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THE ROLE OF AMINO ACID SUPPLEMENTATION IN SARCOPENIA TREATMENT

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SUMMARY

Muscle atrophy accompanying aging is an important problem researched by a lot of experts worldwide. Therefore, a new clinical entity called sarcopenia has been defined in connection with this phenomenon. Physical activity is an area investigated in connection with sarcopenia because it turns out to have a positive impact on maintaining physical performance at the elderly. Currently there is gaining a lot of attention also amino acid supplementation for its anti-atrophic therapy ability. In the past, there has often been shown that an increased intake of essential amino acids in particular can have remarkable effects on remodelling muscle protein and thus positively affects various physiological parameters related to muscle function and quality of life. The aim of this review is to highlight the importance of physical exercise and especially emphasize the role of amino acid supplementation in the treatment of sarcopenia.

Key words: aging, muscle mass loss, hypertrophy, anabolism, skeletal muscles

INTRODUCTION

Aging of a human body is generally associated with a gradual decline in both physical and metabolic functions. A cause of such situation may be a disease called sarcopenia, which was defined by Irving Rosenberg (1989) at the end of the twentieth century as age-dependent muscle mass loss and physical performance decline of the human organism. Sarcopenia may thus also sooner or later contribute to a condition where an individual becomes dependent on their surroundings. Cross-sectional studies carried out recently suggest a high prevalence of sarcopenia at the elderly population (Baumgartner et al., 1998; Castillo et al., 2003; Di Monaco, Vallero, Di Monaco, & Tappero, 2011; Chien, Kuo, & Wu, 2010; T. N. Kim et al., 2009; Sanada et al., 2010; Woo, Leung, Sham, & Kwok, 2009) and especially among community-dwelling elderly people and nursing homes elderly residents (Bahat et al., 2010; Bauer, Kaiser, & Sieber, 2008; Hedayati & Dittmar, 2010; Chien, Huang, & Wu, 2008; Landi et al., 2012; Lin et al., 2004; Mitchell

et al., 2010). In addition, the prevalence of sarcopenia may still rise with an increasing human life expectancy and it may cause a change in health care system with a greater need for hospitalization, treatment and rehabilitation (Candow, 2011). With regard to this fact sarcopenia and related disorders are to be ranked among major public health problems of the twenty-first century (Henderson, Irving, & Nair, 2009). Creating effective strategies to combat with sarcopenia is therefore currently inevitable (Buford et al., 2010). In this review we shall discuss some therapeutic strategies used in both prevention and treatment of sarcopenia. In particular, we shall focus on the influence of specific amino acid supplementation and its effect on body composition, muscle strength and physical performance.

Sarcopenia and Physical Exercise

Since sarcopenia is a condition caused by multiple causes and mechanisms that can also change their relative contribution to the development of sarcopenia in the course of time, finding an effective therapeutic strategy may become a big problem (Cruz-Jentoft, Landi, Topinkova, & Michel, 2010). However, a lot of research suggests that physical activity and resistance training are one of the easiest and most feasible and affordable strategies to combat the threat of sarcopenia (Candow, Chilibeck, Abeysekara, & Zello, 2011; Kosek, Kim, Petrella, Cross, & Bamman, 2006; Petrella, Kim, Cross, Kosek, & Bamman, 2006; Petrella, Kim, Tuggle, & Bamman, 2007; Suetta et al., 2009) especially if physical exercise is accompanied with appropriate nutritional strategies (Brooks et al., 2008; Cornish & Chilibeck, 2009; Tarnopolsky & Safdar, 2008; Verdijk et al., 2009). Resistance training provides a wide range of physiological benefits for muscles (DiFrancisco-Donoghue, Werner, & Douris, 2007) including, but not limited to, reducing inflammation (Meng & Yu, 2010) and increasing mitochondrial function (Hiona et al., 2010). Moreover, intense neuromuscular activity may delay age-related denervation atrophy of myofibrils (Deschenes, Roby, Eason, & Harris, 2010). A significant increase in muscle mass and strength after short resistance training has been observed in adults who lead a sedentary life even after reaching 80 years of age (Aagaard, Suetta, Caserotti, Magnusson, & Kjaer, 2010; Buford, et al., 2010). Endurance exercise also improves physical function and increases appendicular muscle mass and cross-sectional muscle area even at the elderly (Witham, Sumukadas, & McMurdo, 2008). Moreover, mitochondrial biogenesis and total oxygen consumption are increased during endurance exercise performance (Barazzoni, 2011). Endurance exercise is also associated with improving insulin sensitivity (Pedersen, 2006). Although the importance of exercise has been proven in the prevention and treatment of sarcopenia, this strategy cannot often be used mainly due to inability of a lot of patients to perform some of the methods of exercises (Landi et al., 2012). Hypertension, ischemic heart disease, vascular abnormalities (e.g., aneurysms), a history of cerebral hemorrhage (Koster et al., 2011), physical limitations after surgery on the upper or lower limbs or severe joint pain (Hairi et al., 2010), various lung diseases including asthma (Lim et al., 2011) and other limits resulting from comorbid conditions typical for the older generation represent limiting factors for the use of physical exercise. In addition, patients with impaired cognitive function or depression may be very hard to motivate to any physical activity due to unwillingness to cooperate (Landi et al., 2012).

