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An Analysis on the Effect of Patient-controlled Analgesia Performed by Orthopaedic Department or Postoperative Pain Control after Shoulder and Elbow Surgery

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Background: We investigated the effectiveness of pain management and the adverse events of intravenous (IV) patient-controlled analgesia (PCA) after orthopedic surgery.
Methods: From September 2014 and August 2015, we performed a retrospective analysis of 77 patients who underwent orthopedic surgery of the shoulder or the elbow in our hospital. The composition of the intravenous PCA administered to the patients was as follows: 250 mg of dexketoprofen trametamol, 70 mg of oxycodone, and 0.6 mg of ramosetron, which were made up to 79 ml of normal saline. We evaluated and statistically analyzed the difference in the visual analogue scale (VAS) scores for pain at immediate postoperation, at 24 hours of PCA, at 72 hours of PCA, and after discontinuation of PCA and in the incidence of adverse events.
Results: We found that VAS score decreased for 3 postoperative days and that with discontinuation of IV PCA a meaningful change in VAS score was no longer seen. Of the 77 patients, 22 presented with adverse events (28.6%). We terminated IV PCA temporarily in the 21 patients who presented with adverse events; we terminated analgesia permanently in one patient (1.2%). Consequently, 76 of 77 patients carried out IV PCA till the designated period.
Conclusions: Intravenous PCA after orthopedic surgery of the shoulder or the elbow may be accompanied with adverse events. Careful assessment of the patient and treatment of the adverse outcomes are key to a successful maintenance of PCA and to a successful management of postoperative pain.
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Key Words: Patient-controlled analgesia; Non-steroidal anti-inflammatory agents; Oxycodone; Ramosetron; Pain measurement

Introduction

Intravenous patient-controlled analgesia (IV PCA) is known to be one of the most effective and widespread method for management of postoperative pain after an orthopedic surgery.[1] The use of IV PCA and the occurrence of adverse events associated with its use have not been described previously in an orthopedic setting. Although IV PCA is an effective method for pain control, adverse events such as nausea and vomiting often lead to premature termination of PCA. To investigate the appropriate forms of analgesia and of postoperative care for postoperative pain, we analyzed the effectiveness of PCA after orthopedic surgery for pain control and the adverse events that present in patients who underwent PCA.

Methods

Between September 2014 and August 2015, we carried out orthopedic surgery of the shoulder and of the elbow in 77 patients aged between 14 and 87 years (a mean age of 52.1 ± 17.9 years). The patient sample comprised 51 men and 26 women who were asked to partake in a questionnaire and in a retrospective study (Table 1). The contents of this study were approved by the Institutional Review Board based in Inje Uni-

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Table 1. Demographic Data according to the Type of Surgery

Diagnosis	Type of surgery	No. of patient
Clavicle distal and shaft fracture	OR/IF	24
Humerus shaft fracture	Intramedullary nailing	9
Proximal humerus fracture	OR/IF	6
Distal humerus fracture	OR/IF	4
AC-CC injury	Modified Phemister operation	7
Rotator cuff tear	Arthroscopic rotator cuff repair	5
Bankart lesion	Arthroscopic Bankart repair	4
SLAP lesion	Arthroscopic SLAP repair	2
Infective arthritis of the shoulder and the elbow	Arthroscopic debridement	4
Olecranon fracture	OR/IF	5
Acromion and glenoid fracture	OR/IF	1
Coronoid fracture	OR/IF	1
Shoulder mass	Excision	2
Biceps tendinitis shoulder	Tenodesis	1
Adhesive capsulitis shoulder	Arthrocopic capsular release and brisement	1
Cubutal tunnel syndrome	Ulnar nerve release and anterior transposition	1

OR/IF: open reduction and internal fixation, AC-CC: acromioclavicular-coracoclavicular, SLAP: superior labral anterior posterior.

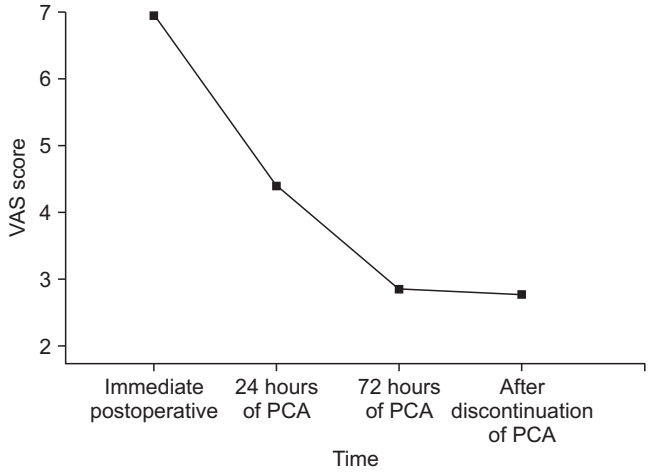

Fig. 1. Postoperative mean visual analogue scale (VAS) scores (0 to 10) through repeated measures ANOVA. PCA: patient-controlled analgesia.

