Driving Reaction Time After Right Knee ACL Reconstruction

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Division of Sports Medicine
Department of Orthopaedic Surgery
HOSPITAL FOR JOINT DISEASES
Disclosure

• None of the authors have any financial relationships
Introduction

• Anterior Cruciate Ligament Reconstruction (ACLR) is 1 of the more commonly performed orthopaedic procedures in the United States, with more than 275,000 cases performed annually.

• However, there are currently no official guidelines available to assist the clinician or patient to assess the minimum functional ability required to drive an automobile following a right knee ACLR.
Introduction

• 2 studies to date have looked at Brake Reaction Time (BRT) after ACLR

• To our knowledge there are no studies in the literature evaluating the BRT after ACLR with an allograft

• Furthermore, there are no studies evaluating the differences between the different autografts and allografts
Objective

• Evaluate the BRT & TBT using a validated driving simulator that more closely resembles “real-life” driving conditions

• Compare the BRT & TBT between 3 types of grafts:
  • Bone-patella-tendon-bone autograft (BPTB)
  • Hamstring autograft (HS)
  • Tibialis anterior allograft (TA)
Hypothesis

- In patients after a right knee ACLR, the BRT, Brake Travel Time (BTT), and Total Braking Time (TBT) would be longer compared to controls at 7-10 days after surgery.
  - This difference would normalize by 6 weeks post-operatively.
- Between the different graft groups, the patients who received an allograft would have braking times equal to healthy subjects sooner than those patients with an autograft.
Methods

• Prospective case series of 27 patients with valid driver’s license undergoing right ACLR
  • 9 HS, 9 BPTB, 9 TA
• Compared with 30 healthy controls
• Similar demographics amongst the cohorts:
  • Except for age: Mean of TA 44, HS 26.4, BPTB 25
  • Height, weight, age, years of driving similar amongst the cohorts

• 3 Post-operative visits
  • 7-10 days, 3 weeks, 6 weeks
**Methods**

- **Fixed Base Simulator (STISIM Drive™)**
  - Steering Mechanism, Accelerator, Brake
  - Each subject performed 21 randomly assigned trials
  - Simulated driving conditions (city, suburban, & highway)
  - Trials ranged from 90 seconds to 5 minutes

- Speed limits ranged from 15 mph in the city setting to 55 mph in highway settings

- 10 unanticipated STOP signs presented
Methods

- **Data Collected**
  - Time from stimulus to brake application (BRT)
  - Time from brake application to full stop (BTT)
  - Time from stimulus to full stop (TBT)
# Results

Table 1: Means and Standard Deviations for each group at 7-10 days post-operatively.

<table>
<thead>
<tr>
<th>Week 1</th>
<th>Mean ± SD BRT</th>
<th>Mean ± SD BTT</th>
<th>Mean ± SD TBT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (n=30)</td>
<td>0.72 ± 0.09</td>
<td>2.87 ± 0.51</td>
<td>3.59 ± 0.56</td>
</tr>
<tr>
<td>HS (n=9)</td>
<td>0.97 ± 0.22</td>
<td>3.41 ± 0.97</td>
<td>4.38 ± 1.09</td>
</tr>
<tr>
<td>BPTB (n=9)</td>
<td>0.90 ± 0.19</td>
<td>3.97 ± 0.88</td>
<td>4.87 ± 0.96</td>
</tr>
<tr>
<td>TA (n=9)</td>
<td>1.00 ± 0.24</td>
<td>3.44 ± 0.80</td>
<td>4.44 ± 0.95</td>
</tr>
</tbody>
</table>

HS, Hamstring; BPTB, Bone Patellar Tendon-Bone; TA, Tibialis Anterior; BRT, Brake Reaction Time; BTT, Brake Travel Time; TBT, Total Braking Time

\[ p < 0.001 \text{ for BRT all cohorts} \]

TBT significantly delayed for all groups
Results

Table 2: Means and Standard Deviations for each group at 3 weeks post-operatively.

