Using Dynamic Stereo Radiography to Measure Temporomandibular Joint Kinematics

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Objectives: Temporomandibular disorders (TMD) are a range of musculoskeletal disorders that may cause pain and affect the function of the temporomandibular joint (TMJ). Mandibular and temporomandibular kinematics can be measured with mechanical devices such as ultrasound machines, MRI, and CT scans. While these systems are precise, their direct contact can induce unnatural jaw movement whereas motion capture is a less invasive technology that can be used to measure TMJ kinematics. 3D anatomical models derived from MRI and CT allow for further transformations between the motion capture coordinate system and the anatomical coordinate system. Dynamic stereo radiography (DSX) paired with cone beam computed tomography (CBCT), electromyography, and motion capture determines neuromuscular effects, whole-body kinematics, and an optimal method for analyzing TMJ movement in vivo for better diagnoses and treatment planning for patients with TMD.

Experimental methods: DSX is a non-invasive, highly accurate and precise method of capturing kinematic data of joint movements. The movement of the bones are tracked by aligning a digitally reconstructed radiograph (DRR) to the x-ray images using a CBCT scan of the head. This data paired with the EMG and motion capture outcomes determines kinematics of the TMJ. Ultimately, DSX is the optimal option for in vivo analysis of the TMJ due to its accuracy, and noninvasiveness.

Results: Kinematic outcomes for more than seven patients using CBCT scans paired with DSX, DRR, EMG, and motion capture allowed for data to be measured and analyzed that provided a more accurate diagnosis/treatment plan of the TMD compared to solely using MRI or CT kinematics.

Conclusion: TMDs can be measured and diagnosed using ultrasound machines, MRI, or CT scans; however, with the combination of CBCT scans, DSX, EMG, and motion capture, the skeletal, muscular, and in vivo analysis of the TMJ allows for more accurate diagnoses for patients suffering from TMD.