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Data Article

Inter-participant variability data in characterization of anthropomorphicity of prosthetic feet fitted to bone-anchored transtibial prosthesis

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ABSTRACT

The data in this paper are related to the research article entitled “Automated characterization of anthropomorphicity of prosthetic feet fitted to bone-anchored transtibial prosthesis” (Frossard et al., 2019: DOI: 10.1109/TBME.2019.2904713). This article contains the individual angles of dorsiflexion and bending moments generated while walking with transtibial bone-anchored prostheses including prosthetic feet with different index of anthropomorphicity. Inter-participant variability were presented for the (A) position of the load cell measuring directly to the bending moments, (B) patterns of angles of dorsiflexion and bending moment as well as moment-angle curves and (C) variations of magnitude of angles of dorsiflexion as well as the raw and bodyweight-normalized bending moments between toe contact and heel off. These initial inter-participant variability benchmark datasets are critical to design future automated algorithms and clinical trials. Online repository contains the files: https://eprints.qut.edu.au/127745/1/127745.pdf.

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Specifications table

Subject area	Biomechanics
More specific subject area	Gait analysis of individuals using lower limb prosthesis
Type of data	Graph, figure, table
How data was acquired	Three participants walked consecutively with two instrumented bone-anchored prostheses including their own prosthetic feet and Free-Flow foot (Ohio Willow Wood, US). Angle of dorsiflexion was extracted from video footage. Bending moment was recorded using multi-axis transducer attached to osseointegrated fixation.
Data format	Analyzed
Experimental factors	Angle of dorsiflexion and bending moment were time-normalized from 0 to 100% during the support phase
Experimental features	Participants fitted with transfemoral bone-anchored prostheses, including a connector, a transducer attached with pyramidal adaptors, a pylon, either their own or Free-Flow prosthetic foot, were asked to perform five trials of level walking in straight-line on a 5-m walkway at self-selected comfortable pace.
Data source location	Brisbane, Australia, Queensland University of Technology
Data accessibility	Data is with this article. Transparency data associated with this article can be found in the online version at https://eprints.qut.edu.au/127745/1/127745.pdf
Related research article	Frossard, L., B. Leech, and M. Pitkin, Automated characterization of anthropomorphicity of prosthetic feet fitted to bone-anchored transtibial prosthesis. IEEE Trans Biomed Eng, 2019. IEEExplore (DOI: 10.1109/TBME.2019.2904713). p. 1–9 [1].

Value of the data

- The individual data includes the angles of dorsiflexion and bending moments generated while walking with transtibial bone-anchored prostheses including prosthetic feet with different index of anthropomorphicity. This information provides valuable insight into inter-participants variability in variables characterizing feet stiffness.
- The individual data presented here that were collected for the first time on individuals fitted with transtibial bone-anchored prostheses constitute an initial benchmark of angles of dorsiflexion and bending moments. This baseline information could be used in future meta-analyses and/or comparative studies involving other cohorts of individuals fitted with transtibial bone-anchored or socket-suspended prostheses, respectively.
- The inter-participant variability of angles of dorsiflexion and bending moments is critical to assist the design of algorithms capable to quantify automatically the anthropomorphycity of prosthetic feet. This will greatly facilitate processing large datasets relying on on-board inertial motion sensors to determine angle of dorsiflexion and embedded load cell to measure directly bending moments.
- The inter-participant variability of angles of dorsiflexion and bending moments provided here can educate the design of subsequent clinical trials testing different types of prosthetic feet. For instance, the ranges of differences between the usual and Free-Flow feet can informed the calculation of sample size required to achieve sufficient statistical power during analytical planning stage.

1. Data

Fig. 1 illustrates inter-participant variability in position of the tri-axial transducer (iPecLab, RTC, US) measuring directly the bending moment in relation the ankle joint that was embedded in the instrumented transtibial bone-anchored prosthesis fitted with Free-Flow Foot.

Fig. 2 provides the inter-participant variability of the mean and standard deviation patterns over time of angle of dorsiflexion and bending moment as well as moment-angle curves of bespoke usual (i.e., RUSH, Trias, Triton) and Free-Flow feet fitted to transtibial bone-anchored prostheses.

Table 1 shows inter-participant variability and difference of mean and standard deviation of magnitude of angle of dorsiflexion as well as variation in raw and bodyweight-normalized bending moment between toe contact and heel off of bespoke usual and Free-Flow feet fitted to transtibial bone-anchored prostheses.

