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The Effect of Various Multimodal Analgesia Regimens During Surgical Treatment of Patients with Spinal Stenosis on the Rate of Failed Back Surgery Syndrome

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Objective — to determine the effect of various methods of perioperative analgesia on the rate of failed back surgery syndrome in patients operated on for spinal stenosis.

Materials and methods. A total of 122 patients were operated on for spinal stenosis in 2010—2016. The patients were assigned to groups according to the type of received analgesia: Group K (*n*=19) underwent analgesia on-demand. Patients in the PMA group (*n*=21) received preventive multimodal analgesia (PMA) with ketoprofen, paracetamol and morphine. Patients in the PMA+PG (*n*=20) and PMA+N (*n*=20) groups additionally received pregabalin and nefopam, respectively. Patients in the PMA+E group (*n*=22) received continuous epidural analgesia with a combination of ropivacaine and morphine. In patients in the PMA+I group (*n*=20), the wound was infiltrated with ropivacaine and ketorolac.

Results and conclusions. In Group K, analgesia was not adequate during five postoperative days. Analgesia with PMA resulted in significant pain reduction during three postoperative days compared to Group K. Wound infiltration in addition to PMA was followed by more significant pain relief during six postoperative hours (compared to the PMA group). Administration of pregabalin or nefopam, as well as epidural analgesia, did not improve quality of postoperative analgesia. Five to seven months after the surgery, 66% (57; 75%) of patients had low back and/or leg pain; 41% (32; 50%) of patients had leg pain. Among patients suffering from pain, 32—41% patients had the severe chronic pain syndrome that resulted in sleep disorder, disability and significant deterioration of quality of life. The rate of failed back surgery syndrome did not depend on the perioperative analgesia regimen.

Keywords: spinal stenosis, lumbar fusion, pregabalin, nefopam, epidural analgesia, wound infiltration, postoperative analgesia, failed back surgery syndrome.

The first decompressive laminectomy in a patient with spinal stenosis was performed by Lane in England in 1893, the first posterior spinal fusion procedure — by Briggs and Milligan in 1944 [1]. Since then, surgical technique has gone far ahead and the operations have become less traumatic. There was an increase of the number of spinal fusion procedures by 220% for the period from 1990 to 2010 [2]. However, 30—45% of operated patients experience pain in months and years after surgery. Long-standing pain syndrome in these patients often results anxiety and depressive disorders with an unproductive "avoidance" behavioral strategy (passive-suffering installation of the victim, drawn into the conflict by the circumstances). This condition complicates pain therapy [3]. The cost of treatment of these patients is high (about $ 19,000 per patient per year in the United States, there are no data for the RF). Moreover, impaired working capacity of patients is followed by increased financial burden on employable population [4]. Considering social significance of this problem, the term "failed back surgery syndrome" (FBSS) is used in the medical literature to account for these patients and improve quality of their treatment [6].

It is believed that preventive measures may be advisable to reduce FBSS incidence [2]. It was supposed that high-quality perioperative analgesia might be one of the methods for FBSS prevention. Indeed, it is known that inadequate analgesia impairs early rehabilitation of patients and increases the likelihood of chronic pain [5].

Thus, the purpose of this research was to study the effect of various methods of perioperative analgesia on FBSS incidence after surgery for spinal stenosis.

Material and methods

A prospective trial was made at the Sklifosovsky Research Institute for Emergency Care and approved by the local ethics committee. Follow-up period was 7 days from the day of surgery. Subsequent telephone interviewing was performed in 5—7 months after surgery. The study included patients aged 18—70 with spinal stenosis and ASA grade I—III (American Society of Anesthesiologists). All patients underwent elective decompression of neural structures and lumbar spine fusion surgery with cage and transpedicular system for the period 2010—2016. All procedures were made in the Department of Neurosurgery of the Sklifosovsky Research Institute for Emergency Care. In-hospital follow-up included 122 patients (55 men and 67 women). Then, 113 out of 122 patients were interviewed by telephone (3 patients were lost for follow-up, 1 patient refused to participate in the study, another 5 patients were excluded from the study due to redo spinal surgery).

Six different analgesic regimens were applied in study patients. Recruitment of patients in each subsequent group was begun after completion of the previous one (at least 20 people). Randomization was impossible due to the absence of all necessary consumables and medicines

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at the same time. The number of study patients in groups was different due to subsequent exclusion of some patients from the study, for example, due to non-compliance with the protocol or refusal analgesics. Data collection was carried out by 3 researchers alternately at different time periods (G.P.G, D.N.S., E.A.A). Preventive multimodal analgesia (PMA) including ketoprofen, paracetamol and morphine was used in the 1st group (PMA group, *n*=21). PMA and pregabalin (PG) were applied in the 2nd group (PMA + PG group, *n*=20); PMA with nefopam (N) for one day after surgery — in the 3rd group (PMA + N group, *n*=20); PMA and prolonged epidural analgesia (EA) with ropivacaine and morphine solution — in the 4th group (PMA + EA group, *n*=22); PMA and intraoperative infiltration (I) of the wound with ropivacain solution and prolonged irrigation using ropivacaine and ketorolac solution — in the 5th group (PMA + I group, *n*=20). Postoperative analgesia on demand was applied in the control group (C group, *n*=19).

