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Short Communication

Relationship between Lower Leg Muscle Morphology and Jump Performance in Chronic Ankle Instability

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BACKGROUND

Ankle sprains are one of the most common injuries in sports activities. Repeated ankle sprains cause chronic ankle instability (CAI), and muscle atrophy in the lower leg after ankle sprains can cause muscle weakness surrounding the ankle joint and a feeling of ankle instability. Lobo et al. [1], reported that the cross-sectional area of the peroneus longus muscle was decreased in subjects with a history of ankle sprain compared to subjects without a history of ankle sprain. On the other hand, Arima et al. [2], found that subjects with CAI had a large cross-sectional area of the peroneus muscle group at the proximal 75%, decreased muscle activity in the peroneus longus muscle, and increased muscle activity in the peroneus brevis. These results suggest that CAI patients may compensate for muscle atrophy and decreased muscle activity by the hypertrophy and overactivity of other muscles. The side hop test (SHT) is a useful tool to assess ankle functional limitations [3]. It has been reported that subjects with CAI have lower peroneus longus muscle activity and longer SHT times compared to healthy subjects [4]. The purpose of this study was to examine the relationship among CAI, lower leg muscle morphology and jump performance.

METHOD

The subjects were 16 male university soccer players (Height : 172.47 cm ± 3.06, Weight : 66.84 kg ± 3.81, Age : 20.50 years old ± 1.46), who were divided into two groups, the CAI group and the Control group, based on their scores on the Cumberland ankle instability tool (CAIT) (Kunugi et al., 2017). In this study, patients were evaluated as CAI if their CAIT score was 24 points or less. There are 8 subjects with CAI according to CAIT. This study was conducted in accordance with the Declaration of Helsinki. Measurement items were lower leg muscle cross-sectional area and SHT.

Muscle Cross-Sectional Area

Lower leg muscle morphology was measured at the proximal 30% (30%), central 50% (50%), and distal 70% (70%) of the straight line connecting the fibular head and lateral malleolus using a 0.25 Tesla magnetic resonance imaging system (MRI) (G-Scan brio, Esaote). The muscle cross-sectional area was calculated using T1 image. The value obtained from the analysis was defined as the absolute muscle cross-sectional area (ACSA) (mm^2), and the value obtained by dividing the absolute muscle cross-sectional area by the total area of the lower leg, including all bones and muscles, was defined as the relative muscle cross-sectional area (RCSA) (%). The muscles measured are the peroneus longus (PL) and peroneus brevis (PB). The sum of the areas of PL and PB was defined as the peroneal muscle group (PG).

Side Hop Test

SHT is a performance test in which the subject performs 10 quick reciprocations with one leg across in 30cm width. All trials were performed with the dominant leg, and sufficient rest was allowed between trials. The measurement items are the time required for 10 round trips (SHT all), the average of all ground contact times during the attempt (CT Ave.), average Medial ground contact time (MCT Ave.), and average Lateral ground contact time (LCT Ave.). The trials were filmed using a high-speed camera (LUMIX DC-GH5S, Panasonic). It was calculated by reading the number of frames for touchdown and takeoff by 240fps.

In statistical, comparisons between the two groups were performed using the unpaired T test for normally distributed samples, and the Mann-Whitney U test for non-normally distributed samples. In both cases, the significance level is $p < 0.05$, $p < 0.10$ and $p < 0.01$. Effect size (ES) used Cohen's d and evaluated 0.8 or higher as a large, 0.50 to 0.79 as a medium, and 0.2 to 0.49 as a small effect size. For correlation analysis, Person's correlation coefficient was used.

RESULTS/DISCUSSION

Subject Characteristics

In this study, we selected 8 athletes with a CAIT score of 25 points or higher as Control group, and 8 athletes who performed vertical Rebound Jump (RJ) at the same level in RJ-index of that of the CAI group [5]. No significant differences were observed in height, weight, RJ-index, RJ jump height, RJ ground contact time, and 30m Sprint [Tables 1,2].

Side Hop Test

The effect size was moderate for SHT all, CT Ave, and MCT Ave, that is the time was long in the CAI group. This supports previous research [4].

