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Comparison of the Difference of Ankle Range of Motion and Hip Strength in Both Legs of Fencing Athletes with Ankle Instability

Background: Ankle sprain in the Lead Leg Side (ALLS) is common in fencing athletes, and studies comparing the ankle range of motion (ROM) and strength of both legs are insufficient.
Objectvies: To compare the ankle ROM and hip strength between two legs in fencing athletes who has ankle instability in the lead leg side.
Design: Cross-sectional design.
Methods: Seven fencing athletes with ankle instability participated in this study, and they randomly assigned into ankle in the Lead Leg Side (ALLS) and ankle in the Rear Leg Side (ARLS). Instability was determined by the Cumberland Ankle Instability Tool (CAIT), and then joint ROM and hip muscle strength were measured.
Results: There were significant differences in dorsiflexion ROM, hip strength (extension and abduction) between the ALLS with ankle instability and ARLS (*P*<.05).
Conclusion: This study suggests that the ankle ROM and hip muscle strength of ARLS are greater than ALLS in fencing athletes with ankle instability.

Keywords: *Fencing; Range of motion; Muscle strength; Ankle instability*

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INTRODUCTION

Fencing athletes have the greatest load on the ankle joint compared to other joints when they step forward.[1] Of the injuries shown in the International Fencing Injury Data for 5 years, 72.4% of fencing athletes around the world had lower extremity injuries, and 26.4% had ankle injuries, so sprains occur most frequently during ankle injuries, and 68.1% of ankle sprains occur in Ankle in the Lead Leg Side (ALLS) because it is vulnerable.[2]

Ankle sprains are mostly considered minor injuries, and are given less treatment.[3] Also, 40% of ankle sprains indicates chronic ankle instability.[4,5] Chronic ankle instability can be divided into mechanical ankle instability and functional ankle instability.[6-8] Mechanical ankle instability includes pathological problems, joint movement disorders, lubricants, and degenerative problems.[8] Functional ankle instability includes a number of problems, such as range of motion (ROM), muscle strength, proprioception, neuromuscular control, and posture control.[9] Among the factors of functional ankle instability, the limited ROM of the dorsiflexion increases the risk of ankle sprains.[10,11] The dorsiflexion of a fencing athlete's ALLS is very stressful.[12]

The typical movements of the gluteus maximus and gluteus medius muscles are to make hip joint extension and abduction. In terms of functional aspect, the gluteus maximus and gluteus medius muscles in the lumbopelvic hip complex adjust position so that the pelvis maintains stability on the coronal plane during weight support.[13] Gluteus muscle group weakness is a risk factor for ankle sprains, and problems such as decreased muscle strength and changes in muscle activity during functional exercise persist in chronic ankle instability patients.[14-17] Patients with ankle sprain are related to the muscle strength of hip abduction and the ROM of the ankle joint.[18] Gluteus muscle weakness of chronic ankle sprain contributes to repeated ankle injury due to loss of stability throughout the kinetic chain or compensation in other areas.[19] Muscle problems in the gluteus muscle group are reported to be the cause of chronic ankle instability.[15]

However, recent studies have reported that there is insufficient evidence of a relationship between ankle injuries and weakness of the gluteus muscle group, and there is a lack of research on professional athletes.[20] Therefore, this study aims to compare the ROM of ankle joint and muscle strength of the hip joint between two legs in fencing athletes who has ankle instability in the lead leg side. This study hypothesis will be that there is a difference in the ROM of ankle joint and muscle strength of the hip joint between the two legs of a fencer with ALLS to instability.

SUBJECTS AND METHODS

Subjects

G*Power software program ver. 3.1.9 was used to determine the required sample size for this study. This study effect size 0.8 and power 80% set. Fifteen players participated before the study. However, eight players were excluded. The inclusion and exclusion criteria for the study are as follows. Inclusion criteria: (a) current players participating in fencing competitions, (b) an ankle instability score of the ALLS less than 27, and (c) who voluntary participation in the study. Exclusion criteria: (a) ankle instability in both feet, (b) a normal athlete without ankle instability. The participants in this study were seven fencing athletes who visited G gym located in Gwangju. Table 1 shows the general characteristics of the seven subjects who participated in this study. Ankle instability score, ankle joint ROM, and gluteus muscle strength required for the study were measured for all study subjects. The measurement procedure was Cumberland Ankle Instability Tool (CAIT), followed by ankle joint ROM and hip muscle strength. All participants received sufficient explanations of the study beforehand and agreed to participate voluntary. This study was conducted in accordance with the ethical standards of the Declaration of Helsinki. A schematic of the study procedure is shown in Figure 1.

