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Reasons for performing study: Although passage is known to differ from trot in footfall patterns and peak ground reaction forces the intricacies of balance management and the mechanical demands on the passaging horse have yet to be fully explored.

Objectives: To measure biomechanical characteristics of passage and evaluate their influence on balance.

Study design: Observational.

Methods: Three Lusitano elite dressage horses of mass 607 ± 9 kg were captured at 120 Hz by a 10 camera motion analysis system performing ridden passage over 4 force platforms recording at 960 Hz. A full body marker set was used in order that the centre of mass (COM) could be determined along with balance variables, which included centre of pressure, pitching moments, dissociation timing, peak force production, and limb and trunk posture. Twenty passage steps were extracted in total and partial correlation (accounting for horse) used to investigate significant ($P<0.05$) relationships between balance variables.

Results: The only variable that correlated significantly to mean sagittal-plane pitching moments was mean pro-retraction of the hindlimb ($R = 0.546$, $P = 0.016$), which was also strongly correlated to peak hindlimb propulsive forces ($R = 0.821$; $P<0.01$) and moderately correlated to diagonal dissociation time (-0.515; $P<0.05$).

Conclusions: Greater mean hindlimb protraction over each step resulted in a shorter hindlimb moment arm and a longer forelimb moment arm, which allowed the forelimbs to generate increased mean nose-up moments during the propulsive phase. Horses that had a more caudal placement of the hindlimb compensated by using an increased propulsive force to generate a nose-up moment. These findings suggest that horses adjust the forces, the moment arms or both to achieve dynamic balance during passage. This is principally achieved by altering fore-aft foot contact position of the hindlimb.

Ethical animal research: Study performed with approval from the Institutional Animal Care and Use Committee, Michigan State University, USA under protocol number 02/08-020-00. Owner consent was not stated. **Sources of funding:** University of Central Lancashire and the McPhail endowment at Michigan State University. **Competing interests:** None declared.