可变反转角HASTE序列在腹部检查中的应用

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【摘要】目的:评估可变反转角半傅里叶单次激发快速自旋回波(vfl HASTE)序列在腹部检查中的应用价值。方法:共选择需行腹部检查78例患者,并通过传统HASTE序列和vfl HASTE序列检查进行冠状位和轴位扫描。评估两个序列获得肝脏组织结构及肝内病灶图像的信噪比和对比信噪比。并由两名放射科医生评估两种图像的清晰度和伪影,进行分析处理。结果:所有检查均顺利完成,vfl HASTE序列图像相对于传统HASTE序列肝组织结构SNR、肝内病灶SNR和肝脾CNR,差异无统计学意义($P>0.05$)。vfl HASTE序列图像锐利度更高伪影更少,对组织和病灶显示更清晰($P<0.05$)。结论:vfl HASTE序列降低了传统HASTE序列的模糊伪影,软组织和病灶显示更清晰,在腹部检查中更有价值。

【关键词】腹部;磁共振成像;可变反转角;半傅里叶单次激发快速自旋回波序列

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Application of variable flip angle HASTE sequence in abdominal examination

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Abstract: Objective To evaluate the application value of variable flip angle half-Fourier acquisition single-shot turbo spin-echo (vfl HASTE) sequence in abdominal examination. Methods A total of 78 patients who needed abdominal examination were enrolled in this study. The coronary and axial scans were performed on the patients by traditional HASTE sequence and vfl HASTE sequence. The signal-to-noise ratios and contrast-to-noise ratios of liver tissues and intrahepatic lesions which were obtained by two different kinds of sequences were evaluated. Moreover, the clarity and artifact of the two kinds of images were evaluated by two radiologists. Results All the examinations were successfully completed. There was no difference in the signal-to-noise ratio of liver tissues and intrahepatic lesions and the contrast-to-noise ratio of liver and spleen between images obtained with vfl HASTE sequence and those obtained with traditional HASTE sequence ($P>0.05$). However, compared with the images obtained with traditional HASTE sequence, those obtained with vfl HASTE sequence not only had higher sharpness, fewer artifacts, but also displayed tissues and lesions more clearly ($P<0.05$). Conclusion vfl HASTE sequence which reduces the fuzzy artifacts in the traditional HASTE sequence and displays soft tissues and lesions more clearly is more valuable in abdominal examination.

Keywords: abdomen; magnetic resonance imaging; variable flip angle; half-Fourier acquisition single-shot turbo spin-echo

前 言

随着磁共振成像(Magnetic Resonance Imaging, MRI)技术的发展,MRI在腹部病变的诊断中越来越重要。腹部病变结构复杂,而且易受呼吸、血管搏动、心脏跳动等影响,要求检查序列更快速,组织对比更清晰[1-3]。目前,半傅里叶单次激发快速自旋回波(Half-Fourier Acquisition Single-Shot Turbo Spin-Echo, HASTE)序列因其检查时间短、图像对比度好而被广泛应用于腹部检查[4-5]。但HASTE序列成像基础会导致图像有不同程度的模糊伪影,而可变反转角HASTE(Variable Flip Angle Half-Fourier Acquisition Single-Shot Turbo Spin-Echo, vfl HASTE)序列可以通过改变反转角的大小来减少图像模糊,以获得更清晰的图像。本研究比较传统HASTE序列和vfl HASTE序列在腹部成像中的成像效果,旨在评估vfl HASTE序列在腹部检查中的应用价值和优势。

1 材料与方法

1.1 基本材料

共选择需行腹部MRI检查78例患者,男51例,女27例,年龄28~75岁,平均年龄51.4岁。患者均签署MRI检查知情同意书。

1.2 扫描方法

扫描前,患者禁水禁食6 h,并进行呼吸屏气训练。扫描设备采用西门子3.0 T spectra,腹部线圈。患者头先进,仰卧位,进行屏气下腹部冠状位和轴位HASTE和vfl HASTE扫描。具体扫描参数见表1。

表1 传统HASTE和vfl HASTE序列主要扫描参数
Tab.1 Main scanning parameters of traditional
HASTE and vfl HASTE sequences

参数	HASTE	vfl HASTE
FOV	400	400
Phase	100%	100%
TR/TE	1 200/92	1 200/94
Part Fourier	4/8	4/8
Voxel/mm	1.6*1.6*5	1.6*1.6*5
BW	698	698
Turbo fact	256	256

HASTE:半傅里叶单次激发快速自旋回波序列;vfl ASTE:可变反转角半傅里叶单次激发快速自旋回波序列;FOV:视野;TR:重复时间;TE:回波时间;BW:带宽

