Limb Salvage Versus Transtibial Amputation: A Comparison of Functional Gait Outcomes

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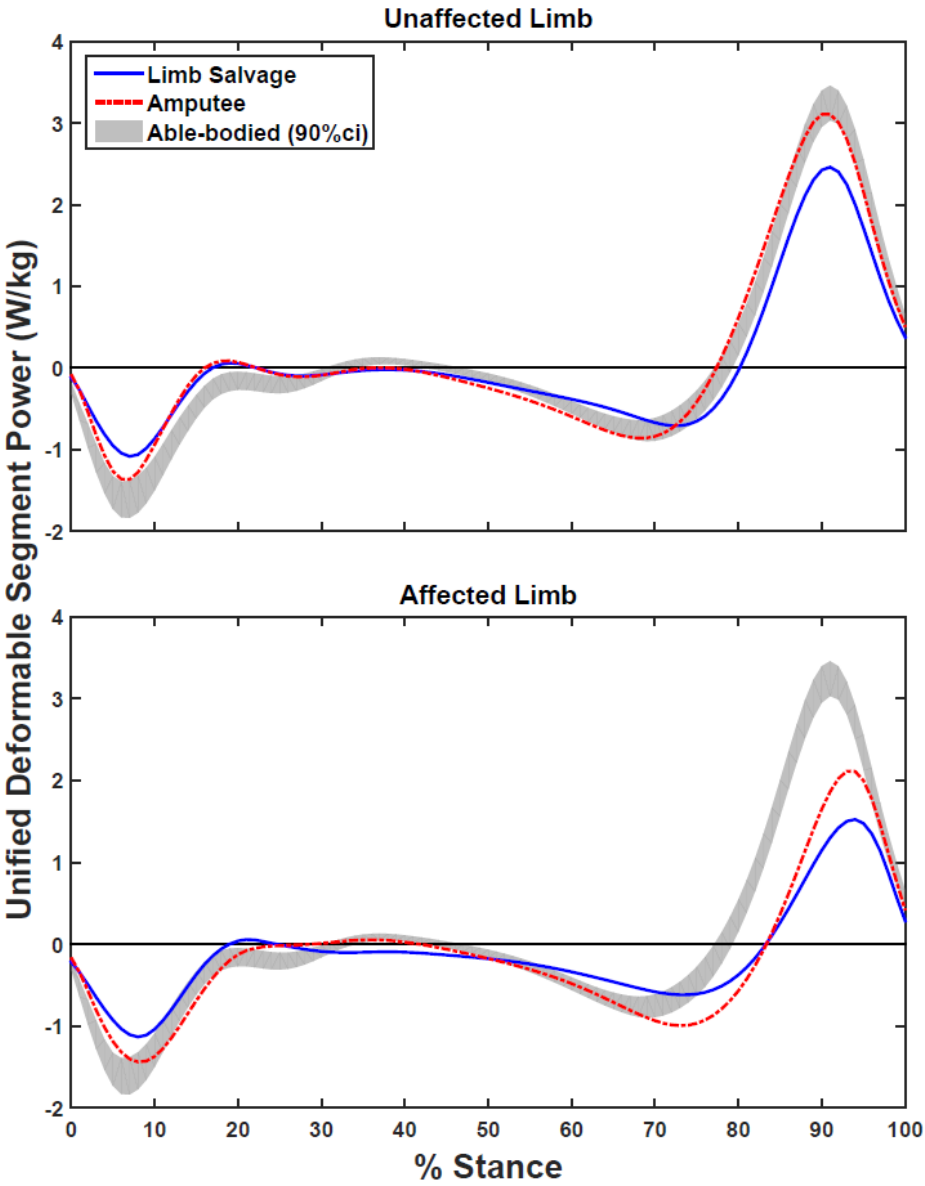
Background/Purpose: Several studies have compared outcomes of transtibial amputation patients and limb salvage patients with no clear advantage evident. With recent military conflicts resulting in significant numbers of lower extremity injuries, this debate has again come to the forefront. The recently developed Intrepid Dynamic Exoskeleton Orthosis (IDEO) has been shown to have superior functional results to other orthoses used with limb salvage. The purpose of this study is to determine if there is a difference in functional gait outcomes between patients with isolated traumatic below-knee single limb injuries treated with either a transtibial amputation or who use an IDEO and have undergone limb salvage procedures.

