Original Research Article

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Study of Effect of Nerve Root Blockade Before the Onset of Noxious Stimuli on Postoperative Pain Control After Thoracolumbar Spinal Surgery

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Abstract

Context: Patient recovery improves with effective postoperative pain control after spinal surgeries. Pain control is not equivocal by different techniques in spite of all the surgical and non-surgical advances made till date.

Aims: This study was aimed at proving the hypothesis that neural root blockade before the onset of noxious stimuli could inhibit or reduce the production of pain.

Settings and Design: Prospective, cohort, and single-blinded clinical study from 2016 to 2018 of 150 cases.

Methods and Material: One hundred and fifty patients undergoing spinal surgeries were included in the study. In 75 of the patients (Group 2), 0.5 ml lidocaine 2% was applied onto the neural root immediately after the exposure and in 75 patients in the control group (Group 1) no topical application was done. All patients were monitored regarding pain determination using Visual Analogue Scale, and the exact time of analgesic requirement during the first postoperative day was recorded.

Statistical analysis used: The Statistical software namely SPSS 18.0, and R environment ver.3.2.2 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables, etc.

Results: Topical perineural lidocaine application extended the early postoperative analgesic duration; although, the pain was not completely suppressed, the lidocaine application helped to manage the postoperative pain more effectively. The patients (Group 2) who received lidocaine application intraoperatively onto the neural root had a statistically significant longer duration before analgesia requested ($p < 0.001$) and also required significantly less analgesic when compared with the control group ($p < 0.001$).

Conclusions: Acute postoperative pain in spinal surgery remains a major concern. The study suggests that lidocaine application onto the dorsal neural sheath immediately before retraction of the root may extend the time before analgesia requested and the total analgesic drug consumption.

Keywords: Nerve root blockade; Noxious stimuli; Pain; Spine surgery.

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Introduction

International Association for the Study of Pain (IASP) described the pain as associate unpleasant, sensory and emotional expertise related to actual or potential tissue harm or outlined in terms of such harm. To control the postoperative pain is an important role in perioperative management which takes into account the fact that beyond the fear for the outcome of surgery, the main concern of patients is related to postoperative pain.[1,2]

Pioneering work done by Crile at the beginning of the 20th century brought the concept of pre-emptive analgesia, i.e., treating or controlling the pain prior to initial surgical incision. It was observed that postoperative mortality was reduced if pain transmission was blocked prior to initial surgical incision, though this method initially was meant to prevent postoperative shock, later on, it was noted that it reduced the duration, frequency, and intensity of postsurgical pain. After this pioneering work and laying the foundation of benefits of pre-emptive analgesia a lot of work has been done in understanding the physiology, pathophysiology, and the pharmacology of pain.

When compared to physiological pain, pathological pain may result from extensive and intense tissue injury, which may be due to central sensitization. This lowers the threshold for perception of pain may be decreased with future injuries. Similar central activation leading to the perception of pain may occur in response to less noxious stimuli (hyperalgesia) or even non-noxious stimuli (allodynia).

The present study aimed to determine whether neural root blockade before the onset of noxious stimuli could inhibit the production of pain in single and multilevel thoracolumbar spinal surgery, thereby by reducing the postoperative pain and thus providing a better postoperative recovery and reducing the need for analgesia in the postoperative period.

Materials and Methods

After approval from the Institutional Ethics Committee, this prospective case-control single-blinded study was conducted on 150 patients between periods of 2016 to 2018. The study conformed to the Helsinki Declaration (World Medical Association, 1995). Written informed consent from each patient or next of kin was taken before enrollment in the study.

All patients after anesthesia were exposed in the prone position and the levels determined under fluoroscopy. The usual method of laminectomy or other methods of exposure of dura was used. In Group 1 patients, as soon as the dura and the root are seen, the extruded herniated disk was removed while pulling aside the root. In Group 2 patients, before pulling aside the root, 0.5 ml 2% lidocaine is infiltrated on its neural root sheath and the extruded herniated disk was removed after waiting for at least 5 minutes. Operating neurosurgeons was contributed equally to the 2 cohorts applying the same method but are blinded with respect to study.

The patients' post-extubation were followed for at least 1 hour in the recovery room, after confirming their consciousness, transported to the neurosurgical ward for follow-up. The time before analgesia requested, VAS scores, and additional analgesic requirements recorded. At the end of 24 hours, the total analgesic dose given was calculated and then compared between patient groups.