Exclusion criteria: 1) previous lumbar spine surgery; 2) difficult communication with a patient (language barrier, mental illness); 3) allergic reactions against certain analgesics; 4) contraindications to analgesics and methods of analgesia (acute gastroduodenal erosions and ulcers; liver and renal failure; exacerbation of chronic obstructive pulmonary disease, respiratory failure grade II—III; decompensated severe diabetes mellitus; chronic heart failure NYHA class 3—4; myocardial infarction within 1 month prior to surgery; alcohol abuse); 5) refusal to participate in the study. Patients were also excluded from the study in case of non-compliance with the protocol or refusal analgesics. In the PMA + EA and PMA + I groups, patients were excluded from the study in case of intraoperative injury of dura mater, since regional methods of anesthesia were associated with risk of uncontrolled spinal block in these patients.

Baseline characteristics of patients (sex, age, body weight) were similar in all groups. However, between-group differences were noted in ASA class (**Table 1**). Unlike other groups, PMA + I group was characterized by no patients with ASA class 1, fewer patients with ASA class 2 and predominant patients with ASA class 3. This may be due to subjective assessment of ASA class (data for PMA + I group were collected by researcher E.A.A. who was not involved in data collection in other groups).

Study patients underwent spinal nerve decompression and spinal fusion surgery. There were no differences in spinal decompression, spinal fusion surgery by the cage, number of screws in fixation system and duration of surgery (**Table 2**). Operations were performed by 5 surgeons with individual experience of spinal surgery over 5 years.

All surgeries were performed under general anesthesia (induction — propofol 2 mg/kg and fentanyl 2 μg/kg, maintenance — 1 MAC of sevoflurane and nitrous oxide in combination with fractional administration of fentanyl, muscle relaxation — rocuronium bromide 0.6 and 0.15 mg/kg, respectively). Finally, patients were weaned from the ventilator in operating theatre and transferred to the intensive care unit after consciousness restoration. Anesthesia was conducted by a group of three anesthesiologists (G.P.G, E.A.A, D.N.S.) under the supervision of a senior anesthesiologist (G.P.G), who has many years of experience in neuroanesthesiology.

Scheme of postoperative analgesia was different in groups. Anesthesia on demand was applied in the control group. Medical staff of intensive care unit and neurosurgical department later chose certain analgesics. Metamizole sodium was injected in 16 (84%) patients, various non-steroidal anti-inflammatory drugs (NSAIDs) — in 17 (89%) patients, paracetamol — in 10 (53%) cases, tramadol — in 13 (68%) patients, promedol — in 8 (42%) patients, nalbuphine — in 3 (16%) cases and morphine in 1 (5%) patient. Excess of maximum single and/or daily doses of metamizol and NSAIDs was observed in 8 (42%) out of 19 patients. PMA was applied in the other groups. This regimen implied intravenous administration of ketoprofen 100 mg and paracetamol 1 g during wound closure, ketoprofen 100 mg per os every 12 hours and paracetamol 1 g intravenously every 6 hours for 3 postoperative days. Subject-regulated dosing of morphine was used in case of insufficient analgesia on the day of surgery. The next days, patients received ketoprofen 100 mg per os on demand (not more than 200 mg/day). In the PMA + N group, nefopam 20 mg (diluted in saline solution 200 ml) was intravenously administered 30 minutes before the end of surgery. Then, prolonged intravenous infusion of this drug (80 mg) was performed in ICU during the first postoperative day. In the PMA + PG group, pregabalin 300 mg per os was administered 1.5 hours before surgery and then 150 mg twice a day for 7 days. In the PMA + EA group, spinal fusion procedure was followed by insertion of the epidural catheter into the upper part of epidural space open after previous decompression. The catheter was passed cranially for 5 cm. As soon as aponeurosis was sutured, ropivacaine solution 0.35% 7 ml was injected into epidural catheter. The following measure was infusion of solution of ropivacaine 2 mg/ml and morphine 50 μg/ml through an elastomeric pump (rate 6 ml/hour). Postoperative infusion rate depended on subjective feeling of pain and ranged from 2 to 6 ml per hour.

