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Differences in static and dynamic bike fit with 3d motion capture

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Abstract

Background: Bicycle fitting is the adjustment of bicycle configuration to suit rider requirements through appropriate placement of contact points; pedals, saddle and handlebars (Burke 1994: Clin Sports Med, 13(1), 1-14). Traditional fitting uses static assessment of parameters such as knee angle through the bottom of the pedal stroke and saddle setback measured by knee over pedal horizontal separation (KOPS) (Holmes et al., 1994: Clinics in Sports Medicine 13(1), 187). Dynamic fitting is now increasingly popular through video analysis or 3d motion capture. However no comparison has been made of differences between static and dynamic measurement or assessment reported of the reliability of motion capture for bicycle fitting.

Purpose: To investigate the repeatability of key bike fitting kinematic parameters and differences between static and dynamic conditions.

Methods: 15 subjects performed repeated motion capture trials over three sessions in both static and dynamic conditions. Markers were applied to anatomical landmarks and kinematics collected using a Vicon 3d motion capture system.

Results: Typical intra-session errors for angular parameters ranged from 1.7° (4.2°) for dynamic (static) knee flexion to 4.2° (4.9°) for ankle plantarflexion. Typical error for KOPS was 6.6 mm (12 mm). Significant ($p<0.001$) differences between static and dynamic conditions were observed for all parameters. Knee flexion was 5.4° greater in dynamic conditions (95% CI 3.5°, 7.4°). Corresponding dynamic ankle plantarflexion was 7.8° greater (5.9°, 9.6°) and hip flexion 5.1° greater (3.8°, 6.5°). KOPS was 7.7 mm further forward in dynamic conditions (3.3, 12.1) and dynamic ankle plantarflexion at KOPS was 3.6° greater (1.8°, 5.4°).

Discussion: Typical errors showed moderate repeatability indicating the system was fit for purpose but these errors require consideration in the fitting process. Differences between static and dynamic parameters appear to originate at the ankle, with a tendency for riders to drop their heels when stationary.

Conclusion: Common guidance to fit to a knee angle between 25-35° should be adjusted to 30-40° for dynamic measurement.

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