Quantifying Oral Analgesic Consumption Using a Novel Method and Comparison with Patient-Controlled Intravenous Analgesic Consumption

H. W. Striebel, MD, PhD, DEAA, W. Scheitza, MD, W. Philippi, MD, U. Behrens, MD, and S. Toussaint, MD, DEAA

Department of Anaesthesiology, Intensive Care and Emergency Medicine, Municipal Medical Center Frankfurt a.M., Höchst Teaching Hospital of the Johann Wolfgang Goethe-University of Frankfurt, Frankfurt a.M., Germany

Patient-controlled IV intravenous analgesia (PCIA) allows individual opioid titration with excellent results (1). However, a prerequisite for PCIA is an IV cannula and an expensive delivery system. An alternative, noninvasive, and inexpensive mode of opioid titration would be desirable.

Because many patients are permitted to drink a few hours after surgery, oral opioid administration would be preferable to PCIA. The oral mode of drug administration should be used whenever possible (2,3). Oral administration of an aqueous morphine solution has been successfully used for decades for cancer pain, and regularly administered oral morphine may be superior to on-demand IM morphine in the treatment of postsurgical pain (4). Demand-adapted oral morphine titration according to patient requirements would be an attractive alternative.

Striebel et al. (5) have described a reliable device for patient-controlled oral analgesia (PCOA) with safety features comparable to a PCIA device, and a first pilot study has revealed promising results. PCOA is simple, noninvasive, and inexpensive. In the present study, PCOA was compared with PCIA for the first time.

Methods

This randomized, prospective study was approved by the local ethics committee. At least 1 day before surgery, ASA physical status I or II patients undergoing orthopedic surgery (17 and 19 internal fixations, 3 and 4 removals of internal fixations, and 10 and 7 other procedures [endoprosthesis, arthrodesis, external fixation] for PCOA and PCIA, respectively) were asked to participate in this study. The patients gave written, informed consent. Exclusion criteria were addiction to opioids, other drugs, or alcohol or an allergy to opioids.

Anesthesia was standardized in all patients. After the IV administration of 1 mg of vecuronium, 3–5 mg/kg thiopental, 0.1–0.2 mg of fentanyl, and an additional 0.08–0.1 mg/kg vecuronium were given. Tracheal intubation was established, and ventilation was controlled using a mixture of O_2/N_2O (1:2) adding enflurane to maintain arterial blood pressure and heart rate within an individually acceptable and stable range.

Patients were studied on the day after surgery. Prerequisites for final inclusion were a pain score >40 on the 101-point numerical rating scale and request for an analgesic. After final inclusion, the patients were allocated to either the PCOA group (maximal dose 20 mg of morphine per 60 min, loading dose 40 mg; $n = 32$) or the PCIA group (bolus 2.0 mg of morphine, lockout time 12 min, loading dose 2 mg, maximal dose 10 mg/h; $n = 32$). A 4% aqueous morphine solution (40 mg/mL) was used for PCOA. The PCOA device described by Striebel et al. (5) provides safety features comparable to a PCIA device. It represents a modified Baxter PCA on-demand system designed for IV drug administration, which has proven to be reliable (6,7). This system consists of a balloon reservoir, a flow restrictor, and a patient-controlled system ("pain watch"). The 0.5-mL reservoir of the pain watch is filled (at a rate of 0.5 mL/h) within 60 min. Instead of an IV cannula, one limb of a short plastic Y-system is connected to the pain watch. A one-way valve is attached to the other limb of the Y-system. The common end of the Y-system is attached to a shortened 24-gauge plastic cannula (5). When the patient-controlled module button of the PCOA device is

Accepted for publication January 21, 1998.

Address correspondence and reprint requests to Priv.-Doz. Dr. med. H. W. Striebel, DEAA, Chefarzt des Instituts für Anästhesiologie, Intensiv-und Notfallmedizin, Städtische Kliniken Frankfurt a.M-Höchst Akademisches Lehrkrankenhaus der Johann Wolfgang Goethe-Universität Frankfurt, Gotenstrasse 6–8, 65929 Frankfurt, Germany.

0003-2999/98/$5.00

pressed, a 0.5-mL bolus of the drug fills the common end of the Y-system, which has a total volume of slightly >0.5 mL. The patient empties the common end of the Y-system as if drinking from a straw. If oral morphine did not provide satisfactory reduction in pain intensity, the patient was excluded from the study.

