Pain Medicine

Pain Medicine 2014; *: **–**
Wiley Periodicals, Inc.

Transforaminal Epidural Steroid Injections Followed by Mechanical Diagnosis and Therapy to Prevent Surgery for Lumbar Disc Herniation

Hans van Helvoirt, M.A., P.T., Dip MDT/MT,* Adri T. Apeldoorn, PhD,†‡ Raymond W. Ostelo, PhD,†§ Dirk L. Knol, PhD,† Mark P. Arts, PhD,¶ Steven J. Kamper, PhD,† and Maurits W. van Tulder, PhD†§**

*Medical Back Neck Centre, The Hague and Rugpoli Brabant Tilburg; ¶Department of Neurosurgery, Medical Center Haaglanden, The Hague; †Department of Epidemiology and Biostatistics, EMGO+ Institute for Health and Care Research, VU University Medical Centre; §Department of Health Sciences, EMGO+ Institute for Health and Care Research, Faculty of Earth and Life Sciences, VU University Amsterdam, Amsterdam; ‡Medical Centre Alkmaar, Alkmaar, The Netherlands; **The George Institute for Global Health, University of Sydney, Sydney, Australia

Reprint requests to: Hans van Helvoirt, M.A., P.T., dip MDT/MT, Medical Back Neck Centre, The Hague and Rugpoli Brabant Tilburg, Van Schoonbekestraat 115, 2018 Antwerpen, Belgium. Tel: +31 (6) 5101 9644; E-mail: hans.van.helvoirt@telenet.be.

Abstract

Study Design. Prospective cohort study.

Objective. To report the clinical course of patients with MRI-confirmed lumbar disc herniation-related radicular noncentralizing pain who received transforaminal epidural steroid injections (TESIs) and mechanical diagnosis and therapy (MDT).

Summary of Background Data. Noncentralizing symptoms in patients with lumbar disc herniation are associated with poor outcome. Commonly used treatments for these patients include TESIs and MDT. No study has evaluated the outcome of combining both strategies.

Methods. Consecutive candidates for herniated lumbar disc surgery with noncentralizing chronic pain were eligible. Patients received TESIs followed by MDT. The primary outcomes were pain severity in the leg, disability (Roland–Morris Disability Questionnaire for Sciatica), and global perceived effect (GPE). Outcomes were measured at baseline, discharge, and 12 months. Linear mixed-models and McNemar's tests were used to analyze outcome data.

Results. Sixty-nine patients receive TESIs. After TESIs, symptoms were resolved completely in 11 patients (16%). In these patients, symptom resolution was maintained at 12 months. A second subgroup of 32 patients (46%) reported significantly less pain after TESIs and showed centralization with MDT reassessment (significant reductions in leg pain and disability [$P < 0.001$]) and a satisfaction rate of 90% at 12 months. A third subgroup of 11 patients (16%) reported significantly less pain after TESIs but still showed noncentralization with MDT reassessment (significant reductions in leg pain and disability [$P < 0.05$] and a satisfaction rate of 50% at 12 months). A fourth subgroup of 15 patients (22%) did not respond on TESIs and received an operative intervention.

Conclusion. The results indicate that a course of TESIs followed by MDT may be able to avoid surgery in a substantial proportion of candidates for herniated lumbar disc surgery.

Key Words. Herniated Disc; Transforaminal Epidural Injection; MDT; Surgery

Introduction

Patients with sciatica due to a herniated lumbar disc often show signs of radiculopathy, with sensory and motor deficits and diminished muscle stretch reflexes [1]. The lifetime prevalence of radiculopathy due to a lumbar disc herniation is estimated at 5% in men and 4% in women [2,3]. The natural course is usually favorable, and for most clinicians, the first treatment option is conservative with nonsteroidal anti-inflammatory drugs and

physical therapy, including mechanical diagnosis and therapy (MDT) [4].

MDT evaluation involves the assessment of symptomatic and mechanical responses to repetitive end-range lumbar test movements (flexion, extension, side-gliding, or rotation) and/or prolonged positioning. A key to an MDT assessment is determination of whether the patient has centralizing pain. Centralizing pain means that the most distal pain abolishes in response to the end-range movements. Research has shown that if centralization occurs, the underlying pain source is likely to be a reversible derangement, and the first treatment option should be conservative mechanical treatment [5–7]. Furthermore, there is preliminary evidence that the results of MDT treatment are better for patients with centralizing symptoms compared with advice to stay active or nondirectional exercises [8,9].

In patients with noncentralizing pain and radiculopathy, some suggest the underlying pain source is most likely to be inflammation of a nerve root, and such pathology is unlikely to respond favorably to mechanical interventions [10–12]. In an effort to address the inflammation, these patients are commonly treated with transforaminal epidural steroid injections (TESIs) [11]. TESIs contain contrast material, local anesthetic, and steroids and target the inflamed nerve root under fluoroscopy guidance. For TESIs, there is moderate evidence for short-term relief, but the effectiveness at long-term is unclear [13–20]. There is also preliminary evidence to suggest that treatment with TESIs may enable some patients to avoid surgery [14,18,19].

