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Clinical Study

Percutaneous laser disc decompression versus conventional microdiscectomy in sciatica: a randomized controlled trial

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Abstract

BACKGROUND CONTEXT: Percutaneous laser disc decompression (PLDD) is a minimally invasive treatment for lumbar disc herniation, with Food and Drug Administration approval since 1991. However, no randomized trial comparing PLDD to conventional treatment has been performed.

PURPOSE: In this trial, we assessed the effectiveness of a strategy of PLDD as compared with conventional surgery.

STUDY DESIGN/SETTING: This randomized prospective trial with a noninferiority design was carried out in two academic and six teaching hospitals in the Netherlands according to an intent-to-treat protocol with full institutional review board approval.

PATIENT SAMPLE: One hundred fifteen eligible surgical candidates, with sciatica from a disc herniation smaller than one-third of the spinal canal, were included.

OUTCOME MEASURES: The main outcome measures for this trial were the Roland-Morris Disability Questionnaire for sciatica, visual analog scores for back and leg pain, and the patient's report of perceived recovery.

METHODS: Patients were randomly allocated to PLDD (n=57) or conventional surgery (n=58). Blinding was impossible because of the nature of the interventions. This study was funded by the Healthcare Insurance Board of the Netherlands.

FDA device/drug status: Approved for this indication (percutaneous laser disc decompression).

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The disclosure key can be found on the Table of Contents and at www.TheSpineJournalOnline.com.

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RESULTS: The primary outcome, Roland-Morris Disability Questionnaire, showed noninferiority of PLDD at 8 (−0.1; [95% confidence interval (CI), −2.3 to 2.1]) and 52 weeks (−1.1; 95% CI, −3.4 to 1.1) compared with conventional surgery. There was, however, a higher speed of recovery in favor of conventional surgery (hazard ratio, 0.64 [95% CI, 0.42–0.97]). The number of reoperations was significantly less in the conventional surgery group (38% vs. 16%). Overall, a strategy of PLDD, with delayed surgery if needed, resulted in noninferior outcomes at 1 year.
CONCLUSIONS: At 1 year, a strategy of PLDD, followed by surgery if needed, resulted in noninferior outcomes compared with surgery.

Keywords: Sciatica; Disc herniation; Discectomy; Minimal invasive techniques; Randomized clinical trial; Percutaneous disc decompression

Introduction

Lumbar disc herniation is the most common cause of the lumbosacral radicular syndrome, also known as sciatica. Most patients recover from their sciatica with conservative treatment within a period of 6 weeks [1]. An additional number of patients may recover during the next 6 months, but their sciatica can be severe and debilitating. In these cases, it is difficult to decide on surgical intervention and the timing thereof [2]. In general, this intervention consists of a microdiscectomy, in which the herniated disc fragment is removed. A drawback of surgery, however, is potential damage to posterior elements and muscles, possibly resulting in back pain that is frequently unresponsive to the back pain in the current treatments.

Theoretically, minimally invasive (percutaneous) procedures are of shorter duration, safer, require less hospital time, enable faster recovery, and cause less scarring. However, if these benefits are reached at the cost of a lower efficacy is not clear. One of these minimally invasive techniques is percutaneous laser disc decompression (PLDD), which is based on the principle of decreasing the intradiscal pressure by applying laser-induced heat to the nucleus pulposus [3]. Although the US Food and Drug Administration approved this treatment in 1991, no randomized controlled trials were performed to date, and its effectiveness has not been evaluated systematically [4].

In this article, we present the results of the first randomized controlled trial comparing the effectiveness of a strategy of PLDD with the strategy of conventional surgery in patients with sciatica refractory to conservative treatment.

Materials and methods

We performed a multicenter randomized prospective open trial aimed at showing noninferiority of the treatment effect of a PLDD strategy to the strategy of conventional surgery. Both treatments were compared in a parallel-group design with the Roland-Morris Disability Questionnaire (RDQ) for sciatica (the primary measure on which the study was powered), visual analog scale (VAS) for back and leg pain, and 7-point Likert scale of perceived recovery as other primary outcome measures. The trial was registered in Current Controlled Trials ISRCTN25884790. Details of the design of this study have been published previously [5]. We received full approval of the institutional review boards of all participating hospitals, and written informed consent was obtained from all patients.

