BRIEF REPORT

Changes in lower extremity muscle mass among bedridden patients with post-stroke hemiplegia in the acute post-stroke period

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Abstract The present study analyzed 16 patients who were bedridden for one week immediately after onset of post-stroke hemiplegia. We used DXA (dual energy X-ray absorptiometry) to determine changes in muscle mass in the lower extremities on both paralyzed and non-paralyzed sides. The first measurement was conducted 3 to 5 days after the onset, and the second measurement was conducted 7 days after the first. Muscle mass in the lower extremities was reduced by approximately 600g (9%) on the paralyzed side with and by 200g on the non-paralyzed side (3%) in the Brunnstrom stage ≤ Ⅱ group (n=5). Although the decrease of muscle mass in the Brunnstrom stage ≥ Ⅲ group (n=11, relatively slight degree of functional motion impairment) was not significant, a decrease of approximately 300g (decrease rate : 5%) was observed on the paralyzed side and approximately 100g (decrease rate : 1.5%) was seen on the non-paralyzed side. Hence, muscle mass declined on both sides, and this occurred regardless of degree of paralysis. The findings suggested that conventional range of motion exercises, functional position maintenance, and postural changes are inadequate to prevent disuse muscle atrophy in post-stroke patients ; thus, it is necessary to develop a new rehabilitation program which adopts different exercises such as trunk motion, even for patients in the acute stage after stoke onset.

Key words : acute post-stroke period, hemiplegia, lower extremity muscle, disuse muscle atrophy , dual energy X-ray Absorptiometry (DXA)

Introduction

Prevention of disuse syndromes, particularly disuse muscle atrophy, in patients who require rehabilitation for hemiplegia due to stroke, is an important issue for patients who require early-stage rehabilitation[1,2)]. However, in the acute post-stroke period, prevention of disuse syndromes must be performed while managing the disease progress and the risk of secondary complications. Therefore, although the need for prevention of disuse syndromes has been recognized, no standardized practical methods have been established[3)].

Most studies on disuse muscle atrophy have used chronic stage post-stroke patients as subjects[4−8)] ; only one observed the course of stroke from the acute to

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chronic periods[9]. For evaluation of changes in lower extremity muscles, CT, ultrasonography, nerve conduction studies, and muscle strength analyzers have been conducted ; however DXA (dual energy X-ray absorptiometry) has not been used for this purpose in post-stroke patients. DXA, which is commonly used for measurement of bone density, can also be applied to body composition measurement in which three body components, bone, muscle, and fat, are distinguished and measured individually for each right and left extremity[10]. Moreover, it is very accurate when used in this way, with measurement error ranging between 0.2 and 2.2%[10,11].

By measuring muscle amount for each body region in acute post-stroke patients and revealing the changes, it is possible not only to provide scientific validation of the intensity and contents of the bed-side exercises currently administered by nurses, and guidance for the patients, but also to contribute to disuse muscle atrophy prevention. Conducting such a study in the field of nursing should therefore be highly meaningful.

In the present study, changes in lower extremity muscle mass were measured using DXA in acute post-stroke patients who had been subject to bed-rest shortly after the onset.

Objective

Using DXA, we aimed to[1] reveal changes in lower extremity muscle mass on the paralyzed and non-paralyzed sides in acute stage post-stroke patients within 2 weeks from the onset, and[2] provide suggestions for nursing intervention based on the results.

Method

1. Subjects

Subjects consisted of 16 patients who were urgently admitted to hospital "A" due to stroke in the period between May 2005 and January 2006. In these patients, hemiplegia was observed, and it was possible to carry out the first measurement immediately after the onset and the second measurement 7 days after the first measurement.

2. Method and Analysis

DXA (QDR Delphi (Hologic, Inc. USA)) was adopted for measurement of muscle mass in each left and right lower extremity. The first measurement was conducted 3-5 days after the onset, and the second measurement was conducted on the 7th day after the first measurement. Brunnstrom stage was determined according to the medical records on the first DXA measurement day.

In data analysis, regarding the difference between first and second measurements of muscle mass, the average value and decrease rate were calculated for each paralyzed and non-paralyzed side. The decrease rate was calculated based on the following formula : (muscle amount in the first measurement-muscle amount in the second amount)/muscle amount in the first measurement×100. The subjects were divided into 2 groups : "mostly immobile (stage Ⅱ or below)" and "slightly or completely mobile (stage Ⅲ or above)" according to the degree of motion of the paralyzed lower extremity. Average values and decrease rates were calculated for each group. A Wilcoxon matched-pair signed-rank test was performed to analyze the data using SPSS 11.5 for Windows with statistical significance set at $P<0.05$.

3. Ethical considerations

The present study was conducted after receiving the approval of the Ethics Committee for Clinical Research at Tokushima University Hospital. The contents of the study were explained to the subjects and their families. Upon explaining orally and in a document that the participation was voluntary, that nobody would be disadvantaged in medical treatment and nursing due to discontinuation or lack of participation in the study, and that privacy would be protected, agreement to participate was obtained in writing.

