

Elastomeric Pain Pump as a Bridge for Local Pain Control After Epidural Removal in Abdominal Surgery Patients

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Citation

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Abstract

Postoperative pain control can be challenging. There are a number of different modalities that can be used to treat postoperative pain. The benefits of good pain control, aside from keeping patients comfortable, are early mobility, decreased incidence of cardiopulmonary complications, decreased ileus, improved sleep, decreased overall complications, and shorter hospital stay^{1,2}. To date there has not been a study comparing the benefit of pain control modalities in enhancing the benefits described above. Another purpose for our study was to evaluate if using both an epidural and elastomeric pump together could be done safely with minimal complications. Adverse effects including skin necrosis, wound infection, and cellulitis have been reported with infusion pump systems¹². We wanted to demonstrate that our patients treated with this method of pain control did not suffer additional complications.

INTRODUCTION

Postoperative pain control can be challenging. There are a number of different modalities that can be used to treat postoperative pain. The benefits of good pain control, aside from keeping patients comfortable, are early mobility, decreased incidence of cardiopulmonary complications, decreased ileus, improved sleep, decreased overall complications, and shorter hospital stay^{1,2}. To date there has not been a study comparing the benefit of pain control modalities in enhancing the benefits described above.

There are a number of medications that can be used to help control pain including narcotics, non-steroidal anti-inflammatories (NSAIDs), and acetaminophen; each with known side effects. Narcotics are frequently used to control postoperative pain, but their use can lead to respiratory depression, sedation, pruritus, ileus, and urinary retention^{2,3}. NSAIDs can cause renal insufficiency, peptic ulcers, diminished platelet function, and bronchospasm². Side effects of acetaminophen are uncommon, but an overdose can lead to irreversible liver damage⁴.

To help reduce unwanted medication side effects, a modality using a local anesthetic may be advantageous. Epidural anesthesia using only a local anesthetic alleviates narcotic side effects, particularly post-operative nausea and

vomiting⁵. Epidurals provide comparable pain relief while limiting the need for systemic intravenous and/or oral analgesics⁵. Many groups have reported superior pain control with epidurals alone when compared to intravenous analgesia⁶. Studies conducted on patients with epidurals containing both local anesthetics and narcotic medications have reported even better pain control than local anesthetic alone. In addition, it appears that adding narcotics to the epidural solution did not increase the incidence of post-operative nausea and vomiting⁵. Additional benefits of epidural analgesia include earlier return of gastrointestinal function⁵, attenuation of the stress response, lower overall pain scores, and diminished stress induced immunosuppression during the post-operative period⁷. Although epidural anesthesia has many benefits, it is not without complications. Complications of epidurals include spinal headache, hypotension, motor blockade, and rarely epidural abscess, meningitis, and epidural hematoma^{8,9}.

Infiltration of a local anesthetic at the incision site(s) may be useful as an adjunct in post-operative pain management. The use of an elastomeric pain pump delivery system (OnQ Pain Buster Post-Op Pain Relief System, I-FLOW Corporation, Lake Forest, CA) to provide continuous infusion of local anesthetic may be more beneficial than a single bolus injection at the incision site, as the effects of

local anesthetics dwindle rather quickly¹. Placing catheters that allow continuous post-operative administration of local anesthetic may allow for a much longer duration of action, and in effect, additional pain relief¹. Local anesthetics directly at the incision site decreases the transmission of nociceptive impulses from the site of injury³. This has shown to be true for many major operations by decreasing the overall quantity of intravenous narcotics needed, and consequently diminishing the systemic side effects of narcotics^{1,10}. Placement of the catheters is important as demonstrated by initial studies with subcutaneously placed pumps not proving beneficial. Since the fascia and peritoneum are both injured and painful after abdominal surgery, placing the catheters in the pre-peritoneal space (blocking peritoneal afferents) improves pain control and decreases overall narcotic use¹. It has been suggested that this method of delivery may provide better pain control than an epidural for the type of pain at the incision site that is associated with movement. The ability to decrease narcotic requirements while improving analgesia with this method has been demonstrated by prospective randomized studies³.

Elastomeric infusion pumps seem to be rate limited, and can have irregular flow rates. Studies have shown that elastomeric pumps initially flow at rates higher than expected, and when the device has less volume, infuse lower than expected. Temperature also appears to affect the flow rate with approximately a 10% increased rate of infusion at elevated temperatures. This change in flow rate can be concerning, but may be potentially beneficial as post-operative patients have decreasing pain as time goes on, so an initially faster rate that gradually decreases may be helpful¹¹. It can be very difficult to predict the exact rate of the pump as it can vary 15% faster or slower than is advertised.