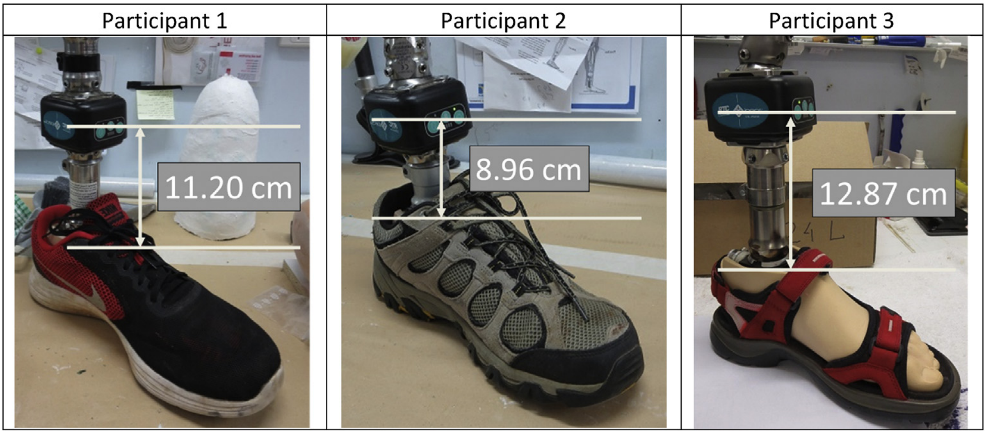

Fig. 1. Inter-participant variability in position of the tri-axial transducer (iPecLab, RTC, US) in relation to the ankle joint embedded in the instrumented transtibial bone-anchored prosthesis fitted with Free-Flow Foot (Ohio Willow Wood).

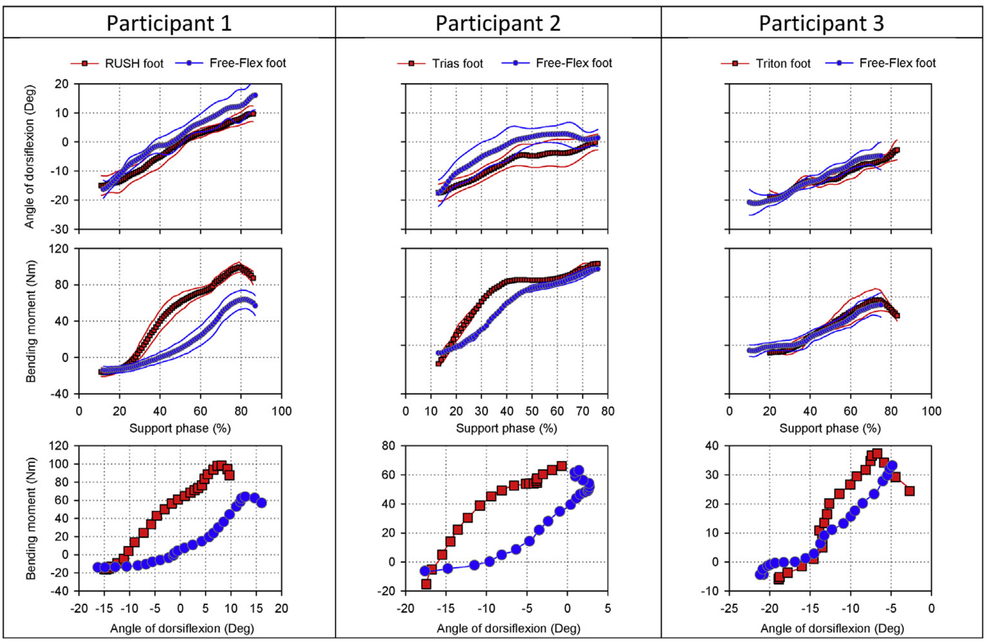

Fig. 2. Inter-participant variability of the mean and standard deviation patterns of angle of dorsiflexionand bending moment as well as moment-angle curves of bespoke usual (i.e., RUSH, Trias, Triton) and Free-Flow feet fitted to transtibial bone-anchored prostheses.

Table 1
Inter-participant variability and difference of mean and standard deviation of magnitude of angle of dorsiflexion and raw and bodyweight-normalized bending moment at and between toe contact (TC) and heel off (HO) of bespoke usual and Free-Flow feet fitted to transtibial bone-anchored prostheses (N: Number of gait cycles, H: High PV, L: Low PV, A: Above MCID, B: Below MCID).

