Diagnostic Dynamic Spinal Visualization and Vertebral Motion Analysis (for Kentucky Only)

Policy Number: CS254KY.04
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Instructions for Use

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Related Policies
None

Application

This Medical Policy only applies to the state of Kentucky.

Coverage Rationale

The following dynamic spinal visualization techniques when used to visualize movement of the back or spine are unproven and not medically necessary due to insufficient evidence of efficacy.

- Digital motion x-ray of the spine
- Cineradiography/videofluoroscopy

Vertebral motion analysis is unproven and not medically necessary due to insufficient evidence of efficacy.

Applicable Codes

The following list(s) of procedure and/or diagnosis codes is provided for reference purposes only and may not be all inclusive. Listing of a code in this policy does not imply that the service described by the code is a covered or non-covered health service. Benefit coverage for health services is determined by federal, state, or contractual requirements and applicable laws that may require coverage for a specific service. The inclusion of a code does not imply any right to reimbursement or guarantee claim payment. Other Policies and Guidelines may apply.

CPT Code	Description
0693T	Comprehensive full body computer-based markerless 3D kinematic and kinetic motion analysis and report
76120	Cineradiography/videoradiography, except where specifically included
76125	Cineradiography/videoradiography to complement routine examination (List separately in addition to code for primary procedure)

Description of Services

Dynamic spinal visualization is a general term addressing different imaging technologies that simultaneously visualize spine (vertebrae) movements and external body movement.

Digital motion x-ray involves the use of either film x-ray or computer-based x-ray 'snapshots' taken in sequence as an individual moves in front of an x-ray camera. Film x-rays are digitized into a computer for manipulation while computer-based x-rays are automatically created in a digital format. The digitized snapshots are then put in order using a computer program and played on a video monitor, creating a moving image of the inside of the body. This moving image can then be evaluated by a physician alone or by using a computer that evaluates several aspects of the body's structure to determine the presence or absence of abnormalities.

Videoradiography or cineradiography are different names for the same procedure that uses fluoroscopy to create real-time video images of internal body structures. Videoradiography works like a video camera, providing motion pictures of the inside of the body. The results of these techniques can be displayed on a video monitor as the procedure is being conducted. They can also be viewed or digitally analyzed.

Vertebral motion analysis systems provide assisted bending with fluoroscopic imaging and computerized analysis. The device uses facial recognition software to track vertebral bodies across the images. Proposed benefits of the vertebral motion analysis are a reduction in patient-driven variability in bending and assessment of vertebral movement across the entire series of imaging rather than at the end range of flexion and extension bending with fluoroscopic imaging and computerized analysis.

Clinical Evidence

Cineradiography/Videoradiography

The current literature evaluating the clinical utility of dynamic spinal visualization techniques, including but not limited to digital motion x-ray and cineradiography (video fluoroscopy), for the evaluation and assessment of the spine is limited to a few studies (Lee et al., 2002; Teyhen et al., 2007; O'Sullivan et al., 2012; Yeager et al., 2014) involving small numbers of participants. While these studies do indicate that there may be some benefit from the use of these technologies, further evidence from large, controlled trials is needed to demonstrate that the results have significant impact on clinical care and are superior to currently available alternatives.

