

The role of leucine and Anabolic Resistance

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Abstract

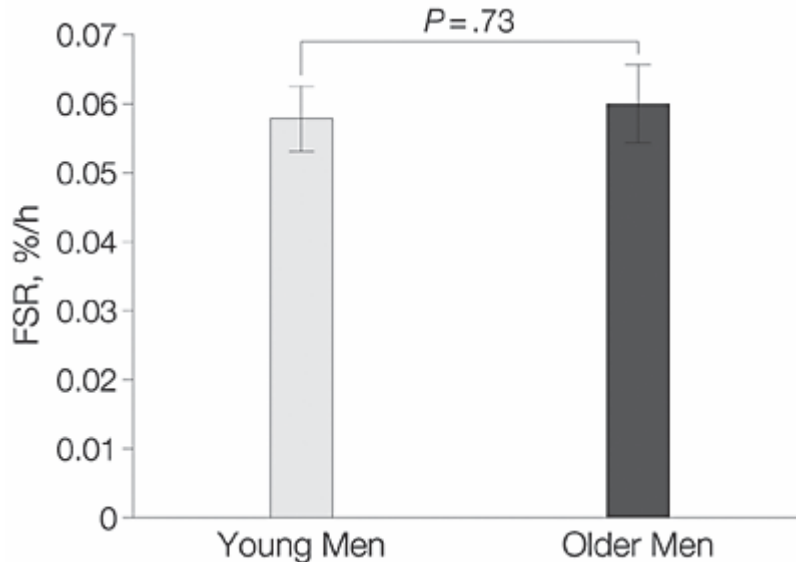
Aging appears to be associated with muscle tissue loss of an average of 0.5 to 2 % per year after the age of 50. These muscle tissue losses appear to be related to a loss of aging muscle tissue's sensitivity to leucine's stimulating effects on protein synthesis. Currently research indicates that proper leucine administration can reverse this lowered deficit back to levels of young individuals. The purpose of this paper will be to analyze this research and to provide practical applications for dietary habits for aging athletes.

Introduction

One of the more frequent questions I receive to my email account and in person is "can I still gain muscle at this age?" Typically my answer is that the evidence supports the efficacy at bodybuilding at any age. However this paper will address the situation from an in depth scientific perspective. Specifically the paper discusses sarcopenia, which is the normal loss of muscle tissue mass after the age of 50. It appears that after age 50 muscle tissue is generally lost at a rate of 0.5-2 % per year, resulting in progressive loss of function in the elderly.

Reasons for Sarcopenia

A major area analyzed in sarcopenia is age related differences in indexes of protein balance. In a classic study, Volpi and colleagues (2001) measured basal (resting conditions in post absorptive states) rates of protein synthesis and degradation in young (28 years of age) and elderly (70 years of age) participants. It was found that leg volume was lower in the elderly than the young suggesting muscle tissue loss. Surprisingly however no significant differences were found in basal protein balance. In more detail there were very small differences in protein synthesis between young and elderly participants. The elderly tended to have slightly higher rates of protein synthesis (figure 1) and degradation than the young, which when added together provided an equal measure of protein balance.



Fractional synthetic rate in young and elderly men.

The authors concluded that the differences in basal muscle protein turnover between older and younger men do not appear to explain muscle loss that occurs with age.

However, research since this time has indicated that it is the response of elderly to a meal that is blunted with aging. Specifically the elderly respond with lower protein synthesis and less suppression of protein degradation following a meal compared to younger individuals, suggesting signaling deficits. For example Katsanos et al (2005) had eleven elderly subjects (68 +/- 2 y) and 8 young subjects (: 31 +/- 2 y) consume 7 g of EAAs. Results found no difference between conditions during basal periods. However following ingestion of the 7 grams of EAAs the elderly had significantly lower protein balance than the young individuals.

In a follow up study Katsanos et al. (2006) administered 7 grams of EAAs to the young and elderly. In condition 1 both groups were given an essential amino acid mixture that contained 26 % leucine. In this condition protein synthesis was increased in the young, but did not increase in the elderly. In condition 2 the elderly were administered a 7 gram mixture of EAAs with the proportion of leucine increased to 41 %. Results found that protein synthesis and net balance were restored to levels seen in young individuals. This suggests that muscle tissue loss in the elderly is related strongly to impaired leucine signaling, and when leucine levels are increased the deficit in protein balance is reversed.

It should be noted that the increased leucine did not increase protein synthesis in the young individuals. The authors postulated that this is because the increase in leucine was at the expense of lowering other EAAs. This contention was supported by past studies in which the nearly 3 grams of leucine were combined with a total mixture of 15 grams of EAAs. In that study protein synthesis was double what occurred in the Katsanos et al. (2006) study, again pointing to the supportive role of other EAAs.

Studies have also compared acute and chronic supplementation of leucines on protein balance. In an excellent experiment Dardevet et al. (2002) had young and old rats consume their normal meals and measured Ubiquitin-proteasome dependent

proteolysis. Recall that Ub-proteolysis is the major pathway for the breakdown of muscle tissue. Results found that the young rats decreased UB-proteolysis by 56 % in response to normal feeding while the elderly rats had no decrease in degradation. However when the elderly rats were supplemented with 5 % leucine they decreased markers of the UB-pathway as completely as the young rats! Therefore it appears that when adequate leucine intake is given that the elderly can completely reverse age related deficits in the capacity to lower protein degradation. In a follow up study Rea (2003) found that 10 days of leucine supplementation still maintained its effects on lowering protein degradation suggesting the efficacy of chronic supplementation.

How can Elderly Individuals Raise leucine intakes?

In the above studies elderly individuals and young were compared with levels of essential amino acids corresponding to 7 grams, which is approximately 15 grams of protein.

During this protocol the elderly clearly have deficits in protein synthesis and degradation. However at higher doses this does not appear to be the case. For example Paddon Jones et al. administered 15 grams of EAAs and found that this increased plasma amino acids by 300 %. These scientists found no significant difference between the young and elderly in protein synthesis. The rationale is that higher levels of EAAs and leucine may have saturated the system such that it elicited a maximal response in the stimulation of muscle protein accretion in both the young and the elderly.

Therefore it appears that at high enough doses of leucine and other EAAs that both the young and elderly have similar responses. The implication is that the elderly should consume a large enough dosage of EAAs each meal to saturate their protein synthetic signaling pathways. This most likely occurs at around 15 to 20 grams of EAAs, or 30-40 grams of high quality protein per meal.

This contention is also supported in studies examining pulse feeding. Arnal et al. compared feeding 80 % of an elderly group's protein in one of their meals compared to spreading their protein intake equally over all meals. It was found that the pulse (80 % condition) feeding improved protein balance relative to the spread pattern. The authors suggested that this was therefore a viable method to enhance protein balance in the elderly. However it is the contention of the current author that what was really demonstrated was that the elderly require a high dose of leucine and supporting EAAs if they are to maximally stimulate protein balance. It is predicted that if the elderly had consumed high protein intakes in each of their meals that their protein balance would increase proportionally to each of these feedings.

Conclusion

Elderly individuals appear to be deficient to the anabolic signaling effects of food intake. Specifically they are insensitive to leucine signaling. However when leucine is supplemented the effects of protein balance are enhanced to levels of young participants. It was suggested that elderly should consume 15 to 20 grams of EAAs per meal, or 20 to 40 grams of protein per meal.

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