*Original Article*

# Pain Scores and Analgesic Therapy for Complex Spine Surgery in Tertiary Care Center

Pensiri Srishewachart MD[1], Manee Raksakietisak MD[1], Chayaporn Subanphanichkul MD[1], Suppachai Poolsappasit MD[1], Monchai Ruangchainikom MD[2], Kornnika Yangan BNS[1], Sirirat Johmrit BNS[1]

[1] Department of Anesthesiology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand

[2] Department Orthopedic Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand

**Background**: Complex spine surgery is an extensive operation with severe pain. At Siriraj Hospital, multimodal analgesia has been used, but it is not clear whether this technique provides adequate analgesia for major spine surgery.

**Objective**: To assess the incidence and related factors of severe pain in patients undergoing complex spine surgery.

**Materials and Methods**: A prospective, descriptive, observational study was conducted on adult patients undergoing complex thoracolumbar spine surgery at Siriraj Hospital between September 2016 and November 2018. The authors collected the patient demographic data, surgical data, perioperative pain management, and postoperative pain scores at rest and in movement. The data were analyzed using descriptive statistics, and the related factors to postoperative pain severity were analyzed using logistic regression analyses.

**Results**: The present study enrolled 195 adults with a mean age of 61 years. Most were female (67.7%). The main diagnosis was spinal stenosis (38.5%). The procedures were laminectomies with posterior instrumentation (54.4%) and posterior instrumentation with interbody fusion (40.4%). The incidences of postoperative severe pain, a numeric pain rating scale score of more than 7 at rest/movement, at the PACU and at 4, 8, 12, 16, 20, 24, and 48 hours were 37.4%/47.2%, 33.3%/48.7%, 25.6%/39.0%, 17.4%/34.4%, 13.8%/31.3%, 11.8%/24.6%, 10.3%/24.6%, and 8.7%/15.9%, respectively. The overall incidence of postoperative severe pain was 35.4%. No relationships were established between the patient and the surgical factors. The related factors were intraoperative ketamine administration and severe pain in the recovery room.

**Conclusion**: The incidence of severe pain remained high despite multimodal analgesia. There is room for improvement.

**Keywords**: Complex spine surgery; Postoperative pain; Multimodal analgesia; Pain management

Received 22 June 2021 | Revised 22 February 2022 | Accepted 2 March 2022

**J Med Assoc Thai 2022;105(7):577-82**

**Website:** http://www.jmatonline.com

Complex spine surgery is an extensive operation that is associated with severe pain[1]. Postoperative pain after spine surgery is the result of different pain mechanisms, involving nociceptive, neuropathic, and inflammatory processes[2]. These days, multimodal analgesia or pain management that combines various groups of analgesics to effect different mechanisms of action, are used for postoperative pain management[3,4]. Nevertheless, it is not clear whether this technique provides adequate analgesia for major spine surgery. Analgesics commonly used in multimodal analgesia regimens include opioids, local anesthetic techniques, paracetamol, non-steroidal anti-inflammatory drugs (NSAIDs), and cyclooxygenase (COX)-2-specific inhibitors, as well as analgesic adjuncts such as steroids, ketamine, α-2 agonists, and anticonvulsants[5].

Age group, mental condition, number of spines involved, and preoperative pain were identified as risk factors that correlated with postoperative pain severity after spine surgery[6-8]. Adequate pain management during the acute postoperative period has been correlated with improved functional outcomes, early ambulation, early discharge, and prevention of the development of chronic pain[9]. In contrast, inadequate pain management during the acute postoperative period contributes to longer lengths of hospital stay, increased morbidity, increased healthcare costs, impaired physical function, and reduced quality of life[10].

**Correspondence to:**

Raksakietisak M.

Department of Anesthesiology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand.

