Egyptian Journal of Anaesthesia (2017) 33, 21–28

HOSTED BY

Egyptian Society of Anesthesiologists

Egyptian Journal of Anaesthesia

www.elsevier.com/locate/egja
www.sciencedirect.com

Research article

Immediate post-discectomy percutaneous facet nerve continuous and nerve root pulsed radiofrequency and intraluminal injection of steroid with hyaluronidase improved outcome of surgery for lumbar disk herniation

Ahmed E. Mohamed Ali [a,*], **Ahmed A. Mohamed** [b], **Ossama H. Salman** [c], **Ashraf M. El Gallad** [d]

[a] *Department of Anesthesiology & ICU, Faculty of Medicine, Tanta University, Egypt*
[b] *Department of Anesthesiology & ICU, Faculty of Medicine, Cairo University, Egypt*
[c] *Department of Anesthesiology & ICU, Faculty of Medicine, South Valley University, Egypt*
[d] *Department of Neurosurgery, Faculty of Medicine, Zagazig University, Egypt*

Received 11 May 2016; revised 20 August 2016; accepted 22 August 2016
Available online 28 December 2016

KEYWORDS

Radiofrequency neurotomy;
Low back pain

Abstract *Objectives:* Evaluation of effects of postoperative (PO) facet nerve continuous thermal radiofrequency neurotomy (CTRFN), nerve root pulsed RF (PRF) and triamcinolone with hyaluronidase injection on outcome of patients undergoing open lumber discectomy.
Patients & methods: Seventy patients were allocated into the following groups: Group S underwent open discectomy alone and Group M underwent open discectomy followed by the three adjuvant procedures. Low back pain (LBP) severity was assessed using numeric rating scale (NRS) and disability was assessed using the Oswestry Disability Index (ODI). Primary outcome measure was at least 50% improvement of NRS and ODI. Secondary outcome involved scoring of pain medication requirements, Odom's criteria for improvement of preoperative abnormal findings and patients' satisfaction.
Results: Throughout 12-m follow-up, mean NRS and ODI scores of all patients were significantly lower than preoperative scores with significantly lower scores in group M than in group S. Frequency of patients had $\geqslant$50% improvement which was significantly higher in group M than in group S.

* Corresponding author.
E-mail address: esam9484@gmail.com (A.E. Mohamed Ali).
Peer review under responsibility of Egyptian Society of Anesthesiologists.

http://dx.doi.org/10.1016/j.egja.2016.08.016
1110-1849 © 2016 Publishing services by Elsevier B.V. on behalf of Egyptian Society of Anesthesiologists.
This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Patients of both groups showed significant reduction of scoring of consumed analgesics with significantly less consumption of PO analgesics in group M than in group S. Odom's scoring, resumption of activity and overall satisfaction scoring were significantly higher in group M than in group S.
Conclusion: Open discectomy provided significant improvement of LBP and disability secondary to LDH. Discectomy with adjuvant therapy including PRF, CTRFN and triamcinolone and hyaluronidase intraluminar injection significantly improved outcome compared to discectomy alone.
© 2016 Publishing services by Elsevier B.V. on behalf of Egyptian Society of Anesthesiologists. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

1. Introduction

Lumbar disk herniation (LDH) may give rise to a compression of one or more nerve roots, which can lead to a nerve root irritation, a so-called radiculopathy, with or without a sensorimotor deficit [1].

Therapeutic approach for low back pain (LBP) secondary to LDH ranges from conservative medical interventional management to surgery. Various studies have confirmed the effectiveness of surgery in the initial management of LDH [2]. While the procedure is not usually technically difficult, satisfactory clinical results require not only precise surgical technique but also precise evaluation of indications with good correlation between clinical and radiological findings and specifying nerve root compression by the herniation as the source of the pain [3].

Failed back surgery syndrome (FBSS) is defined as persistent pain more than 3 months after any form of spinal surgery [4]. The etiology of FBSS depends on age, pathology and the interval between the first and the revision surgery [5]. In young patients the etiology of FBSS is commonly a recurrence of herniation whereas in the elderly population persisting pain might be due to secondary sagittal unbalance associated, as a consequence, with adjacent disk disease or pseudarthrosis [6].

Dealing with FBSS patients is far from simple but it corresponds to daily practice for spine surgeons. Clinical and radiological assessments should include a full diagnostic work-up focusing on sagittal balance. Surgical treatment and re-operation might be an option if a consistent source of pain is detected [7].

Due to its multifactorial origin, FBSS is often difficult to treat. Overall, the literature provides very limited guidance on the comprehensive management of patients suffering from FBSS. There are rehabilitative interventions and behavioral protocols that demonstrate promise. Pathways based on medication management remain difficult to clearly define [8].

A population-based study in Finland found that about 14% of all primary lumbar discectomies required additional surgical interventions; however, Wallis implant is probably incapable of reducing the incidence of recurrent herniations [9]. Moreover, Hegarty & Shorten [10] reported a frequency of persistent pain after lumbar discectomy of 37% and found prediction models of development of persistent pain need further studies to be validated.