Usual foot	Participant 1		Participant 2		Participant 3	
	(N = 5)		(N = 5)		(N = 4)	
Angle of dorsiflexion (Deg)						
At TC	−15.84 ± 2.49	L	−17.32 ± 3.24	L	−19.62 ± 1.28	L
At HO	10.01 ± 2.91	H	−0.08 ± 3.58	H	−3.02 ± 3.07	H
Between TC and HO	25.85 ± 3.89	L	17.24 ± 4.55	H	16.60 ± 2.30	L
Bending moment (Nm)						
At TC	−12.55 ± 4.47	H	−7.45 ± 8.38	H	−5.97 ± 1.24	H
At HO	90.61 ± 10.81	L	66.86 ± 1.35	L	28.65 ± 3.08	L
Between TC and HO	103.16 ± 12.57	L	74.31 ± 8.60	L	34.62 ± 3.24	L
Bending moment (%BWm)						
At TC	−1.17 ± 0.42	H	−0.93 ± 1.04	H	−1.02 ± 0.21	H
At HO	8.46 ± 1.01	L	8.34 ± 0.17	L	4.91 ± 0.53	L
Between TC and HO	9.64 ± 1.17	L	9.27 ± 1.07	L	5.93 ± 0.56	L
Free-Flow foot	(N = 5)		(N = 4)		(N = 5)	
Angle of dorsiflexion (Deg)						
At TC	−16.90 ± 1.76	L	−17.84 ± 4.57	H	−22.71 ± 2.45	L
At HO	16.46 ± 4.57	H	2.60 ± 4.53	H	−2.57 ± 3.40	H
Between TC and HO	33.36 ± 3.43	L	20.44 ± 2.43	L	20.14 ± 5.18	H
Bending moment (Nm)						
At TC	−13.49 ± 0.38	L	−6.29 ± 0.21	L	−4.14 ± 4.58	H
At HO	52.59 ± 12.10	H	50.05 ± 9.24	L	38.69 ± 2.07	L
Between TC and HO	66.07 ± 11.73	L	56.33 ± 9.26	L	42.83 ± 6.22	L
Bending moment (%BWm)						
At TC	−1.26 ± 0.04	L	−0.78 ± 0.03	L	−0.71 ± 0.78	H
At HO	4.91 ± 1.13	H	6.24 ± 1.15	L	6.63 ± 0.35	L
Between TC and HO	6.17 ± 1.10	L	7.03 ± 1.15	L	7.34 ± 1.07	L
Difference (Free-Flow foot-Usual foot)						
Angle of dorsiflexion (Deg)						
At TC	−1.05	B	−0.52	B	−3.09	A
At HO	6.45	A	2.67	A	0.45	A
Between TC and HO	7.51	A	3.20	A	3.54	A
Bending moment (Nm)						
At TC	−0.93	B	1.17	A	1.83	A
At HO	−38.02	A	−16.81	A	10.04	A
Between TC and HO	−37.09	A	−17.97	A	8.21	A
Bending moment (%BWm)						
At TC	−1.05	B	−0.52	A	−3.09	A
At HO	6.45	A	2.67	A	0.45	A
Between TC and HO	7.51	A	3.20	A	3.54	A

2. Experimental design, materials, and methods

2.1. Gait

Participants were fitted with transtibial bone-anchored prostheses including with their own or Free-Flow prosthetic foot and performed five trials of level walking in straight-line on a 5-m walkway at self-selected comfortable pace [2].

2.2. Detection of gait events

Heel contact, toe contact, heel off and toe off events were detected manually using displacements of heel and toe of prosthetic foot as well as loading profile on the long axis. Angle of dorsiflexion and bending moment were time-normalized from 0 to 100% over the support phase of each gait cycle [3].

2.3. Angle of dorsiflexion

Raw video footage obtained with a digital camera (25 Hz) were imported into a motion analysis software package (Kinovea) allowing manual selection of the angle of dorsiflexion corresponding to the projected angle in sagittal plane between the long axes of leg and foot intersecting at the ankle joint for each frame of the support phase with accuracy of approximately 2 Deg. [4–7].

2.4. Bending moment

The raw bending moment was recorded directly using a portable kinetic system (iPecsLab, RTC, US) including a tri-axial transducer sending wirelessly moment (200 Hz) applied on the fixation to a receiver connected to a laptop nearby with an accuracy better than 1 Nm [2,3,8–14]. The raw bending moments were imported into a Matlab program and offset according to load yielded during calibration before being expressed in Nm and percentage of bodyweight (%BWm).

2.5. Variability

Individual or intra-variability of angles of dorsiflexion and bending moments was determined using the percentage of variation (PV = absolute [[standard deviation/mean] ×100]). We considered than a PV inferior or superior to 20% indicated a low (L) or high (H) variability, respectively [2].

2.6. Minimum clinically important difference

The differences in angles of dorsiflexion and bending moments between feet were determined so that a positive difference indicated that Free-Flow foot was algebraically larger than usual foot. We considered that a difference inferior or superior to 10% was below (B) or above (A) a minimum clinically important difference (MCID), respectively [15].

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Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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