Washington State Department of Labor & Industries	**Coverage Decision**	
Topic: **Dynamic Spinal Visualization (DSV)** *Includes Videoflouroscopy (VF), Cineradiography (CR), Digital motion x-ray, Spinal x-ray digitization for the purpose of assessing spinal motion.*	**Process:** OMD Evidence Review **Authorization Requirements:** N/A	**Key Dates:** ***L&I Implementation:*** *1993* ***Last Reviewed:*** 10/12/2012
Coverage Decision: Not Covered There is inadequate evidence to support the use or justify additional cost of videoflouroscopy or other dynamic spinal visualization techniques for the diagnosis and or management of spinal disorders.		
Implementation: CPT billing codes 76496, 76120, and 76125 are not paid for dynamic spinal visualization. Codes suspend for review.		

General background on DSV

A number of technologies collectively referred to as Dynamic Spinal Visualization (DSV) are currently available to assess spinal motion. Videoflouroscopy (VF) or cineradiography (CR) is an imaging technique used by physicians to obtain real motion of an internal structure of interest. A commonly accepted application of VF approach is to assess esophageal blockage during swallowing which is not addressed in this coverage decision. Less common is the use of VF to assess spinal motion. Similar technologies include computer-aided radiographic techniques such as digital motion x-ray and digitization of spinal x-ray. By revealing real time motion, the purpose of these imaging techniques is to provide insight into what happens during dynamic movement of structures such as the spine. VF is periodically requested by providers to assess spinal motion anomalies (e.g., restriction, abnormal motion, instability) for workers with back or neck injuries.

Recent technical advancements appear to utilize significantly less radiation exposure than older VF machines and many older plain film applications. DSV typically begins at a starting (neutral) point, the midpoint and the terminal point of the vertebral movement [1]. It may be performed in multiple planes of motion (e.g., flexion-extension, right-left lateral bend). Limiting factors to the technology include low quality, non-diagnostic images, high cost, and uncertain clinical yield compared to alternatives (e.g., static studies, or conservative therapeutic trial). Although rarely used by chiropractic physicians, spinal motion VF is most frequently requested by a small number of DC with in-office equipment who advocate its use to target manual interventions and monitor physiological change under care.

To date, DSV has been considered a non-covered service for L&I based primarily on a 1992 systematic review. [2] Providers billing for VF and CR for spinal motion studies appear to use CPT code for unspecified VF (76496) at charges in the range of $130 for c-Spine to $920 for complete spine. Comparable bending

studies using plain film radiography appear to be reimbursed at $118 for a complete C-Spine study (72052) and $87 for a complete L-Spine study (72114).

Evidence Reviewed

Evidence to date evaluating the effectiveness of VF for assessment of the spine is limited to 11 Class III and IV studies (Table 1). These studies have very small sample sizes and no comparators. Some studies have suggested that VF may be helpful in identifying criteria for diagnosis of disc degeneration and lumbar segmental instability [3]. No studies have compared VF or other DSV approaches to standard forms of evaluation (commonly used manual palpation, range of motion observation/goniometry which is bundled into office visit charges or conventional radiographic views). How the use of VF and DSV impacts downstream diagnostic and therapeutic utilization, clinical decision making, and health outcomes has not been reported in any of studies to date. ([1, 4-8]).

Published reports indicate that VF techniques and equipment appear to be continuously evolving. VF has been shown to be a reliable technique for evaluating instability in lumbar spine motion, thus contributing to diagnosis of instability. [7] However, the test does not appear to consistently reveal identifiable differences between people with and without instability.

Guidelines, Technology Assessments, Coverage Policies, and Position Papers Reviewed

American Chiropractic College of Radiology and Council on Diagnostic Imaging: Protocol for the Use of Musculoskeletal Videoflouroscopy (2005)

- Videoflouroscopy of the lumbar is discouraged due to low quality of images and patient dosage. The examination should not be performed on individuals exceeding 14 cm in the A-P and 32 cm in the lateral position.
- Musculoskeletal VF serves only as an ancillary diagnostic procedure.
- Musculoskeletal VF shall never be utilized as a replacement for conventional radiograph procedures.
- Musculoskeletal VF shall never be employed as a screening imaging device.

Cigna Medical Coverage Policy: Dynamic Spinal Visualization (2010)

- CIGNA does not cover dynamic spinal visualization (e.g., dynamic motion x-ray, videoflouroscopy of the spine, digital motion x-ray, cineradiography of the spine) for any indication because it is considered experimental, investigational or unproven.