1.3 图像测量和分析

分别在传统HASTE和vfl HASTE图像上测量肝脏和病灶信号强度(Signal Intensity,SI)、同层脾脏的信号强度(SIm)及同层水平的背景噪声标准差(SDn);然后计算信噪比(Signal-to-Noise Ratio,SNR)和对比噪声比(Contrast-to-Noise Ratio, CNR):SNR=SI/SDn,CNR=(SI-SIm)/SDn。

由两位高年资医师用5级分法对图像质量进行评分。其中,5分:图像质量好,肝内结构或病灶边缘锐利,无图像模糊或伪影,完全符合诊断要求;4分:图像质量良好,肝内结构或病灶较锐利,图像轻度模糊或伪影,符合诊断要求;3分:图像质量一般,肝内结构能够辨认,图像中度模糊或伪影,不影响诊断分析;2分:图像质量差,肝内结构不清,大致能够辨认,但有明显伪影,不符合诊断要求;1分:图像质量极差,显示不清,图像模糊、伪影很多,完全不能用于诊断。

1.4 统计学分析

采用SPSS 22.0软件对肝脏及病灶的SNR、肝脾的CNR和图像质量评分进行配对t检验。$P<0.05$为差异有统计学意义。

2 结　果

患者均完成MRI检查,其中5例患者因呼吸引起图像伪影较大,其余获得图像均可用于诊断,肝内组织血管、胆管及占位病灶等组织均可清晰显示。肝内发现原发性或转移肝癌病灶患者54例,肝脏血管瘤患者18例,其余6例未见明显占位性病灶。

传统HASTE序列图像中,肝组织结构SNR、肝内病灶SNR和肝脾CNR分别是20.64±9.13、32.87±33.33和23.73±23.87;而在vfl HASTE序列图像中,相应数值分别是20.14±8.10、30.60±30.79和23.48±20.52,差异无统计学意义($P>0.05$)。

图像质量评分结果显示传统HAST序列和vfl HASTE序列得分别为3.25±0.46和4.53±0.58,差异有统计学意义($P<0.05$),但两名医生间的统计无差异。vfl HASTE序列图像清晰度更好,肝组织及病灶显示边缘更清晰,伪影更少,对诊断影响小(图1)。

3 讨　论

3.1 HASTE序列扫描的优劣

HASTE序列一次90°激励脉冲后连续应用多个180°聚焦脉冲,采集一系列回波信号,完成略多于一半的K空间数据,根据K空间共轭的特性进行重建图像。因为有效回波时间较长,序列有较明显的T_2加权图像的特征,软组织病灶对比度较高。HASTE序列采集速度快,运动伪影显著减少,图像质量高,每幅图像仅一次激发就可完成数据采集。在1~2次屏气中完成腹部数据采集能有效地避免腹部呼吸运动的影响。HASTE序列的缺点在于使用较长的回波链长度,回波链长度中末端回波信号的幅度变小,造成整个回波链信号幅度差异变大,进行傅里叶变化时图像数据发生缺失,引起图像模糊,信噪比下降[6-10],故HASTE序列图像信噪比较低,图像较模糊。同时HASTE序列采用一系列180°重聚脉冲会造成人体射频能量选择性吸收值偏高,在高场强时更明显。

