Assessment of Pain Relief Provided by Interscalene Regional Block and Infusion Pump After Arthroscopic Shoulder Surgery

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Purpose: This study was performed to evaluate the efficacy of interscalene regional blocks and infusion pumps for postoperative pain control after arthroscopic subacromial decompression with or without arthroscopic rotator cuff repair. Methods: Seventy-six patients were included in the prospective study. Participants were randomized into 4 treatment groups: (1) interscalene regional block, (2) infusion pump with 0.5% bupivacaine, (3) interscalene block combined with an infusion pump containing 0.5% bupivacaine, and (4) interscalene block combined with an infusion pump containing 0.9% saline solution. The interscalene regional block was performed with a nerve stimulator. Infusion pump catheters were positioned in the subacromial space. Visual analog scale (VAS) data were collected preoperatively, at 1 and 2 hours postoperatively, and daily for an additional 6 days postoperatively. An analysis of variance with a Student-Newman-Keuls post hoc test was used to identify statistically significant ($P < .05$) differences in VAS scores between the groups at each time point. Percentages of patients who took medication for pain management in the recovery room were compared between the 4 groups by use of $\chi^2$ analysis. Results: Significant differences were noted in VAS scores postoperatively. Group 2 (pump only) had significantly higher scores than all other groups for the first 2 hours. Furthermore, group 4 (block and pump filled with saline solution) had significantly lower VAS scores than group 1 (block only) at 1 hour. This difference was no longer significant by the second hour. The percentage of patients who required oral narcotics or intravenous pain medication was significantly larger for group 2 than for the other groups. Conclusions: The interscalene regional block provided more pain relief than infusion pumps immediately after arthroscopic shoulder surgery. Infusion pumps did not significantly reduce pain levels after the blocks wore off. Level of Evidence: Level II, prospective comparative therapeutic study. Key Words: Pain—Interscalene block—Infusion pump—Shoulder arthroscopy.

Advances in arthroscopic shoulder technology allow some shoulder procedures that once required hospitalization to be performed on an outpatient basis. However, even arthroscopic procedures can be associated with significant postoperative pain.1,2 Therefore, effective pain relief in an outpatient setting is mandated. Two of the more common contemporary methods of pain management are interscalene regional block and infusion pain pumps. As compared with general anesthesia alone, regional anesthesia with only an interscalene regional block reduces postoperative nausea and vomiting and eases postoperative recovery.3 The interscalene block also provides effective pain relief immediately postoperatively, although pain management only lasts for approximately 8 to 10 hours.3,6 Application of the block is an invasive procedure that requires anesthesiologists trained in the technique. Interscalene blocks have been associated with multiple complications, including phrenic nerve injuries with respiratory distress,6,7 anesthetic toxicity leading to cardiac arrest,8,9 seizures,10 and permanent
nerve injury. Infusion pumps are an alternative to interscalene blocks for treating postoperative pain. The pumps deliver a controlled flow of anesthetic from an external reservoir through a catheter that can be inserted into the shoulder to directly address the area of surgery. The controlled flow can last for up to 48 hours, which could potentially provide longer-lasting pain management than an interscalene block. However, pain control is limited to the anatomic region where the catheter is placed. Multiple studies have indicated that infusion pumps reduce postoperative pain, as compared with placebo, although one study indicated that infusion pumps do not effectively reduce pain.

This study was initiated to investigate the efficacy of interscalene regional blocks and infusion pumps after outpatient shoulder arthroscopy. A previous study directly compared interscalene blocks with infusion pumps. Pain levels tended to be lower with the infusion pumps for the first 2 days after surgery, although no statistically significant differences were identified. Pain levels were not recorded immediately postoperatively. This study was performed to evaluate the efficacy of interscalene regional blocks and infusion pumps for postoperative pain control after arthroscopic subacromial decompression with or without arthroscopic rotator cuff repair. We hypothesized that interscalene blocks would be more effective for pain management immediately after arthroscopic shoulder surgery but that infusion pumps would provide longer-lasting pain control.

