

T1 FLAIR PROPELLER序列在3.0T磁共振颅脑增强成像上对抑制各种伪影的应用

骆众星, 石健强, 谢斯栋, 康 庄

中山大学附属第三医院放射科, 广东 广州 510630

【摘要】目的:探讨3.0T磁共振上利用T1 FLAIR PROPELLER序列在颅脑增强成像时对消除各种血管搏动伪影及头部运动伪影和金属伪影等的应用价值。**方法:**对108例患者行常规头部平扫和增强检查,应用PROPELLER技术进行钆造影剂注射后的T1 FLAIR三平面扫描,与常规T1 FLAIR三平面序列进行对比,并进行图像伪影评价。**结果:**108例患者常规增强T1 FLAIR序列均有不同程度的血管搏动伪影,25例患者有明显的运动伪影,22例患者有金属伪影(固定义齿或手术缝合钉、钛板等),这些伪影严重影响图像质量,有部分导致诊断的假阳性判断。应用PROPELLER技术后的T1 FLAIR序列,对比发现,108例均明显消除了血管搏动伪影,106例没有明显运动伪影,22病例金属伪影均有所减轻,获得了有诊断价值的图像。两种序列图像质量有显著差异($P<0.01$)。**结论:**应用PROPELLER技术的T1 FLAIR序列,能最大限度地消除头部增强扫描中的血管搏动伪影以及降低运动伪影、金属伪影,可提供更有临床诊断价值的理想图像。

【关键词】磁共振成像;头部;增强成像;T1 FLAIR PROPELLER;血管搏动伪影;运动伪影;金属伪影

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Application of T1 fluid- attenuated inversion recovery sequences of periodically rotated overlapping parallel lines enhanced reconstruction in inhibiting various kinds of artifacts during 3.0T magnetic resonance imaging brain enhanced imaging

LUO Zhong-xing, SHI Jian-qiang, XIE Si-dong, KANG Zhuang

Department of Radiology, Third Affiliated Hospital of Sun Yat-sen University, Guangzhou 510630, China

Abstract: Objective To discuss on the application value of T1 fluid-attenuated inversion recovery (FLAIR) sequences of periodically rotated overlapping parallel lines enhanced reconstruction (PROPELLER) applied in 3.0T magnetic resonance imaging in eliminating all kinds of vascular pulsation artifacts, head shaking artifacts and metal artifacts during craniocerebral enhanced imaging. **Methods** Conventional head scans and enhanced examinations were carried out for 108 patients. PROPELLER technology was used to undergo the T1 FLAIR three planar scan after gadolinium contrast injection. Compared with conventional T1 FLAIR three planar sequences, image artifacts were evaluated. **Results** Significant differences were found in the image quality of these two kinds of sequences ($P<0.01$). Different degrees of vascular pulsation artifacts were found in the conventional enhanced T1 FLAIR sequences of 108 patients, and obvious motion artifacts were found in 25 patients, and metal artifacts caused by fixed denture, nail surgical suture, titanium plate and so on were found in 22 patients. All the artifacts seriously affected the image quality, and some of them led to the diagnosis of false positives. When T1 FLAIR sequences of PROPELLER was applied, vascular pulsation artifacts of 108 patients were significantly eliminated, and no obvious motion artifacts were found in 106 patients, and metal artifacts of 22 patients were mitigated, obtaining images with diagnostic value. **Conclusion** T1 FLAIR sequences of PROPELLER can maximally eliminate vascular pulsation artifacts in head enhanced imaging, and lower motion artifacts and metal artifacts, proving more satisfactory images with diagnostic value. **Key words:** magnetic resonance imaging; enhanced imaging; T1 fluid- attenuated inversion recovery; periodically rotated overlapping parallel lines enhanced reconstruction; vascular pulsation artifact; motion artifact; metal artifacts

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【作者简介】骆众星(1982-),男,主管技师。Tel: 18665654280; E-mail: 7925325@qq.com。

