

Identification of secondary biomechanical abnormalities in the lower limb joints after chronic transtibial amputation: A proof of concept study using SPM1D analysis

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Demographic Data

Table S1. Group baseline demographic, clinical and locomotor characteristics of sample (n=12).

Baseline Characteristics	Value
Age (years) ^a	46.8 ± 14.6
Range	(26 - 73)
Gender n (%)	
- Male	12 (100%)
Race n (%)	
- Chinese	6 (50%)
- Malay	3 (25%)
- Indian	1 (8.3%)
- Eurasian	1 (8.3%)
- Caucasian	1 (8.3%)
Duration post event at study enrolment, days ^a	2982 ± 2955.2
Range	(906 - 9820)
Diagnoses	
- Transtibial amputation (below knee)	12 (100%)
Side of amputation	
- Right	8 (66.7%)
- Left	4 (33.3%)
Nature	
- Traumatic	9 (75%)
- Peripheral vascular disease (Diabetes Mellitus)	2 (16.7%)
- Others (congenital absence)	1 (8.33%)
Gait Speed (m/s) ^{a,b}	1.43 ± 0.26
Range	(1 - 1.85)
Distance walked (m) ^{a,c}	394.3 ± 57.8
Range	(312 - 500)
AMPPRO ^d /47 ^a	45.5 ± 1.24
Range	(42 - 46)
K level ^e	
- K3	1 (8.33%)
- K4	11 (91.7%)
Walking aid n (%)	
- No	12 (100%)

Legend:.

^avalues presented as Mean ± SD.

^bDetermined using the 10-metre walk test (10 MWT).

^cDetermined using the 6-minute walk test (6 MWT).

^dDetermined using the Amputee Mobility Predictor with prosthesis (AMPPRO).

^eK level: lower limb extremity prosthesis Medicare Functional Classification Levels.

Table S2. Individual baseline demographic, clinical and locomotor characteristics of sample (n=12).

Subject	Age	Gender	Race	Gait Speed ^a (m/s)	Distance walked ^b (m)	AMPPRO ^c /47	K Level ^d (K0-4)	Side	Nature	Duration post amputation (days)
1	33	M	Malay	1.67	500	46	K4	R	Traumatic	1772
2	73	M	Chinese	1.0	369	44	K4	R	Peripheral vascular disease (DM) ^e	Not available
3	52	M	Malay	1.28	417	46	K4	R	Traumatic	1034
4	45	M	Caucasian	1.75	415	46	K4	L	Traumatic	2292
5	52	M	Eurasian	1.70	450	46	K4	L	Others	Not available
6	26	M	Chinese	1.85	410	46	K4	R	Traumatic	906
7	55	M	Malay	1.21	353	46	K4	R	Traumatic	1472
8	53	M	Chinese	1.51	335	46	K4	R	Traumatic	9820
9	28	M	Chinese	1.27	436	46	K4	L	Traumatic	2314
10	35	M	Indian	1.40	420	46	K4	R	Traumatic	Not available
11	66	M	Chinese	1.32	315	46	K4	R	Traumatic	4247
12	44	M	Chinese	1.21	312	42	K3	L	Peripheral vascular disease (DM) ^e	Not available

Legend:.

^a measured by 10 MWT :10-metre walk test.

^b measured by 6MWT: 6-minute walk test.

^c AMPPRO: Amputee Mobility Predictor.

^d K level: lower limb extremity prosthesis Medicare Functional Classification Levels.

^e DM: Diabetes Mellitus.

R: Right.

L : left.

Further plots of TTA patients versus control ref persons' recordings

In Supplementary Figure S1 and Supplementary Figure S2, we show the respective figures of main manuscript Figure 2 and Figure 3 after excluding the outlier person (# 6).