Table 2. Adverse Events Associated with Intravenous Patient-controlled Analgesia

Adverse event	No. of case
Nausea	8
Vomiting	9
Dizziness	3
Hypotension	1
Headache	1
Total	22

versity Sanggye Paik Hospital. We excluded patients with factors that could potentially interfere with drug metabolism such as a medical history of liver or renal disease or abnormal findings of blood tests. Other than the preoperative administration of Fentanyl, we did not use any other form of analgesic pre- or intraoperatively. For the PCA, we mixed 250 mg of dexketoprofen trometamol, 70 mg of oxycodone, and 0.6 mg of ramosetron in 79 ml of saline and administered the formulation to the patient intravenously using a PCA infusion pump (PP-9800B1®; AMPALL Corporation, Seoul, Korea) for 3 days (a basal rate of 1 ml/h, a bolus of 0.5 ml, and a lock out of 15 minutes). We made a statistical analysis of the visual analogue scale (VAS) score and adverse events recorded at the immediate postoperation, at 24 hours of PCA, at 72 hours of PCA, and at post-PCA (PASW ver. 18.0; IBM Co., Armonk, NY, USA).

Results

We found that the VAS score, comparing to its preoperative value, decreased by 24 hours of PCA and by 72 hours of PCA (Repeated measures ANOVA, $p<0.05$). The VAS score did not decrease any more when PCA was terminated after 3 days ($p=1.000$) (Fig. 1). We found that 22 patients (28.6%) presented with postoperative adverse effects (Table 2), for whom the PCA were terminated temporarily and the adverse events, such as nausea, vomiting, dizziness, were treated using 10 mg of IV

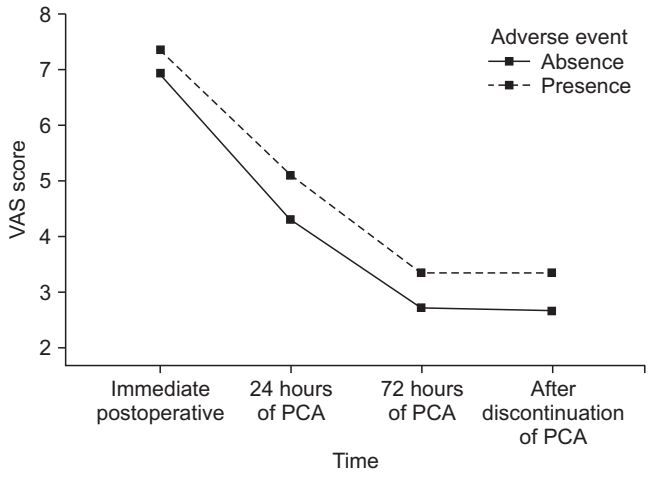

Fig. 2. Comparative analysis of visual analogue scale (VAS) scores between the non-adverse event group and the adverse event group. PCA: patient-controlled analgesia.

Table 3. The Level of Satisfaction of Intravenous Patient-controlled Analgesia

Classification	No. of patient
Satisfactory	51
Normal	20
Unsatisfactory	6

Table 4. Statistical Evaluation of VAS Scores according to Demographic and Clinical Factors

Factor	*p*-value
Age (over/under 60 yr)	0.334
Sex (men/women)	0.555
Disease/fracture	0.356
Bone procedure/soft tissue procedure	0.922
Operation time (over/under 60 min) - Immediate postoperative VAS score	0.044*
Operation time (over/under 60 min) - Postoperative 24 hours VAS score changes	0.918

VAS: visual analogue scale.
*Statistically significant on the Mann-Whitney U-test.

metoclopramide. The PCA was continued under patient consent when the adverse events had disappeared. We terminated PCA permanently in one patient who had presented with hypotension; the patient's adverse event improved after premature termination of analgesia. A total of 76 patients carried out PCA to completion despite occurrence of adverse events. Compared to those with adverse events, those without generally had a higher VAS score, yet a time-matched significant difference was not seen between the two groups ($p>0.05$) (Fig. 2). A satisfaction survey was carried out to assess the patients' subjective rating of pain management through PCA, and the results were categorized into 'satisfied', 'normal', or 'unsatisfied'. We found that 66.2% of patients were satisfied with their clinical outcome (Table 3).

We did not see age-, sex-, disease-, or fracture-dependent difference in VAS scores. Nor did we see a statistically significant difference between patients who received bone surgery concomitant to soft tissue procedure and those who did not. We found that the postoperative VAS score higher when the duration of the operation had exceeded 60 minutes than when it had not, but the change in VAS score during the postoperative 24 hours did not show a statistically significant difference between those whose operation exceeded 60 minutes and those whose did not (Table 4).

