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Transversus Abdominis Plane Block for Laparoscopic Hysterectomy Pain: A Meta-Analysis

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ABSTRACT

Objective: Review the analgesic effect of the transversus abdominis plane (TAP) block and its impact on postoperative pain scores and opioid usage for patients undergoing laparoscopic and robotic hysterectomies.

Methods: Systematic review with meta-analysis of randomized controlled trials that compared the effect of TAP block to either placebo or no block on narcotic use (in morphine equivalent units [MEq]) and pain (per visual analog scale) within 24 h after a laparoscopic or robotic hysterectomy for benign or malignant indications. Searches were conducted in PubMed and Embase through May 31, 2019.

Results: Nine randomized controlled trials met eligibility criteria; 7 evaluated laparoscopic hysterectomy and 2 robotic hysterectomy. A total of 688 subjects were included (559 laparoscopic hysterectomy, 129 robotic hysterectomy). Opioid consumption was similar in the first 24 h postoperative with or without TAP block (−0.8 MEq; 95% CI, −2.9, 1.3; 8 TAP arms; N = 395). Pain scores (visual analog scale) were also similar with or without TAP block (−0.01 U; 95% CI, −0.34, 0.32; 10 TAP arms; N = 636). Neither meta-analysis showed statistical heterogeneity across studies.

Conclusions: The evidence does not support a benefit of TAP block to reduce pain or opioid use for patients receiving laparoscopic or robotic hysterectomies.

Key Words: TAP block, pain; Laparoscopic; Robotic; Hysterectomy.

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INTRODUCTION

Compared with open surgical procedures, laparoscopic and robotic surgeries have been shown to have both short- and long-term benefits, including shorter hospital stays, decreased postoperative pain, and quicker recovery.[1–3] Such benefits are important since up to 78% of minimally invasive hysterectomy procedures may be discharged on the same day of surgery and important factors in predicting same-day discharge include lower pain scores in the postanesthesia care unit and lower narcotic requirements.[4,5]

To improve perioperative clinical outcomes and early surgical recovery, health care institutions are increasingly developing Enhanced Recovery after Surgery protocols. A key tenet of the Enhanced Recovery after Surgery protocols is optimizing postoperative pain by a multimodal approach. One goal of the multimodal approach is the reduction of opioid use as a primary analgesic. Investigations into the efficacy of multimodal analgesia for different types of surgery are of urgent importance given the worsening harms of opioid overprescription, misuse, and abuse, which may lead to use disorder (addiction) and mortality.[6–8]

As part of the multimodal approach, nonopioid medications delivered by neuraxial and peripheral regional anesthesia are high utility analgesic techniques used to optimize pain control, efficiency, and patient satisfaction.[9] The transversus abdominis plane (TAP) block is a regional anesthesia technique for lower abdominal and gynecologic surgeries. TAP targets the innervation of the anterior abdominal wall—the intercostal, subcostal, iliohypogastric, and ilioinguinal nerves through the lumbar triangle of Petit between the transversus abdominis and internal oblique muscles.[10] The goal of the block is to inject a local anesthetic in the plane between these muscles by a midaxillary/lateral, posterior, subcostal, or oblique/subcostal approach to provide analgesia to the anterolateral abdominal wall. This technique has been described favorably in the general surgery and obstetrics literature as a way to help manage postoperative pain.[11–14] In particular, the TAP block has been shown to decrease opioid consumption for the first 24 h in patients who underwent open hysterectomies.[15] However, as surgical practice continues to become less invasive, the value of TAP for the minimally invasive gynecologic surgery patient remains unclear.

The primary goal of this study is to review and analyze the literature on how effective a TAP block is to decrease both postoperative pain and opioid use in patients undergoing laparoscopic and robotic hysterectomies, as well as to evaluate the methods of block administration.

MATERIALS AND METHODS

We conducted a comprehensive literature search in PubMed and Embase (from inception through May 31, 2019) using the following terms: "transversus abdominis plane block," "hysterectomy," "laparoscopic hysterectomy," and "robotic hysterectomy." The search was limited to human trials in the English language.

We included randomized controlled trials (RCTs) of patients with either benign or malignant indications for laparoscopic or robotic hysterectomy. RCTs had to compare the postoperative analgesic effect of a TAP block to placebo or no block.