METHODS

A prospective randomized study was performed with patients undergoing outpatient shoulder arthroscopy. The institutional review board gave approval for the study, and written, informed consent was obtained from each participant. Patients aged 21 years or older undergoing unilateral shoulder arthroscopy with subacromial decompression and possible rotator cuff repair were eligible for inclusion. Exclusion criteria included a history of shoulder injury, daily pain medication for problems not associated with the shoulder, and medical contraindications to regional anesthesia. Because catheters for the pain pumps were inserted into the subacromial space, patients were disqualified postoperatively if procedures other than arthroscopic subacromial decompression with or without a rotator cuff repair were performed.

Participants were randomized into 4 treatment groups: (1) interscalene regional block, (2) infusion pump with 0.5% bupivacaine, (3) interscalene block combined with an infusion pump containing 0.5% bupivacaine, and (4) interscalene block combined with an infusion pump containing 0.9% saline solution. For randomization, patients drew a sealed opaque envelope from a shuffled deck containing a color-coded card representing one of the treatment groups. Patients were not informed of their treatment group, although those in the block-only group were aware that they were not treated with a pump. When a pump was used, the subjects and physicians were blinded with respect to the contents of the pump. In addition, the surgeons were not informed as to which patients received an interscalene block.

Anesthesiologists experienced in regional anesthesia administered the blocks preoperatively using a standard protocol. All interscalene blocks were administered via a nerve stimulator with a 22-gauge, 2-inch insulated needle (B. Braun Medical, Bethlehem, PA) while patients were under light sedation. A localizing motor response was initiated with the lowest achievable current (<0.5 mA) and 30 mL of 0.3% ropivacaine was injected. Patients randomized to the pump groups received a disposable balloon infusion pump (Accufuser; McKinley Medical, Wheat Ridge, CO). Catheters were inserted into the subacromial space under arthroscopic visualization. Pumps were filled with a 48-hour supply of either 0.5% bupivacaine or 0.9% saline solution. The catheter was used to inject 20 mL of the contents of the pump into the subacromial space immediately after insertion. A basal rate of 5 mL/h with an available 1-mL bolus and a 1-hour lockout was used. To relieve pain, patients were asked to try the bolus option first and take medication only if no relief was felt after 15 minutes. Pumps were removed at 48 hours by the patient or a family member.

General anesthesia was used for the operative procedures. Anesthesia was induced with propofol and maintained with either desflurane or sevoflurane. Any breakthrough pain was treated with intravenous fentanyl. The outpatient arthroscopic surgeries were performed by 3 fellowship-trained shoulder surgeons. Two surgeons positioned the patients in the lateral decubitus position, whereas one used the beach-chair position. For each patient, the coracoacromial ligament was released and subacromial decompression was performed to achieve a smooth undersurface of the acromion. The bursal surface of the rotator cuff was visualized and examined. When identified, rotator cuff tears were lightly debrided to expose healthy tissue. Both single-row and dual-row anchor tech-
niques were used to repair the rotator cuff. Both screw-in and push-in anchors (DePuy Mitek, Raynham, MA) were used. At the end of the procedure, an infusion pump catheter was placed into the subacromial space, if required. The mean surgical time (± SD) was 24 ± 12 minutes for patients who underwent only a subacromial decompression and 50 ± 24 minutes for patients who underwent a rotator cuff repair.

Pain level was determined by use of a standard visual analog scale (VAS).\textsuperscript{15-17} Each patient recorded preoperative pain on a 10-cm line. The extremes of pain were noted on either end of the line with “I do not have any pain” on the left end and “My pain could not be worse” on the right end. Postoperative VAS scores were recorded in the same manner at 1 and 2 hours after admission to the postoperative care unit. Postoperative VAS scores were also recorded daily for the following 6 days. The time spent in the recovery room and the pain medications taken in the recovery room were also recorded for each patient.