Desiring the ability to provide good multi-modal analgesia to our post-operative abdominal surgery patients, we sought to maximize the use of local anesthesia delivery devices. Knowing the pain pump infusion rates can be unpredictable, we did not want to run both the epidural and the elastomeric pain pump synchronously related to concern about local anesthetic toxicity. We decided to place the catheters for the elastomeric pain pumps intra-operatively, but not activate them until the epidural was no longer being used. Anecdotally, our patients who had both the epidural and the elastomeric pain pumps were very pleased with their pain control. We looked back at objective data to see if it

affected hospital stay or narcotic use.

Another purpose for our study was to evaluate if using both an epidural and elastomeric pump together could be done safely with minimal complications. Adverse effects including skin necrosis, wound infection, and cellulitis have been reported with infusion pump systems¹². We wanted to demonstrate that our patients treated with this method of pain control did not suffer additional complications.

METHODS

We retrospectively analyzed inpatient records of all consecutive patients over a three-year period at The University of Arizona who underwent an open abdominal operation with the senior author as the primary surgeon. Only patients who had an open laparotomy or subcostal incision were included. Mini-laparotomy patients and hand-assisted laparoscopic cases were excluded. Those who initially had a diagnostic laparoscopy but were converted to an open operation were also included. Patients who had more than one incision (i.e. Ivor-Lewis esophagectomy), as well as patients who were documented to have substantial chronic outpatient narcotic needs, a history of narcotic abuse, or allergies to all narcotics, were also excluded from our study.

Multiple factors in the study group were examined, including patient age, gender, type of operation (and whether or not for malignancy), type of incision (subcostal versus laparotomy), length of hospital stay, method of pain control, total narcotic use for their hospital stay (in intravenous morphine equivalents and morphine units/hospital day), presence of any postoperative complications, and method of pain control (epidural, elastomeric pain pump, both epidural and elastomeric pain pump, and neither epidural or elastomeric pain pump).

Only the patient population of one surgeon was included for consistency in catheter placement and postoperative prescribing methods. All patients who had epidurals received them pre-operatively by the anesthesiologist. All patients who had elastomeric pain pumps had them placed intra-operatively by the surgeon by tunneling two catheters (one on either side of the wound) in between the peritoneum and the transversalis fascia. For the patients whose only method of pain control was the elastomeric pain pump, the catheters were immediately connected after placement with a total volume of 400 mL 0.5% bupivacaine infusing at approximately 2 mL per hour per catheter (4 mL per hour

total). For the patients who also had an epidural, the elastomeric pain pump catheters were placed in the same fashion intra-operatively and were capped for later use after the epidural was discontinued. Patients who did not receive either method typically had patient controlled analgesia pumps (PCA) with narcotics until transitioned to oral pain medications.

Patients received the following narcotics in various amounts: intravenous and/or oral hydromorphone; intravenous and/or oral morphine; intravenous and/or transdermal fentanyl; intravenous meperidine; oral oxycodone; oral propoxyphene; and oral hydrocodone. See Table 1 for conversions utilized in this study.

Table 1
Narcotic Conversions[14]

1 mg of specified narcotic	IV Morphine equivalent
PO Hydrocodone	0.33mg
PO Oxycodone	0.5mg
PO Morphine	0.33mg
PO Hydromorphone	1.33mg
PO Propoxyphene	0.0495mg
IV Meperidine	0.13mg
IV Hydromorphone	6.67mg
IV Fentanyl	100mg
Transdermal Fentanyl	165mg

The methods of pain management were categorized as the following: only Epidural usage (Group E); only elastomeric/OnQ pain pump usage (Group P); both epidural and elastomeric pain pump usage (Group E+P); and neither epidural or elastomeric pain pump usage (Group N).

The aim of the study was first, to assess differences in pain control outcomes between designated groups, and second, to assess complication rates between groups. When assessing the differences in pain control outcomes between groups, we included the length of stay, amount of morphine equivalents used per day, and the total overall morphine equivalents used.