In the PMA + I group, surgeon installed a perforated catheter for prolonged irrigation of the wound after spinal fusion procedure. This catheter was deployed under aponeurosis on the contralateral side. As soon as aponeurosis was sutured, ropivacaine solution 0.35% 7 ml was injected into the catheter with subsequent infusion of analgesic mixture of ropivacaine 2 mg/ml and ketorolac 0.15 mg/ml through elastomeric pump (rate 10 ml/hour). Postoperative infusion rate depended on subjective feeling of pain and ranged from 8 to 10 ml per hour. Closure of the wound was also associated with layer-by-layer in-

Table 1. **Characteristics of study patients**

Group	ASA 1/2/3 *(n)*	Men/women, *n*	Age, years Me (LQ; UQ)*	Body mass, kg, Me (LQ; UQ)*
C (*n*=19)	1/13/5	8/11	58 (51; 61)	82 (73; 90)
PMA (*n*=21)	2/16/3	5/16	57 (49; 63)	90 (75; 100)
PMA+PG (*n*=20)	3/14/3	11/9	54 (48.5; 62)	80 (72; 92)
PMA+N (*n*=20)	4/14/2	9/11	55.5 (40.5; 63.5)	77 (70; 95)
PMA+EA (*n*=22)	5/13/4	12/10	53.5 (49; 65)	81 (75; 103)
PMA+I (*n*=20)	0/8/11	10/10	57 (50.5; 61.5)	86 (66; 100)
p	0.018[1]	0.337[1]	0.935[2]	0.903[2]

Footnote. * — median and quartiles; 1 — between-group comparison using χ2 test; 2 — between-group comparison using Kruskal—Wallis ANOVA test.

Table 2. **Особенности операции**

Group	Decompression, N/F/L**, n	Number of screws, Me (LQ; UQ)*	Spinal fusion cage, *n* (%)	Surgery time, min, Me (LQ; UQ)*
C (*n*=19)	0/10/9	4 (4; 6)	15 (79)	225 (195; 260)
PMA (*n*=21)	3/9/9	4 (4; 6)	21 (100)	220 (175; 295)
PMA+PG (*n*=20)	0/9/11	4 (4; 6)	18 (90)	202 (155; 262)
PMA+N (*n*=20)	2/10/8	5.5 (4; 7)	20 (100)	240 (210; 300)
PMA+EA (*n*=22)	0/5/17	4 (4; 6)	21 (95)	218 (180; 260)
PMA+I (*n*=20)	0/8/12	4 (4; 5)	17 (85)	230 (170; 327)
p	0.771[1]	0.357[2]	0.089[1]	0.500[2]

Footnote. * — median and quartiles; ** — no procedure/facetectomy/laminectomy; 1 — between-group comparison using χ2 test; 2 — between-group comparison using Kruskal—Wallis ANOVA test.

filtration of paraspinal muscles, subcutaneous fatty tissue and skin (ropivacaine solution 0.2% 3 mg/kg).

Severity of pain syndrome was assessed using a visual analogue scale (VAS) with range from 0 to 10 cm for no pain and unbearable pain syndrome, respectively. Pain syndrome was evaluated on the first postoperative day every 2 hours and within 2—7 days once a day. Anesthesia was considered as adequate if median of VAS value ranged 0—3 cm at rest and 0—4 cm for movements.

Presence and severity of pain in the back and leg was analyzed in 5—7 months after surgery during a telephone survey. The following answers were recorded: less than 2 days a week, more than 2 days a week, every day, permanent pain. Mean and maximum pain intensity was also determined using a numerical rating scale (NRS) from 0 to 10 (value 0 — no pain, value 10 — unbearable pain). Sensitive disorders in the lower extremities, pain-related sleep disorders and incidence of analgesics intake were also consisted (answers: “do not use”, “less than 2 days a week”, “more than 2 days a week”, “every day"). Influence of pain syndrome on the quality of life (answers: “does not affect”, “small influence”, “great influence”, “very great influence”) and employment status (answers: “I work”, “I do not work ","I do not work, as retired") were also evaluated. Exclusion criterion was redo surgery within 6 months after inclusion in the study.

Statistical analysis data was performed using the Statistica 9.1 software package (StatSoft, Inc., USA). Quantitative variables are shown as medians and quartiles, qualitative values — absolute and relative frequencies. Quantitative characteristics in 6 independent groups were compared using Kruskal—Wallis ANOVA test. Two groups were compared using Mann—Whitney test, qualitative data — using χ^2 and Fisher's exact tests. We compared data in groups C (conventional anesthesia) and PMA (standard preventive anesthesia). Subsequent analysis included pairwise comparison of variables in PMA group and other groups (PMA + N, PMA + PG, PMA + EA, PMA + I). Differences were significant at $p<0.05$, for pairwise comparisons — 0.01 (with Bonferroni correction). A 95% confidence interval (CI) was calculated for some relative frequencies.

Results and discussion

Control group was characterized by no adequate analgesia within 12 hours after surgery at rest and 5 postoperative days during movement. Other groups without regional anesthesia were also characterized by significant between-group differences in severity of pain syndrome **(Table 3).**

In the PMA group, analgesia was not adequate in 2 hours after surgery at rest, within 6 hours after surgery upon movement and on the 4th postoperative day. PMA + N group was characterized by inadequate analgesia within 4 hours after surgery at rest and 3 days upon movement, PMA + PG group — within 4 hours after surgery at rest and 6 hours upon movement.

