INTRODUCTION

Anterior cruciate ligament (ACL) injury may lead to joint laxity and motor and/or sensory function deficits [1]. In a clinical setting, recovery tends to focus more on the strength of muscles around the knee joint, which is one of the crucial determinants as to whether patients can return to competition. It is known that motor function can be improved through appropriate rehabilitation, but sensory function may not. Moreover, previous studies have indicated that the risk of secondary injuries, including reoccurrence of ACL and osteoarthritis after ACL reconstruction, is increased due to the proprioceptive deficit [1]. Gokeler concluded in his systematic review that the correlation between ACL injury and proprioceptive function was low to moderate. Although the proprioceptive function of the knee might be altered by ACL injury and/or surgical reconstruction, what is actually caused by these factors and appears as behavioral characteristics remains unknown.

The purpose of this study was to attempt assessment of the sensorimotor system at the knee joint and to observe the behavioral characteristics of subjects with ACL reconstruction (ACR-R). This focuses on the relationship between the motor and sensory functions in order to enable understanding of how sensory function affects motor function in active movement after ACL-R.

METHODS

We examined 7 subjects with ACL-R (2 men and 5 women) and 10 healthy age-matched volunteers (4 men and 6 women) with no history of previous knee injury. Table 1 lists the ACL-R subjects’ details at the time of this study. Inclusion criteria for subjects with ACL-R were (1) no serious damage or other lesions except ACL, (2) no sufficient laxity or inflammation, and (3) participation in practice without any problems with knee function. The subjects had undergone a double-bundle ACL reconstruction with a semitendinosus graft performed by the same orthopedic surgeon. The ratio of right and left on the reconstructed (= impaired) knee was 3 and 4. In this study, we carried out the position-matching task for both legs to assess knee joint position sense. All blindfolded subjects were instructed to actively match one leg to the other leg in a sitting position (= knee flexed at 90°). The target angle was set at 30° (= knee flexed at 60°) toward knee extension and the starting position (= knee flexed at 90°) was defined at 0°, as shown in Figure 1. Position matching was performed under 3 conditions: the subject supported the reference leg against gravity at 30°; a 1 kg weight was added to the reference leg at 30°; the weight was increased to 2 kg. The reference leg was determined as either the right or left leg for the healthy group, and the impaired or intact leg for the ACL-R group. We used an electronic goniometer to acquire the knee joint angle during each task, which was carried out 3 times. The angle of deviation from the reference leg was determined as matching errors. Then, we calculated the average, standard deviation (SD), and standard errors (SE).

We statistically analyzed the data using 2-way repeated-measures ANOVA for 2 aspects, with the factors being the counter-weight and the reference leg. This study was carried out at the National Rehabilitation Center for Persons with Disabilities, where the Board of Institutional Review approved the protocol.

RESULTS

Figure 2 shows that the mean matching errors in the healthy group were 4.26° (3.83) at 0 kg; 4.67° (4.1) at 1 kg; 4.92° (4.3) at 2 kg (means (SD)) in the left reference leg and 2.51° (3.43) at 0 kg; 2.69° (4.73) at 1 kg; 3.01° (5.1) at 2 kg in the right reference leg. In the ACL-R group, the mean matching errors were 5.69° (3.53) at 0 kg; 6.32° (3.88) at 1 kg; 6.32° (4.48) at 2 kg in the impaired reference leg and 0.5° (3.23) at 0 kg; 0.98° (3.76) at 1 kg; 0.97° (3.76) in the intact reference leg.

The data for the reference leg were not significantly different in the healthy controls. In contrast, the data from the reference leg were significantly different in subjects with ACL-R (p < 0.05). The matching errors in the impaired reference leg were almost 6 times larger than that of the intact reference leg. In addition, the joint position sense remained unaltered in both groups, although 1 or 2 kg weights were added to the reference leg (p > 0.05); the levels of matching errors in all conditions remained the same.

DISCUSSION

The counter-weight did not create any additional matching errors in both groups. This was reported in a previous study stating that the additional signal from the counter weight may be blended in the afferent signal from the muscle and joint during muscle contraction. It also stated that this might not be a large enough influence on the matching process [2]. This explanation can also be applied for our result. In addition, while the reference led did not change the result in the healthy group, it made a significant difference in the ACL-R group.

In the ACL-R group, matching errors without the counter-weight factor differed depending on the reference leg: impaired or intact. This implies that if the matching process occurs independently for each leg without considering the correlation between the 2 legs, it may be difficult to interpret our results. In other words, an ACL-R may have an influence on the integration of the matching process between the impaired and intact leg. Therefore, we believe that we should not only focus on the reconstructed leg in the ACL-R group; the relation to the intact leg also needs to be taken into account at the same time.

Although this is a preliminary study, our results demonstrate that ACL reconstruction has an influence on knee joint position sense in active matching. However, the mechanism of matching errors cannot be explained by only ACL-R, and it leaves a lot to be desired at this point. Further investigation is required to describe this mechanism in terms of matching process.

SIGNIFICANCE

This study revealed the importance of rehabilitation focused on the sensory function for ACL-R in a year from time of reconstruction.

REFERENCES