Reference

Ö. Ülger, S. Topuz, K. Bayramlar [1]

Effects of a hydraulic knee joint on energy consumption, gait and patient satisfaction in trans-femoral amputees

Fizyoterapi Rehabilitasyon (2009); 20(3):169-177. Open Access.

Products

3R60, 3R15

Major Findings

With hydraulic, multiaxial knee with 5 axes (3R60) compared to mechanical, friction-brake, multiaxial knee with 5 axes (3R15):

→ **Significantly reduced metabolic energy consumption with 3R60 compared to the 3R15**

→ **Significantly improved gait pattern, closer to normal with 3R60**

→ **Higher prosthesis satisfaction and quality of life with 3R60**

- Significantly more comfortable in terms of comfort, cosmetic appearance, and functionality according to SATPRO survey
- Significantly reduced pain according to Nottingham Health Profile (NHP)

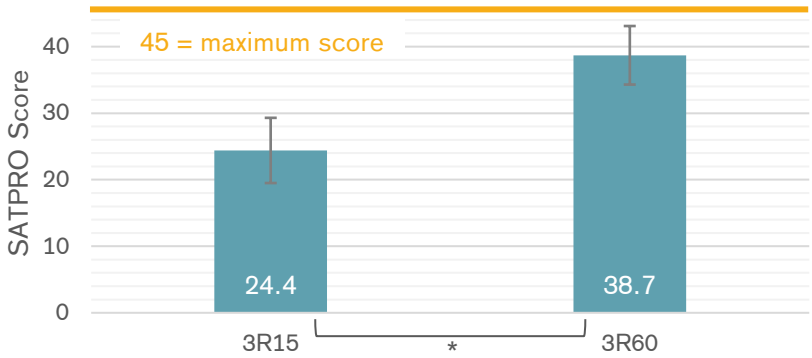


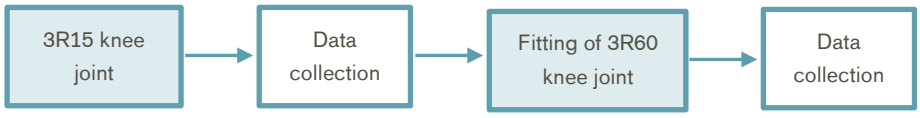
Figure 1. Patient Satisfaction measured by SATPRO for 3R60 compared to 3R15; * indicates a significant difference ($p<0.05$).

Population

Subjects:	10 amputees
Amputation level:	unilateral transfemoral
Previous prosthesis:	mechanic knee joint (3R15) and dynamic foot (1D10)
Amputation cause:	trauma (traffic accident)
Mean age:	22.7 ± 9.4 years
Mean time since amputation:	2.7 ± 0.8 years
MFCL:	n.r. (MOBIS 3)

Study Design

Before-after study design:



Subjects were first assessed while using their existing prosthesis with a mechanical 3R15 knee joint. Following fitting of a new prosthesis incorporating a hydraulic 3R60 knee joint and completion of routine gait training, participants were reassessed using the same outcome measures. Gait analysis was performed using

the Biodex Gait Trainer 2, and energy expenditure was evaluated using the 6-minute walk test.

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** 3R15 (mechanic)	Results** 3R60 (hydraulic)	Sig.*
Level Walking	Velocity and gait cycle increased, while step inequality decreased with the use of 3R60. Weight bearing on the amputated side and ambulation index increased with 3R60			
	Velocity [m/s]	0.7 ± 0.2	**0.8 ± 0.02**	++
	Gait cycle [s]	0.6 ± 0.02	**0.7 ± 0.02**	++
	Step Inequality [cm]	4.5 ± 3.0	**2.6 ± 1.7**	––
	Weight bearing on amputated side [%]	45.3 ± 1.9	**47.2 ± 3.4**	++
	Ambulation index score [0-100]	72.5 ± 3.2	**82.3 ± 4.9**	++
Metabolic Energy Consumption	Physiological Cost Index was lower with the 3R60.			
	Physiological Cost Index [beats/min]	34.9 ± 8.8	**27.8 ± 7.6**	––
Activity, Mobility, Activities of Daily Living (ADLs)	Ambulation activities were completed faster when using 3R60.			
	Sit down on a chair [s]	36.4 ± 8.0	31.4 ± 2.2	–
	Stand up from a chair [s]	32.8 ± 8.1	**28.1 ± 5.7**	––
	Descending stairs [s]	15.5 ± 1.7	**12.1 ± 1.2**	––
	Ascending stairs [s]	17.3 ± 1.3	**14.3 ± 0.9**	––
	Descending slopes [s]	19.6 ± 1.3	**12.9 ± 1.2**	––
	Ascending slopes [s]	21.0 ± 1.2	**13.3 ± 0.9**	––
	Walking over obstacles [s]	2.3 ± 0.7	**1.1 ± 0.3**	––
Safety	Patients could stay balanced much longer and had higher scores with the 3R60.			
	Berg Balance scale [0-56]	21.0 ± 7.4	**49.0 ± 9.9**	++
Preference, Satisfaction, Quality of Life (QoL)	Subjects felt much more comfortable with 3R60 regarding comfort, cosmetic appearance and functionality.			
	Patient Satisfaction (SATPRO) [0-45]	24.4 ± 4.9	**38.7 ± 4.4**	++
	The quality of life did not show any differences between the two prostheses, except for less pain with the 3R60. The total score of the Nottingham Health Profile was lower for 3R60.			
	Nottingham Health Profile Energy Level [0-100]	19.8 ± 8.4	8.7 ± 4.6	0
	Pain [0-100]	14.2 ± 4.9	**5.1 ± 3.0**	––

Category	Outcomes	Results**		Sig.*
		3R15 (mechanic)	3R60 (hydraulic)	
	Emotional Reaction [0-100]	10.2 ± 5.6	8.2 ± 3.6	0
	Sleep [0-100]	10.6 ± 5.6	0.0 ± 0.0	0
	Social Isolation [0-100]	18.4 ± 8.4	17.8 ± 6.6	0
	Physical Abilities [0-100]	17.9 ± 6.1	12.1 ± 6.0	0
	Total Score [0-600]	91.1 ± 28.6	**51.9 ± 12.5**	––

* no difference (0), positive trend (+), negative trend (–), significant (++/––), not applicable (n.a.)
significance set at $p<0.05$; trends set at $0.1>p>0.05$;
** all Values are given as Mean ± Standard deviation; KJ: Knee Joint;
bold values indicate significant improvement;

Author's Conclusion

"In conclusion, we assumed that our results were parallel with the relevant literature and may stimulate interest in conducting further work in the field of prosthetic training. We thought that our study which evidences that proper selection of prosthetic components according to the patients functional level has positive effects on quality of life, gait pattern and energy expenditure, may outline a framework for a further guideline designed to describe prosthetic prescription for both private and governmental insurance systems in Turkey." (Ülger et al., 2009)

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