PROPRIOCEPTION IN INDIVIDUALS WITH ACL-DEFICIENT KNEE AND GOOD MUSCULAR AND FUNCTIONAL PERFORMANCE

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The objective of this study was to verify whether proprioception is affected in individuals with ACL-deficient knees and good functional and muscular performances. Eleven subjects with ACL injury and 11 controls participated in the study. Functional performance was assessed using the Cincinnati Knee Rating System (CKRS), hop index, and figure-eight ratio. An isokinetic test was done to evaluate muscular performance. Proprioception was evaluated through position sense and threshold tests. Analyses of variance were used for data analysis. The injured subjects scored significantly lower in the CKRS (p = 0.001). No statistically significant differences were found in the hop index, in the figure-eight ratio, or in peak torque. There were no statistically significant differences in proprioception between groups and between legs. These results indicated that the individuals evaluated in this study with ACL injury and good functional and muscular performance did not have proprioceptive deficits, suggesting that the ligament mechanoreceptors, in some cases, might not contribute relevantly to proprioception.

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INTRODUCTION


Proprioception is a sensory modality that involves the perception of movement or kinesthesia (threshold of perception of passive movement) and joint positions (position sense) based on information other than visual, auditory, or superficial cutaneous information (Lephart 1995). The sources of proprioceptive information are mechanoreceptors in the capsule, ligaments, tendons, and muscles (Johansson et al. 1991). The function of the mechanoreceptors in the ligaments and their participation in proprioceptive mechanisms have been the aim of various studies (Barrack et al. 1989; Barret 1991; Corrigan et al. 1992; Good et al. 1999; Macdonald et al. 1996; Roberts et al. 1999). A reduction in proprioceptive acuity in individuals with ACL injuries has been demonstrated in most of these studies (Barrack et al. 1989; Corrigan et al. 1992; Macdonald et al. 1996; Roberts et al. 1999). Roberts and Colleagues (1999) detected a high threshold of perception of passive motion in individuals with ACL rupture when compared to healthy controls. MacDonald and Colleagues (1996) and Barrack and Colleagues (1989) obtained similar results when comparing injured and uninjured legs of individuals with ACL damage. In addition, repositioning errors have been documented as a result of ACL injury (Barret 1991; Corrigan et al. 1992). The authors of these studies suggested that the loss of information from ligament mechanoreceptors was associated with the proprioceptive deficits observed. On the other hand, a few studies failed to demonstrate these deficits in individuals with ACL injury (Friden, Roberts, Movin, et al. 1998; Good et al. 1999). Thus, the loss of the information provided by ACL mechanoreceptors does not
always result in proprioceptive deficits. This suggests that other factors may contribute to the proprioceptive acuity in individuals with ACL injury, in addition to ligaments receptors.

The level of muscular and functional performance is another factor that might be associated with the proprioceptive acuity of individuals with ACL-deficient knees. There is evidence in the literature that individuals with high functional status have better proprioceptive acuity than do sedentary ones (Euzet and Gahery 1995). In addition, Goodman and Marks (1998) have found a significant correlation between extensor torque and position sense, indicating that individuals with higher quadricep strength had lower repositioning errors. Thus, a decline in muscular and functional performance following ACL injuries might contribute to the deficits in proprioceptive acuity observed in individuals with ACL-deficient knees. On the other hand, the absence of deficits in proprioception in these individuals reported in some studies might be explained by the functional status of the subjects evaluated. However, most of the studies that investigated proprioception in individuals with ACL deficiency did not report data related to the functional status of their subjects (Corrigan et al. 1992; Good et al. 1999; Macdonald et al. 1996). Therefore, the objective of this study was to test whether proprioceptive deficits, measured through position sense and threshold tests, are present in individuals with ACL-deficient knees and good functional and muscular performance.