**Phone**: +66-2-4197990, Fax: +66-2-4113256

**Email**: manee.rak@mahidol.ac.th, manee95@hotmail.com

**How to cite this article:**

Srishewachart P, Raksakietisak M, Subanphanichkul C, Poolsappasit S, Ruangchainikom M, Yangan K, et al. Pain Scores and Analgesic Therapy for Complex Spine Surgery in Tertiary Care Center. J Med Assoc Thai 2022;105:577-82.

**DOI**: 10.35755/jmedassocthai.2022.07.13097

The present study was undertaken, firstly, to determine the incidence of postoperative severe pain among participants undergoing complex spine surgery and, secondly, to investigate any associations of the anesthetic and surgical factors with perioperative pain management that might affect the severity of the postoperative pain. The present study findings might also be used to improve pain management after complex spine surgery.

## Materials and Methods

### Patient enrollment

After approval by the Siriraj Institutional Review Board (approval number: Si 405/2016), a prospective, observational study was conducted on adult patients scheduled to undergo complex thoracolumbar spine surgery at Siriraj Hospital, a tertiary care hospital in Bangkok, between September 2016 and November 2018. The present study was conducted in accordance with the Declaration of Helsinki (2013) and relevant to the Thai laws and regulations.

The inclusion criteria were patients aged 18 years or older having the American Society of Anesthesiologists (ASA) physical status I-III undergoing elective complex thoracolumbar spine surgery, defined as spine surgery involving three or more levels, or the use of instrument fixation[11-13]. Excluded were any patients who declined or were unable to rate the numeric pain rating scale (NPRS). Cancellation of an operation or a change of the procedure to simple spine surgery were considered as study withdrawals.

### Data collection

After written, informed consents were obtained from the participants, sheets showing the self-reporting NPRS at different time points were provided to them. The sheets were collected 48 hours postoperatively.

The authors collected participant data, which consisted of gender, age, weight, height, ASA physical status classification, underlying diseases, preoperative pain medication such as paracetamol, combination of paracetamol with other drugs, opioid, NSAIDs, or gabapentinoid, preoperative pain score, surgical data such as diagnosis, operation, level of spine surgery, instrumentation, operation time, anesthetic time, recovery time, and estimated blood loss, and the perioperative pain management and postoperative pain scores at rest and in movement while in the postanesthetic care unit (PACU) and at 4, 8, 12, 16, 20, 24, and 48 hours postoperatively. In the present study, the definition of "postoperative severe pain" was a numeric rating scale of 7 or higher on at least two occasions during the 24-hour postoperative period[14].

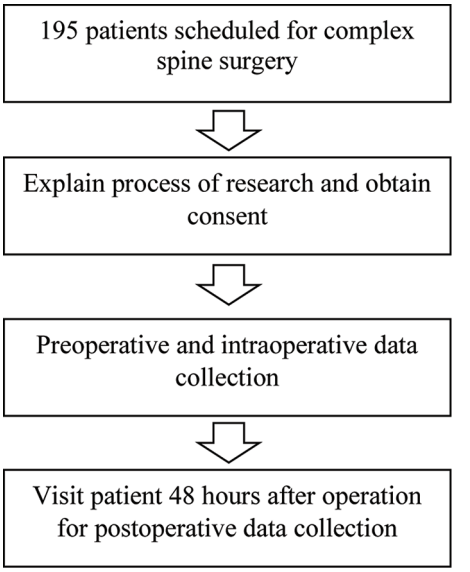


**Figure 1.** Patient flow diagram.

### Statistical analysis

To estimate the sample size, the authors used their in-house pilot data at post-anesthesia care unit that demonstrated a prevalence of severe pain after spine surgery of 45% (p=0.45). Then the authors considered a margin of error of 7% (delta, $\Delta$=0.07) and a probability of a type 1 error of 0.05 (alpha, $\alpha$=0.05). The output of the sample size calculated from n4Studies[15,16] was 195.

