

Reference

Huppert L, Mileusnic M, Hahn A.

Otto Bock Healthcare Products GmbH; Brehmstraße 16, 1110 Vienna.

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:**

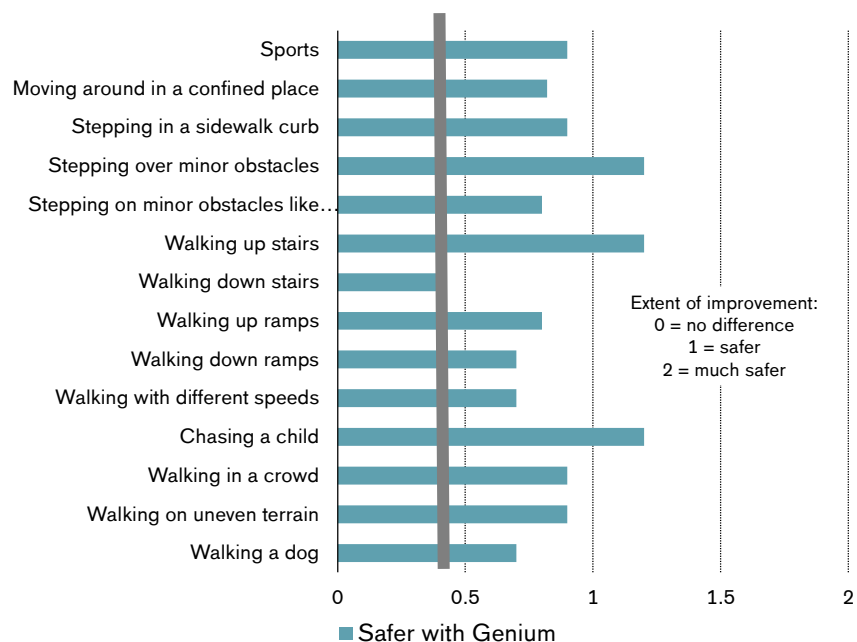
- 70-80% of the patients used step-over-step strategy for stair ascent.
- Range of motion (ROM) of the hip and knee joint of the sound side was reduced by one third and is nearly equivalent to able bodied persons.

→ **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



Kannenberg et al., 2013.

Study Design

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:

Results	Number of studies
Level walking	4
Stairs	3
Ramps, Hills	3
Safety	4
ADLs	1
Quality of Life (QoL)	1
Health	4

Results

Functions and Activities						Participation			Environment
Level walking	Stairs	Ramps, Hills	Uneven ground, Obstacles	Cognitive demand	Energy	Safety	Activity, Mobility, ADLs	Preference, Satisfaction, QoL	Health Economics

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]

Category	Outcomes	Results for Genium vs C-Leg	References
	Maximum knee during swing phase	7° to 8° higher knee flexion angle during ramp ascent and descent with Genium compared to C-Leg.	[1,2,5]
	Standing on a 10 degree ramp for 3 minutes	<ul style="list-style-type: none"> • 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	<p>The risk for stumbling or falling can be reduced through:</p> <ul style="list-style-type: none"> • 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	60% of ADLs showed a clinically relevant gain in safety.	[8]
Activity, Mobility, Activities of Daily Living (ADLs)	ADL questionnaire	<p>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.</p>	[8]
Preference, Satisfaction, Quality of Life (QoL)	Prosthetic Evaluation Questionnaire (PEQ)	<p>4 out of 9 scales were rated significantly higher:</p> <ul style="list-style-type: none"> • Perceived Response • Social Burden • Utility • Well-being <p>“Appearance” and “Sounds” had the tendency to be rated higher, but not significantly.</p> <p>3 out of 9 scales were unchanged:</p> <ul style="list-style-type: none"> • Ambulation • Frustration • Residual Limb Health 	[9]