Three authors each performed an independent review of the citations, and conflicts were resolved by consensus. Potentially eligible abstracts were retrieved in full text and rescreened in duplicate for eligibility. Data were extracted from each study by one reviewer and confirmed by at least one other reviewer. Discrepancies were resolved by discussion. We extracted publication information; patient descriptions, descriptions of the hysterectomies performed; drug, dose, timing, location, and method of TAP infusion and comparator; postoperative opioid dose and pain scores. Opioid doses were converted (as needed) to morphine equivalent (MEq) units. Pain scores were standardized to a 10-point visual analog scale (VAS).

Meta-analyses were performed on the primary outcomes of interest (total opioid use at 24 h in MEq, pain measured by VAS at 24 h). For each outcome, from studies with adequate data we calculated the mean difference between TAP and placebo (or no TAP) with their associated standard errors (SE). For studies that reported median and interquartile range data, we estimated the mean and SE based on Wan et al.[16] For the study that compared two different TAP regimens to placebo,[17] we compared each TAP arm to half the placebo arm (effectively, we estimated the SE for each placebo arm based on half the number of people analyzed in the placebo arm). We meta-analyzed studies using a restricted maximum likelihood random effects model [18]. Meta-regression to evaluate possible interactions based on timing and location of TAP were conducted with the metareg package in Stata 14.2 (StataCorp LLC, College Station, TX).

RESULTS

The literature search yielded 1369 citations, of which 16 were retrieved in full text for rescreening (**Figure 1**). Of these, nine RCTs were deemed eligible.[17,19–26] **Table 1** describes several consistently described characteristics of the RCTs. Seven RCTs evaluated conventional laparoscopic hysterectomy[17,19,21,22,24–26] and two evaluated robotic hysterectomy.[20,23] A total of 688 subjects were included (559 laparoscopic hysterectomy, 129 robotic hysterectomy). Hysterectomies were performed for benign indications in four studies,[17,19,21,25] for malignancy in one study,[23] for both indications in two studies,[20,24] and for unspecified reasons in two studies.[22,26]

The studies compared TAP block to either placebo with saline or no block with the exception of one study described below.[24] Medications used for the blocks were 0.25% bupivacaine in three studies,[19,23,24] 0.375% bupivacaine in one study,[25] 0.375% levobupivacaine in one study,[22] 0.5% ropivacaine in three studies,[20,21,26] and one study had 2 medication arms using 0.5% and 0.25% ropivacaine.[17] Four studies compared bilateral TAP injections with saline placebo blocks[17,19,20,25] and three other bilateral studies compared to no block.[21,22,26] There were two unilateral block studies, one randomizing subjects to either a unilateral TAP block or placebo,[23] and one study

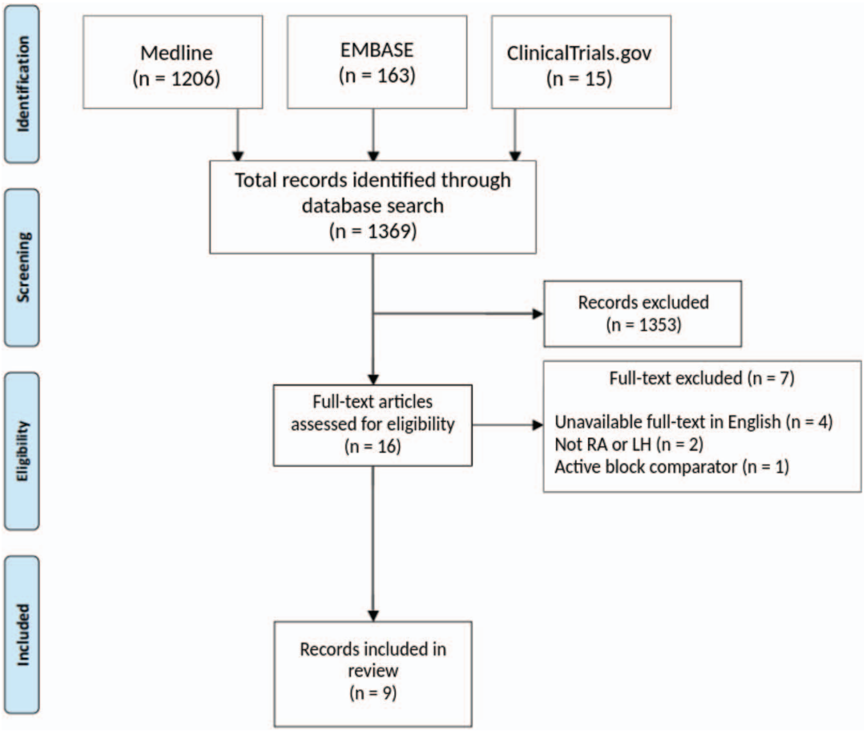

Figure 1. PRISMA flow diagram. Abbreviations: LH, laparoscopic hysterectomy; RA, robotic assisted.