These data indicated the necessity for maximizing the chance of success for the initial surgical interference to minimize the frequency and/or severity of FBSS. Thus, the current study tried to evaluate the effects of immediate postoperative (PO) continuous thermal radiofrequency neurotomy (CTRFN) of median branch of the facet nerve, nerve root pulsed RF (PRF) and intraluminar injection of triamcinolone and hyaluronidase on the outcome of patients underwent open discectomy for lumber disk herniation (LDH).

2. Patients & methods

The current study was conducted at Neurosurgery and Anesthesia Departments at Hospitals of Cairo Faculty Medicine, Nasr Institute and some private hospitals since Jan 2013 till June 2014 to allow a follow-up period for one year for the last case operated upon. The study protocol was approved by Local Ethical Committee of the participating centers. All enrolled patients signed written fully informed consent for study participation, mode of randomization for study groups and procedures assigned for each group. Patients fulfilling inclusion criteria were asked to choose a closed envelop out of heterogeneously arranged similar envelops to determine the group to be enrolled in: Group S included patients assigned for open discectomy as a single therapeutic procedure and Group M included patients assigned to receive single-setting multiple procedures including open discectomy, median branch of facet nerve CTRFN, nerve root PRF and intraluminal injection of steroid and hyaluronidase enzyme.

Inclusion criteria included chronic pain occurring daily for at least 20 h throughout at least the last 3 months and refractory to conservative treatment for 6 weeks with duration of the current attack < 2 weeks. Pain and/or numbness involve lumbar spine, buttock and extending to lower extremity. All patients underwent physical examination for signs consistent with nerve root compression and MRI for assuring diagnosis of unilateral single level LDH that anatomically coincided with the patient's symptoms and signs detected clinically.

3. Anesthetic technique

All procedures were performed in operating room under general anesthesia. General anesthesia was induced with Thiopental (4–5 mg/kg), fentanyl (2 μg/kg), midazolam (0.05 mg/kg), and atracurium (0.5 mg/kg). Anesthesia was maintained by isoflurane inhalation () and fentanyl 1 μg/kg/h was used as intraoperative analgesia. Heart rate (HR), systolic, diastolic, mean arterial blood pressure (MABP) and oxygen saturation were non-invasively monitored throughout the surgery. Bradycardia and hypotension were defined as heart rate (HR) < 60 beat/min, and MABP < 65 mmHg and treated with atropine or ephedrine 5 mg IV, respectively.

Intraoperative blood loss included volume of blood suctioned from the surgical field and blood collected by sponges. The volume of blood transfusion was calculated by number of transfused blood units during the operation.

After extubation, patients were transferred to the postanesthesia care unit (PACU). Immediate postoperative (PO) pain sensation was recorded at the time of PACU arrival and 10, 20, and 30 min thereafter using visual analogue scale (VAS) (0–10 cm: 0 = no pain, 10 = the worst pain possible) [11] and rescue analgesia as intravenous morphine 2 mg given on VAS $\geqslant$ 4. Time till first request of analgesia, total analgesic requirement for the first 24 h and frequency of anesthesia-related complication during PACU stay were recorded.

4. Procedural techniques

All enrolled patients underwent open discectomy using unilateral posterior approach for paraspinal exposure of a posterolateral discal hernia. The procedure was performed as described previously by Wiltse and Spencer [12]. After skin closure and while patients are still anesthetized and in prone position, patients of group M underwent the additional procedures, while those of group S were discharged to the PACU.

4.1. Facet denervation of median branch of the facet nerve by thermal continuous radiofrequency (CRF)

Target level was verified with C-arm at the junction of the transverse process and the base of the superior articular process of the facet joint (FJ). With C-arm in oblique position to check needle trajectory and position, an 18-gauge, 100 mm insulated RF needle with 5 mm active tip was inserted through the sterilized skin and docked onto target point. Motor testing using 2 Hz at 3 V with 1-ms pulse duration was performed without any extremity muscle contraction. The needle was placed parallel to the nerve. Then, a 5-mm active tip electrode was used to create a single lesion at 80 °C for 120 s parallel to medial branch [13].

4.2. Nerve root pulsed radiofrequency (PRF)

PRF was done at 42 °C for 120 s. During each second of a PRF treatment, 2 bursts of 20-millisecond intervals delivered alternating current (500,000 Hz) to the surrounding tissue. The active 20-ms phase was followed by a 480-ms phase for heat dissipation. The voltage output was 45 [14].

4.3. Intraluminar injection of Triamcinolone and Hyaluronidase

A 20 gauge Tuohy needle was inserted approximately 2–3 cm so that the needle went into the interspinal ligament. Then, a syringe containing air was attached to the needle and the needle was inserted slowly, 1–2 mm at a time until no resistance was felt. When the location of the needle was identified in the epidural space through the interspinal ligament, 2 ml triamcinolone 40 mg/ml and 1500 IU hyaluronidase were injected [15].