METHODS AND MEASURES

Subjects

Eleven subjects—2 women and 9 men, with isolated unilateral injury to the ACL treated with physical therapy, with ages varying from 17 to 39 years, and time from injury varying from 3 to 13 months—were included in the ACL-deficient group. All subjects had right leg dominance. Diagnosis of ACL injury was based on MRI exams and confirmed by a positive Lachman test, positive anterior drawer sign, and a documented pivot shift. The subjects had minimum or no valgus opening, no posterior drawer sign, and a negative Lateral Slocum test to exclude injuries of other knee ligaments. Only those individuals with good functional status and without significant deficits in extensor or flexor torques between legs were included in this study. To be included in this study, individuals had to obtain a score indicative of good functional status on a knee functional scale, complete advanced functional tests without any symptoms, and not present significant deficits in knee extensors and flexors peak torques. Only individuals with deficits in peak torque inferior to 10% participated in this study, as deficits within this range are considered
to be acceptable asymmetry (Petschnig, Baron, and Albrecht 1998). Individuals with a history of previous injuries; with reconstructed ACL injury; with bilateral injury to the ACL; with associated injury to the menisci, collateral ligaments, cartilage, or other injuries to any part of the lower extremities; and those with pain or swelling were not included in the study. The control group included 11 individuals without any history of injury to the knee or to the lower extremities that could influence their performance in the tests. These individuals were selected to match the ones in the ACL-deficient group relative to age and gender. The mean and standard deviations of the descriptive data of the subjects are in Table 1. The procedures of the study were explained to the subjects, and informed consent was obtained. Approval was obtained from the Committee of Ethics in Research of the Federal University of Minas Gerais.

**Instrumentation**

The functional status of the subjects was assessed through the Cincinnati Knee Rating System (CKRS; Barber-Westin, Noyes, and McCloskey 1999) and performance tests (Fonseca, Magee, Wessel, et al. 1992). The CKRS is a questionnaire based on the subjects’ perceptions of their functional status. This scale is composed of eight questions that evaluate the presence of signs and symptoms of instability and the performance of the subjects in functional activities. Points are distributed according to the answers given by the subjects. The maximum score that can be achieved is 100 points. The test–retest reliability coefficients of the questions composing the scale varied from 0.71 to 1.00 (Barber-Westin et al. 1999).

The performance tests were a hop test, a straight-line run, and a figure-eight run (Fonseca et al. 1992), which were done in this order by all subjects. Photoelectric cells were used to identify the exact point in time that the subjects started and finished their running tests. A measuring tape was used to determine the distance reached by the subjects in the hop test.

Proprioception was assessed through position sense and threshold tests. These tests were performed using an isokinetic dynamometer (Biodex System 3 Pro). This equipment has a passive mode that allowed the measurement of the proprioceptive variables. This isokinetic dynamometer

| Table 1. Means (Standard Deviations) of the Descriptive Data of the Subjects in the ACL and Control Groups |
|-------------------------------------------------|----------------|----------------|----------------|----------------|
| Group   | Age (years) | Weight (Kg)   | Height (m)    | Injury time (months) |
| ACL     | 26.45 (7.78)| 79.80 (10.48) | 1.80 (0.08)   | 7.73 (3.17)     |
| Control | 27.35 (7.65)| 81.90 (9.47)  | 1.81 (0.06)   | —               |
also was used to evaluate the muscular performance of the individuals participating in the study.

**Procedure**

The tests were divided over two days. On the first day, all subjects answered the CKRS questionnaire, and the individual results were calculated. The subjects completed the functional performance tests, as described by Fonseca et al. (1992). The tests included a 10-meter straight-line run, a 20-meter figure-eight run with a diameter of both curves equal to 4 meters, and a hop test. The hop test was performed starting with the foot being tested placed at a line drawn on the floor. The subjects hopped one time, landed on the same leg, and the distance reached was determined with a measuring tape. After 30 min, a muscular performance test was done using an isokinetic dynamometer. The subjects were seated on the dynamometer’s chair, with trunk and pelvis stabilized. Before the beginning of the test, the dynamometer’s axis of rotation was aligned to the anatomical axis of the knee joint, as described by the manufacturer. The test was done bilaterally on both groups and consisted of five repetitions of the flexion–extension movement (concentric–concentric), at a speed of 60°/sec. Familiarization practice was done on the same conditions of the test, except that only three repetitions was requested of the subjects. The test started 15 min after the familiarization practice, and verbal incentive was given to the subjects to guarantee their maximum performance during this procedure. The extensor and flexor concentric peak torques normalized by body weight were registered for further analysis. The deficits in these parameters between legs and the score on the CKRS were used as exclusion criteria.