【通信作者】康 庄,硕士,主任技师,科副主任。E-mail: 1748085564@qq.com。

前言

MR 颅脑成像中经常出现的血管搏动伪影、运动伪影以及各种金属伪影已经困扰了影像诊断行业多年, 而早期 PROPELLER 技术的出现的确改善了 T2WI、DWI 等序列采集的图像质量^[1]。但在颅脑的增强扫描上, T1WI 的各种伪影依然很严重。GE 公司的 PROPELLER (Periodically Rotated Overlapping Parallel Lines Enhanced Reconstruction) 技术经过长久的发展, 现今已推出了第 3 代, 设计用于减少患者自发移动和生理移动的影响(呼吸、血流和肠蠕动等)并减少磁化伪影。它有助于在有成像挑战性的患者身上和难于成像的解剖部位持续生成良好质量的诊断图像。PROPELLER 3.0 使用放射 k 空间填充, 与笛卡尔方法相比, 它本质上对脑脊液和血流、呼吸、患者颤动或其他自发性移动的敏感性更低。此外, 会采用一种复杂的移动校正后处理算法进一步减少刚性运动的影响。放射 k 空间填充的线性 k 空间中心过采样能提高信噪比(SNR)并实现高组织对比度, 而扫描时间与常规技术相同, 同时 PROPELLER 允许自由呼吸采集。PROPELLER 3.0 适用于所有平面的 T1 FLAIR、T2、T2 FLAIR 成像、脑部轴向弥散加权成像、颈椎 T2 加权成像、身体和 MSK T2/PD 加权成像。本研究对比分析新的 PROPELLER 技术在消除头部增强后的血管搏动伪影以及头部运动伪影和金属伪影的效果, 评价其临床应用价值。

1 材料与方法

1.1 研究对象

随机选取从 2015 年 1 月至 2015 年 2 月共 108 例行头部增强 MRI 检查者, 扫描常规平扫和增强序列, 并增加增强后 T1 FLAIR (fluid-attenuated inversion recovery) PROPELLER 三平面序列对比。其中男 53 例, 女 55 例, 年龄 5 岁~88 岁, 平均 48.6 岁。临床初步诊断为精神分裂症 40 例, 脑外伤出血 8 例, 脑肿瘤术后 12 例, 脑炎 10 例, 脑血管病及多发性硬化症 38 例。所有患者均签署了造影剂注射知情同意书。

1.2 MRI 检查方法

采用 GEDiscovery MR750 3.0T 磁共振成像系统, 搭配头部八通道相控阵线圈。

常规增强序列为矢状位、冠状位、轴位 T1 FLAIR 序列, 扫描参数: 层厚 5 mm, 层间隔 1 mm, FOV=240 mm, 矩阵 320×224, TR=1750 ms, TE=24 ms, 带宽 62.5, 反转时间=800 ms, 回波链长度 10, Auto Refocus Flip Angle=111, NEX=1。扫描时间为 55 s。

T1 FLAIR PROPELLER 三平面对比序列, 扫描参数: 层厚 5 mm, 层间隔 1 mm, FOV=240 mm, 矩阵 320×320, AUTO TR, Req.# of Acqs=2, 带宽 62.5, 反转时间默认值, 回波链长度 12, Auto Refocus Flip Angle=110, NEX=1, Over Sampling Factor=1。扫描时间为 68 s。

经肘静脉注射对比剂马根维显(钆喷酸葡胺 Gd-DTPA)后即开始扫描, 剂量 0.2 mmol/kg。为避免时间因素导致延迟强化的影响, 普通增强 FLAIR 及 T1 FLAIR PROPELLER 序列扫描在注入对比剂后交替随机首先进行。

