C-Leg vs NMPKs

Ramps, Hills

Major Findings

With C-Leg and C-Leg Compact compared to NMPKs:

→ **Improved hill mobility during descent**

K2: Hill Assessment Index score improved from 5.4 to 7.5 (39% increase)
K3: Hill Assessment Index score improved from 7.8 to 8.9 (14% increase)

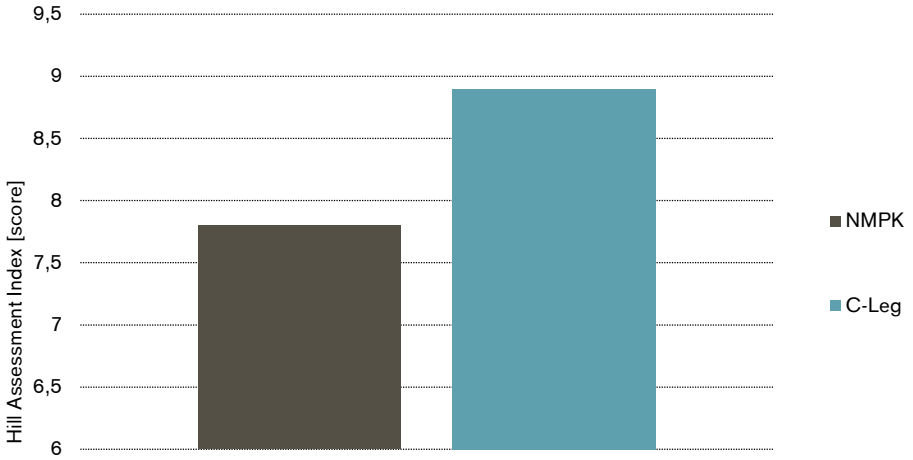
→ **Improved walking velocity during ramp ascent and descent**

K2: walking velocity improved by 28% during ascent and by 36% during descent
K3: walking velocity improved by 40% during descent

→ **More symmetrical gait pattern and improvements in perceived safety**

Duration of single limb support phase on prosthetic side increased by 17% during ramp ascent
Duration of single limb support phase on prosthetic side increased by 17% during ramp descent

Improved ramp mobility with C-Leg for descent



Hill Assessment Index (HAI) score improved from 7.8 with NMPCK to 8.9 with C-Leg in K3 subjects. 8 points represent 'step-to without assistive device' and 9 points represent 'step a little past without assistive device'. (Highsmith et al. 2013)

Clinical Relevance

Similar to stairs, ramps and hills need to be navigated by amputees with a wide range of activity levels to be able to participate in daily life. One way to evaluate performance on ramps is by measuring the time needed to complete a ramp task (velocity). Furthermore, the Hill Assessment Index (HAI) is used to assess quality of walking on sloped terrain based on willingness to perform task, use of assistance, direction of gait relative to the slope, and step length. Biomechanical assessment is conducted to determine joint angles and kinematic parameters.

Summary

The time subjects required to descend and ascend ramp was investigated by several groups. Hafner et al. (2007) reported that walking velocity during ramp descent increased by 29% with C-Leg compared to NMPKs. These findings were confirmed by a later study, which reported that walking velocity during ramp descent in K2 subjects increased by 27% and in K3 subjects even by 40% when using C-Leg

compared to NMPKs (Hafner et al. 2009). An increase by 23% in walking velocity during ramp descent due to transition from NMPK to C-Leg was reported also by Highsmith et al. (2013). A study investigating the difference between C-Leg Compact to NMPKs in K2 subjects, reported for stair ascent an increase in walking velocity of 28% and for stair descent an increase of 36% (Burnfield et al. 2012).

The Hill Assessment Index (HAI) score was improved in K2 subjects by 39% from a score of 5.4 to 7.5 with the transition from a NMPCK to C-Leg (Hafner et al. 2009). 5 points represent 'step a little past with assistive device' and 8 points represent 'step-to without assistive device'. In K3 subjects HAI improved with C-Leg by 14% from a score of 7.8 to 8.9 (Highsmith et al. 2013). 8 points represent 'step-to without assistive device' and 9 points represent 'step a little past without assistive device'. Both studies investigated hill descent only.

The results from the motion analysis showed, that the duration of single limb support phase on the prosthetic side was increased with C-Leg Compact compared to NMPKs during hill ascent and descent. Furthermore, stride length and cadence increased with C-Leg Compact compared to NMPKs during hill ascent and descent (Burnfield et al. 2012). In conclusion, fitting with C-Leg Compact resulted in more symmetrical gait pattern, increased loading on the prosthetic side and therefore improved perceived safety.

References of summarized studies

Burnfield, J. M., Eberly, V. J., Gronely, J. K., Perry, J., Yule, W. J., & Mulroy, S. J. (2012). Impact of stance phase microprocessor-controlled knee prosthesis on ramp negotiation and community walking function in K2 level transfemoral amputees. Prosthetics and Orthotics International, 36(1), 95–104. doi:10.1177/0309364611431611

Hafner, B. J., & Smith, D. G. (2009). Differences in function and safety between Medicare Functional Classification Level-2 and -3 transfemoral amputees and influence of prosthetic knee joint control. The Journal of Rehabilitation Research and Development, 46(3), 417–433.

Hafner, B. J., Willingham, L. L., Buell, N. C., Allyn, K. J., & Smith, D. G. (2007). Evaluation of function, performance, and preference as transfemoral amputees transition from mechanical to microprocessor control of the prosthetic knee. Archives of physical medicine and rehabilitation, 88(2), 207–217. doi:10.1016/j.apmr.2006.10.030

Highsmith, M. J., Kahle, J. T., Miro, R. M., & Mengelkoch, L. J. (2013). Ramp descent performance with the C-Leg and interrater reliability of the Hill Assessment Index. Prosthetics and Orthotics International, 37(5), 362–368. doi:10.1177/0309364612470482