Clinical Policy Bulletin: Computerized Motion Diagnostic Imaging

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Policy

Aetna considers the use of computerized motion diagnostic imaging experimental and investigational for evaluation of the spine or any other indications because there is a lack of evidence that this imaging alters clinical management and improves clinical outcomes.

Aetna considers vertebral motion analysis for evaluation of the spine or any other indications experimental and investigational because of insufficient evidence of its effectiveness.

See also CPB 0263 - Gait Analysis and Electrodynogram; and CPB 0294 - Pedobarography.

Background

Computerized Motion Diagnostic Imaging (CMDI) Systems (Motion Diagnostics Laboratories, Hauppauge, NY) employ a dual-inclinometer and/or a long-arm goniometer and computer software to track range of motion and can allegedly estimate the percentage of impairment of the spine. However, there is a lack of evidence in the published peer-reviewed medical literature to support the usefulness of these devices in improving clinical outcomes.

Piche and colleagues (2007) developed a measurement method that could be implemented in chiropractic for the evaluation of angular and translational intervertebral motion of the cervical spine. Flexion-extension radiographs were digitized with a scanner at a ratio of 1:1 and imported into a software, allowing segmental motion measurements. The measurements were obtained by selecting the most antero-inferior point and the most postero-inferior point of a vertebral body (anterior and posterior arch, respectively, for C1), with the origin of the reference frame set at the most postero-inferior point of the vertebral body below. The same procedure was performed for both the flexion and extension radiographs, and the coordinates of the 2 points were used to calculate the angular movement and the translation between the 2 vertebrae. These researchers reported that this method provided a measure of intervertebral angular and translational movement. It
uses a different reference frame for each joint instead of the same reference frame for all joints and thus provides a measure of motion in the plane of each articulation. The calculated values obtained are comparable to other studies on intervertebral motion and support further development to validate the method. The authors concluded that the present study proposes a computerized procedure to evaluate intervertebral motion of the cervical spine. This procedure needs to be validated with a reliability study but could provide a valuable tool for doctors of chiropractic and further spinal research.

Harrison et al (2008) examined the accuracy in measuring the pelvic orientations of a phantom model (a mannequin was fixed on a rotating platform) using the PosturePrint method. For a set of 3 photographs (left lateral, anterior to posterior, right lateral) of each position, the mannequin pelvis was placed in 68 different postures on a stand, 61 cm from a wall, in front of a digital camera. The camera was at 83.8 cm in height and at 3.35 m from a calibrated wall grid. Mannequin postures were in 5 degrees of freedom: lateral translation (Tx), lateral flexion (Rz), axial rotation (Ry), flexion-extension (Rx), and anterior-posterior translation (Tz). Average errors were the differences of the positioned postures to the PosturePrint computed values. Mean and SD of computational errors for rotation displacements were Rx = 0.5 degrees +/- 0.8 degrees, Ry = 1.3 degrees +/- 0.8 degrees, and Rz = 0.5 degrees +/- 0.3 degrees, and for translation, Tz = 1.2 +/- 0.6 mm and Tx = 0.9 +/- 0.5 mm. The authors concluded that the PosturePrint system allowed for accurate postural measurement of rotations and translations of a mannequin pelvis. The next step in evaluation of this product would be a reliability study on human subjects.

