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Effect of smart artificial leg on gait with transfemoral amputee

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Objective

The purpose of this study was to evaluate the gait abilities by applying a Smart artificial leg(power leg®) to the bilateral femoral amputee.

Subject & Methods

The subject was 48-year-old man who had weared Hydraulic artificial leg(3R80®, Ottobock®) with bilateral transfemoral amputation due to a industrial accident in september 2014. In this study, we compared the gait abilities with 3R80® and power leg® for one patient who has bilateral femoral amputation. The 3R80® is rotary hydraulic, Power leg® is a new Electronic artificial leg that recognizes bio-signals and walking intention through equipped sensor. He walked for 5 minutes at 1.5km/h after wearing each artificial leg. They were evaluated by using the foot pressure analyzer in the form of a treadmill(Zebris FDM®; Zebris Medical GmbH®, Germany) and respiratory gas analyzer(Cosmed K4B2®, Italy).

Results

The analysis of gait abilities showed that the power leg® had more symmetrical gait in the items of ankle rotation, step length, stance, double stance, and butterfly paragram between both limbs than the 3R80®(Table 1, Figure 1). The energy consumption analysis showed that the power leg® was superior in VO2/kg(oxygen consumption), VCO2/kg(carbon dioxide emission) and HR(heart rate) than the 3R80®(Table 2).

Conclusion

In this study, we analyzed the gait abilities between 3R80® and power leg®. We measured the foot pressure and energy consumption with each artificial leg. This Result showed power leg® is more symmetrical and superior in energy consumption than 3R80. We expect that this Result will be used as a data for the improvement of the artificial leg.

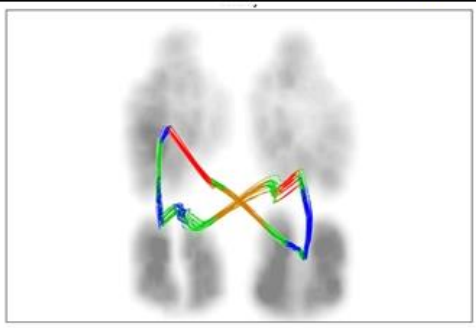
Table 1. Foot Pressure analysis of 3R80 and Power Leg

	Hydraulic artificial leg (3R80®)		Smart artificial leg (Power Leg®)	
	Lt.	Rt.	Lt.	Rt.
Foot rotation, (degree)	-1.6 ± 0.9	5.4 ± 0.9	-0.1 ± 0.9	1.9 ± 0.8
Stride length, (cm)	77 ± 2		84 ± 2	
Step length, (cm)	31 ± 2	45 ± 1	39 ± 1	45 ± 1
Step width, (cm)	28 ± 1		27 ± 1	
Stance phase, (%)	69.1±0.8	72.2±0.5	68.4±2.0	67.9±1.4
Load response, (%)	22.7±0.6	18.6±0.7	19.3±0.6	16.9±2.4
Mid stance, (%)	27.8±0.6	30.9±0.8	32.0±1.3	31.7±2.2
Pre-Swing, (%)	18.6±0.7	22.7±0.7	17.0±2.4	19.4±0.7
Swing phase, (%)	30.9±0.8	27.8±0.5	31.6±2.0	32.1±1.4
Double stance phase, (%)	41.3±1.0		36.3±2.4	

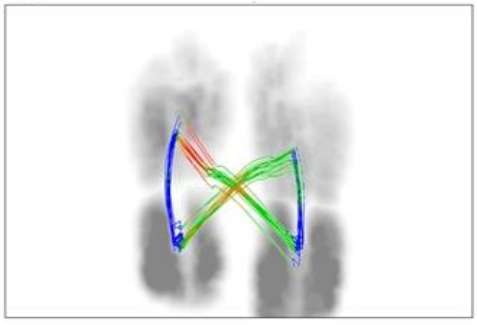
Table 2. Energy Consumption of 3R80 and Power Leg

	Rest	3R80®	Power Leg®	Reduction ratio
VO_2/Kg (ml/kg/min)	4.6	17.3	16.1	- 7%
VCO_2/Kg (l/min)	5.4	16.7	14.6	- 13%
HR (BPM)	92.4	127.9	121.3	- 5%

Butterfly Paragram



Hydraulic Artificial leg (3R80®)



Smart Artificial leg (Power Leg®)

Figure 1. Butterfly Paragram of 3R80 and Power Leg