In our clinical experience, patients with noncentralizing pain frequently change to a centralizing pain pattern after treatment with TESIs. Therefore, we hypothesised that the effects of TESIs could be optimized by treating patients with individually tailored MDT after they have received their course of injections. This intervention includes directional preference exercises for patients with centralizing pain and patient-centered information and advice to stay active for patients with ongoing noncentralizing pain. The course of symptoms in patients receiving this therapeutic combination has not yet been reported.

The primary aim of this study was to evaluate the short- and long-term outcomes of patients with noncentralizing pain and radiculopathy due to herniated lumbar discs treated with TESIs followed by MDT if appropriate. The secondary aim was to determine the differences in baseline characteristics between patients that received an operation during the follow-up period of this study and those that did not.

Methods

Recruitment

Patients that were referred for and consented to herniated disc surgery were eligible for inclusion in the study. Determination of suitability for surgery was performed by neurosurgeons and orthopedic surgeons according to CBO (Dutch Institute for Healthcare Improvement) guidelines for surgery in herniated disc lesions [21]. Eligible patients were offered participation in the study which involved a trial of the TESI/MDT combination treatment prior to undergoing surgery. Patients were referred to one of two interdisciplinary intervention clinics for spinal pain in the Netherlands. All patients had already received treatment according to the Dutch guidelines, including medication (analgesics, NSAIDS) and physical therapy [22,23]. Inclusion criteria were lower extremity pain with or without low back pain (LBP), lower limb to axial pain ratio clearly favored radicular pain (leg > 50%), a lumbar disc herniation confirmed by MRI, two or more positive neurological signs (i.e., sensory and muscle deficits and diminished muscle stretch reflexes or <45° supine straight leg raise), and ability to speak Dutch or English. Patients were assessed during two MDT diagnostic sessions in order to classify individual patients' pain as "centralizing" or "noncentralizing." No MDT treatment was given before injections. If no centralizing pain response was observed on either the first or second MDT session, the patient was eligible for the present study and enrolled if they provided informed consent. The MDT assessment was performed by two diplomat MDT (maximum competence level) therapists and one credentialed MDT (basic competence level) therapist. Research has shown good reliability for observing these responses when done by therapists with sufficient MDT training [24,25]. Patients were excluded if centralizing pain was observed at the initial MDT assessment. Other exclusion criteria were pregnancy, a contraindication for the use of corticosteroids or fluoroscopy (e.g., allergy for corticosteroids) and specific causes of LBP that were not directly related to herniated discs (e.g., [suspicion of] malignancy, fractures, spinal stenosis, severe cases of spondylolisthesis [grade 2 or more]). Data were prospectively collected in two time periods, from August 2008 to October 2008 and from November 2009 to March 2010. The Regional Medical Ethics Committee North Holland determined that formal ethical approval was not required because the study involved only usual care and outcome measurements consistent with daily practice.

Combination Therapy

The first intervention consisted of TESIs. Patients were injected with dexamethasone 20 mg and lidocaïne 0.5cc 2% under fluoroscopic guidance with contrast medium (Omni Pac 240, Ge Healthcare A.S., Oslo, Norway) as prescribed by International Spinal Intervention Society (ISIS) guidelines [26]. TESI using fluoroscopic guidance brings a high concentration of corticosteroids precisely to its target zone [27]. If necessary, within 10–14 days, an appointment was made for extra injections. Segmental level was determined by MRI findings combined with clinical picture. All medical doctors (N = 4) involved in administering the TESIs were trained in and followed ISIS guidelines [26]. If pain relief was between 50% and 80% visual analog scale (VAS) (leg) or if the patient refused

another one, no further injection was provided. Doctors could give up to a maximum of four injections to optimize pain relief. All decisions were made in a shared decision-making process between the patient and physician. No further protocol was used to regulate the number and timing of the injections. TESIs were followed by an MDT assessment and MDT treatment if appropriate. A total of 10–14 days after the last injection, an MDT therapist reclassified each patient to determine whether patients' preinjections' pain responses had changed after injection therapy. Patients were reclassified and treated according to one of the following four subgroups based on pain response:

1. Resolved symptoms (i.e., no or irrelevant pain [VAS max. <5/100] response to MDT assessment). These patients were given advice using MDT principles.
2. Centralizing and significantly less pain according to the patient. These patients were treated according to MDT principles with direction-specific exercises and posture correction.
3. Noncentralizing and significant less pain according to the patient. These patients were treated with information using MDT principles and advice to stay active as much as possible, without causing significant exacerbation of leg pain.
4. Noncentralizing with high levels of pain and/or disability after TESIs. These patients received an operation. No injections were given after MDT reclassification.