comparing a unilateral TAP block to the contralateral site treated with port site infiltration of the same medication in divided doses.[24]

Studies varied in the timing of the TAP block and technique of placement. The blocks were placed after anesthesia induction but before the start of surgery in five studies,[17,20,22,25,26] at the end of the surgical procedure in three studies,[19,21,24] and in one case in the preoperative area.[23] With respect to the position of block placement on the abdomen, four studies utilized a midaxillary approach,[17,20,22,26] three studies a posterior approach,[19,23,24] one study an oblique-subcostal approach,[25] and one study did not specify.[21] The posterior TAP block placements were done with laparoscopic guidance while all other blocks were performed with ultrasound guidance.

Opioid Consumption

Nine RCTs evaluated postoperative opioid consumption; however, one trial did not report opioid consumption at 24 h[19] and one trial did not report sufficient data reported to estimate the SE.[24] However, both trials were generally consistent with the other RCTs. Seven studies, with eight comparisons of TAP to no TAP, were included in the meta-analysis. Opioid consumption was not significantly lower in the TAP block group (mean difference = −0.5 MEq; 95% CI, −2.3, 1.3; **Figure 2**). The RCTs were mostly imprecise and no significant statistical heterogeneity was found (I^2 = 33%).

The single RCT that used the oblique subcostal position[25] favored TAP (mean difference, −2.2 MEq; 95% CI, −3.8, −0.6), whereas the five RCTs (with 6 comparisons) that used the anterior/midaxillary position[17,20,22,23,26] nominally favored no TAP (mean difference, 1.0 MEq; 95% CI, −1.0, 3.1), with an indication of a possible difference across studies based on block location (P = .061). Kane et al.[21] did not report their TAP technique. However, they were the only meta-analyzed RCT that placed the TAP block postoperatively. The effect of TAP in this study (mean difference, −1.0 MEq; 95% CI, −3.9, 1.8) was similar to the effect in the seven comparisons that placed the TAP block preoperatively (mean difference, −0.3 MEq; 95% CI, −2.6, 2.0; P = .79 between groups of studies).

VAS Pain Score

Nine RCTs evaluated VAS pain scores at 24 h postoperative. One study was excluded from meta-analysis because

Table 1.
Study Characteristics

Author	N Analysis	Technique	Timing of TAP Block	Surgery	Medication	Comparison	Opioid Consumption in MEq (24 Hours)	NRS or VAS Pain Score (24 Hours)	Outcomes Summary
Calle et al[19]	197	Laparoscopic guided Posterior approach	End of procedure	LH	Bilateral block, each side with 20 mL—1.5mg/kg of bupivacaine (0.25%)	0.9% Saline	1.8 mg vs. 1.49 mg; $P = 0.20$	95% CI −1.36, −0.13; $P = .237$	No significant difference in opiate use or pain scores
De Oliveira Jr et al[17]	66	Ultrasound guided Midaxillary approach	After induction	LH	Bilateral block, each side with 20mL—0.25% or 0.5% ropivacaine	0.9% Saline	15 mg (saline) vs. 15 mg (0.25% ropivacaine) vs. 7.5 mg (0.5% ropivacaine); $P = .01$	6 (saline) vs. 4 (0.25% ropivacaine) vs. 3 (0.5% ropivacaine); $P = .02$	Decrease in opiate use in the Ropivacaine 0.5% group compared with saline group Decrease in pain score for ropivacaine groups compared with saline group
El Hachem et al[24]	88	Ultrasound guided (Cohort 1) vs. laparoscopic guided (Cohort 2) Posterior approach	End of procedure	LH	Unilateral block with 30mL—0.25% bupivacaine with epinephrine	Contralateral side with local injection at port sites	Difference between mean cumulative narcotic requirement for cohort 1: 9.35 mg and cohort 2: 8.07 mg not significant	Cohort 1: 3.08 vs. 3.33; $P = .41$ Cohort 2: 1.59 vs. 1.38; $P = .56$	No significant difference in opiate use or pain scores
Ghisi et al[22]	44	Ultrasound guided Midaxillary approach	After induction	LH	Bilateral block, each side with 20 mL—0.375% levobupivacaine	None	10.73 mg vs. 10.55 mg; $P = .950$	At rest: 0 vs. 0; $P = 0.94$ With movement: 2 vs. 2; $P = .60$	No significant difference in opiate use or pain scores

