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A Biomechanical Study of Arm Sling Design for People with Brachial Plexus Injury (Part 2: Comparison of Customized and MDesign Arm Sling)

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ABSTRACT

Extended from the previous report, this report examined the differences the customized arm sling and MDesign arm sling in terms of stride characteristics such as speed, cadence and stride length as well as joint kinematics such as wrist angles, thorax angles and pelvis angles during walking and running trials. The results showed that the customized arm sling and the MDesign arm sling achieved similar performances and stability, with the MDesign arm sling showing slightly reduced joint angles at the wrist, thorax and pelvis.

INTRODUCTION

The aim of this experiment was to examine the differences between the customized arm sling and the MDesign arm sling in terms of stride characteristics such as speed, cadence and stride length as well as joint kinematics such as wrist angles, thorax angles and pelvis angles during walking and running trials. We hypothesized that the subject with the customized arm sling and the Mdesign arm sling would have similar performances in stride characteristics and arm stability during both walking and running trials.

METHODS

A subject with right brachial plexus injury was recruited. The subject's age, height, weight and anthropometric data were measured prior to the gait analysis. The subject was instructed to complete 5 normal walking trials and 5 running trials, across a 9m walkway. Kinematic data was synchronously collected at 100 Hz using an 8-camera Vicon motion analysis system (Nexus 1.8, Vicon, UK). Passive reflective markers were secured to the upper and lower extremities, according to the Plug-In-Gait marker set (Nexus 1.8, Vicon, UK). Joint kinematics (wrist angles, thorax angles and pelvis angles) were processed and analyzed. The data was normalized to 100% gait cycle (heel strike to heel strike). Stride characteristics were also determined from the subject during walking and running.

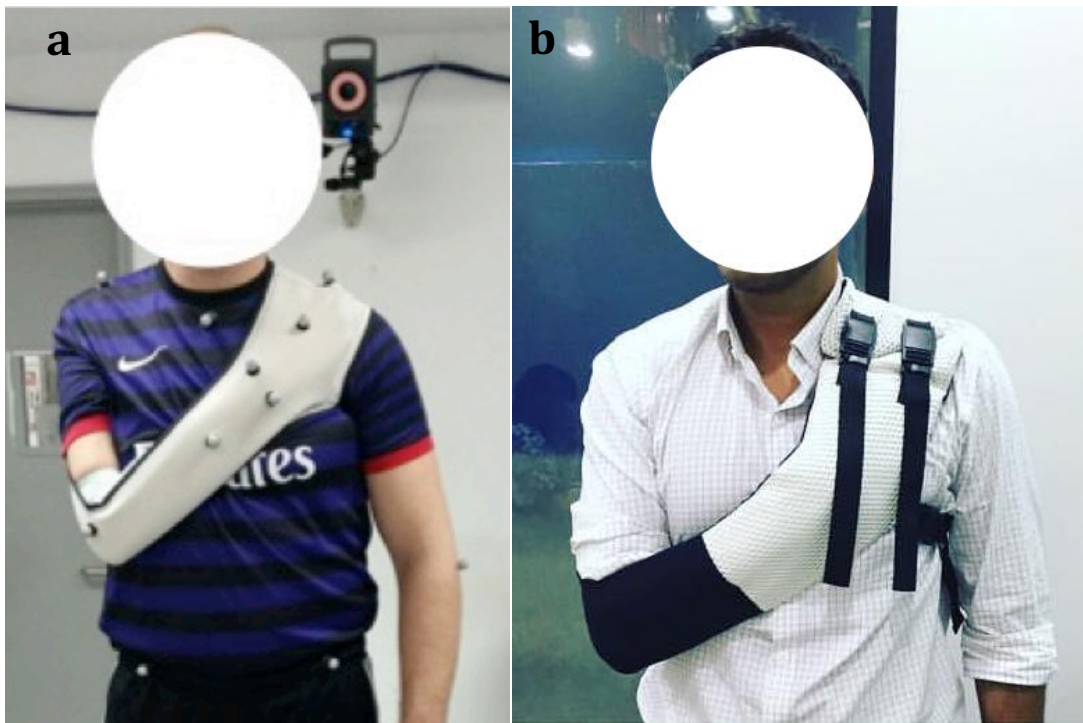


Figure 1: (a) Subject with the customized arm sling, (b) Subject with the MDesign arm sling.