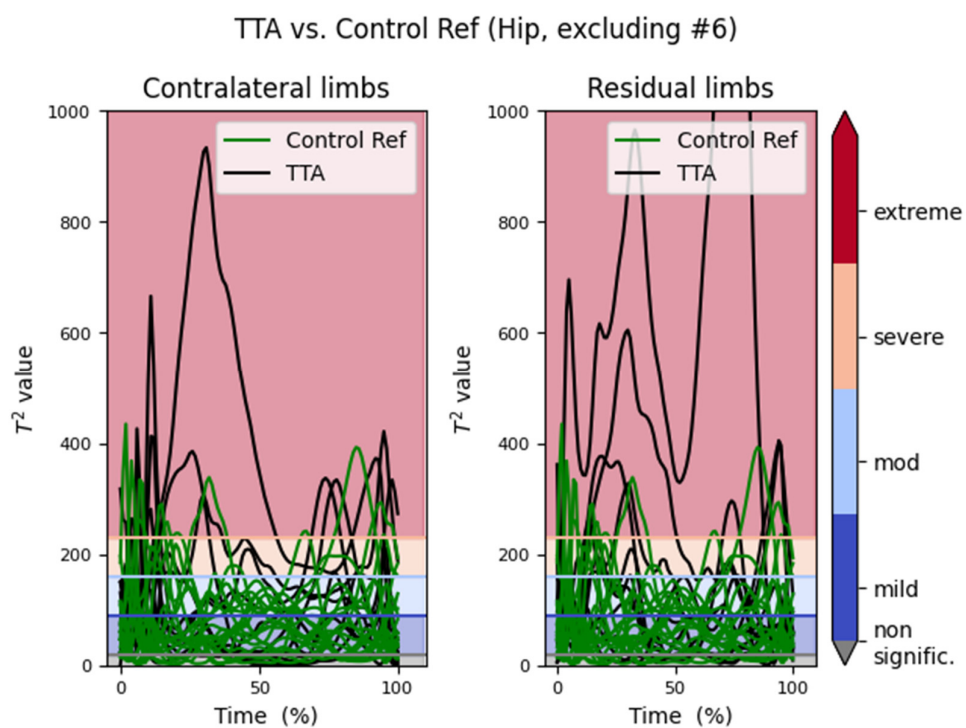


Figure S1. Transtibial Amputation patients recording vs Reference recordings of the hip joint, excluding patient # 6.

