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Optimization of Diffusion-Weighted Imaging (DWI) Protocols by Radiographers for Early Detection of Acute Stroke

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ABSTRACT

Acute ischemic stroke is a leading cause of morbidity and mortality worldwide, requiring urgent neuroimaging for accurate diagnosis and therapeutic decision-making. Diffusion-weighted imaging (DWI) has emerged as the most sensitive MRI sequence for early detection of acute cerebral ischemia, often identifying abnormalities within minutes of onset. Despite its clinical utility, variability in DWI protocols across institutions can lead to differences in image quality, diagnostic accuracy, and scan efficiency. Radiographers play a pivotal role in protocol design, parameter selection, and optimization of imaging workflows. This article discusses the importance of DWI in acute stroke imaging, identifies challenges in current protocols, and outlines strategies for optimization by radiographers. Emphasis is placed on balancing image quality, acquisition time, and patient comfort while minimizing artifacts. The article further proposes an optimized DWI protocol tailored for rapid stroke assessment. By refining DWI acquisition, radiographers can significantly improve diagnostic confidence, reduce false negatives, and contribute to better patient outcomes.

KEYWORDS: *Diffusion-weighted imaging, acute stroke, MRI protocols, radiographer optimization, ischemic stroke, neuroimaging.*

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INTRODUCTION

Stroke remains one of the leading causes of death and disability globally, with acute ischemic stroke (AIS) accounting for nearly 85% of all cases (Feigin et al., 2021). Rapid and accurate diagnosis is critical, as early intervention with reperfusion therapies such as intravenous thrombolysis and mechanical thrombectomy can substantially improve outcomes (Powers et al., 2019). Neuroimaging plays a central role in stroke care, with MRI—particularly diffusion-weighted imaging (DWI)—recognized as the gold standard for early detection of ischemic injury.

DWI is highly sensitive to changes in the random motion of water molecules within tissue, enabling visualization of cytotoxic edema within minutes of ischemia onset (Le Bihan et al., 2001). However, its effectiveness depends on optimized acquisition protocols, as technical factors such as signal-to-noise ratio (SNR), geometric distortion, and motion artifacts can compromise diagnostic accuracy. Given the urgent nature of stroke imaging, DWI protocols must be designed to provide high-quality images within the shortest possible acquisition time.

Radiographers are at the forefront of MRI examinations and play a crucial role in optimizing DWI protocols. Their expertise in parameter adjustment, scanner capabilities, and patient management directly influences image quality and diagnostic outcomes. This article explores how radiographers can optimize DWI protocols for acute stroke imaging and proposes a streamlined protocol for clinical implementation.

Background and Rationale

The success of stroke imaging lies in its ability to rapidly and reliably identify ischemic tissue while excluding mimics such as seizures, migraine, or hypoglycemia. Computed tomography (CT) remains widely used due to accessibility and speed, but it is less sensitive in the hyperacute phase (Kidwell et al., 2004). MRI, though less accessible in some settings,

provides superior sensitivity and specificity, especially with DWI.

The challenge lies in balancing diagnostic accuracy with feasibility. Prolonged scan times increase motion artifacts, delay treatment, and may not be tolerated by unstable patients. Suboptimal DWI acquisition can result in missed infarcts or false positives, undermining the clinical utility of MRI. Therefore, protocol optimization is essential to maximize DWI performance in acute stroke care.

Role of Diffusion-Weighted Imaging in Acute Stroke

DWI detects ischemic changes earlier than conventional MRI sequences such as T1- or T2-weighted imaging. Within minutes of ischemia onset, restricted diffusion in affected tissue manifests as hyperintensity on DWI and corresponding hypointensity on the apparent diffusion coefficient (ADC) map. These findings precede structural changes, enabling early diagnosis and guiding therapeutic decisions (Warach et al., 1995).