Sarcopenia and Amino Acid and Protein Supplementation

The use of various dietary supplements without concurrent application of the locomotive program is another option in prevention and treatment of sarcopenia. As the latest data of the research show, lean body mass is significantly positively associated with protein intake and protein deficiency in a diet seems to be a important factor for sarcopenia development at the elderly (Houston et al., 2008). Moreover, it appears that aging does not reduce the ability of muscle protein synthesis in response to high-protein diet (Paddon-Jones & Rasmussen, 2009). It is assumed that protein intake 1.5 g/kg/day or 15 to 20% of total energy intake is a reasonable target for the elderly who want to optimize protein intake in terms of health and physical function (Wolfe, Miller, & Miller, 2008). The method and timing of protein intake are also important to maintain muscle mass at the elderly (Waters, Baumgartner, Garry, & Vellas, 2010). Muscle protein synthesis may also be positively stimulated by supplementing food with essential amino acids (Buford, et al., 2010). There are shown results of some studies investigating the effect of amino acid supplementation for body composition and physical performance in Table 1. However, it seems that a dose of 7.5 g amino acid mixture administered orally twice a day for three weeks can positively affect body composition at elderly women (Dillon et al., 2009). A dose of 22 g amino acid administered between meals for 12 weeks also had a positive impact on overall body composition and increasing muscle strength of lower extremities for women and men, but it had no positive influence on upper limb muscle mass and improving physical performance (Borsheim et al., 2008). However, even the doses of 8 g amino acids per day had positive influence on the improvement in body composition indicators measured for eight and sixteen weeks respectively (Solerte et al., 2008) and so did even only 2.4 g β-alanine after 90 days after basic measurement (Stout et al., 2008). On the other hand a dose of 6 g amino acid per day had no effect on body composition but had a positive effect on physical performance parameters (Kim et al., 2012). A blend of amino acids that was composed of β-hydroxy-β-methylbutyrate, arginine and lysine had an effective influence on body composition, muscle strength and physical performance (Baier et al., 2009; Flakoll et al., 2004). Arginine itself administered at a dose of 18 g per day had no effect on body composition, but it was associated with significant improvements in legs strength (Fricke, Baecker, Heer, Tutlewski, & Schoenau, 2008). Nevertheless, a dose of 7.5 g of leucine daily for twelve weeks yielded no positive result for body composition and physical performance (Verhoeven et al., 2009). Composition of amino acid supplementation of the aforementioned studies is shown in Table 2.

Table 1. Summary result of some studies on the influence of amino acid supplementation on selected indicators at the elderly population.

study	sex	age (y)	n	duration of experiment	body composition		muscle strength	physical performance
Baier et al. (2009)	females males	76 ± 1.6	77	1 (year)	(BIA, DEXA) +			get-up-and go +
Borsheim et al. (2008)	females males	67.0 ± 5.6	12	12 (wk)	(DEXA) +	leg lean mass (kg) (DEXA) ↔	knee flexors and knee extensors' one repetition maximum +	walking tests ↔
Dillon et al. (2009)	females	67 ± 1	14	3 (wk)	(DEXA) +			
Flakoll et al. (2004)	females	76.7	50	12 (wk)	(BIA) +		knee flexor force (kg), handgrip strength (kg) +	
Fricke, Baecker, Heer, Tutlewski, & Schoenau (2008)	females	54.4 ± 4.1	23	6 (wk)	(DEXA) ↔		the peak jump force +	
Kim et al. (2012)	females	79.2 ± 2.8	39	3 (wk)	(BIA) ↔	leg lean mass (kg) (BIA) +	knee extension strength, Nm/kg +	usual walking speed, m/s +
Solerte et al. (2008)		66–84	41	8, 16 (wk)	(DEXA) +			
Stout et al. (2008)	females males	72.8 ± 11.1	26	90 (day)				physical working capacity (EMG) +
Verhoeven et al. (2009)	males	71 ± 4	30	12 (wk)	(DEXA) ↔	upper leg muscle cross-sectional area (CT) ↔	leg press and leg extension ↔	