5. Outcome evaluation

5.1. Primary outcome involves the following:

– Pain severity was assessed using an 11-point numeric rating scale (NRS) with numbers from 0 to 10 where 0 indicates no pain and 10 indicates worst pain imaginable. NRS was chosen for being more practical than the graphic visual analogue scale, easier to understand for most people, and does not need clear vision, dexterity, paper, and pen [16,17]. Back pain NRS was assessed preoperatively, at time of hospital discharge and every 3-m till the end of one year follow-up.
– Disability secondary to pain was assessed using the Oswestry Low Back Pain Disability Questionnaire which is one of most widely used back-specific disability measurement tools in both clinical work and research [18,19]. The questionnaire included 10 sections for evaluation of pain intensity, personal care, lifting, walking, sitting, standing, sleeping, sex life, social life and traveling. For each section the total possible score is 5: if the first statement is marked the section score = 0; if the last statement is marked, it = 5. If all 10 sections are completed the calculated score is 50. Oswestry Disability Index (ODI) was calculated as follows: patient' score/total possible score multiplied by 100. If one section was missed or not applicable the total score must be 45 and so on. The ODI scores are grouped into five categories: 0–20 minimal, 20–40 moderate, 40–60 severe disability; 60–80 crippled and 80–100 indicates that the patient is either bed-bound or exaggerating his/her symptoms [19,20].
– The primary outcome measure was at least 50% improvement of NRS and ODI scores [21,22].

5.2. Secondary outcome involves the following:

– Pain medication requirements pre- and post-treatment were recorded using a 0–4 point scale with 0: no medication, 1: over-the-counter medications, 2: nonopioid prescription medications, 3: as needed opioid prescription medications, 4: scheduled opioid prescription medications.
– Odom's criteria include 4 grades: Excellent means relief of all preoperative symptoms and all abnormal findings were improved; Good means minimal persistence of preoperative symptoms and all abnormal findings were either unchanged or improved; Fair means definite relief of some preoperative symptoms, while other symptoms were either unchanged or slightly improved; Poor means all preoperative symptoms and signs were unchanged or exacerbated [23].
– Patients' satisfaction with the procedure and willingness to receive treatment again if pain persists. Patient's satisfaction was assessed with a 4-point scale questionnaire, ranging from 4 points (very satisfied) to 1 point (very dissatisfied). Willingness to receive treatment again was checked in a similar fashion using a 5-point scale questionnaire, ranging from 5 points (definitely will) to 1 point (definitely will not).

6. Statistical analysis

Sample size was calculated using the standard nomogram proposed by Kraemer & Thiemann [24] who defined a sample size of 30 patients was sufficient to detect a difference at the 5% significance level and give the trial 60% power [23]. The study included 35 patients per group so as to properly evaluate the primary outcome and thus override the limit of 60% power. Sample size and power were re-calculated and assured using

Power and Sample Size Calculation Software program provided by Department of Biostatistics, Vanderbilt University.

Obtained data were presented as mean with standard deviation, numbers and percentages. Results were analyzed by One-way ANOVA with Bonferroni multiple comparison for inter- and intra-group comparisons and Chi-square test (X2 test) for non-parametric analysis of numbers and ratios. Statistical analysis was conducted using the SPSS (Version 15, 2006; SPSS Inc., Chicago, IL, USA) for Windows statistical package. P value <0.05 was considered statistically significant.

7. Results

The study included 70 patients allocated into two equal groups showed non-significant difference as regards enrollment data as shown in Table 1.

Adjuvant procedures consumed additional theater time that induced significantly ($p < 0.05$) longer theater time in group M compared to duration of discectomy only. Time till first request of rescue analgesia was significantly ($p < 0.05$) longer, while the frequency of doses of rescue analgesia and total used dose of rescue analgesia was significantly ($p < 0.05$) lower in group M compared to group S. There was non-significant ($p > 0.05$) difference between both groups as regards duration of discectomy, amount of IO blood loss, number of transfused units and PO hospital stay. Details of operative and immediate PO data are shown in Table 2.

Throughout 12-m follow-up period, mean NRS scores of all studied patients were significantly ($p < 0.05$) lower compared to their preoperative scores with significantly ($p < 0.05$) lower scores of patients of group M compared to those of patients of group S (Fig. 1). The frequency of patients who had decrease of their preoperative NRS by $\geqslant 50\%$ was significantly ($p < 0.05$) higher with significantly ($p < 0.05$) higher total percentage of decrease in group M compared to group S (Table 3, Fig. 2).

Similarly, at the end of 12-m follow-up period, mean ODI scores of all studied patients were significantly ($p < 0.05$) lower compared to their preoperative ODI scores with significantly ($p < 0.05$) lower scores of patients of group M compared to that of patients of group S. The frequency of patients who had decrease of their preoperative ODI score by $\geqslant 50\%$ was significantly ($p < 0.05$) higher, but with non-significantly ($p < 0.05$) higher total percentage of decrease in group M compared to group S (Table 3, Fig. 2).

Patients of both groups showed significant ($p < 0.05$) reduction of scoring of consumed analgesics both as frequency and as total scoring. However, patients of group M consumed significantly ($p < 0.05$) less PO analgesics compared to patients of group S. Patients' evaluation of the extent of pain relief and resumption of activity, at the end of follow-up, was significantly ($p < 0.05$) higher in group M compared to group S. Patients' distribution according to overall satisfaction by procedural outcome was significantly ($p < 0.05$) higher in group M compared to group S (Table 4).