In the PMA + EA group, analgesia was inadequate only 2 within hours after surgery at rest and upon movement **(Table 4).**

***Table 3*. VAS score of pain syndrome in groups C, PMA, PMA + N and PMA + PG**

Control period	Condition	Pain severity in study groups, Me (LQ, UQ)*, significance of differences, *p*						
		C (*n*=19)	PMA (*n*=21)	p^1	PMA+N (*n*=20)	p^2	PMA+PG (*n*=20)	p^3
2 h	Rest	6 (3, 7)	4.75 (3; 6)	0.185	3.5 (3; 5)	0.298	3 (2: 5.5)	0.224
	4 h	8 (6.5: 9)	6.5 (4.75; 7.25)	0.030	6.25 (4.5; 7.5)	0.860	6.25 (3; 8)	0.957
6 h	Rest	5.75 (3; 7.5)	3 (2; 5)	**0.005**	3.25 (2; 5.5)	0.978	3.25 (1.5; 5.5)	0.633
	8 h	8 (6; 8.5)	6 (4;7)	0.019	5.75 (4;7.3)	0.978	6 (3.5;7.5)	0.715
10 h	Rest	5.5 (3.5; 7)	2 (1; 4)	**0.001**	2 (1.3; 4.5)	0.365	2 (1.25; 5)	0.365
	12 h	7.5 (6; 8)	5 (2.5; 6)	**0.001**	5.5 (3.5; 6.5)	0.365	4.75 (3; 6.5)	0.860
2 days	Rest	4 (2; 6.5)	1.75 (1; 2.75)	**0.002**	2.5 (1.0; 4.0)	0.351	2 (1; 3.5)	0.646
	3 days	6.5 (5; 7)	4 (2.5; 5.5)	**0.009**	5.25 (4.5; 6.5)	0.108	4 92; 6)	0.850
4 days	Rest	4 (2.5; 7)	1 (0; 1.5)	**0.000**	2 (1; 4)	0.044	1 (0.25; 2)	0.426
	5 days	6.5 (5; 7)	2 (1.5; 4)	**0.001**	5 (4; 6)	**0.002**	3 (1.5; 5.5)	0.575
6 days	Rest	4 (2; 6.5)	9 (0; 1)	**0.000**	1.5 (0.8; 3.0)	0.016	1 (0; 2)	0.176
	7 days	6.5 (6; 8)	2 (1.5; 4)	**0.000**	5.5 (3.3; 6.3)	0.012	3 (2;6)	0.250
2 days	Rest	3 (1.5; 7)	0.5 (0; 2)	**0.004**	1.5 (1; 4)	0.088	1 (0;2)	0.755
	Movement	7.5 (4.5; 9)	3.5 (2; 6)	**0.003**	4.5 (3.5: 6)	0.194	3.5 (3; 5)	0.766
3 days	Rest	2.5 (2; 4)	1.25 (0; 2)	**0.004**	1.5 (0.5; 2)	0.725	1 (0; 2)	0.736
	Movement	6 (4; 8)	3.75 (1; 6.25)	0.018	4.5 (3.0; 6.5)	0.261	3 (1; 5.5)	0.643
4 days	Rest	2 (1; 4.5)	1.5 (0; 2.5)	0.070	2 (0; 3)	0.626	1.5 (0; 2.5)	0.989
	Movement	5 (2.5;7)	4.5 (2; 5.5)	0.184	4 (2.5; 6.5)	0.626	3.5 (2; 5)	0.542
5 days	Rest	2 (1; 5)	1 (0.5; 3)	0.093	1 (1; 2.5)	0.968	1.5 (0; 2)	0.524
	Movement	5 (1.5; 8)	3.5 (1.5; 7)	0.184	3.5 (3; 6)	0.882	2.5 (1; 5)	0.424
6 days	Rest	1.5 (1; 4.5)	0.5 (0; 1)	0.010	1 (0; 2.5),	0.297	1 (0; 2)	0.336
	Movement	4 (2; 9)	2 (0.5; 4.5)	0.028	3 (2.5; 5)	0.190	2.5 (1; 4)	0.685
7 days	Rest	1 (1; 3.5)	1 (0; 2)	0.104	1 (0; 1.5)	0.797	0 (0; 1.5)	0.422
	Movement	3 (2.7)	3 (0; 4)	0.163	2 (1.5; 4)	0.655	2 (0.5; 3.5)	0.811

Footnote. *— median and quartiles; p^1 — comparison of the C and PMA groups using Mann—Whitney test; p^2 — comparison of the PMA and PMA + N groups using Mann—Whitney test; p^3 — comparison of the PMA and PMA + PG groups using Mann—Whitney test.

Pain syndrome severity was significantly less in this group than in the PMA group only in 6 hours after surgery upon movement. There was a tendency ($p<0.05$) to a decrease of intensity of dynamic pain (compared to PMA group) after 4, 8 hours and on the 2nd day. Analgesia was adequate throughout entire follow-up period in the PMA + I group.

Pain syndrome was diagnosed in 75 (66%) out of 113 (95% CI 57—75) patients in 5—7 months after lumbar disc herniation repair. Leg pain was observed in 46 (41%) of them, back pain — in 29 patients. Mean and maximum NRS score of pain intensity was 4 (2; 5) and 6 (3; 7), respectively. We did not find significant between-group differences in the incidence of back and leg pain during telephone survey despite different severity of early postoperative pain syndrome (**Table 5**).