1.3 图像评价

由一名高级职称和一名中级职称的神经组影像诊断人员进行双盲法阅片, 单组评分。对伪影予以 4 级评分: 0 分代表没有伪影; 1 分代表轻度伪影, 不影响病灶显示和判断; 2 分代表中度伪影, 较影响颅底或部分脑组织显示和病灶判断; 3 分代表严重伪影, 严重影响大部分脑组织的显示和病灶判断。

1.4 统计学处理

采用 SPSS 13.0 统计软件, 两序列伪影评分的差异评价采用 *t* 检验, $P<0.05$ 为差异有统计学意义。

2 结果

2.1 结果评价

采用 PROPELLER 技术后的 T1 FLAIR 增强序列在 3 个平面上的伪影评分明显低于普通 T1 FLAIR 增强序列得分(表 1)。PROPELLER T1 FLAIR 序列只有 22 例因有固定义齿或手术缝合钉、钛板等评分为 1, 且伪影对比减轻, 有 2 例因患者不配合有较大运动动作而产生轻微运动伪影, 评分为 1; 而普通 T1 FLAIR 序列 108 例三平面均出现明显血管波动伪影, 25 例患者有明显的运动伪影, 22 例患者有金属伪影(表 2), 评分为 2 分有 68 例, 评分为 3 分有 40 例。两序列图像质量有显著差异($P<0.01$)。

2.2 典型病例

如图 1 为同一患者相邻两层轴位图对比。临床诊断为: 脑膜脑炎, 双侧额顶颞枕部蛛网膜下腔出血。图 1a 和 1c 为常规 T1 FLAIR 增强序列, 可见横窦、直窦、窦汇、第四脑室等区域的相位编码方向发生了比较严重的搏动伪影。而对比相应应用了 PROPELLER 方式的 T1 FLAIR 增强序列图 1b、1d 可见, 所有血管搏动造成的搏动伪影消失, 颞叶脑炎改变仍清晰可见。图 2 上, 图 2a 可见脑干有伪影, 颈髓段有高信号疑似出血点; 图 2b 为对比的 PROPELLER T1 FLAIR 图, 相关伪影消失, 确认颈髓高信号为伪

表 1 两种扫描方法的评分情况
Tab.1 Scores of two scanning methods

Artifact classifications	T1 FLAIR sequences	T1 FLAIR PROPELLER sequences
0 for no artifact	0	84
1 for mild artifact	0	24
2 for moderate artifact	68	0
3 for serious artifact	40	0
Total score	256	24

Note: FLAIR: Fluid- attenuated inversion recovery; PROPELLER: Periodically rotated overlapping parallel lines enhanced reconstruction

表 2 两种扫描方法伪影出现情况及分类
Tab.2 Artifacts and classifications of two scanning methods

Classifications	T1 FLAIR sequences	T1 FLAIR PROPELLER sequences
Vascular pulsation artifact	108	0
Motion artifact	25	2
Metal artifacts	22	22
Artifacts in counting	155	24

影。图 2c 为脑膜脑炎,小脑疑似高信号区域,在 PROPELLER T1 FLAIR 序列的图 2d 上小脑高信号消失,排除为假阳性。图 3a 观察普通 T1 FLAIR 增强脑桥疑似血管搏动伪影,通过观察采用 T1 FLAIRPROPELLER 序列的图 3b,确认为脑桥亚急性脑出血。图 3c 观察小脑区域高信号疑似出血,图 3d 为同一层面 PROPELLER T1 FLAIR 采集,小脑高信号消失,排除为假阳性。

3 讨论

脑部 MRI 增强扫描图像以往因受到各种血管搏动和脑脊液伪影、运动伪影以及金属伪影而造成不少假阴性和假阳性病灶判断^[2]。血管搏动伪影多出现在大脑大静脉、上矢状窦、乙状窦、横窦、直窦、窦汇、第四脑室等区域的相位编码方向,影响观察脑部特别是小脑、延髓以及脑干。