3.2 vfl HASTE序列的改进与不足

vfl HASTE针对HASTE序列的缺点对180°重聚脉冲进行改进。不再固定重聚脉冲,而是采用可变翻转角的超长回波链采集。根据特定算法优化的可变翻转角模式可以克服T_2衰减效应,使回波信号在长回波链长度差异变小,避免长回波链带来的模糊
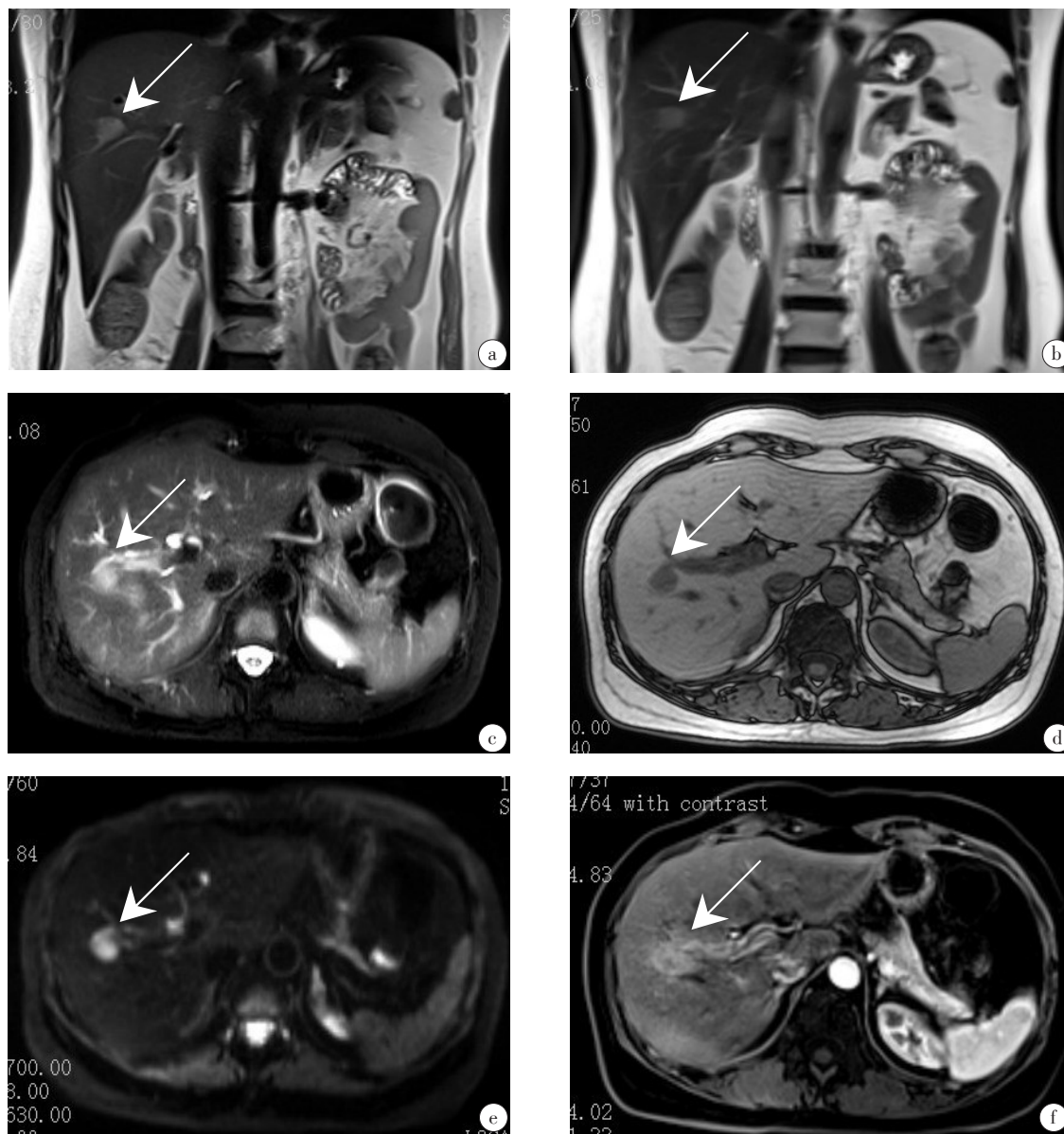
图1　48岁女患者结肠癌术后图像
Fig.1 Postoperative images of a 48−year−old female patient with colon cancer
平扫可见肝脏右叶圆形病灶(箭头), T$_2$呈高信号(图 1a HASTE、图 1b vfl HASTE、图 1c HASTE 压脂序列)、T$_1$WI 呈低信号(图 1d)、DWI 呈高信号(图 1e); 增强扫描(图 1f)可见病灶明显强化。根据病灶扫描显示可见 vfl HASTE 序列图像(图 1b)相对于传统 HASTE 图像序列(图 1a 和 c)更清晰和模糊程度更低

效应[11-15], 因此应用 vfl HASTE 序列采集的图像更清晰, 更有利于病灶的显示。而且由于重聚脉冲不再是统一的大角度重聚脉冲, 人体射频能量选择性吸收值也会显著降低[16]。

　　传统 HASTE 序列图像和 vfl HASTE 序列图像相对于呼吸门控 TSE 图像质量都有不足, 成像优势在于呼吸等运动伪影控制较好。当 HASTE 序列图像显示不清时应当进行呼吸门控 TSE 成像, 并在检查前进行严格的呼吸训练以避免运动伪影[17-18], 继续提高图像质量和信噪比是 HASTE 序列改进的目标。

　　总而言之, vfl HASTE 序列通过可变反转角提高传统 HASTE 序列的图像清晰度, 对肝内组织和病灶显示更清晰, 同时降低患者射频能量选择性吸收值。vfl HASTE 序列在腹部检查中具有较大的发展潜力和优势, 应成为腹部检查的常规序列。

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