Wellmark Blue Cross Blue Shield: Cineradiography of the spine or dynamic motion X-Ray Benefit Guideline (2011)

- DMX, cineradiography and videoflouroscopy of the spine are considered **investigational.**
- The evidence at this time is insufficient to evaluate the effect on health outcomes of digital motion x-rays or cineradiography/videoflouroscopy of the spine for any indication.

Health Net National Medical Policy (2011)

- Health Net Inc. considers dynamic spinal visualization investigational and therefore not medically necessary due to inadequate scientifically controlled studies in the medical literature to validate its effectiveness in the evaluation and assessment of the spine.

Blue Cross Blue Shield of North Carolina Dynamic Spinal Visualization Evidence Based Guideline (2012)

- Dynamic spinal visualization, including, but not limited to, digital motion x-ray of the spine, with or without digitization of spinal x-rays and computerized analysis of the back or spine, is not recommended for any indication. Also, videoflouroscopy (cineradiography), when used to visualize movement of the back or spine, is not recommended.

Table 1: Published studies on videoflouroscopy/cineradiography for spinal motion.

Author/Year	Summary of study	Findings	Notes and comments
Ahmadi A./2009[3]	Case control study N=15; 12 female, 3 male with CLBP suspected to have lumbar segmental instability and 15 matched healthy subjects (12 female, 3 male). Motion was investigated during flexion and extension in vivo. Test is performed in two positions (lying with feet on floor and then lifting legs off the floor. Subjects were also asked to bend forward from standing at 10° lumbar hyperextension and then return from full flexion to starting position. DF collected 5 frames per second.	Intersegmental linear translation was significantly higher in patients during both flexion and extension movements at L5-S1 segment ($p<0.05$). Arc length of PICR was significantly higher in patients for L1-L2 and L5-S1 motion segments during extension movement ($p<0.05$). 6 patients at L5-S1 level showed "delayed sequence" movement pattern (chi-sq=7.5, $p<0.01$). In the flexion and extension movement arcs, there was a significant difference in the Intersegmental linear translation at level L5-S1 of lumbar range during motion. VF can help in identifying criteria for diagnosis of non specific back pain patients.	Class III- small sample size Narrow spectrum of participants Non Homogenous nature of the study participants. There was no comparator
Okawa A./1998[4]	Case control study Volunteers=controls (N=13; mean age=22.3) and Patients with CLBP (N=8; mean age=43.5) and patients with degenerative spondylolisthesis (DS) (N=8; mean age=63.1). Subjects were asked to bend forward with arms overhead from neutral to flexion position. Data was acquired for 30 frames. The outcome measure was disc degeneration.	Of the 13 volunteers, 6 exhibited a sequential motion spreading pattern, 4 a simultaneous pattern. 6 of the CLBP patients showed sequential or a simultaneous pattern. In the DS group the L4 moved first, then L2 and L3, this spreading pattern is said to be disordered. Also found was a prolonged deflection of L4. L4 failed to return to zero when L2 and l3 had begun to extend. In summary, 3 out of 13 volunteers, 7 out of 8 patients with degenerative spondylolisthesis, and 2 out of 8 patients with	Class III- Data collection was not well defined. There was comparison to standard imaging. Motion speed could not be controlled strictly for older patients. The sample size was small. Narrow spectrum of