Systolic blood pressure, heart rate, arterial hemoglobin oxygen saturation, respiratory rate, and pain intensity were recorded at 30-min intervals. Self-evaluation of pain intensity was performed using a 101-point numerical rating scale (0 = no pain, 100 = worst pain possible). At the end of the study, patients were asked to rate their global satisfaction as very good, good, satisfactory, poor, very poor, or not acceptable and to give their opinion about the advantages and disadvantages of the pain management they received.

Sixty-four patients aged 19–76 yr were included in the study. Randomization of patients was performed postoperatively. Two patients in the PCOA group and one patient in the PCIA group did not complete the study because of nausea and dizziness. One patient in the PCIA group did not complete the study because he wanted to stop repeated questioning and measuring. None of the patients was excluded because of insufficient pain relief. Thirty patients in each study group completed the study.

The data are presented as mean ± SD. The Mann-Whitney test was used to analyze intergroup differences in pain intensity and demographic data (adaption to Bonferroni-Holm). Time-dependent changes in pain intensity in one group were assessed by using Wilcoxon's test for matched samples. A significant intergroup difference was assumed at $P < 0.05$. A nominal value of $P < 0.0084$ was required to achieve a true intragroup significance level of $P < 0.05$ after 16 repeated tests (8).

Results

There was no statistically significant intergroup difference regarding patient characteristics (Table 1) or type and duration of surgery. Patients in the PCOA group required 136 ± 69.4 mg of morphine, whereas those in the PCIA group required 25.8 ± 14.3 mg of morphine. The morphine dose in the PCOA group was 5.27 times larger than that in the PCIA group.

There were no differences in systolic blood pressure or heart rate between the groups. There were statistically significant intergroup differences in arterial hemoglobin oxygen saturation and respiratory rate at four measurement points. However, none of the patients showed signs of respiratory depression (e.g., slow respiratory rate and/or decreased arterial hemoglobin oxygen saturation).

Table 1. Demographic Patient Characteristics

	PCOA	PCIA
n	30	30
Male	21	17
Female	9	13
Age (yr)	39.9 ± 13.1 (19–73)	43.7 ± 15.9 (22–76)
Weight (kg)	77.4 ± 15.7 (47–116)	75.1 ± 17.1 (50–120)
Height (cm)	176.2 ± 9.1 (155–193)	174.8 ± 9.6 (155–194)

Values are mean ± SD (range).
There were no significant differences between groups.
PCOA = patient-controlled oral analgesia, PCIA = patient-controlled IV analgesia.

At the 30- to 480-min measurement points, there was a significant decrease in pain intensity in both the PCOA ($P < 0.0001$) and the PCIA group ($P < 0.0001$) compared with the initial score (Fig. 1). There was no significant intergroup difference in pain intensity at any measurement point.

No patient had problems using the PCOA device; no PCOA device failed. Overall patient satisfaction with pain management was good, and all patients cited independence/self-administration as an advantage of PCOA or PCIA (Table 2).

Discussion

This study demonstrates for the first time that both PCOA and PCIA with morphine are equally effective. Patient satisfaction with PCOA is comparable to that with PCIA. Thus, we conclude that PCOA is an attractive, noninvasive alternative for postoperative pain management in patients permitted to drink oral fluids. The analgesic effect 30–480 minutes after the initiation of oral titration was as good as that after IV titration. The equally rapid decrease in pain intensity after oral and IV morphine seems to be due to the oral loading dose in the PCOA group.

In the present study, the required dose of oral morphine was 5.27 times larger than that required for IV titration. For PCOA, 20-mg boluses of morphine were administered, because a high hepatic first-pass effect has to be considered in oral morphine administration. The oral-parenteral relative ratio is 1:5 to 1:4 (9–11). Therefore, an oral dose of 20 mg corresponds to approximately 4–5 mg of morphine IM. The difference in morphine consumption between the two groups (1:5.27) concurs with the 20%–25% bioavailability after oral morphine.

The overall patient assessment of pain management was good in both groups. The major advantages of PCIA and PCOA were independence/self-administration (cited by all 30 patients in the PCIA group and all 30

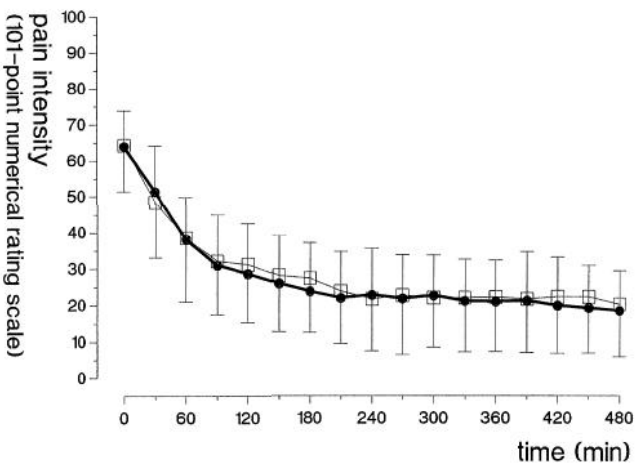

Figure 1. Postoperative course of pain intensity over 480 min, evaluated every 30 min with the aid of a 101-point numerical rating scale. Patient-controlled oral analgesia group (●), patient-controlled IV analgesia group (□).