Outcome Measures

The primary outcome measures were current (average over the last 24 hours) leg pain, back pain-related disability, and global perceived effect (GPE). Leg pain was measured using a 100-mm VAS ranging from 0 (no pain) to 100 (worst imaginable pain). Disability was measured using the Roland–Morris Disability questionnaire for Sciatica (RMDQs) [28]. In this modified version, five items of the original RMDQ scale were replaced by four others from the original Sickness Impact Profile. The RMDQs score is calculated by adding the number of positive answers into a sum score, which ranges from 0 (no disability) to 23 (maximum disability). GPE was measured using a 7-point Likert Scale, which ranged from 1 (completely recovered) to 7 (worse than ever). We dichotomized GPE into "satisfaction" (scores 1 and 2) and "nonsatisfaction" (scores 3–7).

Secondary outcome measures were current (average last 24 hours) back pain, anxiety, depression, medication use, work status, other treatments during the follow-up period including lumbar surgery, and complications due to any of the study treatments. Back pain was measured with a 100-mm VAS ranging from 0 (no pain) to 100 (worst imaginable pain). Anxiety and depression was measured with the Hospital Anxiety and Depression Scale [29]. The questionnaire contains two subscales of seven items for depression and seven items for anxiety; each item is scored from 0 (no) to 3 (max). Minimum clinically relevant improvement was set at 30% reduction of leg pain VAS or RMDQs score [30]. To regard the therapy as a "success," we used a more strict definition (i.e., the patient was not operated during the follow-up period of 12 months), and both leg pain (VAS) and disability (RMDQs) improved ≥50% compared with baseline. Other data gathered were age, sex, duration of the complaints, number of TESIs, and number of MDT treatment sessions. Data were collected at intake, at MDT discharge between 4 and 7 weeks (short term), and at 12 months after intake (long term).

Data Analysis

Linear mixed model analysis was used for continuous data to examine short- and long-term outcomes in the nonsurgery group. To account for dependency of the responses, an unstructured covariance matrix was chosen. To assess the influence of regression to the mean (i.e., a variable that is extreme on its first measurement will tend to be closer to the center of the distribution for a later measurement) for nonsurgery patients at short term, a scatterplot of change against baseline was constructed for disability and pain severity in the leg. As the dichotomized outcomes of satisfaction, minimum clinically relevant improvement, and success could not be determined at baseline, percentages were calculated only at short term (discharge) and long term (12 months). Differences between discharge and 12-month percentages were evaluated by McNemar's tests.

For the patients who did undergo surgery only, baseline and short-term outcomes were available, and dependent *t*-tests and Wilcoxon signed rank tests were used to evaluate short-term treatment effects. Finally, independent *t*-tests, Mann–Whitney tests, and chi-squared tests with continuity correction were used to assess differences in baseline characteristics between the groups that did and did not receive an operation. For all tests, $P < 0.05$ (two-tailed) was considered significant. The data were analyzed using IBM SPSS Statistics Version 20.0 (IBM Corporation, Armonk, NY, USA)

Results

A total of 132 potentially eligible participants were screened of which 71 patients met all inclusion criteria and were enrolled in the study. The reasons for ineligibility were pain duration less than 12 weeks (N = 8), centralizing pain response (N = 41), insufficient understanding of English or Dutch language (N = 4), refused injections (N = 5), and undefined reasons (N = 3). Of the 71 patients who participated and were injected, two patients dropped out: one moved to another address and did not want to continue participation and one refused further cooperation; no follow-up data were available for these patients (Figure 1). This resulted in a final study sample with 69 patients. Table 1 presents the description of the patients at baseline.

TESIs and MDT

The number of injections varied from one to four (one, 15%; two, 65%; three, 13%; four, 7%). In multilevel