Patients and randomization

All patients between 18 and 70 years with sciatica that was refractory to conservative management for more than 6 to 8 weeks and who were candidates for surgery were considered eligible for inclusion in the trial if a disc herniation at the corresponding level was shown by magnetic resonance imaging and if the herniated fragment was smaller than one-third of the spinal canal (Fig. 1). This subgroup of herniations was considered suitable for this kind of treatment based on early PLDD publications [6,7]. Herniated discs without magnetic resonance imaging–confirmed nerve root compression were excluded from the study as were patients with cauda equina syndrome, previous spinal surgery at the same disc level, lytic or degenerative spondylolisthesis, sequestered disc herniation, disc height less than 7 mm, central canal stenosis, pregnancy, severe somatic or psychiatric diseases, inadequate knowledge of the Dutch language, or emigration planned within 1 year of study inclusion. All eligible patients were examined and questioned by the treating neurosurgeon and a research nurse who recorded the baseline variables, follow-up questionnaires, and outcome measures. Patients were randomly allocated to a strategy of PLDD or conventional surgery on a 1:1 ratio. A computer-generated randomization list was prepared for each research nurse and each of the participating academic hospitals (n=2) and teaching hospitals (n=6). Blocks of random size (varying between two and four) of random numbers were formed to ensure equal distribution of the randomization among hospitals and nurses, the variable block size being used to minimize predictability. The data manager at the Department of Medical Statistics and Bioinformatics, who was not involved in the selection and allocation of patients, prepared coded sealed envelopes containing the treatment allocation. The envelopes were opened in the

presence of the patients to learn their allocation group. Treatment was planned within the subsequent 4 weeks.

Intervention

Conventional surgery consisted of a discectomy performed under general or spinal anesthesia. The aim of the surgery was to remove the herniated disc fragment, without any attempt to remove the disc itself, using a unilateral transflaval approach. Patients were operated with loupe magnification or microscope depending on the surgeon's preference. All the participating surgeons had extensive experience in the technique. The length of hospital stay was in keeping with the usual care of the participating hospitals.

In the PLDD group, computed tomography–guided treatment was performed with the patient in prone position under local anesthesia. An 18-gauge needle was placed centrally in the nucleus pulposus and parallel to the end plates by means of a posterolateral approach under local anesthesia and sterile conditions. Through the needle, a glass fiber of 600 micron was advanced into the disc, enabling the application of laser energy (diode laser; Biolitec Inc, East Longmeadow, MA, USA; 980 nm, 7 W, 0.6-second pulses, and an interval of 1 second) to a total energy delivered of 1,500 J (2,000 J for L4–L5 level) (Fig. 1). The treatment took place in an outpatient setting and was performed by a radiologist with experience in interventional procedures.

Both treatment strategies were followed by active mobilization in the postoperative period. Early resumption of daily activities and work was encouraged.

Outcome measures

For assessment of outcomes, several validated outcome parameters were used. The primary outcome measure was the patient's self-reported functional disability in the modified 23-item RDQ for sciatica, which was used for the power calculation. For primary endpoint analyses, we also used the perceived recovery on the 7-point Likert scale and the 100-mm VAS for leg and back pain [8–10]. These scores were collected at 1, 3, 4, 6, 8, 12, 26, 38, and 52 weeks after randomization. Additional secondary outcome measures, at 4, 8, 26, and 52 weeks, were the functional and economic scores on the Prolo scale, bodily pain and physical functioning scores on the 36-Item Short Form Health Survey, sciatica frequency and bothersomeness index scores, neurological examination by the research nurse, and complication and reoperation rates [8,11–13]. Because of the fact that the PLDD treatment is performed without skin incision, without general/spinal anesthesia and in the radiology department, the patient could not be blinded for the randomized strategy. During the follow-up period, the research nurses were not blinded because the absence of the surgical scar was notable. Furthermore, it could not be guaranteed that the patients would not disclose the treatment they had had.

EVIDENCE & METHODS

Context
Percutaneous laser disc decompression (PLDD) of the lumbar spine has been approved for more than 20 years. No high quality investigation, however, has compared this treatment to conventional surgical approaches for lumbar disc decompression. The authors present results of a randomized, prospective, non-inferiority trial.

Contribution
In this study, 57 patients were randomized to PLDD and 58 underwent conventional decompression. An intent-to-treat analysis was performed. Non-inferiority of PLDD was demonstrated in the primary outcome measure. Patients who received PLDD were more likely, however, to necessitate further surgical intervention. The authors conclude that PLDD, with delayed conventional surgery if necessary, might be considered a viable treatment approach.

Implications
This study was a non-inferiority trial and as such was not designed to address which surgical approach was more effective, only that PLDD was not less effective than conventional surgery. It should be noted that the conventional approach consisted of open or microscope-assisted surgery and that, as the study began more than 10 years ago, findings may be different if this study was performed in the present. While the authors' conclusions may be supported by their findings, the need for further surgery in more than 1/3 of patients undergoing PLDD is clearly a concern, especially in the current cost-conscious environment.

