10.5005/jp-journals-10039-1097

ORIGINAL ARTICLE

Major Surgeries are More Painful: Perioperative Pain Management and the Role of Preexisting Chronic Pain in Two Types of Spine Surgery

[1]Eva M Tiefenauer, [2]Beate Poblete, [3]Florian Marti, [4]Christoph J Konrad, [5]Karl F Kothbauer

ABSTRACT

Aim: To answer the question whether the postoperative pain intensity and individual satisfaction correlate with the extent of surgery in two distinct types of spinal surgery and whether the perioperative pain management differs between the two groups in the context of chronic preoperative pain.

Materials and methods: The PAIN OUT assessment tool was used for this retrospective comparative study. One hundred and eighty five nonconsecutive patients were grouped into two surgical groups: Group A (= "minor" operations) were patients undergoing either kyphoplasty, microsurgical fenestration for disk hernia removal, or decompression of spinal stenosis. Group B (= "major" operations) were patients who underwent spinal instrumentation of at least one lumbar segmental level in addition to microsurgical decompression.

Results: In group A (n = 146) the amount of fentanyl administered intraoperatively per hour was higher. Patients in group B (n = 39) underwent longer operation times and received more often remifentanil. They also indicated higher postoperative pain scores and longer pain duration, desired more often additional pain medication, and were less satisfied with analgesic treatment. There was no significant difference in preoperative chronic pain between groups A and B.

Conclusion: More invasive spinal surgeries cause significantly more pain and less patient satisfaction, which we think is largely due to an insufficient perioperative pain management. Contrary to prior reports, the presence of chronic preoperative pain did not predict higher pain perception in the two groups.

Clinical significance: Chronic low back pain is a high prevalent problem with significant clinical and socioeconomic consequences. Current pain management concepts – especially in a perioperative setting – are still unsatisfactory.

Keywords: Case-control study, Decompressive fenestration, Disk hernia, Kyphoplasty, Low back pain, Pain management, Spinal fusion, Spinal stenosis, Spinal surgery, Vertebroplasty.

[1,3]Resident, [2]Senior Physician, [4]Professor, [5]Private Lecturer

[1-4]Department of Anesthesia, Luzerner Kantonsspital, Lucerne Switzerland

[5]Division of Neurosurgery, Luzerner Kantonsspital, Lucerne Switzerland and Division of Neurosurgery, University of Basel Basel, Switzerland

Corresponding Author: Christoph J Konrad, Professor Department of Anesthesia, Luzerner Kantonsspital, Lucerne Switzerland, Phone: +41412051111, e-mail: christoph.konrad@luks.ch

How to cite this article: Tiefenauer EM, Poblete B, Marti F, Konrad CJ, Kothbauer KF. Major Surgeries are More Painful: Perioperative Pain Management and the Role of Preexisting Chronic Pain in Two Types of Spine Surgery. J Spinal Surg 2016;3(3):83-89.

Source of support: Nil

Conflict of interest: None

INTRODUCTION

The prevalence of chronic pain in Europe has been reported up to one-fifth of the people, with 15% of them resulting from trauma and surgery.[1] Sensitization of the nervous system after injury can be a possible explanation for the development of chronic pain, which is often underrecognized, underappreciated, or simply ignored.[2] The process behind the progression from acute to chronic pain is complex, multifaceted, and still poorly understood.[3] After the identification of risk factors like individual vulnerability and poorly controlled acute postsurgical pain, a dynamic view of both the physiological and psychological responses of an individual after injury seems essential to improve understanding and treatment of chronic pain.[4]

Severe pain following a surgical procedure is known to be a common problem with significant clinical and socioeconomic consequences. The surprising finding of a recent cohort study refutes a relationship between postoperative pain intensity and the type of surgery, incision size, or extent of trauma.[5] Clinicians seem to underestimate, misjudge, and ignore patient's pain intensity and requirements for analgesic medications, which results in delayed and/or insufficient analgesic administration,[6] especially after laparoscopic procedures and the so-called "minor" surgeries.[7] According to a large French survey, nearly 90% of the patients who underwent surgery of all types suffered from postoperative pain despite intraoperative administration of analgesics.[8] However, preoperative chronic pain intensity, younger age, symptoms of psychological distress, or depression, and in some studies female gender, have been identified as possible predictors for increased postoperative pain.[5,9-11]

