

Novel Musculoskeletal Loading and Assessment System

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HAT: 6.3.d TA: Human System Research priority area (TA06) TRL: start 4 / current 6

OVERVIEW

- Ground based and ISS exercise research have shown that axial loading via two-point loading at the shoulders and load quality (i.e. consistent load and at least 1:1 concentric to eccentric ratio) are extremely important to optimize musculoskeletal adaptations to resistance exercise.
- The Advanced Resistance Exercise Device (ARED) is on ISS now and is the “state of the art” for resistance exercise capabilities in microgravity; however, the ARED is far too large and power consuming for exploration vehicles
- The single cable exercise device design selected for MPCV, does not readily allow for the two-point loading at the shoulders.

INNOVATION

- We developed a novel light weight and compact hardware innovation, the musculoskeletal loading system (MLS) and “Smart Bar” to optimize single cable exercise device capabilities and measure spaceflight induced losses in musculoskeletal health during exploration class missions (Fig 1).
- The ability to measure muscle strength is not even available on ISS today.



Fig 1. Squat exercise using the MLS and “Smart Bar” attached to a single cable exercise device.

OUTCOME

- The MLS and “Smart Bar” were successfully designed, fabricated, and tested.
- Squat biomechanic form using the MLS attached to a single cable exercise device was similar to the “gold standard” free weight squat (Fig. 2).
- Load measured by the “Smart Bar” was similar to the small exercise device load, indicating that the MLS maintained load quality (Fig. 3).

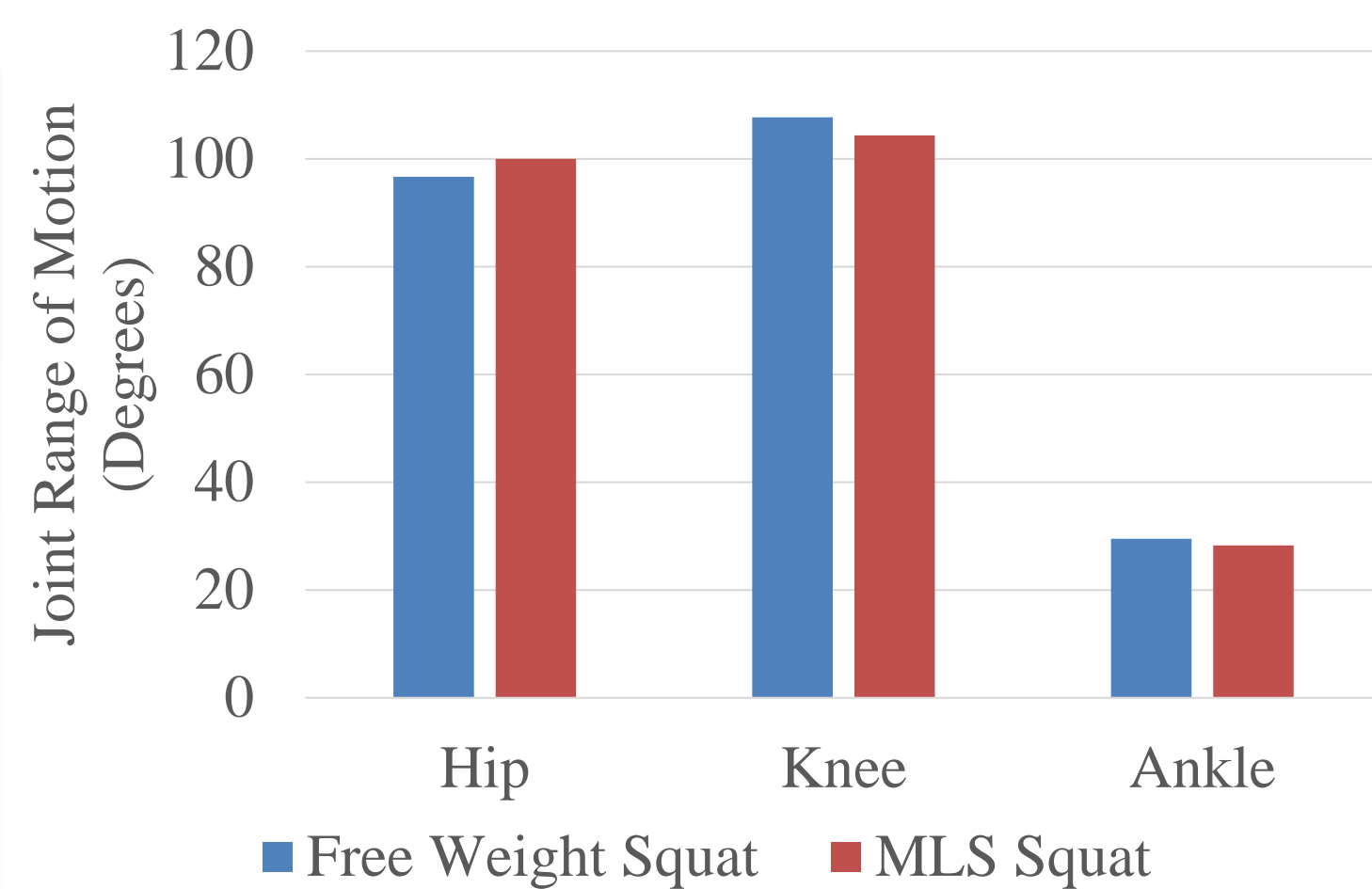


Fig. 2. Average joint ROM at the hip, knee, and ankle was similar between squat conditions.