Table 1. Characteristics of subjects

General characteristic	Mean ± SD
Gender (male/female)	3/4
Age (years)	21.43 ± 1.27
Height (cm)	174.86 ± 8.95
Weight (kg)	72.00 ± 11.08
CAIT (score)	16.71 ± 3.35

CAIT: Cumberland Ankle Instability Tool

Cumberland Ankle Instability Tool (CAIT)

The CAIT was used to measure ankle instability. This is a questionnaire containing nine items used to identify and evaluate the self-awareness of ankle instability. The maximum score is 30 and values below 27 indicate chronic ankle instability. The ankle instability questionnaire used in this study has high reliability (ICC=.96).[21]

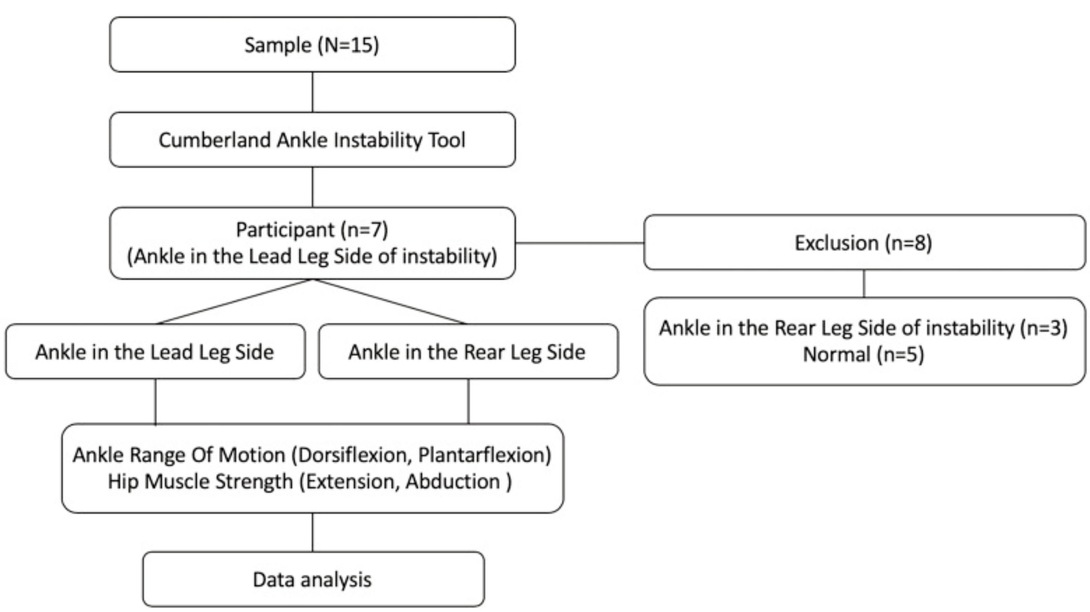

Figure 1. Study procedure

Range of Motion (ROM)

A general plastic goniometer was used to measure the ROM of ankle joint dorsiflexion and plantar flexion. The measurements were made by a physical therapist. The measurer was prevented from looking closely at the measured values. The measurer told the recorder when the measurement was complete. The recorder visually confirmed and recorded the measured value. The data used an average value of three measurements.

The measurement method is as follows. The measurer was located on the side of the participant's ankle joint. The goniometer was positioned so that the its axis rested over the center of the lateral malleolus of the fibula. The stationary goniometer arm was aligned parallel to the longitudinal axis of the fibula, and the mobile arm was placed parallel to the longitudinal axis of the fifth metatarsal bone.[22] Goniometer measurements had high reliability of dorsiflexion (ICC=.87) and plantar flexion (ICC=.76).[22]

Muscle Strength

A portable muscle strength meter (JTech PowerTrack II Commander HHD, JTECH Medical, USA) was used to measure the muscle strength of the extension and abduction of the hip joint. The measurements were made by a physical therapist. The measurer was prevented from looking closely at the measured values. The measurer told the recorder when the measurement was complete. The recorder visually confirmed and recorded the measured value. The data used an average value of three measurements.