The data were analyzed using PASW Statistics for Windows, version 18.0 (SPSS Inc., Chicago, IL, USA). The descriptive data were reported by using descriptive statistics as mean ± standard deviation (SD), number (%) or median (interquartile range). The comparison data were analyzed with independent t-test, Mann-Whitney U test, and chi-squared test, as appropriate. A p-value of less than 0.05 was considered as being statistically significant. The association factors significantly related to postoperative severe pain were subsequently assessed using multiple logistic regression analyses.

## Results

The 195 patients enrolled in the present study were completely analyzed (Figure 1). Table 1 details the clinical and demographic characteristics of the participants as gender, age, body mass index, ASA

**Table 1.** Clinical and demographic characteristics

| Variables | n=195 |
|---|---|
| Sex: female; n (%) | 132 (67.7) |
| Age (years); mean±SD | 61.4±13.5 |
| BMI (kg/m$^2$); mean±SD | 25.0±4.5 |
| ASA classification; n (%) | |
| I | 22 (11.3) |
| II | 122 (62.6) |
| III | 51 (26.2) |
| Diagnosis; n (%) | |
| Spinal stenosis | 75 (38.5) |
| Spondylolisthesis | 51 (26.2) |
| Scoliosis | 19 (9.7) |
| Spinal metastasis | 16 (8.2) |
| Osteoporosis vertebral compression fracture | 7 (3.6) |
| Adjacent segment degeneration | 7 (3.6) |
| Other | 20 (10.3) |
| Instrument; n (%) | |
| No instrumentation | 10 (5.1) |
| Posterior instrumentation | 106 (54.4) |
| Posterior instrumentation + interbody fusion | 79 (40.4) |
| Underlying diseases; n (%) | |
| Hypertension | 103 (52.8) |
| Dyslipidemia | 42 (21.5) |
| Diabetes mellitus | 47 (24.1) |
| Coronary artery disease | 8 (4.1) |
| Cancer | 15 (7.7) |
| Obesity | 7 (3.6) |
| Preoperative pain score; median (range) | |
| Rest | 3 (1 to 6) |
| Movement | 6 (3 to 9) |
| Preoperative pain control >2 weeks; n (%) | |
| Yes | 107 (54.9) |
| No | 88 (45.1) |
| Premedication; n (%) | |
| Paracetamol | 21 (10.8) |
| Paracetamol with other | 10 (5.1) |
| Opioid | 10 (5.1) |
| NSAIDs | 3 (1.5) |
| Gabapentinoid | 28 (14.4) |

SD=standard deviation; BMI=body mass index; ASA=American Society of Anesthesiologists; NSAIDs=non-steroidal anti-inflammatory drugs

classification, diagnosis and operation, underlying disease, preoperative pain score, and preoperative pain medication. The mean age of the patients was 61.4±13.5 years, and most were female (67.7%). The predominant diagnosis was spinal stenosis (38.5%). The bulk of the procedures were laminectomies with posterior instrumentation (54.4%) and posterior instrumentation with interbody fusion (40.4%).

**Table 2.** Intraoperative and postoperative data

| Parameter | n=195 |
|---|---|
| Intraoperative data | |
| Medication; n (%) | |
| • Morphine equivalent (mg); mean±SD | 16.3±7.3 |
| • Non-steroidal anti-inflammatory drugs | 62 (31.8) |
| • Dexmedetomidine | 6 (3.1) |
| • Ketamine | 11 (5.6) |
| • Dexamethasone | 27 (13.8) |
| • Local anesthetic agents | 118 (60.5) |
| Time; mean±SD | |
| • Anesthesia time (minute) | 281±98 |
| • Operative time (minute) | 218±88 |
| • Post-anesthesia care unit time (minute) | 82±27 |
| Postoperative data | |
| Incidence of severe pain; n (%) | 69 (35.4) |
| Medication; n (%) | |
| • Morphine equivalent; mean±SD | 33.6±29 |
| • Intravenous, patient-controlled analgesia | 58 (29.7) |
| • Nonsteroidal anti-inflammatory drugs | 142 (72.8) |
| • Paracetamol | 191 (97.9) |
| • Gabapentinoid | 161 (82.6) |
| Complications | |
| • Nausea and vomiting | 67 (34.4) |
| • Itching | 10 (5.1) |