8. Discussion

All patients passed uneventful intraoperative (IO) and immediate PO course without evident surgical or anesthetic complica-

Table 1 Patients' enrollment data.

Data			Group S (n = 35)	Group M (n = 35)	p value
Age (years)	<40		12 (34.3%)	10 (28.5%)	0.818
	40–50		9 (25.7%)	8 (22.9%)	
	>50–60		11 (31.4%)	15 (42.9%)	
	>60		3 (8.6%)	2 (5.7%)	
	Total		45.9 ± 10	47.7 ± 8.8	0.411
Gender	Males		19 (54.3%)	22 (62.9%)	0.467
	Females		16 (45.7%)	13 (37.1%)	
BMI data	Weight (kg)		85.9 ± 7.3	89.2 ± 8.3	0.087
	Height (cm)		170.3 ± 3.4	170.5 ± 3.8	0.799
	BMI (kg/m^2)	<25	1 (2.9%)	1 (2.9%)	0.177
		25–30	19 (54.3%)	13 (37.1%)	
		>30–35	15 (42.8%)	20 (57.1%)	
		>35	0	1 (2.9%)	
		Total	29.6 ± 2.1	30.6 ± 2.4	0.063
Clinical findings	Duration of LBP	<24	7 (20%)	12 (34.3%)	0.067
		24–36	23 (65.7%)	16 (45.7%)	
		>36	5 (14.3%)	7 (20%)	
		Total	30.5 ± 7.6	29.2 ± 9.1	0.529
	Side	Rt.	13 (37.1%)	12 (34.3%)	0.803
		Lt.	22 (62.9%)	23 (65.7%)	
	Level	L2-3	1 (2.9%)	2 (5.7%)	0.899
		L3-4	4 (11.4%)	4 (11.4%)	
		L4-5	13 (37.1%)	10 (28.6%)	
		L5-S1	17 (48.6%)	19 (54.3%)	

Data are shown as mean ± SD and numbers; percentages are shown in parenthesis; SLR: Straight-leg raising test.

Table 2 Operative and immediate PO data of studied patients.

Parameter			Group S (n = 35)	Group M (n = 35)	p value
Theater time (min)	Duration of surgical procedure (min)		56 ± 10	53 ± 10.4	0.222
	Duration of adjuvant procedures (min)		0	18 ± 4.1	0
	Total theater time (min)		56 ± 10	71 ± 11.8	0.001
Blood loss data	Amount of IO blood loss (cc)		438.7 ± 99.3	450.1 ± 107.9	0.658
	Blood transfusion	Frequency	5 (14.3%)	3 (8.6%)	0.452
		Number of units	1.6 ± 0.5	1.3 ± 0.6	0.543
PACU pain data	Time till request of 1st rescue analgesia		69.4 ± 48.7	108 ± 47.3	0.0013
	Number of doses of rescue analgesia	1	6 (17.1%)	12 (34.3%)	0.0316
		2	10 (28.6%)	16 (45.7%)	
		3	14 (40%)	6 (17.1%)	
		4	5 (14.3%)	1 (2.9%)	
		Mean	2.3 ± 0.9	1.9 ± 0.8	0.031
	Dose of rescue analgesia (mg)		4.7 ± 1.9	3.8 ± 1.6	0.03
Hospital stay	Frequency	1-day	9 (25.7%)	10 (28.6%)	0.435
		2-day	11 (31.5%)	15 (42.8%)	
		3-day	15 (42.8%)	10 (28.6%)	
	Mean duration (days)		2.2 ± 0.8		0.37

Data are shown as mean ± SD and numbers; percentages are shown in parenthesis.

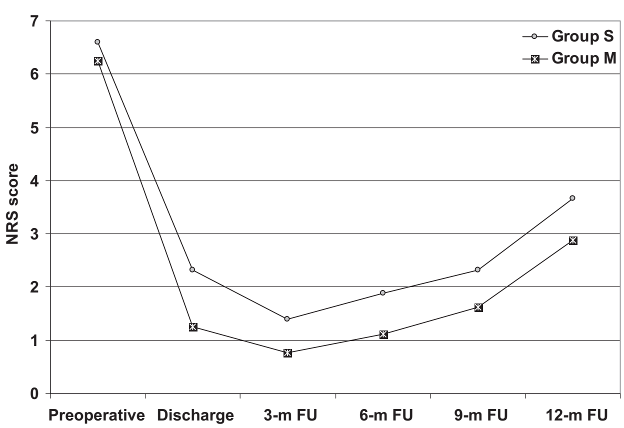

Figure 1 Mean NRS scores determined throughout follow-up compared to preoperative score.

tions or significant difference between both studied groups. Intraoperative blood loss induced non-significant alteration of hemodynamic measures compared to baseline measures and only 8 patients (11.4%) required IO blood transfusion. The choice of one-level surgery could explain the minimized blood loss and frequency of blood transfusion. In support of such attribution, Zou et al. [26] found significant differences between one-level and two-level discectomy in bleeding volumes, IO blood transfusion and in final drainage.

