Effects of anterior tibial displacement on the proprioceptive functions of soccer players’ knee joints

Cem Çetin, MD, Rüştü Güner, MD, PhD, Burak Kunduracioglu, MD, Bülent Ülkar, MD.

ABSTRACT

Objective: To investigate the effects of joint laxity on proprioceptive functions of the knee joints of soccer players.

Methods: In this study, we measured anterior tibial displacements and thresholds to detect the knee joint passive motion of 20 healthy soccer players (18.1±1.6 years of age). We performed all the measurements in Autumn 2000 in Ankara, Turkey. We applied the Mann-Whitney U test to analyze the relationship between the anterior tibial displacement and threshold to detect the passive motion (TDPM).

Results: There were no statistically significant differences between the TDPM values of the knee joints with insignificant laxity differences at different angles, and direction of motion ($p>0.05$). At 45° of knee flexion and externally directed motion, we found the TDPM of looser knees to be significantly greater ($p<0.05$).

Conclusion: Increased knee laxities without any clinical pathologic findings, have negative effects on knee joint proprioception. This is possibly due to the overuse degeneration of the anterior cruciate ligaments, which are the main stabilizers of knee joints.

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Effects of anterior displacement (laxity) values of the athletes with no knee laxity differences between the knees are presented in Table 1. There were significant differences between the laxities obtained by 30 lb anterior displacement and manual maximum tests of the right and left knees of the 15 athletes. The TDPM scores measured with the starting position of 15° and 45° flexion revealed no significant differences either to flexion and extension direction in these 15 subjects. The TDPM scores and the anterior displacement (laxity) values of the athletes with no laxity differences between the knees are presented in Table 1. There were significant differences between the laxities obtained by 30 lb anterior displacement and manual maximum tests of the right and left knees of 5 athletes. At the starting position of 45° flexion, the TDPM scores of the knees with significant laxities were found to be significantly higher than the other knees while the knees were moving to the extension direction \( (p=0.028) \). At the starting position of 15° flexion, there were no significant differences between the TDPM scores of the knees with significant laxities than the other knees while the knees were moving to the extension direction \( (p=0.071) \). At a starting position of 15° and 45° flexion, there were significant proprioceptive differences between the normal and lax knees.

Results. The average age of the athletes participating in the study was 18.1 ± 1.6 years, and the regular training period was 8.7 ± 1.8 years. There were no significant differences between the laxities obtained by 30 lb anterior displacement and manual maximum tests of the right and left knees of the 15 athletes. The TDPM scores measured with the starting position of 15° and 45° flexion revealed no significant differences either to flexion and extension direction in these 15 subjects. The TDPM scores and the anterior displacement (laxity) values of the athletes with no laxity differences between the knees are presented in Table 1. There were significant differences between the laxities obtained by 30 lb anterior displacement and manual maximum tests of the right and left knees of 5 athletes. At the starting position of 45° flexion, the TDPM scores of the knees with significant laxities were found to be significantly higher than the other knees while the knees were moving to the extension direction \( (p=0.028) \). At the starting position of 15° flexion, there were no significant differences between the TDPM scores of the knees with significant laxities than the other knees while the knees were moving to the extension direction \( (p=0.071) \). At a starting position of 15° and 45° flexion, there were
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Table 1 - Anterior tibial displacement (mm) and TDPM values (degrees) of athletes with no significant knee laxity differences (n=15).

<table>
<thead>
<tr>
<th>Joint</th>
<th>Anterior tibial displacement with KT-1000</th>
<th>TDPM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Extension direction</td>
<td>Flexion direction</td>
</tr>
<tr>
<td></td>
<td>30 lb</td>
<td>MM</td>
</tr>
<tr>
<td>Right knee</td>
<td>6.60±1.64</td>
<td>7.80±1.57</td>
</tr>
<tr>
<td>Left knee</td>
<td>6.53±1.60</td>
<td>7.47±1.46</td>
</tr>
<tr>
<td>p-value</td>
<td>0.911</td>
<td>0.551</td>
</tr>
</tbody>
</table>

MM - manual maximum test, TDPM - Threshold to detect the passive motion

Table 2 - Anterior tibial displacement (mm) and TDPM values (degrees) of athletes with significantly different displacements (n=5).

<table>
<thead>
<tr>
<th>Joint</th>
<th>Anterior tibial displacement with KT-1000</th>
<th>TDPM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Extension direction</td>
<td>Flexion direction</td>
</tr>
<tr>
<td></td>
<td>30 lb</td>
<td>MM</td>
</tr>
<tr>
<td>Normal knee</td>
<td>6.40±1.34</td>
<td>7.40±0.89</td>
</tr>
<tr>
<td>Knee with laxity</td>
<td>8.80±1.30</td>
<td>10±0.71</td>
</tr>
<tr>
<td>p-value</td>
<td>0.033*</td>
<td>0.007*</td>
</tr>
</tbody>
</table>

MM - manual maximum test, TDPM - Threshold to detect the passive motion, *significant value

no significant differences between the TDPM scores of the knees with significant laxities than the other knees while the knees were moving to the flexion direction (p=0.401). The TDPM scores and the anterior displacement (laxity) values of the athletes with significant laxity differences between the knees are presented at Table 2.

