Defining the role of leucine and omega-3 fatty acids in skeletal muscle function

Issue
Skeletal muscle is a major site of metabolic activity and the most abundant tissue in the human body, and accounts for almost 40% of total body mass. For skeletal muscle to function at optimal levels, efficient activation of processes that regulate muscle development, growth, regeneration and metabolism is required. Mitochondria are particularly important for skeletal muscle function. According to the mitochondrial theory of aging, functional alterations in mitochondria contribute to the aging process. Aging impairs mitochondrial function by affecting both the capacity and the control of oxidative phosphorylation. Oxidative stress within aging skeletal muscle has been shown to contribute to sarcopenia. An age-related decline of mitochondrial capacity for oxidative phosphorylation has been demonstrated in both human skeletal muscle and rat hearts. Nutrition is also an important modulator of health and function in the elderly. Inadequate nutrition can contribute to the development of sarcopenia. Therefore, it is important to develop an optimal nutritional therapy that will improve skeletal muscle function.

Action
Dietary supplementation with leucine has been shown to increase muscle protein synthesis in the elderly and has recently been demonstrated to support cardiac and skeletal muscle mitochondrial biogenesis and prevent oxidative damage in middle-aged mice. In addition, omega-3 fatty acids have been linked to improved muscle function since intake is related to an increase in leg strength, chair-rise capacity and grip strength in elderly individuals. Currently, there is limited data available on the role of omega-3 fatty acids in skeletal muscle function during aging. There is increasing evidence that confirms the relation between nutrition and skeletal muscle function, however our present knowledge of nutrition and cellular aspects of age-associated sarcopenia is still limited. Therefore, this research is designed to determine if treatment with the nutrients leucine and omega-3 fatty acids will improve skeletal muscle function in aged cells by improving mitochondrial biogenesis and oxidative phosphorylation and, when added simultaneously, we hypothesize that leucine and omega-3 fatty acids will have a synergistic effect.

Impact
By 2050, it is anticipated that Americans aged 65 or older will number nearly 89 million people, or more than double the number of older adults in the United States in 2010. Over the last 20 years, mounting scientific evidence has provided new information on the role and impact of nutritional status on functional capacity and health of the aging individual. A number of studies identify protein (and the branched-chain amino acid leucine) as a key nutrient for older adults. Protein intake greater than the amount required can reduce rapid loss of muscle mass associated with the aging process. Benefits of increased protein intake include improved muscle function and quality of life in healthy elderly individuals and may also improve the ability of hospitalized elderly patients to recover from disease and trauma, which could result in reduced health care costs.

Data from our lab demonstrates that leucine and omega-3 fatty acids are able to work synergistically to increase muscle protein synthesis in vitro. This could mean that when taken together they could increase skeletal muscle mass. In addition, both leucine and omega-3 fatty acids increase cellular bioenergetics in isolated muscle cells. This is a biomarker for increased mitochondrial biogenesis and improved muscle function at the cellular level.

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