Pain was predominantly nagging in 69 (92%) patients in 5—7 months after surgery, stabbing, shooting and burning — in 6 (8%), 11 (15%) and 8 (11%) patients, respectively. Forty-six (61%) patients noted pain only upon movement, pain at rest was observed in 29 (39%) patients. In 10 (13%) patients, pain occurred less than 2 days a week, in 18 (24%) patients — more than 2 days a week, in 35 (47%) — every day. Pain was permanent in 12 (16%) patients. Sleep disorders were observed in 24 (32%) patients. Analgesics intake was not required in 48 (64%) out of 75 patients with pain syndrome. Six (8%) patients took painkillers up to 2 days a week, 14 (19%) patients — over 2 days a week, 7 (9%) patients had to take analgesics every day. There was no impairment of quality of life in 13 (17%) patients. Mild, significant and extremely significant decrease of quality of life was observed in 30 (40%), 19 (25%) and 11 (15%) patients, respectively. Sensitive disorders in the lower extremities in 6 months after surgery were reported by 62 (55%) out of 113 respondents. There were these disorders in 50 (44%) patients. Thirty-nine (35%) patients returned to full-time work, 8 (7%) patients were part-time employees. Thirty-five (31%) patients did not work due to retirement age, 30 (27%) ones did not return to work after surgery due to persistent pain syndrome. Thus, 30 (40%) out of 75 patients with pain syndrome in 6 months after surgery became disabled.

In conclusion, we would like to emphasize certain limitations of our study. These limitations are non-randomized study design, surgeries performed by several surgeons, anesthesia provided by various anesthesiologists and small number of patients in each group. We also did not take into account the role of risk factors (socio-demographic, psychological, clinical) in assessment of the results of surgical treatment in patients with herniated intervertebral discs. We will report these data in subsequent publications. Currently, we continue to search for

***Table 4*. VAS score of pain syndrome in groups PMA, PMA + EA and PMA + I**

Control period	Condition	Pain severity in study groups, Me (LQ, UQ)*, significance of differences, *p*				
		PMA (*n*=21)	PMA+EA (*n*=22)	p^1	PMA+I (*n*=20)	p^2
2 h	Rest	4.75 (3; 6)	3.5 (0;5)	0.141	2.24 (0.5; 3)	**0.001**
	Movement	6.5 (4.75; 7.25)	5 (2; 7.5)	0.213	3 (0.5; 4)	**0.000**
4 h	Rest	3 (2; 5)	1.75 (0; 3.5)	0.047	1.25 (0; 2.5)	**0.004**
	Movement	6 (4; 7)	2 (0; 6)	0.023	2 (1.25; 45)	**0.000**
6 h	Rest	2 (1; 4)	0 (0; 2)	0.033	1 (0; 3)	0.245
	Movement	5 (2.5; 6)	2 (0;’ 3.5)	**0.004**	2 (1; 3.5)	**0.005**
8 h	Rest	1.75 (1; 2.75)	0.5 (0; 2)	0.104	0.75 (0; 175)	0.086
	Movement	4 (2.5; 5.5)	1.25 (0; 4)	0.016	2 (1; 4)	0.011
10 h	Rest	1 (0; 1.5)	0 (0; 1.5)	0.520	1 (0; 2)	0.715
	Movement	2 (1.5; 4)	1.5 (0; 5)	0.331	2.5 (0.25; 5)	0.506
12 h	Rest	0 (0; 1)	0.5 (0; 2)	0.369	1 (0; 2)	0.175
	Movement	2 (1.5; 4)	1.75 (0; 6)	0.512	3 (1; 4)	0.735
2 days	Rest	0.5 (0; 2)	0 (0; 1)	0.202	1 (0; 1.5)	0.958
	Movement	3.5 (2; 6)	2 (0; 4)	0.021	3 (1; 4.5)	0.167
3 days	Rest	1.25 (0; 2)	1 (0; 2.5)	0.588	1.5 (0; 3.25)	0.570
	Movement	3.75 (1; 6.25)	3.5 (2; 5)	0.980	4 (2; 6)	0.387
4 days	Rest	1.5 (0; 2.5)	1 (0; 3)	0, 780	1 (0.75; 2.5)	0.804
	Movement	4.5 (2; 2.5)	3 (2; 5)	0.618	3 (2; 5.5)	0.764
5 days	Rest	1 9),5; 3)	1.5 (1; 4)	0.589	1.5 (0; 3)	0.804
	Movement	3.5 (1.5; 7)	3.5 (2; 6)	0.660	3 (2; 4.5)	0.927
6 days	Rest	0.5 (0; 1)	2 (1; 3)	**0.004**	1 (0; 2.5}	0.235
	Movement	3.5 (1.5; 7)	3.5 (2; 6)	0.660	3 (2; 4.5)	0.927
7 days	Rest	1 (0; 2)	1.5 (0.5; 2)	0.392	1 (0; 3)	0.411
	Movement	3 (0; 4)	3 (2; 5.5)	0.232	3 (1.5: 4)	0.434

Footnote. *— median and quartiles; p^1 — comparison of the PMA and PMA + EA groups using Mann—Whitney test; p^2 — comparison of the PMA and PMA + I groups using Mann—Whitney test.