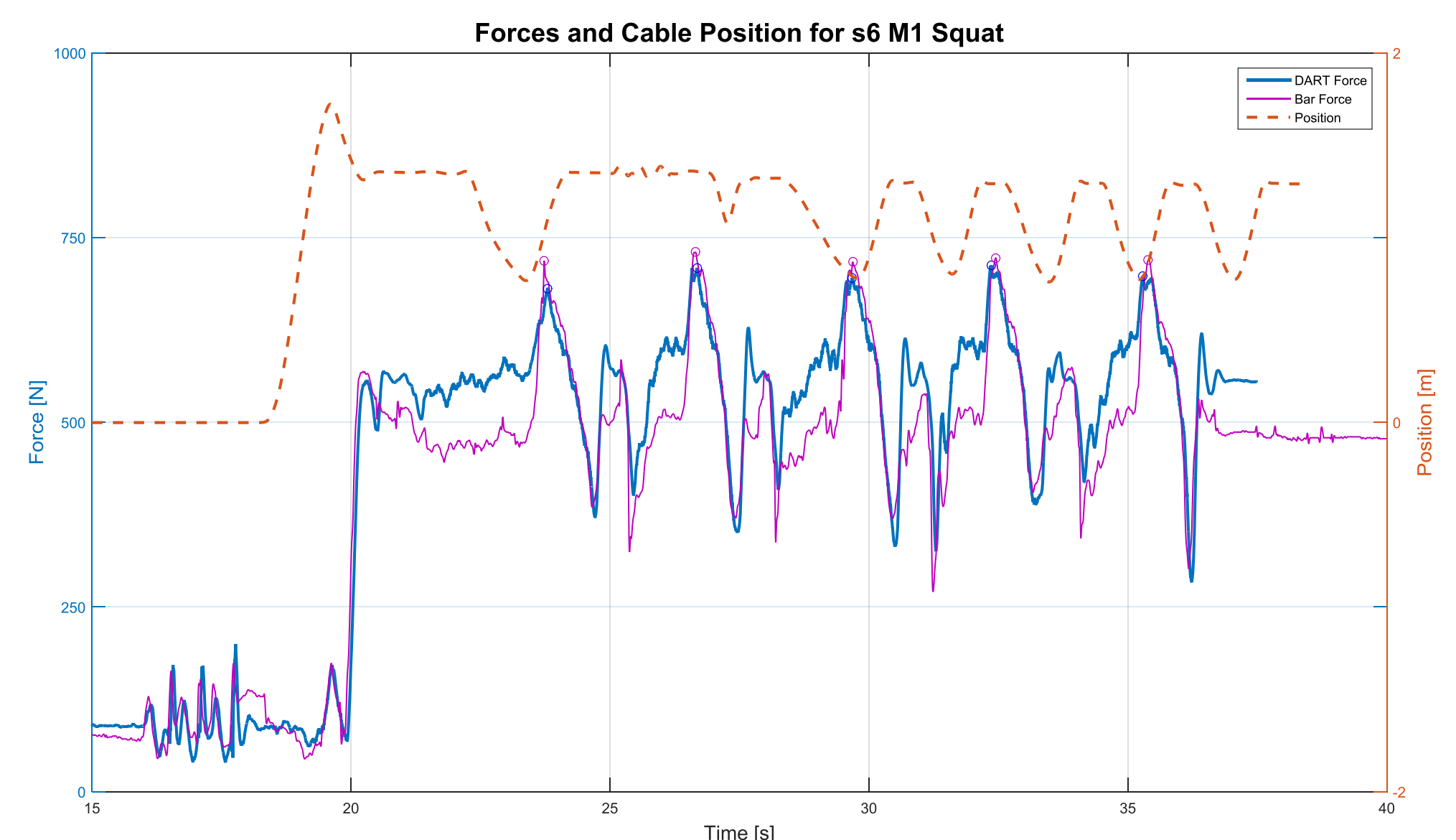


Fig. 7. Continuous measurement of force at the “Smart Bar” and small exercise device during squat exercise.

PARTNERSHIPS / COLLABORATIONS

- This technology development fostered successful collaborations with industry partners (Quantum Fitness) and other NASA centers (GRC).
- With a second year of IR&D funding we have expanded our collaborations to include University of Houston and University of Minnesota.

PAPERS / PRESENTATIONS

NA

FUTURE WORK

- A second year of IR&D funding was awarded to expand and refine the MLS and “Smart Bar”.
- Funding has been secured for parabolic flight testing in FY17.