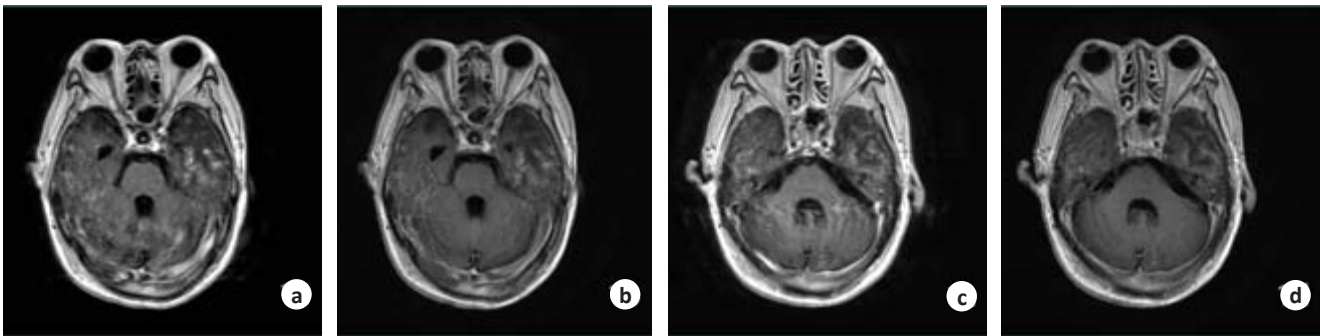


图 1 同一患者相邻两层轴位图对比
Fig.1 Adjacent two layers of axis figure comparison for the same patient

Note: Figure a, the result of conventional T1 FLAIR enhanced sequences, showed artifacts from main line, sigmoid sinus and transverse sinus region of the phase direction throb, parenchymal view. Figure c was also the result of conventional T1 FLAIR enhanced sequences, appearing artifacts from main line, transverse sinus, straight sinus areas such as pulse phase direction, influencing the observation of ventricle and cerebellar regions. Figure b and figure d were the results of T1 FLAIR sequences of PROPELLER, showing all the corresponding artifacts were disappear

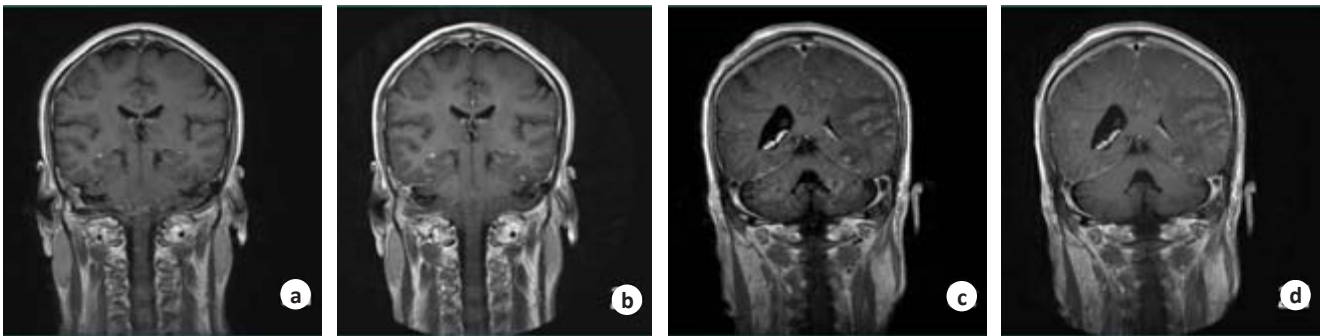


图 2 两组患者冠状位图对比
Fig.2 Coronary figure comparisons for two groups of patients

Note: Figure a, the result of conventional T1 FLAIR sequences, showed a suspected bleeder because cervical spinal had high signal, however, no abnormal signals were found in the corresponding figure b, the result of T1 FLAIR sequence of PROPELLER. The suspected bleeder should be the result of artifacts. Figure c showed cerebellum suspected high signal area which had not been found in the corresponding figure d, the result of T1 FLAIR sequence of PROPELLER

