# Understanding the roles of active and passive components within the equine forelimb

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## Summary

The equine forelimb is supported by a combination of active (muscle-tendon complexes) and passive support (ligaments). The distal limb has both types of supports integrated as the digital flexors and their accessory ("check") ligaments. The interaction of active and passive components makes it difficult to identify how load is carried by the system. Utilizing a novel testing frame and cadaveric samples, compressive limb loading and muscle engagement forces can be applied while measuring displacements, tendon strains, and joint angles. With the horse being a relevant and comparable model to similar human musculoskletal injuries, this research stands to be translatable and benefical to both species.

## Introduction

Naturally occurring musculoskeletal overuse injuries and degenerative changes are unfortunately common in the horse, like their human counterparts. By studying complex equine injury mechanics and identifying risk factors, we can benefit the horse while advancing our understanding of similar human conditions. To better prevent and treat these injuries, we need to be able to identify the relationship between active and passive components, especially during high-intensity athletic performances, when fatigue becomes a factor that increases injury susceptibility.

The distal forelimb of the horse contains two flexor muscle-tendon units, each supported by their check ligaments. The superficial and deep digital flexor muscles (SDFm and DDFm) and tendons (SDFT and DDFT) connect with the proximal check (PC) and distal check (DC) ligaments, respectively. While both are flexor tendons, they have different compositional make-up, and the SDFT is more frequently injured than the DFFT [1, 2]. The goal from this study is to determine the pattern of load distribution in the equine forelimb digital flexor system during support.

## Methods

A novel equine testing frame system (Figure 1) was developed and used to test cadaveric forelimbs [N=7]. Cyclic loads of 1000-3000N were applied vertically to the limb (at the mid-radius) and 500-1000N were applied to both the SDFm and DDFm to simulate active muscle contributions. Three limb conditions were created: (a) the intact limb (b) PC [N=4] or DC [N=3] transected, and (c) both check ligaments transected. Four muscle engagement trials were completed per condition: (1) no muscle engagement/limb only, (2) SDFm. only (3) DDFm. only and (4) both SDFm. and DDFm. engaged simultaneously. Joint angle, tendon strains, force and displacement data were measured.

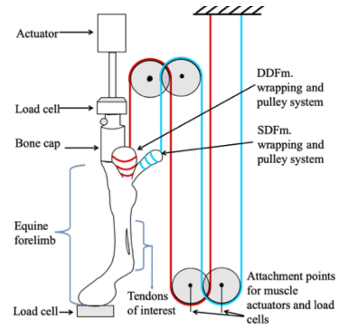


**Figure 1**: Testing frame schematic, depicting the DDFm. and SDFm. wrapped with rope and attached to actuators via a pulley system.

## Results and Discussion

Limb stiffness was calculated as the slope of applied force vs. limb displacement. The mean and standard deviation were calculated when comparing the limb stiffness as a percent of the intact stiffness after a single check ligament was transected (Figure 2). The PC transection resulted in a larger decrease of limb stiffness than the DC transection in all limbs during all muscle engagement trials. Analysis of fetlock joint angle and tendon strain in the SDFT and DDFT are currently ongoing.

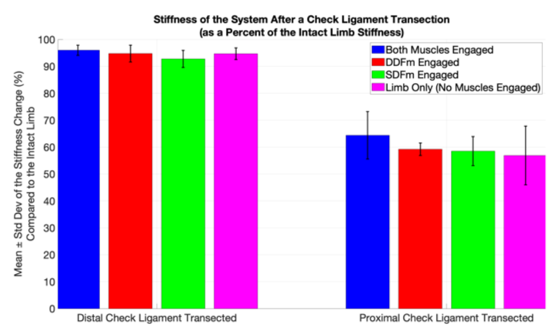


**Figure 2**: Limb stiffness shown as a percentage of the intact limb stiffness after either the DC or PC ligament was transected.

## Conclusions

This novel testing frame is showing strong potential in identifying load distribution patterns of the digital flexor systems within the equine forelimb during support.

## Acknowledgements

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## References

[1] Butcher et al., (2007) *Equine Vet J*, **39**: 540-545.
[2] Ribitsch et al., (2019) *Journal of Anatomy*, **236**:688-700