The measurement method is as follows. Participants laid on their side to measure hip abduction. The opposite leg was flexed. Resistance was applied 5 cm proximal to the proximal edge of the lateral malleolus, against hip abduction. The examiner applied resistance in a fixed position and the person being tested exerted the maximum effort against the dynamometer and the examiner.[23] Between each measurement, a 1-minute rest was taken so as not to be affected by muscle fatigue.[24] The participants flexed their knees 70-90 degrees and were in a prone position to measure hip extensions. Resistance was applied 5 cm proximal to the knee joint line, at the posterior aspect of the thigh, against the hip extension. The examiner applied resistance in a fixed position and the person being tested exerted the maximum effort against the dynamometer and the examiner.[25] The standardized command by the examiner was "ready-go-power-power-power-power and relax" (lasting 5s). The portable muscle strength meter is a reliable device for clinically evaluating hip muscle strength.[25]

Data and Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics ver. 21.0 (SPSS Inc., Chicago, IL, USA). A Wilcoxon signed rank test was used to determine the differences in outcome variables in outcome variables between the ALLS and ARLS. Statistical significance was set at α=.05.

RESULTS

The statistics showed a significant decrease in the ankle dorsiflexion ROM in the lead leg side ($P<.05$) (Table 2). The statistical decrease in the muscle strength of hip extension in the lead leg side ($P<.05$) (Table 2). The statistical decrease in the muscle strength of hip abduction in the lead leg side ($P<.05$) (Table 2).

Table 2. Comparison of ALLS and ARLS

Variable	ALLS	ARLS	Z	*P*
Range of motion (°)				
Dorsiflexion	16.43 ± 2.51	20.86 ± 2.41	−2.428	.015*
Plantar flexion	37.86 ± 3.02	38.71 ± 3.04	−1.656	.098
Muscle strength (N)				
Hip extension	55.07 ± 9.52	59.05 ± 13.03	−2.028	.043*
Hip abduction	41.14 ± 4.73	44.13 ± 5.82	−2.117	.034*

*$P<.05$, ALLS: Ankle in the lead leg side, ARLS: Ankle in the rear leg side

DISCUSSION

Fencing athlete ankle injuries are common with excessive lunge movements.[26,27] A study on the injuries of elite Korean fencers for eight years also reported that their ankles were injured the most.[28] These injuries result in ankle instability.

This study compared the ROM of ankle joints of both legs of a fencer with ankle instability in the ALLS. As a result of comparison, it was found that there was a difference in the ROM of dorsiflexion of the ALLS. In a number of previous studies, patients with ankle instability had limitations in ROM for dorsiflexion.[29-31] Limitation of dorsiflexion does not convey normal afferent information about motor sensation.[32] The limited ROM of dorsiflexion was said to be a factor in re-injury.[33,34] Restrictions on dorsiflexion in patients with ankle instability need to be treated first.[35] Therefore, in this study, the limitation of dorsiflexion was found in fencing athletes with functional ankle instability in the lead leg side. It is thought that if this is not improved, re-injury and various functional limitations may occur to the fencing athletes.

This study showed that there was a difference in the hip extension and abduction muscle strength of both legs of a fencer with ankle instability in the ALLS. A previous study compared the hip muscle strength of the same side of participants with chronic ankle sprain to the opposite leg and reported a decrease in the muscle strength of hip abduction in the foot with an ankle sprain.[18] Other previous studies reported that tape was applied to soccer players with ankle instability to improve hip abduction muscle strength.[36] This study, the muscle strength of hip abduction of the ALLS with ankle instability was weaker than the ARLS. Therefore, in this study, the decrease of hip muscle strength was found in fencing athletes with functional ankle instability in the lead leg side.

A previous study suggested that lunge movements could be included in rehabilitation exercises to increase the muscle strength of hip abduction and muscle activity of the hip joint of patients with ankle instability.[17] Other prior studies compared hip muscular strength to the ALLS and ARLS of elite fencing athletes who had no injuries and said that the ALLS had more muscle strength in hip extension than the ARLS.[37] In fencing, when there is a lunge move, the lead leg acts as a braking device when the motion is over, and the posterior leg creates a driving force when moving forward.[38] The gluteus muscle of the lead leg during a lunge causes eccentric contraction. Eccentric contraction is perceived to stimulate muscle strength more strongly than concentric contraction.[39,40] However, in this study, the muscle strength of hip extension of the ALLS with ankle instability was weaker than the ARLS. In this study, the relationship between CAIT assessing ankle instability, ROM and gluteus muscle strength do not investigate. Further study is needed to understand clinical fencing performance or movements and why ALLS is weaker than ARLS.

This study has some limitations. First, the number of fencers who participated in the study is small. Second, it was not compared to a control group.

CONCLUSION

Fencers with ankle instability of the ALLS were different from that of the normal ARLS in the ROM of dorsiflexion and the muscle strength of hip extension and abduction. For the clinical treatment and training of fencers, it is necessary to consider the ROM of the ankle and gluteus muscle strength. Further studies are needed to supplement limitations.

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