SD=standard deviation

Incidence of severe pain=pain score ≥7, and ≥2 times in 24 hours

The overall incidence of postoperative severe pain was 35.4% with 69 out of 195 participants. Details of the intraoperative and postoperative pain management are presented in Table 2. Postoperative severe pain, with a NPRS score of 7 or more at rest/movement at the PACU and 4, 8, 12, 16, 20, 24, and 48 hours after the operations were 37.4%/47.2%, 33.3%/48.7%, 25.6%/39.0%, 17.4%/34.4%, 13.8%/31.3%, 11.8%/24.6%, 10.3%/24.6%, and 8.7%/15.9%, respectively (Figure 2).

No relationships were found between the incidence of postoperative severe pain and either the patient or the surgical factors. However, the intraoperative ketamine administration and severe pain at the PACU were significantly related to the incidence of postoperative severe pain (Table 3).

Moving on to the multiple linear logistic regression analyses, the severe pain in the recovery room and the intraoperative ketamine administration were still related to the incidence of postoperative severe pain, as demonstrated in Table 4. Participants who experienced severe pain in the recovery room had a p-value of <0.001 and an adjusted odds ratio 11.94

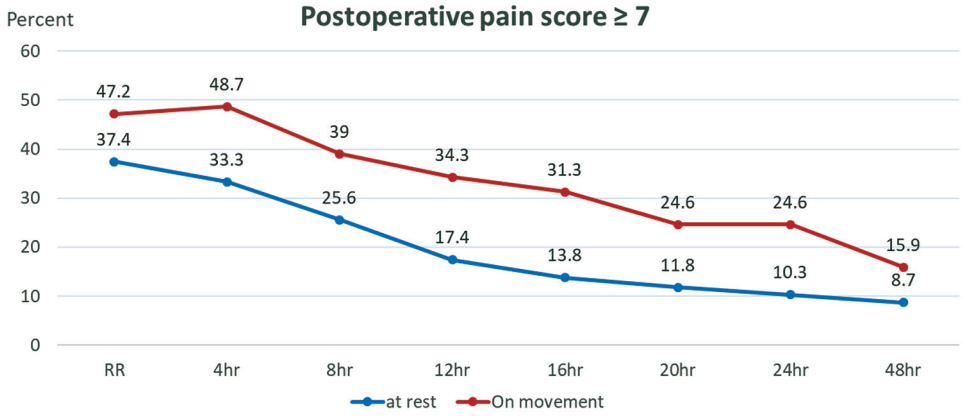


**Figure 2.** Incidence of severe pain at different time points.

(95% CI 5.82 to 24.49). The intraoperative ketamine administration had a p-value of 0.003 and an adjusted odds ratio 9.48 (95% CI 2.10 to 42.81).

## Discussion

Complex spine surgery is a major procedure that results in severe postoperative pain due to the extensive dissection of muscles, ligaments, and bones that it entails[17]. The present study found an incidence of severe operative pain as high as 35.4% in the subjects. Another study[18] established an incidence of postoperative moderate to severe pain in spine surgery at 45%. The disparity in the outcomes might be caused by differences in the definitions of severe pain used and in the administration of medications. Severe postoperative pain might be associated with inadequate pain management in the operating room and in the PACU.

Age group, mental status, and preoperative severe pain have been found to be associated with postoperative severe pain by previous studies[6-8]. Despite the present study having a similar group of patients, it did not demonstrate statistical significance among these factors.

To decrease the incidence of postoperative severe pain, pain should be assessed accurately and in a timely manner in the PACU[19]. The gold standard for assessing the pain levels experienced by patients who are conscious and able to communicate is with a self-reporting assessment system, such as the visual analog scale (VAS), NPRS, and verbal rating scale (VRS)[20]. In the present study, the authors assessed the patients' pain levels by using the NPRS. Aggressive pain control by an intravenous, patient-controlled analgesia (IV-PCA) might be indicated for patients who report severe pain in the PACU[21].

