Randomized controlled double-blind trial of transversus abdominis plane block versus trocar site infiltration in gynecologic laparoscopy

Lena El Hachem, MD; Ethan Small, MD; Peter Chung, MD; Erin L. Moshier, MS; Kathryn Friedman, BA; Suzanne S. Fenske, MD; Herbert F. Gretz III, MD

OBJECTIVE: The objective of the study was to determine whether transversus abdominis plane (TAP) block reduces postoperative pain when compared with trocar site infiltration of bupivacaine in gynecological laparoscopy.

STUDY DESIGN: This was a prospective, randomized, double-blinded clinical trial using patients as their own controls. Women undergoing gynecologic laparoscopy using a 4-port symmetrical technique were randomly assigned to right- or left-sided TAP block using 30 mL of 0.25% bupivacaine with epinephrine. Two cohorts of patients were studied. Cohort 1 consisted of anesthesiologist-administered ultrasound-guided TAP block. Cohort 2 consisted of surgeon-administered laparoscopic-guided TAP block. In both cohorts, contralateral port sites were infiltrated with an equal amount of bupivacaine in divided doses. All patients received intraoperative acetaminophen and ketorolac. Postoperative abdominal pain was assessed at 1, 2, 4, 6, 8, 12, 18, 24, and 48 hours on the block and contralateral sides, before and after palpation, using the 10 point visual analog scale. A 2 point difference in the reported pain scores was considered clinically meaningful.

RESULTS: Eighty-eight patients were eligible for statistical analysis: 45 and 43 patients in cohorts 1 and 2, respectively. In both cohorts, most patients reported equal pain on the block side and local side. In cohort 1, there was a statistically significant difference in mean reported pain scores at 2 hours and across time favoring the ultrasound-guided block; however, this did not reach clinical significance. There was no statistically significant difference found at all other time points or when pain scores were objectively assessed after palpation of the incisions. When comparing laparoscopic-guided block with local infiltration, there was no statistically significant difference in reported mean pain scores at all time points or after palpation.

CONCLUSION: As part of this multimodal analgesic regimen, neither block method provided a significant clinical benefit compared with trocar site bupivacaine infiltration.

Key words: bupivacaine, gynecological laparoscopy, local anesthetic, port-site infiltration, postoperative pain, transversus abdominis plane block

During the last 2 decades, laparoscopic surgery has assumed an important role in gynecological surgery. Studies have demonstrated improved outcomes compared with those of conventional open procedures in terms of cosmesis, postoperative pain, and morbidity.1,2 Despite the brief recovery time, laparoscopy is certainly not pain free in the acute period, and the issue of controlling pain from port-site wounds remains challenging.3 Postoperative pain can lead to an increased consumption of opioids, with subsequent nausea, delayed bowel function, and prolonged postoperative recovery.4

In an effort to address pain-related complications, various methods of pain control have been attempted.5-9 Currently, no standard of care exists and management is based on surgeon and anesthesiologist preferences. The transversus abdominis plane (TAP) block is a regional anesthetic technique that has recently gained popularity in open surgery. It blocks the abdominal wall neural afferents by introducing local anesthetic into the neurofascial plane between the internal oblique and transversus abdominis muscles, consequently providing unilateral analgesia between the costal margin and the inguinal ligament.10 This modality
proved to be particularly efficacious in reducing postoperative pain scores and opioid requirements after open abdominal surgery\textsuperscript{11,15} as demonstrated in a metaanalysis of 18 randomized controlled trials.\textsuperscript{14,16}

In the setting of laparoscopy, TAP block has been suggested as a useful technique.\textsuperscript{16-19} However, there are conflicting data regarding gynecological laparoscopy. Whereas TAP block failed to add any analgesic benefit in some comparative trials,\textsuperscript{20} pain control was clearly superior in others.\textsuperscript{21,22} Optimal perioperative pain management remains controversial, and the debate continues with regard to the best method of local anesthesia that would provide clinically relevant alleviation of postoperative pain.

The rationale for this research is based on our observation that in the setting of multimodal analgesia, patients typically have minimal pain after gynecological laparoscopic surgery. The inference is that additional procedures and costs without demonstrable clinical benefits are not justified.

