

## Reference

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# Functional Stability of Transfemoral Amputee Gait Using the 3R80 and Total Knee 2000 Prosthetic Knee Units

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## Products

**3R80**

## Major Findings

With 3R80 (single-axis, hydraulic stance and swing control) compared to Total Knee 2000 (polycentric, geometric lock for stance control, hydraulic swing control):

→ **3R80 provides less overall stability than Total Knee 2000**

→ **3R80 is more stable than Total Knee 2000 in the early stance phase, while Total Knee 2000 is more stable in mid- and late-stance**

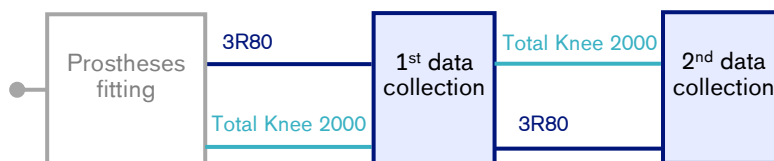
- 3R80 requires a smaller hip extension moment during loading response
- 3R80 requires a smaller hip flexion moment in terminal stance phase

## Population

Subjects:	5 subjects
Amputation level:	unilateral transfemoral
Previous prosthesis:	<b>Knee:</b> C-Leg (1), 3R80 (1), 3R36 (1), TK1900 (1), TK2000 (1) <b>Foot:</b> Ottobock Luxon Journey (1), College Park Multi-axial foot (2), Modular III Flex Foot (1), Endolite Multi-axial foot (1)
Amputation causes:	Trauma (4), cancer (1)
Mean age:	44.8 ± 9.3 years
Mean time since amputation:	19 ± 14.0 years
Mean residual limb length:	30.2 ± 5.8cm (range: 23cm - 36cm)
MFCL:	K2 and higher

## Study Design

Interventional, cross-over study:



Experimental prostheses were fitted during a fitting session, followed by a physical therapy session. Then, kinetic, and kinematic parameters were examined in a gait analysis session. Patients were asked to walk at a self-selected speed along the data collection corridor until each subject made five clean force plate strikes with each foot. Directly following, patients were asked to answer questionnaires on the perceived exertion and on their perception of their stability with each experimental knee (3R80 and Total Knee 2000).

## Results

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

Category	Outcomes	Results for 3R38 vs. Total Knee 2000	Sig. <sup>a</sup>
Level Walking	Velocity [m/s]	- Slower self-selected walking speed with 3R80 compared to Total Knee 2000, statistically significant in 3/5 subjects.	++
	Cadence [steps/min]	- 4 out of 5 subjects (80%) show a higher cadence with 3R80 compared to Total Knee 2000, statistically significant in 2/5 subjects.	++
		- 1 out of 5 subjects (20%) shows a significantly lower cadence with 3R80 compared to Total Knee 2000.	
	Stride length [m]	- Shorter stride length with 3R80 compared to Total Knee 2000, statistically significant in 4/5 subjects.	++
	Step length [m]	- Shorter step length with prosthetic limb with 3R80 compared to Total Knee 2000, statistically significant in 3/5 subjects	++
		- Shorter step length with sound limb with 3R80 compared to Total Knee 2000, statistically significant in 1/5 subjects	++
	Prosthetic stance duration [%]	- Longer prosthetic stance duration with 3R80 compared to Total Knee 2000, statistically significant in 4/5 subjects	++
	Prosthetic swing duration [%]	- Shorter prosthetic swing duration with 3R80 compared to Total Knee 2000, statistically significant in 4/5 subjects	++
	Single support duration [% stride time]	- Longer single support duration on the prosthetic side with 3R80 compared to Total Knee 2000, statistically significant in 1/5 subjects	++
		- Shorter single support duration on the sound side with 3R80 compared to Total Knee 2000, statistically significant in 4/5 subjects	++
	Double support duration [% stride time]	- Longer double support duration on the prosthetic side with 3R80 compared to Total Knee 2000, statistically significant in 2/5 subjects	++
		- Longer double support duration on the sound side with 3R80 compared to Total Knee 2000, statistically significant in 2/5 subjects	++
	Hip moments [Nm/kg]	- No significant intra-subject differences	0
- Slightly larger required hip extension moment during loading response with Total Knee 2000 → less stable in early stance.		0	
- Slightly less required hip flexion moment during terminal stance with 3R80 → less stable than Total Knee 2000		0	
Preference, Satisfaction, QoL	No significant differences found in the questionnaires regarding the subject's perceived exertion and perception of their prosthetic limb stability with both the 3R80 and Total Knee.	0	

Category	Outcomes	Results for 3R38 vs. Total Knee 2000	Sig. <sup>a</sup>
		Subjects 1 and 4 had different residual limb lengths (1: long, 4: very short), this might be a reason for the slightly different responses in their subjective questionnaires. #4 perceived the higher weight of 3R80 as major hindrance and showed a much higher level of exertion with 3R80 and found the Total Knee 2000 more stable and comfortable. 4 out of 5 subjects (S1 to S4) answered the questionnaires	

<sup>a</sup> no difference (0), positive trend (+), negative trend (-), significant (++)/(--), not applicable (n.a.)

### Author's Conclusion

"In summary, the analyses conducted in this study indicated that the Total Knee 2000 had a higher degree of overall stability than the 3R80. The basis for this higher level of overall stability was the increased stability exhibited by the Total Knee 2000 in mid and late stance phases, as the Total Knee 2000 was found to be less stable than the 3R80 in early stance phase. This difference in stability between the two knees led to differences in the required hip moments between the knees, with the Total Knee 2000 requiring a larger hip extension moment during loading response due to its decreased stability at this point in the gait cycle, and a larger hip flexion moment in terminal stance due to its increased stability at this point in the gait cycle." [...]

"Although the results of this study suggest that the Total Knee 2000 performs better with respect to stability than the 3R80, there are some TF amputees for whom this knee may not be the best choice. Amputees who are healthy and very active and have good voluntary control of their prosthesis may find that the increased stability of the Total Knee 2000 limits their activity by requiring them to overcome the stability of the knee design before they can initiate swing phase. These individuals may find that the 3R80 allows them to initiate swing more easily, or they may prefer a prosthetic knee that does not incorporate stance phase control but rather relies on alignment stability and their residual limb musculature to maintain stability during stance phase. This type of knee component would be more versatile for an amputee who has the muscular ability to control the prosthesis and, as well as the endurance to maintain a high level of voluntary control for an extended period of time." (Silver-Thorn & Glaister, 2009)

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