***Table 5*. Characteristics of pain syndrome in 5—7 months after surgery**

Group	Number of patients with pain, *n* (%)	Number of patients with leg pain, *n* (%)	Mean NRS score of pain syndrome, Me (LQ; UQ)*
C (*n*=16)	15 (94)	8 (50)	4 (1; 5)
PMA (*n*=21)	15 (71)	10 (48)	4 (2; 5)
PMA+N (*n*=17)	10 (59)	6 (35)	2.75 (1.5; 3)
PMA+PG (*n*=18)	10 (56)	8 (44)	3.5 (2; 5)
PMA+EA (*n*=22)	12 (55)	7 (32)	4 (3; 5)
PMA+I (*n*=19)	13 (68)	7 (37)	4.5 (3; 5)
p	0.078[1]	0.769[1]	0.383[2]

Footnote. *p* — significance of between-group differences; * — median and quartiles; [1] — comparison of groups using χ^2 test; [2] — comparison of groups using Kruskal—Wallis ANOVA test.

effective methods of analgesia for patients undergoing spinal surgery.

Conclusions

1. Subject-regulated dosing of analgesics is followed by inadequate analgesia in at least 50% of patients with spinal stenosis within 5 days after decompression of neural structures and spinal fusion surgery. Preventive multimodal analgesia including ketoprofen, paracetamol and morphine results more significant relief of postoperative pain within 3 days after surgery in comparison with analgesia on demand.

2. Intraoperative infiltration of the wound with ropivacaine solution and prolonged postoperative irrigation with analgesic mixture of ropivacaine and ketorolac in addition to preventive multimodal anesthesia result even more significant (in comparison with PMA) relief of postoperative pain syndrome within 6 hours after decompression of neural structures and spinal fusion surgery.

3. Pregabalin and nefopam, as well as epidural analgesia with solution of ropivacaine and morphine in the

scheme of preventive multimodal analgesia are not followed by improved quality of postoperative analgesia.

4. Back and/or leg pain is observed in 66% of patients in 5—7 months after surgery for spinal stenosis, leg pain — in 41% of patients. In 32—41% of patients, severe chronic pain syndrome results sleep disturbances, disability and significant aggravation of quality of life.

5. Incidence of failed back surgery syndrome after operations for spinal stenosis did not depend on the perioperative analgesia scheme.

Authors' participation:
Concept and design of the study — P.G, V.T.
Collection and analysis of data — P.G., N.D., A.E.
Statistical analysis — P.G., O.R.
Writing the text — P.G.
Editing — V.T., A.G., O.R.

Authors declare no conflict of interests.

REFERENCES

1. Mikhailovsky MV. Stages of spine surgery development: historical excursus. Hirurgiâ pozvonočnika. 2004;1:10-24. (In Russ.).
2. Chan CW, Peng P. Failed back surgery syndrome. *Pain Med*. 2011;12(4):577-606.
3. Hasenbring M, Marienfeld G, Kuhlendahl D, Soyka D. Risk factors of chronicity in lumbar disc patients. A prospective investigation of biologic, psychologic, and social predictors of therapy outcome. *Spine* (Phila Pa 1976). 1994;19(24):2759-2765.
4. De Lissovoy G, Brown RE, Halpern M, Hassenbusch SJ, Ross E. Cost-effectiveness of long-term intrathecal morphine therapy for pain associated with failed back surgery syndrome. *Clin Ther*. 1997;19(1):96-112.
5. Perkins FM, Kehlet H. Chronic pain as an outcome of surgery: A review of predictive factors. *Anesthesiology*. 2000;93(4):1123-1133.
6. Shapiro CM. The failed back surgery syndrome: pitfalls surrounding evaluation and treatment. *Phys Med Rehabil Clin N Am*. 2014;25(2):319-340.

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Commentary

It is well known that pain is the main reason for treating a patient with spinal pathology to a neurosurgeon [1]. Therefore, pain relief is one of the main effects expected from neurosurgical intervention while postoperative chronic pain syndrome instead of pain relief is very disheartening situation. This result is determined as "failed back surgery syndrome" in modern literature. Moreover, there are over 9000 publications devoted to this problem in the PubMed database that clearly indicates its relevance in the world. This article is devoted to the same problem.

The authors have done a serious job. Analysis included 122 patients who underwent surgery in one of the leading neurosurgical clinics of our country over 7-year period. The hypothesis tested by the authors is quite simple and concrete. Is there correlation between the effectiveness of perioperative analgesia and incidence of failed back surgery syndrome? It should be recognized that the authors received a quite convincing answer. There is no so correlation. I will say right away that this conclusion is somewhat different from the generally accepted point of view [2—6]. Nevertheless, a result is presented to us and we must consider it.