We hypothesized that TAP block does not reduce postoperative pain compared with traditional trocar site infiltration of bupivacaine in gynecological laparoscopy. Therefore, we designed a prospective, randomized controlled, double-blinded clinical trial comparing the efficacy of port-site infiltration of local anesthetic with ultrasound-guided TAP block and laparoscopic-guided TAP block for postoperative pain relief after laparoscopic gynecological surgery. We used patients as their own controls to avoid the confounding factors limiting prior studies.

**Materials and Methods**

After approval by the Institutional Review Board at White Plains Hospital Center, written informed consent was obtained preoperatively from women 18 years old or older undergoing gynecological laparoscopic surgery using a 4-port symmetrical technique. Patients with a known allergy to local anesthetic were not enrolled. Cases requiring a conversion to a laparotomy or the use of more than 4 laparoscopic ports were also excluded from the analysis. After informed consent, patients were randomized according to a computer-generated randomization list in sealed white envelopes to either right- or left-sided TAP block (experimental arm), and in each case the contralateral side of the abdomen was treated with a trocar site infiltration of anesthetic (control arm). Patients and postoperative assessors were blinded to the treatment assignment.

All patients received general anesthesia with endotracheal intubation. A standard multimodal intraoperative intravenous analgesic regimen was used including 1 g of acetaminophen and 30 mg of ketorolac. All the surgeries were performed by a single surgeon trained in advanced laparoscopy and a fellow in minimally invasive gynecology.

The surgical approach consisted of 4 laparoscopic ports inserted at or below the umbilicus: 1 periumbilical balloon trocar of 12 mm (T10 dermatome), 2 accessory ports of 5 mm inserted into the right lower quadrant and the left lower quadrant, and 1 accessory port of 5 or 12 mm in the suprapubic region (T12-L1 dermatomes). In every case, peritoneal access was obtained using an open port placement technique in the periumbilical area.

The control arm consisted of a total of 30 mL of 0.25% bupivacaine with epinephrine injected in divided doses in the trocar sites on 1 side of the abdomen: the lateral port received 40% of the dose, the midline umbilical port was injected with 40% on the control side only, and the suprapubic site was injected with 20% on the control side only.

The experimental arm consisted of the same total amount of 30 mL of 0.25% bupivacaine with epinephrine injected in the midaxillary line between the costal margin and the iliac crest.

In cohort 1, the TAP block was performed using a posterior approach under ultrasound guidance by 1 of 2 anesthesiologists, both with significant experience with this technique. A high-frequency linear ultrasound probe was positioned in a transverse plane on the anterolateral abdominal wall in the midaxillary line, between the lower costal margin and the iliac crest.

A 20-gauge 10 cm needle was inserted in the plane of the ultrasound beam and followed visually until it reached the plane between the internal oblique and the transversus abdominis muscles. Two milliliters of the local anesthetic solution were injected to visualize the spread of the solution and confirm correct needle position after which the remainder of the 30 mL was administered (Figure 1).

In cohort 2, the surgeon performed the TAP block injection under laparoscopic guidance. A 20-gauge 10 cm needle attached to a syringe of 30 mL of 0.25% bupivacaine with epinephrine was introduced through the abdominal wall using the same anatomic landmarks. After skin puncture, the needle was advanced to the level of the parietal peritoneum under direct laparoscopic visualization. Loss of resistance was felt while the needle passed through the external oblique and the internal oblique muscles. As the needle approached the peritoneum, slow injection was performed to tent the peritoneum, and the needle was then slightly withdrawn to infiltrate the correct plane. A diffuse bulge could be visualized expanding anterior to the peritoneum and transversus abdominis (Figure 2). The needle was withdrawn and redirected in the event of incidental peritoneal perforation.

All treatments were performed at the end of the surgical procedure and immediately prior to extubation. In all patients, the total amount of 0.25% bupivacaine with epinephrine used did not exceed the recommended safe dose of 2.5 mg/kg. Patients weighing less than 60 kg received a reduced amount of local anesthetic; otherwise, patients received a total volume of 60 mL. Careful aspiration was performed prior to all injections to minimize the risks of intravascular entry and subsequent local anesthetic toxicity.

At the completion of the surgery, patients were transferred to the postanesthetic care unit (PACU). Throughout the postoperative period, analgesic medications including acetaminophen, nonsteroidal antiinflammatory drugs, and systemic narcotics were administered upon patient request. Postoperative
abdominal pain was assessed at 1, 2, 4, 6, 8, 12, 18, 24, and 48 hours (0 hours being at admission to the PACU) on the TAP and contralateral sides. During the hospital stay, the nursing staff completed all timed assessments.