Table 1.
Continued

Author	N Analysis	Technique	Timing of TAP Block	Surgery	Medication	Comparison	Opioid Consumption in MEq (24 Hours)	NRS or VAS Pain Score (24 Hours)	Outcomes Summary
Guardabassi et al[26]	40	Ultrasound guided Midaxillary approach	After induction	LH	Bilateral block, each side with 15mL—0.5% ropivacaine	None	10 mg vs. 7 mg; $P = .20$	0 vs. 0; $P = .50$	No significant difference in opioid use or pain scores
Hotujec et al[23]	64	Ultrasound guided Midaxillary approach	Prior to OR	RH	Unilateral block with 30mL—0.25% bupivacaine with epinephrine	0.9% Saline	64.9 mg vs. 69.3 mg; $P = .52$	3.12 vs. 3.61; $P = .30$	No significant difference in opiate use or pain scores
Kane et al[21]	56	Ultrasound guided Technique not described	End of procedure	LH	Bilateral block, each side with 20mL—0.5% ropivacaine with epinephrine	None	7.5 mg vs. 9.0 mg; $P = .61$	50 vs. 50; $P = .84$	No significant difference in opiate use or pain scores
Komarz et al[25]	60	Ultrasound guided Oblique-subcostal approach	After induction	LH	Bilateral block, each side with 20mL—0.375% bupivacaine	0.9% Saline	33.3 mg vs. 35.5 mg; $P = .01$	3 vs. 3; $P = .04$	Decrease in opiate use and pain scores
Torup et al[20]	65	Ultrasound guided Midaxillary approach	After induction	RH	Bilateral block, each side with 20mL—0.5% ropivacaine	0.9% Saline	17.5 mg vs. 17.5 mg; $P = .65$	At rest: 12 vs. 7; $P = .11$ While coughing: 20 vs. 21; $P = .35$	No significant difference in opiate use or pain scores

Abbreviations: LH, laparoscopic hysterectomy; RH, robotic hysterectomy; OR, operating room.

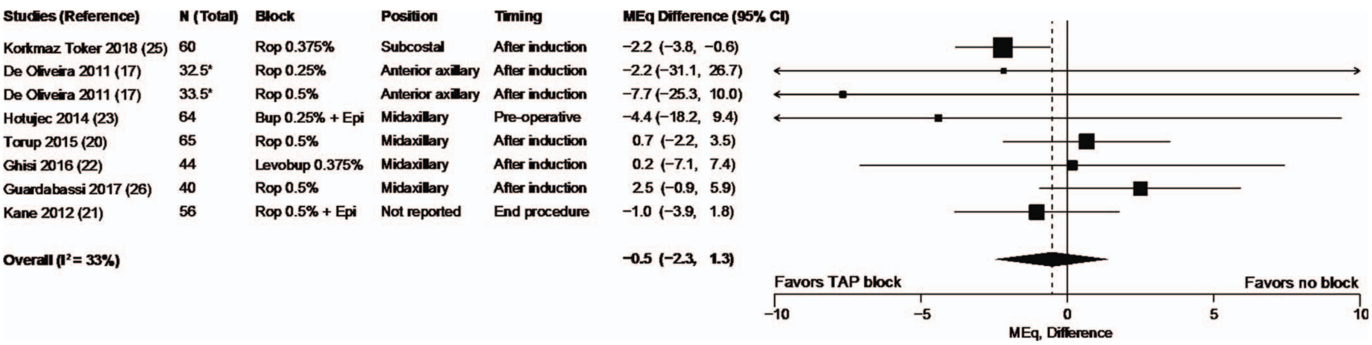

Figure 2. Morphine equivalents at 24 h postoperative. Forest plot of studies comparing TAP block versus no block on mean opioid use at 24 h, in mean morphine equivalents. Abbreviations: Bup, bupivacaine; CI, confidence interval; Epi, epinephrine; Levobup, levobupivacaine; MEq, morphine equivalents; Rop, ropivacaine; TAP, transversus abdominis plane. *, Three-arm study with two TAP block arms. For the purpose of meta-analysis, each analysis includes half the 23 participants who received placebo block.

the SE could not be estimated[22]; this study found no difference in VAS between TAP block and placebo. One RCT had two TAP groups (with ropivacaine, 0.25% or 0.5%)[17] and another study included two separate comparisons of TAP block (one with ultrasound guidance and one with laparoscopic guidance)[24]; thus the meta-analysis included 10 comparisons of TAP to placebo (or no TAP). VAS scores were similar with or without TAP at 24 h postoperative (−0.01 U; 95% CI, −0.35, 0.32; **Figure 3**). No significant statistical heterogeneity was found across studies (I^2 = 19%).

