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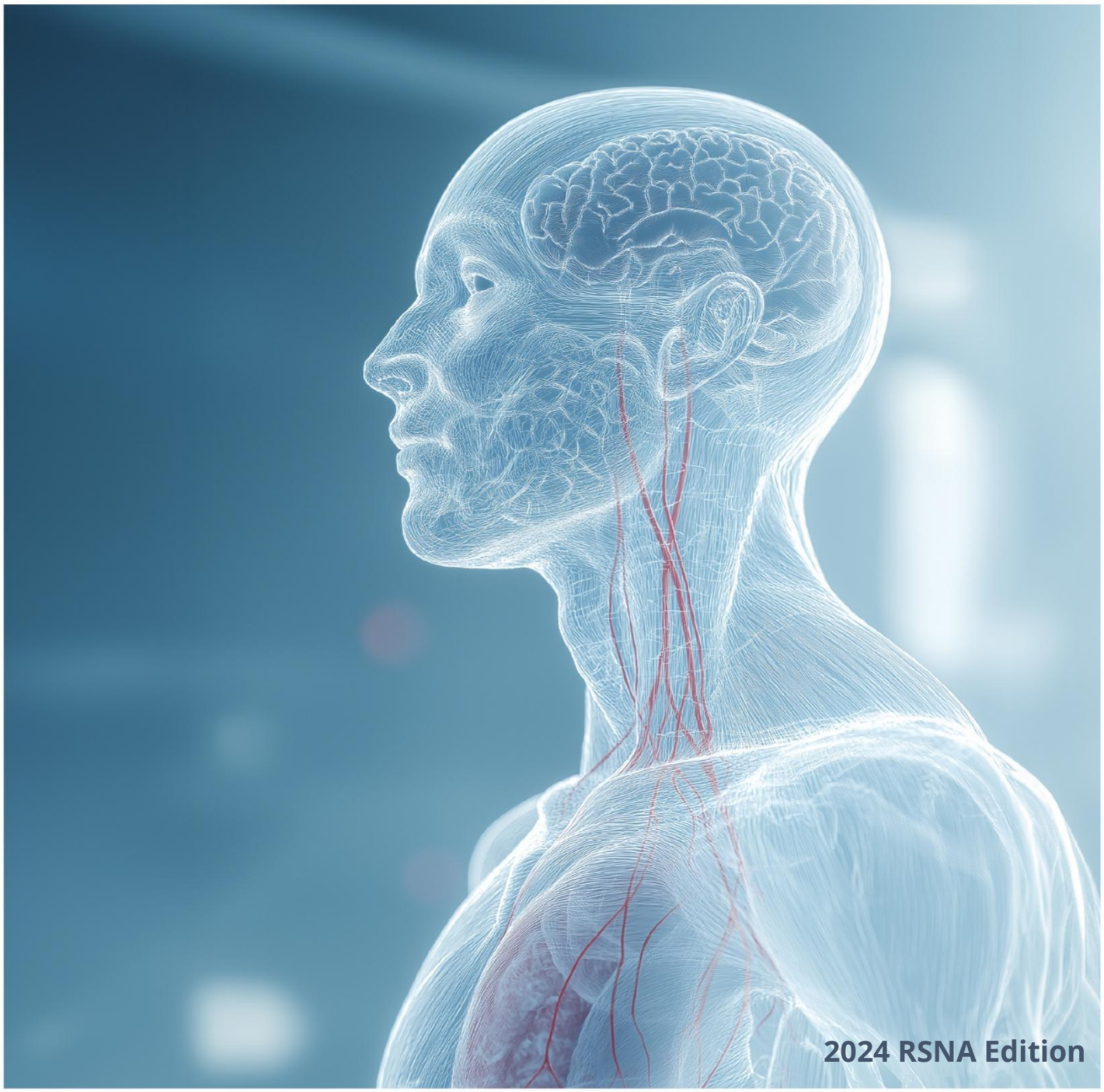

Issue Highlights

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Editorial: The Transformative Power of Neurological Imaging: Pushing the Boundaries of Brain Science

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The human brain has long been considered the final frontier in medicine. Despite centuries of research, its complex structure and function continue to captivate scientists and clinicians alike. Neurological imaging has emerged as a pivotal tool, transforming the field of neuroscience by providing unprecedented insight into the brain's architecture and activity. From detecting early signs of disease to exploring consciousness, brain imaging technologies have revolutionized both diagnosis and research in neurology.