Table 2. Patient Satisfaction with the Pain Management

	PCOA	PCIA
Global assessment		
Very good	14	14
Good	15	14
Satisfactory	1	2
Poor/very poor/not acceptable	0	0
Advantages (incidence)		
Independence/self-administration	30	30
Good/continuous pain relief	24	26
Simple mode of administration	6	0
Disadvantages (incidence)		
Tiredness/dizziness/nausea	6	2
Bitter taste	6	0
Pain at the IV cannula	0	3

PCOA = patient-controlled oral analgesia, PCIA = patient-controlled IV analgesia.

patients in the PCOA group, as well as good and continuous pain relief (26 of 30 patients in the PCIA group and 24 of 30 patients in the PCOA group). Of the 30 patients, 6 cited the bitter taste of morphine as a disadvantage of PCOA, but no patient refused oral morphine, and patient acceptance of oral morphine is documented in chronic pain management because oral aqueous morphine was the drug of choice for many years. The bitter taste may even be a safety feature because patients might not use it when they are not in pain. However, patients may occasionally press the demand button of a PCIA device even when not in pain.

The PCOA device used in this study costs approximately $70. When used for four days, the cost is $18 per day. However, this device was a prototype. We meanwhile use a modified one-way device that costs only one third of the Baxter device (Go Medical Industries Pty Ltd; Western Australia). We think that it would be possible to construct a device especially for PCOA that costs only a few dollars.

In conclusion, in this randomized, prospective study of 60 postoperative orthopedic patients, we demonstrated that PCOA and PCIA provide equally effective pain relief. Patient satisfaction was comparable in both study groups. PCOA is an attractive, simple, inexpensive, and patient-convenient mode of opioid administration for patients who are permitted to drink oral fluids after surgery.

References

1. Lehmann KA. Patient-controlled intravenous analgesia for postoperative pain relief. In: Max MB, Portenoy RK, Laska EM, eds. Advances in pain research and therapy. Vol 18. The design of analgesic clinical trials. New York: Raven Press, 1991:481–506.
2. Moote C. Techniques for post-op pain management in the adult. Can J Anaesth 1993;40:R19–24.
3. Moote CA. The prevention of postoperative pain. Can J Anaesth 1994;41:527–33.
4. McCormack JP, Warriner CB, Levine M, Glick N. A comparison of regularly dosed oral morphine and on-demand intramuscular morphine in the treatment of postsurgical pain. Can J Anaesth 1993;40:819–24.
5. Striebel HW, Römer M, Kopf A, Schwagmeier R. Patient-controlled oral analgesia with morphine. Can J Anaesth 1996; 43:749–53.
6. Stoddard PA, Cooper A, Russel R, Reynolds F. A comparison of epidural diamorphine with intravenous patient-controlled analgesia using the Baxter infusor following Caesarean section. Anaesthesia 1993;48:1086–100.
7. Robinson SL, Rowbotham DJ, Mushambi M. Electronic and disposable patient-controlled analgesia systems: a comparison of the Graseby and Baxter systems after major gynaecological surgery. Anaesthesia 1992;47:161–3.
8. McPherson K. Statistics: the problem of examining accumulating data more than once. N Engl J Med 1974;289:501–2.
9. Osborne R, Joel S, Trew D, Slevin M. Morphine and metabolite behavior after different routes of morphine administration: demonstration of the importance of the active metabolite morphine-6-glucuronide. Clin Pharmcol Ther 1990;47:12–9.
10. Hoskin PJ, Hanks GW, Aherne GW, et al. The bioavailability and pharmacokinetics of morphine after intravenous, oral and buccal administration in healthy volunteers. Br J Clin Pharmacol 1989;27:499–505.
11. Gourlay GK, Cherry DA, Cousins MJ. A comparative study of the efficacy and pharmacokinetics of oral methadone and morphine in the treatment of severe pain in patients with cancer. Pain 1986;25:297–312.