Patients with chronic low back pain after unsuccessful conservative treatment may benefit from posterior lumbar interbody fusion (PLIF) and transforaminal lumbar interbody fusion (TLIF) in terms of quality of life

and function.[12] However, the results are highly variable and difficult to predict for the individual patient as the currently used prognostic tests in clinical practice do not qualify to predict the relief of low back pain by spinal fusion.[13] In case of symptomatic lumbar disk herniations, postoperative outcomes with respect to pain relief are good,[14] particularly for microendoscopic lumbar discectomy.[15-17] Major spinal surgery is frequently associated with high pain scores, insufficient perioperative analgesia,[7] and persistent back pain, also identified under the term "failed back surgery syndrome."[18]

The PAIN OUT research project has been established as an international acute pain registry, funded from 2009 to 2012 by the European Commission's 7th Framework Programme. It is now continued since 2013 on a self-sustaining and nonprofit basis of participating clinicians and researchers worldwide. In cooperation with the International Association for the Study of Pain (IASP), efforts are made to maintain, disseminate, and develop the registry. The project supports clinicians in decision-making and optimizing pain management by offering them standardized and validated tools for measurement, international benchmarking, and evidence-based recommendations.[17]

In opposition to the findings of Gerbershagen et al,[5] we hypothesized that in certain spine surgeries the postoperative pain intensity and individual satisfaction correlate with the extent of surgery. To this we identified two patient groups: One undergoing decompressive surgery, presumably minor operations, and the other undergoing stabilizing spine surgery, presumably more extensive procedures. These two groups were to be compared with each other in matters of postoperative pain intensity and patient satisfaction, perioperative pain management, and the presence of prolonged preoperative pain.

MATERIALS AND METHODS

Our study was conducted at the Department of Anesthesiology (Klinik für Anästhesie, Rettungsmedizin und Schmerztherapie, KLIFAiRS) of the Lucerne Central Hospital in Switzerland. We analyzed perioperative pain and analgesic management of 185 patients undergoing decompressive or stabilizing spine surgery from 2011 to 2014. Data were collected in a standardized interview based on the International Pain Outcomes Questionnarie[19] modified for our purpose inquiring perioperative pain intensity and duration, impairment of basic activities of everyday life, side effects of analgesics, wish for more analgesic treatment, and general satisfaction with pain therapy (Table 1). Agreement for participation in the survey was obtained from the patients orally before starting the interview. Approval from our local ethics committee for collecting nonidentified patient data was obtained. Furthermore, we registered pre- and intraoperative opioid administration.

Patients

Patients eligible for the study were identified consecutively from the daily operation chart on the day prior to surgery. The inclusion criteria were German-speaking adult patients age 18 years and older, undergoing decompression of the spinal canal, excision of a herniated intervertebral disk, percutaneous vertebral augmentation, fusion of two or three lumbar or lumbosacral vertebrae, or a combination of lumbar/lumbosacral decompression and fusion. The indication for surgery was sciatica or back pain, depending upon the pathology. Time of data collection was during the 1st day after surgery (i.e., between midnight after the end of surgery and the following midnight). Patients were only included when they were back on the floor after staying in the recovery room for not longer than 6 hours. Exclusion criteria were inability to cooperate, the inability to speak or understand German, and patients requiring care at the intensive or intermediate care units. For organizational reasons, it was not possible to assess every single consecutive patient.

All study patients underwent general anesthesia supervised by an experienced staff anesthesiologist. Standard monitoring consisted of continuous electrocardiography, pulse oximetry, and temperature measurement as well as noninvasive or invasive blood pressure monitoring. Both inhalational anesthetics and total intravenous anesthesia (TIVA) were utilized, the latter including bispectral index (BIS) monitoring. The perioperative administration of analgesics was prescribed and documented by the anesthesiologist in charge of the patient. It consisted of nonopioids (paracetamol, diclofenac or celecoxibe, metamizol) and opioids (morphine, fentanyl, remifentanil).