—The Editors

Statistical analysis

The study was initially designed as an equivalence study comparing percentages of success on the RDQ scale. The study showed an accrual rate far lower than expected. For this reason, before the data were analyzed in any respect and thus without unblinding the study, the design was modified by the principal investigator in agreement with the project team, the funding agency (The Dutch Health Insurers Collective), and the institutional review board. The protocol was amended in two respects. First, the outcome measure was reverted to the underlying continuous RDQ scale (hence, clinically the same measure) to increase power, and second, the main statistical test was changed to a noninferiority design (instead of a symmetric equivalence design). A difference of four on the RDQ has been recognized as the minimum clinically important difference as long as the mean improvement is at least 11 points. By

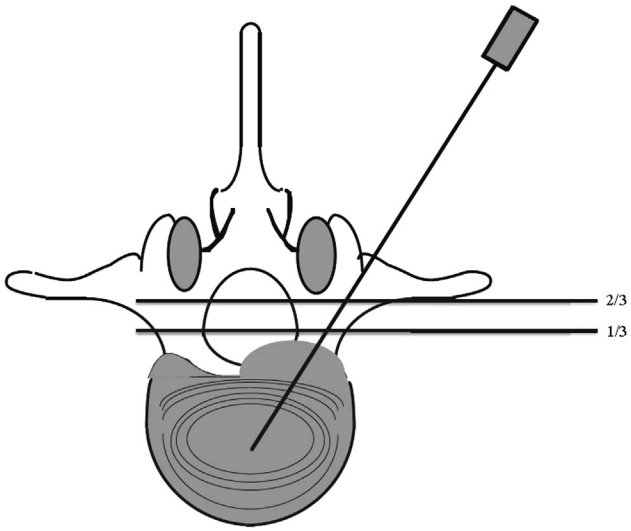

Fig. 1. Illustration of the disc herniation and route of the needle. The size of the disc herniation should be less than one-third of the spinal canal to be eligible for the trial. The needle is placed centrally in the nucleus pulposus via a posterolateral approach for the percutaneous laser disc decompression treatment.

using the 4 value as the upper limit of the equivalence interval, with an alpha level of 0.05, a power of 0.90, and a standard deviation of 5, the required sample size was 98 (49 per treatment arm). To adjust for an estimated 8% loss to follow up, we planned to include at least 110 patients.

The calculations were based on a comparison of averages at a single point in time.

Baseline data were compared between the two treatment groups using the chi-square or Student *t* test, as appropriate using a 95% confidence interval (CI). All analyses were performed in accordance with the intent-to-treat principle, analyzing all patients within their randomization groups, regardless of whether the allocated treatment was actually performed or completed.

When analyzing the RDQ as primary outcome measure, the primary analysis will consist of both a comparison at Weeks 8 and 52 (point estimates) and a repeated-measures analysis of variance (comparing the averages over the entire 1-year period).

In the analysis of the 7-point Likert scale, the scores are dichotomized defining recovery as complete or nearly complete. First occurrence of perceived recovery was used as the primary outcome variable in a Cox regression analysis, comparing rates of recovery by calculating a hazard ratio (HR). Both Kaplan-Meier estimates were used to estimate time elapsed between randomization and recovery, and curves were compared using the log-rank test (equivalent to testing the HR being equal to 1 in a univariate Cox model with a score test).

The secondary outcome measures were also assessed in a repeated-measures analysis of variance using a first-order autoregressive covariance matrix. The scores were expressed as means with 95% CIs and were tested

