ONE-FOOT VERTICAL JUMP WITH APPROACH IN UNILATERAL TRANSTIBIAL AMPUTEES

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INTRODUCTION

Jumping is a key skill in many team sports and sporting situations, for example a jump shot in basketball, a block in volleyball, an interception in netball or basketball and a jump in football are all common maneuvers in sport and recreation. While many types of jump (countermovement, approach, static etc) have been researched in some way for non-disabled performers [1,2] there is little evidence of research into the mechanisms, compensations and alterations made by disabled performers in similar situations. An understanding of the biomechanics of amputee jumping and the identification of the compensatory mechanisms employed by amputees to achieve controlled flight is justified.

The aim of the study was to assess the biomechanical technique used by transtibial amputees to reach maximum flight height in a 1-footed vertical jump with an approach from the sound and prosthetic sides. Through this assessment, alterations to jump biomechanics could be identified and compensatory mechanisms detailed.

METHODS

Three male transtibial amputees were asked to perform maximal one-legged vertical jump with approach from their right and left limbs. Of the three, only two were comfortable completing the task and achieving height from the prosthetic side. One participant withdrew from the research. Both remaining participants were traumatic left-sided amputees and were healthy and active and free of musculoskeletal injuries. Participant one (P-1) had a mass of 69kg and height of 1.78m. The amputation had taken place 8 years prior to testing. Participant two (P-2) had a mass of 81kg and height of 1.77m. The amputation had taken place 12 years to testing. For the motion capture, a seven camera VICON 512 retro-reflective motion analysis system was used. The cameras were operating at a frequency of 120Hz. Thirty-three retro-reflective markers were placed with tape on the head, trunk, arms and legs. One-foot vertical jumps with an approach were analysed. The participants took a 2-3 step approach followed by a take off from the sound limb or the prosthetic limb. The instruction to the participants was simply to jump as high as possible.

Both participants warmed up for about ten minutes prior to data collection and they were allowed sufficient time to practice the jumps. At least 3 practice attempts were taken. Each participant then performed three jumps of each type and the best jump, defined by maximum height of the Centre of Mass (CoM) was selected for further analysis.

RESULTS AND DISCUSSION

Outcome results for the subjects are presented in Table 1.

Table 1 Outcome results for jump with approach

	Participant 1			Participant 2		
	Sound	Pros	*Diff*	Sound	Pros	*Diff*
Max Height of CoM (m)	1.39	1.26	*0.13*	1.32	1.20	*0.12*
Flight Height of CoM (m)	0.19	0.10	*0.17*	0.17	0.15	*0.02*
Height of CoM @ TO (m)	1.20	1.16	*0.04*	1.15	1.05	*0.1*
Vv of CoM @ TO (m/s)	2.0	1.36	*0.64*	1.80	1.52	*0.28*
Min Height of CoM (m)	0.81	0.98	*0.17*	0.75	0.89	*0.14*
Last step length (cm)	31	14	*17*	61	47	*14*
Vy of CoM at end of approach (m/s)	0.51	0.20	*0.31*	1.13	0.80	*0.33*

For both participants the maximum height achieved was reduced on the prosthetic side compared to the sound side. For P-1 the flight height from the prosthetic limb was substantially lower than that from the sound limb, while for P-2 the flight height was similar from both. This is due to the varied joint angles at take-off.

A key aspect in a jump with an approach is the approach itself. The length of the last step prior to the jump was asymmetrical for both participants and P-2 took a longer step than P-1 on both sides. For both participants the step was longer from the prosthesis onto the sound limb. The horizontal velocity is lower in both cases for P-1 than for P-2. This indicates that P-2 has greater horizontal momentum as he begins the jumping action. However, as P-2 does not jump as high as P-1 it is probable that he cannot make full use of this momentum.

Table 2 Temporal characteristics associated with the approach and take-off phases of the jump

	Participant 1		Participant 2	
	Sound	Pros	Sound	Pros
Final approach (s)	0.57	0.72	0.44	0.40
Countermovement (s)	0.89	0.37	0.89	0.56
Push-off (s)	0.3	0.23	0.48	0.2

The timing of the phases for the jump was asymmetrical for both participants and different between the amputees. For both amputees the jump on the sound side took longer than on the prosthetic side, mainly due to the extended countermovement and push-off phases.

REFERENCES

1. Van Soest AJ et al *Med Sci Sports Exerc,*, **17**, 635-639 1985.
2. Aragon-Vargas LF *Journal of Applied Biomechanics*, **13**, 24-44 1997.