We allocated patients with decompressive fenestration of the lumbar spinal canal for spinal stenosis, lumbar microsurgical fenestration with removal of a disk herniation, and patients with a percutaneous vertebral augmentation (vertebro- or kyphoplasty) to the group "decompressive spine surgery" (group A).

Patients operated on for spinal fusion of two or three levels in lumbar and/or lumbosacral segments as well as patients undergoing a combined surgery with lumbar and/or lumbosacral decompression and fusion were allocated to the group "spinal stabilization" (group B).

Questionnaire and Standardized Interview

The International Pain Outcomes Questionnaire[19] (Table 1) is divided into three parts:

1. Process (administrative information, screening, demographics, patient history and medications): These data were collected from the patient's medical and nursing records by the interviewer.

Table 1: Modified International Pain Outcomes Questionnaire (translated from German)[19]

1 How strong was your maximal pain after surgery?

0	1	2	3	4	5	6	7	8	9	10

No pain — maximal pain

2 How strong was your minimal pain after surgery?

0	1	2	3	4	5	6	7	8	9	10

No pain — maximal pain

3 How often since surgery did you experience strong pain?

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

Never strong pain — constant strong pain

4 To which extent did postoperative pain affect or impede the following activities:

a. Activities in bed (e.g., turning, sitting up, change of position)

0	1	2	3	4	5	6	7	8	9	10

No affection — maximal affection

b. Deep inspiration or coughing

0	1	2	3	4	5	6	7	8	9	10

No affection — maximal affection

c. Sleep

0	1	2	3	4	5	6	7	8	9	10

No affection — maximal affection

d. Did you quit the bed since surgery?

☐ No ☐ Yes

If yes, to which extent did pain affect or impede the activities outside of bed (walking, sitting, standing)?

0	1	2	3	4	5	6	7	8	9	10

No affection — maximal affection

5 Did you observe one or more of the following side effects?

a. Nausea

0	1	2	3	4	5	6	7	8	9	10

No nausea — strong nausea

b. Drowsiness

0	1	2	3	4	5	6	7	8	9	10

No drowsiness — strong drowsiness

6 Would you have wished more analgesic therapy since your surgery?

☐ No ☐ Yes

7 How happy are you with the analgesic therapy since your surgery?

0	1	2	3	4	5	6	7	8	9	10

Very unhappy — very happy

8 Did you suffer from constant pain lasting three or more months before you came to hospital due to this surgery?

☐ No ☐ Yes

a. If yes, how strong was this pain for most of the time?

0	1	2	3	4	5	6	7	8	9	10

No pain — maximal pain

b. If yes, where did this constant pain appear?

☐ site of surgery ☐ other site ☐ both

2. Outcomes (postoperative pain, analgesic therapy): This information was obtained from the interview.
3. Structure (organizational structures of the hospital, e.g., number of beds, number of surgeries carried out in a year, etc.): This information was not considered relevant for our study and was therefore not recorded.

The process of data collecting was guided by the PAIN OUT Standard Operating Procedures (SOPs).[19]

Statistical Analysis

Data were stored in a Microsoft Excel spreadsheet. Statistical comparison was made for postoperative pain intensity and analgesic management between groups A and B.

Data analysis was performed with MATLAB [TheMathworks®, Release 7.8.0 (R2009a)] software. To compare means, the Wilcoxon rank-sum test was used for nonparametric analysis (MATLAB command "rankssum") for two-sided test for equal medians. Dichotomous data were analyzed using a chi-square test. All data are presented as means or medians with 2.5%- and 97.5%-percentile in brackets. The level of significance was set at $p < 0.05$.

RESULTS

Between 2011 and 2014, a total of 185 patients were interviewed using the International Pain Outcomes Questionnaire modified for our purpose. One hundred and forty-six patients underwent a decompressive operation (group A), while 39 underwent a more extensive stabilizing procedure (group B).

