Effect of Exercise Therapy Combined with Branched-Chain Amino Acid Supplementation on Muscle Strengthening in Persons with Total Hip Arthroplasty

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Introduction

Previous studies have reported that even after total hip arthroplasty (THA), many patients suffer from a prolonged decrease of hip muscle strength despite their reconstructed hip joint and improved mechanical efficiency.

Muscle protein metabolism requires more branched-chain amino acids (BCAAs), particularly more in older than in younger persons[1)]. Regarding interventions for sarcopenia, Yoshimura et al [2)] showed that the combined therapy of exercise and BCAA intake significantly improved muscle strength and muscle mass compared with exercise or BCAA intake alone. On the other hand, a nutritional support regimen after artificial joint surgery has not been established [3)].

In persons with hip OA, combined therapy using BCAAs with low-load, high-volume tube exercise can significantly strengthen not only the affected side but the contralateral side hip muscle[4)]. This study suggested that, in non-operated hip OA with joint deformity, decreased mechanical efficiency and pain, it was difficult to strengthen hip muscles even with combined BCAA supplementation and exercise. Hypothetically, the combined therapy after hip reconstruction that improves mechanical efficiency and eliminates pain may be more effective in muscle strengthening.

Purpose

Present study investigated the effects of treatment with muscle strengthening exercises and BCAA supplementation on improving muscle strength in person with THA.

Participants

The eligible patients were 31 elderly women who were admitted to ward for rehabilitation during convalescence after THA and revisions. Inclusion criteria were as follows: female, age 70 years and older, and no deglutition disorder. Exclusion criteria were as follows: rheumatoid arthritis; disorders of the nervous system and muscles; dementia; depression; schizophrenic disorder; and untreated cardiovascular disease.

	BCAA group (n=18)	Control group (n=13)
Age (years)	75.2±4.9	75.6±6.6
Body mass index (kg/m²)	21.9±4.0	25.5±3.7 *
Co-morbidity Index (score)	1.4±2.1	1.8±2.4
Diagnosis: Osteoarthritis Loosening of artificial joint Other	13 persons 3 persons 2 persons	13 persons 0 person 0 person
Surgical procedure: Postero-lateral (PL)	14 persons	10 persons
PL + Osteotomy	1 person	1 person
Antero-lateral	0 persons	2 persons
Revision	3 persons	0 person
Postoperative days of admission (days)	23.3±4.3	20.4±4.6

Methods

A one-month period of supplementation was combined with physical exercises. The subjects were randomly assigned to two groups: the BCAA group (n=18) and the control group (n=13).

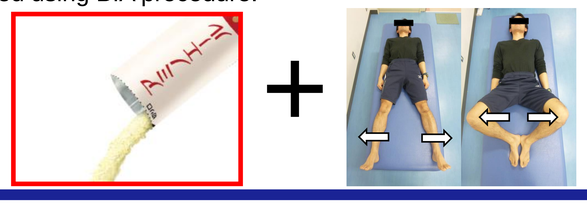
The supplementation was provided every day for 1 month in both groups. Immediately after the exercise therapy session.

BCAA group: participants ingested a 3.4-g amino acid supplement (Amino-aile, Ajinomoto Co., Inc., Tokyo, Japan). **The supplement contained 3.0-g of amino acids: BCAAs and essential amino acids (1.2 g leucine, isoleucine, and valine and 1.8 g lysine; the percentage content of leucine was 40%)**.

Control group: participants ingested a 1.2-g starch (polysaccharide)

The exercise intervention was performed every day for 1 month in both groups. Each rehabilitation session consisted of a 3-set exercise menu (**1 set of 20-min muscle strength exercise, 1 set of 20-min range of motion exercise, and 1 set of 20-min gait training**) and activities of daily living training. Muscle strengthening exercises included hip abduction exercise, clamshell exercise, and knee extension.

We determined isometric muscle strengthening (hip abduction, knee extension), grip strength, upper limb muscle cross-sectional area, skeletal muscle mass, and FIM score. Isometric muscle strength were measured using hand held dynamometer. Skeletal muscle mass was measured using BIA procedure.



Results

Group × time analysis of muscle strength, upper-limb muscle cross-sectional area, and FIM score

	Group	Pre-intervention	Post-intervention	Interaction (synergistic effect)
Hip abduction (Nm/kg) Operated side	BCAA	0.52±0.35	0.78±0.33	
	Control	0.55±0.22	0.78±0.25	
Hip abduction (Nm/kg) Contra-lateral side	BCAA	0.73±0.32	0.95±0.33	
	Control	0.70±0.29	0.85±0.26	
Knee extension (kgf/kg) Operated side	BCAA	0.24±0.10	0.31±0.08	
	Control	0.26±0.06	0.31±0.08	
Knee extension (kgf/kg) Contra-lateral side	BCAA	0.37±0.13	0.43±0.13	*
	Control	0.31±0.09	0.33±0.09	
Grip strength (kgf)	BCAA	17.4±5.2	18.4±4.3	
	Control	18.6±5.0	19.3±4.3	
Upper arm muscle Cross-sectional Area (AMA) (cm²)	BCAA	48.4±11.6	47.0±11.6	*
	Control	61.3±19.9	58.5±12.8	
Functional Independence Measure (FIM: score)	BCAA	78.8±9.2	82.7±9.8	
	Control	75.6±7.4	84.4±4.0	

Comparisons of the improvement rates of muscle strength between the two groups

	BCAA (n=18)	Control (n=13)	p-value
Hip abduction strength:			
Operated side (%)	8.9±21.6	-0.3±14.2	0.31
Contra-lateral side (%)	14.9±19.4	-2.6±16.5	0.18
Knee extension strength:			
Operated side (%)	47.7±53.5	14.4±18.3	0.04 *
Contra-lateral side (%)	18.9±19.1	10.0±10.4	0.14
Skeletal muscle mass (%)	1.4±4.9	-2.0±5.4	0.07 †

Note: The percentages for each outcome measure are differences from baseline.

Discussion & Conclusions

The present study showed that BCAA supplementation combined with muscle strengthening exercises showed significant interaction on knee extension strength on the contralateral side and upper arm cross-sectional area. In addition, the improvement rate of knee extension strength on the operated side was significantly higher in the BCAA group than in the control group.

There was no significant interaction for hip muscle strength, and the improvement rate of hip muscle strength, skeletal muscle mass did not differ significantly between the groups. Considering the effects were observed in other than the hip joint, these results did not support our hypothesis and was similar previous study. The present study suggests that it may be difficult to strengthen the operated hip muscle effectively even if BCAAs is combined with exercise both before and after surgery.

Why the combined therapy did not improve hip muscle strength? Because the improvement rate of hip abductor strength was over 50% from baseline in both groups, there was no prolonged decrease of hip muscle strength during hospitalization. The primary purpose of THA is reconstructing the joint lever arm and improving mechanical efficiency. We believe that the impact of BCAA on postoperative hip muscle strength compared with that of mechanical efficiency would be limited.

AMA showed a significant decrease in the control group. There was also a slight AMA decrease in the BCAA group. It is important that reduction of AMA was affected by physical activity during the hospitalization period. Most participants had rehabilitation sessions for approximately 1.6 h per day and were inactive at other times. Compared with household work before surgery, the participants might have had a sedentary lifestyle during hospitalization.

References

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Contact details

Regarding presenter, further information