ANOVA and Fisher's Exact Test, or chi-square as appropriate, were used to characterize group differences taking into account patient demographics and patient attributes. Analysis of covariance (MANCOVA) was used to compare the effect of the intervention (type of pain management) on outcomes parameters (i.e. length of stay, total IV morphine equivalents) after adjustment for multiple comparisons (Sidak model) for age, gender, and presence of

cancer. Chi-square-tests were used for between group comparisons for dichotomous outcomes (i.e. incidence of complications, incidence of infection). All data are reported as the mean +/- standard deviation. A p value of less than or equal to 0.05 was considered statistically significant. Statistical analyses were performed using SPSS Statistics (IBM Co., Version 22).

RESULTS

A total of 109 patients who met the outlined criteria were included in final analysis. Table II summarizes the demographics and patient characteristics for each specified intervention. Overall, no differences between groups were observed for demographics and patient attributes. Results suggest that patients with cancer have an increased likelihood of having an epidural, an elastomeric pain pump, or a combination of both for pain management (p=0.040). On a similar note, 33.3% of the ninety identified cancer patients fell in the epidural subset, which was higher than any other pain management modality utilized (p=0.040).

Table 2
Subject demographics and clinical characteristics

	Neither epidural or pain pump (Group N) N=30	Epidural (Group E) N=32	OnQ pain pump (Group P) N=22	Both epidural and pump (Group E+P) N=25	p-value
Age, years	58.5±13.6	59.7±13.8	55.4±11.8	60.6±14.7	0.662
Gender (% Male)	50.0	59.4	59.0	52.0	0.852
Subcostal Incision (%)	30.0	51.2	40.9	44.0	0.448
Cancer (%)	66.7	93.8	86.4	84.0	0.040
Whipple (%)	13.3	28.1	22.7	28.0	0.491

Table III summarizes between group comparisons for the outcomes of this study. Although the rate of complications was almost half for groups 'N' and 'E+P' when compared to other groups, no significant between-group difference was noted for the number of complications (p=0.462). Additionally, no between group difference was noted for the rate of wound infection (p=0.735).

Table 3

Between subject effects comparison for outcomes after adjustment for age, gender, and presence of cancer

	Neither epidural or pain pump (Group N) N=30	Epidural (Group E) N=32	On pain pump (Group P) N=22	Both epidural and pump (Group E+P) N=25	p-value
Complications, (%)	10.0	21.9	22.7	12.0	0.462
Wound infection (%)	0.0	3.1	4.5	4.0	0.735
Total IV morphine equivalents ^a	299.5±290.3	471.1±510.2	491.9±553.6	433.0±667.6	0.605
Morphine per day ^a	45.5±44.4	48.3±36.0	63.4±98.5	42.3±33.2	0.464
Length of hospitalization (Days) ^a	8.8±5.4	10.6±7.2	9.9±6.8	8.8±4.1	0.523

^a Adjustment for multiple comparisons Sidak. Covariates appearing in the model are evaluated at the following values: Age (years) = 59.972, Cancer (1 yes, 0 no) = .826, Gender (1 M, 0 F) = .550.

After adjusting for age, presence of cancer, and gender, no between group difference was observed for any of the outcomes of this study ($p > 0.05$). However, group ‘N’ had a trend to use less total IV morphine equivalents on average when compared to groups ‘E’, ‘P’, and ‘E+P’ by 36.3%, 39.1%, and 27.1% respectively (Figure 1). Group ‘E+P’ had the least morphine equivalent per day usage compared to groups ‘N’, ‘E’, and ‘P’ on average by 7.0%, 12.4%, and 33.3%, respectively (Figure 2). But this trend didn’t achieve statistical significance in our sample ($p > 0.05$).

Figure 1

Total IV morphine equivalents as a function of pain management modalities.