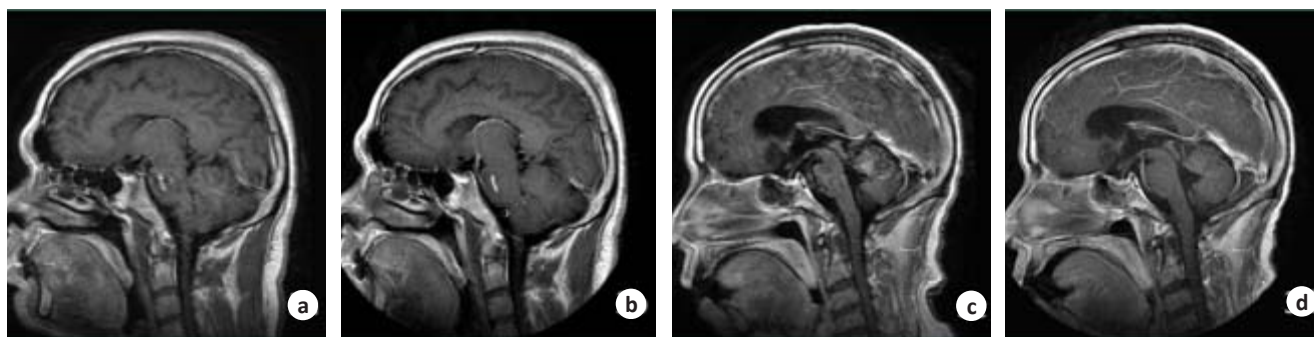


图3 两组患者矢状位图对比

Fig.3 Sagittal figure comparisons for two groups of patients

Note: Figure a, the result of conventional T1 FLAIR enhance sagittal sequence, suspected vascular beating artifacts, while figure b, the result of T1 FLAIR PROPELLER, identified it as pons subacute cerebral hemorrhage. Figure c, the result of conventional T1 FLAIR enhance sagittal sequence, suspected cerebellum hemorrhage for the observation of high signal, but figure d, the result of T1 FLAIR PROPELLER, did not observe any cerebellum high signal, eliminating false positive

T1 FLAIR 序列是近年来在脑部扫描中作为补充替代传统 T1 SE 序列的较好选择。T1FLAIR 序列上灰质与白质对比更好,基底节核团显示清楚,T1FLAIR 显示病变与水肿及周围正常脑组织的对比度高于 SE 序列 T1 加权像^[3],其对于脑膜病变的显示体现出独特的价值和优势^[4]。增强 FLAIR 序列对于感染性脑膜病变的显示具有较高的敏感性和准确性^[5],并可在病变的早期阶段作出正确诊断^[6]。

GE 公司最新的 PROPELLER 3.0 应用在 T1 FLAIR 序列上,既传承了 T1 FLAIR 的优势,还减轻了各种金属伪影,并解决了长久以来的增强扫描血管搏动伪影及运动伪影问题^[7-10]。在矢状面和冠状面,小脑、脑干、延髓等以往被血管搏动伪影严重干扰的现象被彻底解决,轴位上经常被大脑大静脉、上矢状窦、乙状窦、横窦、直窦、窦汇、第四脑室等的搏动伪影也一去无踪。同时,躁动患者出现的偶尔不配合所引起的运动伪影也被一带修复,固定义齿、术后缝合钉等引起的金属伪影也大大减弱。

本文认为,T1 FLAIR PROPELLER 序列在扫描空间分辨率上与常规 T1 FLAIR 序列没有区别,扫描时间也与常规 T1 FLAIR 序列没有明显差别,而其能最大限度地消除或减轻因增强后血管波动以及运动、金属引起的伪影,使图像信噪比增加,降低假阳性率,有望逐步代替常规 T1 FLAIR 增强序列。

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