MacDonald and colleagues (2010) stated that previous research has quantified cervical spine motion with conventional measurement techniques (e.g., cadaveric studies, motion capture systems, and fluoroscopy), but these techniques were not designed to accurately measure three-dimensional (3-D) dynamic cervical spine motion under in-vivo conditions. The purposes of this study were to characterize the accuracy of model-based tracking for measuring 3-D dynamic cervical spine kinematics and to demonstrate its in-vivo application. The accuracy of model-based tracking for measuring cervical spine motion was determined in an in-vitro experiment. Tantalum beads were implanted into the vertebrae of an ovine specimen, and biplane X-ray images were acquired as the specimen's neck was manually moved through neck extension and axial neck rotation. The 3-D position and orientation of each cervical vertebra were determined from the biplane X-ray images using model-based tracking. For comparison, the position and orientation of each vertebra were also determined by tracking the position of the implanted beads with dynamic radio-stereometric analysis. To demonstrate in-vivo application of this technique, biplane X-ray images were acquired as a human subject performed 2 motion tasks: neck extension and axial neck rotation. The positions and orientations of each cervical vertebra were determined with model-based tracking. Cervical spine motion was reported with standard kinematic descriptions of translation and rotation. The in-vitro validation demonstrated that model-based tracking is accurate to within +/- 0.6 mm and +/- 0.6 degrees for measuring cervical spine motion. For the in-vivo application, there were significant rotations about all 3 anatomical axes for both the neck extension and axial neck rotation motion tasks. The authors concluded that model-based tracking is an accurate technique for measuring in-vivo, 3-D, dynamic cervical spine motion. They noted that these preliminary data acquired using this technique are in agreement with previous studies. It is anticipated that this experimental approach will enhance the understanding of cervical spine motion under normal and pathologic conditions.

Mieritz et al (2012) reviewed the literature on reproducibility (reliability and/or measurement error) of 3-D regional lumbar motion measurement systems. Electronic searches were performed in PubMed, Cumulative Index of the Nursing and Allied Health Literature, Embase, and Mantis databases. To be included, original studies had to report on the
reproducibility of a 3-D computerized regional lumbar spinal motion analysis system in human subjects. A detailed checklist was developed based on guidelines for reporting reliability and agreement studies, the standards for reporting of diagnostic accuracy, and quality assessment of diagnostic accuracy studies and used for data extraction and quality assessment. The checklist consisted of descriptive items divided into 4 domains: (i) study population, (ii) testing circumstances, (iii) equipment, and (iv) data analysis and presentation. The descriptive items were used as foundation for the quality assessment reflecting the reporting level of the included articles. A total of 15 articles were included in this study. These researchers found incomplete reporting in 1 or more domains in all articles. A varying amount of measurement error was reported in 8 of the 15 articles. Because of incomplete reporting, these reliability and measurement error estimates are difficult to interpret. The authors concluded that the current literature on the reliability and measurement error of measures created by regional 3-D spinal instruments contained uncertainties especially in relevant clinical populations. There is uncertainty with respect to the degree that repeated measurements by 3-D regional spinal motion instruments are reproducible. However, limited to the studies where reliability estimates were provided, most instruments used under standardized conditions may be considered reliable enough to be used for research purposes on the group level, but it is uncertain if they can be used on the individual patient level.

**Vertebral Motion Analysis:**

O’Sullivan et al (2012) stated that a novel, minimally invasive posture monitor that can monitor lumbar postures outside the laboratory has demonstrated excellent reliability, as well as concurrent validity compared to a surface marker-based motion analysis system. However, it is unclear if this device reflects underlying vertebral motion. A total of 12 participants performed full range sagittal plane lumbo-pelvic movements during sitting and standing. Their posture was measured simultaneously using both this device (BodyGuard) and digital videofluoroscopy. Strong correlations were observed between the 2 methods (all r (s) > 0.88). Similarly, the coefficients of determination were high (all r (2) > 0.78). The maximum mean difference between the measures was located in the mid-range of motion and was approximately 3.4° in sitting and 3.9° in standing. The authors concluded that the BodyGuard appears to be a valid method for analyzing vertebral motion in the sagittal plane and is a promising tool for long-term monitoring of spinal postures in laboratory and clinical settings in people with low back pain (LBP).

