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Acute effects of anesthetic lumbar spine injections on temporal spatial parameters of gait in individuals with chronic low back pain: A pilot study

Carl L. Herndon[a], MaryBeth Horodyski[b], Heather K. Vincent[b,*]

[a] Department of Orthopaedic Surgery at Columbia University Medical Center/New York-Presbyterian Hospital, 622 W 168th Street, PH11, New York, NY, 10032, USA
[b] Department of Orthopaedics and Rehabilitation, Division of Research, Interdisciplinary Center for Musculoskeletal Training and Research, University of Florida, PO Box 112727, Gainesville, FL, 32611, USA

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ABSTRACT

This study examined whether epidural injection-induced anesthesia acutely and positively affected temporal spatial parameters of gait in patients with chronic low back pain (LBP) due to lumbar spinal stenosis. Twenty-five patients (61.7 ± 13.6 years) who were obtaining lumbar epidural injections for stenosis-related LBP participated. Oswestry Disability Index (ODI) scores, Medical Outcomes Short Form (SF-36) scores, 11-point Numerical pain rating (NRS_{pain}) scores, and temporal spatial parameters of walking gait were obtained prior to, and 11-point Numerical pain rating (NRS_{pain}) scores, and temporal spatial parameters of walking gait were obtained after the injection. Gait parameters were measured using an instrumented gait mat. Patients received transforaminal epidural injections in the L1-S1 vertebral range (1% lidocaine, corticosteroid) under fluoroscopic guidance. Patients with post-injection NRS_{pain} ratings of "0" or values greater than "0" were stratified into two groups: 1) full pain relief, or 2) partial pain relief, respectively. Post-injection, 48% (N = 12) of patients reported full pain relief. ODI scores were higher in patients with full pain relief (55.3 ± 21.4 versus 33.7 12.8; $p = 0.008$). Post-injection, stride length and step length variability were significantly improved in the patients with full pain relief compared to those with partial pain relief. Effect sizes between full and partial pain relief for walking velocity, step length, swing time, stride and step length variability were medium to large (Cohen's $d > 0.50$). Patients with LBP can gain immediate gait improvements from complete pain relief from transforaminal epidural anesthetic injections for LBP, which could translate to better stability and lower fall risk.

1. Introduction

Low back pain (LBP) is a significant source of global morbidity [1]. A common source of pain is from lumbar stenosis. Pain limits the ability to perform activities of daily living [2], impairs gait velocity [3], and reduces control of start and stop motion during walking [4]. LBP also deteriorates physical and mental aspects of quality of life (QOL). Compared to healthy people, individuals with LBP have aberrant temporal spatial parameters of gait including slow velocity, shorter step lengths, wider base of support, longer double stance support times, and different plantar pressures [5]. LBP impairs coordination and normal motion of the trunk and lower extremity muscles during ambulation [6], which reflects compensation to avoid pain [5]. In the larger context, these gait impairments are risk factors for adverse outcomes such as physical disability, falls, institutionalization and mortality [7]. The secondary musculoskeletal pain burden and pain sequelae such as depression, anxiety and sleep disorders are high in persons with LBP [8]. Rapid pain relief and subsequent restoration of normal gait parameters have the strong potential to quickly minimize the stresses of compensatory motion and systemic pain burden. Moreover, gait improvements can reflect that a patient is better prepared to engage in physical therapies for back pain and conditioning.

One common treatment for stenosis pain is a lumbar transforaminal epidural injection, which contains both an anesthetic and a corticosteroid. While these injections can acutely reduce pain [9], it is not known if pain reduction can rapidly modify temporal spatial parameters of gait. Improvements in gait parameters are related to enhancement of medial-lateral and backward stability, and to possible reduction of fall risk [10]. Moreover, rapid restoration of walking velocity and other parameters can help people with LBP quickly reengage in regular ambulatory activities, which in turn reduces risks for adverse health events and improves overall health prognosis [11]. This pilot study determined whether or not epidural injection-induced anesthesia could rapidly and positively affect gait patterns. We hypothesized that

* Corresponding author at: Department of Orthopedics and Rehabilitation, Division of Research, UF Orthopaedics and Sports Medicine Institute, PO Box 112727, Gainesville, FL, 32611, USA.
E-mail addresses: ch3181@cumc.columbia.edu (C.L. Herndon), horodmb@ortho.ufl.edu (M. Horodyski), vincehk@ortho.ufl.edu (H.K. Vincent).

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administration of an anesthetic transforaminal epidural injection would reduce pain severity scores and the magnitude of the pain relief would correspond with the improvements in temporal spatial parameters of gait including gait velocity, cadence, base of support, and stride length. Positive findings would suggest a beneficial and rapid improvement in gait stability and better tolerance to environmental perturbations to ambulation.

2. Methods

2.1. Study design

This prospective pilot study used a repeated-measures design to test whether or not anesthetic spine injections acutely altered gait parameters. This study and its procedures were approved by the local Institutional Review Board.

