

# Effectiveness and Cost Analysis of Adjuvant Modalities to Control Pain in Shoulder Arthroscopy with Mini-open Rotator Cuff Repair

Gordon I. Groh M.D. • Blue Ridge Bone and Joint Clinic • 129 McDowell, Asheville NC 28801 • Telephone 828-258-8800 • Email: ggroh@brbj.com

Susan E. Sutherland, Ph.D • Research Institute, Mission Hospitals • 509 Biltmore Avenue, Asheville, NC 28801

## ABSTRACT:

**Purpose:** This study was initiated to evaluate the efficacy and cost analysis of three pain control adjuvants in rotator cuff surgery. The three modalities studied were constant infusion pain control pump, constant infusion plus bolus demand infusion pain pump, and interscalene block. **Type of Study:** Consecutive cohort study. **Methods:** Data on 61 consecutive patients undergoing mini-open rotator cuff repair were available. All patients received a general anesthetic and one of three adjuvants for postoperative pain control. Twenty consecutive patients received an interscalene block prior to administration of general anesthesia. The next consecutive 20 patients received a continuous infusion pump containing 0.5% bupivacaine solution at a flow rate of 2.08 mL per hour for 48 hours (pain pump I). The final 21 consecutive patients received a pain infusion pump containing 0.25% bupivacaine with a continuous flow rate of 4 mL per hour and ability for the patient to bolus an additional 1mL per hour (pain pump II) for seventy-two hours. All catheters were placed in the subacromial space. Patients evaluated their pain by a visual analogue scale, and also tabulated their amount of narcotic use in the first 5 days after surgery. Hospital charges for materials and professional fees associated for use of these three methods were tabulated. **Results:** There was a statistically significant difference in all parameters tested in the continuous infusion plus demand pain catheter group when compared to either the continuous infusion pain catheter group or the interscalene block group. Patients treated with continuous infusion plus demand pain infusion pumps utilized fewer narcotic pain pills. These patients further reported significantly lower pain scores on postoperative days one through five. Hospital charges for materials and professional fees in the continuous infusion group were \$650.84. Charges in the continuous infusion plus demand group were \$921.80. Charges in the interscalene block group were \$952.71.

**Conclusion:** The administration of bupivacaine via a continuous infusion pump with a bolus demand function was the most effective adjuvant in rotator cuff repair. Cost of treatment between the three techniques studied varied with pain infusion pumps being the least expensive.

**Key words:** pain pump, rotator cuff repair, interscalene block

## INTRODUCTION

The role of postoperative pain control has risen in importance during the last 15 years as the push to perform more procedures on an ambulatory basis has increased. A variety of techniques have evolved in conjunction with rotator cuff surgery to decrease postoperative pain (1,3,17). The most common techniques include the use of pain infusion pumps delivering local anesthesia, and interscalene nerve blocks (1,4).

The technology of pain infusion pumps has changed over the past 10 years evolving from demand only to continuous infusion, and finally the addition of bolus demand to continuous infusion pain pumps. Similarly, the acceptance of interscalene anesthesia as an adjuvant for pain control in shoulder surgery has resulted in its increased utilization. The purpose of the study is to evaluate and compare the effectiveness and cost of interscalene block, continuous infusion pain pump (pain pump I) and continuous infusion plus bolus demand pain pump (pain pump II) in mini open rotator cuff repair.

## METHODS

The records of all patients undergoing mini-open rotator cuff repair by the author were reviewed between the period of January 2003 and July 2004 after approval by our institutional review board. Twenty consecutive patients had been treated with an interscalene block. The next twenty patients treated with a constant demand infusion pump, and a final twenty-one consecutive patients treated with a continuous flow plus demand mode pain pump. All procedures were performed in the beach chair position under general anesthesia. Exclusion criteria included those patients with allergies to hydrocodone bitartrate or bupivacaine.

Two types of pain controlled infusion pumps were utilized during the study. A continuous flow model (Stryker Instruments, Kalamazoo, MI) was filled with 0.5% bupivacaine without epinephrine and delivered 2.08 mL of solution via its 100mL reservoir (pain pump I). The second model (Stryker Instruments, Kalamazoo, MI) consisted of both a continuous flow rate of 4.0 mL per hour of .25% bupivacaine and in addition a 1mL per hour option for a bolus demand infusion (pain pump II). The reservoir of this model is 250 mL. The catheter for delivery of bupivacaine was placed in the subacromial space in both these groups. The patient or family member removed the catheter after the anesthetic agent was exhausted. This occurred at 48 hours in the continuous flow model, and at 72 hours in the continuous plus bolus demand group.