On the second day, the subjects who fulfilled the inclusion criteria were submitted to the proprioception tests. The protocol for the position sense assessment was composed of two tests. The first test (passive–passive test) involved passive positioning and passive repositioning of the leg. The second (passive–active test) involved passive positioning and active repositioning of the leg. For both tests, the subjects were seated with eyes closed, and fitted with an air cuff above the maleolus to minimize cutaneous sensory information (Barrack et al. 1989; Good et al. 1999). All subjects had the “Hold” button in their hands, so they could stop the dynamometer’s lever arm by pressing the button with their thumb. The starting position of the knee joint was set at 90°, and the target angle was 35° (Barrack et al. 1989; Macdonald et al. 1996) of flexion. Instructions about the tests procedures were given to the subjects prior to their initiation. In the passive–passive test, the dynamometer’s lever arm extended the knee passively at a speed of 10°/sec. until the target angle was reached and waited
there for 5 sec. After that time, the lever arm returned the knee to the starting position and immediately extended it again at a speed of 5°/sec. When the subjects thought they had reached the target angle, they stopped the dynamometer’s lever arm by pressing the Hold button. The speed of the passive movement was changed to reposition the leg so that the subjects could not use the time elapsed to position the leg at the target angle as a cue for the test. The angle selected by the subjects was recorded. The same procedure was used for the passive–active test. However, after the lever arm returned to the initial position, the passive mode was immediately turned off. As soon as this was done, the subjects repositioned the lever arm actively, attempting to reach the reference angle. These tests were performed bilaterally in both groups. Three measures were obtained bilaterally for each of the two tests. The repositioning error was an absolute value obtained through the calculation of the difference between the target angle and the mean of the three angles chosen by the subjects. The order that the tests were done and the order the legs were tested were randomly assigned by a custom-made computer program.

For the threshold test, the subjects were seated with their eyes closed, wearing headphones and fitted with an air cushion above the maloeolus. The initial knee angle was 35° (Barrack et al. 1989; Macdonald et al. 1996) of flexion, and the dynamometer’s lever arm speed was 2°/sec into extension. The subjects were instructed to press the ‘Hold’ button as soon as they perceived any movement of their knee joint. The length of time elapsed before the movement of the leg was different in each trial. At the moment the movement was interrupted, the knee angle was measured and registered. This procedure was repeated three times. The order the legs were tested was randomized. The mean value of the three angles measured was subtracted from the initial value, which represented the threshold of perception of passive motion.

**Data Reduction**

Two variables were obtained with the performance tests results. The first was the time obtained in the figure-eight run divided by the time obtained in the straight-line run. The ratio of the figure-eight run time to the straight-leg run time was called the figure-eight ratio. According to Fonseca and Colleagues (1992), this ratio minimizes the influence of personal factors such as velocity and agility in the test results. The second variable was the hop index (Fonseca et al. 1992). This was calculated by dividing the longest distance reached by the uninvolved leg by the longest distance reached by the involved leg (Fonseca et al. 1992). The objective of the hop index was to normalize the results, allowing comparisons between subjects.
The legs of the individuals in the control group were classified as involved and uninvolved. The involved leg of the subjects in the ACL-deficient group defined the “involved leg” of their matched subjects in the control group based on leg dominance. For example, if the dominant leg of a subject in the ACL-deficient group was involved, the dominant leg of his matched control also was defined as involved. This definition allowed the calculation of the hop index in the individuals of the control group and the comparison of proprioception between legs. The values in knee extensor and flexor peak torque were corrected to take into account the effect of gravity, and the deficits between legs were calculated as the percentage of the difference between the involved and uninvolved leg in relation to the uninvolved leg.

Data Analysis

Repeated measured analyses of variance (ANOVA) with one between-subject effects (groups) and one within-subject effects (leg) were used to compare the following dependent variables: (a) passive–passive position sense error; (b) passive–active position sense error; and (c) threshold of perception of movement between individuals with and without ACL injury. The same analysis was done to compare the knee extensor and flexor peak torques. This statistical procedure allowed the testing of the main effects group and leg, as well as interaction effects. Independent t-tests were used to test for significant differences between groups in the results obtained by CKRS, hop index, and figure-eight ratio. The level of significance was set at $\alpha = 0.05$. However, for the independent t-tests, because we tested three dependent variables, the $\alpha$ level was adjusted to 0.016 using Bonferroni correction.

RESULTS

Functional Profile

Score on CKRS
An independent t-test demonstrated a significant difference in the score of the CKRS when comparing ACL and control groups ($p = 0.0001$). The mean and standard errors of each group are illustrated in Table 2.