Bifulco et al (2012) stated that in-vivo analysis of intervertebral kinematics provides useful information about spinal disorders and performance of disk prostheses. Diagnosis of intervertebral instability is based on measurement of abnormal range of segmental motion in sagittal plane through functional flexion-extension radiography; however, this concise measure does not take into account the progression of segmental motion in between flexion and extension extremes. Fluoroscopy can support analysis of intervertebral kinematics during patient's motion with an acceptable X-ray dose. A spline-based method designed for a continuous-time description of intervertebral motion extracted by videofluoroscopy is proposed. Fluoroscopic sagittal sequences of lumbar spine were processed by an automated method based on template matching to track vertebrae. A smoothing spline interpolation of the estimated intervertebral kinematic data was performed and a continuous-time description of segmental rotation and translation was obtained; the smoothing parameter was chosen both to preserve motion and to reduce noise. Concise measurements were extracted by the continuous-time kinematics and compared with standard clinical measurements of intervertebral sagittal rotation and translation. The trajectory of instantaneous center of rotation, never presented before for in-vivo spinal segments, was provided and compared with standard measurements of the finite center of rotation. Results showed a good agreement with standard clinical
measurements: on average, absolute differences resulted 0.74 degree for sagittal rotation, 0.59 mm for translation and 1.02 mm for the x- and y-position of center of rotation. The authors concluded that the proposed method offers an effective technique for the continuous-time description of intervertebral motion, maintaining standard clinical measurements for diagnosis of lumbar instability. This appears to be a feasibility study; its validity in the clinical setting needs to be ascertained in well-designed studies.

Tojima et al (2013) studied the repeatability and reliability of a novel 3-D motion analysis method for measuring the lumbar spine range of motion (ROM). They established a novel set of marker positions for 3-D motion analysis (VICON system) to determine lumbar spine ROM (LROM) and lumbar motion precisely; they compared the repeatability and reliability of VICON system with those of an electrogoniometer. The VICON system and electrogoniometer measured LROM and lumbar motion in 7 healthy males during 7 days. Differences between both systems were analyzed using Bland-Altman plots. Repeatability and reliability of the LROM measurements was assessed using coefficients of multiple correlations and intra-class correlation coefficients, respectively. Standard error of measurement was calculated to quantify the systematic error in LROM measurements. The mean maximum LROM values using the VICON system/electrogoniometer were 42°/52° for flexion, 17°/24° for extension, 16°/16° for lateral bending, and 8°/2° for axial rotation, respectively. Between the VICON system and the electrogoniometer, Bland-Altman plots revealed no discrepancies in LROM values except for flexion. Coefficients of multiple correlations for LROM showed excellent repeatability. LROM measurements with VICON system showed excellent reliability for flexion and extension and fair-to-good reliability for other motions. LROM measurements with the electrogoniometer showed excellent reliability for flexion and fair-to-good reliability for other motions. Except for axial rotation, maximum intra-class correlation coefficients using the VICON system were more reliable than the electrogoniometer for measuring lumbar motion. The authors concluded that the VICON system with their novel marker set allowed practical and reliable longitudinal assessment of dynamic LROM. This was a repeatability and reliability study using healthy subjects (n = 7); these preliminary findings need to be validated by well-designed studies in patients with LBP.

The Work Loss Data Institute’s guideline on “Low back -- lumbar & thoracic (acute & chronic)” (2013) recommended fluoroscopy for epidural steroid injections (diagnostic and therapeutic). It does not recommend videofluoroscopy (for ROM).

Moreover, the American College of Occupational and Environmental Medicine (ACOEM)'s occupational medicine practice guideline on “The Low back disorders” (2011) stated that following:

- Fluoroscopy for evaluating acute, subacute, or chronic LBP -- Not Recommended, Insufficient Evidence (I)
- Videofluoroscopy for the assessment of acute, subacute, or chronic LBP -- Not Recommended, Insufficient Evidence (I)

Furthermore, an UpToDate review on “Diagnostic testing for low back pain” (Staiger et al, 2015) does not mention videofluoroscopy and vertebral motion analysis as management tools.

CPT Codes / HCPCS Codes / ICD-9 Codes

CPT codes not covered for indications listed in the CPB:
96000  Comprehensive computer-based motion analysis by video-taping and 3-D kinematics

96001  with dynamic plantar pressure measurements during walking

96004  Review and interpretation by physician or other qualified health care professional of comprehensive computer-based motion analysis, dynamic plantar pressure measurements, dynamic surface electromyography during walking or other functional activities, and dynamic fine wire electromyography, with written report

ICD-9 codes not covered for indications listed in the CPB:

739.0 - 739.9  Non-allopathic lesions, NEC

The above policy is based on the following references:


Vertebral Motion Analysis/Videofluoroscopy:


