Clinical measurement of proprioceptive function after anterior cruciate ligament reconstruction

Abdullah A. Al-Othman, FRCS (Ed), MD.

ABSTRACT

Objectives: Proprioception is very important for the integrity and stability of the knee joint. Patients with anterior cruciate ligament (ACL) tear have a decline in proprioceptive functions of the injured knee. However, improvement of proprioceptive functions of the knee after ACL reconstruction is a subject of considerable debate. This study was conducted to evaluate the results of a simple clinical proprioception test developed by the author in patients with ACL reconstructed knees.

Methods: This study was conducted in King Fahd Hospital of the University, Al-Khobar, Kingdom of Saudi Arabia, from January 1996 to June 2002. The proprioceptive function of the knee joint was studied in a group of ACL reconstructed patients (n=22) and compared them with a group of ACL deficient patients (n=32) and a group of healthy controls (n=30). Proprioception was evaluated based on the performance in a simple clinical test.

Results: There was a significant difference in proprioceptive functions between the ACL deficient knees and the ACL reconstructed group (p<0.05), but there was no significant difference between the ACL reconstructed and the normal control group (p>0.05).

Conclusions: These findings indicate that proprioceptive deficits in ACL deficient knees, as measured clinically using the described test, might improve after ACL reconstruction.


Repair of the injured anterior cruciate ligament (ACL) is currently a common surgical procedure carried out routinely and arthroscopically at many centers in the Kingdom of Saudi Arabia (KSA). Anatomical reconstruction of the torn ACL using different types of grafts is meant to restore normal functions of the knee. Proprioceptive functions of the knee are very important for the integrity and stability of the joint. Many clinical studies have shown that the knee joints of patients with ACL tear have a decline in proprioceptive functions of the injured joint. However, improvement of proprioceptive functions of the knee after ACL reconstruction is a subject of considerable debate. While MacDonald et al, Co et al, and Jerosch and Prymka, did not show improvement of proprioception in their patients with ACL reconstruction, other investigators found an improvement after reconstruction. Contradictory results were attributed to the method, and the test used to quantify the overall proprioceptive ability of the examined knee. Several tests of knee proprioception have been described, but these tests are mostly experimental and require complex equipments. They evaluate either joint position sense, kinaesthesia (joint motion sense) or postural control (stabilometric tests). This study was conducted as a continuation of our previous report to evaluate the results of our simple clinical proprioception test in patients with ACL reconstructed knees.

From the Department of Orthopedic Surgery, King Fahad Hospital of the University, Al-Khobar, Kingdom of Saudi Arabia.

Received 26th May 2003. Accepted for publication in final form 20th October 2003.

Address correspondence and reprint request to: Dr. Abdullah A. Al-Othman, Associate Professor and Consultant, King Fahad Hospital of the University, PO Box 2845, Al-Khobar 31952, Kingdom of Saudi Arabia. Tel. +966 55808852. Fax. +966 (3) 8966735. E-mail: absoahmed10@yahoo.com
Methods. The material comprised 84 subjects, a reconstructed group of 22 patients who had ACL reconstruction using a bone patellar tendon bone graft (Group A), and non reconstructed group of 32 subjects with unilateral ACL rupture (Group B), and 30 healthy controls (Group C). The mean age of patients in this study was 27 ± 1 years. The study was performed in King Fahd Hospital of the University, Al-Khobar, KSA during the period from January 1996 to June 2002. All subjects in the study were males. The postoperative follow up period for Group A ranged from 1-6-years (average 3.6 years). The performance of subjects in groups A and B was evaluated according to Lysholm scoring. An independent observer also tested joint laxity clinically. None of the ACL reconstructed patients required a revision ACL reconstruction surgery, and all the ACL deficient patients had arthroscopic evidence of complete rupture of the ligament. The normal volunteers formed part of our previous study to verify the accuracy of measurements of proprioception.

The proprioceptive function in the knees for all subjects was assessed with a simple single limb standing test that was described earlier by the author “Al-Othman et al test” The test was designed to measure changes in patient capacity to reposition the tested limb accurately. All external clues to limb position or motion were eliminated. Thus, wearing thick cotton socks and separating both lower limbs during the test maneuver neutralized cutaneous sensations. Visual inputs were also removed by using blindfolds. A mean value for the deviations of the tested limb during its repositioning to the reference O-line was recorded for the 3 test trials. A senior physiotherapist carried out testing in a blind manner. Descriptive statistics (mean value and standard deviation) were used to determine the clinical performance and the proprioceptive function of the studied knees in all subjects. Results of the 3 studied groups were compared using t-test and Mann-Whitney test. The correlation between the test results and Lysholm scores for the study groups A and B was tested by Spearman’s test. A level of \( p<0.05 \) was selected for statistical significance.

Results. All patients in group A demonstrated a negative or grade I Lachman and pivot-shift tests except for 3 cases, while all patients in group B had at least a grade II Lachman test and a positive pivot-shift test. The ACL reconstructed group obtained a higher Lysholm score (90.5 ± 5.23) compared with the ACL deficient group (74.47 ± 8.20) with a statistically significant difference \( (p<0.05) \). In addition, there was a significant negative correlation between the Lysholm score and the test result for both group A and B combined \( (r =-0.732, p>0.001) \). (Figure 1).

Proproprioceptive testing. The study group (A) and the control group (C) demonstrated virtually identical mean values with a mean variation of 8.65%, and no significant difference (Mann-Whitney test, \( p>0.05 \)). The ACL deficient knee group (B), however, showed a significantly higher mean value (1.76 ± 1.33) with a statistically significant difference when compared with both the ACL reconstructed group (A) and the control group (C) \( (p<0.05) \) (Table 1).