Patients of group M showed significantly lower PO pain scores and consumption of rescue analgesia with significantly shorter duration of hospital stay. This favorable immediate PO course could be attributed to the effect of injected steroids owing to its suppressive effect on nociceptive cytokines. In line with these findings, Jirarattanaphochai et al. [27] found peridural methyl-prednisolone and wound infiltration with bupivacaine reduced PO pain and cumulative morphine consumption dose after posterior lumbosacral spine surgery for discectomy, decompression, and/or spinal fusion without complication. Rasmussen et al. [28] documented that epidural methyl-prednisolone enhances recovery after discectomy for herniated disk disease manifested as significant reduction of hospital stay and number of patients with neurologic signs. Ranguis et al. [29] also reported that epidural steroids significantly decreased PO analgesic consumption, length of stay and increased the possibility of returning to full-time work at 1 year without significant adverse events. Recently, Jamjoom & Jamjoom [30] reviewed literature aimed at examining the efficacy of the use of IO epidural steroids in lumbar disk surgery and found relatively strong evidence for its effectiveness in reducing pain and consumption of analgesia in the early PO stage. Aljabi et al. [31] reported that intraoperative application of epidural corticosteroids significantly reduces PO pain, length of PO stay and duration to return to daily living activities following lumbar discectomy.

Addition of hyaluronidase to injected steroid was suspected to magnify its effects as previously documented by Rahimzadeh et al. [32] who found adding hyaluronidase to the epidural injection of a mixture of bupivacaine 0.5% and triamcinolone was effective in the management of chronic low back pain in patients with failed back surgery syndrome. Also, Ko et al. [33] found that in patients with lumbar radiculopathy, the rebound pain that occurs within 2–4 weeks after the injection of the routine regimen can be reduced when hyaluronidase is added to the routine selective nerve root block regimen.

Concerning the main problem, that is low back pain (LBP) and subsequent disability with its impact on quality of life (QOL), the reported significant reduction of both NRS pain scores and ODI compared to preoperative scores, in both groups illustrated the beneficial effect of discectomy as a line of management for such cases. In support of this finding, Veresciagina et al. [34] suggested that sufficient decompression clinically improved the health-related QOL parameters. Sedighi & Haghnegahdar [35] documented that surgery for lumbar disk herniation is effective in reducing radicular and

Table 3 NRS pain scoring and ODI scoring of studied patients throughout follow-up period compared to preoperative scores.

Parameter				Group S (n = 35)	Group M (n = 35)	p value
NRS score	Score	Preoperative		6.6 ± 1.3	6.3 ± 1.4	0.095
		At time of discharge		2.3 ± 1.5	1.3 ± 1.1	0.0013
		At 3-m follow-up		1.4 ± 1.1	0.8 ± 0.9	0.0098
		At 6-m follow-up		1.9 ± 1	1.1 ± 0.7	0.001
		At 9-m follow-up		2.3 ± 1.3	1.6 ± 0.6	0.006
		At 12-m follow-up		3.7 ± 1.2	2.9 ± 1.5	0.001
	Percentage of decrease	Frequency	⩾50%	13 (37.1%)	23 (65.7%)	0.017
			<50%	22 (62.9%)	12 (34.3%)	
			p value	0.001	0.001	
		Mean percentage		44.7 ± 14.2	55.5 ± 17	0.0053
ODI score	Preoperative			32.8 ± 5.1	30.5 ± 5.2	0.069
	At end of follow-up			18 ± 3.5	15.4 ± 3	0.001
	Percentage of decrease	Frequency	⩾50%	12 (34.3%)	21 (60%)	0.0312
			<50%	23 (65.7%)	14 (40%)	
		Mean percentage		43.9 ± 13.7	48.4 ± 12.3	0.155

Data are shown as mean ± SD and numbers; percentages are shown in parenthesis.

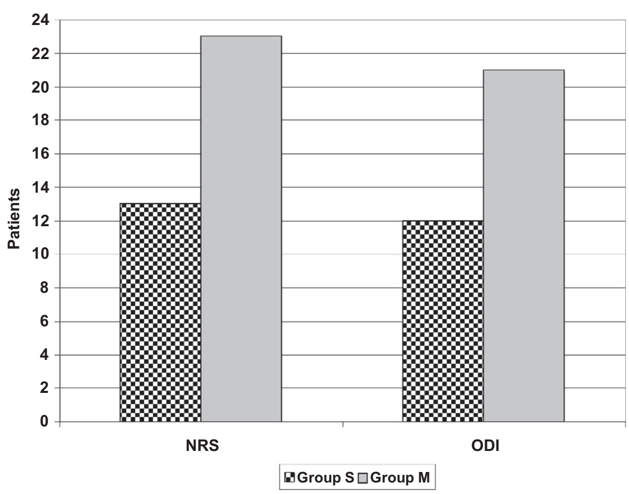

Figure 2 Frequency of patients had >50 improved NRS and ODI in both groups.

LBP, irrespective of applied surgical approach but laminectomy achieved significantly better outcome compared with other methods. Lubelski et al. [36] reported that pain, disability and QOL and psychosocial outcomes improved after primary and revision discectomy, but the improvement diminished after revision discectomy.

