

Metabolic Abnormalities in Muscles of Fibromyalgia Patients Detected with P-31 Magnetic Resonance Spectroscopy

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Introduction

Fibromyalgia (FM) is a serious debilitating disease of unknown etiology which is three times more prevalent than rheumatoid arthritis. The most common complaints of FM patients are widespread muscle pain, specific tender points, and sleep disorders. These symptoms, along with weakness, fatigue and stiffness, are observed in most, if not all, patients (1). Weakness and fatigue are often associated with metabolic abnormalities in muscle. Nevertheless, there is a prevalent perception that FM muscle symptoms are of cerebral rather than musculoskeletal origin. In the present study, we used P-31 MRS to quantitate the levels of ATP and PCr in the quadricep muscles of patients during rest and exercise. Metabolic abnormalities correlated with limited functional capacity of the FM patients.

Subjects and Methods

Twelve FM patients and eleven normal controls were studied. The clinical status of all subjects was determined by a modified health assessment questionnaire (mHAQ) and visual analog scales for pain, weakness and fatigue. P-31 spectra of the quadricep muscles were obtained using a 1.5 Tesla magnet and a 10 cm surface coil. Spectra were acquired during each minute of a six minute rest period. For exercise, a weight equivalent to 25% maximum voluntary contractile force (MVC) was secured on the ankle, and the subject raised the lower leg by contraction of the quadriceps once every 5 sec over a 6 min interval. Levels of Pi, PDE, PCr and ATP were determined from the resonance areas under the peaks (2). Functional capacity was determined by calculation of the phosphorylation potential (PP) and total oxidative capacity (Vmax).

Results

Levels of PCr and ATP in the muscles of FM patients at rest were 15% lower than normal values ($P < 0.004$) (Table 1). The PCr/Pi ratio was also significantly lower ($P < 0.04$). The low PCr/Pi ratios were due to lower PCr levels as Pi was equivalent in both groups. The phosphorylation potential (PP) was 60% lower in FM patients ($P < 0.01$). During exercise at 25% MVC, PCr and ATP levels were still reduced in FM patients. Accordingly, work performed (V) and oxidative capacity (Vmax) showed 40% and 44% decreases.

Discussion

MRS showed 15% reductions in PCr and ATP in FM muscles, which is in close agreement with biopsy determinations in the trapezius muscles demonstrating decreases of 21% and 17% for PCr and ATP, respectively (3). The low PCr/Pi ratios indicate inefficient generation of PCr and ATP. Calculated free ADP was elevated in FM muscles, affording additional evidence for an abnormal bioenergetics status. Low energy reserve (PP) and PCr/Pi ratios portend the reduced MVC and work (V) by the patients. The decreased Vmax indicated that oxidative phosphorylation was severely impaired and might be translated into fatigue and lack of endurance commonly observed in FM.

In conclusion, the MRS data provide objective evidence for metabolic abnormalities in accord with weakness and fatigue in FM patients.

References

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METABOLIC PARAMETERS IN CONTROLS AND FM PATIENTS

SUBJECT GROUP	REST					25% MVC	
	Pi*	PCr	ATP	Pi/PCr	PP	V**	Vmax
Control	3.3	24.7	5.5	7.7	378	80	220
FM	3.2	21.3	4.7	6.7	145	48	124
P Value	NS	<.0001	<.004	<.04	<.01	<.003	<.0007

*Pi, PCr, ATP = mmoles/kg wet wt; **V = Joules/min