The differences in VAS scores with or without TAP were similar in RCTs that injected the TAP block in the anterior/midaxillary position (0.21; 95% CI, −0.05, 0.46; 5 comparisons),[17,20,23,26] the posterior position (−0.31; −0.81, 0.20; 3 comparisons),[19,24] or the oblique subcostal position (−0.33; 95% CI, −2.97, 2.30; 1 comparison; P = .26 across groups of studies).[25] The differences in VAS scores with or without TAP were also similar in RCTs that injected the TAP block preoperatively (0.20; 95% CI, −0.05, 0.46; 6 comparisons)[17,20,23,25,26] or postoperatively (−0.30; −0.81, 0.20; 4 comparisons; P = .12 between groups of studies).[19,21,24]

DISCUSSION

The TAP block has been shown to benefit patients during the recovery period in certain open obstetric and gynecologic procedures[11–14] but the literature with regard to laparoscopic cases is less obvious; the question remained as to whether or not patients undergoing a minimally invasive surgical approach, which results in less postoperative pain

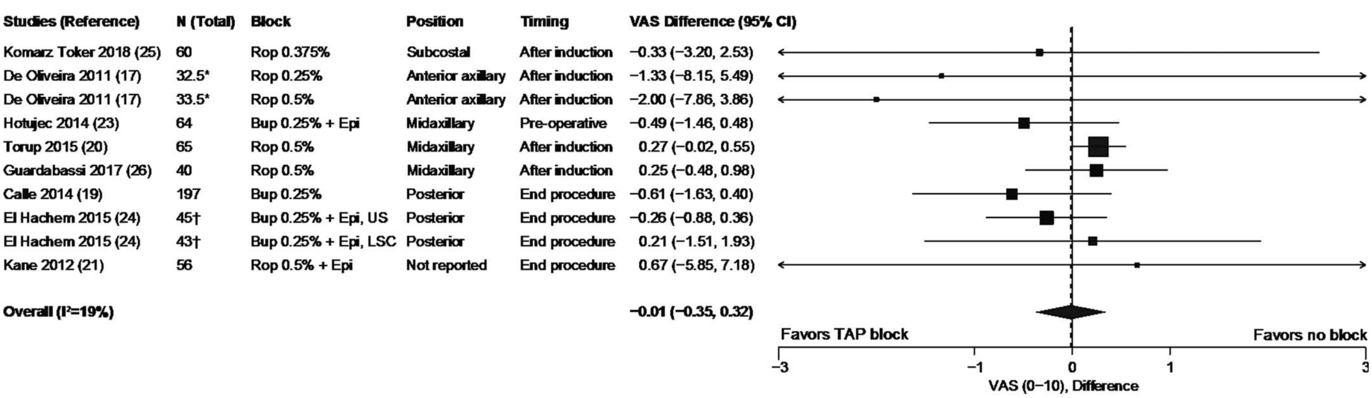

Figure 3. VAS pain scores at 24 h postoperative. Forest plot of studies comparing TAP block versus no block on mean pain score at 24 h, on a 10-point VAS. Abbreviations: Bup, bupivacaine; CI, confidence interval; Epi, epinephrine; LSC, laparoscopic guided; Rop, ropivacaine; TAP, transversus abdominis plane; US, ultrasound guided; VAS, visual analog scale. *, Three-arm study with two TAP block arms (0.25% and 0.5%). For the purpose of meta-analysis, each analysis includes half the 23 participants who received placebo block. †, Each woman served as her own control. Patients received TAP on one randomly determined side and placebo block on the other.

than open surgery, would still receive a significant improvement in pain outcome measures with the addition of the TAP block.

To the best of our knowledge, our study is the largest review assessing postoperative pain and opioid use after endoscopic hysterectomy, which also includes robotic procedures, and surgeries for benign and malignant indications. Five studies specified the preoperative conditions for surgery, type of hysterectomy performed, and concomitant procedures.[17,20,21,23,24] There were no significant differences between the comparison arms for any of these variables in these studies. The other four studies did not describe the indication for surgery or other surgical characteristics.[19,22,25,26] Future investigations should uniformly consider potential differences in postoperative pain for different preoperative conditions and type of surgery performed, for example, postoperative pain management needs may differ after prolonged surgery requiring extensive dissection for advanced stage endometriosis vs. a hysterectomy for simple hyperplasia.