At the time of discharge, patients were given a prescription for 5 mg of oxycodone with 325 mg of acetaminophen or hydrocodone and acetaminophen (5 mg/500 mg) if allergies existed. Patients documented the pain medications taken daily over the course of the study, and mean values were calculated for each group. Medications were divided into oral narcotics and over-the-counter medications (nonsteroidal anti-inflammatory drugs), with each tablet treated as 1 dose.

Statistical analyses were performed to compare pain levels, recovery time, medications taken, and demographic information between the 4 groups. An analysis of variance (ANOVA) was used to compare VAS scores between the 4 groups at each time point and to compare postoperative oral narcotics and over-the-counter medications taken over the course of the study between the 4 groups. An ANOVA was also used to compare the time in the post-anesthesia phase of recovery and patient age between the 4 groups. A Student-Newman-Keuls test was used for post hoc comparisons between the 4 groups when an ANOVA identified statistically significant variations. A power analysis performed for an ANOVA, with an assumed difference in VAS scores between groups of 3 cm and an SD of 2.4 cm, indicated that 18 patients per group would be needed to achieve a power of 0.9 with a significance of 0.05. The gender distribution, the distribution between patients who did and did not undergo a rotator cuff repair, the distribution between patients positioned in the lateral decubitus and beach-chair positions, and the distribution between patients who did and did not take medication for pain management in the recovery room were compared between the 4 groups via \( \chi^2 \) analysis. Statistical significance was set at \( P = .05 \) for each test.

**RESULTS**

A total of 128 patients were enrolled in the study between August 2002 and May 2005, although 36 were excluded postoperatively because of variations in surgical procedures that did not meet the inclusion criteria. Of the remaining 92 patients, 6 subsequently dropped out because of premature pump removal and 7 others did not complete the follow-up evaluations. Follow-up data were not recorded for 1 other patient because of mechanical pump failure. Two patients who were treated with only a pump rated their pain as 10 cm within 1 hour postoperatively, and the pain was uncontrollable with intravenous medication. These patients were withdrawn from the study, and an interscalene block was performed in the recovery room. Of the 76 patients who completed the study, 3 did not indicate their pain scores for 1 or 2 days on the second postoperative day or later. Statistical analyses were performed without including these patients at the missing time points. No surgical complications were noted for the 76 patients.

Demographic data were similar for the 4 groups (Table 1). No significant differences were found between the 4 groups in patient ages (\( P > .3 \)), distribution between men and women (\( P > .5 \)), distribution between the lateral decubitus and beach-chair positions (\( P > .5 \)), or distribution between those who did and those who did not undergo a rotator cuff repair (\( P > .5 \)).

The VAS scores were similar for the 4 groups, except at 1 and 2 hours postoperatively. The VAS scores were significantly larger for group 2 (infusion pump only) than for the other 3 groups at 1 and 2

**Table 1. Demographic Data for Each Group**

<table>
<thead>
<tr>
<th>Block Only</th>
<th>Pump Only</th>
<th>Pump and Block</th>
<th>Saline Solution Pump and Block</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>20</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>Age (yr) (mean ± SD)</td>
<td>48 ± 12</td>
<td>45 ± 11</td>
<td>52 ± 7</td>
</tr>
<tr>
<td>Men</td>
<td>11</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Cuff repair</td>
<td>12</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Lateral decubitus</td>
<td>8</td>
<td>11</td>
<td>11</td>
</tr>
</tbody>
</table>
hours postoperatively (Fig 1). In addition, at 1 hour, the VAS scores were significantly larger for group 1 (block only) than for group 4 (block and infusion pump filled with saline solution). No other significant differences were noted at the preoperative time point or any other postoperative time point ($P > .3$). From postoperative day 1 through day 6, the VAS scores tended to be larger for the group with only a block than for the other 3 groups, including the group with a block and a pump filled with saline solution.