Discussion. Soccer players participated in this study, and the values obtained by KT 1000 arthrometer did not reveal any obscure results consistent with ACL rupture. The KT 1000 arthrometer has been extensively studied, and is widely used to test ACL deficient knees before and after reconstruction. Daniel et al tested 128 normal subjects to create baseline data for uninjured knees. In predominantly adult subjects, the mean anterior tibial excursion at 20 lb was 7.2±1.9 mm (range, 3-13). Eighty-eight percent of the normals had a right-left difference of less than 2 mm. In another study by Daniel et al, they emphasized the importance of side-to-side difference when using the arthrometer to diagnose ACL insufficiency. Normal ranges were established for a control group of 48 normal subjects in another study. With the KT 1000 device at 89 N of applied tibial force, 95% of normal knees have an anterior laxity less than 9 mm, and a side-to-side difference less than 2 mm. Daniel et al stated that displacement over 14 mm at 20 lb, 3 mm displacement differences between the knees, and 15 mm displacement at manual maximum test were strong indicators of ACL rupture.

Fifteen athletes were found to have anterior tibial displacement values with side-to-side differences under 2 mm. These revealed no significant differences in TDPM results. Five athletes with side-to-side anterior tibial differences between 2-3 mm had significant differences in TDPM values at 45° flexion position (p=0.028) when tested at extension direction, whereas at 15° flexion position, they had near significant changes in TDPM values (p=0.071).

Most investigators consider ligaments to be passive stabilizers of the joints. However, more than 100 years ago, clinicians and investigators recognized the presence and potential roles of mechanoreceptors in the function of joints. Joint mechanoreceptors have been most often studied in the knee, with most investigations focusing on the ACL. The presence of mechanoreceptors in the ACL has led several authors to suppose that these receptors influence motor function and, conversely, that their loss leads to disfunction. Loss of the ACL alters the kinematics of the knee and probably induces a change in the stimulation and the afferent signals or output of the remaining mechanoreceptors – for example, those in the joint capsule. Therefore, the
function of the receptors of the ACL per se, must be distinguished from that of the remaining receptors in the knee.19,26 Beynnon et al23 studied joint position sense in knees within the first few months after ACL disruption, and found no differences in comparison with the contralateral uninjured knee.23 Others have studied joint position sense in knees with chronic ACL tears and determined that there are differences in comparison with the contralateral knee.4,23 Similarly, the threshold to detection of passive knee motion is altered in subjects with chronic ACL tears.3,4,23,27 In a previous study of subjects with uninjured knees, Beynnon et al23 determined that measurement of the threshold to detection of passive knee motion was more accurate, precise, and reliable in comparison with joint position sense. Threshold to detect the passive motion was preferred to evaluate the proprioceptive ability of the knee joints of the soccer players in our study.

Borsa et al24 demonstrated TDPM deficits at the ranges of knee extension (15°). For the ACL-deficient limb, TDPM at 15° moving into extension was significantly lower than moving into flexion. Similarly, in the ACL-deficient limb, TDPM at 15° moving into extension was significantly lower than at 45°. Mechanoreceptors of the ACL are stimulated primarily by hyperextension. Krauspe et al,26 in single-fiber studies, identified 26 mechanoreceptors of the cruciate ligament among 13 animals. No activity was seen with the knee in the resting position of 30° of flexion. All fibers responded to movement, primarily extension, with a marked increase in activity if internal or external rotation was added in extension. Our study revealed similar results. The knee joints with greater displacement values had lesser ACL tension, which might have led to increased thresholds to detect the passive motion.

In one study,11 female athletes were compared with their male counterparts, and results revealed that women inherently possess significantly greater knee joint laxity values, and demonstrate a significantly longer time to detect the knee joint motion moving into extension. In this study, all tests were performed at the starting position of 15° of knee flexion. This starting position is near the end range of the joint’s motion. As the knee further extends from this position, the ACL becomes increasingly taut, which may be why the investigators found differences between men and women in joint kinesthesia. The significantly greater knee joint laxity inherent to the female athletes may have caused them to have less taut, and therefore less sensitive, ligaments at the initiation of testing.

Ligaments and other capsular structures, which surround the knee joint, contain collagen as a primary constituent. Because of this, they could be expected to demonstrate viscoelastic behavior. There is clinical evidence that ligaments undergo significant loading with many activities, since the symptomatology from ACL insufficiency and medial collateral ligament insufficiency is a major indication for reconstruction of these ligaments.25 In our study, 5 athletes with significantly different anterior displacement values between their knee joints did not cope with ACL injury criteria. The displacement values that were under 3 mm were thought to result from continuous mechanical loadings experienced during the training sessions.

In this study, a relationship has been sought between mechanical and neuromuscular functions of knee joints. Mechanically, anterior tibial displacements were tested, TDPM test was performed to evaluate the proprioceptive status of the knee joints of soccer players. The most considerable outcome of this study is that differences under pathologic limits resulted in significant kinesthetic losses.

In conclusion, this study demonstrates the knee joints with greater displacement values had lesser ACL tension, which might have led to increased thresholds to detect the passive motion. Increased knee laxities without any clinical pathologic findings, have negative effects on knee joint proprioception. This is possibly due to the overuse degeneration of the ACLs, which are the main stabilizers of knee joints.

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References

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