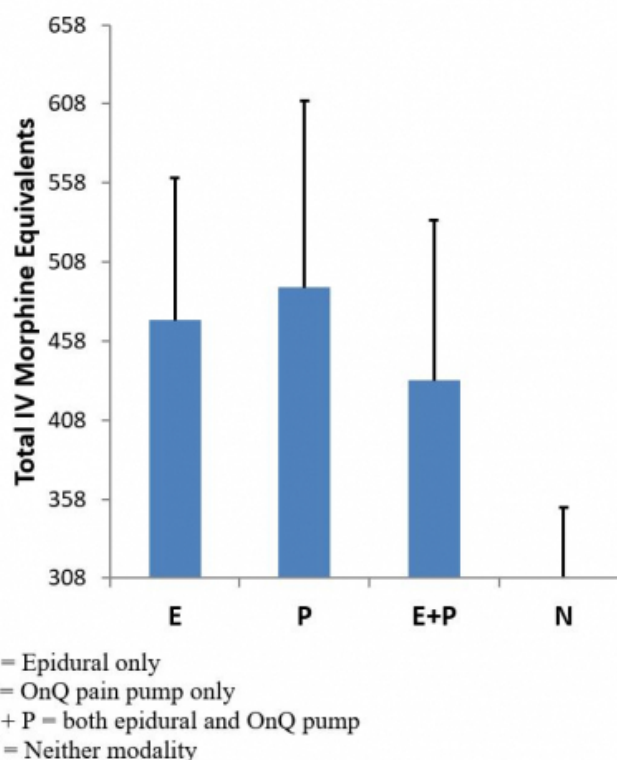
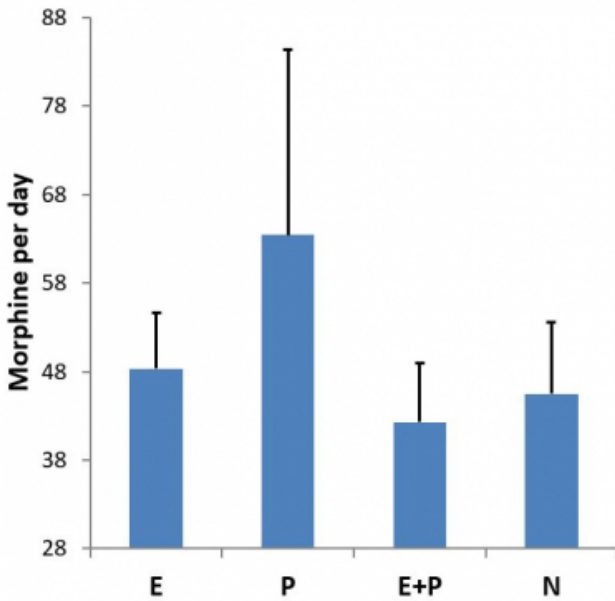


Figure 2

Morphine per day usage as a function of pain management modalities.

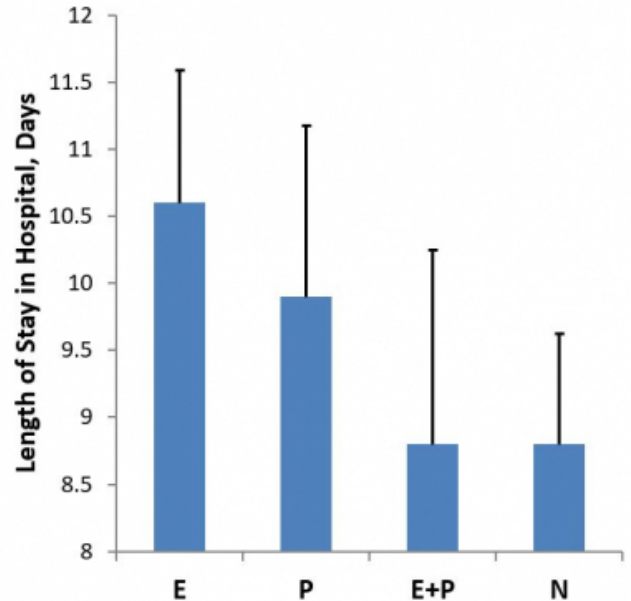


E = Epidural only
 P = OnQ pain pump only
 E + P = both epidural and OnQ pump
 N = Neither modality

Results suggest that a combination of epidural and elastomeric pump for pain management may reduce the length of hospitalization by 16.7% compared to epidural alone, and 10.4% compared to isomeric pump alone modalities (Figure 3). This trend however also did not achieve statistical significance in our sample ($p > 0.05$). Additionally, no noticeable difference was observed between groups 'E+P' and 'N' for length of hospitalization.

Figure 3

Length of hospitalization as a function of pain management modalities



E = Epidural only
 P = OnQ pain pump only
 E + P = both epidural and OnQ pump
 N = Neither modality

Results suggest age had significant effect on length of hospitalization ($p = 0.023$), total IV morphine equivalents ($p = 0.005$), and morphine per day ($p < 0.001$). Gender however, did not have an effect on any outcomes of this study. In addition, presence of cancer had significant effect on total IV morphine equivalents ($p = 0.005$) and morphine per day equivalents ($p = 0.037$), but no effect on length of hospitalization ($p = 0.604$). Finally, complications and wound infections had a significant effect on the length of hospitalization ($p < 0.05$) but did not have an effect on total IV morphine equivalents nor on the daily amount of morphine equivalents.