Subjective and objective methods were used to evaluate postoperative pain at each time point. Patients were first asked whether they had more pain on 1 side of the abdomen or the other (yes or no). Next, patients were asked to subjectively quantify their pain level on each side using a 10 point visual analog scale (VAS), a simple and validated measure of pain ranging from 0, representing no pain, to 10, representing the worst pain imaginable. Then the nurse palpated the incisions bilaterally and recorded the VAS scores obtained on each side. Finally, patients were asked to rate their overall abdominal pain using the 10 point VAS at each time point.

Intraoperative and postoperative analgesic medications used were abstracted from the chart. For the purpose of analysis, all narcotic use was converted to morphine sulfate equivalents using equianalgesic tables. Patients discharged prior to 48 hours postoperatively were asked to record the amount of pain medications used and complete the remaining pain assessments. The 48 hour pain diary was then collected at the 2 week postoperative visit.

Demographic and surgical data were retrieved from the patient charts. This included age, race, body mass index, American Society of Anesthesiologists physical status classification, diagnosis, type of procedure, operative skin-to-skin time, estimated blood loss, and length of stay in the PACU and in the hospital. Antiemetic medications used postoperatively on request or prophylactically were abstracted from the nursing flow sheets. The sites of injection of the TAP block were inspected for hematoma formation or signs of infection.

The primary outcome of the study is the difference in patient-reported pain scores between the abdominal side treated with TAP block and the contralateral side treated with local trocar infiltration at different points in time. Secondary outcomes included total narcotic consumption, opioid-related adverse effects (nausea and vomiting), and TAP block related complications.

We based the sample size calculation on the assumption that a 2 point difference in VAS pain scores would be clinically meaningful. A sample size of 34 patients in each cohort would be able to detect a difference of 2.0 points in pain score with a power of 80% and a type 1 error (alpha) of 0.05 using a 2-tailed test, assuming the SD of the differences to be 4. With an exclusion rate of 20%, 42 patients would need to be enrolled in each cohort.

Normally distributed continuous variables were described as means with SD, whereas continuous variables that were skewed were described as medians with ranges (minimum-maximum). Means were compared between study groups using a Student t test, whereas medians were compared using a Wilcoxon rank-sum test. Differences in mean pain scores between TAP and non-TAP sides were estimated with 95% confidence intervals, and paired t tests were used to test whether the difference in pain scores at each follow-up was equal to zero. Categorical data were expressed as percentages and then compared between groups using a Fisher exact test.

To test for difference in pain scores between the TAP and non-TAP sides over time, a mixed model analysis of
Variance was used with random intercepts and an unstructured covariance to account for the correlation among measures made on the same patient over time. All hypothesis testing was conducted at the 5% level of significance. Statistical analyses were performed using SAS software version 9.2 (SAS Institute, Inc, Cary, NC).

RESULTS

Between January and August 2013, 93 patients signed a preoperative written consent form and were enrolled in the study. Five patients were excluded: 1 because of an intraoperative conversion to a laparotomy secondary to malignancy and 4 requiring an additional laparoscopic port. Eighty-eight patients were eligible for randomization, 45 and 43 patients in cohorts 1 and 2, respectively. There were no patients lost to follow-up. The statistical analysis included a total of 88 patients (Figure 3).

There was no significant difference between cohorts with respect to age, race, body mass index, American Society of Anesthesiologists physical status, preoperative diagnosis, operative time, estimated blood loss, type of procedure, time spent in the recovery room, or length of hospital stay (Table 1). In all patients, the TAP block was easily performed on the intended abdominal side, and there were no described complications with either approach. Upon inspection, the sites of injection revealed no bruising, hematomas, swelling, or infection. There were no reported anaphylactic reactions or episodes of toxicity.

When patients were asked whether 1 side of the abdomen hurt more than the other side, the majority of patients in both cohorts answered no. In cohort 1, 53% of patients reported equal pain on both sides across all time points, whereas 29% and 18% reported the TAP side as more painful and the local side as more painful, respectively. In cohort 2, 61% of patients reported equal pain on both sides across all time points, whereas 20% and 19% of patients reported the TAP side as more painful and the local side as more painful, respectively.

