Joint Laxity and Anterior Cruciate Ligament Injuries

by
Hiroshi Mizuta, Kouichi Kai, Kenshi Sakamoto, Hiroaki Sakata, Kenji Kubota, Noriaki Nagamoto, Koichiro Ishikawa and Toshio Kitagawa

Department of Orthopaedic Surgery, Kumamoto University Medical School, Kumamoto, Japan
2 Minoru Shiraishi
Kumamoto Rehabilitation Hospital, Kumamoto, Japan

Introduction

Injuries of the anterior cruciate ligament (ACL) occur frequently associated with athletic activities, and loss of function of ACL results in severe problems for the patient. Most athletes or sportsmen can't pursue athletic activities satisfactorily because of instability due to anterior cruciate ligament insufficiency (ACLI) without surgical repair or reconstruction. Furthermore, it takes a full year to be able to return to the previous level of activities after operation is performed.

Consequently, investigating any factors that would predict an athlete's or sportsman's susceptibility would be invaluable in preventing ACL injuries.

From this point of view, we investigated the relationship of joint laxity to the occurrence of ACL injuries.

Subjects

The study group consisted of 32 patients with ACLI (ACLI group), 16 males and 16 females. Most of the injuries occurred during athletic activities. In 9 males, ACL ruptures were caused by a non-contact type of injury (non-contact ACLI group), and in 7 males by a contact type of injury (contact ACLI group).

In all female patients, ACL ruptures were caused by a non-contact type of injury. All patients were diagnosed as having ACL ruptures by arthroscopy or operation.

A group of healthy, age-matched controls (control group) was also studied. None of this group had any previous episode of knee injury or had shown ACLI. This group consisted of 20 males and 20 females. The mean age and age distribution of both groups is shown in Table 1.

Table 1.

<table>
<thead>
<tr>
<th>Group</th>
<th>No</th>
<th>Mean Age</th>
<th>Age Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACLI group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>male</td>
<td>16</td>
<td>23.4</td>
<td>13-35</td>
</tr>
<tr>
<td>female</td>
<td>16</td>
<td>21.5</td>
<td>13-50</td>
</tr>
<tr>
<td>Control group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>male</td>
<td>20</td>
<td>23.8</td>
<td>18-34</td>
</tr>
<tr>
<td>female</td>
<td>20</td>
<td>21.3</td>
<td>19-25</td>
</tr>
</tbody>
</table>
Methods

1) General joint laxity test

General joint laxity of each subject was determined using six tests described previously (Fig. 1). A total number of positive tests was recorded as a laxity score. When a test was positive in only one side joint, it was considered as a half point.

2) Stress roentgenographical test of anterior laxity of the knee joint.

Lateral roentgenograms of the knee joint at 90° flexion in a supine position were taken both with anterior drawer stress to the knee joint (anterior stress position) and without it (neutral position). Anterior drawer stress was applied by a manual maneuver. We defined a mid-point displacement rate, proposed by Murase et al., on roentgenogram in anterior stress position and in neutral position as AD and N, respectively. And then, we recorded AD - N as rentographical anterior laxity of the knee joint (Fig. 2).

These measurements were performed in both knee joints of the control group and in uninjured knee joints of ACLI group.

Statistically significant difference between the groups was determined by using the Student's t-test.
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Fig. 2 Stress roentgenographical test of anterior laxity in the knee joint

Fig. 3 Distributions of values of the laxity score in ACLI group and control group
Table 2. Comparison of values of the laxity score in ACLI group and control group

<table>
<thead>
<tr>
<th></th>
<th>male</th>
<th>female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>1.55±0.99</td>
<td>2.70±1.49</td>
</tr>
<tr>
<td>ACLI group</td>
<td>1.81±1.25 (\text{ns})</td>
<td>3.25±1.71 (\text{ns})</td>
</tr>
<tr>
<td>non-contact</td>
<td>2.22±1.39 (\text{ns})</td>
<td>3.25±1.71 (\text{ns})</td>
</tr>
<tr>
<td>contact</td>
<td>1.29±0.86 (\text{ns})</td>
<td>—</td>
</tr>
</tbody>
</table>

NS: not significant

Control group

![Diagram of control group]

ACLI group

![Diagram of ACLI group]

Fig 4 Distributions of values of AD-N in ACLI group and control group

Table 3. Comparison of values of AD-N in ACLI group and control group

<table>
<thead>
<tr>
<th></th>
<th>male</th>
<th>female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>6.3±3.1</td>
<td>5.4±2.7</td>
</tr>
<tr>
<td>ACLI group</td>
<td>10.8±4.7 (\text{**})</td>
<td>9.9±6.5 (\text{*})</td>
</tr>
<tr>
<td>non-contact</td>
<td>12.0±5.2 (\text{**})</td>
<td>9.9±6.5 (\text{*})</td>
</tr>
<tr>
<td>contact</td>
<td>9.1±3.6 (\text{*})</td>
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</tr>
</tbody>
</table>

\(\text{*}\): significant at the \(P<0.05\) level
\(\text{**}\): significant at the \(P<0.01\) level

Results

1) General joint laxity

The results of general joint laxity test are summarized in Fig.3 and Table 2. In general, females had higher laxity scores than males. Both females and males in the ACLI group had high laxity scores compared with females and males in the control group, respectively, but this difference
was not statistically significant. When compared with the non-contact ACLI group, the control group did not reveal any statistical difference in the laxity score either.