Neurological imaging has come a long way since the early days of X-ray imaging. The modern era of brain imaging began with the invention of the computed tomography (CT) scan in the early 1970s, followed by the development of magnetic resonance imaging (MRI) and positron emission tomography (PET). These technologies allow us to peer inside the brain in ways that would have been unimaginable just decades ago.

Enhancing Diagnostics and Personalized Medicine

Neurological imaging has revolutionized the way we diagnose and treat conditions such as epilepsy, multiple sclerosis, and traumatic brain injuries. High-resolution MRI scans allow for the precise identification of lesions and abnormalities, while advances in diffusion tensor imaging (DTI) have enabled the visualization of the brain's white matter pathways, crucial for understanding diseases that affect brain connectivity.

Beyond diagnosis, imaging plays a vital role in personalized medicine. By analyzing the structure and function of an individual's brain, doctors can tailor treatments to the specific needs of the patient. For example, in epilepsy, imaging helps to identify the exact location of seizure activity, guiding surgical interventions that can dramatically improve the quality of life for patients who do not respond to medication.

Imaging has also become crucial in the early detection of neurodegenerative diseases. Alzheimer's disease, which begins its destructive course years before noticeable symptoms emerge, can now be detected early through imaging biomarkers. This is a game-changer in developing treatments that can slow or halt the progression of the disease before irreversible damage occurs.

Challenges and Ethical Considerations

Despite the transformative potential of neurological imaging, the field faces significant challenges. One of the most pressing is the interpretation of the vast amount of data generated by these technologies. Brain scans produce detailed and complex images that require expert analysis. Artificial intelligence (AI) and machine learning have already begun to play a role in this area, offering the potential for more accurate and faster diagnoses, but there is still a long way to go in making this a reliable tool in clinical settings.

Moreover, as our ability to image the brain becomes more precise, ethical questions inevitably arise. fMRI studies can reveal a great deal about an individual's mental processes, raising concerns about privacy. Could these technologies be misused to infer thoughts, emotions, or even intentions? How do we balance the benefits of neurological imaging with the need to protect individuals' cognitive liberty?

The Future of Neurological Imaging

Neurological imaging is rapidly advancing with the introduction of non-contrast-enhanced magnetic resonance angiography (NCE-MRA) at ultra-high magnetic fields. Traditionally performed at 1.5T and 3T, NCE-MRA is now expanding into the realm of ultra-high field imaging with systems like the 5.0T uMR® Jupiter, which offers whole-body vascular scans without the need for contrast agents. This has been introduced and described very well by author Li Hao in his article "Preliminary Application of 5.0T Whole Body Non-Contrast-Enhanced Magnetic Resonance Angiography". This article discusses this new platform and its enhancements in signal-to-noise ratio (SNR), resolution, and acquisition speed, particularly in brain vessel imaging, with

fewer limitations than the 7T systems.

Further Fei King, Zhaojuan Xie and Wenhui Ma focus on validation and evaluation of a vendor provided head motion correction algorithm on uMI Panorama PET/CT system in our next article.

The article describes about NeuroFocus [1] Algorithm that aims at Revolutionizing Head Motion Correction in PET Imaging. A new data-driven approach, the NeuroFocus algorithm, offers a promising solution by detecting, estimating, and correcting motion using PET raw data without the need for additional hardware or patient restraints. This study is a landmark validation of NeuroFocus, focusing on its effectiveness in detecting and correcting head motion during 18F-FDG brain PET/CT imaging.

Further this magazine delves into the advancements and future potential of brain PET imaging, focusing on the uNeuroEXPLORER [2] system. Dr. Richard Carson, in his interview, highlights the significance of PET brain evolution, starting from the HRRT scanner to the recent innovations in imaging technology. He discusses the improvements in resolution, sensitivity, and patient comfort enabled by the new system, which promises to open new avenues in the study of neurological disorders like Parkinson's and Alzheimer's. The interview emphasizes the growing role of brain PET in both clinical and research settings, particularly in disease diagnosis, drug development, and treatment monitoring.

In the next article, authors Marufjon Salokhiddinov and Gulnara Rahkimbaeva introduce the aspects of machine learning in the diagnosis of Alzheimer Disease (AD). A recent study leveraged cutting-edge deep learning techniques, specifically the Cascaded Weakly Supervised Confidence Integration Network (CINet), to measure brain volume in healthy controls (HC) and individuals with mild AD. The study used MRI data from the Alzheimer's Disease Neuroimaging Initiative (ADNI) to analyze and compare GM and WM volumes.