The patients included in this study who were suffering from back pain for more than 1 year although they had received medical therapy (including various drugs and rehabilitation). All the participants should be American Society of Anesthesiologists I and II and undergoing multilevel thoracolumbar spinal surgery should have undergone magnetic resonance imaging showing D1 to L5-S1 disk herniation, single or multiple levels, with or without listhesis or primary tumors. All should have radicular pain and evidence of nerve-root irritation with a positive nerve-root tension sign (straight leg raise—positive between 30 and 60 degrees) and a corresponding neurologic deficit in a myotomal distribution and a dermatomal distribution or asymmetrical reflexes.

Patients who had prior thoracolumbar surgery, segmental instability, vertebral osteoporosis and fractures, scoliosis, tumoral or infectious diseases involving the spine, cauda equina syndrome, immune spondyloarthropathy, or an accompanying comorbid condition contraindicating surgery were excluded from the study.

Statistical Methods: Groups were compared with independent sample *t*-test with respect to the time before analgesia requested and the cumulative analgesic requirement during the first postoperative day with emphasis to cost-effectiveness in relief of pain. Descriptive and inferential statistical analysis was carried out in the present study. Mean and SD (Min-Max) are represent as continuous measurements and results

on categorical measurements are presented in Number (%). At 5% level of significance, it was assessed. The following assumptions on data are made: 1. Dependent variables should be normally distributed, 2. Samples drawn from the population should be random, Cases of the samples should be independent student *t*-test (two-tailed, independent) has been used to find the significance of study parameters on continuous scale Intergroup analysis on metric parameters. Leven`s test for homogeneity of variance has been performed to assess, the homogeneity of variance. Chi-square / Fisher's exact test has been used to find the significance of study parameters on a categorical scale between two or more groups, Non-parametric setting for Qualitative data analysis. Fisher's exact test used when cell samples are very small. The Statistical software namely SPSS 18.0, and R environment ver.3.2.2 were used for the analysis of the data and Microsoft Word and Excel have been used to generate graphs, tables, etc. *p*-value of less than 0.05 was considered significant.

Results

This is a single-blinded study in which age distribution ranged from 20 to 80 years in both the cases and control groups and decade wise frequency distribution does not show any significant *p*-value, (p = 0.666, Student *t*-test) while the maximum distribution of both the cases and controls were in fourth decade, i.e., between 41 and 50 years, 36% of cases and 37% of control were in these age groups which corresponds to the recent literature being the age of degenerative spinal disorders.

Table 1: Age Distribution of Patients Studied

Age in years	Test Group	Control Group	Total
<20	1 (1.3%)	0 (0%)	1 (0.7%)
20–30	8 (10.7%)	7 (9.3%)	15 (10%)
31–40	15 (20%)	15 (20%)	30 (20%)
41–50	27 (36%)	28 (37.3%)	55 (36.7%)
51–60	16 (21.3%)	17 (22.7%)	33 (22%)
61–70	7 (9.3%)	5 (6.7%)	12 (8%)
71–80	1 (1.3%)	3 (4%)	4 (2.7%)
Total	**75 (100%)**	**75 (100%)**	**150 (100%)**
Mean ± SD	46.00 ± 12.30	46.87 ± 12.22	46.43 ± 12.23
Female/Male	25 (33.3%) / 50 (66.6%)	31 (41.3%) / 44 (58.6%)	56 (37.3%) / 94 (62.7%)

The sex distribution in both the groups was compatible with slight male preponderance in both cases and control groups constituting 66.6% and 58.6% respectively and 62.7% of total sample size, i.e., 94 out of 50 cases in the study. Groups were compared for sex by chi-square test and no statistical significance was found (p = 1.000, Not Significant). Duration of symptoms in both the groups was analyzed as shown in Table 2. The mean duration for the test group was 29.24 months whereas for the control group it was 20.22 months. The duration range in this study was 6 months to 60 months. The mean duration was more in the test group so it was not taken as a confounding factor. Most of the cases 29 out 75 (38.7%) and 41 out of 75 (54.7%) control had the symptoms for 6–24 months.

Table 2: Duration of Symptoms Distribution in Two Groups of Patients Studied

Duration of Symptoms	Test Group	Control Group	Total
<6	16 (21.3%)	20 (26.7%)	36 (24%)
6–24	29 (38.7%)	41 (54.7%)	70 (46.7%)
24–60	22 (29.3%)	12 (16%)	34 (22.7%)
>60	8 (10.7%)	2 (2.7%)	10 (6.7%)
Total	**75 (100%)**	**75 (100%)**	**150 (100%)**
Mean ± SD	29.24 ± 28.00	20.22 ± 22.76	24.73 ± 25.83

p=0.032*, Significant, Student *t* test

The level of vertebral column according to the diagnosis and treatment of the cases and control included in the study were given in Table 3.