Group A: Median age was 63 years (25;86). Seventy-eight patients were males and 68 females. The median operation time was 1.8 hours (0.6;4.8). Sixty-six percent of the patients reported chronic preoperative pain, defined as constant pain lasting 3 months or more prior to surgery. Based on the numeric rating scale (NRS) ranging from 0 (= no pain) to 10 (= maximal pain), mean preoperative pain intensity was 6 (0;10). Twenty-seven percent of the patients stated a preoperative opioid usage. Maximal postoperative pain was 4 (0;10) for a median duration of 2.4 hours (0;18.8). Maximal postoperative pain was 4 (0;10) in both patients with and without (0;10) chronic preoperative pain. There is no statistical difference between those two groups ($p = 0.83$). Nine percent of the patients requested more analgesic treatment. General satisfaction with pain management was 9 (3;10) in a scale ranging from 0 (= very unhappy) to 10 (= very happy). Intraoperative opioid administration consisted of 400 µg fentanyl in total (150;700) and 225 µg fentanyl per hour (70;622). Morphine was given in less than 50% of the patients intraoperatively. Forty-seven patients (32%) received additional remifentanil as a continuous intravenous infusion with only the infusion rates documented but the overall dosages not recorded.

Group B: Median age was 65 years (28;81); 18 patients were males and 21 females. The median operation time was 4.4 hours (1.3;8.9). Seventy-two percent of the patients reported chronic preoperative pain with a mean NRS of 5 (0;10). Thirty-one percent of the patients stated a preoperative opioid usage. Maximal postoperative pain was 7 (1;10) for a median duration of 9.6 hours (0;20.5). Maximal postoperative pain was 7 in both patients with (2;10) and without (1;10) chronic preoperative pain. There is no statistical difference between those two groups ($p = 0.72$). Thirty-one percent of the patients requested more analgesic treatment. General satisfaction with pain management was 8 (5;10). Intraoperative opioid administration consisted of 500 µg fentanyl in total (100;926) and 133 µg fentanyl per hour (20;339). A median of 10 mg (0;30) morphine or 2.4 mg morphine per hour (0;8.6) was given intraoperatively. Twenty-three patients (59%) received additional remifentanil as a continuous intravenous infusion with only the infusion rates documented but the overall dosages not recorded.

In both groups, nonopioid analgesics (paracetamol, diclofenac, celecoxibe, metamizol) were given but in such a heterogeneous distribution that meaningful comparison was not feasible.

The two groups differed in the following respects (Table 2): The operation time in group A was significantly shorter ($p < 0.0001$). The maximal postoperative pain was significantly greater ($p < 0.0001$) and lasted significantly longer in group B ($p < 0.0001$). Significantly more patients would have desired additional pain medication in group B ($p = 0.0004$). Patient satisfaction was significantly greater in group A ($p = 0.04$). Absolute fentanyl administration was significantly higher in group B ($p = 0.005$), but fentanyl usage per hour was significantly higher in group A ($p < 0.0001$). Absolute morphine administration was significantly higher in group B ($p = 0.0004$), whereas the difference of relative morphine administration was not significant between the two groups. Significantly more patients in group B received remifentanil intraoperatively ($p = 0.002$).

DISCUSSION

The primary hypothesis for this study was that pain relief will be better after a decompressive spine surgery (group A) than after a more extensive procedure, including spinal stabilization (group B). This assumption was based on the underlying pathogenetic principle, which finally leads to the operation and which is different in groups A and B. The pain provoking problem of patients in group A is a compression and irritation of sensory nerve roots and can be eliminated by the decompression. In contrast, the pathogenesis of chronic low back pain in patients belonging to group B is multifactorial, complex,