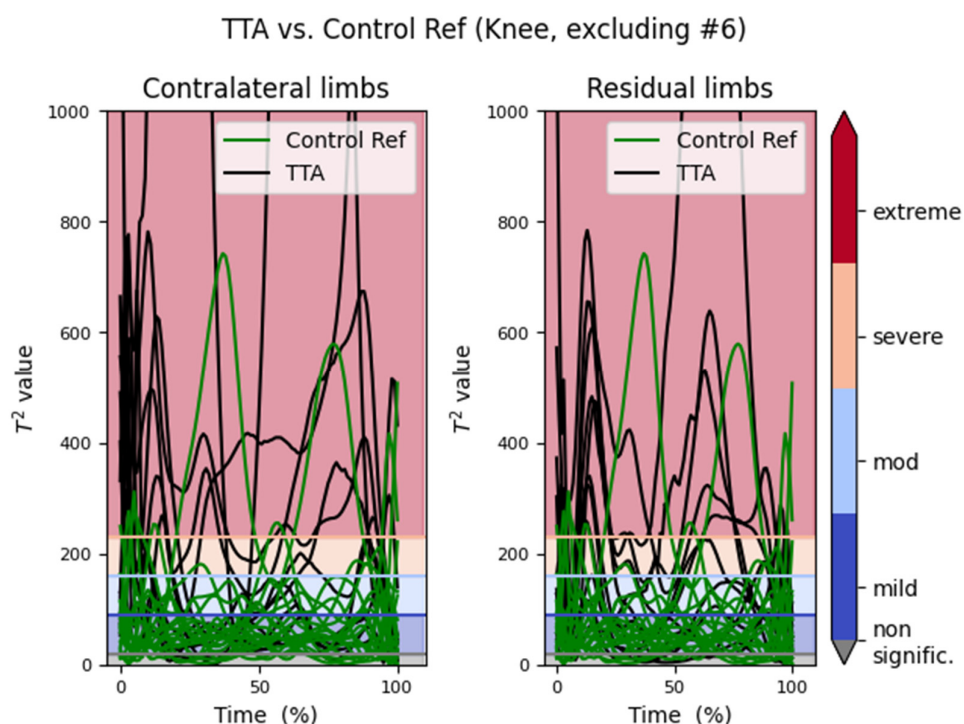


Figure S2. Transtibial Amputation patients recording vs Reference recordings of the knee joint, excluding patient # 6.

Differential analysis of deviations

To further analyze the results, we calculated the frequency of deviation per joint in our sample. In the following figures, we draw the histogram of deviation of the each TTA patients' joints. It is not logical to count the cases with very short and transient spikes as a case of severe deviation. Therefore, we considered 20% of the stance time to be the time threshold to consider a joint to be deviated. That is to say, if a joint has extreme deviation from the reference (shown as Red) for 25% of the time, it would be considered belonging to and will be counted with the category "Extreme". However, a joint that has extreme deviation (Red color) for only 5% of the time, severe deviation (Orange color) for 10% of the time and moderate deviation (Cyan color) for 10% of the time will be considered only moderate, because 20% of the time at least showed moderate deviation.

Looking to the contralateral limb in Supplementary Figure S3, the patients have either moderate (6 patients: 50%) or extreme (6 patients: 50%) deviations from the normative data set. All extreme deviations affect the contralateral knee, and they may or may not include other contralateral joints: 2 cases with isolated knee severe deviation, 2 cases with both Hip and knee and 2 cases with both knee and ankle.

However, in contrast, the situation in the residual limb (Supplementary Figure S4) showed that: 5 patients had extreme deviation in at least one joint. All of the 5 patients had extreme deviation in the hip and 3 thereof show extreme deviation in the knee as well.