Studies have shown that perioperative ketamine administration is effective in reducing opioid requirements and postoperative pain levels[22-24]. However, the present study results contrasted to those earlier findings. The authors found patients who received intraoperative ketamine had a higher incidence of postoperative severe pain than those patients who did not receive any ketamine (odds ratio 5.0, 95% CI 1.28 to 19.50). The authors postulate that this difference may have been due to the practice at our hospital of discontinuing ketamine infusion at the end of the operation and administering less opioid to those patients during their intraoperative period, resulting in their higher postoperative pain scores.

## Conclusion

The incidence of postoperative severe pain in complex spine surgery was 35.4%. Severe pain while in the recovery room and intraoperative ketamine use were identified to be significant factors related to the incidence of postoperative severe pain. Adequate pain management in the recovery room is recommended as a part of the measures that can be taken to prevent the occurrence of postoperative severe pain in complex spine surgery.

### What is already known on this topic?

Complex spine surgery is associated with severe pain. Despite multimodal analgesia technique, inadequate pain management occurs and contributes to longer lengths of hospital stay, increased morbidity, increased healthcare costs, impaired physical function, and reduced quality of life.

### What this study adds?

The incidence of postoperative severe pain in

**Table 3.** Factors involved in postoperative severe pain

| | Pain intensity 24 hours after surgery; n (%) | | p-value | OR (95% CI) |
|---|---|---|---|---|
| | Severe pain (n=69) | No severe pain (n=126) | | |
| Patient factors | | | | |
| Sex: female | 52 (75.4) | 80 (63.5) | 0.090 | 1.76 (0.91 to 3.29) |
| Age | | | 0.345 | 0.75 (0.42 to 1.36) |
| • 18 to 64 years | 41 (59.4) | 66 (52.4) | | |
| • ≥65 years | 28 (40.6) | 60 (47.6) | | |
| BMI | | | 0.597 | 0.78 (0.30 to 1.99) |
| • <30 | 62 (89.9) | 110 (87.3) | | |
| • ≥30 | 7 (10.1) | 16 (12.7) | | |
| ASA classification | | | 0.299 | 0.69 (0.35 to 1.38) |
| • I-II | 54 (78.3) | 90 (71.4) | | |
| • III | 15 (21.7) | 36 (28.6) | | |
| Preoperative PS | | | 0.626 | 1.20 (0.57 to 2.54) |
| • <7 | 55 (79.7) | 104 (82.5) | | |
| • ≥7 | 14 (20.3) | 22 (17.5) | | |
| Underlying disease | | | | |
| • HT | 39 (56.5) | 64 (50.8) | 0.444 | 1.26 (0.70 to 2.27) |
| • DLP | 13 (18.8) | 29 (23.0) | 0.498 | 0.78 (0.37 to 1.62) |
| • DM | 15 (21.7) | 32 (25.4) | 0.568 | 0.82 (0.41 to 1.64) |
| • CAD | 3 (4.3) | 5 (4.0) | 0.898 | 1.1 (0.26 to 4.75) |
| • Cancer | 5 (7.2) | 10 (7.9) | 0.863 | 0.91 (0.30 to 2.77) |
| • Obesity | 3 (4.3) | 4 (3.2) | 0.700 | 1.39 (0.30 to 6.38) |
| Surgical factors | | | | |
| Level | | | 0.887 | 1.05 (0.57 to 1.91) |
| • <3 | 42 (60.9) | 78 (61.9) | | |
| • ≥3 | 27 (39.1) | 48 (38.1) | | |
| Instrument | | | 0.296 | 2.27 (0.47 to 11.01) |
| • No | 2 (2.9) | 8 (6.3) | | |
| • Yes | 67 (97.1) | 118 (93.7) | | |
| Surgical time | | | 0.717 | 0.89 (0.49 to 1.64) |
| • <180 minutes | 27 (39.1) | 46 (36.5) | | |
| • ≥180 minutes | 42 (60.9) | 80 (63.5) | | |
| PS at rest at RR ≥7 | 49 (73.1) | 24 (26.1) | <0.001* | 11.15 (5.61 to 22.14) |
| Intraoperative | | | | |
| Morphine equivalent (mg) | | | 0.124 | 0.63 (0.35 to 1.14) |
| • <15 | 33 (47.8) | 46 (36.5) | | |
| • ≥15 | 36 (52.2) | 80 (63.5) | | |
| NSAIDs | 25 (36.2) | 37 (29.4) | 0.325 | 1.37 (0.73 to 2.55) |
| Dexmedetomidine | 1 (1.4) | 5 (4.0) | 0.426 | 0.36 (0.04 to 3.11) |
| Ketamine | 8 (11.6) | 3 (2.4) | 0.018* | 5.0 (1.28 to 19.50) |
| Dexamethasone | 9 (13.0) | 18 (14.3) | 0.810 | 0.90 (0.38 to 2.13) |
| Local anesthetic | 42 (35.6) | 76 (60.3) | 0.940 | 1.02 (0.56 to 1.87) |