Methods: 24 IDEO and 99 transtibial amputation patients were studied in our instrumented gait lab from 2007 to 2014. Transtibial amputation patients with a gait study completed between 6 months and 1 year after walking without assistive devices were included, while IDEO patients were included if they had completed the "Return to Run" training program. Ten patients with amputations were matched by body mass index to the ten limb salvage patients. These two groups were then compared in regards to demographics and injury characteristics. Three-dimensional gait analysis data were collected with a 12-camera Motion Analysis Corporation system. Temporal spatial, kinetic (vertical ground reaction force), unified deformable (UD) power, work, and efficiency during walking at a self-selected speed were evaluated. A paired t test of the differences was utilized for statistical analysis.

Results: There were no significant differences between IDEO and amputation patients in regard to demographics or injury characteristics. IDEO patients walked with a significantly slower cadence ($P = 0.036$), spent less time on their affected limb in stance ($P = 0.045$), and more time in swing ($P = 0.019$) compared to transtibial amputation patients. Transtibial amputation patients and IDEO patients did not have significantly different vertical ground reaction forces. Transtibial amputation patients had significantly increased maximum positive power in the affected ($P = 0.004$) and unaffected ($P = 0.029$) limbs along with increased maximum negative power on the unaffected limb ($P = 0.035$) compared to the IDEO patients. There was significantly increased positive and negative work in the affected limb of amputation patients ($P = 0.0009$ and $P = 0.014$) and positive work in the unaffected limb ($P = 0.042$). There was no significant difference in the efficiency between the groups in either the affected or unaffected limb ($P = 0.174$).

Conclusion: Analysis of temporal spatial gait data showed statistically significant decreases in cadence, as well as diminished stance and increased swing times on the affected limb, consistent with a more antalgic gait pattern in IDEO patients. The UD power analysis demonstrated a more dynamic gait in transtibial amputation patients, with minimum and maximum peak values more closely resembling that of normative data. Thus in our sample of ten matched patients, those with a prosthesis had more dynamic functional outcomes compared to IDEO patients.

See pages 47 - 108 for financial disclosure information.



The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Table 1. Temporal spatial gait parameters.

Parameter	Limb Salvage	Transtibial Amputation	*P*
Velocity (cm/sec)	1.26 ± 0.16	1.36 ± 0.10	0.071
Cadence (steps/sec)	104.72 ± 4.76	110.44 ± 6.86	**0.036**
Stride width (cm)	0.13 ± 0.03	0.12 ± 0.03	0.514
Stance time Aff (% gait cycle)	0.60 ± 0.01	0.61 ± 0.01	**0.045**
Stance time Un(% gait cycle)	0.63 ± 0.01	0.64 ± 0.02	0.696
Swing time Aff (% gait cycle)	0.40 ± 0.01	0.39 ± 0.01	**0.019**
Swing time Un (% gait cycle)	0.37 ± 0.01	0.37 ± 0.02	0.854
Stride length Aff (cm)	1.44 ± 0.14	1.48 ± 0.09	0.457
Stride length Un (cm)	1.44 ± 0.13	1.49 ± 0.09	0.340
Step length Aff (cm)	0.72 ± 0.07	0.76 ± 0.05	0.172
Step length Un (cm)	0.72 ± 0.07	0.72 ± 0.04	0.894

Aff: affected extremity, Un: unaffected extremity.

Table 2.Unified deformable segment power generation.

Segment power (W/kg)	Limb Salvage	Transtibial Amputation	*P*
Aff Max Positive	1.53 ± 0.38	2.14 ± 0.41	**0.004**
Un Max Positive	2.49 ± 0.53	3.21 ± 0.54	**0.029**
Aff Max Neg MS	-1.16 ± 0.37	-1.49 ± 0.55	0.128
Un Max Neg MS	-1.10 ± 0.31	-1.51 ± 0.59	**0.035**
Aff Max Neg LS	-0.64 ± 0.39	-1.04 ± 0.20	**0.005**
Un Max Neg LS	-0.77 ± 0.22	-0.90 ± 0.10	0.181

Aff: affected extremity, Un: unaffected extremity, Neg: negative, MS: mid-stance, LS: late stance.

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