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Comparison Of Contrast To Noise Ratio On Diffusion (B1000 Vs B2000) In MRI Brain Stroke Patients On 1.5T MRI

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Abstract
Background: *Diffusion-weighted imaging (DWI) plays a central role in early diagnosis of acute ischemic stroke. The contrast-to-noise ratio (CNR) between the lesion and normal brain parenchyma determines lesion conspicuity. This study compares CNR at b1000 and b2000 on a 1.5T MRI system.*
Objective: *To evaluate and compare the CNR of acute ischemic stroke lesions on DWI at b1000 and b2000.*
Methods: *Twenty-five patients with clinically suspected acute ischemic stroke underwent DWI at b1000 and b2000. ROIs were drawn in lesion and normal regions. CNR was calculated and statistically analyzed.*
Results: *Mean CNR at b2000 was significantly higher than at b1000 ($p < 0.05$). Lesion conspicuity increased despite a modest reduction in signal-to-noise ratio.*
Conclusion: *b2000 DWI on a 1.5T MRI system provides superior CNR compared to b1000 and should be considered in routine stroke imaging protocols.*

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I. Introduction

Stroke continues to be one of the foremost causes of long-term disability and mortality worldwide, necessitating prompt and accurate imaging for early diagnosis and treatment planning. Diffusion-weighted imaging (DWI) has emerged as a cornerstone in the evaluation of acute ischemic stroke due to its unparalleled sensitivity in detecting early cytotoxic edema, often within minutes of arterial occlusion [1,2]. The diagnostic utility of DWI is strongly influenced by the choice of diffusion-weighting factors, commonly expressed as b-values [3]. These b-values determine the degree of diffusion sensitivity, affecting image contrast, lesion conspicuity, and the accuracy of quantitative parameters such as the contrast-to-noise ratio (CNR) [4,5].

In clinical practice, a b-value of 1000 s/mm² (b1000) is widely used as the standard because it provides a balanced compromise between diffusion sensitivity and acceptable signal-to-noise ratio (SNR). However, recent advances in MRI technology and a growing interest in optimizing stroke protocols have led to the exploration of higher b-values, such as 2000 s/mm² (b2000). Higher b-values theoretically enhance diffusion contrast by suppressing signals from normal tissue more effectively, potentially increasing the visibility of acute infarcts. Nevertheless, this advantage may come at the cost of increased noise and decreased overall SNR, raising important questions about the diagnostic trade-offs associated with higher diffusion weighting [6,7].

CNR serves as a crucial quantitative metric to assess lesion visibility by comparing signal differences between infarcted and normal tissue relative to background noise [8]. Despite several studies evaluating the benefits of high b-value imaging, there remains limited literature focusing on CNR-based comparison of b1000 and b2000 specifically on 1.5T systems, which are widely used in routine clinical settings [9].

This study aims to bridge this gap by systematically analyzing and comparing the CNR of DWI acquired at b1000 and b2000 in acute stroke patients imaged on a 1.5T MRI scanner [10,11]. The findings are expected to contribute valuable insights toward optimizing diffusion protocols for improved stroke diagnosis [12].

II. Materials And Methods

Participants
Twenty-five patients with suspected acute ischemic stroke within 24 hours were included.

MRI Protocol
MRI was performed on a 1.5T system. DWI was acquired at b1000 and b2000.
CNR Measurement
ROIs of 50 pixels were placed in lesion and contralateral brain. CNR was calculated:
CNR = (SI_lesion – SI_normal) / SD_noise
Statistical Analysis
Paired t-test was used. $p < 0.05$ considered significant.