Hop Index
An independent t-test did not show any statistically significant differences between control and ACL groups in the hop index ($p = 0.073$). Table 2 shows the mean and standard errors of each group.
There was no significant difference between ACL and control groups in the figure-eight ratio, as demonstrated by the independent t-test (\(p = 0.421\)). The mean and standard errors of each group are illustrated in Table 2.

**Flexor Peak Torque Normalized by Body Weight**
The ANOVA did not show any significant differences between groups (\(f = 0.090; p = 0.767\)), between legs (\(f = 1.610; p = 0.219\)), or in the leg × group interaction (\(f = 0.633; p = 0.436\)) in the flexor peak torque normalized by body weight. The mean and standard errors of each group are illustrated in Table 2.

**Extensor Peak Torque Normalized by Body Weight**
The ANOVA did not show any significant differences between groups (\(f = 0.668; p = 0.423\)), between legs (\(f = 1.530; p = 0.230\)), or in the leg × group interaction (\(f = 3.248; p = 0.087\)) in the extensor peak torque normalized by body weight. The mean and standard errors of each group are illustrated in Table 2.

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**Table 2. Means and (Standard Errors) of the Variables Related to Functional Performance (Score on the CKRS, Hop Index, and Figure-Eight Ratio), Muscular Performance (Flexor and Extensor Peak Torque Normalized by Body Weight—Nm/BW) and Repositioning Errors of Passive–Passive and Passive–Active, and Threshold of Perception of Movement Tests (Degrees) of the ACL and Control Groups**

<table>
<thead>
<tr>
<th>Variables</th>
<th>ACL Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Involved leg</td>
<td>Uninvolved leg</td>
</tr>
<tr>
<td>Extensor torque</td>
<td>278.6 (14.2)</td>
<td>307.6 (17.2)</td>
</tr>
<tr>
<td>Flexor torque</td>
<td>143.9 (9.3)</td>
<td>137.5 (7.0)</td>
</tr>
<tr>
<td>Position sense Passive–passive</td>
<td>9.47 (1.66)</td>
<td>10.36 (2.14)</td>
</tr>
<tr>
<td>Position sense Passive–active</td>
<td>6.77 (0.94)</td>
<td>4.67 (1.15)</td>
</tr>
<tr>
<td>Threshold</td>
<td>0.88 (0.14)</td>
<td>0.87 (0.13)</td>
</tr>
<tr>
<td></td>
<td>控制组</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Involved leg</td>
<td>Uninvolved leg</td>
</tr>
<tr>
<td>Extensor torque</td>
<td>311.9 (15.3)</td>
<td>306.6 ()</td>
</tr>
<tr>
<td>Flexor torque</td>
<td>137.8 (11.1)</td>
<td>136.6 (7.3)</td>
</tr>
<tr>
<td>Position sense Passive–passive</td>
<td>6.88 (1.57)</td>
<td>9.27 (1.23)</td>
</tr>
<tr>
<td>Position sense Passive–active</td>
<td>3.46 (1.12)</td>
<td>4.40 (1.41)</td>
</tr>
<tr>
<td>Threshold</td>
<td>1.13 (0.19)</td>
<td>0.79 (0.15)</td>
</tr>
</tbody>
</table>

*Significant difference (\(p < 0.016\)).
Proprioceptive Acuity

Position Sense

Passive–Passive Test
The ANOVA did not show any significant differences between groups (f = 0.876; \( p = 0.360 \)), between legs (f = 1.481; \( p = 0.238 \)), or in the leg \( \times \) group interaction (\( f = 0.309; p = 0.584 \)) in the position sense passive–passive test. The mean and standard errors of each group are illustrated in Table 2.

Passive–Active Test
In the passive–active test, the ANOVA did not show any significant differences between groups (f = 1.665, \( p = 0.212 \)), between legs (f = 0.424; \( p = 0.522 \)), or in the leg \( \times \) group interaction (\( f = 2.930; p = 0.102 \)). Table 2 shows the mean and standard errors of each group.

Threshold of Perception of Passive Movement
The ANOVA did not demonstrate any statistically significant differences when comparing the threshold of the perception of passive movement between groups (\( f = 0.246; p = 0.626 \)), between legs (\( f = 1.575; p = 0.224 \)), or in the leg \( \times \) group interaction (\( f = 1.413; p = 0.248 \)). The mean and standard errors of the threshold of perception of passive movement are presented in Table 2.