Patient self-assessed pain scores were reported on the 10 point VAS and analyzed using paired t tests at each time point. When the TAP was performed under ultrasound-guidance, there was a statistically significant lower mean pain score on the TAP side compared with the local side at 2 hours postoperatively. However, the 95% confidence interval (CI) excludes the clinically meaningful difference of 2 (95% CI, 0.27–1.33). At all other documented time points, no statistical significance was found (Table 2).

When analyzed across time using the mixed regression model, there was a statistically significant difference in mean pain scores between TAP and contralateral side, with the local side having a 0.41 point higher average pain score than the TAP side. Similarly, the 95% CI excludes the clinically meaningful difference of 2 (95% CI, 0.20–0.61) (Figure 4).

In the second cohort, when the TAP was performed under laparoscopic guidance, there was no statistically significant difference between TAP and contralateral side mean pain scores at any time point when using the paired t test (Table 3) or overall across time points when using the mixed regression model (Figure 5).

During hospitalization, the postoperative nurses objectively assessed pain scores by palpating the incision on the local infiltration side and the TAP block side. Notably, there was no statistically significant difference between TAP and contralateral side mean pain scores at any time point when using the paired t test (Table 3) or overall across time points when using the mixed regression model (Figure 5).

Finally, patients were asked to report their overall abdominal pain scores at each time point. Both cohorts achieved...
effective pain control with low mean overall VAS scores ranging between 1.82 and 3.95. When we compared both cohorts, there was a significantly lower mean overall abdominal pain score favoring the surgeon-administered TAP block group at 18 and 24 hours. However, when we looked at the data across time, the difference of 0.43 point (95% CI, 0.10–0.77) favoring the surgeon-administered block, even though statistically significant \( P = .011 \) was not clinically meaningful.

The total narcotic use was low in both cohorts. The mean cumulative narcotic requirement 24 hours following surgery was only 9.35 mg and 8.07 mg of morphine sulfate equivalents in cohorts 1 and 2, respectively. There was no significant difference in mean narcotic consumption between both cohorts, intraoperatively, at 24 hours or at 48 hours (Figure 6). Antiemetic medications were used prophylactically or therapeutically in 29% of patients in the anesthesiologist-administered TAP cohort vs 32% of patients in the surgeon-administered TAP cohort. No statistical difference was found with respect to antiemetic use between both cohorts \( P = .818 \), Fisher exact test).

**Comment**

Our study demonstrates that, as part of a multimodal analgesic regimen, neither ultrasound-guided nor laparoscopic-guided TAP blocks offer significant clinical benefit over local anesthetic port site infiltration in women undergoing gynecological laparoscopy. The differences detected at 2 hours and across time in the patient-reported mean pain scores favoring the ultrasound-guided TAP block, although statistically significant, have no meaningful impact in clinical settings.

We chose a difference of 2 points in the VAS pain score to represent a substantial clinical benefit. Because the 95% CI of 0.20–0.61 using the mixed regression model and the 95% CI of 0.27–1.33 using the paired \( t \) test at 2 hours exclude 2, these statistically significant results do not reach clinical significance. Moreover, we found that the majority of patients described equal pain across time on both sides of the abdomen, and when both treatments were assessed objectively after palpation of the incisions, there was no statistically significant difference found overall across time.

Importantly, we demonstrated that laparoscopic-guided TAP blocks are simple, safe, and equally effective to port-site infiltration of bupivacaine. Consequently, we believe that the systematic use of intraoperative acetaminophen and ketorolac in conjunction with a locoregional anesthetic block, whether via local infiltration or TAP block, results in excellent postoperative pain relief.

Previous comparative trials examining ultrasound-guided TAP block for laparoscopic surgery have yielded varying results ranging from considerable pain

