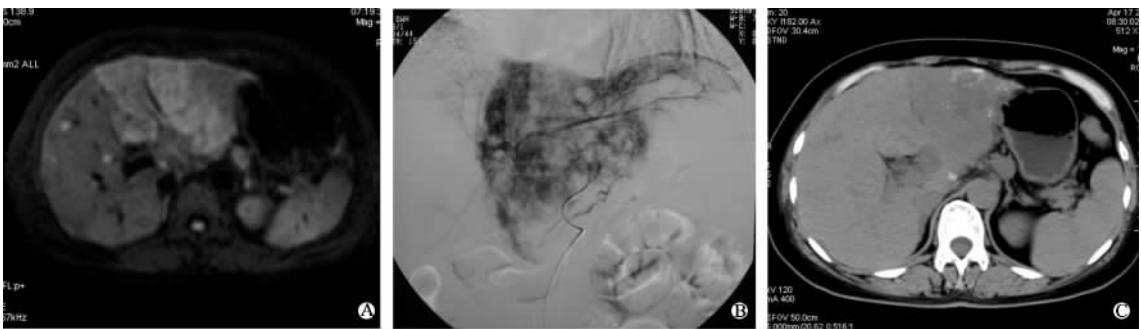


图 4 肝癌 TACE 术后无或少许碘油沉积病灶的 DWI、DSA 和 CT 图像特征

Fig 4 DWI, DSA and non-contrast CT image features with no or slight accumulation of iodized oil within lesion after TACE

A 52-year-old female patient with liver cancer in left lobe received TACE twice. Recurrent viable tumor in left lobe showed hyperintensity on DWI(A) and tumor staining on DSA(B). There is regional hypointensity on DWI at corresponding site of non tumor staining on DSA, suggesting necrosis tumor tissue had regional lower density and slight accumulation of iodized oil on non-contrast CT(C)

近年来,国内外学者也在研究 MRI 用于随访的临床价值^[8-9]。由于磁共振成像具有良好的组织分辨率、无辐射损失等优势,特别是一些新技术的开发应用,显示出在此方面应用的良好潜质。

DWI 是通过检测生物组织内水分子运动状态的改变来间接反映组织结构及细胞功能变化等信息。DWI 对于组织的一些生理学和形态学改变非常敏感,如细胞密度、组织活性,以及对各种治疗的反应等。近年,国外已有学者应用 DWI 对肿瘤疗效进行了临床和相关实验研究^[10-11]。DWI 显示了在肿瘤放化疗疗效的预测和早期评价方面具有的潜质。

在本组资料中,我们发现 T₂WI 和 DWI 在检出

肝脏 TACE 术后肝内新发病灶的能力是相当的(分别发现 46 和 43 个),均比 T₁WI 敏感(发现 38 个)。在病灶-肝脏对比信噪比(CNR)的研究中,DWI 与 T₂WI 中新发病灶的 CNR 差异有统计学意义(P=0.015 1),可以说明新发病灶在 DWI 上较 T₂WI 上拥有更高的信噪比,与一些文献报道相一致^[12-13],由于肝癌含水量增多,分子自由弥散运动受限,在 DWI 成像时其信号强度明显增高。可以认为 DWI 是肝癌 TACE 术后检测新发小病灶的敏感序列。

在 16 个 TACE 术后的肿瘤病灶造影特点和 DWI 信号特征的分析中,病灶内部信号在 DWI 是复杂的,与 DSA 造影对照分析发现,在 DWI 图像上,TACE 术后病灶的残留或复发组织、碘油的沉积

情况以及肿瘤组织的缺血坏死在 DWI 图像上均各有特征,能够很好地将它们区分开来。在本组资料中,有 2 个 TACE 术后病灶碘油沉积良好、完整,DSA 造影未见复活的活组织,在 DWI 上表现为类圆形的均匀一致的低信号;2 个病灶碘油沉积,但在局部边缘碘油缺损,DSA 造影显示局部出现肿瘤染色,说明存在复发活肿瘤组织,在 DWI 图像上,碘油沉积区呈低信号,而肿瘤复发区则为高信号改变;在 12 个碘油沉积不良或无沉积的病灶中,DSA 造影见复现大量肿瘤染色,病灶内部均有不同程度的缺血坏死区,表现为无或乏肿瘤染色区,边界移行,在这些病灶的 DWI 图像上,散在分布的残留碘油灶表现为低信号,DSA 示缺血坏死的肿瘤组织也表现为较低或低信号。

我们知道,在肝癌 TACE 术后随访中,影像学检查的主要任务是确定有无新发病灶,肿瘤坏死情况以及有无残留或复发的肿瘤活组织,通过本研究的初步结果来看,DWI 能够较敏感地检出新发病灶,同时显示肿瘤活组织和观察碘化油沉积情况亦有相当的应用前景。在后续的研究中,我们将通过 ADC 测量与增强 CT 相对照,定量分析 DWI 在评价肝癌 TACE 术后监测坏死和残留或复发的肿瘤组织的能力。

总之,通过本研究发现 DWI 能够较敏感地检出 TACE 术后新发病灶,亦能较准确显示肿瘤活组织、坏死组织和碘化油沉积情况,同时由于其成像方法相当简捷、无损伤等优点,在临床上用于肝癌 TACE 术后随访是可行的,其临床应用前景亦相当诱人。

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