Author's Conclusion

“Erste wissenschaftliche Studien, welche die Leistungsversprechungen des Genium biomechanisch, funktionell und hinsichtlich des subjektiven Zugewinns an Sicherheit und Einfachheit in der Durchführung von Aktivitäten des täglichen Lebens sowie den Einfluss auf die Lebensqualität überprüften, liefern Hinweise darauf dass mit dem Genium selbst im Vergleich zum C-Leg weitere Gebrauchsvorteile realisiert werden können. Von Bedeutung sind diese Ergebnisse insbesondere im Hinblick auf die Sicherheit des Anwenders sowie deren Schutz ihres gesamten Bewegungsapparates.” (Huppert, 2016)

Extract of References of the Systematic Review:

1. Bellmann M, Schmalz T, Ludwigs E, Blumentritt S. Immediate effects of a new microprocessor-controlled prosthetic knee joint: a comparative biomechanical evaluation. *Arch Phys Med Rehabil*, 2012; 93 (3): 541–549. doi: 10.1016/j.apmr.2011.10.017
2. Blumentritt S, Bellmann M, Ludwigs E, Schmalz T. Zur Biomechanik des mikroprozessorgesteuerten Prothesenkniegelenks Genium. *Orthopädie-Technik*, 2012; 01 (12): 24–35
3. Highsmith MJ, Kahle JT, Lura DJ, Dubey RV, Carey SL, Quillen WS, Mengelkoch LJ. Short and Mid-Distance Walking and Posturography With a Novel Microprocessor Knee. *Technology & Innovation*, 2014; 15 (4): 359–368. doi: 10.3727/194982413X13844488879302
4. Highsmith MJ, Kahle JT, Lura DJ, Lewandowski AL, Quillen WS, Kim SH. Stair ascent and ramp gait training with the Genium knee. *Technology & Innovation*, 2014; 15 (4): 349–358. doi: 10.3727/194982413X13844488879267
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. *Clinical Biomechanics*, 2015; 30 (2): 175–181. doi: 10.1016/j.clinbiomech.2014.12.003
6. Bellmann M, Schmalz T, Ludwigs E, Blumentritt S. Stair ascent with an innovative microprocessor-controlled exoprosthetic knee joint. *Biomed Tech (Berl)*, 2012; 57 (6): 435–444. doi: 10.1515/bmt-2011-0029
7. Aldridge Whitehead JM, Wolf EJ, Scoville CR, Wilken JM. Does a Microprocessor-controlled Prosthetic Knee Affect Stair Ascent Strategies in Persons With Transfemoral Amputation? *Clin Orthop Relat Res*, 2014. doi: 10.1007/s11999-014-3484-2
8. Kannenberg A, Zacharias B, Mileusnic M, Seyr M. Activities of Daily Living: Genium Bionic Prosthetic Knee Compared With C-Leg. *JPO Journal of Prosthetics and Orthotics*, 2013; 25 (3): 110–117. doi: 10.1097/JPO.0b013e31829c221f
9. Highsmith MJ, Kahle JT, Miro RM, Lura DJ, Dubey RV, Carey SL, Quillen WS, Mengelkoch LJ. Perceived differences between the Genium and the C-Leg microprocessor prosthetic knees in prosthetic-related function and quality of life. *Technology & Innovation*, 2014; 15 (4): 369–375. doi: 10.3727/194982413X13844489091297

© 2014, Otto Bock HealthCare Products GmbH (“Otto Bock”), All Rights Reserved. This article contains copyrighted material. Wherever possible we give full recognition to the authors. We believe this constitutes a ‘fair use’ of any such copyrighted material according to Title 17 U.S.C. Section 107 of US Copyright Law. If you wish to use copyrighted material from this site for purposes of your own that go beyond ‘fair use’, you must obtain permission from the copyright owner. All trademarks, copyrights, or other intellectual property used or referenced herein are the property of their respective owners. The information presented here is in summary form only and intended to provide broad knowledge of products offered. You should consult your physician before purchasing any product(s). Otto Bock disclaims any liability related from medical decisions made based on this article summary.