---

### Table 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cohort 1, AAT (n = 45)</th>
<th>Cohort 2, SAT (n = 43)</th>
<th>( P ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y), mean (SD)</td>
<td>53.6 (9.8)</td>
<td>53.5 (11.6)</td>
<td>.985&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>BMI (kg/m&lt;sup&gt;2&lt;/sup&gt;), mean (SD)</td>
<td>28.2 (7.8)</td>
<td>28.4 (6.0)</td>
<td>.882&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Race, n (%)</td>
<td></td>
<td></td>
<td>.512&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>White</td>
<td>38 (84)</td>
<td>37 (86)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>7 (16)</td>
<td>6 (14)</td>
<td></td>
</tr>
<tr>
<td>Preoperative diagnosis, n (%)</td>
<td></td>
<td></td>
<td>.084&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Fibroid uterus</td>
<td>7 (16)</td>
<td>10 (23)</td>
<td></td>
</tr>
<tr>
<td>Adnexal mass</td>
<td>16 (35)</td>
<td>14 (33)</td>
<td></td>
</tr>
<tr>
<td>Malignancy</td>
<td>15 (33)</td>
<td>17 (19)</td>
<td></td>
</tr>
<tr>
<td>Abnormal uterine bleeding</td>
<td>0 (0)</td>
<td>2 (5)</td>
<td></td>
</tr>
<tr>
<td>Chronic pelvic pain</td>
<td>3 (7)</td>
<td>0 (0)</td>
<td></td>
</tr>
<tr>
<td>Operative time, min, mean (SD)</td>
<td>88.9 (40.7)</td>
<td>80.8 (30.5)</td>
<td>.293&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Estimated blood loss, mL, mean (SD)</td>
<td>91.6 (53.1)</td>
<td>106.7 (77.1)</td>
<td>.283&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Procedures, n (%)</td>
<td></td>
<td></td>
<td>.378&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Adnexal only</td>
<td>4 (9)</td>
<td>1 (2)</td>
<td></td>
</tr>
<tr>
<td>LSH with or without BSO</td>
<td>13 (29)</td>
<td>13 (30)</td>
<td></td>
</tr>
<tr>
<td>TLH with or without BSO</td>
<td>18 (40)</td>
<td>16 (38)</td>
<td></td>
</tr>
<tr>
<td>TLH with or without staging</td>
<td>10 (22)</td>
<td>13 (30)</td>
<td></td>
</tr>
<tr>
<td>Time in the recovery room (min), mean (SD)</td>
<td>125 (50.7)</td>
<td>116 (39.4)</td>
<td>.329&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Length of stay (d), median (range)</td>
<td>1 (0–4)</td>
<td>1 (0–9)</td>
<td>.051&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Data are mean (SD), median (range), or number (percentage) unless otherwise specified.

AAT, anesthesiologist-administered TAP block; ASA, American Society of Anesthesiologists; BMI, body mass index; BSO, bilateral salpingo-oophorectomy; LSH, laparoscopic supracervical hysterectomy; SAT, surgeon-administered TAP block; TLH, total laparoscopic hysterectomy.

<sup>a</sup> Student \( t \) test used to compare means; \(<sup>b</sup> Fisher exact test used to compare proportions; \(<sup>c</sup> Wilcoxon test used to compare distributions.

reduction to no pain reduction.\textsuperscript{20,21}

Our study differs from the literature in its design. First, all patients and postoperative assessors were blinded to the randomization process. Second, by treating opposite sides of the abdomen in patients with symmetrical port placement, we used patients as their own controls. This enabled us to eliminate the potential confounding factor arising from the variability of pain perception between different patients.

Even though our study showed no clinical superiority of one anesthetic method over the other, it confirmed our clinical impression that in the setting of multimodal analgesia, gynecological laparoscopy is not usually associated with severe discomfort. Overall mean postoperative pain scores reported during the first 48 hours were low, ranging from 1.8 to 4 and from 2 to 3.2 in cohorts 1 and 2, respectively.

In designing the study, we did not want to stray from our usual intraoperative analgesic regimen. However, this use of multimodal systemic analgesics might have reduced pain to levels that made it more difficult for patients to detect variations in pain intensity. Moreover, we have found that the small incisions corresponding to the lateral 5 mm laparoscopic port sites are not typically very painful and may have made it more challenging to demonstrate a significant reduction in pain between treatment arms.

Heretofore, because of its simplicity, safety, and low cost, many surgeons utilize local anesthetic instillation at trocar insertion sites to alleviate postoperative pain experienced after laparoscopic surgery.\textsuperscript{6} A prospective randomized trial by Bellows and Berger\textsuperscript{5} found that local anesthetic infiltration into all layers of the abdominal wall is effective in decreasing postoperative pain after laparoscopic surgery.

Until now, there have been limited data supporting a standard dosing regimen, and we have observed many surgeons utilizing as little as 2-4 mL per site. It is possible that the larger volumes of local anesthetic used at the trocar sites in our study have contributed to the high analgesic effect obtained. Nevertheless, bupivacaine was used in conjunction with epinephrine and was in all patients within the recommended safe dose range (2.5 mg/kg).