Table 2: Results

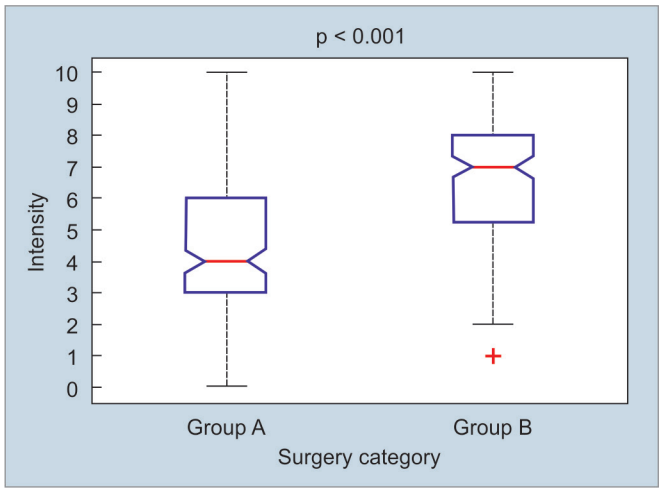
	Decompressive spine surgery (group A)	*Spinal stabilization (group B)*	*p-value*
Number of patients	146	39	
Mean age (yr)	63 (25;86)	65 (28;81)	0.86
Gender (m/f)	78/68	18/21	
Operation time (hr)	1.8 (0.6;4.8)	4.4 (1.3;8.9)	<0.0001
Preoperative chronic pain (% of pt)	66±4	72±7	0.48
Preoperative mean NRS	6 (0;10)	5 (0;10)	0.84
Preoperative opioid consumption (% of pt)	27±4	31±7	0.61
Postoperative max. NRS	4 (0;10)	7 (1;10)	<0.0001
Duration of max. postoperative. NRS (hr)	2.4 (0;18.8)	9.6 (0;20.5)	<0.0001
Wish for more treatment (% of pt)	9±2	31±7	0.0004
Patient satisfaction	9 (3;10)	8 (5;10)	0.04
Intraoperative fentanyl (µg)	400 (150;700)	500 (100;926)	0.005
Per hour	225 (70;622)	133 (20;339)	<0.0001
Intraoperative morphine (mg)	0 (0;20)	10 (0;30)	0.0004
Per hour	0 (0;12)	2.4 (0;8.6)	0.20
Intraoperative remifentanil (% of pt)	32±4	59±8	0.002

yr: Years; hr: Hours; pt: Patients; NRS: Numeric rating scale. 2.5% and 97.5% percentile in brackets and standard deviation behind prefix± respectively

and less well understood. Furthermore, the correlation between clinical findings and imaging is poor,[20] and of course, more extensive surgeries inevitably cause more local irritation, resulting in a higher degree of postsurgical pain. We did include the augmentation procedures in the "simple" group A because they are, in fact, much less invasive procedures than the instrumented stabilizations, and the expected and most common postoperative course is the same as in the decompressive surgeries.

To assess pain and the use of analgesic medication in a surgical setting, modified International Pain Outcomes Questionnaire[19] was used, because it is a simple enough and validated tool and most staff are familiar with it.

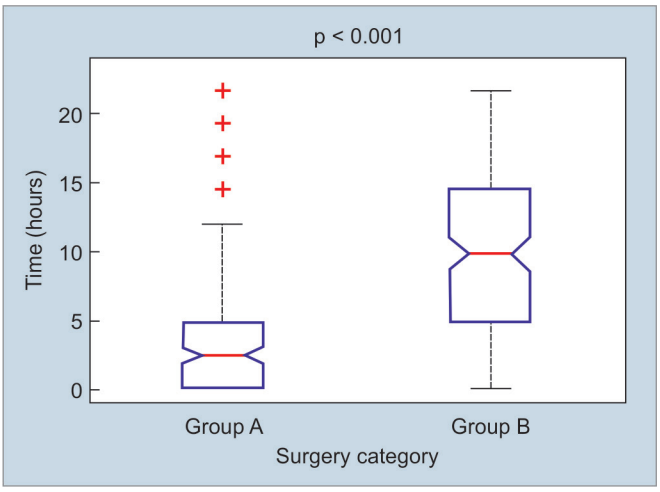
The results confirm the primary hypothesis: The patients in group B with the more extensive surgeries indeed have a significantly higher pain intensity postoperatively (Graph 1), as well as longer duration of intense pain (Graph 2). They would have also desired significantly more additional analgesics and were less satisfied with the postoperative pain management. This was expected as the group B surgeries involved more extensive approaches to the spine with plausibly more tissue traumatization and thus more reason for pain. It was, however, also found that more patients in group B received remifentanil intraoperatively, exactly to counteract the effect of the extensive surgery. But the results show that this objective was not reached. It is possible that the more extensive use of remifentanil intraoperatively may play a role in the higher postoperative pain values of group B patients. This assumption would be supported by a study from Angst and Clark,[21] who reported an opioid-induced hyperalgesia after both the acute systemic administration of high-opioid doses as