2) Anterior laxity of the knee joint

The results of anterior laxity of the knee joint are shown in Fig. 4 and Table 3. The mean value for males in control group was 6.3, and that for males in ACLI group was 10.8. This difference was statistically significant at the 0.01 level. Although in males, contact ACLI group had slightly lower value than the total ACLI group, the difference between contact ACLI group and control group was also significant at the 0.05 level.

The mean value for females in control group was 5.4, and that for females in ACLI group was 9.9. This difference was statistically significant at the 0.05 level.

There was no relationship between general joint laxity test and stress roentgenographical test for anterior laxity of the knee joint.

Discussion

There is diverse opinion regarding the relationship of joint laxity to the occurrence of knee injuries. In 1970, Nicholas classified professional football players as loose or tight based on five tests to determine the upper and lower extremity laxity. Of the loose group with at least three positive tests, 72% ruptured their knee ligaments and required surgery. On the other hand, only 9% of the tight group with two or less positive tests ruptured their ligaments. He concluded that an increased likelihood of ligamentous rupture of the knee occurred in loose-jointed and of muscles tears in tight-jointed football players. Nakajima et al reported a four-year study on female college gymnasts using similar tests as used in our study. Although they found no statistical difference in a laxity score of players sustaining ACL injury when compared with that of uninjured players, an injured player had a tendency to have a higher laxity score than uninjured players. Obara et al determined that there is a relationship between general joint laxity and the occurrence of ACL injury by using the same test as were used in the present study. On the other hand, contradictory opinions were also reported. Grana and Moretz tested high school football and basketball players using the five tests described by Nicholas and found no correlation between ligamentous laxity and the occurrence or type of injury. Kalenak and Morehouse studied joint laxity in college football players using a biomechanical evaluation of knee ligament stability and joint laxity test described by Nicholas. They concluded that it is not possible to predict knee injuries by these evaluations. Koga et al used similar tests proposed by Fairbank to screen high school basket ball players and found no correlation between sport injuries and joint laxity.

In our study, there was no significant difference in a laxity score between ACLI group and control group. On the other hand, in stress roentgenographical tests of anterior laxity of the knee joint, ACLI group showed significant high values compared to control group. This result corresponds with our clinical impression that uninjured knee joint are also loose frequently in patients with ACL injury.

It is characteristic that many of ACL ruptures occur by a non-contact type of injury, especially in females. In this type of injury, simple motions such as stopping, jumping or twisting, etc can cause ACL ruptures. This fact suggests that there may be intrinsic factors susceptible to ACL injuries. Morita et al cited a high degree of posterior tilting angle of tibia as one of the factors.
The findings of the present study suggest the greater likelihood of ACL injury occurring as the anterior laxity of the knee joint increases. Although, the present study did not clarify if increased anterior laxity of the knee joint is based on a biomechanical property of ACL, the findings obtained in this study may be valuable in preventing ACL injuries.

**Conclusion**

General joint laxity tests and stress roentgenographical tests of anterior laxity of the knee joint were performed on 32 patients with ACLI and 40 normal controls. Although no correlation was found between general joint laxity and ACL injuries, there was significant relationship between anterior laxity of the knee joint and ACL injuries. These results suggest the increased likelihood of ACL injuries occurring with the increased anterior laxity of the knee joint.

**Reference**

膝前十字靭帯損傷における関節弛緩性的検討

熊本大学整形外科
水 田 博 賢・甲 斐 功 一
坂 本 憲 史・坂 田 泰 章
久保田 健 治・長 元 法 喜
石 川 浩 一 郎・北 川 敏 夫

熊本リハビリテーション病院
白 石 稔

前十字靭帯（以下 ACL）の損傷は、スポーツで頻度が高く、かつ重篤な外傷であり、患者に強い負担が大きい。本損傷の原因を明らかにすることは、スポーツ外傷の予防という意味からも重要である。そこで、われわれは関節弛緩性に注目し、検討を加えた。

対象ならびに方法）男女各16名、計32名の ACL 損傷群、及び男女各20名、計40名の对照群に対し、全身関節弛緩性、膝関節前方動揺性的 2 点について評価をおこなった。膝関節前方動揺性的評価は、ACL 損傷群では健側、対照群では両膝を用い、X 線学的におこなった。

結果ならびに考察）全身関節弛緩性については、両群間に有意な差を認めなかった。一方、ACL 損傷群の膝関節前方動揺性は、対照群に比べ有意な大きな値を示した。今回の検討より、膝関節前方動揺性が大きいものは、ACL 損傷を引き起こしやすい可能性が示唆された。