Our study differs from prior randomized studies in the timing of administration of the anesthetic. Because we anticipated some variability in the length of our procedures (1-3 hours) and because bupivacaine is a long-acting

---

**TABLE 2**

Comparison of mean pain scores at each time point in the anesthesiologist-administered TAP block cohort

<table>
<thead>
<tr>
<th>Hour</th>
<th>Mean local anesthetic pain score</th>
<th>Mean TAP pain score</th>
<th>Mean difference (SD)</th>
<th>95% CI</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.97</td>
<td>1.59</td>
<td>0.38 (2.16)</td>
<td>−0.32 to 1.08</td>
<td>.273</td>
</tr>
<tr>
<td>2</td>
<td>2.00\textsuperscript{a}</td>
<td>1.20\textsuperscript{#}</td>
<td>0.80 (1.65)\textsuperscript{a}</td>
<td>0.27 to 1.33</td>
<td>.004\textsuperscript{a}</td>
</tr>
<tr>
<td>4</td>
<td>1.56</td>
<td>1.13</td>
<td>0.44 (1.43)</td>
<td>−0.03 to 0.90</td>
<td>.064</td>
</tr>
<tr>
<td>6</td>
<td>1.79</td>
<td>1.34</td>
<td>0.45 (1.48)</td>
<td>−0.04 to 0.93</td>
<td>.071</td>
</tr>
<tr>
<td>8</td>
<td>2.26</td>
<td>1.66</td>
<td>0.61 (2.46)</td>
<td>−0.20 to 1.41</td>
<td>.137</td>
</tr>
<tr>
<td>12</td>
<td>2.46</td>
<td>2.08</td>
<td>0.38 (1.88)</td>
<td>−0.25 to 1.00</td>
<td>.228</td>
</tr>
<tr>
<td>18</td>
<td>3.23</td>
<td>2.79</td>
<td>0.44 (2.36)</td>
<td>−0.33 to 1.20</td>
<td>.256</td>
</tr>
<tr>
<td>24</td>
<td>3.33</td>
<td>3.08</td>
<td>0.26 (1.93)</td>
<td>−0.37 to 0.88</td>
<td>.412</td>
</tr>
<tr>
<td>48</td>
<td>2.55</td>
<td>2.63</td>
<td>−0.08 (1.73)</td>
<td>−0.65 to 0.49</td>
<td>.780</td>
</tr>
<tr>
<td>Overall</td>
<td>0.41\textsuperscript{a}</td>
<td>0.20—0.61\textsuperscript{a}</td>
<td>.001\textsuperscript{a,b}</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data are mean (SD) and analyzed using paired t-tests unless otherwise specified.

CI, confidence interval; TAP, transversus abdominis plexus.

\textsuperscript{a} Value of P < .05; \textsuperscript{\#} Mixed-model analysis of variance.


---

**FIGURE 4**

Mean VAS pain scores over time in the anesthesiologist-administered TAP block cohort

This figure illustrates the mean VAS pain scores with 95% CIs over time in the anesthesiologist-administered TAP block cohort. Error bars indicate SE.

CI, confidence interval; TAP, transversus abdominis plexus; VAS, visual analog scale.

anesthetic agent with a rapid onset of action and an effect that dissipates by 24 hours, we chose to administer the local anesthetic at the end of the surgeries, prior to extubation. Because laparoscopic procedures are reported to cause pain during the first 24 hours, this choice allowed us to synchronize the most effective duration of the treatment with the more painful initial postoperative period for all patients.

The TAP block as first described by Rafi in 2001, consisted of a blind double-pop technique using a blunt needle introduced through the external and internal oblique muscles and fascia at the iliolumbar triangle of Petit. However, in this landmark technique, the blocks have blind endpoints, making their success unpredictable, and a few complications have been reported including intrahepatic injection, intraperitoneal injection, and bowel hematoma.10,11

Recently, ultrasonography guidance was described, offering the advantage of real-time imaging of the needle trajectory and anesthetic spread, consequently improving both safety and effectiveness of the block.25 On the other hand, this technique is time consuming, complications may still occur, and it requires sonographic equipment and technical skills.26,27

In this study, we describe an alternative technique that is safe, easy to perform, less time consuming, and does not require any extra equipment. Surgeon-administered laparoscopically guided TAP block is technically simple