Interscalene block prior to the induction of general anesthesia was performed after sterile prepping and draping of the shoulder. Sedation prior to institution of the block was administered at the discretion of the anesthesiologist. The technique utilized included the use of an insulated needle at the level of the space between the anterior and middle scalene muscles at the cricoid cartilage (6). Medication for insertion of the block included either 0.5% bupivacaine 30mL, or bupivacaine .5% 30mL plus the addition of 10 mL of lidocaine without epinephrine 2%.

In addition, other pain control efforts were utilized in all patients. All patients received an injection into the subacromial space and around all portal and wound sites with 30 mL of 0.25% bupivacaine with epinephrine at the conclusion of the procedure. Unless contraindicated, all patients received 30mg of ketorolac tromethamine at the end of the procedure. Contraindications for ketorolac tromethamine administration included known allergy, renal insufficiency, bleeding disorder, anticoagulant use, or bronchospasm. A prescription for hydrocodone bitartrate ten milligram, with acetaminophen was provided to each patient as they left the surgery center. All patients were provided with a sling for support.

Each patient was asked to record the level of pain using a visual analog scale (VAS) (4). Patients were asked to record their pain from the day of surgery through the fifth postoperative day. Patients also recorded their daily utilization of hydrocodone bitartrate during this same 5 day postoperative period. All data was then presented to the surgeon at the first postoperative visit, two weeks after surgery and recorded.

Hospital costs associated with each protocol were examined. Charges included medications utilized, supplies for administration, medical devices utilized, and professional fees associated with administration.

The data were analyzed with analysis of variance methods using SAS non parametric analysis which resulted in similar findings as parametric methods. Post-hoc comparisons of significant differences at each time point were performed with Tukey's studentized range test. A two tailed test with  $p < 0.05$  was considered to be statistically significant (9,15).



PAIN PUMP I



PAIN PUMP II

## RESULTS

65 consecutive patients underwent mini-open rotator cuff repair during the study period. Four patients were excluded due to allergy to medications utilized in this study. There were 20 patients with complete data sets available for review utilizing a continuous flow pain pump and 21 patients in the continuous flow pain pump with bolus demand. 20 complete patient data sets were available for review in the interscalene block group.

The average age of patients in the continuous flow pain control infusion pump was 52.5 +/- 15.6 years (range 38 to 84 years). Patients utilizing the continuous plus bolus demand pain control infusion pump had an average age of 56.2 +/- 12.8 years (range 42 to 75 years). Patients in the interscalene block group had an average age of 55.1 years +/- 14.3 years (range 44 to 75 years). There were 12 men and 8 women in the interscalene block group. In the continuous flow pain control infusion pump there were 11 women and 9 men. In the continuous flow plus bolus pain control infusion pump there were 13 women and 8 men.

The visual analogue pain scores were measured at the time of discharge from the surgery center (day 0), and then on postoperative days 1, 2, 3, 4, and 5. Figure 1 is a plot of the mean VAS at each time interval for each of the three groups. At the time of discharge from the surgery center, patients receiving an interscalene block registered a statistically significant lower pain score than either of the pain infusion pump groups. However, at each subsequent measured interval, patients receiving a continuous plus bolus demand pain infusion pump (pain pump II) had a lower pain score. The difference in the curves was statistically significant at  $p < .05$ . Further the mean pain score was significantly lower for continuous plus bolus pain control infusion pump patients (pain pump II) than for continuous pain control infusion pump alone (pain pump I) at all time points except postoperative day 1 ( $p < 0.05$ ).

The use of hydrocodone bitartrate was recorded and is shown in Figure 2. There is a significant difference between the number of pain pills taken by patients with a continuous plus bolus pain control infusion pump (pain pump II) when compared to patients undergoing an interscalene block or patients with a continuous flow only pain control infusion pump ( $p < .05$ ). There was no significant difference between the number of pain pills taken in the interscalene block and continuous flow pain infusion pump (pain pump I) group at any of the time points considered.