Adjuvant procedures provided superior outcome manifested as significantly lower 12-month NRS scores compared both to preoperative and to corresponding scores of patients received discectomy alone. Such beneficial effect of adjuvant procedure was also manifested as significantly lower consumption of analgesics and ODI scores in conjunction with higher patients' satisfaction scores in group M compared to group S. Moreover, the frequency of patients had ⩾50% reduction of preoperative LBP and ODI score was significantly higher in group M (65.7% & 60%, respectively) compared to group S (37.3% & 34.3%, respectively).

Unfortunately, there was no single study used such combination of adjuvant procedures, but the reported superior outcome of patients received adjunct procedures over discectomy alone go in hand with previous studies evaluated each of these adjuvant procedures separately as a single therapeutic modality or as an adjunct to other therapeutic modalities for management of chronic LBP wherein Burnham et al. [37] reported that radiofrequency neurotomy (RFN) provides safe and significant short-term improvement in pain, analgesic requirements, function, satisfaction, and direct costs reduction in patients with chronic LBP of facet origin. Klessinger [38] retrospectively studied 1490 patients treated with lumbar RFN and reported a significant pain reduction in 65% of these patients.

MacVicar et al. [39] reported that chronic LBP, mediated by the lumbar medial branches, can be stopped and patients fully restored to normal living, if treated with RFN. Jeong et al. [40] demonstrated that endoscopic RFN of medial branch could be an effective alternative treatment modality for chronic LBP originating from facet joints and provided long-term pain relief. Kanchiku et al. [41] suggested that percutaneous radiofrequency facet joint denervation is a safe, long-lasting, and effective treatment for chronic facet joint pain.

Recently, McCormick et al. [42] demonstrated a durable treatment effect of RFN for lumbar facet syndrome at long-term follow-up, as measured by improvement in function, pain, and analgesic use with improved function and pain by ⩾50% in 58% and 53% of individuals. Akinduro et al. [43] conducted a systemic review for studies comparing IO use of epidural steroids in lumbar discectomy surgery versus discectomy alone and concluded that there is good evidence that epidural steroids can decrease pain in the short term and decrease the usage of PO narcotics after lumbar spinal surgery for degenerative spinal disease, but with non-significant increased frequency of infection. Kim et al. [44] found that the mean duration of relief after initial RFN following microscopic discectomy was 9.2 months, while the mean duration of relief after secondary RFN was 9 months.

The target for using such combination of adjuvant modalities is to take the advantage of each and so augmenting the LBP relieve. In support of this target Roy et al. [45] reported that combined RFN and steroid nerve block produced sub-

Table 4 Patients' distribution according to scoring of PO analgesics consumption, Odom's criteria and satisfaction scoring by procedural outcome in both groups.

Items	Score	Group A (n = 35)		Group B (n = 35)	
		Pre	PO	Pre	PO
PO medications	0	0 (0%)	13 (37.2%)[a]	0	21 (60%)[a,b]
	1	1 (2.8%)	15 (42.9%)	3 (8.6%)	11 (31.4%)
	2	26 (74.3%)	6 (17.1%)	24 (68.6%)	3 (8.6%)
	3	5 (14.3%)	1 (2.8%)	6 (17.1%)	0
	4	3 (8.6%)	0	2 (5.7%)	0
	Total score	2.3 ± 0.7	0.9 ± 0.8	2.2 ± 0.7	0.5 ± 0.7†
Odom's criteria	Excellent	7 (20%)		13 (37.2%)[b]	
	Good	20 (57.1%)		17 (48.6%)	
	Fair	5 (14.3%)		4 (11.4%)	
	Poor	3 (8.6%)		1 (2.8%)	
Satisfaction scoring	Very satisfied	12 (34.3%)		19 (54.3%)[b]	
	Satisfied	19 (54.3%)		14 (40%)	
	Dissatisfied	3 (8.6%)		2 (5.7%)	
	Very dissatisfied	1 (2.8%)		0	

0 indicates no medication; 1 indicates over-the-counter medications; 2 indicates nonopioid prescription medications; 3 indicates as needed opioid prescription medications; 4 indicates scheduled opioid prescription medications.
[a] Significant difference versus preoperative score.
[b] Significant difference versus group A.

stantial improvement in terms of long-term pain relief and QOL where NRS showed pain relief after the procedure by 85%, 78%, 65%, and 59.5% at 1, 2, 6, and 12 months and Roland-Morris QOL score was 7.6 and 8.5 at 6 and 12 months after the procedure compared to preliminary score of 18. Lakemeier et al. [46] found intraarticular steroid infiltration or radiofrequency denervation appears to be a managing option for chronic function-limiting LBP of facet origin with favorable short- and midterm results in terms of pain relief and function improvement, but improvements were similar for both modalities. Koh et al. [47] documented that transforaminal epidural injection (TFEI) provided significant short-term pain relief and pulsed RF can be applied in conjunction with TFEI to achieve higher treatment efficacy compared with TFEI alone.

It could be concluded that open discectomy provided significant improvement of LBP and disability secondary to lumber disk herniation. Discectomy with adjuvant therapy including PRF, CTRFN and triamcinolone and hyaluronidase intraluminar injection significantly improved outcome compared to discectomy alone.

