Effects of a Lower Limb Injury Prevention Program for High Risk Basketball Athletes

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INTRODUCTION:
Anterior cruciate ligament (ACL) injuries often occur in non-contact situations such as landing and cutting. Female athletes are at an increased risk for ACL injury with an injury rate 3 to 5 times that of male athletes. Hewett et al [1] reported that greater knee abduction during landing was a risk factor for ACL injury. At the time of injury, the position of the knee also shows greater knee abduction.

Recently, many studies have focused on ACL prevention. These studies have required all players of a subject team to complete the prevention program. However, screening the players at high risk for injury and recommending only those players carry out the prevention program is a more effective approach. Since greater knee abduction during landing is a risk factor for ACL injury, those who demonstrate a greater knee abduction angle during landing can be regarded as high risk players. However, the effects of a prevention program on high risk players compared to low risk players are unknown.

In this study, those who demonstrated greater knee abduction during landing were regarded as high risk. The purpose of this study was to determine the effects of a prevention program on the high risk players and on the low risk players. Our hypothesis was upon completion of the prevention program the high risk players will show a decrease in knee abduction during landing and an increase in balance ability.

METHODS:
Forty-two female collegiate basketball athletes (84 limbs) participated in this study. All subjects performed a continuous jump test which consisted of five continuous vertical jumps using both legs with maximal effort [2]. The trail was recorded using digital video cameras providing frontal and sagittal views. Average peak knee abduction and flexion angles of each leg from the second to fourth landings were measured for analysis. From the results of the average peak knee abduction angle of the continuous jump test, we distributed the subjects into either the high or low risk group. Since a cutoff point for peak knee abduction has not been reported, a receiver operating characteristic (ROC) curve analysis was used to identify such a point for the continuous jump test. The knee abduction angle that corresponded to the point on the curve that maximized both the sensitivity and specificity of the continuous jump test was identified. Hewett et al [1] found that the average knee abduction angle of ACL injured athletes during the drop jump landing was 9 degree. ROC curve analysis yielded a cutoff point of 6.23 degrees for the knee abduction angle for the continuous jump test. Therefore, those subjects who demonstrated more than 6.23 degrees of knee abduction during the continuous jump test were distributed into the high risk group.

All subjects performed the lower limb injury prevention program which consisted of four training factors (strength, balance, jump and coordination) and three levels (basic, standard and advanced). Each training factor was performed more than twice a week. Before and after completion of the prevention program which lasted four months, the knee flexion angle, the knee abduction angle during landing and the Star Excursion Balance Test (SEBT) were measured. A two-way ANOVA model (risk (2) x training (2)) was used to examine the main effects and interaction effects (risk/training). To determine each significant difference, t-tests were performed as post hoc tests. Significance was set at p<0.05.

RESULTS:
The results were calculated for 33 of the 42 subjects for a total of 60 limbs. Some subjects did not complete the prevention program and measurement, and some video data during the continuous jump test had error. The high risk group included 23 limbs and the low risk group included 37 limbs.

Table 1 presents the results of the continuous jump test and SEBT score for pre and post training. With regards to the knee abduction angle during the continuous jump test, a significant interaction was observed (p<0.01). In the high risk group, the knee abduction angle post-training decreased compared to that at pre-training (p<0.01) (Figure 1). With regards to the knee flexion angle, a significant main effect on training was observed (p<0.05), i.e., in the low risk group, the knee flexion angle post-training decreased compared to that at pre-training (p<0.01). With regards to SEBT score, a significant interaction was observed (p<0.01). In the low risk group, the SEBT score post-training was greater than that at pre-training (p<0.01).

DISCUSSION:
The results of this study supported our hypothesis that high risk players show a decrease in knee abduction angle during landing upon completion of a lower limb injury prevention program. The prevention program was effective to decrease knee abduction angle, especially in those who had greater knee abduction angles. Greater knee abduction during landing is thought to be an ACL-injury risk factor. Therefore, the prevention program decreased the risk for ACL injury in the high risk female basketball players.

Most studies of injury prevention programs target every player on the subject team. However, before starting a prevention program, extracting those who have greater knee abduction angles as a high risk group, and recommending a prevention program for them can lead to a more effective prevention procedure.

Against our hypothesis, the low risk group increased their SEBT score after completion of the prevention program, but the high risk group did not. It has been reported that balance ability predicts lower limb injury [3]. For the low risk group which was distributed by the continuous jump test, the prevention program increased their balance ability and decreased their risk for lower limb injury. For the high risk group, the prevention program did not influence their balance ability while their knee abduction angle during landing was decreased. In a future study, the long term effects on the balance ability of the high risk group should be examined.

REFERENCES:

Figure 1. Continuous jump test
All subjects performed five vertical jumps and landings using both legs with maximum effort.

Table 1 The results of continuous jump test and balance test
<table>
<thead>
<tr>
<th></th>
<th>Abduction (deg)</th>
<th>Flexion (deg)</th>
<th>SEBT (cm)</th>
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</thead>
<tbody>
<tr>
<td><strong>High risk group</strong></td>
<td></td>
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<tr>
<td>Pre-training</td>
<td>7.8 (1.3)**</td>
<td>46.5 (9.6)</td>
<td>97.3 (6.1)</td>
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<td>Post-training</td>
<td>5.7 (1.8)*</td>
<td>45.1 (8.7)</td>
<td>97.7 (4.3)</td>
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<td><strong>Low risk group</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Pre-training</td>
<td>4.0 (1.3)**</td>
<td>47.2 (6.8)‡*</td>
<td>95.2 (7.2)‡</td>
</tr>
<tr>
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<td>42.0 (10.6)‡</td>
<td>99.9 (5.2)‡</td>
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<tr>
<td>Pre-training</td>
<td>5.5 (2.3)</td>
<td>46.9 (7.9)‡</td>
<td>96.0 (6.8)‡</td>
</tr>
<tr>
<td>Post-training</td>
<td>4.9 (2.2)</td>
<td>43.2 (10.1)‡</td>
<td>99.1 (4.9)‡</td>
</tr>
</tbody>
</table>

Main effects (Risk)
Main effects (Training)
Interaction (Risk x Training)

‡: p < 0.01 between high risk group and low risk group
**: p < 0.05 between high risk group and low risk group
*: p < 0.01 between Pre-training and Post-Training