Lumbar discectomy was the most common pathology in this study group with n = 61 (81.3%) in cases and n = 52 (69.3%) in control group

constituting about 75% of the total cases. Followed by fusion at lumber level and decompression at thoracic and dorsolumbar region. Comparison of the study and control group did not show any statistical significance with a $p = 0.203$.

Various other clinical parameters which are investigated as routine tests, as per our institutional protocol, for preoperative evaluation were compared between the groups and difference was not statistically significant, (Table 4).

Table 3: Diagnosis Type Distribution in Two Groups of Patients Studied

Diagnosis Type	Test Group	Control Group	Total
L	61 (81.3%)	52 (69.3%)	113 (75.3%)
F	13 (17.3%)	21 (28%)	34 (22.7%)
T	1 (1.3%)	1 (1.3%)	2 (1.3%)
DL	0 (0%)	1 (1.3%)	1 (0.7%)
Total	**75 (100%)**	**75 (100%)**	**150 (100%)**

p=0.203, Not Significant, Fisher's exact test. L= Lumbar disc, F=Fusion, T= Thoracic DL = Dorsolumbar

Table 4: Comparison of Clinical Variables in Two Groups Studied

Variables	Test Group	Control Group	Total	*p*-value
Hemoglobin (g/dl)	14.76 ± 14.71	13.17 ± 1.72	13.99 ± 10.57	0.385
TLC	8060.84 ± 2278.25	8636.09 ± 1930.06	8337.65 ± 2129.55	0.120
ESR	28.58 ± 13.58	29.52 ± 14.17	29.03 ± 13.82	0.698
Blood Urea (mg/dl)	22.67 ± 7.43	22.78 ± 7.46	22.72 ± 7.42	0.933
Serum Creatinine (mg/dl)	0.85 ± 0.19	2.08 ± 9.40	1.44 ± 6.53	0.276

Anesthetic parameters such as respiratory rate and oxygen saturation of haemoglobin (SpO_2) in immediate postoperative period was compared (Table 5).

Table 5: Respiratory Rate/SpO_2 Comparison in Two Groups of Patients Studied

	Test Group	Control Group	Total	*p*-value
Respiratory rate	12.86 ± 1.20	14.05 ± 2.97	13.45 ± 2.32	0.097
Oxygen saturation in hemoglobin	93.00 ± 20.79	89.22 ± 28.17	91.07 ± 24.63	0.612

Student *t* test (two-tailed, independent)

Immediate post-op respiratory rate and SpO_2 comparison did not show any statistically significant differences between the groups. The visual analogue scale was used for assessment of pain in the study. A lower score denotes better pain control. The scale ranged from 1 to 10. The frequency distribution of VAS assessment in both the groups is as given in Table 6.

Table 6: VAS Score–Frequency Distribution

VAS score for pain	1st demand		2nd demand	
	Control Group	Test Group	Test Group	Control Group
0	0	0	0	0
1–3	0	0	1 (1.3%)	2 (2.66%)
4–6	28 (37.3%)	41 (54.7%)	74 (98.7%)	73 (97.3%)
7–10	47 (62.7%)	34 (45.3%)	0	0
Total	**75 (100.0%)**	**75 (100.0%)**	**75 (100.0%)**	**75 (100.0%)**
	0.033*		1.00	

Chi-square test/Fisher's exact test

For the first demand of analgesia in both the cases and control groups, the pain control was better, as depicted by lower (4–6) VAS score in cases as $n = 41$ (54.7%) cases were having better pain control, than the control group which has $n = 28$ (37.3%) only. The difference is statistically significant having a *p*-value of 0.033. This significant difference was not found in the VAS score at time of second demand.

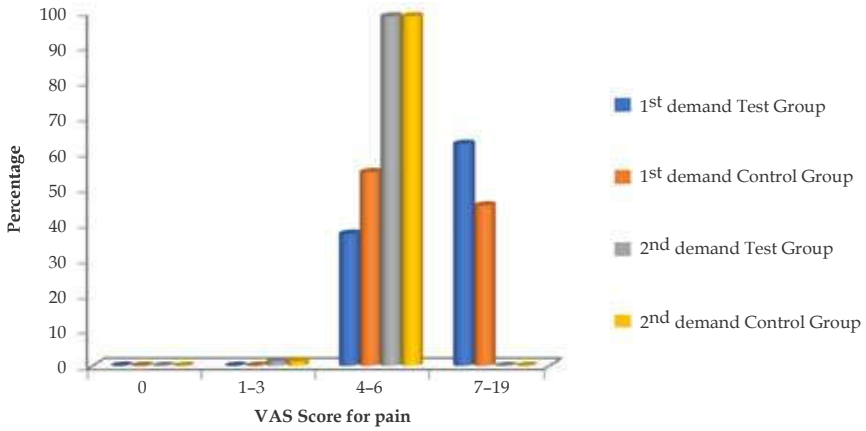

Fig. 1: VAS Score–Frequency Distribution

The average time for first demand of analgesia was analyzed as given in Table 7.