Time in the recovery room was similar for the 4 groups, although patients with only a pump took more medication during this time period. The percentage of patients who took medication in the recovery room was significantly larger for group 2 than for the other 3 groups (Table 2). Furthermore, for both fentanyl and oral narcotics, the percentage of patients who took medication was significantly larger for group 2 than for the other 3 groups. Medications taken for nausea did not differ significantly between the groups ($P > .25$). No significant differences in either over-the-counter pain medications ($P > .1$) or oral narcotics ($P > .5$) taken over the study period were noted between the 4 groups (Table 3).

**DISCUSSION**

The results of this study indicate that the combination of interscalene blocks and general anesthesia provides better pain control than infusion pumps and general anesthesia immediately after arthroscopic shoulder surgery. Pain scores at 1 and 2 hours postoperatively were significantly larger for the group treated with only a pain pump than for the other 3 groups, all of which included an interscalene block for pain control. In addition, 2 patients treated with only a pain pump had to be converted to an interscalene block because of uncontrollable pain and were subsequently withdrawn from the study. Combining an interscalene block and a pain pump tended to lower pain scores immediately postoperatively, with a significant difference noted between patients treated with only a block and patients treated with a block and a pump filled with saline solution at 1 hour postoperatively. The decrease in pain scores with the infusion of saline solution indicates that the presence of the pump could produce a placebo effect. We are not aware of another direct comparison between interscalene blocks and infusion pumps that focuses on the first 2 hours postoperatively. Similar to our study, previous research performed to characterize the effectiveness of interscalene blocks for patients undergoing outpatient shoulder arthroscopy showed that 63% reported no pain at 4 hours postoperatively. Also similar to our study, patients who were given infusion pumps for pain management after arthroscopic rotator cuff repair had a mean VAS score of 7.6 immediately postoperatively. In two other studies performed with infusion pumps, the mean pain levels were lower than those recorded in our study, with mean pain levels of less.

![Figure 1. Mean VAS scores for the 4 methods of pain management (groups 1 to 4), with SDs shown for 2 groups. At 1 and 2 hours postoperatively, the VAS scores were significantly larger for group 2 than for the other 3 groups. At 1 hour, VAS scores were also significantly larger for group 1 than for group 4. No significant differences were identified preoperatively or from day 1 to 6.](image)

**Table 2. Number of Patients Who Took Recovery Room Pain Medications for Each Group**

<table>
<thead>
<tr>
<th>Medication Type</th>
<th>Block Only</th>
<th>Pump Only</th>
<th>Pump and Block</th>
<th>Saline Solution Pump and Block</th>
</tr>
</thead>
<tbody>
<tr>
<td>No medication</td>
<td>11</td>
<td>2</td>
<td>13</td>
<td>14</td>
</tr>
<tr>
<td>Fentanyl</td>
<td>1</td>
<td>13</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Oral narcotic</td>
<td>4</td>
<td>15</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Anti-nausea</td>
<td>10</td>
<td>7</td>
<td>4</td>
<td>7</td>
</tr>
</tbody>
</table>

*Data missing at days 6 and 7 for 1 patient.

**Table 3. Total Medication Usage for Each Group**

<table>
<thead>
<tr>
<th>Medication Type</th>
<th>Block Only</th>
<th>Pump Only</th>
<th>Pump and Block</th>
<th>Saline Solution Pump and Block</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral narcotic (mean ± SD)</td>
<td>25 ± 18</td>
<td>21 ± 15</td>
<td>17 ± 11</td>
<td>24 ± 19</td>
</tr>
<tr>
<td>Over the counter (mean ± SD)</td>
<td>17 ± 24</td>
<td>10 ± 16*</td>
<td>20 ± 14</td>
<td>8 ± 11</td>
</tr>
</tbody>
</table>

*Data missing at days 6 and 7 for 1 patient.
than 3 at approximately 2 hours postoperatively. One of these studies used a verbal response from patients to measure pain and indicated that the infusion pumps provided no reduction in pain as compared with placebo at the time of patient discharge. In the other study the VAS scores at 2 hours postoperatively were less than 4 for both patients treated with an infusion pump and patients treated with a placebo, although the pain was significantly reduced for patients treated with an infusion pump. An initial analysis of the results gives the impression that the pain pumps reduced pain once the blocks wore off. The data showed a nonsignificant trend for higher pain for the patients treated with only an interscalene block than for the patients treated with only a pain pump at postoperative day 1 through day 6. Similar to our study, a previous study that compared interscalene blocks with infusion pumps showed a nonsignificant trend for decreased pain with infusion pumps 1 and 2 days after surgery.