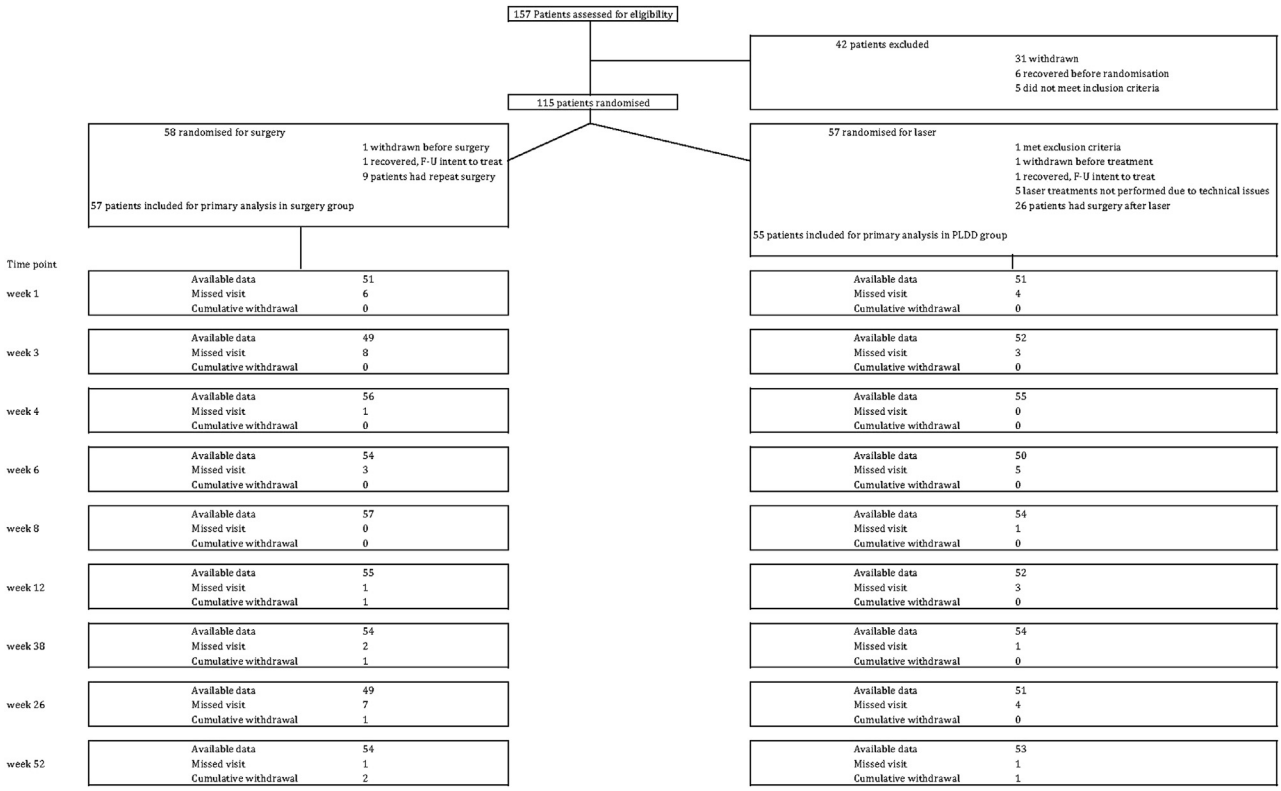

Fig. 2. Flowchart of patient inclusion.

for superiority. Pointwise estimates and their CI were obtained by using models with time as a categorical covariate to allow assessment of systematic patterns. The differences between randomization groups were determined by estimating the main effect at 8 and 52 weeks and the treatment-time interaction over the 52-week period. When assessing the treatment effect as a point estimate rather than an overall difference in repeated measurements, we prespecified two time points (8 and 52 weeks). Hence, corresponding tests using these point estimates need a Bonferroni correction for multiple testing, leading to an alpha of 2.5% instead of the usual 5% boundary.

In the intention-to-treat analysis, all observed data points were taken into account. Patients were never excluded from the repeated-measures analysis of variance, even when one or more observations for a patient were missing at specific time points but assumed to be missing at random.

All data were stored via the Internet-based secure data management system (Project Manager Internet Server, ProMISe) of the Department of Medical Statistics and Bioinformatics. Analyses were carried out by PAB and RB using SPSS software, version 17 (SPSS, Inc., Chicago, IL, USA).

Results

Patient characteristics

Between January 2005 and September 2007, we included 115 patients for the trial. Fifty-five patients were allocated to PLDD and 57 to surgery. Three patients were excluded after randomization (Fig. 2). Baseline characteristics showed no significant differences between both treatment groups (Table 1).

In five patients (9%), the PLDD treatment could not be performed because of either laser malfunction (n=1) or inability to reach the disc space (n=4) because of narrowing of the lateral disc space and/or the presence of spondylophytes. One patient, who was free of complaints after a failed PLDD treatment, was followed according to the intent-to-treat principle. Four patients (7%) underwent subsequent surgery, of which three also needed repeated surgical intervention within the next year. Twenty-one patients (38%) underwent additional surgery during the first year after technically successful PLDD treatment leading of a total of 24 (44%) patients receiving additional surgical intervention (reoperation) in the PLDD arm. Nine patients (16%) allocated to surgery needed a reoperation. At 1 year, two patients (3.5%) in the surgery group and one patient (1.8%) in the PLDD group were lost to follow-up. At 1 year, data from 54 patients in the surgery group were analyzed for the primary outcome measure, against 53 patients in the PLDD group (Fig. 2). The complication rate was 11% (n=6) in the surgery group. These complications were dural tear/cerebrospinal fluid leak (n=3), micturition problem requiring a catheter (n=1), transient nerve root injury (n=1), and surgery at the wrong level (n=1). In the PLDD group, the complication rate was 5% and consisted of transient nerve root injury (n=3). However, technical failure in the PLDD group was 9% (n=5). No permanent deficits were observed.