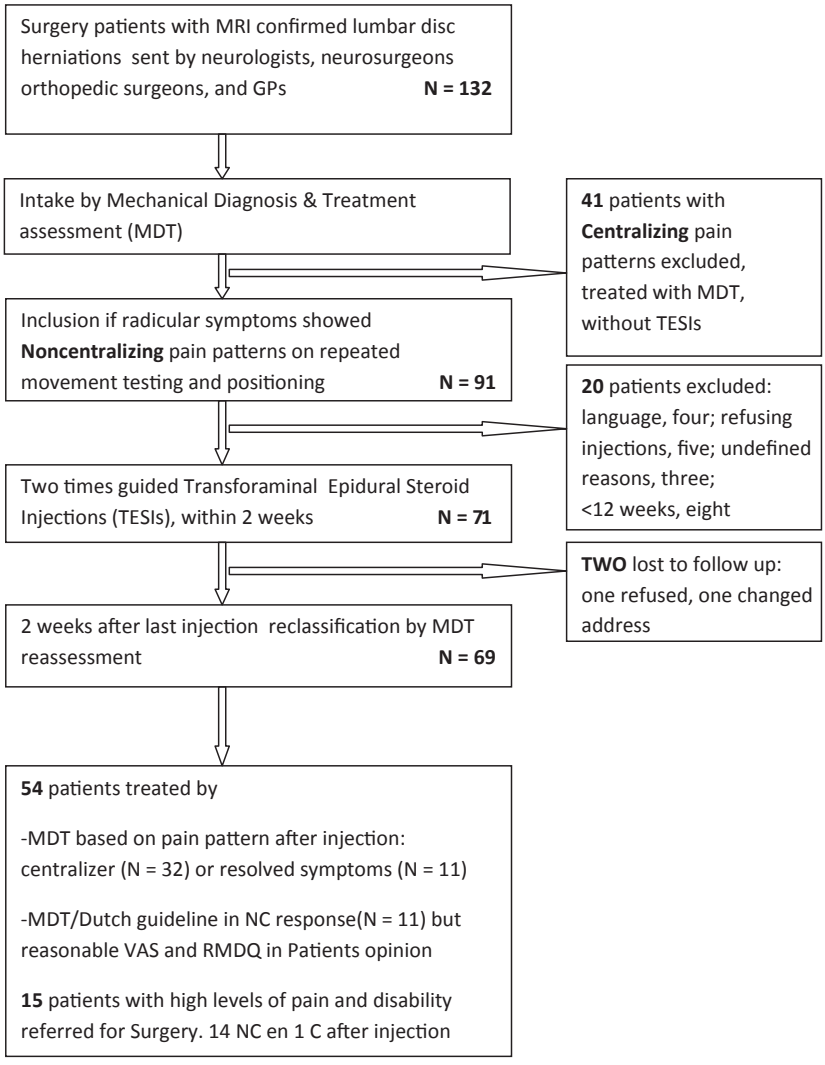

Figure 1 Flow chart.

Table 1 Baseline characteristics (N = 69)

Characteristics	%
Age, years†	47.3 (9.4)
Male	49.3
Previous lower back surgery	2.9
Duration of current LBP, months‡	9.0 (5.0–24.0)
Continuous pain in the lower back	56.1
Continuous pain in the leg	57.6
Currently taking medication for LBP	59.4
Pain in sitting	75.4
Employed	91.0
Employed and currently working	50.8
Employed but currently working fewer hours or lighter duty	4.9
Employed but currently on sick leave	44.3

Values are percentages unless otherwise indicated.
† Mean (standard deviation).
‡ Median and interquartile range.
LBP = low back pain.

hernias, three or four TESIs were used. After receiving their course of TESI treatment, the 69 patients were classified into four subgroups using MDT assessment. A total of 11 patients (15.9%) were classified in the first subgroup (resolved symptoms), 32 patients (46.4%) in the second subgroup (centralizing and significantly less pain), and 11 patients (15.9%) in the third subgroup (noncentralizing and significantly less pain). Initially, 14 patients (20.2%) were classified in the fourth subgroup (noncentralizing with ongoing high levels of pain and disability). One patient did not fit into any of the subgroups because of high levels of pain and disability but centralizing pain during MDT reassessment. Eventually, this patient was categorized in the last subgroup and was referred for lumbar disc surgery after not responding to MDT treatment. Therefore, the latter subgroup consisted of 15 patients (21.7%).

The 11 patients who were pain free after TESIs received one or two MDT sessions (mean 1.2; standard deviation [SD] 0.4). The 43 patients (62.3%) in subgroups two and three with partially reduced symptoms after TESIs were

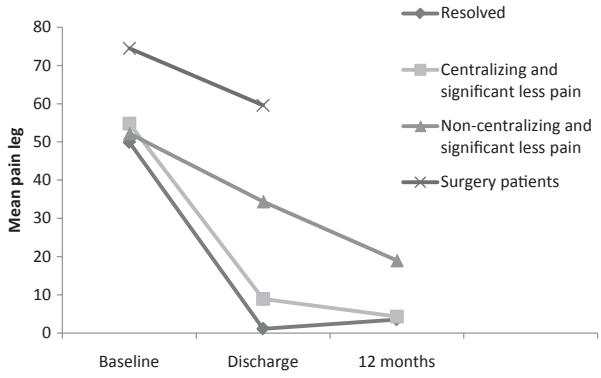

Figure 2 Short- and long-term mean pain in the leg scores for four subgroups.

treated with a mean of 3.6 (SD 1.4) and 2.7 (SD 1.8) MDT sessions, respectively. The 15 patients in the latter subgroup received a mean of 2.7 (SD 0.8) MDT sessions.

Short- and Long-Term Results

The short- and long-term results for the patients in the four subgroups are presented in Tables 2 and 3 and Figures 2 and 3. None of the 54 patients (78.3%) with partially or completely resolved symptoms (the first three groups) underwent surgery during the follow-up period of 12 months. The 15 patients (21.7%) whose high levels of pain and/or disability continued after TESIs all underwent surgery. All except one (N = 14) were referred for surgery almost immediately after MDT reassessment.