<table>
<thead>
<tr>
<th>TABLE 3</th>
<th>Comparison of mean pain scores at each time point in the surgeon-administered TAP block cohort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hour</td>
<td>Mean local anesthetic pain score</td>
</tr>
<tr>
<td>1</td>
<td>1.64</td>
</tr>
<tr>
<td>2</td>
<td>0.90</td>
</tr>
<tr>
<td>4</td>
<td>1.25</td>
</tr>
<tr>
<td>6</td>
<td>1.51</td>
</tr>
<tr>
<td>8</td>
<td>1.69</td>
</tr>
<tr>
<td>12</td>
<td>1.80</td>
</tr>
<tr>
<td>18</td>
<td>1.68</td>
</tr>
<tr>
<td>24</td>
<td>1.38</td>
</tr>
<tr>
<td>48</td>
<td>1.53</td>
</tr>
<tr>
<td>Overall</td>
<td>0.11</td>
</tr>
</tbody>
</table>

Data are mean (SD) and analyzed using paired t tests unless otherwise specified.
CI, confidence interval; TAP, transversus abdominis plane.
* Mixed-model analysis of variance.

| FIGURE 5 | Mean VAS pain scores over time in the surgeon-administered TAP block cohort |

This figure illustrates mean VAS pain scores with 95% CIs over time in the surgeon-administered TAP block cohort. Error bars indicate SE.
CI, confidence interval; TAP, transversus abdominis plane; VAS, visual analog scale.

| FIGURE 6 | Postoperative narcotic consumption |

This table illustrates the postoperative narcotic consumption in morphine sulfate equivalents (milligrams) by time intervals. Light gray columns indicate cohort 1 (AAT). Dark gray columns indicate cohort 2 (SAT).
AAT, anesthesiologist-administered TAP block; SAT, surgeon-administered TAP block.
and eliminates the risks of intraperitoneal injection by visualizing any peritoneal perforation. This approach provided consistent analgesia, equivalent to port-site anesthetics infiltration as shown in the second cohort. In theory, the success of a TAP block is thought to be dependent on correctly identifying the plane between the internal oblique and transversus abdominis muscles.

The challenge with the laparoscopic-guided TAP block is that the appropriate neurovascular plane is identified by a subtle sensation of loss of resistance as the needle passes through the external oblique and internal oblique muscles. By using a large volume of a dilute local anesthetic, the TAP block techniques also rely on local anesthetic spread.11,13 Recent data indicate that the administration of local anesthetic between fascia layers is associated with fast absorption kinetics and high plasma levels.28 Overall, laparoscopic-guided TAP block as demonstrated in this study provided analgesic results equivalent to anesthesiologist-administered TAP block.

One potential drawback of our study is that we did not compare the effect of either treatment on the midline incisions. However, we specifically intended not to address this question for several reasons. First, we believe that neither the patients nor the nurses could accurately differentiate laterality of pain in the umbilical area. Second, there has been controversy in the literature regarding the spread and level of block achieved with a posterior TAP block injection as described in this trial.

Although early studies showed a T7 to L1 spread with this approach,29 other studies failed to demonstrate a spread cephalad to T10, making it more suited for lower abdominal surgery.30,31 In the latter case, augmentation with an oblique subcostal TAP injection would be necessary to attain a higher block that covers the periumbilical area.12 Furthermore, treatment of a midline incision using TAP block is typically accomplished with bilateral injections to account for the overlap of terminal cutaneous branches of the intercostal nerves across the midline. However, in our attempt to minimize patient bias when reporting pain, patients received only unilateral TAP blocks with port-site injections of local anesthetic around the contralateral half of the umbilicus. Finally, even though pain scores obtained after nurse palpation are likely to isolate incisional pain from other sources of pain, they have questionable reproducibility that limits their interpretation.

In conclusion, TAP blocks achieved postoperative pain scores that are comparable with high-volume local port site infiltration of anesthetics. This study also shows that laparoscopic-guided TAP block is a safe, simple, effective, and low-cost alternative to the ultrasound-guided TAP block. The objectivity achieved in our study by blinding observers and using patients as their own controls is particularly valuable because it eliminates significant bias in measuring the effectiveness of this new technology.

In view of the overall low pain scores and efficiency of local infiltration of anesthetic, the role of TAP block in gynecological laparoscopy remains unsupported. Where local infiltration of ports is in practice, the TAP block confers little incremental benefit, and we cannot recommend its routine use in laparoscopy. Rather, we recommend a multimodal analgesic regimen associated with port-site infiltration of adequate doses of local anesthetic.

REFERENCES


