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Das Genium-Prothesenkniegelenk – ein Überblick über die wissenschaftliche Evidenz

(Genium prosthetic knee joint–Overview of scientific evidence)
Orthopädie Technik 2016. 4: 44-49.

### Products

| Genium vs C-Leg |

### Major Findings

With Genium compared to C-Leg:

- **Level walking:**
  - More physiological walking due to increased knee flexion angle during standing and swing phase while walking on level ground and ramps.
  - Reduced impact forces through 4° “Preflex” at initial heel contact
  - Reduction of step length gait asymmetry while level walking by 40-60%.
  - Correct swing initiation of 95% of the subjects when walking with small steps with Genium instead of 75% with C-Leg.
  - Safe detection of walking backwards and therefore reliable blocking of the swing phase release.

- **Improved stair ambulation:**
  - 70-80% of the patients used step-over-step strategy for stair ascent.
  - Range of motion (ROM) of the hip and knee joint of the sound side was reduced by one third and is nearly equivalent to able bodied persons.

- **More balanced and safer standing on ramps.**

- **Activities of daily living (ADLs)** showed a clinically relevant decrease in perceived difficulty (53% of ADLS) and gain in safety (60% of ADLS).

- **Quality of life (QoL)** is significantly improved including 4 out of 9 scales of Prosthetic Evaluation Questionnaire (PEQ)

### Genium makes activities of daily living safer

- Extent of improvement:
  - 0 = no difference
  - 1 = safer
  - 2 = much safer

Kannenberg et al., 2013.
Systematic review:

Nine publications were identified comparing Genium to C-Leg with each including on average between 10 and 20 transfemoral participants. The following table lists topics that were reviewed in this overview including the number of supporting studies:

<table>
<thead>
<tr>
<th>Results</th>
<th>Number of studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level walking</td>
<td>4</td>
</tr>
<tr>
<td>Stairs</td>
<td>3</td>
</tr>
<tr>
<td>Ramps, Hills</td>
<td>3</td>
</tr>
<tr>
<td>Safety</td>
<td>4</td>
</tr>
<tr>
<td>ADLs</td>
<td>1</td>
</tr>
<tr>
<td>Quality of Life (QoL)</td>
<td>1</td>
</tr>
<tr>
<td>Health</td>
<td>4</td>
</tr>
</tbody>
</table>

Results

Functions and Activities

<table>
<thead>
<tr>
<th>Level walking</th>
<th>Stairs</th>
<th>Ramps, Hills</th>
<th>Uneven ground, Obstacles</th>
<th>Cognitive demand</th>
<th>Energy</th>
<th>Safety</th>
<th>Activity, Mobility, ADLs</th>
<th>Preference, Satisfaction, QoL</th>
<th>Environment</th>
<th>Health Economies</th>
</tr>
</thead>
</table>

**Category** | **Outcomes** | **Results for Genium vs C-Leg** | **References** |
---|---|---|---|
Level walking | Forces at initial heel contact | The 4° "Preflex" at initial heel contact reduces impact forces, thus protecting the body. | [1,2]|
| Knee flexion during standing phase | Increased knee flexion angle during stance phase up to 2° with Genium while walking very slow, slow or fast. | [5] |
| Adaptive swing phase control | Maximum knee flexion angle was 64°, which ensures toe clearance at different gait velocities. | [1,2] |
| | With Genium, the knee flexion increased significantly at very slow, slow and fast walking speed compared to C-Leg. These angles are nearly equivalent to those of able bodied persons. | [5] |
| | Adding more weight on the prosthetic foot (like heavy shoes), led to higher knee flexion angles. | [3] |
| | At 95% of small steps, swing was initiated correctly through adaptive swing phase control of Genium. With C-Leg the percentage was only 75%. | [1,2] |
| Asymmetry of step length | Asymmetry of step length was reduced by 40-60%, depending on gait velocity. | [1,2] |
Stairs | Stair ascent strategy | 70-80% of the patients could use step-over-step strategy to ascent stairs with Genium. | [4,6,7] |
| Range of motion (ROM) | Compensations in terms of ROM of the hip and knee joint on the sound side were reduced by about one third, which is nearly equivalent to an able bodied person. | [6] |
Ramps, Hills | Maximum knee flexion during stance phase | During ramp descent at slow and fast walking speed the knee flexion angle increased significantly with Genium. | [5] |
<table>
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<th>Results for Genium vs C-Leg</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum knee during stand during swing phase</td>
<td>7° to 8° higher knee flexion angle during ramp ascent and descent with Genium compared to C-Leg.</td>
<td>[1,2,5]</td>
</tr>
</tbody>
</table>
|                   | Standing on a 10 degree ramp for 3 minutes    | • Higher loading of the affected side up to 86%.  
• Sagittal knee flexion moment on the prosthetic side increased by 92%.  
• Reduction of postural sway of the prosthetic side. | [1,2]      |
| Safety            | Stumbles and falls                            | The risk for stumbling or falling can be reduced through:  
• Better toe clearance through higher knee flexion. [1,2,5]  
• Initiation of the swing phase, while making small steps. [1,2]  
• Walking backwards detection, thus blocking the swing phase release. [2] | [1,2,5]    |
| ADL questionnaire | Activity, Mobility, Activities of Daily Living (ADLs) | 60% of ADLs showed a clinically relevant gain in safety. | [8]        |
|                   | ADL questionnaire                             | 53% of ADLs showed a clinically relevant decrease in perceived difficulty.  
Especially ascending and descending stairs and ramps as well as walking backwards improved significantly. | [8]        |
| Preference, Satisfaction, Quality of Life (QoL) | Prosthetic Evaluation Questionnaire (PEQ) | 4 out of 9 scales were rated significantly higher:  
• Perceived Response  
• Social Burden  
• Utility  
• Well-being  
“Appearance” and “Sounds” had the tendency to be rated higher, but not significantly.  
3 out of 9 scales were unchanged:  
• Ambulation  
• Frustration  
• Residual Limb Health | [9]        |

**Author's Conclusion**  
Extract of References of the Systematic Review:


5. Lura DJ, Wernke MM, Carey SL, Kahle JT, Miro RM, Highsmith MJ. Differences in knee flexion between the Genium and C-Leg microprocessor knees while walking on level ground and ramps.


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