DISCUSSION

Individuals with ACL-deficient knees can present with functional instability that may prevent their participation in sport activities (McNair and Marshall 1994). Traditionally, proprioception has been related to functional instability in these individuals (Barrack et al. 1989; Corrigan et al. 1992; Macdonald et al. 1996). Therefore, the objective of the present study was to verify whether deficits in position sense and threshold of detection of passive movement are present in individuals with good functional status. The results of the present study did not show any significant differences between the ACL and control groups or between involved and uninvolved legs in the threshold of perception of passive movement or in position sense (passive–passive and passive–active tests).

In agreement with the present study, Friden and Colleagues (1998) and Good and Colleagues (1999) did not find significant deficits in proprioceptive acuity when comparing groups with and without ACL injury or when comparing involved and uninvolved legs of the experimental group. On the other hand, MacDonald and Colleagues (1996) observed a higher threshold of perception of passive movement in the involved leg when compared to the uninvolved leg. In the same study, no significant differences were found between ACL and control groups. These authors
selected a lower speed of movement of the dynamometer’s lever arm (0.5°/sec) than the one chosen in this study, which could explain the differences observed in their study. The speed selected in the present study was the lowest allowed by the device used for the evaluation of the threshold of perception of passive movement. Even though it is a limitation of the present study, the speed used was not the only possible reason for the lack of proprioceptive deficits. Pap, Machner, Nebelung, et al. (1999) selected an even lower speed (0.1°/sec) and still did not demonstrate any significant differences between involved and uninvolved legs of individuals with ACL-deficient knees. In these studies, there was no information about the functional status of subjects. Thus, the level of muscular and functional performance could be an alternative explanation for the conflicting results of the studies. There also are differences between studies relative to the knee positions chosen for the evaluation of proprioception. The angle chosen in the present study was based on the studies of Grood and Noyes (1988). The reason for this choice is that at around 30° of flexion, the knee is in a loose-packed position, where the mechanical function of the ACL is the least efficient (Grood and Noyes 1988). Thus, neuromuscular mechanisms related to joint stability involving this ligament would be most important around this position.

In the present study, the absence of differences in the threshold of perception of passive movement and in position sense between involved and uninvolved legs of the ACL group indicates that proprioceptive acuity was not directly influenced by the ligament injury of the subjects who participated in the study. These results indicate that the ligament mechanoreceptors may not always play a major role in proprioception. For example, Barrack, Skinner, Cook, et al. (1983) did not observe any significant differences between operated and nonoperated legs of individuals subjected to total knee arthroplasty that did not preserve any ligaments. In addition, experimental studies in which capsules and ligaments were anesthetized, leaving unaffected only the muscle spindles, have not demonstrated any proprioceptive deficits, despite the absence of the information provided by the joint mechanoreceptors (Barrack and Skinner 1983; Konradsen and Ravn 1990). The results of these studies suggest that the muscle spindles are the most important source of proprioceptive information. Even though the rupture of the ACL ligament could alter the activity in the muscle-spindles through its influence on the gamma-muscle spindle loop (Konishi, Konishi, and Fukubayashi 2003), the loss of proprioceptive information from this structure may be compensated for by the information generated by the mechanoreceptors also present in different structures, such as capsules, tendons, muscles, and ligaments (Johansson et al. 1991). This fact reflects the multimodal characteristic of proprioceptive information that is possibly not dependent only on the receptors of one
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structure. This might explain the absence of proprioceptive deficits in the subjects evaluated in this study, who had only isolated injury of the ACL ligament.

The presence of proprioceptive deficits also can be associated with the level of functional and muscular performance. Euzet and Gahery (1995) showed that trained healthy individuals demonstrated higher proprioceptive acuity than sedentary subjects. The lower proprioceptive acuity observed in sedentary individuals possibly was due to a lower responsiveness of their muscle-spindle system secondary to a diminished muscular and functional performance (Goodman and Marks, 1998). Jerosch, Schmidt, and Prymka have observed proprioceptive deficits in individuals with retropatellar pain (1997a), rupture of the meniscus (1997b), and arthrosis (Jerosch and Prymka 1997). All individuals in those studies had intact ligaments and, possibly, all they had in common was the presence of pain or muscle wasting. Pain often results in decreased activity levels and reduced muscle strength (Lund Donga, Widmer, et al. 1991). This altered behavior could diminish the activation level of the muscle spindles, and as a consequence, reduce proprioceptive acuity. Therefore, alterations in the responsiveness of the muscle spindles associated with a diminished muscular and functional performance could be an alternative explanation for the occurrence of deficits in proprioceptive acuity in individuals with ACL injury.