Relative muscle cross-sectional area of peroneus muscle

Table 3 shows RCSA (%) of the peroneus muscle at the 30%, 50%, and 70%. At 50%, the peroneus muscle group tended to be smaller in the CAI group (p=0.08). In ES, the peroneus longus (ES = 0.65) and peroneus brevis (ES = 0.64) in the CAI group were small in 50%, and the peroneus brevis in the CAI group was large in 70% (ES = - 0.61). After an ankle sprain, the peroneus longus muscle atrophies, and the peroneus brevis muscle might hypertrophy to compensate for these muscle atrophy [6,7].

CORRELATION

Figure 1 shows the correlation between the cross-sectional area of the peroneus longus and MCT or LCT. At 50%, a correlation was found between PL and CT Ave (Control group: r = -0.054; CAI group: r = -0.537), MCT Ave, and LCT Ave. In the CAI group, a negative correlation was observed in which the smaller the peroneus longus muscle, the longer the CT. In individuals with a history of ankle sprains, atrophy and decreased muscle activity of the peroneus longus could be involved in delayed times in each phase.

Table 1 : Physical characteristics of subjects, field test and CAIT Score

	Control group			CAI group			p-value	ES
Height (cm)	173.03	±	3.99	171.91	±	2.20	0.50	0.35
Weight (kg)	66.20	±	4.38	67.49	±	3.99	0.53	-0.32
RJ								
RJ-index	2.13	±	0.26	2.15	±	0.25	0.89	-0.07
Height (cm)	37.91	±	3.90	39.49	±	3.86	0.43	-0.41
Contact time (msec)	178.88	±	18.33	189.38	±	48.49	0.58	-0.29
30m Sprint (sec)	4.30	±	0.15	4.29	±	0.15	0.87	0.09
CAIT Score	28.63	±	1.85	20.50	±	2.88	< 0.01**	3.36

**: p < 0.01

Table 2 : Side hop Test

	Control			CAI			p-value	ES
SHT all (sec)	6.36	±	0.54	6.93	±	0.90	0.15	-0.77
CT Ave (msec)	184.10	±	13.95	196.80	±	31.81	0.32	-0.52
MCTAve (msec)	179.20	±	12.26	194.70	±	30.13	0.20	-0.67
LCTAve (msec)	188.90	±	17.95	199.50	±	34.65	0.45	-0.39

†: p < 0.10 *: p < 0.05 **: p < 0.01

Table 3 : Relative cross-sectional area of Peroneus muscle

		Control			CAI			p-value	ES
Peroneus longus (%)	30%	3.07	±	0.70	2.96	±	0.57	0.76	0.16
	50%	3.43	±	0.74	2.96	±	0.68	0.21	0.65
	70%	5.01	±	1.06	4.70	±	1.09	0.57	0.29
Peroneus Brevis (%)	30%	3.52	±	0.49	3.29	±	0.90	0.52	0.33
	50%	3.84	±	0.93	3.30	±	0.78	0.22	0.64
	70%	4.88	±	0.68	5.52	±	1.30	0.24	-0.61
Peroneus group (%)	30%	6.59	±	0.69	6.25	±	0.91	0.42	0.42
	50%	7.27	±	1.03	6.26	±	1.14	0.08†	0.93
	70%	10.09	±	1.28	10.20	±	1.82	0.70	-0.07

†: p < 0.10

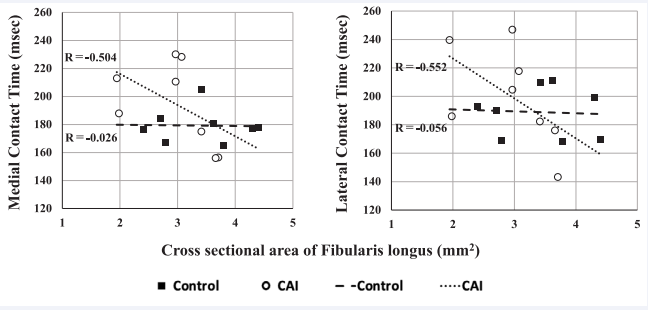

Figure 1 Correlation between Contact Time during SSH and cross-sectional area of Fibularis muscle.

The above results indicate that individual with CAI experience changes in the morphology of their lower leg muscles, which may result in decreased ability to perform SSC movements. However, there was no difference in RJ or 30m sprint among the subjects in this study. In addition, Ono (2023), reported that individual with CAI have different movement strategies during SHT than those without CAI, and the torque exerted at the knee and hip joints were higher. Based on the results of this study, it is thought that individuals with CAI experience changes in muscle morphology and compensatory movement due to ankle sprains.

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