Table 1
Patient characteristics for baseline variables

Parameter	PLDD	Surgery
Age, mean (SD), y	43.2±11.8	43.7±9.7
Female sex, n (%)	19 (35)	24 (42)
Body mass index, mean (SD)	25.1±4.4	25.0±5.2
Smoker, n (%)	23 (42)	18 (32)
Duration of sciatica, median (range), wk	30.0±9, 182	26.0±8, 260
8–26 wk, n (%)	12 (23)	26 (46)
26–52 wk, n (%)	21 (40)	12 (21)
52+ wk, n (%)	19 (37)	18 (32)
Sick leave, n (%)	26 (49)	31 (55)
Radicular pain lateralized in right leg, n (%)	28 (51)	27 (47)
Sensory disturbance,* n (%)	46 (100)	45 (94)
Muscle weakness, n (%)	33 (40)	34 (60)
Asymmetric tendon reflexes		
Knee, n (%)	5 (9)	7 (13)
Ankle, n (%)	6 (11)	15 (27)
Pain tests (positive)		
SLR, n (%)	47 (86)	51 (90)
XSLR, n (%)	9 (17)	15 (27)
Slump test, n (%)	42 (79)	43 (80)
Level of disc herniation		
L2–L3, n (%)	1 (2)	0 (0)
L3–L4, n (%)	5 (9)	3 (5)
L4–L5, n (%)	21 (39)	25 (44)
L5–S1, n (%)	26 (48)	28 (49)
L6–S1, n (%)	1 (2)	1 (2)
RDQ, mean (SD)	15.7±4.9	15.5±4.7
VAS score		
Back pain, mean (SD)	44.7±27.6	45.8±26.7
Leg pain, mean (SD)	56.9±20.4	60.7±19.9
General health, mean (SD)	47.3±24.7	49.4±23.7
Prolo scale		
Function, mean (SD)	1.1±0.6	0.9±0.5
Economic, mean (SD)	1.7±1.7	2.1±1.7
Rand SF-36		
Bodily pain, mean (SD)	32.8±20.5	30.0±16.1
Physical function, mean (SD)	41.0±22.6	38.6±20.9
Sciatica index		
Frequency, mean (SD)	3.6±1.1	3.8±1.2
Bothersomeness, mean (SD)	3.3±1.2	3.1±1.3
Preference for treatment		
PLDD, n (%)	20 (37)	20 (36)
No preference, n (%)	23 (43)	30 (54)
Surgery, n (%)	11 (20)	6 (11)
Time to surgery, mean (SD), d	13.9±9.2	18.6±9.3

PLDD, percutaneous laser disc decompression; SD, standard deviation; SLR, straight leg raising; XSLR, crossed straight leg raising; RDQ, Roland-Morris Disability Questionnaire; VAS, visual analog scale; SF-36, 36-Item Short Form Health Survey.

* Sensory disturbance: any sensory deficit, comprising paresthesia, anesthesia, and hypesthesia.

Treatment effects

The primary outcome RDQ showed noninferiority of PLDD at 8 (−0.1; 95% CI, −2.3 to 2.1) and 52 weeks (−1.1; 95% CI, −3.4 to 1.1) compared with conventional