DISCUSSION

Although a trend was observed towards decreased overall and daily morphine use our results failed to reach statistical significance. Baig et al and Beaussier both found that narcotic use was diminished in patients using the elastomeric pain pump when compared to patients who did not have this modality (or those who had saline infused as a control)^{1,3}. In a randomized trial, Rigg et al found decreased pain scores on the first three postoperative days when a continuous epidural was used postoperatively¹³. Considering these studies, a diminished use of morphine would be expected

with combined modalities. It is possible that with a larger study population statistical significance may have been reached. Another factor that may have contributed to the lack of correlation is the diversity of the study patient population. Though accounting for narcotic sensitivity by excluding patients with chronic opiate use and opiate abuse history, patients in general have differing tolerance to opiates. Patients who underwent different operations may have different pain requirements related to the nature of their operation. Another confounding factor is the variability with narcotic conversion. We used the conversions listed in Table II4, although frequently these conversions can be represented by ranges.

Our institution records pain scores when patients are receiving pro re nata (PRN) pain medications. Therefore, data were not available for daily pain scores on patients not receiving PRN medications. It is possible that study patients who utilized both epidural and elastomeric pain pump analgesia were more comfortable than the other groups despite not demonstrating significant narcotic use differences.

Studying these factors in a prospective manner may be worthwhile. Clinician bias concerning patients who were assumed to be higher risk for difficulty with pain management may have influenced which patients received specific treatment modalities. For instance, those patients that were assumed would experience worse pain were likely to get both an epidural and elastomeric pump for pain control. This may have masked potential differences. Patients who were receiving an operation for cancer diagnoses had a statistically significant higher use of epidurals, demonstrating a difference between sample groups in terms of diagnosis and type of operation.

No statistical significance was seen when length of hospital stay was compared between groups. This may be the result of having an uncontrolled patient population. Complications contributed to increased length of stay. Some patients underwent a number of different operations, therefore type of surgery and indication for surgery likely contributed significantly to the length of hospital stay. We attempted to look at the patients undergoing the Whipple procedure specifically, but lacked numbers in order to look at this group individually. Other contributions to length of hospitalization that were not accounted for in our study include patients who were waiting in the hospital for a bed at a nursing home or rehabilitation institution to become

available, and other medical co-morbidities contributing to prolonged hospital stay.

Fortunately, there were relatively few complications in any of the study groups. There were no differences seen in complications between groups, specifically when wound infection, the most likely adverse effect from an elastomeric pain pump, was considered. This suggests that initially using an epidural and transitioning to an elastomeric pain pump is a safe way to incorporate local anesthesia as an adjunct into postoperative pain management plans. We were unable to infer from chart review if those who used narcotics had additional untoward side effects such as nausea/vomiting and ileus, or if using multimodal of local anesthetics diminished these side effects.

In conclusion, though no statistical significance was seen with the method of transitioning from an epidural to isomeric pain pumps, it appears to be a safe option. And of course, a multimodal and individualized approach to post-operative pain management is recommended.

DISCLOSURES

Drs. Rose, Gordon, Romero, Najafi, Boyle, and Ong have no conflict of interest or financial disclosures relevant to the topic of the submitted manuscript.

All authors were involved in the drafting of the manuscript or revised it critically for important intellectual content, and all authors gave final approval of the version of the article to be published.

Additionally,

Jessica Rose: Concept design, acquisition of data, analysis of data

Janalee Gordon: Concept design, acquisition of data

Andrew Romero: Acquisition of data

Bijan Najafi: Analysis of data

Patrick Boyle: Concept design

Evan Ong: Concept design

QUESTIONS:

1. The best modality for post-operative pain control is...?
 - a. Narcotics
 - b. Benzodiazepines

- c. Local anesthetics
- d. Multimodal

Answer = D. As stated in the introduction, there are pros and cons of all groups of medications. One can infer that using multiple different types of medications, in our case both narcotics and local anesthetics, is beneficial in post-operative pain control.

2. True or false. A higher complication rate can be expected if you combine epidural anesthesia with elastomeric pain pumps?

- a. True
- b. False

Answer is B. We did not find any increased complications with both modalities.

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