磁共振成像

月刊
总第157期
2010年1月创刊

2025年第16卷第7期
2025年7月20日出版

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出版单位 《磁共振成像》杂志社有限公司

发行范围 公开
发行单位 本刊发行部

国内发行 中国邮政集团有限公司北京市报刊发行局
邮发代号 2-855
国外总发行 中国国际图书贸易集团有限公司
国外发行代号 M 8958
印刷单位 北京科信印刷有限公司

电　话 010-67113815
E-mail editor@cjmri.cn
网　址 www.chinesemri.com
定　价 每册30元

国内统一连续出版物号
CN 11-5902/R
国际标准连续出版物号
ISSN 1674-8034

广告发布登记证号 京西市监广登字20170242号

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磁共振成像（magnetic resonance imaging, MRI）因其无电离辐射、高软组织分辨率等优势，已广泛应用于多系统疾病的诊断。目前临床常用的MRI线圈多为标准化商用产品，如头颈联合线圈、腹部线圈及各类专用线圈，具有结构固定、参数标准化、适用部位明确等特点。

尽管上述硬件配置已基本满足常规成像需求，MRI系统在更复杂应用场景中仍面临诸多技术挑战。尤其在高磁场环境下，对电子设备的抗干扰能力提出了更高要求，致使多种电磁敏感设备无法在扫描过程中正常运行，限制了MRI在跨模态监测及术中导航等新兴领域的发展。在实际应用中，传统商用线圈尚存在适应性差、贴合性低、部位专用性强等问题，尤其在术中成像、体型多样或需跨空间转运的场景下，难以兼顾图像质量与操作便捷性。一方面，固定结构线圈不易贴合不同患者体型，易致信噪比下降、对比度不足，延长扫描时间；另一方面，各部位专用线圈需单独配置，增加了设备投入与临床操作负担，缺乏通用性。

针对上述问题，本研究团队自主研发了“可转运磁共振成像探测阵列”（transportable magnetic resonance imaging detection array, TMRDA），力求突破现有成像设备在适用性与灵活性方面的局限。TMRDA不仅能够在手术室与MRI扫描室之间实现无缝转运，还能进行即时成像，为患者手术状态和效果提供实时、精准的监测。高密度柔性线圈作为TMRDA的关键组成部分，其成像性能必须经过严格的验证。本研究系统评估TMRDA与商用线圈（头颈联合线圈和腹部线圈）在颅脑、肝脏及髋关节成像中的表现。通过标准水模及34例健康志愿者的对比研究，结果显示，TMRDA在T1WI和T2WI图像中的信噪比、对比噪声比等关键指标均优于或不劣于传统商用线圈；主观评分方面亦获放射科医师高度一致的评价（Cohen's κ值>0.8）。此外，TMRDA在多参数定量成像中的稳定性亦表现良好，充分验证了其在MRI多部位临床成像中的广泛适用性和技术先进性。

本研究首次从图像质量的主客观维度全面评估了TMRDA的临床性能，展示了该系统在术中导航、跨平台成像等新兴场景下的转化潜力和工程价值。详见正文第72页。

CHINESE JOURNAL OF MAGNETIC RESONANCE IMAGING

ISSN 1674-8034, CN 11-5902/R, CODEN CCIHBW, Established in 2010 Monthly Vol. 16, No. 7, Jul 20, 2025

Responsible Institution
National Health Commission of the People's Republic of China

Sponsor
Chinese Hospital Association
Beijing Tiantan Hospital of Capital Medical University

Editing
Editorial Board of Chinese Journal of Magnetic Resonance Imaging

Publishing
Publishing House of Chinese Journal of Magnetic Resonance Imaging

General Distributor
Domestic: Beijing Newspaper and Periodical Distribution Bureau of China Post Group Co., Ltd.
Postal Code: 2-855
Overseas: China International Book Trade Group Co., Ltd., P.O. Box 399, Beijing, China
Code No.: M 8958

Mail Order
Third Floor, Building 4, No. 358, Yudaihe East Street, Tongzhou District, Beijing 101100, China

Tel & Fax 8610-67113815
E-mail editor@cjmri.cn
Website www.chinesemri.com
Price: USD 30.00

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About the cover

Magnetic resonance imaging (MRI) has been widely applied in the diagnosis of multisystem diseases due to its advantages of non-ionizing radiation and high soft-tissue resolution. In current clinical practice, standardized commercial coils are commonly used, including head and neck combined coils, abdominal coils, and various region-specific coils. These coils are typically characterized by fixed structures, standardized parameters, and specific anatomical targeting.

Although the above hardware configurations generally meet the requirements of routine imaging, MRI systems still face considerable technical challenges in more complex application scenarios. In particular, the high magnetic field environment imposes stringent demands on the electromagnetic compatibility of surrounding devices, rendering many electromagnetically sensitive instruments unable to function properly during scanning. This limitation hinders the advancement of MRI in emerging fields such as cross-modal monitoring and intraoperative navigation. In practical applications, conventional commercial coils face several challenges, including limited adaptability, poor anatomical conformity, and restricted generalizability. These issues are particularly evident in scenarios involving intraoperative imaging, variable body habitus, or spatial transfer between rooms. Rigid coil structures often fail to conform to different patient anatomies, leading to reduced signal-to-noise (SNR) ratio, lower contrast, and prolonged scan times. Furthermore, region-specific coils usually require separate configurations, increasing both equipment costs and clinical complexity.

To address these limitations, our research team developed a transportable magnetic resonance imaging detection array (TMRDA) to improve the flexibility and applicability of MRI hardware. The TMRDA system supports seamless transport between operating rooms and MRI suites, while also enabling real-time imaging to monitor surgical status and outcomes. High-density flexible coils serve as a key component of the system, and their imaging performance must be rigorously validated.

In this study, we systematically evaluated the imaging performance of TMRDA compared with commercial coils (head-neck combined coil and abdominal coil) for imaging the brain, liver, and hip. Using both standardized phantom experiments and scans of 34 healthy volunteers, we found that TMRDA achieved superior or comparable performance in key imaging parameters such as SNR and contrast-to-noise ratio in T1- and T2-weighted sequences. Subjective assessments by radiologists also demonstrated high consistency (Cohen's $\kappa > 0.8$). Additionally, the system maintained stable performance in multiparametric quantitative imaging, confirming its reliability across multiple anatomical regions.

This study provides a comprehensive evaluation of TMRDA from both objective and subjective imaging perspectives. The results demonstrate its potential for clinical translation and engineering value in scenarios such as intraoperative navigation and multi-site imaging. Please see text page 72.