References

[1] Corniola MV, Tessitore E, Schaller K, Gautschi OP. Lumbar disc herniation–diagnosis and treatment. Rev Med Suisse 2014;10(454):2376–82.
[2] Ran J, Hu Y, Zheng Z, Zhu T, Zheng H, Jing Y, Xu K. Comparison of discectomy versus sequestrectomy in lumbar disc herniation: a meta-analysis of comparative studies. PLoS ONE 2015;10(3):e0121816.
[3] Blamoutier A. Surgical discectomy for lumbar disc herniation: surgical techniques. Orthopaedics Traumatol: Surg Res 2013;99S:S187–96.
[4] Durand G, Girodon J, Debiais F. Medical management of failed back surgery syndrome in Europe: evaluation modalities and treatment proposals. Neurochirurgie 2015;61(Suppl 1):S57–65.
[5] Rodrigues FF, Dozza DC, de Oliveira CR, de Castro RG. Failed back surgery syndrome: casuistic and etiology. Arq Neuropsiquiatr 2006;64(3B):757–61.
[6] Aghion D, Chopra P, Oyelese AA. Failed back syndrome. Med Health R I 2012;95(12):391–3.
[7] Assaker R, Zairi F. Failed back surgery syndrome: to re-operate or not to re-operate? A retrospective review of patient selection and failures. Neurochirurgie 2015;61(Suppl 1):S77–82.
[8] Desai MJ, Nava A, Rigoard P, Shah B, Taylor RS. Optimal medical, rehabilitation and behavioral management in the setting of failed back surgery syndrome. Neurochirurgie 2015;61(Suppl 1):S66–76.
[9] Huskisson EC. Measurement of pain. Lancet 1974;2:1127–31.
[10] Floman Y, Millgram MA, Smorgick Y, Rand N, Ashkenazi E. Failure of the Wallis interspinous implant to lower the incidence of recurrent lumbar disc herniations in patients undergoing primary disc excision. J Spinal Disord Tech 2007;20(5):337–41.
[11] Hegarty D, Shorten G. Multivariate prognostic modeling of persistent pain following lumbar discectomy. Pain Physician 2012;15(5):421–34.
[12] Wiltse LL, Spencer CW. New uses and refinements of the paraspinal approach to the lumbar spine. Spine (Phila Pa 1976) 1988;13(6):696–706.
[13] Mikeladze G, Espinal R, Finnegan R, Routon J, Martin D. Pulsed radiofrequency application in treatment of chrnic zygapophyseal joint pain. Spine J 2003;3:360–2.
[14] Simopoulos TT, Kraemer J, Nagda JV, Aner M, Bajwa ZH. Response to pulsed and continuous radiofrequency of the dorsal root ganglion and segmental nerves in patients with chronic lumbar radicular pain. Pain Physician 2008;11:137–44.
[15] Farrar JT, Young Jr JP, LaMoreaux L, Werth JL, Poole RM. Clinical importance of changes in chronic pain intensity measured on an 11-point numerical pain rating scale. Pain 2001;94:149–58.
[16] Williamson A, Hoggart B. Pain: a review of three commonly used pain rating scales. J Clin Nurs 2005;14(7):798–804.
[17] Fairbank JC, Couper J, Davies JB, O'Brien JP. The oswestry low back pain disability questionnaire. Physiotherapy 1980;66 (8):271–3.