Table 2
Postoperative outcomes

	4 Wk			8 Wk		
	PLDD	Surgery	Difference between PLDD and surgery*	PLDD	Surgery	Difference between PLDD and surgery*
	Mean±SE	Mean±SE	(95% CI)†	Mean±SE	Mean±SE	(95% CI)†
RDQ	10.8±0.8	13.2±0.7	2.5 (0.2 to 4.7)	7.8±0.9	7.8±0.7	−0.1 (−2.3 to 2.1)
VAS leg pain	38.7±3.9	30.9±3.6	−7.4 (−16.8 to 1.9)	24.9±3.5	20.1±3.2	−5.7 (−15.0 to 3.7)
VAS back pain	38.0±3.5	39.7±3.7	2.0 (−7.2 to 11.3)	28.7±3.6	22.6±2.8	−6.3 (−15.5 to 2.9)
General health	63.8±3.3	58.4±3.5	−5.9 (−14.8 to 3.1)	66.7±3.5	74.6±2.9	8.3 (−0.6 to 17.2)
Prolo functioning	1.8±0.1	1.7±0.1	−0.2 (−0.6 to 0.2)	2.2±0.1	2.4±0.1	0.2 (−0.3 to 0.6)
Prolo economic	1.3±0.2	0.3±0.2	−1.1 (−1.6 to −0.5)	1.9±0.2	1.6±0.2	−0.2 (−0.8 to 0.3)
SF-36 pain	39.5±3.0	35.9±2.4	−4.1 (−12.9 to 4.8)	51.1±3.3	50.7±2.9	−0.6 (−9.3 to 8.1)
SF-36 physical functioning	59.4±3.0	41.2±2.7	−18.4 (−26.8 to −10.0)	67.5±3.4	62.1±2.6	−5.6 (−13.9 to 2.7)
Sciatica frequency index	2.3±0.2	2.3±0.2	−0.1 (−0.6 to 0.4)	1.8±0.2	1.6±0.1	−0.1 (−0.5 to 0.4)
Sciatica bothersomeness index	2.0±0.2	1.9±0.2	−0.1 (−0.6 to 0.4)	1.6±0.2	1.3±0.1	−0.2 (−0.7 to 0.2)
	26 Wk			52 Wk		
	PLDD	Surgery	Difference between PLDD and surgery*	PLDD	Surgery	Difference between PLDD and surgery*
	Mean±SE	Mean±SE	(95% CI)†	Mean±SE	Mean±SE	(95% CI)†
RDQ	7.0±1.0	4.8±0.8	−2.2 (−4.4 to 0.1)	5.4±1.0	4.4±0.7	−1.1 (−3.4 to 1.1)
VAS leg pain	19.9±3.8	15.7±3.3	−4.2 (−13.6 to 5.2)	18.1±3.1	12.6±2.4	−5.7 (−15.2 to 3.8)
VAS back pain	30.6±3.9	20.4±3.3	−9.4 (−18.6 to −0.1)	22.9±3.3	16.6±2.6	−7.6 (−16.9 to 1.7)
General health	69.4±3.7	78.7±3.0	8.9 (−0.2 to 17.9)	77.0±3.1	78.5±3.0	1.7 (−7.3 to 10.8)
Prolo functioning	3.0±0.1	2.9±0.1	−0.1 (−0.5 to 0.3)	2.8±0.1	3.0±0.1	0.2 (−0.2 to 0.6)
Prolo economic	2.3±0.2	3.0±0.2	0.7 (0.2 to 1.3)	3.0±0.2	2.8±0.2	−0.1 (−0.7 to 0.4)
SF-36 pain	59.5±4.1	71.6±3.3	11.3 (2.4 to 20.1)	70.0±3.4	72.4±3.0	2.5 (−6.4 to 11.3)
SF-36 physical functioning	70.8±3.5	74.3±3.2	3.2 (−5.1 to 11.6)	77.8±3.2	81.2±2.7	3.2 (−5.2 to 11.6)
Sciatica frequency index	1.6±0.2	1.5±0.2	−0.1 (−0.6 to 0.4)	1.5±0.2	1.3±0.2	−0.1 (−0.6 to 0.3)
Sciatica bothersomeness index	1.3±0.2	1.0±0.2	−0.3 (−0.7 to 0.2)	1.2±0.2	1.0±0.1	−0.2 (−0.7 to 0.2)
	Repeated-measurement analysis (1–52 wk)					
	PLDD	Surgery	Difference between PLDD and surgery			
	Mean±SE	Mean±SE	(95% CI)*			
RDQ	9.1±0.5	8.9±0.5	−0.2 (−1.6 to 1.2)			
VAS leg pain	27.8±2.1	20.9±2.1	−6.9 (−12.6 to −1.3)‡			
VAS back pain	31.5±2.1	26.9±2.1	−4.6 (−10.4 to 1.1)			
General health	66.1±1.8	71.3±1.7	5.2 (0.3 to 10.0)			
Prolo functioning	2.5±0.1	2.5±0.1	0.0 (−0.3 to 0.3)			
Prolo economic	2.2±0.1	1.9±0.1	−0.3 (−0.7 to 0.1)			
SF-36 pain	55.4±2.1	57.0±2.0	1.6 (−4.2 to 7.3)			
SF-36 physical functioning	69.2±2.1	63.9±2.1	−5.3 (−11.2 to 0.7)			
Sciatica frequency index	1.8±0.1	1.7±0.1	−0.1 (−0.4 to 0.2)			
Sciatica bothersomeness index	1.5±0.1	1.3±0.1	−0.2 (−0.5 to 0.1)			

PLDD, percutaneous laser disc decompression; SE, standard error; 95% CI, 95% confidence interval; RDQ, Roland-Morris Disability Questionnaire; VAS, visual analog scale; SF-36, 36-Item Short Form Health Survey.

* The between-group difference at 4, 8, 26, and 52 weeks are adjusted for baseline values.

† CIs at various time points are at the 95% level and were not adjusted for multiple testing.

‡ The only significantly different primary outcome measure (p=.02). Statistical significance may only be concluded if the p value is below the Bonferroni boundary of 2.5%.

surgery (Table 2). The overall RDQ result in the 1- to 52-week period showed no significant difference either (Table 2) (Fig 3). The null hypothesis (being that PLDD is inferior to conventional surgery by at least four points) can be rejected because a difference of four points is not contained in either the 8- or 52-week CIs, leading to a claim of noninferiority for the primary outcome measure.