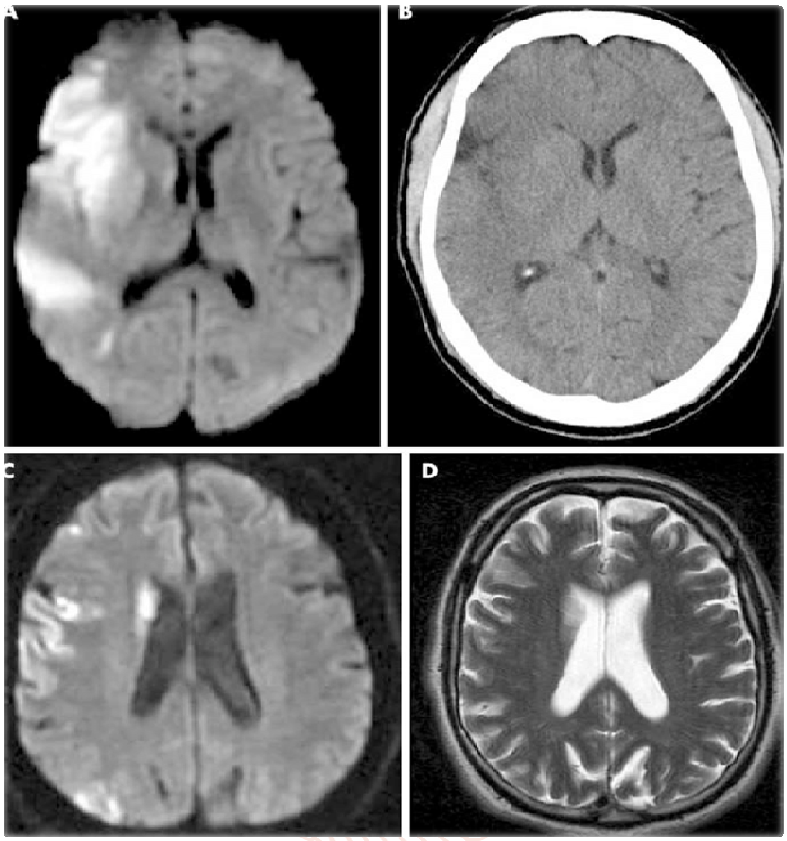

Figure 1: Improved lesion conspicuity of DWI in acute ischaemic stroke. (A) DWI and (B) CT in acute right MCA occlusion. CT shows early ischaemic changes (sulcal effacement, loss of greywhite differentiation, compression of lateral ventricle, loss of posterior lentiform nucleus definition, anterior insular ribbon loss). (C) DWI and (D) conventional T2 weighted MRI in multifocal (post-thrombolytic treatment) right MCA infarction.

In addition to early detection, DWI provides information on stroke core volume, lesion topography, and potential mismatch with perfusion imaging. These parameters are critical for patient selection in reperfusion therapies beyond conventional time windows. Thus, optimized DWI is not only diagnostically valuable but also clinically transformative.

Challenges in Current DWI Protocols

- **Susceptibility artifacts:** Echo-planar imaging (EPI), the standard DWI technique, is prone to geometric distortion, especially near air-tissue interfaces.
- **Motion artifacts:** Stroke patients may be restless, aphasic, or confused, leading to degraded image quality.
- **Trade-off between SNR and speed:** Higher resolution improves lesion conspicuity but prolongs acquisition, which is not ideal in emergencies.
- **Scanner variability:** Differences in field strength (1.5T vs 3T), gradient performance, and coil design affect protocol optimization.
- **Inconsistent b-value selection:** Variations influence sensitivity and lesion detection, with some centers adopting non-standardized values.

Role of Radiographers in Protocol Optimization

Radiographers serve as the link between imaging technology and clinical application. Their role in optimizing DWI for acute stroke includes:

- **Parameter adjustment** (TR, TE, slice thickness, matrix size).
- **Artifact management** (parallel imaging, fat suppression, motion correction strategies).
- **Patient handling** (immobilization, communication, comfort).
- **Workflow efficiency** (streamlining acquisition sequences, reducing delays).