I have no any serious remarks regarding design of the study, methods of research and statistical analysis. However, I was personally somewhat embarrassed by the following aspects.

1. A rather high incidence of failed back surgery syndrome (32—41%). This value is significantly higher than in one recent publication [7]. Therefore, the reasons of such difference are discussable. Unfortunately, the authors did not comprehensively analyze this result. In addition, list consisting of six references looks quite modest.

2. Positive effect of postoperative analgesia with gabapentinoids. There are certain trials devoted to these drugs administered in sufficiently high doses (1,200 mg) and according to a pre-emptive scheme (even a week prior to surgery in one study) [8]. However, there was no serious analgesic effect compared with the basic scheme of analgesia (subject-regulated intravenous morphine administration). Only a very moderate decrease of the required dose of morphine and reduced incidence of undesirable effects of opiates were observed. Similar data were obtained in other works [9—13].

3. Conversely, no serious analgesic effect of epidural anesthesia. These results are especially difficult for me to perceive for two reasons. The first cause is world literature data. These data are also interesting in their own way. There is a relatively small number of publications devoted to intraoperative and postoperative epidural analgesia [14—19]. Various authors report the use of epidural anesthesia only for postoperative analgesia after spinal neurosurgery (one or two epidural catheters depending on wound dimension are installed by neurosurgeon under visual control prior to suturing of the wound) [14, 20—23]. It is important that general conclusion of all these works is simple. There is nothing more effective than epidural anesthesia. Moreover, there are additional benefits associated with effective analgesia and refusal of opiates including fast rehabilitation of patient and no problems with intestinal motility and urination. The second reason is our own experience of these procedures [24—26]. I did not understand why the authors obtained opposite data.

In conclusion, I would like to say that the research turned out to be interesting, useful and worthy of discussion. It is essential for further analysis of this actual and unresolved problem.