Graph 1: Maximal postoperative NRS. The central mark of the boxplots is the median, the edges of the box are the 25th and 75th percentiles (Q1 and Q3, respectively), the whiskers extend to the most extreme data points the algorithm considers to be not outliers, and the outliers are plotted individually. Points are drawn as outliers if they are larger than Q3 + 1.5×(Q3–Q1) or smaller than Q1–1.5×(Q3–Q1), corresponding to approximately ± 2.7 sigma and 99.3% coverage if the data are normally distributed. Two medians are significantly different at the 5% significance level if intervals of the notches do not overlap

well as after chronic opioid administration.[21] However, this review mainly investigated the effect of morphine, whereas in our findings the relative amount of morphine administered during operation was not significantly different in groups A and B.

The study also demonstrates that over two-thirds of patients with degenerative spinal disease have chronic pain (i.e. duration > 3 month) before undergoing spinal surgery. We found no significant difference in prevalence and intensity of chronic preoperative pain (Graph 3) as well as in preoperative opioid administration in group A *vs* group B.



Graph 2: Duration of maximal postoperative NRS (hours)

Graph 3: Preoperative mean NRS

However, the results indicate that the patients in group B experience more intensive postoperative pain for a longer duration. Interestingly, the slightly higher postoperative pain score in patients with preoperative chronic pain is not significant compared to patients without preexisting chronic pain in both groups. This is in contrast to a study from Kalkman et al[11] who showed that the level of preoperative pain acts as an independent predictor of severe postoperative pain.

The analgesic management of patients undergoing spine surgery includes administration of nonopioids like nonsteroidal antiinflammatory drugs, including selective cyclo-oxygenase-2 inhibitors[22,23] or antineuropathic drugs like pregabalin or gabapentin.[24-26] All of them are reported to contribute to a better pain control or have an opioid-sparing effect. The results in this study cannot be applied to this particular issue as the postoperative use of nonopioid drugs was too heterogeneous in both groups to be comparable, both between the groups and in relation to opioid dosage.

The limitations of this study are its retrospective and observational design and an inevitable bias resulting from the selected patient population undergoing surgery. The standardization of the anesthetic approach was less than desired as analgesics were administered heterogeneously and often just according to the preference of the attending anesthesiologist. Due to limited personnel, not every patient who would have met the inclusion criteria could indeed be included. Therefore, the population is not a consecutive one, opening further bias and uncertainty.

The results of this study open the question of improved pain management, particularly for patients like the ones in group B, with less than desired pain control. Methadone has been suggested for this purpose, either alone[27] or combined with ketamine.[28] This would reduce postoperative pain and subsequent opioid usage because of the involvement of another system in the mechanism of opioid tolerance and hyperalgesia. Furthermore, many studies examined the favorable analgesic and opioid-sparing effects of subcutaneous, intramuscular, or local application of corticosteroids and/or local anesthetics.[29-33] Other studies emphasize the importance of a multimodal regimen for analgesia in the setting of spine surgery.[34-37]

CONCLUSION

Our study confirms the hypothesis that more extensive spinal surgeries are more painful and carry higher risks for inadequate pain management, independent of the presence of chronic preoperative pain. The consequence of this must be the development of more intensive perioperative pain management concepts which again must be validated in further studies. Nevertheless, we believe that an adequate multidisciplinary management of chronic pain should be a treatment priority to prevent patients from undergoing a surgical intervention.

ACKNOWLEDGMENT

Many thanks to Friedemann Eckhart for his helpful advice during the preparation of this study and his assistance the PAIN OUT assessment tool.