Further analysis of the results indicates that the trend for long-term pain relief provided by the pain pumps is not clinically relevant. From day 1 to 6, the mean VAS scores for patients with a saline solution–filled pump and a block (group 4) were lower than the mean VAS scores for patients with only a block (group 1), again suggesting that the presence of the pump produced a placebo effect. The largest difference in mean VAS scores between group 4 and the group with only a pump (group 2) was 0.7 cm, which occurred at day 6. Previous studies have reported that the minimum difference in the VAS score that is clinically relevant ranges from 0.9 to 1.3 cm. From a statistical point of view, even with the placebo effect included, for the mean values and SDs recorded for this study, more than 100 patients per group would be needed to identify a statistically significant difference in VAS scores between the block-only (group 1) and pump-only (group 2) groups at day 6 with a power of 0.9 and a significance of .05. More subjects would be needed for day 1 to 5. More subjects would also be needed to account for the placebo effect and compare groups 2 and 4. In addition, the mean VAS scores for group 4 and the group with a block and a bupivacaine-filled pump (group 3) varied by less than 0.5 cm from day 1 to 6, indicating that combining a pain pump with a block did not have a clinically relevant influence on long-term pain relief. The benefit of using infusion pumps may have been more apparent if VAS scores were collected when the blocks wore off, at approximately 8 to 10 hours postoperatively. As a result of late-afternoon surgical times for many patients, the VAS scores could not be consistently collected within this time frame.

This study was confined to patients undergoing arthroscopic procedures in the subacromial space only: subacromial decompression with or without rotator cuff repair. These procedures were chosen to maximize the effectiveness of a catheter placed within the subacromial space. Although many other procedures can be performed arthroscopically in the subacromial space, we tried to limit the number to avoid confounding the results.

Reported complications of interscalene block include paresthesias of the fingers, phrenic nerve injuries with respiratory distress, spinal anesthesia, anesthetic toxicity leading to cardiac arrest, seizures, and nerve injury. A retrospective review of interscalene regional anesthesia in a community setting reported a failure rate of 13%, with 33% of patients requiring intravenous pain medication immediately postoperatively, leading to the conclusion that the benefits of the block need to be weighed carefully against the risks. For our study, blocks were performed by anesthesiologists with fellowship training in regional anesthesia or with significant experience with the interscalene block technique. Although the completeness of the block was not specifically assessed for each patient, patients were noted to have a “heavy” arm before the induction of general anesthesia. Furthermore, only 5% of patients who received a block required any intravenous pain medication immediately postoperatively, and no complications were noted from the blocks. Our results are similar to those of a prospective evaluation of more than 500 interscalene blocks, performed by anesthesiologists skilled in the administration of interscalene blocks, which reported a 97% success rate for the blocks and a complication rate for patients undergoing arthroscopic shoulder surgery of 1.4%, with all complications classified as nonacute.

Patients with only a pump were more likely to take medication in the recovery room than patients who received an interscalene block. The increased medication usage did not significantly delay recovery time. Previous studies have shown significantly shorter recovery room stays with the use of an interscalene block or a pump, as compared with general anesthesia, although recovery room times have not previously been directly compared between interscalene blocks and infusion pumps, to our knowledge.
CONCLUSIONS

In this study interscalene blocks provided better pain relief than infusion pumps immediately after arthroscopic subacromial decompression with or without rotator cuff repair. Infusion pumps did not provide a significant benefit after the blocks wore off. When anesthesiologists experienced in regional anesthesia are available, an interscalene block is reliable for postoperative analgesia in patients undergoing arthroscopic shoulder surgery.

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REFERENCES