BMI=body mass index; ASA=American Society of Anesthesiologists; HT=hypertension; DLP=dyslipidemia; DM=diabetes mellitus; CAD=coronary artery disease; PS=pain score; RR=recovery room; NSAIDs=non-steroidal anti-inflammatory drugs; OR=odds ratio; CI=confidence interval

**Table 4.** Risk factors for postoperative severe pain

| | Crude OR (95% CI) | p-value | Adjusted OR (95% CI) | p-value |
|---|---|---|---|---|
| PS at rest at RR ≥7 | 11.15 (5.61 to 22.14) | <0.001 | 11.94 (5.82 to 24.49) | <0.001 |
| Intraoperative ketamine | 5.0 (1.28 to 19.50) | 0.018 | 9.48 (2.10 to 42.81) | 0.003 |

PS=pain score; RR=recovery room; OR=odds ratio; CI=confidence interval

complex spine surgery was 35.4%. Severe pain while in the recovery room and intraoperative ketamine use were identified to be significant factors related to the incidence of postoperative severe pain.


## Acknowledgement

The authors would like to thank Ms. Nichapat Thongkaew and Ms. Chusana Rungjindamai of the Research Unit, Department of Anesthesiology for their administrative tasks and Mr. Suthipol Udompunthurak for his statistical assistance.


## Conflicts of interest

The authors declare no conflict of interest.