REFERENCES

1. Breivik H, Collett B, Ventafridda V, Cohen R, Gallacher D. Survey of chronic pain in Europe: prevalence, impact on daily life, and treatment. Eur J Pain 2006 May;10(4):287-333.
2. Joshi GP, Ogunnaike BO. Consequences of inadequate postoperative pain relief and chronic persistent postoperative pain. Anesthesiol Clin North America 2005 Mar;23(1):21-36.
3. Katz J, Seltzer Z. Transition from acute to chronic postsurgical pain: risk factors and protective factors. Expert Rev Neurother 2009 May;9(5):723-744.
4. Lavand'homme P. The progression from acute to chronic pain. Curr Opin Anaesthesiol 2011 Oct;24(5):545-550.
5. Gerbershagen HJ, Pogatzki-Zahn E, Aduckathil S, Peelen LM, Kappen TH, van Wijck AJ, Kalkman CJ, Meissner W. Procedure-specific risk factor analysis for the development

of severe postoperative pain. Anesthesiology 2014 May; 120(5):1237-1245.
6. Sjöström B, Haljamäe H, Dahlgren LO, Lindström B. Assessment of postoperative pain: impact of clinical experience and professional role. Acta Anaesthesiol Scand 1997 Mar;41(3):339-344.
7. Gerbershagen HJ, Aduckathil S, van Wijck AJ, Peelen LM, Kalkman CJ, Meissner W. Pain Intensity on the first day after surgery. Anesthesiology 2013 Apr;118(4):934-944.
8. Fletcher D, Fermanian C, Mardaye A, Aegerter P. A patient-based national survey on postoperative pain management in France reveals significant achievements and persistent challenges. Pain 2008 Jul 15;137(2):441-451.
9. Caumo W, Schmidt AP, Schneider CN, Bergmann J, Iwamoto CW, Admatti LC, Bandeira D, Ferreira MB. Preoperative predictors of moderate to intense acute postoperative pain in patients undergoing abdominal surgery. Acta Anaesthesiol Scand 2002 Nov;46(10):1265-1271.
10. Ip HY, Abrishami A, Peng PW, Wong J, Chung F. Predictors of postoperative pain and analgesic consumption. Anesthesiology 2009 Sep;111(3):657-677.
11. Kalkman CJ, Visser K, Moen J, Bonsel GJ, Grobbee DE, Moons KG. Preoperative prediction of severe postoperative pain. Pain 2003 Oct;105(3):415-423.
12. Kunze B, Drasseck T, Kluba T. Posteriore und transforaminale lumbale interkorporelle Fusion (PLIF/TLIF) zur Therapie des lokalisierten Segmentaufbrauchs der LWS. Z Orthop Unfall 2011;149(3):312-316.
13. Willems P. Decision making in surgical treatment of chronic low back pain: the performance of prognostic tests to select patients for lumbar spinal fusion. Acta Orthop(Suppl) 2013 Feb;84(349):1-35.
14. Lurie JD, Tosteson TD, Tosteson AN, Zhao W, Morgan TS, Abdu WA, Herkowitz H, Weinstein JN. Surgical versus nonoperative treatment for lumbar disk herniation. Spine (Phila Pa 1976) 2014 Jan 1;39(1):3-16.
15. Kulkarni AG, Bassi A, Dhruv A. Microendoscopic lumbar discectomy: technique and results of 188 cases. Indian J Orthop 2014 Jan;48(1):81-87.
16. Chang X, Chen B, Li H, Han X, Zhou Y, Li C. The safety and efficacy of minimally invasive discectomy: a meta-analysis of prospective randomised controlled trials. Int Orthop 2014 Jun;38(6):1225-1234.
17. Hussein M, Abdeldayem A, Mattar MM. Surgical technique and effectiveness of microendoscopic discectomy for large uncontained lumbar disk herniations: a prospective, randomized, controlled study with 8 years of follow-up. Eur Spine J 2014 Sep;23(9):1992-1999.
18. Chan C, Peng P. Failed back surgery syndrome. Pain Med 2011 Apr;12(4):577-606.
19. PAIN OUT STANDARD OPERATING PROCEDURES (SOPs) for collecting data (Internet). Version 2.0, 2011 Mar (cited 2016 Jul). Available from: http://pain-out.med.uni-jena.de/downloads.