Methodological Considerations for Optimization

Table 1: Shows the protocols for optimization

Parameter	Standard Practice	Optimization Strategy	Clinical Impact
b-values	0 & 1000 s/mm²	Add 1500 s/mm² at 3T	Improved lesion conspicuity
Slice thickness	5–7 mm	5 mm, no gap	Balanced resolution & speed
Matrix size	128×128	128–192×128–192	Improved SNR & detail
TE/TR	TE 90–120 ms, TR 4000 ms	TE 60–100 ms, TR 3000–4000 ms	Reduced distortion & time
Acceleration	No parallel imaging	Use GRAPPA/SENSE	Faster acquisition
Acquisition time	2–3 minutes	≤ 1 minute	Faster stroke triage

Proposed Optimized Protocol

- **Scanner field strength:** 1.5T or 3T
- **Acquisition type:** Single-shot EPI with parallel imaging
- **TR:** 3000–4000 ms
- **TE:** 60–100 ms
- **Slice thickness:** 5 mm, no gap
- **Matrix:** 128 × 128 or 192 × 192
- **FOV:** 220–240 mm
- **b-values:** 0 and 1000 s/mm² (±1500 s/mm² for 3T)
- **NEX (averages):** 1–2
- **Total acquisition time:** ≤ 1 minute

Workflow Optimization

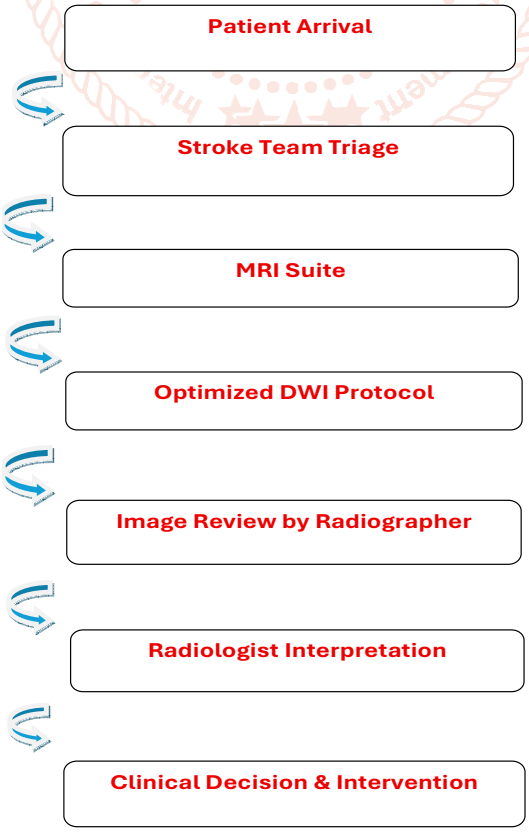

Figure 2: Shows the steps involved in the optimization workflow

Clinical and Diagnostic Implications

Optimized DWI enhances lesion conspicuity, improves diagnostic confidence, and facilitates early decision-making. Accurate detection of acute infarcts influences eligibility for reperfusion therapy, stroke classification, and prognosis estimation. Furthermore, standardized protocols reduce inter-institutional variability, enabling reliable comparisons in multicenter research and clinical trials.

Discussion

Optimizing DWI protocols is a multidisciplinary task requiring collaboration between radiographers, radiologists, physicists, and clinicians. Radiographers, as frontline operators, play a central role in implementing evidence-based adjustments. Protocol standardization enhances diagnostic accuracy, workflow efficiency, and patient care.

Challenges remain in adapting protocols across scanners with different hardware capabilities. Future advancements such as multiband acceleration, non-EPI DWI, and artificial intelligence–based artifact reduction hold promise for further optimization.

Future Directions

- **AI integration** for automated protocol selection and artifact correction.
- **Ultra-fast imaging** (<30 seconds DWI acquisition).
- **Personalized imaging** based on patient-specific factors.
- **Global standardization** with international guidelines.

Conclusion

Diffusion-weighted imaging is indispensable for early detection of acute ischemic stroke. Radiographers play a vital role in optimizing DWI protocols, balancing image quality, acquisition speed, and patient comfort. By refining acquisition parameters and managing artifacts, radiographers ensure reliable images that support rapid clinical decision-making. Protocol standardization and continuous optimization remain essential to maximizing DWI's potential in stroke care.

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