RESULTS

Both customized and MDesign arm slings achieved similar performances:

- a) Similar in walking and running speed, cadence and stride length (Table 1)
- b) Similar thorax and pelvis peak internal (counter-clockwise) rotation angle during walking and running (Table 2, Figure 2)
- c) Similar wrist flexion/extension and pronation/supination range of motion (i.e. more stabilized) during walking and running (Table 3)

Table 1. Stride characteristics during walking and running.

Stride Characteristics		Customized	MDesign
		Mean±SD	Mean±SD
Speed (m/s)	Walking	1.33±0.03	1.25±0.04
	Running	2.40±0.06	2.30±0.07
Stride length (m)	Walking	1.35±0.03	1.36±0.04
	Running	1.86±0.09	1.93±0.01
Cadence (steps/min)	Walking	118.3±0.7	108.8±1.5
	Running	158.1±6.2	151.3±2.9

Table 2. Peak thorax and pelvis internal rotation angles during walking and running.

Joint Kinematics		Customized	MDesign
		Mean±SD	Mean±SD
Thorax peak internal rotation angle	Walking	8.27±0.95	5.86±0.29
	Running	18.27±1.45	14.83±1.37
Pelvic peak internal rotation angle	Walking	3.98±0.05	3.99±0.50
	Running	5.56±1.03	3.35±0.17

Table 3. Wrist joint range of motion.

Range of Motion		Customized	MDesign
		Mean±SD	Mean±SD
Flexion/Extension	Walking	2.45±0.40	2.37±0.40
	Running	8.68±2.20	7.93±0.30
Pronation/Supination	Walking	9.55±0.38	5.10±1.74
	Running	15.51±2.20	13.73±4.49

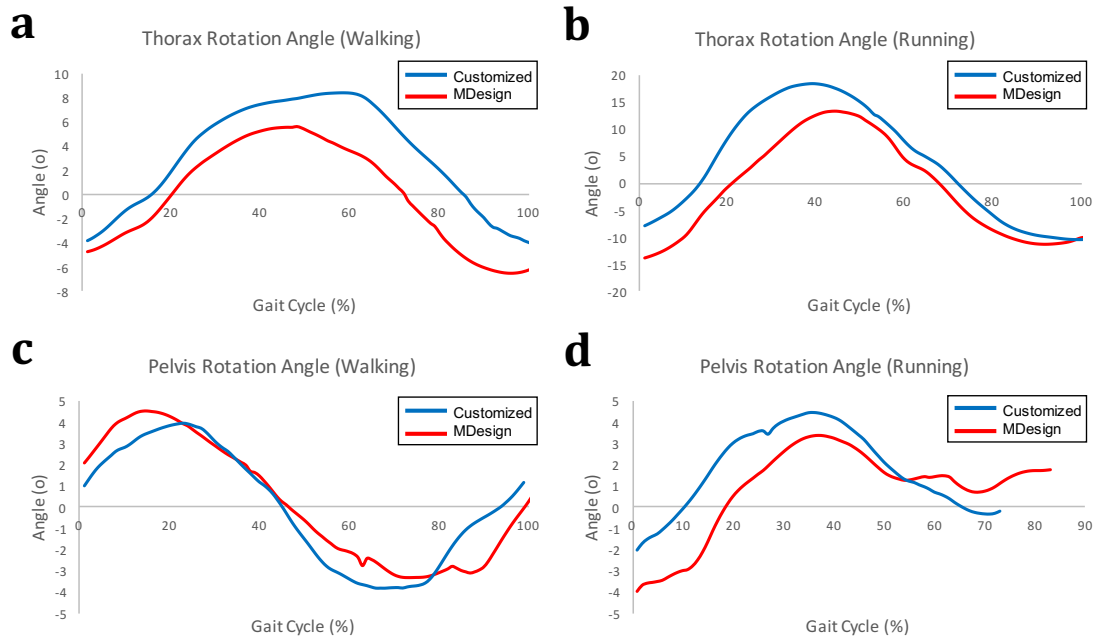


Figure 2: Thorax rotations during (a) walking, (b) running and pelvis rotations during (c) walking, (d) running. Positive angles of thorax and pelvis are internal rotations i.e. rotations to the left (counter-clockwise).