Additional strengths of our study include a focus on RCTs and the systematic review methodology employed, with meta-analysis and meta-regression. Of the nine studies included in this review, seven did not report a significant difference in either postoperative pain score or opiate use in the first 24 h after surgery.[19–24,26] Two studies demonstrated significant decreases in both outcomes,[17,25] but our meta-analysis demonstrated neither clinical nor statistically significant differences at 24 h postoperative: less than 1 MEq difference between the TAP and saline or placebo groups and no difference on a 0–10 VAS pain scale.

The RCTs we reviewed provided data on a range of procedural techniques, including medications used, position of TAP block, timing of drug administration, and other features such as inherent variability in practitioner technique. Despite these differences, the RCTs yielded homogeneous results; although, the failure to find evidence of statistical heterogeneity may have been due to the limited power of several of the trials.

The studies had several limitations in their reports, which precluded further analysis. An important omission was a standardized description of perioperative analgesia. For example, they did not consistently describe intra-operative opioid consumption including the use of long-acting anesthetics.[21] Only two studies described whether or not port sites were injected with local anesthetic after completion of the surgery.[20,23] Postoperatively, several studies calculated morphine consumption in the absence of other analgesics while other studies also incorporated anti-inflammatory drugs and acetaminophen.[17,20,24,26] We recommend that future TAP block investigations include these descriptions and state a clearly defined multimodal analgesic perioperative protocol in order to fully assess the efficacy of TAP blocks as part of an opioid minimizing technique. Another deficiency of the reviewed studies is that two studies did not report complete results data and therefore one study each was omitted from both the meta-analysis of opioid consumption[24] and of VAS pain score.[22] It should be noted that conclusions from the meta-regressions (e.g., interactions between the TAP block position and the relative effectiveness of the block) are not definitive and should be evaluated directly within trials; however, we avoided comparisons that may be affected by ecological fallacy (e.g., based on patients' mean weight).

The location of the TAP block could theoretically impact the effectiveness of the block to reduce postoperative pain. We did find what may be a suggestion that an oblique subcostal block may be more effective to reduce postoperative opioid consumption than the anterior/midaxillary position; however, this conclusion is based on only a single study that used the subcostal approach. The difference in effect between this study and the remaining studies may have been due to factors other than location of the TAP block. No differences in VAS scores at 24 h were found across studies based on TAP position.

Another factor to consider which may impact block efficacy is trocar placement, which was not detailed in all the studies. Four studies we investigated did not describe trocar placement in conjunction with a description of their TAP block injection technique.[17,19,20,26] The most common approach for block placement was in the midaxillary line between the costal margin and iliac crest.[17,20,22,25–26] One of these studies, by Ghisi et al,[22] describes port placement in the periumbilical and upper abdominal areas. However, an oblique subcostal approach may be more suitable in cases with upper abdominal port trocars to cover a wider thoracolumbar nerve distribution.[27]

Finally, further investigations evaluating the impact of TAP block timing either prior to surgical incision or after completion of surgery may be helpful to determine optimal efficacy. In the meta-analysis of TAP block for open and laparoscopic hysterectomies by Bacal et al,[28] a subgroup analysis was performed for those who underwent a total abdominal hysterectomy and received the block either before or after surgery. The authors reported a greater reduction in pain scores in the group with the block given prior to incision, thus suggesting a benefit of preemptive analgesia in these cases. However, in our analyses of opioid consumption, all but one of the studies administered the TAP block after induction but prior to surgical incision, limiting any conclusions about potential differences in effectiveness of pre- and postoperative TAP block in minimally invasive surgeries. Notably though, there was no significant difference in VAS scores in our subgroup analysis of TAP block given prior to or after surgery.

The benefits of a minimally invasive procedure over open abdominopelvic surgery with respect to postoperative pain and recovery are well established in the literature. However, opioids are still a significant component of the postoperative pain regimen for laparoscopic and robotic hysterectomies. From our review, although pain scores and opioid consumption was lower in the TAP block groups, these differences were quite small and not statistically significant. The evidence does not support a benefit of TAP block to reduce pain or opioid use for patients receiving laparoscopic or robotic hysterectomies. For future studies, consideration of the above variations in block techniques and timing, medications, and of perioperative anesthetic protocols, may clarify the impact of TAP block after minimally invasive hysterectomy to affect clinical change.

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