+ there was a significant improvement in that indicator
↔ there was no improvement in that indicator
DEXA is dual energy x-ray absorptiometry
BIA is bioelectrical-impedance analysis

Table 2. Composition of amino acid supplementation tested in selected studies in connection with sarcopenia.

Amino acid	Baier et al. (2009)	Borsheim et al. (2008)	Dillon et al. (2009)	Flakoll et al. (2004)	Fricke, Baecker, Heer, Tutlewski, & Schoenau (2008)	Kim et al. (2012)	Solerte et al. (2008)	Stout et al. (2008)	Verhoeven et al. (2009)
β-alanine	–	–	–	–	–	–	–	2.4	–
Arginine	5	2.2	–	5	18	–	–	–	–
Cysteine	–	–	–	–	–	–	0.3	–	–
Histidine	–	0.72	1.64	–	–	–	0.3	–	–
Isoleucine	–	1.88	1.56	–	–	0.63	1.25	–	–
Leucine	–	7.9	2.78	–	–	2.52	2.5	–	7.5
Lysine	1.5	3.76	2.34	1.5	–	0.84	1.3	–	–
Methionine	–	0.78	0.46	–	–	–	0.1	–	–
Phenylalanine	–	1.02	2.34	–	–	0.42	0.2	–	–
Threonine	–	2.1	2.2	–	–	0.63	0.7	–	–
Thyrosine	–	–	–	–	–	–	0.06	–	–
Tryptophan	–	–	–	–	–	–	0.04	–	–
Valine	–	1.64	1.72	–	–	0.63	1.25	–	–
β-hydroxy-β-methylbutyrate	2	–	–	2	–	–	–	–	–
other	–	–	–	–	–	0.33	–	–	–
total intake g/day	8.5	22	15	8.5	18	6	8	2.4	7.5

CONCLUSION

Treatment of sarcopenia is currently one of the key tasks not only for clinical geriatricians but it is also a challenge for dieticians and other specialists who deal with the treatment of diseases accompanying aging of the human organism. In terms of using physical exercise to prevent sarcopenia at the elderly it is crucial to find answers to questions about how to motivate seniors to take part in such activities. Food composition for the elderly is also one of the important questions which must be answered. However, essential amino acids supplementation appears to be a relatively effective solution without any healthy risk. Nevertheless, there is a need to make other studies to verify a number of issues related to sarcopenia treatment.

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ÚLOHA SUPLEMENTACE AMINOKYSELIN V LÉČBĚ SARKOPENIE

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SOUHRN

Svalová atrofie provázející stárnutí je v současné době jedním z důležitých témat, jejichž řešením se zabývají odborníci na celém světě. V souvislosti s tímto jevem byla jako nová klinická jednotka definována sarkopenie. Jednou ze sledovaných oblastí v souvislosti se sarkopenií je tělesná aktivita, která, jak se ukazuje, má pozitivní vliv pro udržování tělesné výkonnosti u seniorů. Rovněž aminokyselinové suplementace patřící mezi anti-atrofické terapie si v současnosti získávají velkou pozornost. V minulosti bylo častokrát prokázáno, že zvýšený příjem především esenciálních aminokyselin může mít pozoruhodné účinky na remodelaci svalových bílkovin, a tak pozitivně ovlivňovat různé fyziologické parametry, které souvisejí se svalovou funkcí i kvalitou života. Cílem tohoto přehledu je poukázat na význam tělesných cvičení a především upozornit na roli aminokyselinových suplementací v léčbě sarkopenie.

Klíčová slova: stárnutí, úbytek svalové hmoty, hypertrofie, anabolismus, kosterní svaly

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