		CLBP were considered to have abnormal motion.	patients.
Lee, B.W/2010[1]	Case control N=27 (18 with lumbar lesions (asymptomatic) and 9 with herniated nucleus pulposus (HNP). Asymptomatic group comprised f 8 men and 10 women (mean age 36.5) and the HNP group included 5 male and 4 female patients (mean age=48.5) Fluoroscopy was performed with the pelvic region supported in a sitting position to restrict compensation. Right and left lateral flexion and rotation was performed. 33 frames per second were collected. Second and first lumbar vertebrae were excluded from analysis because the images were not clear.	During lateral flexion the lumbar vertebrae did not rotate in the regular direction at the same pattern as the asymptomatic subjects. The degree of flexion was significantly wider in the asymptomatic group during lateral flexion ($p<0.05$). There was a difference in the sacral descent between the two groups. In the asymptomatic group the angle was 5° to 7°; and in the patients with HNP, it was more than 10°. Patients were similar in the compensatory patterns. Fluoroscopy showed coupled patterns of bending during lateral bending and rotation.	Class III Narrow spectrum of subjects. Data was measured in 2 D methods. Quality of image was a problem, leading to exclusion of some of the images. Outcome not clearly defined. There was no comparator.
Lee S.W/2001[7]	Cross sectional N=30 (16 male and 14 female), ages 20-30. Subjects were excluded if they experience any LBP, surgery in the previous year. The subjects were asked to perform flexion and extension. Intervertebral flexion-extension was calculated in 10° intervals, from 40°of flexion to 10° extension.	The maximum range of flexion was 53° ± 10.2° and the maximum range of extension was 15.4° ± 8.3°. At L1-L2, the Intervertebral flexion extension (IVFE) increased steadily from 10° of extension to 40° of flexion. A linear pattern of the ICFE curve was observed. The IVFE curve for L2-L3 aligned immediately next to L1-L2 and a linear pattern was also observed. Videoflouroscopy is a reliable for evaluating instability in lumbar spine motion; as a result this could lead to diagnosis of spine disorders.	Class IV No comparator Outcome not clearly defined. Small sample size Narrow spectrum of patients

Wong K.W.N/2004[5]	Cross sectional N=100 volunteers, 50 males, and 50 female. The sample was divided into four groups based on age group. Subjects wore a harness connected to an electrogoniometer. The participants were asked to perform flexion, extension and return to the neutral position. The retrieved data went under distortion correction and analyzed by an in house image analysis program.	Outcome was assessment of spinal motion. The intervertebral flexion-extension (IVFE) among the different age groups was found to increasing from group A (younger group) to D (oldest group) in all spinal levels. At L1-L2 the IVFE increased steadily from 10°of extension to 40° of flexion. As compared to different spinal levels, the IVFE gradually decreased from L1-L2 to L5-S1 in all age groups. However IVFE curve in group D was different from the rest of the groups. The results of the study suggested that the flexibility of the lumbar spine decreased generally from proximal to distal levels. Assessment of the lumbar spinal motion has to be potentially helpful for the identification of spinal disorders	Class III No comparator Good sample size. Images went under distortion correction which could bias the results
Croft A.C/1994[9]	Random selection of 7 patients for cervical spine injury sustained during an accident. 4 were males and 3 were female (mean age 36). Healthy volunteers who had no previous history of trauma or neck pain (controls). All the controls were judged to be radiographically normal. Examiners were selected at random. They were asked to evaluate each briefly and determine whether each of the 8 segments (OCC-C1 through C7-T1) were normal, hypomobile or hypermobile and “unable to determine”.	The purpose of the study was to determine if board certified chiropractors will be in agreement with the interpretation of VF examinations. The group Kappa was 0.479 (SE0.111, $p<0.001$), indicating a moderate agreement. Agreement was moderate for C3-C4 (kappa 0.419) and the rest were mostly in fair agreement. The study concluded that fair to moderate agreement can be reached among radiologist from a rather heterogeneous background in terms of their training in VF. VF should never be part of routine workup. It would only	Class IV Study design not standard Narrow number of patients and examiner. No comparator.

		appear to offer information on spinal motion but only at high radiation exposure and significant monetary cost.	
Cakir B/2006[10]	24 patients with non segmental degenerative disease. The levels of L4-L% and L5-S1 were measured with the cob and superimposition methods on flexion and extension radiographs. 3 different observers with different levels of experience analyzed the radiographs. Two of the observers were experienced and one was inexperienced.	The purpose of this study was to measure Intra and inter observer reliability of radiographs. Intraobserver –intramethod" reliability (95% CI of ±4.2° for cob method and ±4.0° for superimposition method). Intraobserver –intermethod" reliability (reliability of inexperienced observer 2 (95% CI -6.7°/+6.5°) was inferior to experienced observer 1(95% CI -5.5°/+6.5°). Interobserver-intramethod" reliability (the reliability of the cob method (95% CI -7.5°/+5.8°) was inferior to the superimposition method (95% CI -4.9°/+4.5°) when measurements of an inexperienced and experienced observer were compared. Interobserver –intermethod" reliability (results did not differ between experienced and inexperienced observer. No clinically relevant differences could be found for an experienced observer between the superimposition and cob methods.	Class IV No comparator Narrow spectrum of patients DX criteria not clearly defined Did not included patients with disease/symptoms.
Muggleton J.M/1997 [11]	Develop a procedure to locate vertebrae in DVF images automatically in order to minimize manual effort and reduce error. A two dimensional template was used for image segmentation. Template matching is done using a grey based segmentation approach, optimum match is determined with minimum difference. The template and each matching region are computed and the region where the difference is minimized gives the best match.	Quantify spine movement in vivo. Means and SD's of calculated angles (means are calculated to the nearest 0.1° and SD's to the nearest 0.01°) At 5° mean coronal plane measurement is (mean=5.4° and SD=0.22°) and at the sagital plane (mean=4.5° and SD=0.16°). At 10° mean coronal plane measurement is (mean=10.5° and SD=0.00°) and at the sagital plane (mean=10.1° and SD=0.38°).	Class IV