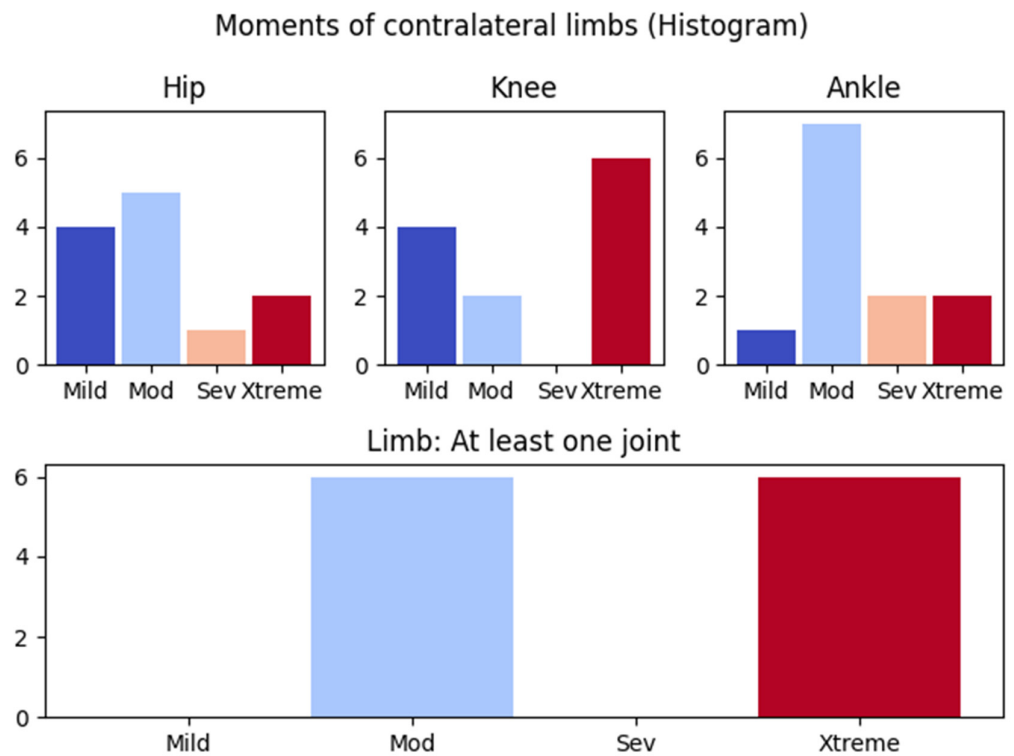


Figure S3. Histogram of deviation in TTA patients' contralateral limbs.

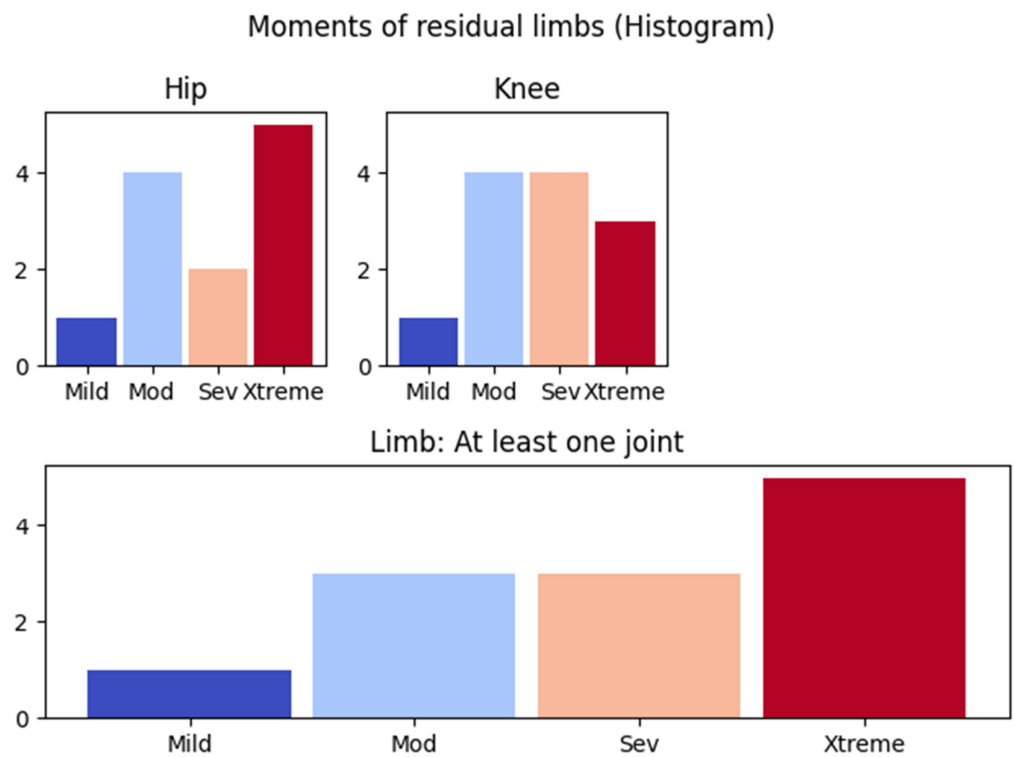


Figure S4. Histogram of deviation in TTA patients' residual limbs (no ankle joint).

Marker Placement
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Figure 1 displays the placement of 100 markers on a human skeleton, categorized by color and code. The markers are distributed across the head, torso, arms, legs, and feet. A legend indicates the marker type (1-8) and the corresponding color. The legend also includes a table for marker placement, listing markers for the Head, Thorax, Pelvis, and Limbs, along with their corresponding colors and codes.

