Clinical Neurology and Neurosurgery 143 (2016) 4–8

Contents lists available at ScienceDirect

Clinical Neurology and Neurosurgery

journal homepage: www.elsevier.com/locate/clineuro

The value of dynamic radiographic myelography in addition to magnetic resonance imaging in detection lumbar spinal canal stenosis: A prospective study

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ARTICLE INFO

Article history:
Received 6 December 2015
Received in revised form 9 January 2016
Accepted 31 January 2016
Available online 6 February 2016

Keywords:
Dynamic myelography
Supine MRI
Lumbar spinal stenosis

ABSTRACT

Objective: MRI is regarded as the study of choice in the diagnosis of lumbar spinal stenosis. In some cases, the supine MRI leads to a misdiagnosis in the extent of lumbar spinal stenosis. Dynamic myelography can detect lumbar spinal stenosis in these cases of where the MRI may not be as sensitive.

To compare the sensitivities of dynamic radiographic myelography and supine MRI in lumbar canal stenosis (LCS) patients and to determine whether dynamic radiographic myelography is a valuable diagnostic exam in the work-up of lumbar canal stenosis.

*Patients & method***s**: Over two years, the imaging data of 100 consecutive patients who were suspected of having LCS were prospectively analyzed. All lumbar intervertebral segments were evaluated in each patient on sagittal MR T2-weighted images and lateral plane images by myelography using a semi-quantitative scoring system. The differences in scores for 5 motion segments under 3 conditions (supine MRI, upright sitting myelography and standing myelography with extension) were analyzed statistically.

Results: Of 100 patients with 500 analyzed intervertebral segments, 23 patients with inconclusive supine MRI results had LCS in standing myelography with extension. Compared with upright sitting myelography and supine MRI, standing myelography with extension yielded the highest score for every segment from L1/2 to L5/S1. Compared with the upright sitting myelography position, 61 more patients received a diagnosis of lumbar stenosis in the standing myelography with extension position, and 121 more stenotic segments were diagnosed. Compared with the supine MRI position, standing myelography with extension detected 64 more stenotic patients and 137 more stenotic segments.

Conclusio: n Based on a large patient sample, dynamic myelography is a valuable diagnostic tool in detecting lumbar spinal stenosis. Patients with lumbar spinal stenosis may have inconclusive supine MRI in 23% of cases being misdiagnosed as normal. This missed rate of LCS patients with unclear supine MRI results can be avoided with dynamic myelography. The combination of supine MRI and dynamic myelography is critical in the evaluation of LCS, especially if multisegmental findings are detected.

1. Introduction

With the increasing age and morbidity, the incidence of spinal degenerative disease has increased annually. Lumbar canal stenosis (LCS) is a common diagnosis, causing various symptoms, such as low back pain, radiating leg pain, and intermittent claudication [1,2]. In LCS, degenerative pathologies, such as facet hypertrophy, ligamentum flavum hypertrophy, disc herniation, and spondylolisthesis, encroach upon the spinal canal and compress fragile neural tissues, cauda equine, and lumbar nerve roots [3,4].

The static morphological data on lumbar canal contents can be acquired easily by computed tomography imaging or magnetic resonance imaging in the supine position [5]. However, the spinal

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http://dx.doi.org/10.1016/j.clineuro.2016.01.031
0303-8467/

Table 1
Stenosis scores for lumbar segments.

Ø	Uprightsitting myelography	Standing myelography with extension	Supine MRI
L1/2	20	40	11
L2/3	45	76	28
L3/4	39	84	35
L4/5	35	79	34
L5/S1	4	5	4
Total	143	284	112

canal configuration is significantly and dynamically related to lumbar spine extension [6]. Thus, the vertebral instability that is caused by lumbar degeneration can go unnoticed in the supine radiological examination due to the lack of axial load. Mild spondylolisthesis and buckled ligaments that are undetectable in the supine position can be observed in an upright position [7]. Commonly, decompression surgery should be planned based on the neuropathic level and the level of canal stenosis, so determining the exact extent and level of stenosis in various axial load positions can have important clinical consequences [8].