Frey et al. (2025) conducted a validation study to examine the correlation between skin-based lumbar spine kinematics measurements (Accels and 3D MoCap) and intervertebral kinematics tracked via quantitative fluoroscopy (QF) during spine flexion and extension in a healthy female population. Twenty asymptomatic female participants aged 30 to 65 were conveniently sampled from the general population in Bournemouth, UK. Exclusion criteria included a self-reported BMI over 30 kg/m², back pain limiting normal activity for more than one day in the past year, a history of abdominal surgery, spondylosis, medical radiation exposure exceeding 8 mSv in the past two years, and pregnancy. Results showed that skin-based markers varied in accuracy among participants, sometimes overestimating and sometimes underestimating lumbar spine angles. While the median difference between QF and skin-based markers was close to zero, the reproducibility coefficients (RC) increased as the spine angle moved away from upright standing. Skin-based markers estimated vertebral lumbar angles within ±19.0° (MoCap) and ±16.7° (Accel) during flexion, and ±13.3° (MoCap) and ±12.0° (Accel) during extension, which did not meet the clinically accepted range (RMSE ≤ 5° & RC ≤ 5°). Spine angles measured with skin-based sensors should be regarded as estimates of intervertebral angles. The study revealed that measurement errors varied significantly among participants and were more pronounced in the lower vertebrae, likely due to the complex lumbar spine structure and surrounding soft tissue. Factors such as BMI, soft tissue firmness, and marker placement contributed to this variability. This study has several limitations. There were only females over 30, limiting the generalizability to other populations. A larger sample size would have been beneficial, though similar studies have used even smaller samples. The use of a guided flexion protocol may differ from freestanding flexion, potentially affecting the range of motion. Additionally, the pelvic brace used to limit movement might have altered skin and soft tissue movement, especially in participants with higher BMI. In conclusion, while skin-based markers showed good agreement with each other and can be used interchangeably, they should only be considered estimates of intervertebral angles. Measurement errors do not increase linearly throughout the range of motion, and normalizing angles might reduce these errors. Further research is needed to improve the accuracy of skin-based markers for measuring lumbar spine kinematics.

Scataglini et al. (2024) performed a systematic review and meta-analysis to compare the accuracy, validity, and reliability of marker-less camera-based 3D motion capture systems (MCBS) and marker-based 3D motion capture systems (MBS). MCBS, despite their advantages, still fall short of the gold standard set by MBS. Ongoing research addressing issues

such as occlusions, noise, and computational complexity, with advances in computer vision, machine learning, and sensor technologies are helping to close the gap. However, there is still no clear consensus on the accuracy, validity, and reliability of marker-less systems in gait analysis. There were 2047 potential records screened with a total of 22 retained for inclusion in this systematic review after the screening process. After review, the results were as follows, spatiotemporal parameters showed overall good to excellent accuracy, validity, and reliability. For kinematic variables, hip and knee showed moderate to excellent agreement between the systems, while for the ankle joint, there was poor concurrent validity and reliability measured. The accuracy and concurrent validity of walking speed were considered excellent in all cases, with only a small bias. The meta-analysis of the inter-rater reliability and concurrent validity of walking speed, step time, and step length resulted in a good-to-excellent intraclass correlation coefficient (ICC) (0.81; 0.98). There were several limitations identified. Most studies focused on spatial and temporal outcomes rather than kinematic outcomes of the lower limb during gait. The heterogeneity in reliability types (inter-rater, inter-session, intra-session) made it difficult to draw firm conclusions about the reliability of marker-less systems compared to marker-based systems. The wide range of methodological approaches complicated general conclusions about concurrent validity and accuracy. Small participant numbers lead to inaccurate estimates, and most studies involved young, healthy individuals, limiting generalizability to clinical settings. The risk of bias and incomplete methodological descriptions made it challenging to generalize results. Some articles indirectly addressed the review question, raising concerns about their relevance and applicability. The results indicated that MBS is the gold standard, although MBCS shows promising results. Further research is needed to compare the accuracy, concurrent validity, and reliability of marker-less and marker-based gait analysis systems.

ECRI (2023) performed a clinical evidence assessment for dynamic spinal visualization for assessing lumbar spine abnormalities. They concluded that evidence from one cohort study and two diagnostic cohorts on dynamic MRIs compared with flexion/extension radiography provide no evidence that dynamic spinal visualization improves patient outcomes or diagnoses for patients with lumbar spine abnormalities. The studies suggest that dynamic spinal visualization may identify lumbar abnormalities; however, too few data exist per dynamic visualization technique, and the studies are of too low quality to provide conclusive evidence of efficacy.