Hospital charges related to each of the three groups (Table 1) were evaluated. Hospital charges for the interscalene block group totaled \$952.71. These charges included an anesthesia professional fee of \$760, medication charges of \$12.71 and a supply charge of \$ 180. Charges for the continuous flow only pain control infusion pump totaled \$650.84. These charges included a charge of \$ 600 for the device, and \$50.84 for medication. Charges for the continuous plus bolus demand pain control infusion pump were \$921.80. This includes a charge of \$825 for the device and \$96.80 for bupivacaine to fill the device. There is no professional fee associated with insertion of the pain control infusion pumps.

There were no complications attributable to either of the pain control infusion pumps. One patient who received an interscalene block complained of shortness of breath postoperatively. A chest radiograph revealed no evidence of pneumothorax. The patient required admission to the hospital overnight and oxygen with resolution of his symptoms.

## DISCUSSION

The impetus to convert an increasing array of surgical procedures into outpatient surgery has not escaped the orthopaedic surgeon. Procedures which in past typically required inpatient hospitalization are now routinely performed on an outpatient setting. Often, the determining factor in patient discharge is their response to surgically induced pain. As a result, the utilization of interscalene block anesthesia and continuous pain infusion pumps has seen dramatic increases in rotator cuff surgery applications (7).

Historically, the choice of adjuvant pain modification has been empiric with studies supporting the utilization of both techniques (8,10,16). Meanwhile, a new type of pain infusion pumps has been developed with the ability to infuse a demand bolus of medication. This new mode has been coupled with the ability to infuse local anesthetics over a longer time frame. No study has determined the efficacy of this new generation of pain infusion pump, nor compared its effectiveness to the prior generation.

We observed a significant reduction in the VAS pain rating; along with a significant reduction in oral narcotics when comparing this generation of pain infusion pump to the earlier continuous only pain infusion pump. This is particularly significant in outpatient repair of rotator cuff tears because the patients tend to be older and may tolerate oral narcotics less well (7). The effectiveness of the new continuous plus demand bolus pumps appear to justify their slightly increased cost over the older continuous flow pain infusion pumps.

