Assessment of knee muscle performance in para-athletes with unilateral transtibial amputation

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INTRODUCTION & AIM

Unilateral transtibial amputation (TTA) can lead to persistent knee muscle deficits and inter-limb asymmetry (ILA) that may be velocity-dependent and differ between flexors and extensors. Quantifying velocity-specific torque deficits, ILA patterns, and H/Q balance in para-athletes supports strength profiling and interpretation using intact-limb reference values.
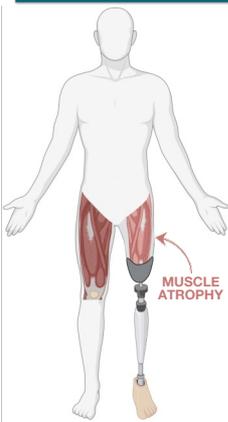
AIM

1. Quantify prosthetic-limb peak torque (PT) deficits across 60–300°·s⁻¹ (n=4)

2. Map velocity-dependent inter-limb asymmetry for knee flexion and extension (n=4)

3. Compare H/Q ratio between limbs to evaluate flexor–extensor balance (n=4)

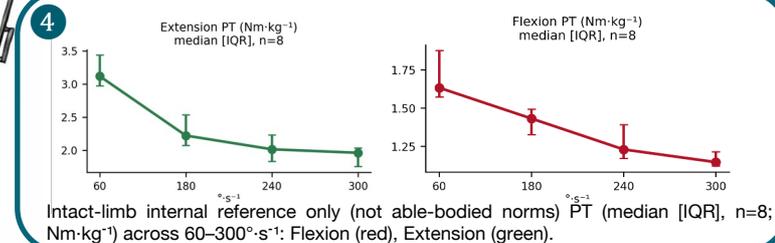4. Report intact-limb PT reference values to characterize the cohort (n=8; internal reference)
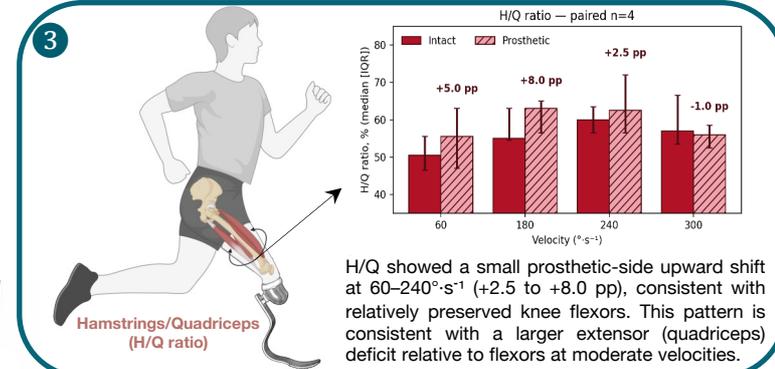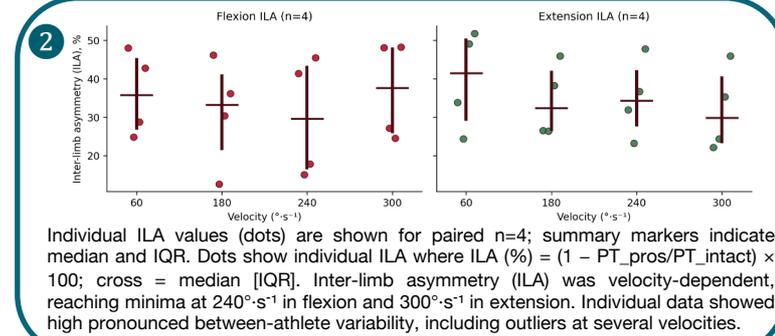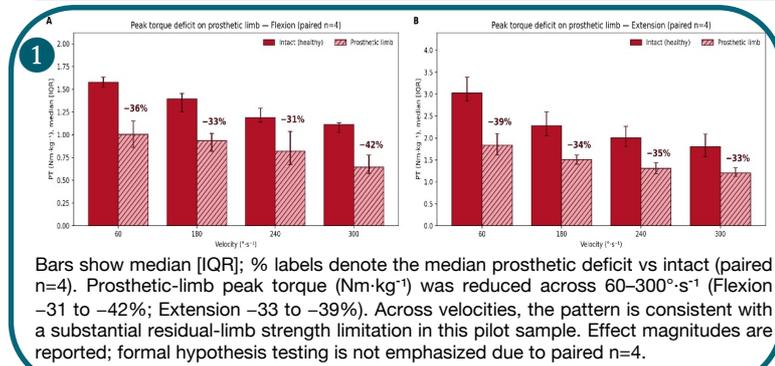
METHOD

Cohort snapshot

Competitive male para-athletes with unilateral TTA (C2-C4) n=8
Weight (no prosthesis): **68.9 ± 7.9** kg
Height: **172.9 ± 7.2**, BMI: **22.9 ± 1.9**
Tested 31.1±10.4 months post-amputation
Time from amputation to prosthetic gait initiation: **4.4 ± 1.5** months
Limitation: paired n=4 (pilot); descriptive, hypothesis-generating

MUSCLE ATROPHY

Pilot descriptive dataset for profiling and hypothesis generation. Eight athletes participated (intact limb tested in n=8; prosthetic limb testing available in n=4 for paired analysis). Concentric knee flexion/extension PT was assessed on an isokinetic dynamometer **(IsoMed 2000)** at **60/180/240/300°·s⁻¹** and normalized to body mass (Nm·kg⁻¹). The intact limb served for within-subject comparisons (paired n=4) and as an internal cohort reference (n=8; not able-bodied norms).

RESULTS & DISCUSSION

Bars show median [IQR]; % labels denote the median prosthetic deficit vs intact (paired n=4). Prosthetic-limb peak torque (Nm·kg⁻¹) was reduced across 60–300°·s⁻¹ (Flexion −31 to −42%; Extension −33 to −39%). Across velocities, the pattern is consistent with a substantial residual-limb strength limitation in this pilot sample. Effect magnitudes are reported; formal hypothesis testing is not emphasized due to paired n=4.

Individual ILA values (dots) are shown for paired n=4; summary markers indicate median and IQR. Dots show individual ILA where ILA (%) = (1 − PT_pros/PT_intact) × 100; cross = median [IQR]. Inter-limb asymmetry (ILA) was velocity-dependent, reaching minima at 240°·s⁻¹ in flexion and 300°·s⁻¹ in extension. Individual data showed high pronounced between-athlete variability, including outliers at several velocities.

Hamstrings/Quadriceps (H/Q ratio)

H/Q showed a small prosthetic-side upward shift at 60–240°·s⁻¹ (+2.5 to +8.0 pp), consistent with relatively preserved knee flexors. This pattern is consistent with a larger extensor (quadriceps) deficit relative to flexors at moderate velocities.

Intact-limb internal reference only (not able-bodied norms) PT (median [IQR], n=8; Nm·kg⁻¹) across 60–300°·s⁻¹: Flexion (red), Extension (green).

CONCLUSION

In this pilot sample, the profile suggests a predominant extensor deficit with clear velocity specificity, motivating future interventional testing of velocity-matched prosthetic-side extensor strengthening.

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