Early Interlimb Loading Asymmetry After a Lower Extremity Long Bone Fracture Is Associated With Self-Reported Physical Function

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BACKGROUND

- Tibial and femoral diaphyseal fractures in warfighters lead to prolonged rehabilitation, delayed return to duty, and reduced operational readiness leading to profile restrictions.
- Little is known about early differences in limb loading after fracture and how they relate to self-reported physical function.
- A need remains to evaluate if pain and fear contribute to loading asymmetries. This is critical to define in order to guide more precision based rehabilitation.

This study evaluated early limb loading differences and their relationship to physical function following lower extremity long bone fracture.

METHODS

Demographics

57 Military Age Participants

33% Female

31 ± 9 yrs of age

73 ± 31 days post surgery

32 Tibial (56%) / 25 Femoral (44%) Fractures

Tampa Scale of Kinesiophobia (TSK)

PROMIS Physical Function (PROMIS-PF)

Brief Pain Inventory (BPI)

Assessments Performed:

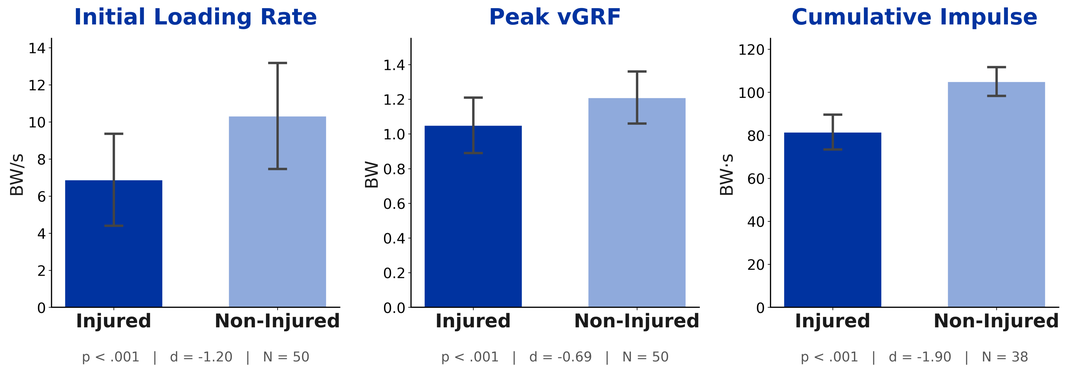
6-Minute Walk Test (6MWT) with bilateral instrumented insoles (Loadsol®, 200 Hz) to continuously measure vertical ground reaction force (GRF)

Initial loading rate = GRF slope during early weight acceptance (3–12% of stance); cumulative impulse = area under the GRF-time curve across stance; both normalized to body weight (BW)

Injured vs. non-injured limbs compared via paired t-tests (α = .05). Pearson Product Moment correlations used to assess relationships between patient reported factors to GRF variables

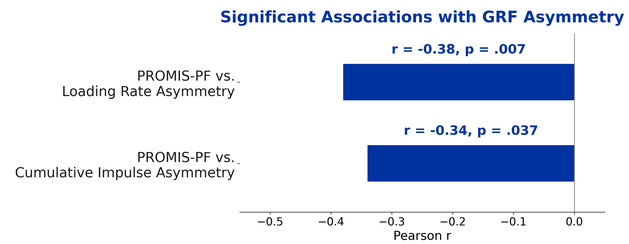
RESULTS

Interlimb Loading Asymmetry (Injured vs. Non-Injured)



Loading Variable	Injured (Mean ± SD)	Non-Injured (Mean ± SD)	p-value	Cohen's d	N
Initial Loading Rate (BW/s)	6.89 ± 2.48	10.33 ± 2.86	< 0.001	-1.20	50
Peak vGRF (BW)	1.05 ± 0.16	1.21 ± 0.15	< 0.001	-0.69	50
Cumulative Impulse (BW·s)	81.53 ± 8.10	105.04 ± 6.71	< 0.001	-1.90	38

Loading Asymmetry & Patient-Reported Outcomes



Outcome Measure	Mean ± SD
PROMIS Physical Function	40.9 ± 5.4
Tampa Scale of Kinesiophobia (TSK)	39.2 ± 4.7
Brief Pain Inventory (BPI)	3.1 ± 2.0

TSK and BPI showed no significant relationship to GRF asymmetry.

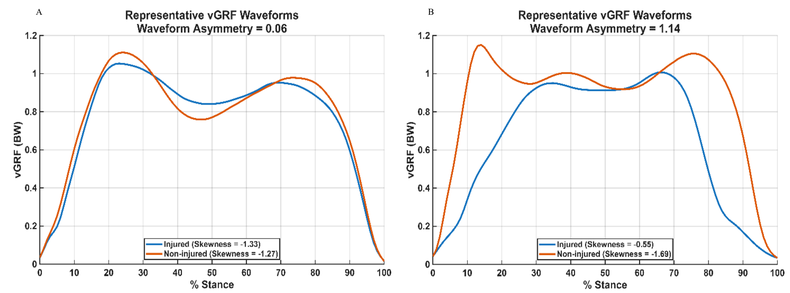


Figure 1: Representative vGRF waveforms displaying the differences in waveform shape. A) Example of lower waveform asymmetry, displaying similar loading patterns between limbs, including comparable weight acceptance, double-peak profiles, and timing of loading across stance B) Example of larger waveform asymmetry, displaying differences in the temporal distribution of laoding of between limbs despite relatively similar overall loading magnitude

DISCUSSION

- Significant interlimb loading differences remain 2–3 months after definitive fixation of a long bone fracture.
- Adequate mechanical loading is essential for bone remodeling and healing; persistent deficits may contribute to delayed healing and prolonged profile restrictions.
- Only PROMIS Physical Function was associated with GRF loading variables, suggesting reduced limb loading contributes to poorer early self-reported outcomes.
- No significant associations were found between GRF asymmetry and fear of movement (TSK) or pain (BPI), suggesting asymmetry may be driven more by learned behavior, strength deficits, or motor patterns than by psychosocial factors.
- These results inform future interventions to help warfighters return to duty after a lower extremity fracture.

TAKE HOME POINT

Patients recovering from lower extremity fracture continue to underload the injured limb months after fixation. The amount of loading asymmetry was not related to pain or fear of movement Reduced loading tracked with poorer self-reported physical function, pointing to loading symmetry as a future rehabilitation target to help warfighters return to duty.

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