Marker	Color	Code
HEAD	Red	B2
Thorax	Yellow	D3
Pelvis	Green	B3
Limbs	Blue	D5
Limbs	Dark Blue	B6
Limbs	Light Green	E4
Limbs	Green	D7
Limbs	Orange	B4
Limbs	Red	A4
Limbs	Yellow	C4
Limbs	Light Green	E7
Limbs	Blue	D6
Limbs	Dark Blue	B7
Limbs	Light Green	E8
Limbs	Green	D8
Limbs	Orange	B8
Limbs	Red	A8
Limbs	Yellow	C8
Limbs	Light Green	E9
Limbs	Blue	D9
Limbs	Dark Blue	B9
Limbs	Light Green	E10
Limbs	Green	D10
Limbs	Orange	B10
Limbs	Red	A10
Limbs	Yellow	C10
Limbs	Light Green	E11
Limbs	Blue	D11
Limbs	Dark Blue	B11
Limbs	Light Green	E12
Limbs	Green	D12
Limbs	Orange	B12
Limbs	Red	A12
Limbs	Yellow	C12
Limbs	Light Green	E13
Limbs	Blue	D13
Limbs	Dark Blue	B13
Limbs	Light Green	E14
Limbs	Green	D14
Limbs	Orange	B14
Limbs	Red	A14
Limbs	Yellow	C14
Limbs	Light Green	E15
Limbs	Blue	D15
Limbs	Dark Blue	B15
Limbs	Light Green	E16
Limbs	Green	D16
Limbs	Orange	B16
Limbs	Red	A16
Limbs	Yellow	C16
Limbs	Light Green	E17
Limbs	Blue	D17
Limbs	Dark Blue	B17
Limbs	Light Green	E18
Limbs	Green	D18
Limbs	Orange	B18
Limbs	Red	A18
Limbs	Yellow	C18
Limbs	Light Green	E19
Limbs	Blue	D19
Limbs	Dark Blue	B19
Limbs	Light Green	E20
Limbs	Green	D20
Limbs	Orange	B20
Limbs	Red	A20
Limbs	Yellow	C20
Limbs	Light Green	E21
Limbs	Blue	D21
Limbs	Dark Blue	B21
Limbs	Light Green	E22
Limbs	Green	D22
Limbs	Orange	B22
Limbs	Red	A22
Limbs	Yellow	C22
Limbs	Light Green	E23
Limbs	Blue	D23
Limbs	Dark Blue	B23
Limbs	Light Green	E24
Limbs	Green	D24
Limbs	Orange	B24
Limbs	Red	A24
Limbs	Yellow	C24
Limbs	Light Green	E25
Limbs	Blue	D25
Limbs	Dark Blue	B25
Limbs	Light Green	E26
Limbs	Green	D26
Limbs	Orange	B26
Limbs	Red	A26
Limbs	Yellow	C26
Limbs	Light Green	E27
Limbs	Blue	D27
Limbs	Dark Blue	B27
Limbs	Light Green	E28
Limbs	Green	D28
Limbs	Orange	B28
Limbs	Red	A28
Limbs	Yellow	C28
Limbs	Light Green	E29
Limbs	Blue	D29
Limbs	Dark Blue	B29
Limbs	Light Green	E30
Limbs	Green	D30
Limbs	Orange	B30
Limbs	Red	A30
Limbs	Yellow	C30
Limbs	Light Green	E31
Limbs	Blue	D31
Limbs	Dark Blue	B31
Limbs	Light Green	E32
Limbs	Green	D32
Limbs	Orange	B32
Limbs	Red	A32
Limbs	Yellow	C32
Limbs	Light Green	E33
Limbs	Blue	D33
Limbs	Dark Blue	B33
Limbs	Light Green	E34
Limbs	Green	D34
Limbs	Orange	B34
Limbs	Red	A34
Limbs	Yellow	C34
Limbs		

Figure S5. Marker Placement protocol.