The average time for the first demand of analgesia was 29.633 minutes as compared to 141.433 minutes for the test group had a statistically significant difference with a *p*-value of <0.001. The average time difference between the groups is almost 100 minutes.

Distribution of Demand for Additional Analgesic Dose in First 24 Hours:

Table 7: Average Time in Minutes at First Demand of Analgesia.

Time at first demand of analgesia	**Control**	**Test**	***p*-value**
	29.633	141.433	<0.001**

Out of the total 150 patients, 18 in the test group and all 75 in the control group required 2 or more doses of analgesic during the 1st 24 hours post-surgery (62%). In the test group, *n* = 57 (76%) required only 1 additional dose of analgesic and *n* = 18 (24%) required 2 doses of analgesics. In the control group, *n* = 51 (68%) required 2 additional doses of analgesic and *n* = 24 (32%) required 3 doses by the end of 24 hours (Table 8).

Table 8:

Test		**Control**	
No. of Doses	**No. of patients**	**No. of Doses**	**No. of patients**
1	57	1	0
2	18	2	51
3	0	3	24

p<0.001**

Discussion

In spinal pathologies such as disk herniation and spondylolisthesis, pain relief remains as one of the primary goals and responsibilities of spine surgeons and pain physicians. Despite the many advances in surgical techniques, after the failure of surgery in relieving back pain, post-laminectomy pain continues to be a relatively common occurrence.[3,4] Post-laminectomy pain in patients with unrelieved pain after lumbar spine surgery has been attributed to the presence of possible pathologic changes, including inflammation, edema, fibrosis, venous congestion, mechanical pressure on the posterior longitudinal ligament, reduced or absent nutrient delivery to the spinal nerve or nerve root, and central sensitization.[5,6] In particular central sensitization that plays a major role in acute post-spinal surgical pain, may be the result of the neural root irritation, even if minimal.[7] Central sensitization triggered by sudden rises in extracellular concentrations of excitatory amino acids, as a result of unintentional stretch and/or deformation/compression damage to dorsal roots or to the dorsal surface of the spinal cord during surgery, is known to occur when extracellular glutamate concentrations are abnormally high. This results in glutamate receptor-mediated signal transduction cascades that lead to dorsal horn neuronal hyperexcitability and

supersensitivity to evoked mechanical stimuli.[8,9] Administration of analgesic medication, before the actual onset of the painful stimulus, which is the principle of pre-emptive analgesia, may prevent nociceptive inputs generated during surgery from sensitizing central neurons and, therefore, may reduce postoperative pain.[10,11] Further, pre-emptive analgesia interventions such as epidural analgesia, local anesthetic wound infiltration, systemic N-methyl-D-aspartic acid receptor antagonists, systemic non-steroidal anti-inflammatory drugs, and systemic opioids are found to be more effective than conventional regimens in managing acute postoperative pain.[12–14] The timing and the application method together with the type of local anesthetic and its dose are very important in pre-emptive analgesia. The idea of interrupting the pain transmission before it starts is the key element in this prediction. In our study, considering the neural root as the target site to block the pain transmission, we attempted to apply the local anesthetic immediately after exposure. Lidocaine pre-treatment as the anesthetic agent could offer a safety measure for prevention of acute and chronic pain following surgical back procedures (nerve entrapment release, intervertebral disk modification, and laminectomies) is given during the procedures by topical administration onto spinal nerves and/or the dorsal spinal surface.[15] In this study, we predicted that intraoperative pre-treatment with lidocaine into the dorsal root ganglion before the onset of the noxious stimuli would attenuate surgically induced allodynia, thus preventing intensive postoperative acute back pain. The study concluded that pre-emptive analgesia is effective in reducing the postoperative pain in spinal surgeries for herniated disc and fusion procedure for spondylolisthesis and the total dose of analgesia required is reduced during the immediate postoperative period.

Key Messages

Lidocaine application onto the dorsal neural sheath immediately before retraction of the root may extend the time before analgesia requested and the total analgesic drug consumption.

Support: Nil

Conflicts of interest: Nil

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