		At 15° mean coronal plane measurement is (mean=15.9° and SD=0.20°) and at the sagital plane (mean=15.6° and SD=0.45°). At 20° mean coronal plane measurement is (mean=21.1° and SD=0.18) and at the sagital plane (mean=20.6° and SD=0.34°). This analysis procedure enables for location of vertebrae in digitized videoflouroscopy images of the spine.	
Hino H. /1999 [12]	Case control study. Ten healthy subjects and 12 patients with unstable cervical spines (C1-C2 subluxations caused by rheumatoid arthritis, n=10; instability below C2, n=2) were studied. Cervical motion during flexion and extension were recorded using cineradiography. Cervical segmental motions (C1-C2 to C5-C6) were continuously measured through quantifying cineradiography images projected to a digitizer. The subjects with the trunk immobilized in a sitting position by shoulder straps were asked to perform active cervical flexion from maximum extension to maximum flexion.	To determine normal and pathologic motion patterns in the cervical spine through an in vivo continuous motion analysis. Normal cervical spine was seen in the normal group. Longitudinal displacements were similar to angular motion data. In patients with rheumatoid arthritis who had subluxations, C1-C2 motion initiated significantly earlier than C2-C3 motion. In patients with segmental disability below C2, motion in the unstable segment preceded that in the upper intact segments. Cervical motion patterns were cineradiographically examined in normal and pathologic spines.	Class III Included both healthy and unstable cervical spine patients. Narrow number of patients
Takayanagi K. /2001[13]	A case control study. Asymptomatic patients (n=20; control group) and symptomatic patients with L4 degenerative spondylolisthesis (n=40; DS group). The study participants were measured at flexion and	To identify motion patterns of the lumbar spine in asymptomatic volunteers and symptomatic patients. In DS group 1 (n=21), the L4-L5 segment showed a large motion pattern in f-e angle and an intermediate motion pattern in f-e, and a small motion pattern in translation. The relative range of f-e angle at L4-L5 segment had the largest	Class III Included both healthy and unstable cervical spine patients. Narrow number of

	extension from a sitting neutral position and back to the neutral position. Cineradiography was used to record lateral segmental lumbar motions. The DS group was classified into 2 groups according to the percentage of slip: DS group 1, with a slip equal to or less than 15%; and group 2 with a slip of more than 15%.	range in DS group 1 and the relative translation showed a serial decrease from the control group through DS group 2. Harmonious pattern was noted at the L2-L3, L3-L4 and L4-L5 segments in the control group. The harmonious motion pattern at L4-L5 segment was significantly less in the DS group than in the control group. The loss of harmonious motion pattern was well revealed in the DS group 2 at the L4-L5. Motion analysis using cineradiography can explain the phenomena of lumbar kinematics.	patients
Wong K.W.N/ 2006[14]	To develop and validate a new method for continuous assessment of lumbar kinematics. A new in house developed image analysis was used to perform automatic segmentation and tracking. In vitro and in vivo validity were evaluated. Intervertebral flexion and extension was assessed in healthy volunteers (n=30).	In Vitro and in vivo validity test have been conducted with good results. A linear liked pattern of intervertebral flexion, extension (IVFE) curves in different levels was found and the IVFE decreased in descending order from L1-L5 at different points of range of motion in flexion. Extension was evenly distributed at different levels. The newly developed technique in assessing the dynamic motion is reliable and able to analyze the lumbar spine.	Class IV No comparator Narrow spectrum of patients DX criteria not clearly defined Did not included patients with disease/symptoms.

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