MRI signal intensity ratio of intrinsic hand muscles for the early diagnosis of carpal tunnel syndrome

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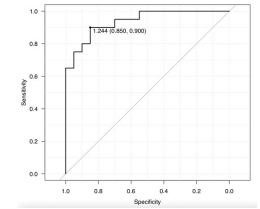
INTRODUCTION:
In the diagnosis of carpal tunnel syndrome (CTS), limited research has focused on the intrinsic muscles of the hand using MRI. A high T2 signal in muscle tissue on MRI is known as a denervation finding and is an early change in peripheral neuropathy. We hypothesized that while the cross-sectional area and thickness of the thenar muscle are not useful in mild cases without muscle atrophy, the presence of high signal intensity in thenar muscle on STIR images is a valuable indicator, even in mild cases prior to muscle atrophy. This study aimed to determine whether the signal intensity ratio (SIR) of the abductor pollicis brevis (APB) compared to unaffected muscles is useful in evaluating both mild and severe CTS.
METHODS:
This study analyzed 57 MRI examinations of hands from patients with idiopathic CTS diagnosed by electrophysiological tests at a single institution between 2020 and 2024. After excluding cases with C6, C7, C8, or T1 myelopathy and root injury, cubital tunnel syndrome, and thoracic outlet syndrome, 43 cases (17 males and 16 females, mean age 68.5 years) were included. Patients were categorized into two groups: the mild (M) group with preserved sensory nerve action potentials (SNAP) and the severe (S) group with absent SNAP. The M group consisted of 20 hands and the S group consisted of 23 hands. Additionally, 20 healthy volunteers served as the control (C) group. The SIR of the APB to the pronator quadratus (PQ) muscle and the APB to the abductor digiti minimi (ADM) muscle were calculated. Differences in SIR among the three groups were compared using the Kruskal-Wallis test. To assess the diagnostic performance of the test, ROC analysis of SIR values was performed for groups C and M.
RESULTS:
Significant differences in the APB/PQ ratio were found among groups C, M, and S ($p < 0.0001$), but not between groups M and S ($p = 0.09$, Table. 1). The APB/ADM ratio showed significant differences among groups C, M, and S ($P < 0.0001$) and between groups M and S ($P = 0.01$, Table. 2). The optimal cutoff values, area under the curve, sensitivity, and specificity for SIR values in distinguishing between Group C and Group M were 1.30, 0.82, 1.0, and 0.75 for APB/PQ (Table. 3) and 1.24, 0.94, 0.85, and 0.90 for APB/ADM (Table. 4), respectively.
DISCUSSION AND CONCLUSION: Although MRI is known to be superior to ultrasonography in detecting denervation findings, there have been few reports demonstrating the usefulness of MRI signal intensity of intrinsic hand muscles in CTS. One of the reasons for this is that most of the previous reports on signal intensity were qualitative evaluations. In this study, we conducted a quantitative evaluation of signal intensity using SIR and found significant differences between mild cases and normal cases. There was no significant difference between severe and mild cases, suggesting that other parameters such as degree of fatty degeneration, muscle thickness, and median nerve swelling may be more useful in determining severity. In summary, our results suggest that SIR of the intrinsic muscles of the hand may be a diagnostic aid, especially in the detection of mild cases that are difficult to diagnose in clinical practice.

Figure. 3
ROC curves for SIR of APB/ADM between Group C and Group M



ROC, receiver operating characteristic; SIR, signal intensity ratio; APB, abductor pollicis brevis; ADM, abductor digit minmi

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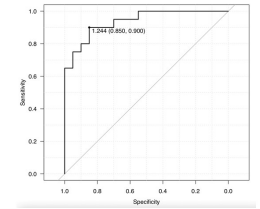
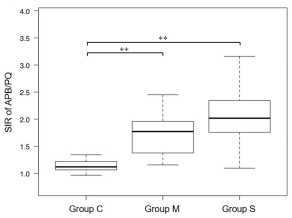
ROC curves for SIR of APB/ADM between Group C and Group M



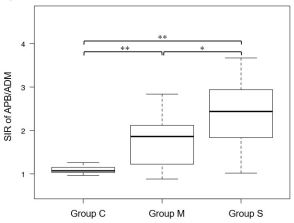
ROC, receiver operating characteristic; SIR, signal intensity ratio; APB, abductor pollicis brevis; ADM, abductor digit minmi

Figure. 1



SIR, signal intensity ratio; APB, abductor pollicis brevis; PQ, pronator quadratus; **, $p < 0.001$

Figure. 2



SIR, signal intensity ratio; APB, abductor pollicis brevis; ADM, abductor digit minmi; *, $p < 0.05$; **, $p < 0.001$