Squats are Safer Than Leg Extension On the ACL...Deal With It!!!

Quentin Posey

What is a Squat?
- Squats are regularly used by coaches and trainers.
- The back squat is a multi-joint movement.
- Squat are good indicators of lower body strength.
- Squat develops several muscle groups at once.
- Weight bearing movement
- Squats are Closed Kinetic Chain Exercises

Leg Extension
- Single Joint Exercise
- Used to develop the quadriceps muscles
- Non-weight bearing exercise.
- Open kinetic chain exercise
About the ACL

- ACL stands for Anterior Cruciate Ligament
- The ACL is an important ligament for the structural integrity of the knee.
- ACL tears are a fairly common injury.
- Approximately 200,000 ACL injuries happen every year.
- 60,000 – 75,000 ACL reconstructions every year.
- ACL grafts have an 8% failure rate.
- Female athletes suffer up to eight times as many injuries as their male counterparts.

BIOMECHANICAL MODEL AND EVALUATION OF A LINEAR MOTION SQUAT TYPE EXERCISE


Purpose

- Biomechanical analysis of the knee and hip during a linear squat.
- Evaluate Hip and Knee angles with varying foot positions.
- Evaluate Hip and Knee forces with varying foot positions.
Methods

Experimental Approach
• Smith machine was used for the linear squat
• Various foot position were used
• Starting from under the hips to an anterior position

Subjects
• Researchers created a scaled model of a average man

Procedures
• The model was 110 kg, and the weight of the bar was 110 kg.
• Center of mass, moments of the hip and knee, external forces of the hip and knee were mathematically calculated.

Results

1. Starting knee moments are lower with anterior placement of the foot
2. No significant difference in ending knee moments

Figure 4. Knee moments at various foot position with hip position at varying anterior placement.

1. Hip moment is significantly changed by foot position.
2. Hip moment always ends lower than it begins

Figure 5. Hip moments at various foot position with hip position at anterior placement.

Results Continued

1. Hip work and knee work are inversely related.
2. Law of conservation – although work is dispersed differently by various foot positions the weight is still 110 kg.

Figure 6. Hip work work at various foot positions.

1. Knee range of motion is constant during all foot positions
2. Hip range of motion increase with anterior foot placement

Figure 7. Range of motion at various foot positions.

Figure 8. Range of motion of the hip and knee joint in a linear squat with foot positions at varying anterior placement.
BIOMECHANICS OF THE KNEE-EXTENSION EXERCISE

Purpose

• Determine the moment arm of the knee extensor.
• Determine what angle was ACL stressed the most.
• Determine anterior displacement of the knee.

Methods

Subjects

• 3 cadavers were used
• Legs were removed from each cadaver.

Procedures

• Leg was mounted to an Instron model-1321 by threading the femur with a threaded rod.
• Test one had no weight on the foot.
• Test two had 32 pounds attached to the leg.
• Each test was performed with and without the ACL.

Measurements

• 6-degree-of-freedom was used to measure knee joint forces.
• Knee flexion and anterior tibial translations were the only measurements used.
Results

ACL Intact During Leg Ext. | ACL Cut During Leg Ext.

1. Anterior displacement was significantly different between intact and cut ACL.
2. Highest anterior displacement was noted between 30 to 60 degrees.

Purpose

- Compare open and closed kinetic chain resistance training programs on the ACL.
- Compare uninjured and injured ACL resistance training programs.
- Determine if ACL is at a higher risk during open kinetic chain exercises.
Methods

Subjects
- 37 patients who had ACL reconstruction.
- Subjects had no other injuries.
- No accidents before training program.
- All subjects had a tendon graph.

Resistance Training Program
- Attend physical therapy sessions three times a week for four weeks.
- Closed kinetic chain performed unilateral resistance training with leg press.
- Open kinetic chain group performed isolated machines on the knee extensor machine.

Testing Procedures
- Hughston Clinic visual analog scale subjective knee questionnaire.
- Walking on flat, ascending, and descending surfaces was evaluated by Model 4120 force plate.

Results
1. No significant difference between OKC and CKC during Ascent.
2. No significant difference between OKC and CKC during Descent.
3. Significant difference between injured and uninjured subjects.

Joanna Kvist & Jan Gillquist, The American Journal of Sports Medicine
2001

SAGITTAL PLANE KNEE TRANSLATION AND ELECTROMYOGRAPHIC ACTIVITY DURING CLOSED AND OPEN KINETIC CHAIN EXERCISES IN ANTERIOR CRUCIATE LIGAMENT-DEFICIENT PATIENTS AND CONTROL SUBJECTS
Purpose

- Determine tibial translation during squat movements and leg extension
- Identify the coactivation of the quadriceps and gastrocnemius during squat and leg extension.
- Identify sagittal translation during squat and leg extension

Methods

Subjects
- 12 subjects with unilateral ACL injuries

Measurements
- Computerized goniometer linkage CA-4000
- Electromyography

Testing protocol
- Active Knee Extension
- Squat with COG over feet
- Squat with COG behind feet
- Squat with COG in front of feet
- Lachman Test

Results

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Control</th>
<th>Treatment 1</th>
<th>Treatment 2</th>
<th>Difference</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active Extension</td>
<td>0.2 ± 0.17</td>
<td>0.4 ± 0.19</td>
<td>0.2 ± 0.24</td>
<td>0.0 ± 0.25</td>
<td>0.005</td>
</tr>
<tr>
<td>Squat over COG</td>
<td>0.8 ± 0.07</td>
<td>0.8 ± 0.08</td>
<td>0.8 ± 0.07</td>
<td>0.0 ± 0.01</td>
<td>0.068</td>
</tr>
<tr>
<td>Squat behind COG</td>
<td>0.8 ± 0.06</td>
<td>0.8 ± 0.07</td>
<td>0.8 ± 0.07</td>
<td>0.0 ± 0.01</td>
<td>0.068</td>
</tr>
<tr>
<td>Squat in front of COG</td>
<td>0.8 ± 0.06</td>
<td>0.8 ± 0.07</td>
<td>0.8 ± 0.07</td>
<td>0.0 ± 0.01</td>
<td>0.068</td>
</tr>
</tbody>
</table>

1. Active Extension tibial translation increased with weight.
2. Active Extension had the most tibial translation.
3. Squatting with center of gravity over the feet had the second least amount of force applied on the knee.
4. Squatting with center of gravity behind the feet had the second most tibial translation.
5. Squatting with center of gravity in front of the feet had the least amount of tibial translation.

*Significance level is set at 0.05. Comparisons were made between the control group and the treatment groups.
Research supports that the ACL is safer during a squat than a leg extension.

Leg Extension cause more displacement on the ACL than squat

ACL tension is regulated by hip and knee joints.

Research suggests that Closed kinetic chain exercises are safer on the ACL then open kinetic chain exercises.
Recommendation

• After ACL surgery the leg extension should be avoided because of unnecessary stress caused by tibial displacement.
• After ACL surgery squats can be safely recommended.

Future Research
Front Squat Vs. Back Squat

Knees are in front of toes    Knees are over the Toes