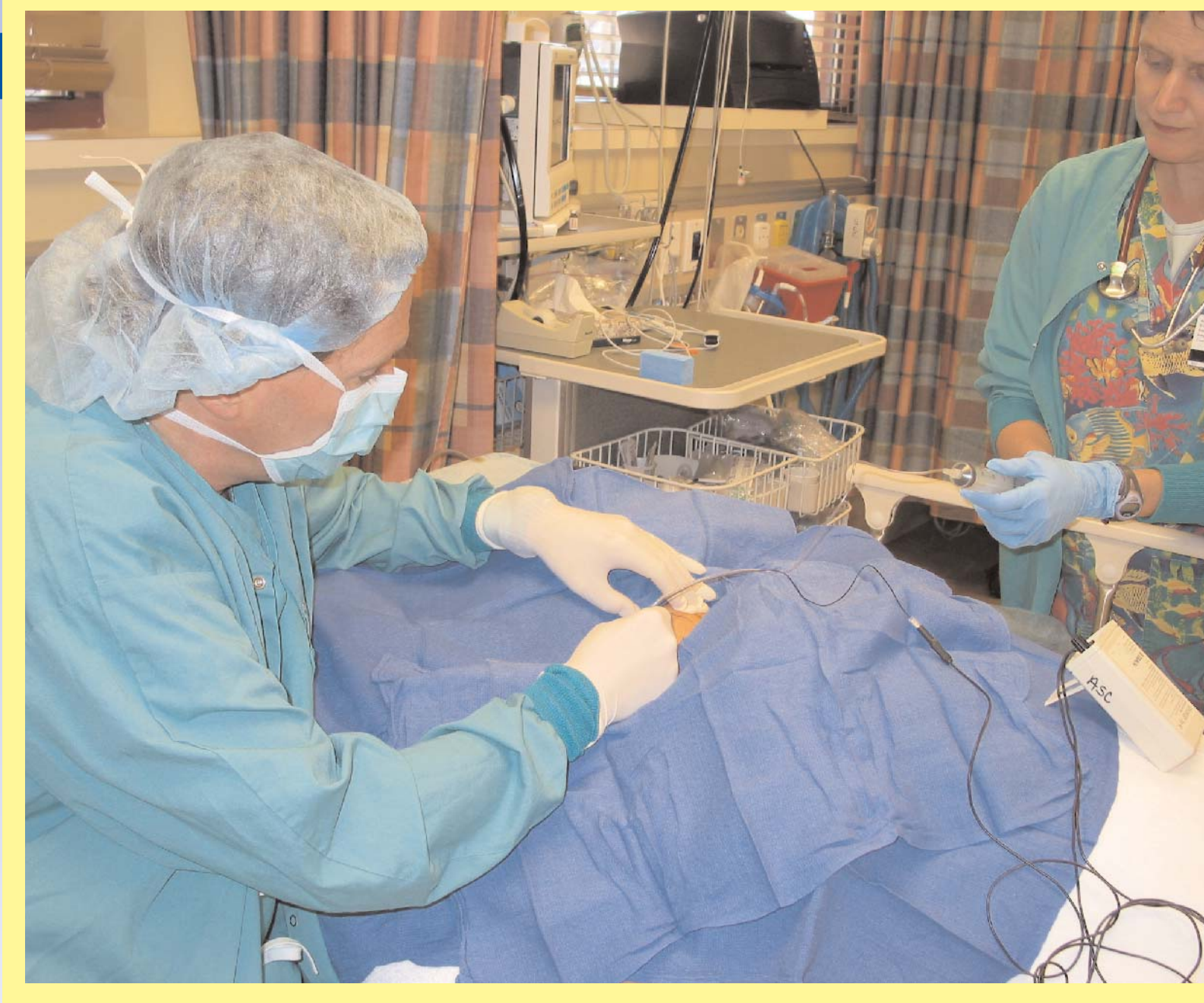
Although patients receiving an interscalene block left the outpatient surgery center with no or little pain, many reported severe pain after the block had dissipated. This occurred despite instructions to these patients to begin utilization of narcotics as soon as they felt their interscalene block begin to subside. We saw significant improvements in VAS pain measurements and reduction in oral narcotics when comparing patients treated with a continuous flow plus demand bolus pain infusion pumps (pain pump II) versus an interscalene block. These results were substantial and significant on postoperative days one through five. Further, it appears that in our community setting that continuous flow plus demand bolus pain infusion pumps are slightly more cost effective than the utilization of interscalene block in conjunction with general anesthesia.

Concerns have been addressed regarding potential complications of pain infusion pumps. These potentials have included arrhythmia, seizure, and infection. Toxic levels of bupivacaine have been established at 225 mg for a single dose or 400 mg in 24 hours (12). The dosage utilized in this study falls below both of these parameters, and the author has not witnessed an adverse reaction to the bupivacaine in these pumps in his 5 years of utilization. Similarly, no cases of infection were noted in this series. The author has similarly not experienced a pain infusion pump related infection during the past five years. An incidence of infection complaints logged while a pain infusion pump has been utilized is 0.00291% (11). Bupivacaine has been reported as having antimicrobial activity (14).

While there were no attributable complications to pain infusion pumps in this study, a complication did occur in the interscalene block group. Shortness of breath after an interscalene block may be attributable to pneumothorax or block of the phrenic nerve causing hemidiaphragmatic paresis, which occurs in virtually all patients receiving an interscalene block (19). Resolution occurred in this study after admission to the hospital and supplemental oxygen. Other potential complications for interscalene block include neurologic and vascular injury (20).

This study compares the cost and effectiveness of three methods of controlling postoperative pain after mini-open rotator cuff surgery. The efficacy of pain pumps in shoulder surgery has been evaluated in multiple studies (18). Early studies demonstrated the efficacy of these pumps in decreasing postoperative pain (1,10,16). Two small prospective studies have concluded that pain pumps were not effective in relief of pain after shoulder surgery (2,13). This study does not evaluate the effectiveness of pain pump usage versus placebo; but compares the results of three commonly utilized postoperative pain management regimes. The efficacy of pain pumps in a large prospective trial is currently under investigation at the author's institution.

The new continuous plus bolus demand pain infusion pump appears to be more effective in reducing both pain and narcotic use postoperatively, when compared with basal models or interscalene block. It appears to be more cost effective than interscalene block used in conjunction with general anesthesia. Further, the technique appears to be associated with a paucity of reported complications.