The primary endpoint analyses of the Likert scale showed no significant difference at 1 year; 69% of patients in the PLDD group showed recovery versus 75% in the surgery group (odds ratio, 0.81 [95% CI, 0.4–1.9]). However, the first-time recovery during the follow-up period was attained at a significantly slower rate in the PLDD group, resulting in an HR of 0.64 (95% CI, 0.42–0.97). The Kaplan-Meier estimates of the curves estimating time to first

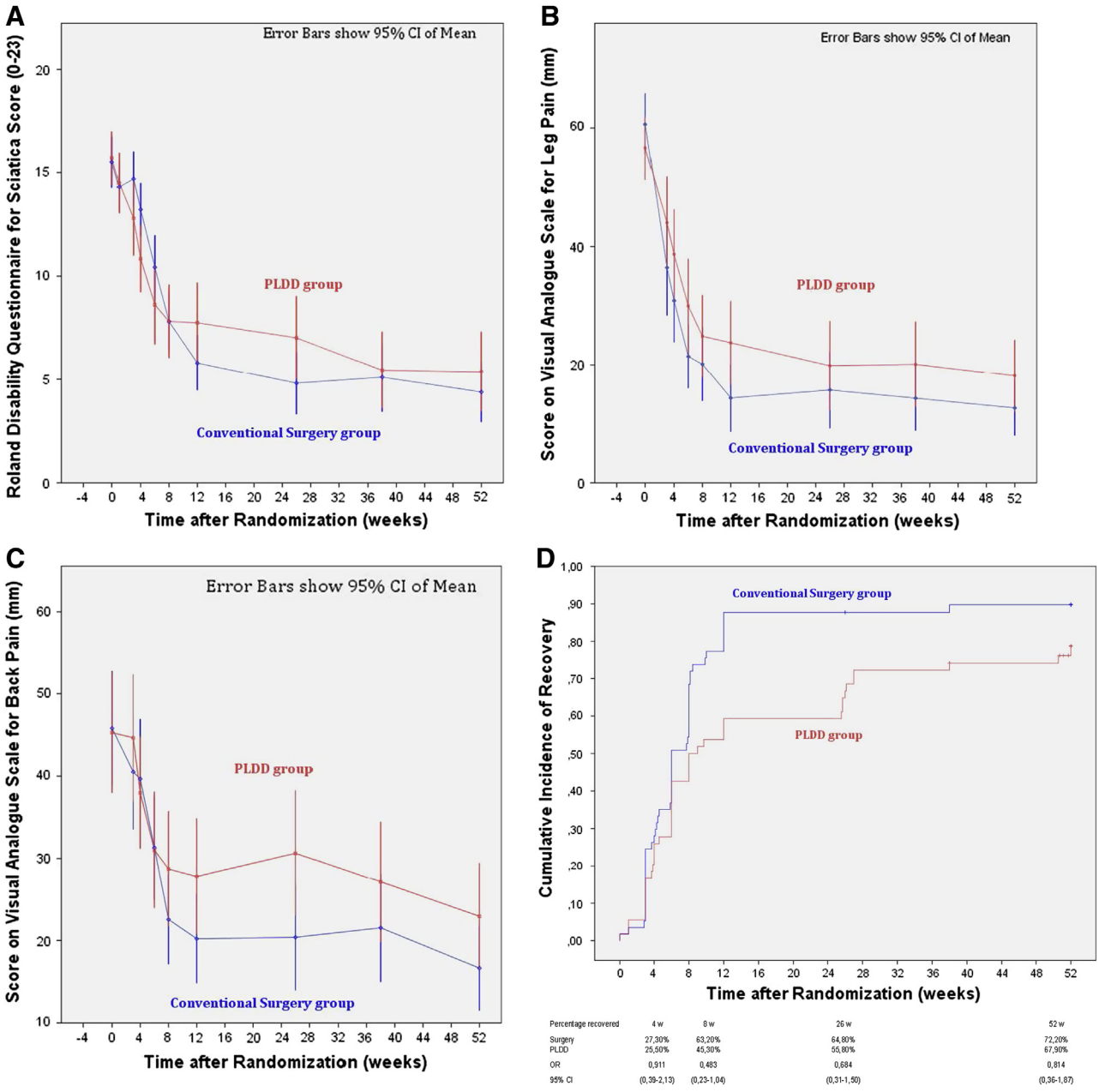

Fig. 3. A. Curve of the mean scores (±standard error [SE]) for the Roland-Morris Disability Questionnaire (RDQ). The graphs represent the course of the scores within the first 52 weeks after randomization. In Graphs 1 and 2, the minimum score is 0 mm and the maximum score is 100 mm. Graph 3 shows the RDQ with scores ranging from 0 to 23. The maximum scores represent poorer clinical conditions. B. Curve of the mean scores (±SE) for the visual analog scale for leg pain. The graphs represent the course of the scores within the first 52 weeks after randomization. In Graphs 1 and 2, the minimum score is 0 mm and the maximum score is 100 mm. Graph 3 shows the RDQ with scores ranging from 0 to 23. The maximum scores represent poorer clinical conditions. C. Curve of the mean scores (±SE) for the visual analog scale for back pain. The graphs represent the course of the scores within the first 52 weeks after randomization. In Graphs 1 and 2, the minimum score is 0 mm and the maximum score is 100 mm. Graph 3 shows the RDQ with scores ranging from 0 to 23. The maximum scores represent poorer clinical conditions. D. Inverse Kaplan-Meier curves of the cumulative incidence of recovery based on a dichotomized 7-point Likert scale. The hazard ratio assessed with the Cox model was 0.64 (95% CI, 0.42–0.97). PLDD, percutaneous laser disc decompression; CI, confidence interval; OR, odds ratio.

perceived recovery were significantly different (because the unadjusted Cox model showed a significant HR) with a median time to recovery of 8 (95% CI, 3.2–12.8) weeks versus 6 (95% CI, 5.2–6.9) weeks, respectively.