Knippenberg et al. (2017) conducted a systematic review to investigate 1) which marker-less motion capture systems (MCS) are used as training devices in neurological rehabilitation, 2) how they are applied, 3) in which target population, 4) what the content of the training and 5) efficacy of training with MCS. A computerized systematic literature review was conducted in four databases (PubMed, Cinahl, Cochrane Database and IEEE). The Van Tulder's Quality assessment was used to score the methodological quality of the selected studies. The descriptive analysis is reported by MCS, target population, training parameters and training efficacy. Eighteen studies were selected (mean Van Tulder score = 8.06 ±3.67). Based on methodological quality, six studies were selected for analysis of training efficacy. The most used MCS was Microsoft Kinect, whereby training was mostly conducted in upper limb stroke rehabilitation. Training programs varied in intensity, frequency, and content. None of the studies reported an individualized training program based on a client-centered approach. The investigators concluded that marker-less motion capture systems have the potential in neurological rehabilitation to increase motivation during training and may assist improvement on one or more International Classification of Functioning, Disability and Health (ICF) levels. Future technological developments should take up the challenge to combine marker-less MCS with the principles of a client-centered task-oriented approach and prove efficacy using randomized controlled trials (RCTs) with long-term follow-up. According to the investigators, because there are few RCTs and controlled clinical trials and few studies with long-term follow-up, it is difficult to prove the efficacy of marker-less MCS based on the studies included in this review.

Vertebral Motion Analysis

For individuals who have back or spine pain who receive vertebral motion analysis, the evidence includes comparisons to standard flexion/extension radiographs. These studies reported that vertebral motion analysis reduces variability in measurement of rotational and translational spine movement compared with standard flexion/extension radiographs. Whether the reduction in variability improves diagnostic accuracy or health outcomes is uncertain. The evidence is insufficient to determine if the effects of the technology will positively impact clinical health outcomes.

Hurley et al. (2021) compared leg length measurements (LLM), and varus/valgus knee measurements (VVM) performed clinically, radiologically and using marker-less motion analysis (MMA) in patients being assessed for potential total knee replacement (TKR). Twenty-three patients awaiting unilateral primary TKR were included in the study. According to the authors, the most important finding of this study was that significant differences were reported between results obtained for calculating LLM and VVM clinically, radiologically and using MMA. As much of the literature has previously validated the use of clinical and radiological in obtaining LLM, this study poses the question as to whether the results obtained using MMA for LLM and VVM can be utilized.

van Kersbergen et al. (2021) investigated whether a consumer depth camera can capture changes in gait features of Parkinson's patients. The dataset consisted of 19 patients (tested in both a practically defined OFF phase and ON phase)

and 8 controls, who performed the "Timed-Up-and-Go" test multiple times while being recorded with the Microsoft Kinect V2 sensor which records Red-Green-Blue (RGB)-depth data and tracks 25 anatomical landmarks in 3D space without the need for body-attached sensors or markers. Camera-derived features were step length, average walking speed and mediolateral sway. Motor signs were assessed clinically using the Movement Disorder Society Unified Parkinson's Disease Rating Scale. The authors were able to detect group differences in gait features between people with PD and healthy controls using the Kinect depth camera. However, the current task setup and analysis approach lacks sensitivity to detect small intra-individual changes in symptom severity. According to the authors, limitations of this study include the small sample size, subjects with relatively mild symptoms and a not complete age match with the population control. The standard outcome for the TUG (task duration) could not be analyzed because of missing frames at the beginning of the recording.

In a systematic review, Puh et al. (2019) evaluated the validity and reliability of using the Kinect camera (a markerless motion capture system) as an assessment tool for transitional movement and balance. A total of 21 research articles, published from 2012 to 2018, were included in the analysis and qualitative synthesis. Many of the included studies reported validity and did not report reliability, which limited the application to practice. According to the authors, the translation into practice for Kinect is also limited by lack of redundancy among studies and access to the software to implement the tests.

U.S. Food and Drug Administration (FDA)

This section is to be used for informational purposes only. FDA approval alone is not a basis for coverage.

Products used for diagnostic dynamic spinal visualization and vertebral motion analysis are extensive. Refer to the following website for more information and search by product name in device name section: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfPMN/pmn.cfm. (Accessed March 12, 2025)

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Policy History/Revision Information

Date	Summary of Changes
01/01/2026	**Applicable Codes** • Removed CPT codes 76496 and 76499 **Supporting Information** • Updated *Description of Services*, *Clinical Evidence*, and *References* sections to reflect the most current information • Archived previous policy version CS254KY.03

Instructions for Use

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