Several studies in the literature have identified deficits in proprioception in individuals with ACL deficient knees (Barrack et al. 1989; Barret 1991; Macdonald et al. 1996; Roberts et al. 1999). These deficits have been associated with the loss of the ligament mechanoreceptors, as there is evidence that transection of anterior cruciate ligament significantly alters electrical activity in the articular nerves, which carry proprioceptive information (Johansson et al. 1991). However, only a few studies evaluated the functional performance of individuals with ACL injury, which could be another explanation for the deficits observed. (Borsa, Lephart, Irrgang, et al. 1997; Carter, Jenkinson, Wilson, et al. 1997; Friden et al. 1998). In this study, the figure-eight ratio and the hop index did not differentiate the control from the ACL groups. The ACL group subjects demonstrated performances on these tests that were similar to the performances of the control group. However, the subjects in the ACL group had significantly lower scores than did the subjects in the control group in the CKRS. Even though this difference was statistically significant, the mean score obtained by the ACL group (86.46) is indicative of good functional capacity (Sgaglione, Del Pizzo, Fox, et al. 1995), in accordance with the inclusion criteria.

These results suggest that the subjects with ACL-deficient knees in this study are among those who have obtained an effective functional status
with only conservative treatment (Noyes, Mooar, and Matthews 1983). In addition, the subjects in the ACL group have adequate muscular strength. This was demonstrated by the isokinetic tests results, which did not show any significant difference in extensor and flexor peak torques normalized by body weight between involved and uninvolved legs or between groups. This fact might be associated with the absence of significant differences in proprioceptive acuity between groups, which is supported by Co, Skinner, and Cannon (1993). These authors have shown that, despite the absence of ligament mechanoreceptors in the involved leg, individuals with ACL reconstruction were more sensitive to the detection of passive movement bilaterally than individuals in the control group. According to these authors, the lack of proprioceptive deficits could be explained by the participation of the subjects with ACL reconstruction in a muscle-strengthening program, suggesting an association between muscle strength and proprioceptive acuity. That is, an adequate level of muscle strength would guarantee effective proprioception, as the muscle spindles are the primary structures responsible for this mechanism.

In the present study only individuals who had isolated injury to the ACL and were functionally adapted were included. These inclusion criteria limited our sample size to 11 subjects. Because the sample size is a limitation of this study, the probability of type-2 error must be considered when interpreting the results. The power analysis for the study’s main effect demonstrated a statistical power of 65% for the variable passive–active position sense error. However, the statistical powers for the other variables were above 80%, which implies that the absence of differences in the variables passive–passive position sense error and threshold to detection of passive movement probably were not influenced by the small sample size. Thus, the results add further evidence to the idea discussed in the literature that the loss of information provided by the ligaments mechanoreceptors may not always be primarily responsible for decreases in proprioceptive acuity (Good et al. 1999). It seems that the functional and muscular performance are important factors related to the presence or absence of proprioceptive deficits in individuals with ACL-deficient knees (Euzet and Gahery 1995; Friden et al. 1998; Goodman 1998). This idea is supported by the present research, which did not show any significant
difference in proprioceptive acuity between individuals with ACL-deficient knees presenting with good muscular and functional performance and their matched controls.

The treatment of individuals with ACL-deficient knees usually emphasizes the improvement of proprioception, with the objective of obtaining better dynamic stability and functional performance. However, it is possible that a decline in functional and muscular performance leads to a reduction in proprioceptive acuity, and not the opposite. Thus, based on the results of this study, the aim of the rehabilitation should be on muscular and functional training when the objective is the achievement of dynamic stability. More studies are necessary to investigate the direction of a possible association between proprioception and functional level, as it could lead to changes on the treatment focus of individuals with ACL-deficient knees.

CONCLUSION

The present study indicated that the individuals evaluated, with isolated injury to the ACL and good functional and muscular performance, did not present proprioceptive deficits. This fact suggests that proprioceptive acuity has multimodal characteristics and is not always primarily dependent on the sensory information of ligament mechanoreceptors.

REFERENCES