Discussion

We found a statistically significant decrease in VAS score for pain with 3 days of postoperative IV PCA, indicating IV PCA as an effective analgesic tool. Compared to those who presented with adverse events and those who did not, the VAS score did not show a statistically significant difference. But because 28.6% of patients who received IV PCA present with complications, the occurrence of adverse effects cannot be overlooked. Analgesic drugs are classified according to their mode of action; recent studies have shown that a multimodal analgesia protocol enhances postoperative control of pain.[2-7] Other studies have found that the prophylactic use of antiemetics with the opioids reduces postoperative nausea and vomiting (PONV).[8] These two findings were taken into consideration when formulating our PCA medication.

One of the analgesics used in this study was oxycodone, a strong opioid that acts on mu- and kappa-opioid receptors. Its pharmacological actions are known to be similar to those of morphine but with a larger analgesic effect; oxycodone can relieve neuropathic and somatic pain, even of malignant origin with a swift time-to-effect and with a drug effect that lasts up to 12 hours.[9] A comparative analysis by Silvasti et al.[10] found that in patients who received spinal fusion surgery or breast reduction and had undergone IV PCA oxycodone and morphine showed similar analgesic efficacies when oxycodone was administered as bolus doses of 30 μg/kg (3 mg/ml) without basal infusion; of those who were administered oxycodone, 18 of 24 patients presented with PONV. Taking the results of these studies into consideration, we lowered the basal rate of oxycodone to 0.7 mg/ml per hour and administered the opioid as boluses of 0.35 mg in order that complications associated with oxycodone are minimized.

The second analgesic drug, with a different mode of action to oxycodone, used in this study was dexketoprofen, which is an S-isomer of the racemic drug ketoprofen. Beltrán et al.,[11]

in a multicentre double-blind randomized trial, showed that the analgesic effect of dexketoprofen is swift, quickly resolving symptoms of pain in patients with degenerative arthritis of the knee. Sweetman[12] reported that dexketoprofen trometamol has high analgesic potency for not only patients with musculoskeletal diseases, such as degenerative arthritis and lower back pain, but also those with postoperative, dental, or menstrual pain. Further, trometamine salt has been shown to contribute to enhanced drug absorption into body and a reduced time of action. Zippel and Wagenitz[13] reported that analgesic efficacy of dexketoprofen after an orthopedic surgery is larger than that of ketoprofen and that the former is associated with less complications; still, the prevalence of adverse events was far from being insignificant as 16% to 21% of patients presented with them. Further, additional analgesia had to be employed in more than 80% of patients in both groups. Of note, the authors stated the choice of the dual drug should be selected from across drug class.

Koh et al.[14] have reported that the prophylactic administration of ramosetron in patients who were treated for total knee arthroplasty was not effective against PONV although at the first postoperative 24 hour they did show that PONV were more reduced with analgesia than without. In a prospective randomized double-blind study by Choi et al.,[15] ramosetron was shown to have a greater analgesic effect and to be associated with a third less PONV than ondansetron; both drugs are Hydroxytryptamine receptor 3 antagonists, but ramosetron has a higher binding affinity to the receptor than Ondansetron. Lee et al.[8] reported that an oral administration of ramosetron give 30 minutes before the operation reduces PONV more than when it is given after general anesthesia.

The use of postoperative analgesics has been associated with adverse events. To reduce the rate of complications studies have attempted to assess the effect of lowered volumes of analgesics or of multimodal analgesia.[2-7,16,17] For instance, Sinatra et al.[18] found that by using a Cox 2 inhibitor the volume of analgesics used could be decreased. In this study, we used multimodal analgesia by combining oxycodone and ketoprofen; we used oxcodone for its strong analgesic efficacy and Ketoprofen for its use in reducing overall drug volume. A multimodal analgesic approach to treatment can lead to an additive or a synergistic effect.

Limitations of this study include the fact that according to surgery type and to the mode of anesthesia the basal pain elicited may differ between patients and the need to also adjust volume with age and with bodyweight was overlooked. We attempted to use lower volumes and concentrations of the medication constituents than those used in other studies in an effort to minimize the incidence of adverse events; still, we found that around 28.6% of patients presented with adverse effects. In the future, a greater number of studies are required to investigate ways to reduce the rate of adverse events or, if possible, to block the incidence of the events at all. Until then, we must find ways to improve the immediate postoperative response to such adverse events at the patient ward.

Conclusion

Management of pain after orthopedic surgery of the shoulder and elbow can be achieved through IV PCA with a satisfactory level of control. But 28.6% of patients who are administered IV PCA present with adverse events. To gain a better understanding of the occurrence of adverse events, more studies that assess the effect of changing the constituents of analgesia and their volumes on pain management are required. We found that when adverse events do occur the key to a successful IV PCA and, ultimately, to postoperative pain control is to treat the adverse complications appropriately and promptly.

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