Investigating the effect of four water depths on canine forelimb kinematics during walking on an underwater treadmill

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Background

Given the multiple orthopaedic and neurological conditions affecting forelimb kinematics, it is vital to understand the impact of altering specific parameters on the underwater treadmill (UWTM), to improve clinical outcomes based on individual needs. The properties of water provide multiple advantages on canine limb kinematic and stride parameters [1,2,3,4]. However, research which can quantitatively inform evidence-based practice regarding forelimb kinematics utilising an UWTM, is limited.

The aims of this study were to objectively obtain baseline forelimb range of movement (carpus, elbow and shoulder), stride length and stride frequency measurements in healthy canine subjects at differing water depths, to provide guidance and assist therapists selecting appropriate parameters for their canine patient.

Materials and Methods

Kinematic analysis (2D) was utilised to assess range of movement of the canine shoulder, elbow and carpus joints, alongside stride length and frequency. Eight medium to large breed dogs participated, all free from musculoskeletal abnormalities, neurological or degenerative diseases. Reflective markers were placed on anatomical landmarks (dorsal border of spine of scapular, greater tubercle of the humerus, lateral epicondyle of the humerus, ulnar styloid process) and dogs walked at 2.4m/s for 150-seconds at four water depths. Digital video cameras captured the data, and a video kinematic analysis tool was utilised to examine forelimb kinematics. A one-way repeated-measures ANOVA determined the effect of water depth on the range of movement of a canine's forelimb, stride length and frequency. Bonferroni correction was applied, where applicable.

Results

Carpus and shoulder peak flexion significantly increased when walking at various depths on the UWTM (Table 1). Carpus peak flexion was significantly lower when walking on the dry, with flexion increasing at all other water depths and most peak flexion produced at the mid-ulnar depth. Shoulder PF increased with higher water depths, with most shoulder PF produced at mid-humerus water level. Water depth did not have a significant effect on peak flexion at the elbow, extension of all three forelimb joints, stride length or frequency.

Water Depth	Dry			Mid-carpus			Mid-ulnar			Mid-humerus		
	Carpus	Elbow	Shoulder	Carpus	Elbow	Shoulder	Carpus	Elbow	Shoulder	Carpus	Elbow	Shoulder
Dry	/	/	/	0.001 (-20.38 - -5.49)	0.000 (-23.37 – -9.51)	1.000 (-29.40 – 11.52)	0.000 (-36.92 – -15.20)	0.000 (-34.49 – -16.51)	0.006 (-11.40 – -1.65)	0.007 (-27.17 – -3.83)	0.000 (-35.43 – -20.07)	0.000 (-17.01 – -7.49)
Mid-Carpus	0.001 (5.49-20.38)	0.000 (9.51 – 23.37)	1.000 (-11.52 – 29.40)	/	/	/	0.035 (-25.51 – -0.74)	0.04 (-17.8 l – -0.32)	1.000 (-18.20 – 22.83)	1.000 (-17.70 – 12.58)	0.004 (-19.30 – -3.32)	1.000 (-24.27 – 17.65)
Mid-Ulnar	0.000 (15.20-36.92)	0.000 (16.51 – 34.49)	0.006 (1.65 – 11.40)	0.035 (0.74 – 25.51)	0.040 (0.32 – 17.80)	1.000 (-22.83 – 18.20)	/	/	/	0.035 (1.85-19.28)	1.000 (-7.03 – 2.53)	0.001 (-9.01 – -2.43)
Mid-humerus	0.007 (3.83-27.17)	0.000 (20.07 – 35.43)	0.000 (7.49 – 17.01)	1.000 (-12.58 – 17.70)	0.004 (3.32 – 19.3)	1.000 (-17.65 – 24.27)	0.013 (-19.28 – -1.85)	1.000 (-2.53 – 7.03)	0.001 (2.24 – 9.01)	/	/	/

Table 1: Significant values for pairwise comparisons for peak flexion at different water heights with confidence intervals in parenthesis.

Conclusion

This investigation demonstrates the effect of differing water depths on range of movement of the forelimb joints (carpus, elbow and shoulder) and forelimb stride parameters. The findings illustrate the beneficial effects of adapting UWTM depth on range of movement, providing a greater insight into subsequent canine forelimb kinematics. The findings also provide therapists with valuable information for delivering hydrotherapy treatment to dogs with neuromusculoskeletal pathologies and provide further information on canine forelimb kinematics, which may benefit future research.

References

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