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Serum Levels of Carnitine in Chronic Fatigue Syndrome: Clinical Correlates

Key Words
Carnitine
Chronic fatigue syndrome
Fatigue

Abstract
Carnitine is essential for mitochondrial energy production. Disturbance in mitochondrial function may contribute to or cause the fatigue seen in chronic fatigue syndrome (CFS) patients. One previous investigation has reported decreased acylcarnitine levels in 38 CFS patients. We investigated 35 CFS patients (27 females and 8 males); our results indicate that CFS patients have statistically significantly lower serum total carnitine, free carnitine and acylcarnitine levels, not only lower acylcarnitine levels as previously reported. We also found a statistically significant correlation between serum levels of total and free carnitine and clinical symptomatology. Higher serum carnitine levels correlated with better functional capacity. These findings may be indicative of mitochondrial dysfunction, which may contribute to or cause symptoms of fatigue in CFS patients.

Introduction

Profound muscle fatigue, precipitated by minimal physical activity, is one of the major symptoms in chronic fatigue syndrome (CFS) patients [1]. In CFS there have been reports of excessive intramuscular acidification [2] and abnormal jitter in CFS with single-fiber electromyography [3] suggestive of abnormal muscle membrane function. However, other investigators have not found abnormalities in muscle fatigability and excitation-contraction coupling [1, 4].

In vitro tests have shown depressed muscle mitochondrial respiration in CFS, and patients have demonstrated reduced aerobic work capacity [5]. Mitochondrial palmitate oxidation has been reported to be reduced in CFS patients [6]. Intracellular concentration of adenosine triphosphate has been demonstrated to be reduced at peak exercise in CFS patients [7]. These results suggest a mitochondrial abnormality.

Recent investigations in Great Britain have shown that 70% of CFS patients have ultrastructurally abnormal muscle mitochondria [8–11]. These mitochondria have abnormal sizes, shapes and a peculiar infolding of the inner mitochondrial membrane, producing 'compartmentalization' of their internal structure. These structural abnormalities may be associated with deficits in mitochondrial energy production that may lead to fatigue.

Carnitine is essential in mitochondrial energy metabolism. It has two principal functions: (1) to transport long-chain fatty acids into the mitochondrion for β-oxidation; (2) to help regulate the intramitochondrial ratio of acetyl-coenzyme A to free acetyl-coenzym A [12]. Carnitine deficiency conditions may be primary, such as those associated with inborn errors of metabolism, or secondary, such as those associated with inadequate intake or those that are induced by medicines. Clinical symptoms of carnitine deficiency may include myopathy, cardiomyopathy and encephalopathy. In a study of 38 CFS patients, serum lev-

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