2.2. Participants

All potential participants were recruited and enrolled through the Department of Orthopaedics and Rehabilitation at a large academic institution (N = 25). Participants met the following inclusion criteria: a patient between the ages of 30–82 years, scheduled to receive a transforaminal lumbar epidural anesthetic/steroid injection for lumbar spinal stenosis. Exclusion criteria were: body mass index values exceeding 35 kg/m^2, use of assistive devices, existence of significant comorbidities that inhibited their cognitive or physical abilities, and use of medications that impacted balance. All participants, read, understood, and signed the study informed consent document prior to testing.

2.3. Perceived disability due to pain and quality of life

Responses were obtained from the modified Oswestry Disability Index (ODI) and the Medical Outcomes Short-Form 36 (SF-36). The ODI is one of the primary condition-specific outcome instruments for persons with spine-related disorders [12]. The modified version of the ODI used in the present study is responsive to intervention treatments for LBP, is reliable, and corresponds well with the SF-36 [13]. Physical and mental component scores were calculated and these scores were adjusted by a population mean and standard deviation to produce norm-based scores with a common mean of 50 and a standard deviation of 10 points [14]. A score below 50 is considered different from the 'norm'.

2.4. Injection procedure

Patients were placed in a prone position and the skin was prepared using a standard sterile technique. Transforaminal injections were administered to one or more locations within the L1-S1 vertebrae range. A local anesthetic (2 ml 1% lidocaine, preservative free) was administered using a 22 gauge needle. Fluoroscopic guidance in the oblique view was used to position the needles in the appropriate foramen at the superior aspect of the exiting nerve. Contrast dye (Omnipaque 240) was injected through microbore tubing under live fluoroscopy to confirm epidural flow pattern. Once it was established that there were no complications, the corticosteroid (2 ml dexamethasone [12.5 mg/ml] or triamcinolone [40 mg/ml]) was then injected through the tubing. Once complete, participants were asked to sit quietly in the recovery area until the second gait measurement. The repeat measurement occurred within 30 min. The levels for injection in this study population were: 11.1% L3-L4, 16.6% L4-L5, 61.1% for L5-S1, and 11.2% for S1.

2.5. Pain ratings

LBP pain intensity was self-assessed by an 11-point numerical pain rating scale (NRS_{pain}) with terminal descriptors (anchors of 0 = no pain; 10 = worst possible pain ever experienced). The NRS_{pain} scale is an accepted outcome measure for chronic pain conditions, as described in the Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials (IMMPACT) [15]. Pain measures were obtained from patients while sitting at rest, and reflected average pain level experienced during that day. Measures were repeated post-injection during recovery.

2.6. Patient stratification based on full and partial pain relief

To better understand analgesia effects on gait, we defined patients who reported NRS_{pain} ratings of "0" to be those who achieved full pain relief after the injection. The patients who reported values above "0" and below their pre-injection pain rating were considered to have partial pain relief.

2.7. Temporal spatial parameters of gait

Gait analysis was performed on a 26′ long instrumented walkway (GaitRite®; CIR Systems, Inc.; Havertown, PA). Each participant walked at a self-selected pace across the mat three times before their scheduled injection and within 30 min after injection. Temporal spatial parameters including gait velocity, cadence, step and stride length, step width, swing time, stance time, single and double support times were averaged over the three trials. Variability of walking gait was estimated using the step length differential, standard deviations of step length, and standard deviations of stride length. For the parameters we used in the this study, the intraclass correlations using the GaitRite® system have ranged from 0.66–0.94 in older adults [16].

2.8. Data analysis

Statistical analyses were performed using Statistical Package for the Social Sciences (version 23.0, SPSS Inc, Chicago, IL). Values are expressed in means and standard deviations (SD). Descriptive statistics were performed on the baseline characteristics. Differences in pre-post injection scores were determined and calculated as a percent change. Differences between patients who reported full or partial pain relief were determined using chi-square tests (χ^2) for categorical variables and by *t*-tests for continuous variables. A 2 × 2 repeated measures analyses of variance was used to determine if differences existed in the gait parameters between patients with different pain relief. The between subject factor was pain relief (full, partial) and the within subject factor was time point (pre-injection, post-injection). Cohen's *d* were calculated to determine the effect sizes in post-injection differences in gait parameters between patients with full and partial pain relief. Statistical significance was established at $p < 0.05$ á priori.

3. Results

3.1. Patient characteristics

Table 1 provides the characteristics of all patients, and patients when separated by pain relief post-injection. There were no significant

Table 1
Survey responses from study participants. Values are expressed in points and are shown in mean ± SD. All scores are significantly different between groups at $p < 0.001$.

	Healthy (n = 30)	Back Pain (n = 25)	p (sig)
Women (%, #)	43.3 (13)	60.0 (15)	0.223
Age (yr)	31.9 ± 12.4	51.2 ± 17.9	0.001*
Height (cm)	173.2 ± 9.6	171.0 ± 9.3	0.389
Weight (kg)	73.2 ± 12.9	81.5 ± 15.8	0.050*
Body mass index (kg/m2)	24.2 ± 2.7	27.8 ± 4.4	0.001*

* Denotes different between groups at $p < 0.05$.