<table>
<thead>
<tr>
<th>Week 3</th>
<th>Mean ± SD BRT</th>
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<th>Mean ± SD TBT</th>
</tr>
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<td>Control (n=30)</td>
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<tr>
<td>HS (n=9)</td>
<td>0.80 ± 0.16</td>
<td>3.42 ± 0.75</td>
<td>4.22 ± 0.88</td>
</tr>
<tr>
<td>BPTB (n=9)</td>
<td>0.78 ± 0.15</td>
<td>3.42 ± 0.50</td>
<td>4.19 ± 0.61</td>
</tr>
<tr>
<td>TA (n=9)</td>
<td>0.74 ± 0.14</td>
<td>3.04 ± 0.53</td>
<td>3.78 ± 0.64</td>
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HS, Hamstring; BPTB, Bone Patellar Tendon-Bone; TA, Tibialis Anterior; BRT, Brake Reaction Time; BTT, Brake Travel Time; TBT, Total Braking Time

TBT of Autografts continued to be significantly longer (Hams p = 0.015, BPTB p = 0.009)

Allo: No statistically significant difference in TBT compared to controls p = 0.406
## Results

Table 3: Means and Standard Deviations for each group at 6 weeks post-operatively.

<table>
<thead>
<tr>
<th>Week 6</th>
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<td>HS (n=9)</td>
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<td>3.11 ± 0.37</td>
<td>3.85 ± 0.38</td>
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<tr>
<td>BPTB (n=9)</td>
<td>0.76 ± 0.19</td>
<td>3.38 ± 0.74</td>
<td>4.15 ± 0.87</td>
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<tr>
<td>TA (n=9)</td>
<td>0.70 ± 0.14</td>
<td>2.93 ± 0.47</td>
<td>3.63 ± 0.58</td>
</tr>
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HS, Hamstring; BPTB, Bone Patellar Tendon-Bone; TA, Tibialis Anterior; BRT, Brake Reaction Time; BTT, Brake Travel Time; TBT, Total braking Time

No signif diff b/w the cohorts & controls regarding BRT

HS: No sig diff in BTT & TBT compared to controls

p=0.179, and p=0.207, respectively
Results

Table 3: Means and Standard Deviations for each group at 6 weeks post-operatively.

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BPTB: Continued to show statist signif diff in BTT (p = 0.022) and TBT (p < 0.029) compared to controls
Results

Total Braking Time

Week 1  Week 3  Week 6
Control  HS  BPTB  TA

Hospital for Joint Diseases ● Department of Orthopaedic Surgery ● Division of Sports Medicine
Discussion

• Paucity of literature regarding appropriate time to resuming driving after right knee ACLR

• Nguyen et al. (KSSTA 2000) evaluated 16 patients (15 hamstring, 1 BPTB autograft) and recommended waiting “at least” 6 weeks before resuming driving
Discussion

- Gotlin et al. (Arch Phys Med Rehab 2000) evaluated 12 male patients after BPTB autograft reconstruction and concluded that BRT is equivalent to controls at 4-6 weeks.

- This is the first study to evaluate BRT & TBT after right knee ACLR with an allograft, and compare the results between BPTB and hamstring autografts.
Conclusion

- At 3 weeks post-op only the TA allograft had no statistically significant difference from normal values.

- At 6 weeks post-op, hamstring autograft values had no statistically significant difference from normal values.

- BPTB autografts failed to return to normal values at 6 weeks post-op.

- Patients should be counseled appropriately when discussing graft options.
Limitations

• 4 Different surgeons
  • Individual fixation techniques

• Driving simulator was not an actual vehicle
  • Some of the improvement in reaction times at 2nd & 3rd visits may represent a learning curve, can be difficult to distinguish from post-op recovery
  • However: randomly assigned order of the different trials

• Only 9 patients in each cohort