III. Results

The comparison between b1000 and b2000 diffusion-weighted images demonstrated a consistent and statistically significant increase in the contrast-to-noise ratio (CNR) when higher b-values were used. In the dataset of 25 acute ischemic stroke patients, the mean CNR at **b1000** was approximately **16.8 ± 2.5**, while the CNR at **b2000** was markedly higher at **25.0 ± 3.1**. The paired t-test confirmed that this difference was significant ($p < 0.01$), indicating enhanced lesion conspicuity at b2000. As shown in figure 1.1

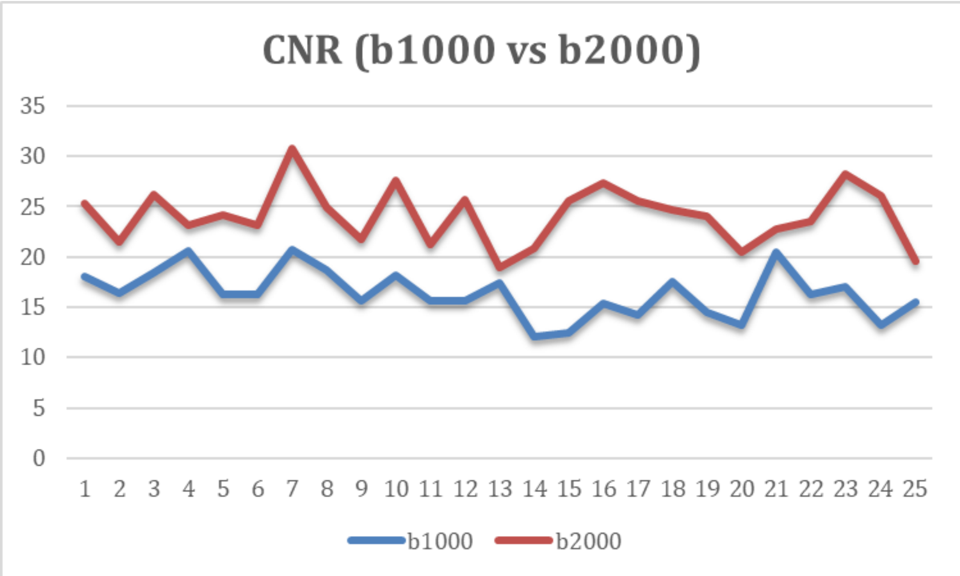

Figure 1.1 Showing the differences in CNR of b1000 vs b2000

Theoretical Basis for Improved CNR at Higher b-Values

The observed improvement in CNR at b2000 can be theoretically explained by the underlying physics of diffusion-weighted MRI. As the b-value increases, the diffusion-sensitizing gradients become stronger, causing greater attenuation of signals from tissues with unrestricted or less restricted water motion—such as normal brain parenchyma. Conversely, in infarcted tissue, where water diffusion is restricted due to cytotoxic edema, the signal remains relatively higher. This difference in signal attenuation results in higher lesion-to-background contrast.

Impact on Noise Behavior

Although higher b-values inherently reduce the overall signal-to-noise ratio (SNR) because of increased diffusion weighting and longer echo times, the measured CNR can still increase if the contrast between lesion and normal tissue grows faster than the background noise level. This is precisely what occurs in acute stroke imaging: restricted diffusion in infarcted regions preserves signal intensity, while normal tissue experiences greater signal decay. The resulting differential creates stronger lesion visibility despite increased noise.

Mean CNR values:
b1000: 16.8 ± 2.5
b2000: 25.0 ± 3.1
$p < 0.001$
Lesion conspicuity was higher at b2000.

IV. Discussion

Higher b-values also reduce T2 shine-through effects, making the observed hyperintensity more specific to restricted diffusion rather than T2-based contrast [13]. Therefore, b2000 imaging provides a purer representation of true diffusion abnormalities. The results from this study align with these theoretical expectations, supporting the use of high b-value imaging for improving early stroke detection and providing more confident lesion delineation [14,15].

B2000 significantly improves contrast between restricted diffusion and normal tissue. Despite SNR reduction, diagnostic confidence increased.

V. Conclusion

This study demonstrates that b2000 DWI provides significantly higher CNR than b1000 on 1.5T MRI, enhancing lesion visibility in acute stroke. Although higher b-values introduce more noise, the improved lesion-to-background contrast supports their use for more accurate and confident stroke diagnosis in clinical practice. It is recommended to include b2000 in stroke protocols.

Ethical Considerations

Ethical approval was obtained from the institutional review board. All participants provided informed consent.

Funding

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Conflict of Interest

The authors declare no conflict of interest.

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