20. Jensen MC, Brant-Zawadzki MN, Obuchowski N, Modic MT, Malkasian D, Ross JS. Magnetic resonance imaging of the lumbar spine in people without back pain. N Engl J Med 1994 Jul 14;331(2):69-73.
21. Angst MS, Clark JD. Opioid-induced hyperalgesia. Anesthesiology 2006 Mar;104(3):570-587.
22. Jirarattanaphochai K, Thienthong S, Sriraj W, Jung S, Pulnitiporn A, Lertsinudom S, Foocharoen T. Effect of parecoxib on postoperative pain after lumbar spine surgery. Spine (Phila Pa 1976) 2008 Jan;33(2):132-139.
23. Jirarattanaphochai K, Jung S. Nonsteroidal antiinflammatory drugs for postoperative pain management after lumbar spine surgery: a meta-analysis of randomized controlled trials. J Neurosurg Spine 2008 Jul;9(1):22-31.
24. Kim JC, Choi YS, Kim KN, Shim JK, Lee JY, Kwak YL. Effective dose of peri-operative oral pregabalin as an adjunct to multimodal analgesic regimen in lumbar spinal fusion surgery. Spine (Phila Pa 1976) 2011 Mar 15;36(6):428-433.
25. Gianesello L, Pavoni V, Barboni E, Galeotti I, Nella A. Perioperative pregabalin for postoperative pain control and quality of life after major spinal surgery. J Neurosurg Anesthesiol 2012 Apr;24(2):121-126.
26. Ozgencil E, Yalcin S, Tuna H, Yorukoglu D, Kecik Y. Perioperative administration of gabapentin 1,200 mg day-1 and pregabalin 300 mg day-1 for pain following lumbar laminectomy and discectomy: a randomised, double-blinded, placebo-controlled study. Singapore Med J 2011 Dec;52(12):883-889.
27. Gottschalk A, Durieux ME, Nemergut EC. Intraoperative methadone improves postoperative pain control in patients undergoing complex spine surgery. Anesth Analg 2011 Jan;112(1):218-223.
28. Pacreu S, Fernández Candil J, Moltó L, Carazo J, Fernández Galinski S. The perioperative combination of methadone and ketamine reduces post-operative opioid usage compared with methadone alone. Acta Anaesthesiol Scand 2012 Nov;56(10):1250-1256.
29. Glasser RS, Knego RS, Delashaw JB, Fessler RG. The perioperative use of corticosteroids and bupivacaine in the management of lumbar disk disease. J Neurosurg 1993 Mar;78(3):383-387.
30. Ersayli DT, Gurbet A, Bekar A, Uckunkaya N, Bilgin H. Effects of perioperatively administered bupivacaine and bupivacaine-methylprednisolone on pain after lumbar discectomy. Spine (Phila Pa 1976) 2006 Sep;31(19):2221-2226.
31. Mirzai H, Tekin I, Alincak H. Perioperative use of corticosteroid and bupivacaine combination in lumbar disk surgery. Spine (Phila Pa 1976) 2002 Feb 15;27(4):343-346.
32. 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. Spine (Phila Pa 1976) 2007 Mar 15;32(6):609-616.
33. Lundin A, Magnuson A, Axelsson K, Kogler H, Samuelsson L. The effect of perioperative corticosteroids on the outcome of microscopic lumbar disk surgery. Eur Spine J 2003 Dec;12(6): 625-630.
34. Buvanendran A, Thillainathan V. Preoperative and postoperative anesthetic and analgesic techniques for minimally invasive surgery of the spine. Spine (Phila Pa 1976) 2010 Dec 15;35(Suppl 26):S274-S280.
35. Lee BH, Park JO, Suk KS, Kim TH, Lee HM, Park MS, Lee SH, Park S, Lee JY, Ko SK, et al. Pre-emptive and multi-modal perioperative pain management may improve quality of life in patients undergoing spinal surgery. Pain Physician 2013 May-Jun;16(3):E217-E226.
36. Rajpal S, Gordon DB, Pellino TA, Strayer AL, Brost D, Trost GR, Zdeblick TA, Resnick DK. Comparison of perioperative oral multimodal analgesia versus IV PCA for spine surgery. J Spinal Disord Tech 2010 Apr;23(2):139-145.
37. Turk DC, Swanson KS, Tunks ER. Psychological approaches in the treatment of chronic pain patients—when pills, scalpels, and needles are not enough. Can J Psychiatry 2008 Apr;53(4):213-223.