[18] Fairbank JC, Pynsent PB. The oswestry disability index. Spine 2000;25(22):2940–53.
[19] Davidson M, Keating J. A comparison of five low back disability questionnaires: reliability and responsiveness. Phys Ther 2002;82:8–24.
[20] Manchikanti L, Singh V, Falco FJE, Cash KA, Pampati V, Fellows B. Comparative effectiveness of a one-year follow-up of thoracic medial branch blocks in management of chronic thoracic pain: a randomized double-blind active controlled trial. Pain Physician 2010;13:535–48.
[21] Manchikanti L, Cash RA, McManus CD, Pampati V, Fellows B. Fluoroscopic caudal epidural injections with or without steroids in managing pain of lumbar spinal stenosis: one year results of randomized, double-blind, active-controlled trial. J Spinal Disord Tech 2012;25:226–34.
[22] Odom GL. Neurosurgical care of the severely injured patient. J Am Med Assoc 1958;168(16):2087–90.
[23] Avellanal M, Diaz-Reganon G, Orts A, Soto S. One-year results of an algorithmic approach to managing failed back surgery syndrome. Pain Res Manage 2014;19(6):313–6.
[24] Kraemer HC, Theimann S. How many subjects? Statistical power analysis in research. Newbury Park, CA: Sage; 1987.
[26] Zou H, Li Z, Sheng H, Tan M, Yang F, Liang L, Zhao J. Intraoperative blood loss, postoperative drainage, and recovery in patients undergoing lumbar spinal surgery. BMC Surg 2015;15:76.
[27] Jirarattanaphochai K, Jung S, Thienthong S, Krisanaprakornkit W, Sumananont C. Peridural methylprednisolone and wound infiltration with bupivacaine for postoperative pain control after posterior lumbar spine surgery: a randomized double-blinded placebo-controlled trial. Spine (Phila Pa 1976) 2007;32 (6):609–16, discussion 617.
[28] Rasmussen S, Krum-Møller DS, Lauridsen LR, Jensen SE, Mandøe H, Gerlif C, Kehlet H. Epidural steroid following discectomy for herniated lumbar disc reduces neurological impairment and enhances recovery: a randomized study with two-year follow-up. Spine (Phila Pa 1976) 2008;33(19):2028–33.
[29] Ranguis SC, Li D, Webster AC. Perioperative epidural steroids for lumbar spine surgery in degenerative spinal disease. A review. J Neurosurg Spine 2010;13(6):745–57.
[30] Jamjoom BA, Jamjoom AB. Efficacy of intraoperative epidural steroids in lumbar discectomy: a systematic review. BMC Musculoskelet Disord 2014;15:146.
[31] Aljabi Y, El-Shawarby A, Cawley DT, Aherne T. Effect of epidural methylprednisolone on post-operative pain and length of hospital stay in patients undergoing lumbar microdiscectomy. Surgeon 2015;13(5):245–9.
[32] Rahimzadeh P, Sharma V, Imani F, Faiz HR, Ghodraty MR, Nikzad-Jamnani AR, Nader ND. Adjuvant hyaluronidase to epidural steroid improves the quality of analgesia in failed back surgery syndrome: a prospective randomized clinical trial. Pain Physician 2014;17(1):E75–82.
[33] Ko SB, Vaccaro AR, Chang HJ, Shin DY. An evaluation of the effectiveness of hyaluronidase in the selective nerve root block of radiculopathy: a double blind, controlled clinical trial. Asian Spine J 2015;9(1):83–9.
[34] Veresciagina K, Spakauskas B, Ambrozaitis KV. Clinical outcomes of patients with lumbar disc herniation, selected for one-level open-discectomy and microdiscectomy. Eur Spine J 2010;19(9):1450–8.
[35] Sedighi M, Haghnegahdar A. Lumbar disk herniation surgery: outcome and predictors. Global Spine J 2014;4(4):233–44.
[36] Lubelski D, Senol N, Silverstein MP, Alvin MD, Benzel EC, Mroz TE, Schlenk R. Quality of life outcomes after revision lumbar discectomy. J Neurosurg Spine 2015;22(2):173–8.
[37] Burnham RS, Holitski S, Dinu I. A prospective outcome study on the effects of facet joint radiofrequency denervation on pain, analgesic intake, disability, satisfaction, cost, and employment. Arch Phys Med Rehabil 2009;90(2):201–5.
[38] Klessinger S. Radiofrequency neurotomy for treatment of low back pain in patients with minor degenerative spondylolisthesis. Pain Physician 2012;15(1):E71–8.
[39] MacVicar J, Borowczyk JM, MacVicar AM, Loughnan BM, Bogduk N. Lumbar medial branch radiofrequency neurotomy in New Zealand. Pain Med 2013;14(5):639–45.
[40] Jeong SY, Kim JS, Choi WS, Hur JW, Ryu KS. The effectiveness of endoscopic radiofrequency denervation of medial branch for treatment of chronic low back pain. J Korean Neurosurg Soc 2014;56(4):338–43.
[41] Kanchiku T, Imajo Y, Suzuki H, Yoshida Y, Nishida N, Taguchi T. Percutaneous radiofrequency facet joint denervation with monitoring of compound muscle action potential of the multifidus muscle group for treating chronic low back pain: a preliminary report. J Spinal Disord Tech 2014;27(7):E262–7.
[42] McCormick ZL, Marshall B, Walker J, McCarthy R, Walega DR. Long-term function, pain and medication use outcomes of radiofrequency ablation for lumbar facet syndrome. Int J Anesth Anesth 2015;2(2), pii: 028.
[43] Akinduro OO, Miller BA, Haussen DC, Pradilla G, Ahmad FU. Complications of intraoperative epidural steroid use in lumbar discectomy: a systematic review and meta-analysis. Neurosurg Focus 2015;39(4):E12.
[44] Kim MH, Kim SW, Ju CI, Chae KH, Kim DM. Effectiveness of repeated radiofrequency neurotomy for facet joint syndrome after microscopic discectomy. Korean J Spine 2014;11(4):232–4.
[45] Roy C, Chatterjee N, Ganguly S, Sengupta R. Efficacy of combined treatment with medial branch radiofrequency neurotomy and steroid block in lumbar facet joint arthropathy. J Vasc Interv Radiol 2012;23(12):1659–64.
[46] Lakemeier S, Lind M, Schultz W, Fuchs-Winkelmann S, Timmesfeld N, Foelsch C, Peterlein CD. A comparison of intraarticular lumbar facet joint steroid injections and lumbar facet joint radiofrequency denervation in the treatment of low back pain: a randomized, controlled, double-blind trial. Anesth Analg 2013;117(1):228–35.
[47] Koh W, Choi SS, Karm MH, Suh JH, Leem JG, Lee JD, Kim YK, Shin J. Treatment of chronic lumbosacral radicular pain using adjuvant pulsed radiofrequency: a randomized controlled study. Pain Med 2015;16(3):432–41.

Further reading

[25] Murphy KR, Myors B. Statistical power analysis: a simple and general model for traditional and modern hypothesis tests. 2nd ed. Lawrence Erlbaum Associates Inc; 2003.