HOSPITAL CHARGES OF ADJUVANT PAIN PROCEDURES			
	PAIN PUMP I	PAIN PUMP II	INTERSCALENE BLOCK
Charges for anesthetic agent	\$50.84	\$96.80	\$12.71
Charges for device or kit	\$600	\$825	\$180
Professional fee	0	0	\$760
Total charges	\$650.84	\$921.80	\$952.71

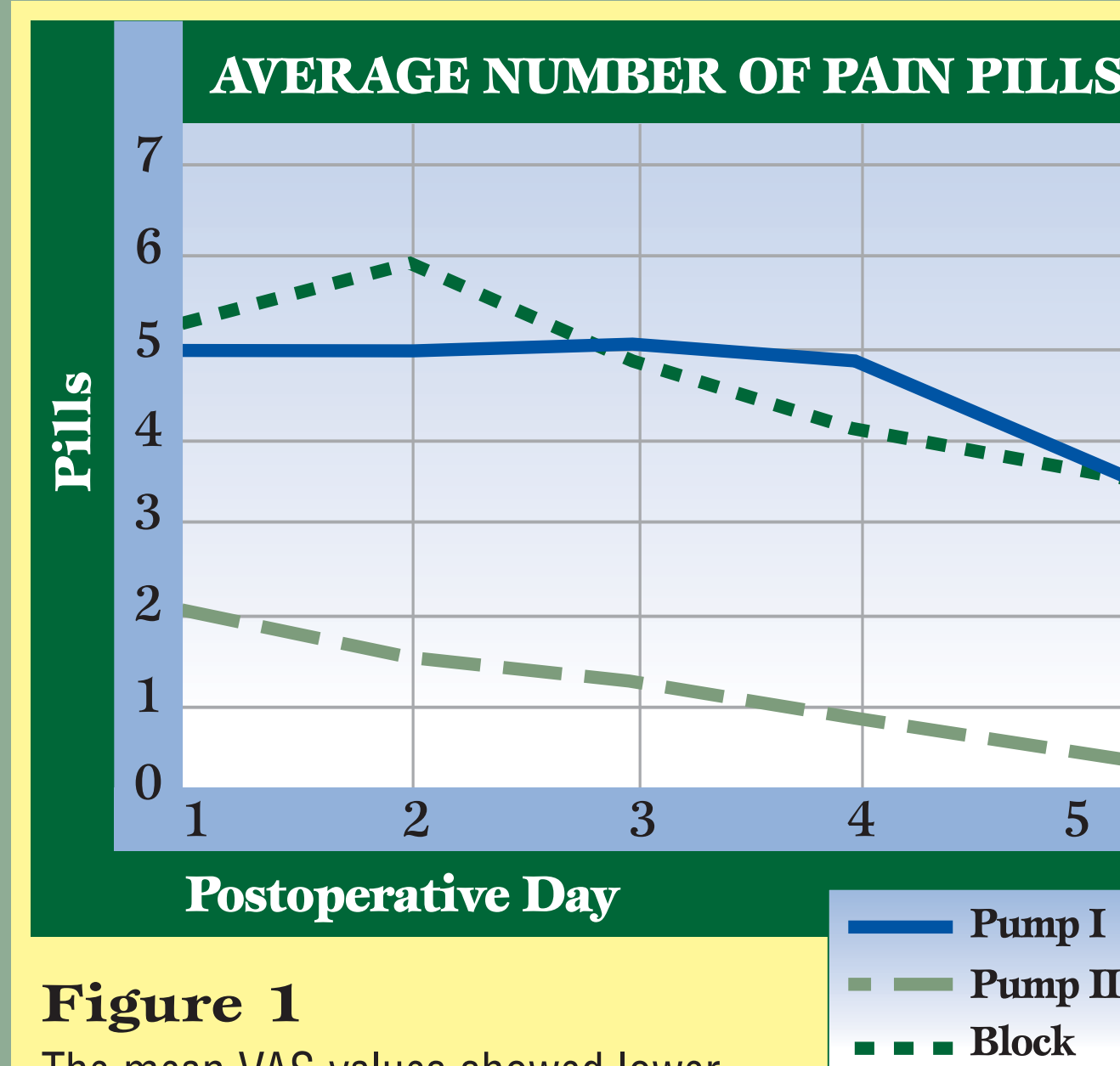


Figure 1

The mean VAS values showed lower pain scores for patients using the continuous plus demand pain infusion pump on postoperative days one through five; than those patients utilizing an interscalene block or a continuous only pain infusion pump.