Discussion. Proprioception in the ACL reconstructed knees has recently attracted considerable attention and debate. Several tests of knee proprioception have been described, but there is no standard established consensus or reference. These tests are mostly experimental and evaluate joint position sense,2,10 kinesthesia (joint motion sense),13 or postural control (stabilometric tests).15,16 Many authors have made conflicting conclusions on the overall proprioception after ACL reconstruction.

Table 1 - Mean deviation in Al-Othman et al test in the 3 groups.

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>Mean ± SD</th>
<th>( p ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A*</td>
<td>22</td>
<td>0.95 ± 0.95</td>
<td>( &lt;0.05 )</td>
</tr>
<tr>
<td>Group B†</td>
<td>32</td>
<td>1.76 ± 1.33</td>
<td>( &lt;0.05 )</td>
</tr>
<tr>
<td>Group C‡</td>
<td>30</td>
<td>1.04 ± 0.93</td>
<td></td>
</tr>
</tbody>
</table>

* anterior cruciate ligament reconstructed knees, † anterior cruciate ligament deficient knees, ‡ control, A and C - not significant

Figure 1 - Correlation between the test results and Lysholm knee scores for Group A and B.
because of using only a joint position sense test, a
kinaesthesia test or a stabilometric test for postural
control. The proprioceptive function of the knees in this study was determined based on
a simple clinical single limb standing test developed by
the authors. The capacity of the patient to
reposition the examined limb accurately to
the reference O-line in this test combine more than one
element of proprioceptive functions, namely, postural control, joint position sense and joint
motion sense in a standing and dynamic condition.
However, further studies are needed to evaluate the
correlation between the results of our clinical test
and other tests of kinaesthesia, joint position sense
and stabilometric tests.

The present study demonstrates significant
difference in the proprioceptive functions between
ACL reconstructed, ACL deficient group and
controls. These results are in accordance with many
other studies\textsuperscript{2-13,15,16} that have used complex
equipment to measure proprioceptive functions. In
addition, knee function as measured by Lysholm
score was significantly better among the ACL
reconstructed group compared to the ACL deficient
cases, and it has shown a significant negative
correlation with proprioceptive measurements. This
indicates that a wide aberration of the test result
from the O-reference line signals a decline in
proprioception and the knee function as evaluated by
Lysholm score. Whether the better
proprioceptive function of the surgically treated
cases is due to the improvement of the joint
stability\textsuperscript{11,20} or due to the regeneration of new
sensory nerve endings and mechanoreceptors in the
tendon graft\textsuperscript{11,22} is a matter of speculation.

References

1. Barrack RL, Skinner HB, Buckley SL. Proprioception in
17: 1-6.
2. Barrett DS. Proprioception and function after anterior
cruciate reconstruction. \textit{J Bone Joint Surg (Br)} 1991; 73:
833-837.
3. Friden T, Roberts D, Ageberg E, Walden M, Zatterstrom R.
Review of knee proprioception and the relation to extremity
function after an anterior cruciate ligament rupture. \textit{J Orthop
4. MacDonald PB, Hedden D, Pacin O, Sutherland K.
Proprioception in anterior cruciate ligament-deficient and
5. Al-Othman A, Moussa M, Eraky MZ. A simple outpatient
6. Peo G, Machner A, Nebering W, Kwisrus F. Detailed
analysis of proprioception in normal and ACL-deficient
Proprioception in people with anterior cruciate ligament-deficient knees; comparison of symptomatic and
asymptomatic patients. \textit{J Orthop Sports Phys Ther} 1999;
29: 587-594.
8. Co FH, Skinner HB, Cannon WD. Effect of reconstruction
of the anterior cruciate ligament on proprioception of the
knee and the heel strike transient. \textit{J Orthop Res} 1993; 11:
696-704.
9. Jerosch J, Prymka M. Knee joint proprioception in normal
volunteers and patients with anterior cruciate ligament
tears, taking special account of the effect of a knee bandage.
\textit{Arch Orthop Trauma Surg} 1996; 115: 162-166.
Can knee joint proprioception by reconstruction of the
anterior cruciate ligament be restored? A prospective
Proprioeptive improvement in knees with anterior cruciate
regeneration of sensory neurones in the anterior cruciate
13. Risberg MA, Beynnon BD, Peura GD, Uh BS. Proprioception
after anterior cruciate ligament reconstruction with and
7: 303-309.
Lack of correlation between different measurements of
84: 614-618.
15. Henriksson M, Ledin T, Good L. Postural control after
anterior cruciate ligament reconstruction and functional
16. Shiraishi M, Mizuta H, Kubota K, Otsuka Y, Nagamoto N,
Takagi K. Stabilometric assessment in the anterior cruciate
32-39.
17. Jerosch J, Schaffer C, Prymka M. Proprioeptive abilities of
surgically and conservatively treated knee joints with
injuries of the cruciate ligament. \textit{Unfallchirurg} 1998; 101:
26-31.
18. Harrison EL, Duenuel N, Dunlop R, Russell G. Evaluation of
single-leg standing following anterior cruciate ligament
19. Kuster MS, Grob K, Kuster M, Wood GA, Gachter A. The
benefits of wearing a compression sleeve after ACL
20. Beynnon BD, Ryder SH, Konraden L, Johnson RJ,
Johnson K, Renstrom PA. The effect of anterior cruciate
ligament trauma and bracing on knee proprioception. \textit{Am J
Mechanoreceptors in the anterior cruciate ligament contribute to the joint position sense. \textit{Acta Orthop Scand}
22. Georgoulis AD, Pappa L, Moebius U, Malamou-Mitsi V,
Pappa S, Papageorgio CU et al. The presence of
proprioeptive mechanoreceptors in the remnants of the
ruptured ACL as a possible source of re-innervation of the
9: 364-368.