The VAS scores for leg pain showed improvement in both groups after the treatment without significant difference at the predefined time points. The between-group difference at 1 year was also not statistically significant. However, the overall reduction of leg pain during the first year showed a significant difference in favor of the surgery group with a mean between-group difference of −6.9 (95% CI, −12.6 to −1.3). The VAS scores for back pain

improved in both groups postoperatively. The differences between the groups were not statistically significant.

Discussion

This trial was performed to test the hypothesis that a strategy of PLDD, in comparison to a strategy of conventional surgery, would not result in worse clinical outcome (four points or more on the RDQ scale) for patients suffering from sciatica because of a lumbosacral disc herniation. This was the only outcome measure with a predefined cutoff point for noninferiority. This assumption is substantiated by the statistical analyses. All other analyses (be it primary or secondary) are based on estimation of the treatment effect (superiority/difference) and its associated CI. As always in the case of group comparisons in clinical trials, in case of the interval containing zero (no treatment effect), the lower bound of the interval allows an interpretation of noninferiority subject to the reader's choice of what is and is not an acceptable cutoff point for inferiority. At 1 year, no significant difference for the RDQ, the perceived recovery on the Likert scale, and the VAS scores for leg and back pain was found. There is also no significant difference in the overall repeated-measurement analysis (1–52 weeks) for these variables, except for the significant difference in the reduction of the VAS score for leg pain during the first year in favor of the surgical allocation. However, the magnitude of this difference of 6.9 mm on the 100-mm scale is small and is clinically not relevant [14].

The Cox analysis showed that the speed of recovery was in favor of surgery. This finding however should be evaluated considering that the trial was not powered on this outcome measure, a boundary of noninferiority specified, and the fact that the strategy of PLDD, with delayed surgery if needed, resulted in comparable outcomes at the end of the first year.

The number of additional surgical operations performed in the PLDD group was 24, of which 21 were because of the absence of the treatment effect. The number of reoperations, which was considered a secondary endpoint, is significantly different between both groups and favors conventional surgery. A technical failure in 9% of the PLDD group was considered high and was attributed to the failure to reach the disc space. Preoperative assessment of bony ridges and disc space narrowing, by focused imaging, can prevent this problem.

When noninferiority is associated with reduced cost, the intervention could become cost effective. Cost-effectiveness based on additional cost diaries is being studied and will be reported separately. In addition, long-term follow-up will be performed in due time.

This trial had some limitations. The reoperation rate was high in the PLDD group. Unexpectedly, this was also the case in the conventional surgery group, with 16% reoperation within the first year. The incidence of reoperation in our conventional surgery group is double the figure reported as average reoperation rate (7%) within the first 5 years after surgery [15]. Furthermore, Arts et al. [16], who conducted a trial parallel to our study with the same participating centers and surgeons, published a reoperation rate of 7% for conventional surgery as opposed to 16% in this study. Obvious differences between these studies are the size of the disc herniation and the duration of complaints, but it is unsure if these factors could explain the high reoperation rate.

In addition to the morphologic characteristics of the disc herniations, the patients in this trial had long-standing complaints ranging up to 260 weeks with 62% of patients suffering from sciatica for more than 26 weeks, and 33% for more than 1 year. Folman et al. [17] showed that the benefit for patients with contained herniations, treated more than 12 weeks after onset of complaints, was only intermediate.

With a procedure that could act as an intermediate intervention between conservative treatment and surgery, the timing of the PLDD after onset of the complaints is very likely to influence the results. Unfortunately, this trial was not designed to study different timing periods in a controlled way, and this should be an ingredient for future studies.

In conclusion, this is the first trial that assessed the effectiveness of PLDD in comparison to conventional surgery in a population of patients that were surgical candidates. The strategy of PLDD, with additional surgery when needed, proved to be noninferior on the primary endpoint. However, as this is so far the only relatively small trial, evidence derived from these results should be regarded to be preliminary and should be confirmed and supplemented with further studies. Whether a prolonged conservative therapy might have had similar results was not studied in this trial. The role of PLDD as an adjunct to conservative treatment, the exact timing of the intervention, and the role in the treatment of larger disc herniations and in patients with a short duration of complaints will have to be evaluated in dedicated randomized trials.

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