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REFERENCES

1. Greenberg MS (ed.). *Handbook of Neurosurgery*. 7th ed Thieme (NY). 2006; 428-530.
2. Kim SI, Ha KY, Oh IS. Preemptive multimodal analgesia for postoperative pain management after lumbar fusion surgery: a randomized controlled trial. *Eur Spine J*. 2016;25:1614-1619. https://doi.org/10.1007/s00586-015-4216-3
3. Siriburungwong K, Cheewakidakarn J, Tangtrakulwanich B, Nimmaanrat S. Comparing parecoxib and ketorolac as preemptive analgesia in patients undergoing posterior lumbar spinal fusion: a prospective randomized double-blinded placebo controlled trial. *BMC Musculoskelet Disord*. 2015;16:59. https://doi.org/10.1186/s12891-015-0522-5
4. Luo J, Min S. Postoperative pain management in the postanesthesia care unit: an update. *J Pain Res*. 2017;10:2687-2698. https://doi.org/10.2147/JPR.S142889.eCollection2017
5. Cata JP, Zaky S. Postoperative acute pain. In: Farag E. (Ed.). *Anesthesia for Spine Surgery*. Cambridge. UK. 2012;302-320.
6. Souzdalnitski D, Cheng J. Postoperative chronic pain management. In: Farag E. (Ed.). *Anesthesia for Spine Surgery*. Cambridge. UK. 2012;321-346.
7. Baber Z, Erdek MA. Failed back surgery syndrome: current perspectives. *J Pain Res*. 2016;9:979-997. https://doi.org/10.2147/JPR.592776
8. Ture H, Sayin M, Karlikaya G, Bingol CA, Aykac B, Türe U. The analgesic effect of gabapentin as a prophylactic anticonvulsant drug on postcraniotomy pain: a prospective randomized study. *Anesth Analg*. 2009;109: 1625-1631. https://doi.org/10.1213/ane.0b013e3181b0f18b
9. Yan C, Kuang MJ, Ma JX, Ma XL. The efficacy of preoperative gabapentin in spinal surgery: a metaanalysis of randomized controlled trials. *Pain Physician*. 2017;20:649-661.
10. Li XD, Han C, Yu WL. Is gabapentin effective and safe in open hysterectomy? A PRISMA compliant metaanalysis of randomized controlled trials. *J Clin Anesth*. 2017;41:76-83. https://doi.org/10.1016/j.jclinane.2017.07.002
11. Zhai L, Song Z, Liu K. The effect of gabapentin on acute postoperative pain in patients undergoing total knee arthroplasty: a metaanalysis. *Medicine*. 2016;95:e3673. https://doi.org/10.1097/MD.0000000000003673
12. Mao Y, Wu L, Ding W. The efficacy of preoperative administration of gabapentin/pregabalin in improving pain after total hip arthroplasty: a meta-analysis. *BMC Musculoskelet Disord*. 2016;17:373. https://doi.org/10.1186/s12891-016-1231-4
13. Liu B, Liu R, Wang L. A metaanalysis of the preoperative use of gabapentinoids for the treatment of acute postoperative pain following spinal surgery. *Medicine*. 2017;96:e8031. https://doi.org/10/1097/MD.00000000008031
14. Lubnin AYu, Imaev AA, Solenkova AV. Problema ostroy posle operatsionnoy boli u neirokhirurgicheskikh bolnukh. *Reg. anest. i lechenie ostroi boli*. 2016;10:282-290. (In Russ.). https://doi.org/10188.21/1993-6508-2016-10-4-282-290
15. Patil H, Garg N, Banabokade L, Navakar D. Lumbar spine surgeriesunder spinal anesthesia in high risk patients: a retrospective analysis. *World Neurosurg*. 2019. pii: S1878-8750(19)30117-2. https://doi.org/10.1016/j.wneu.2019.01.023
16. De Rojas JO, Syre P, Welch WC. Regional anesthesia versus general anesthesia for surgery on the lumbar spine: a review of the modern literature. *Clin Neurol Neurosurg*. 2014;119:39-43. https://doi.org/10.1016/j.clinturo.2014.01.016
17. Zorilla-Vaca A, Healy RJ, Mirski MA. A comparison of regional versus general anesthesia for lumbar spine surgery: a metaanalysis of randomized studies. *J Neurosurg Anesth*. 2017;29:415-425. https://doi.org/10.1097/ANA.0000000000000362
18. Kahveci K, Doger C, Ornek D, Gokcinar D, Aydemir K, Ozay R. Perioperative outcome and cost-effectiveness of spinal versus general anesthesia for lumbar spine surgery. *Neurol Neurochir Pol*. 2014;48:167-173. https://doi.org/10.1016/j.pjnns.2014.05.005
19. Finsterwald M, Muster M, Farshad M, Saporito A, Brada M, Aguirre JA. Spinal versus general anesthesia for lumbar spine surgery in high risk patients: Perioperative hemodynamic stability, complications and costs. *J Clin Anesth*. 2018;46:3-7. https://doi.org/10.1016/j.jclinane.2018.01.004
20. Gessler F, Mutlak H, Tizi K, Senft C, Setzer M, Seifert V, Weise L. Postoperative patient-controlled epidural analgesia in patients with spondylodiscitis and posterior spinal fusion surgery. *J Neurosurg Spine*. 2016;24:965-970. https://doi.org/10.3171/2015.8.SPINE15415
21. Lu S, Ma SC, Wang YY, Zhu ZH, Fan HW, Zhao GQ. Comparison of pain relief between patient-controlled epidural analgesia and patient-controlled intravenous analgesia for patients undergoing spinal fusion surgeries. *Arch Orthop Trauma Surg*. 2015;135:1247-1255. https://doi.org/10.1007/s00402-015-2263-1
22. Li Y, Lu S, Ma SC, Fan HW, Zhao GQ. Effects of Patient-Controlled Epidural Analgesia and Patient-Controlled Intravenous Analgesia on Analgesia in Patients Undergoing Spinal Fusion Surgery. *Am J Ther*. 2016;23: e1806-e1812. https://doi.org/10.1097/MJT.0000000000000338
23. Schenk MR, Putzier M, Kügler B, Tohtz S, Voigt K, Schink T, Kox WJ, Spies C, Volk T. Postoperative analgesia after major spine surgery: patient-controlled epidural analgesia versus patient-controlled intravenous analgesia. *Anesth Analg*. 2006;103:1311-1317. https://doi.org/10.1213/01.ane/0000247966.49492.72
24. Solenkova AV, Lubnin AYu, Konovalov NA, Asyutin DS, Dzyubanova NA, Poddubskaya AA, Zakirov BA, Martynova MA. Posleoperatsionnaya prodlennaya epidural'naya analgeziya pri spinal'nykh neirokhirurgicheskikh vmeshatel'stvakh. Ch. I. Analiz effektivnosti i bezopasnosti primeneniya prodlennoi epidural'noi analgezii v sravnenii s traditsionnymi skhemami obezbolivaniya pri spinal'nykh neirokhirurgicheskikh vmeshatel'stvakh. *Anesteziologiya i reanimatologiya*. 2017;3:172-177. https://doi.org/10.18821/0201-7563-2017-62-3-172-177
25. Solenkova AV, Lubnin AYu, Konovalov NA, Korolishin VA, Asyutin DS, Martynova MA, Moshkin AV, Aref'eva IA, Teryaeva NB. Posleoperatsionnaya prodlennaya epidural'naya anal'geziya pri spinal'nykh neirokhirurgicheskikh vmeshatel'stvakh. Ch. II. Vliyanie prodlennoi epidural'noi anal'gezii na obshchii vospalitel'nyi stress-otvet. *Anesteziologiya i reanimatologiya*. 2017;3:178-184. https://doi.org/10.18821/0201-7563-2017-62-3-178-184
26. Solenkova AV, Lubnin AYu, Shevelev IN. Vozmozhnosti primeneniya epidural'noi anestezii pri khirurgicheskikh vmeshatel'stvakh na pozvonochnike i spinnom mozge. *Reg. anest. i lechenie ostroi boli*. 2008;4:53-63.