Nonsurgery Patients

Over the course of the study, mean levels of pain in the leg and disability decreased significantly compared with the baseline values in the 54 patients that did not receive surgery (Table 2 and Figures 2 and 3). For the first subgroup (resolved symptoms), the recovery rates were 100% at discharge and at 12 months. For the second subgroup (centralizing and significantly less pain), the satisfaction rates were at discharge and 12 months, 100% and 90%, respectively. The third subgroup (noncentralizing and significantly less pain) showed least favorable satisfaction rates, 27% at discharge and 50% at 12 months. The mean scores for the secondary outcome measures, lower back pain, depression, and anxiety, decreased significantly for the first two subgroups but not significantly for the third subgroup.

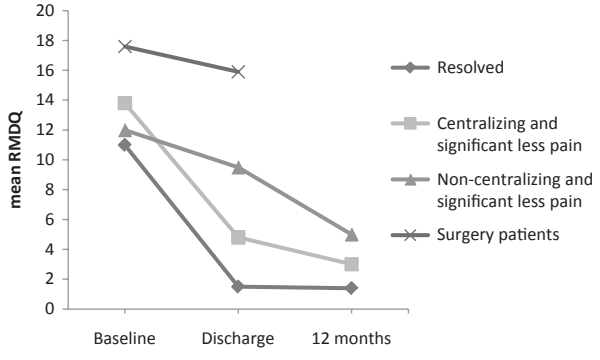

Figure 3 Short- and long-term Roland–Morris Disability Questionnaire for sciatica (RMDQ) scores for four subgroups.

Work restrictions and sick leave for the 54 patients decreased from 40% at baseline to 15% at short term and 10% at long term. Use of pain medication decreased from 54% at baseline to 11% at short term and to 6% at long term. During the 12-month follow-up period, 21% of the patients received additional physical therapy (mostly graded activity) in addition to MDT.

To assess the influence of regression to the mean for nonsurgery patients at short term, the data were log-transformed to make them approximately normally distributed. A scatterplot of change against baseline showed that there was no clear tendency that large or small measurements at baseline were followed by measurements closer to the mean at discharge ($r^2 = 0.06$ for disability and $r^2 = 0.04$ for pain severity in the leg).

The 15 patients who underwent surgery reported statistically significant positive effects for pain in the leg and back but not for disability, anxiety, and depression after TESIs (Table 3). Only one patient (6.7%) was satisfied at discharge. No long-term follow-up measurements were collected for these patients, as such, their clinical status after surgery is unknown.

Table 4 shows that these patients had significantly higher baseline scores on pain (leg and lower back), disability, anxiety, and depression compared with the nonsurgery patients. This group also had a lower employment rate.

Discussion

This study followed a cohort of candidates for lumbar disc surgery with noncentralizing radicular pain. TESIs were administered, followed by MDT reassessment, the findings from which guided the subsequent treatment. The results suggest that the combination of TESIs and MDT might reduce surgery rates in this population. Of the 69 patients referred for surgery in the study, only 22% of patients actually required an operation during the following year. The fact that most of our patients had chronic complaints suggests that improvements in our cohort were not due to natural history. Our analyses also confirmed that improvements were unlikely to be due to regression to the mean.

Discussion about the role of TESIs is ongoing, and evidence for their effectiveness is not clear. Reviews about TESIs have come to different conclusions. Pinto et al. [31] found only evidence to support the use of epidural

Table 2 Short- and long-term mean scores for three nonsurgery subgroups on primary and secondary outcome measures

Subgroup	Resolved Symptoms (N = 11)				Centralizing and Significant Less Pain (N = 32)				Noncentralizing and Significant Less Pain (N = 11)			
	Baseline	Discharge			Baseline	Discharge			Baseline	Discharge		
Primary Outcomes	(95% CI)	(95% CI)	1 year (95% CI)	*P* value	(95% CI)	(95% CI)	1 year (95% CI)	*P* value	(95% CI)	(95% CI)	1 year (95% CI)	*P* value
RMDQs (0–23)	11.0 (7.0–15.0)	1.5 (0.4–2.6)	1.4 (0.6–2.1)	0.001	13.8 (12.1–15.4)	4.8 (3.5–6.1)	3.0 (1.7–4.2)	<0.001	12.0 (9.2–14.8)	9.5 (6.1–13.0)	5.5 (3.3–7.6)	0.012
Pain leg (0–100)	49.9 (31.0–68.8)	1.1 (0.0–2.2)	3.5 (−1.3 to 8.3)	<0.001	54.8 (46.6–63.1)	8.9 (5.0–12.8)	4.3 (0.7–8.0)	<0.001	52.2 (31.5–72.8)	34.4 (17.0–51.8)	19.0 (4.1–34.0)	0.049
Satisfaction (GPE; completely recovered and much improved)† %		100	100			100	90			27	50	
Secondary Outcomes												
Pain lower back (0–100)	39.8 (22.8–56.9)	2.0 (0.1–3.9)	3.4 (−2.0 to 8.7)	0.001	45.7 (37.6–53.7)	12.1 (7.5–16.6)	8.0 (2.7–13.4)	<0.001	34.4 (22.5–46.3)	32.6 (14.9–50.4)	21.4 (7.7–35.2)	0.102
HADSA (0–21)	2.4 (1.6–3.1)	1.4 (0.7–2.0)	1.4 (0.6–2.1)	0.023	5.2 (4.1–6.2)	3.1 (2.3–3.9)	2.7 (2.0–3.4)	<0.001	5.2 (2.5–7.9)	4.4 (1.7–7.1)	4.4 (2.2–6.7)	0.365
HADSD (0–21)	2.7 (1.5–4.0)	1.1 (0.4–1.8)	1.2 (0.6–1.8)	0.010	5.0 (3.9–6.0)	3.0 (2.2–3.8)	2.3 (1.6–3.0)	<0.001	5.7 (3.3–8.2)	5.1 (2.3–7.9)	3.7 (1.4–6.1)	0.119
MCRI pain leg (≥30% improved from baseline)† %		100	100			97	94			50	89	
MCRI disability (RMDQs ≥30% improved from baseline)† %		100	100			91	97			27	60	
Success (pain leg and RMDQs ≥50% improved from baseline)† %		100	100			81	84			20	44	