## References


1. Gerbershagen HJ, Aduckathil S, van Wijck AJ, Peelen LM, Kalkman CJ, Meissner W. Pain intensity on the first day after surgery: a prospective cohort study comparing 179 surgical procedures. Anesthesiology 2013;118:934-44.
2. Devin CJ, McGirt MJ. Best evidence in multimodal pain management in spine surgery and means of assessing postoperative pain and functional outcomes. J Clin Neurosci 2015;22:930-8.
3. Joshi GP, Schug SA, Kehlet H. Procedure-specific pain management and outcome strategies. Best Pract Res Clin Anaesthesiol 2014;28:191-201.
4. Mathiesen O, Dahl B, Thomsen BA, Kitter B, Sonne N, Dahl JB, et al. A comprehensive multimodal pain treatment reduces opioid consumption after multilevel spine surgery. Eur Spine J 2013;22:2089-96.
5. Nielsen RV. Adjuvant analgesics for spine surgery. Dan Med J 2018;65:B5468.
6. Dorow M, Löbner M, Stein J, Konnopka A, Meisel HJ, Günther L, et al. Risk factors for postoperative pain intensity in patients undergoing lumbar disc surgery: A systematic review. PLoS One 2017;12:e0170303.
7. Kim HJ, Park JH, Kim JW, Kang KT, Chang BS, Lee CK, et al. Prediction of postoperative pain intensity after lumbar spinal surgery using pain sensitivity and preoperative back pain severity. Pain Med 2014;15:2037-45.
8. Bernard JM, Surbled M, Lagarde D, Trennec A. [Analgesia after surgery of the spine in adults and adolescents]. Cah Anesthesiol 1995;43:557-64.
9. Bajwa SJ, Haldar R. Pain management following spinal surgeries: An appraisal of the available options. J Craniovertebr Junction Spine 2015;6:105-10.
10. Gan TJ. Poorly controlled postoperative pain: prevalence, consequences, and prevention. J Pain Res 2017;10:2287-98.
11. Raksakietisak M, Sathitkarnmanee B, Srisaen P, Duangrat T, Chinachoti T, Rushatamukayanunt P, et al. Two doses of tranexamic acid reduce blood transfusion in complex spine surgery: A prospective randomized study. Spine (Phila Pa 1976) 2015;40:E1257-63.
12. Puvanesarajah V, Liauw JA, Lo SF, Lina IA, Witham TF, Gottschalk A. Analgesic therapy for major spine surgery. Neurosurg Rev 2015;38:407-19.
13. Nielsen RV, Fomsgaard JS, Dahl JB, Mathiesen O. Insufficient pain management after spine surgery. Dan Med J 2014;61:A4835.
14. Sanansilp V, Dejarkom S, Deetayart S. Postoperative pain management and the risk factors in major operation: A baseline study of acute pain service, Siriraj Hospital. J Med Assoc Thai 2016;99:549-56.
15. Wiley WW. Biostatistics: A foundation of analysis in the health sciences. 6th ed. New York: John Wiley & Sons; 1995.
16. Ngamjarus C, Chongsuvivatwong V. n4Studies: Sample size and power calculations for android The Royal Golden Jubilee Ph.D. Program-The Thailand Research Fund & Prince of Songkla University. Songkla: Prince of Songkla University; 2014.
17. Bajwa SJS, Haldar R. Pain relief following spinal surgeries: A challenging task. J Spine 2015;4:233.
18. Thienthong S, Jirarattanaphochai K, Krisanaprakornkit W, Simajareuk S, Tantanatewin W, Sathitkarnmanee A. Treatment of pain after spinal surgery in the recovery room by single dose lornoxicam: a randomized, double blind, placebo-controlled trial. J Med Assoc Thai 2004;87:650-5.
19. Luo J, Min S. Postoperative pain management in the postanesthesia care unit: an update. J Pain Res 2017;10:2687-98.
20. Hjermstad MJ, Fayers PM, Haugen DF, Caraceni A, Hanks GW, Loge JH, et al. Studies comparing Numerical Rating Scales, Verbal Rating Scales, and Visual Analogue Scales for assessment of pain intensity in adults: a systematic literature review. J Pain Symptom Manage 2011;41:1073-93.
21. Rungwattanakit P, Sondtiruk T, Nimmannit A, Sirivanasandha B. Perioperative factors associated with severe pain in post-anesthesia care unit after thoracolumbar spine surgery: A retrospective case-control study. Asian Spine J 2019;13:441-9.
22. Radvansky BM, Shah K, Parikh A, Sifonios AN, Le V, Eloy JD. Role of ketamine in acute postoperative pain management: a narrative review. Biomed Res Int 2015;2015:749837.
23. Sleigh J, Harvey M, Voss L, Denny B. Ketamine – More mechanisms of action than just NMDA blockade. Trends Anaesth Crit Care 2014;4:76-81.
24. Cohen SP, Bhatia A, Buvanendran A, Schwenk ES, Wasan AD, Hurley RW, et al. Consensus guidelines on the use of intravenous ketamine infusions for chronic pain from the American Society of Regional Anesthesia and Pain Medicine, the American Academy of Pain Medicine, and the American Society of Anesthesiologists. Reg Anesth Pain Med 2018;43:521-46.