In this magazine we not only focus on facilitation of cutting-edge imaging but the UIH collaborative initiative with our various collaborators that continues to push the boundaries of brain imaging, supported by key philanthropic contributions and a crucial collaboration with Stony Brook to optimize PET technology for neurological applications with uMI 550 PET model.

The author Paul Vaska focuses on the practical challenges, such as patient positioning and head motion, and addresses them through customized protocols, including the use of infrared-based motion tracking systems, ensuring precise data collection and analysis.

Recent advancements in MRI technology are propelling the field of neuroimaging into a new territory. High-resolution brain mapping, crucial for understanding cognition and diagnosing neurological diseases, has traditionally faced limitations due to physical constraints like scan time, resolution, and signal-to-noise ratio (SNR). However, the next authors Liyi Kang and Dan Wu focus on NeuroFrontier[3] 3.0T MRI system from United Imaging Healthcare which has allowed us to overcome many of these obstacles with innovations in ultra-high gradient strength, artificial intelligence (AI), and motion correction techniques, marking a significant step forward in brain imaging.

Recent developments in ultra-high field MRI, particularly with systems operating at 5T and 7T, have revolutionized the field of neurological imaging. Authors Zhensong Wang and Jie Gan focuses on a comparative study between 5T and 3T MRI, emphasizing the benefits of 5T in capturing more detailed anatomical images without extending scanning time. Importantly, the study highlights that ultra-high field MRI is particularly beneficial for detecting small lesions and subtle brain changes that may be missed at lower field strengths. This advancement holds promise for improving the diagnosis and treatment planning for conditions like multiple sclerosis, epilepsy, and other neurodegenerative diseases.

Acute ischemic stroke (AIS) represents a significant global health challenge, necessitating rapid and effective imaging techniques to optimize patient outcomes. In a groundbreaking study, authors Jin Fang and Guihua Jiang explored the efficacy of a one-stop dynamic whole-brain computed tomography perfusion (CTP) protocol using a 320-row scanner (uCT 960+, United Imaging Healthcare) to

[1,2,3] This product is not available for sale in the U.S. for clinical uses and also may not be available for such sales in other countries.

streamline imaging for AIS patients. The study highlights that timely recanalization can markedly improve clinical outcomes, underscoring the importance of swiftly identifying salvageable brain tissue.

The final article of this issue discusses the advancement of MULTIPLEX MRI (MTP)[4] as a transformative tool in the characterization of brain tumors. The author H.K. Anand of this study highlights the effectiveness of machine learning (ML) algorithms in processing of MTP MRI data for automated tumor classification, revealing that combinations of T1, T2*, and QSM provide superior diagnostic performance compared to individual parameters.

Looking ahead, the future of neurological imaging is poised for even greater advances. Emerging technologies such as ultra-high-field MRI, optogenetics, and advanced PET tracers promise to further refine our ability to image the brain at both structural and functional levels. These tools could revolutionize the way we understand psychiatric disorders like depression and schizophrenia, which have long eluded clear-cut diagnostic criteria.

Neurological imaging has already transformed the practice of neurology and the broader field of brain science.

Collectively, this issue of uINNOVATION 2024 offers an insight into the new innovations in the field of neuroimaging. From diagnosis to personalized treatments, from understanding brain function to correcting the head motion, the future of neurological imaging promises both tremendous opportunities and significant challenges. What is clear, however, is that brain imaging is, and will remain, at the heart of modern neurology, guiding the field into a future where the mysteries of the brain become ever clearer.

Guest Editor Biography

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Dr. Hemant Patel is the Director of Gujrat Imaging Center group of diagnostics centres and Professor of Radiology at the Post-Graduate Institute of Radiology & Imaging in Ahmedabad. Dr Patel obtained his MBBS degree followed by advanced medical degrees such as DMRE, MD and DNB in the field of radiology. In the year 2018, Dr Patel had served as the national president of Indian Radiological Imaging Association (IRIA). Dr Patel has been awarded best radiology entrepreneur at Health Express Radiology conclave in the year 2019. Dr Patel had published over 200 scientific articles in the field of radiology and delivered over 80 scientific talks at various national and international avenues, and he is the editor of "Comprehensive Textbook of Clinical Radiology" published under Elsevier. Currently, Dr Patel holds Executive Committee position at World Radiology Society and Treasurer of Asian Oceanic Society of Radiology. Dr Patel is also serving as RSNA Coordinator for Asian Subcontinents.

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