Values presented are estimates of linear mixed model analysis (except dichotomized variables†).
CI = confidence interval; GPE = Global perceived effect; HADSA = Hospital Anxiety Depression Scale for Anxiety; HADSD = Hospital Anxiety Depression Scale for Depression; MCRI = Minimum clinically relevant improvement; RMDQ = Roland–Morris Disability Questionnaire for sciatica.

Table 3 Short-term mean scores on primary and secondary outcome measures for surgery patients (N = 15)

Primary Outcomes	Baseline	Short Term	*P* value
RMDQs (0–23)	17.6 (3.9)	15.9 (5.4)	0.149
Pain leg (0–100)	74.5 (17.5)	59.6 (25.4)	0.042
Satisfaction (GPE; completely recovered and much improved)		7%	
Secondary Outcomes			
Pain lower back (0–100)†	60.0 (48.0–81.0)	51.0 (23.3–70.0)	0.006
HADSA (0–12)†	9.0 (4.0–12.0)	8.0 (3.0–11.0)	0.093
HADSD (0–12)	8.1 (3.8)	7.3 (3.9)	0.075
MCRI pain leg (≥30% improved from baseline)*		29%	
MCRI disability (RMDQs ≥30% improved from baseline)*		7%	

Values are mean (standard deviation) unless otherwise indicated.
† Median and interquartile range.
RMDQ = Roland–Morris Disability Questionnaire for sciatica; GPE = Global perceived effect; HADSA = Hospital Anxiety Depression Scale for Anxiety; HADSD = Hospital Anxiety Depression Scale for Depression; MCRI = Minimum clinically relevant improvement.

injections in radicular symptoms in the short term, with no difference between different approaches. Buenaventura et al. [27] found moderate evidence for short-term relief and low-level evidence for long-term improvement in managing lumbar and sciatic pain using TESIs. In a more recent review, Manchikanti et al. [11] reported evidence for the effectiveness of TESIs for patients with lumbar disc herniation. Given that 54 patients (78.3%) in our study reported partially or completely reduced symptoms directly after TESIs, our results are also suggestive of a beneficial effect. To our knowledge, this is the first study which has shown the impact of TESIs on the pattern of pain centralization. In nearly half of the patients (N = 32, 46.4%), the initially noncentralizing symptoms changed to a centralizing pattern after TESIs. This is an important observation because studies have shown that the outcome of conservative treatment is more favorable in patients with centralizing pain than those with noncentralizing pain [23,32]. It might be that this change in pain pattern is due to a reduction of inflammation around the nerve root induced by TESIs. We hypothesize that this inflammation was obstructing reduction of the mechanical derangement by MDT before the TESIs. In our view, TESIs should not be applied as a standalone intervention but should be followed by physical therapy where appropriate. We believe that MDT and physical therapy should be

Table 4 Differences at baseline between patients who underwent surgery or not during the follow-up period of 12 months (N = 69)

Characteristics	Nonoperated Patients (N = 54)	Operated Patients (N = 15)	*P* values
Age in years	47.5 (10.0)	46.5 (7.0)	0.704
Male, %	51.9	40.0	0.603
Previous lower back surgery, %	1.9	6.7	0.910
Duration of current LBP in months†	9.5 (5.8–24.0)	6.0 (4.0–24.0)	0.479
Continuous pain in the lower back, %	54.9	60.0	0.957
Continuous pain in the leg, %	56.9	60.0	1.000
Currently taking medication for LBP, %	53.7	80.0	0.124
Pain in sitting, %	72.0	86.7	0.415
Employed, %	96.2	71.4	0.020
Roland–Morris Disability Questionnaire (0–23)	12.8 (4.8)	17.7 (3.8)	0.001
Pain leg (0–100)	53.3 (25.3)	74.9 (16.9)	<0.001
Pain lower back (0–100)†	43.0 (24.0–56.3)	60.0 (48.0–81.0)	0.011
HADSA (0–12)†	4.0 (2.0–7.0)	9.0 (4.0–12.0)	0.003
HADSD (0–12)	4.7 (3.1)	8.1 (3.7)	0.001

Values are the mean (standard deviation) unless otherwise indicated.
† Median and interquartile range.

provided in patients whose pain is not completely resolved after TESIs. Besides MDT reassessment findings can guide further treatment options.

