Assessing the Use of Ultrasound to Quantify Spine Kinematics

Dan Desroches, P.Eng

Biomechanics Lab of Dr. Janessa Drake

Introduction: Spine research aims to reduce the burden of LBP by understanding movement related injury mechanisms. Understanding segmental spine kinematics might prove to be a useful link between existing in-vitro research on injury mechanisms and gross spine kinematics. External methods include optical motion capture and inertial measurement units. External methods are prone to soft tissue artefact (Benoit et al., 2006) which introduce proportionally larger error for small movements close to joint centres (Cappozzo et al., 1996). Internal approaches include intracortical bone pins, videofluoroscopy, and magnetic resonance imaging (MRI) which are less impacted by soft tissue artefact, but are invasive, radiotoxic, and/or are heavily restrictive to movement (e.g. MRI bore size). As a result, measuring segmental spine rotation is difficult with existing methods. Recently, ultrasound has been used to measure flexion/extension (Chleboun et al., 2012) and was validated against MRI for static lumbar twist positions (Mayberry et al., 2018). Purpose: Study 1. Assess the error tolerance of ultrasound in measuring spine kinematics; Study 2. Evaluate ultrasound relative to optical motion capture in quantifying spine kinematics during a semi-constrained manual materials handling reaching task. Methods: In Study 1, an inclinometer and measuring tape will be to quantity the effect of transducer tilt/translation on subsequent image processing using the approach described by Mayberry et al. (2018). In Study 2, optical motion capture will be used to quantify the position of the participant as per Drake & Callaghan (2008) as well as the ultrasound transducer during the task. Ultrasound images will be captured in the starting position. End-point reaching positions will attempt to match the images of the starting position. In this position, the motion of the transducer will approximate motion of the vertebrae. Expected Results: It is expected that translational motion will affect image quality to a lesser degree than rotation (5mm permissible translation vs only 3 degrees permissible rotation). It is expected that this measurement system will successfully measure segmental flexion and rotation simultaneously.