Results

Table 1 shows the clinicodemographic background of the 16 subjects. They comprised 11 men and 5 women with an average age of 63.1 (SD 12.4). Cause of stroke (primary disease) was cerebral infarction in 9 subjects,

and intracranial hemorrhage in 7. Hemiplegia was left-sided in 11 subjects with and right-sided in 5. The Brunnstrom stage≥ Ⅲ group comprised 11 subjects, while the Brunnstrom stage ≤ Ⅱ group comprised 5 subjects.

Average decrease in lower extremity muscle mass (g) and decrease rate are shown in Table 2. Average decrease in muscle mass was significantly greater on the paralyzed side than the non-paralyzed side (382 g (SD293) vs. 127 g (SD279), $P<0.05$). In the Brunnstrom stage ≥ Ⅲ group (n=11), average decrease was significantly greater on the paralyzed side than the non-paralyzed side (304 g (SD275) vs. 108 g (SD307), $P<0.05$); decrease rate was 4.6% and 1.4% on the paralyzed and non-paralyzed sides, respectively. In the Brunnstrom stage ≤ Ⅱ group (n= 5), in which the degree of hemiplegia was more severe, the average decrease on the paralyzed side was as large as 554 g (SD 282) and the decrease rate reached 9.3%. The average decrease on the non-paralyzed side was lower at 168g (SD232), with a decrease rate of 2.6%; however, the difference between the paralyzed and non-paralyzed sides was not significant.

Table 1 Background of subjects

		Male	Female	Total
Gender		11	5	16
Age	40-49	1	5	2
	50-59	5	1	6
	60-69	0	2	2
	70-79	3	0	3
	Above 80	2	1	3
Primary disease	Cerebral infarction	7	2	9
	Intracranial hemorrhage	4	3	7
Side of paralysis	Right	2	3	5
	Left	9	2	11
Degree of hemiplegia				
Brunnstrom stage Ⅲ or above (lower extremities)		7	4	11
Brunnstrom stage Ⅱ or below (lower extremities)		4	1	5

Discussion

The importance of preventing disuse syndromes and developing a rehabilitation program based on a sufficient level of risk management for post-stroke patients 1-2 weeks after the onset is well-recognized[1,2]. Since muscle atrophy rapidly progresses within 2 weeks of stroke onset, and it takes 8 weeks to recover from this damage[8], it is particularly necessary to develop measures to prevent muscle atrophy and declining muscle strength immediately after stroke onset. However, it remains to be clarified whether and how much early-stage rehabilitation prevents disuse muscle atrophy. The present study therefore attempted to reveal changes in lower extremity muscle mass in post-stroke patients within 2 weeks after stroke onset.

According to a previous CT study of a patient group who required total care 2 weeks after stroke onset, femoral muscle cross sectional area decreased by 19%

Table 2 Average decrease and rate of decrease of lower extremity muscle mass

		N	Muscle amount decrease (g) Mean (SD)	Decrease rate (%)	Wilcoxon matched-pair signed-rank test
All cases	Paralyzed side	16	382 (293)	6.1	*
	Non-paralyzed side	16	127 (279)	1.8	
Brunnstrom stage Ⅲ or above (lower extremities)					
	Paralyzed side	11	304 (275)	4.6	*
	Non-paralyzed side	11	108 (307)	1.4	
Brunnstrom stage Ⅱ or below (lower extremities)					
	Paralyzed side	5	554 (284)	9.3	n. s.
	Non-paralyzed side	5	168 (232)	2.6	

(*; $P<0.05$ n. s.: not significant)

on the paralyzed side and by 21% on the non-paralyzed side[9]. In the present Brunnstrom stage≤ Ⅱ group, which had approximately the same degree of paralysis at the same interval after stroke as the patients in the above-mentioned study, lower extremity muscle mass decreased by approximately 600 g (decrease rate : 9 %) on the paralyzed side and 200 g (decrease rate : 3 %) on the non-paralyzed side. Furthermore, like the above-mentioned study[9], we observed a decrease in muscle mass not only on the paralyzed side but also on the non-paralyzed side, and this reduction became more significant as the degree of paralysis became more severe. In the present study, after the initial examination (3-5 days after stroke onset) nurses performed postural changes and functional position maintenance and physiotherapists performed forced range of motion exercises on all patients in this study. Nonetheless, decreases of muscle mass were observed.

Therefore, based on the present findings indicating that a more significant degree of decrease occurs in muscle mass as the severity of motor functional impairment increases, and that disuse muscle atrophy occurs on both paralyzed and non-paralyzed sides, we can make the following suggestions. It is necessary to actively conduct rehabilitation on bedridden patients from immediately after stroke onset, and the greater the motor paralysis, the more actively the rehabilitation should be conducted. Rehabilitation should be applied to include the lower extremities of both the paralyzed and non-paralyzed sides. It is necessary to provide complete instruction regarding motion exercises for both sides. It was also suggested that trunk muscle movement should be included when exercising the lower extremities for bedridden patients.

Furthermore, in the present study, DXA enabled the comparison of muscle weight between the entire left and right lower extremities. This technique should therefore be further for evaluating muscle mass in this situation.

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