A total of 25 patients (36%) remained noncentralizers after TESIs of whom 14 underwent surgery shortly after receiving their course of TESIs. Only one patient with centralization symptoms at MDT reclassification underwent surgery a half year after TESIs due to ongoing high levels of pain and disability. Our results are in line with Skytte et al. [23] who found that patients whose leg pain did not centralize were six times more likely to receive an operation.

Substantial baseline differences were observed between patients who went on to have surgery and those that did not. At baseline, patients who underwent surgery scored significantly higher on disability, pain in the leg, pain in the back, anxiety, and depression compared with the nonsurgery patients. These results are in concordance with other studies [19,33]. It may be possible to distinguish these patients at baseline; however, further investigation to explore the sensitivity and specificity of any screening is necessary.

To the authors' knowledge, only one small pilot RCT has studied the effect of TESIs as standalone treatment vs TESIs combined with physical therapy. The researchers found no additional effect of physical therapy, and both groups showed a 50% decrease in pain and disability at 6-month follow-up [33]. The researchers did not classify the patients with MDT. A review of four high-quality studies concluded that patients could expect a 70% pain relief and 60% less disability following TESIs [27]. As our study sampled a chronic population with noncentralizing symptoms, our results may not be directly comparable with other studies. However, in the present study, 94% of the patients had improved to a clinically important extent on pain and 90% on disability in the nonsurgery group at 1 year. This may indicate that management matched to the different response groups based on MDT assessment after TESIs improves outcomes even further.

Limitations

We did not include a control group, and therefore, we cannot draw firm conclusions regarding the relative effects of TESI and MDT or the effect of the combination compared with other strategies. High-quality randomized controlled trials are necessary to study the effects of combined treatment compared with TESIs alone or with other conservative treatments or surgery.

We did not attempt to categorize the morphology of disc herniations or grade of nerve root compression on MRI; hence, the specific effects of the treatments on the disc and nerve root structures are unknown. We did not have access to long-term data from the group that received surgery, so we could not compare the clinical outcome in this group.

Conclusions

We studied a group of surgical candidates with chronic (≥12 weeks) radicular pain due to lumbar disc herniations and a poor prognosis for conservative treatment (i.e., noncentralization). Most of our patients experienced significant and clinically relevant improvements on all outcome measures at short and long term after treatment of TESIs and matched MDT treatment.

After injections, nearly half the sample demonstrated centralization, which has established prognostic validity, and almost all patients that needed an operation demonstrated noncentralization after TESIs. A total of 78% of the patients did not need surgery during the follow-up period of 1 year. The results of this study indicate that TESIs followed by MDT have the potential to be an effective strategy in preventing surgical interventions for patients with lumbar disc herniation. Further research is needed on the effectiveness and cost-effectiveness of TESIs alone and in combination with conservative treatments to avoid surgery in patients with lumbar disc herniations.

References

1 Frymoyer JW. Back pain and sciatica. N Engl J Med 1988;318:291–300.

2 Heliovaara M, Knekt P, Aromaa A. Incidence and risk factors of herniated lumbar intervertebral disc or sciatica leading to hospitalization. J Chronic Dis 1987;40:251–8.

3 Manninen P, Riihimak H, Heliovaara M. Incidence and risk factors of low-back pain in middle-aged farmers. Occup Med 1995;45:141–6.

4 McKenzie R, May S. The lumbar spine. Mechanical diagnosis & therapy, Vol. 1&2, 2nd edition. Waikanae: Spinal Publications New Zealand Ltd; 2003.

5 Donelson R, Aprill C, Medcalf R, Grant W. A prospective study of centralization of lumbar and referred pain. A predictor of symptomatic discs and anular competence. Spine 1997;22:1115–22.

6 Broetz D, Burkard S, Weller M. A prospective study of mechanical physiotherapy for lumbar disk prolapse: Five year follow-up and final report. Neurorehabilitation 2010;26:155–8.

7 Albert HB, Manniche C. The efficacy of systematic active conservative treatment for patients with severe sciatica: A single-blind, randomized, clinical, controlled trial. Spine 2012;37:531–42.