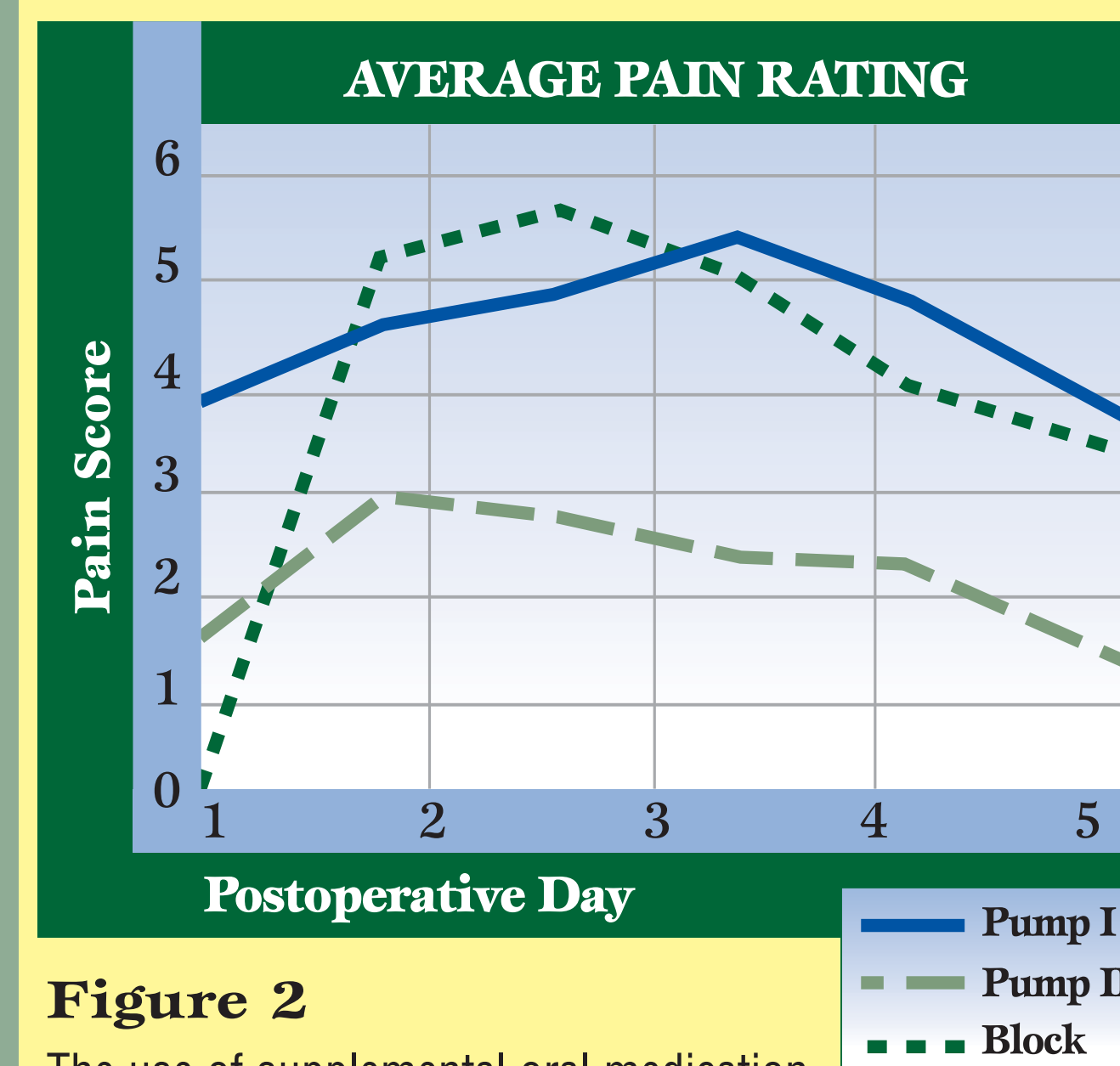


Figure 2

The use of supplemental oral medication was greater in patients utilizing either interscalene block or continuous flow only pain infusion pump, when compared to those patients utilizing a continuous plus bolus demand pain infusion pump.

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