With regard to computed tomography, high-resolution spatial myelography is provided by flat-panel volumetric computed tomography (FPVCT) with one-third of the radiation of ordinary multi-slice CT [9]. Although noninvasive, MR myelography can be performed in the upright position, but its cost is greater and its availability remote [10]. Furthermore, patients with pacemakers or ferromagnetic implantations cannot get a MRI scan. Consequently, radiographic myelography is a preliminary option for a patient who is suspected of having LCS [8].

Radiographic myelography to observe lumbar spinal stability dynamically in an upright position with flexion and extension has been used to diagnose LCS for more than 30 years [11]. Its disadvantage is the risk of lumbar puncture, which leads infrequently to infection or cerebrospinal leakage [12,4]. Modern puncture needle and techniques have significantly decreased these risks. Other side effects may be caused by the administered contrast agent, including allergic reactions and arachnoiditis. Furthermore, patients with hyperthyroidism require a special treatment for blocking thyroid function before the administration of contrast medium. The use of myelography is also limited in patients with renal insufficiency with low creatinine clearance. Finally, radiation exposure for myelography is not inconsequential. The utility of upright myelography is best suited for the following conditions: patients with instrumentation, revision surgery, geographic locations where an upright MRI is not available or the cost of the study prohibitive.

The purpose of this study was to compare the sensitivity of dynamic radiographic myelography with that of supine MRI in LCS patients and to determine whether dynamic radiographic myelography is a valuable adjunct diagnostic test in the evaluation of lumbar canal stenosis.

2. Methods

2.1. Patients

The imaging data of 100 consecutive patients who were suspected of having LCS were prospectively analyzed over a 24-month period. All patients suffered from claudication and various degrees of other neural deficits, including lower limb radiating pain, sensory and motor deficits. Three types of lumbar spine imaging modalities were investigated: (1) supine MR imaging, (2) upright sitting lumbar myelography, and (3) standing myelography with extension. The patients ranged in age from 22 to 91 years (mean 62.3 years). There were 51 men and 49 women. Five hundred intervertebral segments were observed (5 lumbar intervertebral segments from L1/2 to L5/S1 for each patient).

2.2. Evaluation methods

One neurosurgeon (MM) and one neuroradiologist (SD) evaluated the imaging data independently. Patients underwent a supine MRI for the lumbar spine, then an upright lumbar myelography in the sitting position, and finally standing lumbar myelography in extension. Sagittal magnetic resonance T2-weighted (MR T2) images were evaluated first then the lateral images by myelography. A simple semi-quantitative evaluation method of determining the extent of lumbar stenosis was used. Segments with no compression received a score of 0. If the anterior or posterior signal of the cerebrospinal fluid (CSF) in the three mid-sagittal MR T2 image or contrast medium (CM) in the myelography lateral view was not visible in a segment, the segment received a score of 1. Neural tissue compression received a score of 2, regardless of whether the compression affected the anterior or posterior canal space. The differences in stenosis scores of the 5 lumbar motion segments between imaging methods were compared.

2.3. Statistical analysis

The sample size was 100 patients and 500 segments, the scores for which were discontinuous data, allowing the differences in scores to be analyzed directly between each patient and segment. We defined a difference in stenosis by score of 0 as not increased segment stenosis (NISS), a difference of 1 as an Increased Segment Stenosis (ISS), and a difference of 2 as a severe increased segment stenosis (SISS). Friedman test followed by the Dunn's post-test was used to evaluate differences among groups. A value of $p < 0.05$ was considered significant and a value of $p < 0.001$ was considered high significant.

2.4. Complications

Complications and side effects after myelography, such as headache, sickness, bleeding, and infections, were recorded.

3. Results

The total score (sum of all segments of the 100 patients evaluated) in the standing myelography with extension position was 284 and therefore 2 and 2.5 times that of upright sitting lumbar myelography) and supine MRI, respectively (Table 1). Compared with sitting lumbar myelography and supine MRI, standing myelography in extension score was the highest for every segment from L1/2 to L5/S1. The segment with the highest score, concerning the amount of stenosis was L3/4 (84), followed by L4/5 (79).

The difference between total scores (sum of all segments of the 100 patients evaluated) by upright sitting myelography (143) and supine MRI (112) was 31. The segment score is the amount of the individual segments. For each segment, the difference between the upright sitting myelography and supine MRI segment score was small, especially between L3/4 to L5/S1. In none of the compared