8 Kilpikoski S, Alen M, Paatelma M, et al. Outcome comparison among working adults with centralizing low back pain: Secondary analysis of a randomized controlled trial with 1-year follow-up. Adv Physiother 2009;11:210–2.

9 Long A, Donelson R, Fung T. Does it matter which exercise? A randomized control trial of exercise for low back pain. Spine 2004;29:2593–602.

10 Donelson R. Mechanical diagnosis and therapy for radiculopathy. Phys Med Rehabil Clin N Am 2011;22: 75–89.

11 Manchikanti L, Buenaventura RM, Manchikanti KN, et al. Effectiveness of therapeutic lumbar transforaminal epidural steroid injections in managing lumbar spinal pain. Pain Physician 2012;15:E199–245.

12 Brisby H. Pathology and possible mechanisms of nervous system response to disc degeneration. J Bone Joint Surg Am 2006;88(suppl 2):68–71.

13 Cohen SP, White RL, Kurihara C, et al. Epidural steroids, etanercept, or saline in subacute sciatica: A multicenter, randomized trial. Ann Intern Med 2012;156:551–9.

14 Ghahreman A, Ferch R, Bogduk N. The efficacy of transforaminal injection of steroids for the treatment of lumbar radicular pain. Pain Med 2010;11:1149–68.

15 Karppinen J, Malmivaara A, Kurunlahti M, et al. Periradicular infiltration for sciatica: A randomized controlled trial. Spine 2001;26:1059–67.

16 Ng L, Chaudhary N, Sell P. The efficacy of corticosteroids in periradicular infiltration for chronic radicular pain: A randomized, double-blind, controlled trial. Spine 2005;30:857–62.

17 Tafazal S, Ng L, Chaudhary N, Sell P. Corticosteroids in peri-radicular infiltration for radicular pain: A randomised double blind controlled trial. One year results and subgroup analysis. Eur Spine J 2009; 18:1220–5.

18 Vad VB, Bhat AL, Lutz GE, Cammisa F. Transforaminal epidural steroid injections in lumbosacral radiculopathy: A prospective randomized study. Spine 2002;27:11–6.

19 Riew KD, Yin Y, Gilula L, et al. The effect of nerve-root injections on the need for operative treatment of lumbar radicular pain. A prospective, randomized, controlled, double-blind study. J Bone Joint Surg Am 2000;82-A:1589–93.

20 Riew KD, Park JB, Cho YS, et al. Nerve root blocks in the treatment of lumbar radicular pain. A minimum five-year follow-up. J Bone Joint Surg Am 2006; 88:1722–5.

21 CBO. Richtlijn lumbosacraal radiculair syndroom [Dutch institute for Health Care Improvement: Guideline lumbosacral radicular syndrome]. Utrecht: CBO: 2008.

22 Mens JMA, Chavannes AW, Koes BW, et al. NHG-Standaard Lumbosacraal radiculair syndroom (Eerste herziening) [Dutch College of General Practitioners' guideline lumbosacral radicular syndrome (first update). Huisarts Wet 2005;48:171–8.

23 Skytte L, May S, Petersen P. Centralization: Its prognostic value in patients with referred symptoms and sciatica. Spine 2005;30:E293–9.

24 Clare HA, Adams R, Maher CG. Reliability of McKenzie classification of patients with cervical or lumbar pain. J Manipulative Physiol Ther 2005;28:122–7.

25 Kilpikoski S, Airaksinen O, Kankaanpaa M, et al. Interexaminer reliability of low back pain assessment using the McKenzie method. Spine 2002;27:E207–14.

26 Bogduk N. Practice guidelines for spinal diagnostic and treatment procedures. San Francisco. Kentfield: International Spinal Intervention Society; 2004.

27 Buenaventura RM, Datta S, Abdi S, Smith HS. Systematic review of therapeutic lumbar transforaminal epidural steroid injections. Pain Physician 2009;12: 233–51.

28 Patrick DL, Deyo RA, Atlas SJ, et al. Assessing health-related quality of life in patients with sciatica. Spine 1995;20:1899–908.

29 Zigmond AS, Snaith RP. The hospital anxiety and depression scale. Acta Psychiatr Scand 1983;67: 361–70.

30 Ostelo RW, Deyo RA, Stratford P, et al. Interpreting change scores for pain and functional status in low back pain: Towards international consensus regarding minimal important change. Spine 2008;33:90–4.

31 Pinto RZ, Maher CG, Ferreira ML, et al. Epidural corticosteroid injections in the management of sciatica: A systematic review and meta-analysis. Ann Intern Med 2012;157:865–77.

32 Werneke M, Hart DL. Centralization phenomenon as a prognostic factor for chronic low back pain and disability. Spine 2001;26:758–64.

33 Thackeray A, Fritz JM, Brennan GP, Zaman FM, Willick SE. A pilot study examining the effectiveness of physical therapy as an adjunct to selective nerve root block in the treatment of lumbar radicular pain from disk herniation: A randomized controlled trial. Phys Ther 2010;90:1717–29.