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A combination of ultrasound-guided rectus sheath and transversus abdominis plane blocks is superior to either block alone for pain control after gynecological transumbilical single incision laparoscopic surgery

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Summary

Purpose: To investigate the efficacy of the combination of ultrasound-guided rectus sheath (RS) and transversus abdominis plane (TAP) blocks compared with TAP or RS block alone in gynecological single-incision laparoscopic surgery (SILS). M*aterials and Methods:* Bilateral TAP blocks (Group A, n = 12), TAP and RS blocks (Group B, n = 12), and RS blocks (Group C, n = 12) with 40 ml ropivacaine/patient were performed for ovarian tumor SILS. The analgesic effects were evaluated using a numerical rating scale (NRS) at zero, six, 12, 24, and 48 hours post-surgery. *Results:* Umbilical pain on completion of general anesthesia was significantly less frequent in Group B (1/12) than Group A (7/12) ($p = 0.03$). The postoperative NRS scores were significantly lower in Group B than Group A at zero ($p = 0.02$) and six ($p = 0.03$) hours and Group C at zero ($p = 0.001$), six ($p = 0.02$), and 12 ($p = 0.004$) hours. *Conclusion:* The combination of RS and TAP blocks reduced early postoperative pain compared with RS or TAP block alone for gynecological SILS.

Key words: Single-incision laparoscopic surgery; Transversus abdominis plane block; Rectus sheath block.

Introduction

Single incision laparoscopic surgery (SILS) has recently become popular and has improved the outcome of gynecological surgery. However, a large-sized port scar due to SILS causes umbilical pain in some patients. Postoperative pain requiring bed rest and persistent gastrointestinal dysfunction are key factors that prolong hospitalization [1]. Therefore, adequate postoperative pain control is important to improve the quality of life and reduce the duration of hospital stays.

Abdominal wall blocks can be achieved by perineural injections, which have several advantages compared with neuraxial blockade. They have less severe consequences of infection or bleeding at the injection site, minimal interference with bladder and bowel function, and decreased incidence of lower extremity motor weakness, allowing early ambulation [2]. Abdominal wall blocks are performed using the classic landmark technique, but ultrasound (US)-guided blocks have recently gained popularity. The use of US, which allows non-invasive real-time imaging of the important anatomical structures, can make blocks safer and improve the placement accuracy [3].

Previous randomized controlled trials demonstrated the efficacy of the transversus abdominis plane (TAP) block as a component of a multimodal regimen in providing analgesia after abdominal surgery [4, 5]. One paper reported that postoperative pain was decreased by administering the TAP block for gynecological laparoscopic surgery with four port scars [6–8]. The effectiveness of this block in pain management after SILS procedures has also been reported [9]. The rectus sheath (RS) block provides analgesia after procedures requiring a midline incision by acting on the terminal branches of the 7^{th}–11^{th} intercostal nerves within RS. RS block has also been utilized for postoperative analgesia in patients who underwent umbilical hernia repair [10, 11]. The aim of this study was to investigate the efficacy of the combination of US-guided RS and TAP blocks compared with either TAP or RS blocks alone in gynecological SILS procedures.

Materials and Methods

Subjects

The authors obtained the approval of the institutional review board of Nissay Hospital to conduct a retrospective review of the medical charts of 36 patients aged 23–61 years (mean age, 33 years). Every patient underwent a transumbilical SILS for an ovarian tumor in the period between February 2010 and October 2011 and was classified by the American Society of Anesthesiologists as a physical status of 1 or 2.

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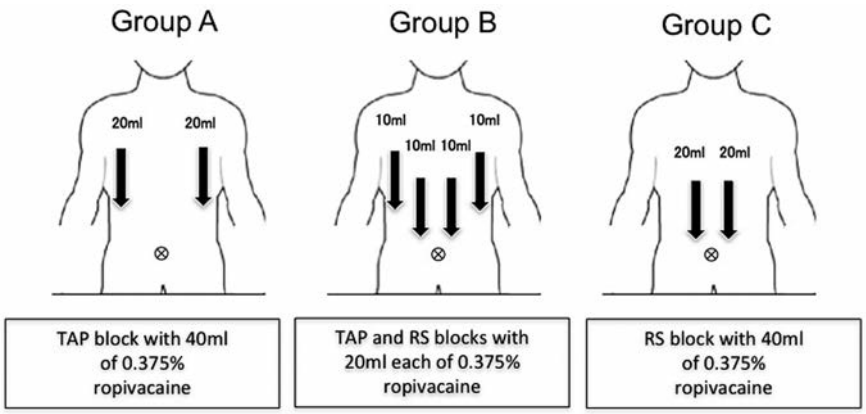

Figure 1. — Puncture sites for the transversus abdominis plane (TAP) block, combined TAP and rectus sheath (RS) blocks, and the RS block. The combination block was administered bilaterally using 50% doses under ultrasound-guided control.

Anesthesia

Without premedication, 500 ml of acetate Ringer's solution was administered via peripheral venous access. Standard monitoring, including non-invasive blood pressure monitoring, three-lead electrocardiography, and pulse oximetry, were performed (S/5 anesthesia monitor. All patients were assessed using the bispectral index (BIS). Patients in both groups received propofol, 0.3 μg /kg/min of remifentanil, and one mg/kg of rocuronium before tracheal intubation. Propofol was administered via target-controlled infusion pumps with a target plasma concentration of 3.0 μg/ml. After intubation, the lungs were ventilated to an end-tidal carbon dioxide concentration within the range of 30–40 mmHg.

Following the induction of general anesthesia, bilateral TAP blocks were performed with 20 ml of 0.375% ropivacaine in 12 patients (Group A), bilateral TAP and RS blocks with ten ml of 0.375% ropivacaine each were performed in 12 patients (Group B), and bilateral RS blocks with 20 ml of 0.375% ropivacaine were performed in 12 patients (Group C) (Figure 1). The authors used a real-time, in-plane needle insertion technique under US guidance to perform TAP and RS blocks. A portable US device with a linear 6–13-MHz US transducer was used. The blocks were administered with a 22 gauge, 80 mm Tuohy nerve block needle.

The TAP block was administered using a mid-axillary approach. After visualization of the external oblique abdominal muscle (EOAM), internal oblique abdominal muscle (IOAM), and transverse abdominal muscle (TAM) at the level of a mid-axillary line between the 12th rib and the iliac crest, the puncture area and US probe were prepared in a sterile manner. After placing the tip of the needle in the space between IOAM and TAM and confirming negative aspiration of blood, the TAP block was bilaterally administered by infusion of 20 ml or ten ml of 0.375% ropivacaine per side in Groups A and B, respectively.

The area of the abdomen between the lateral border of the rectus muscle and one cm cephalad to the umbilicus and a US probe were prepared in a sterile manner in patients undergoing RS blocks. The needle tip was placed close to the lateral border of RS between the posterior sheath and rectus muscle. A spread of the local anesthetic was visualized between RS and rectus abdominis muscle under US guidance. The RS block was bilaterally administered by infusion of ten ml or 20 ml of 0.375% ropivacaine per side in Groups B and C, respectively.

Anesthesia was maintained by propofol and remifentanil titrated to maintain a mean arterial blood pressure of 80–120% of that measured before the induction of anesthesia. The propofol dose was adjusted to maintain BIS between 40 and 60 during surgery. Following skin closure, 100 mg of tramadol and five mg of prochlorperazine or 50 mg flurbiprofen intravenously, or 400 mg of acetaminophen administered by suppository were provided and anesthesia was discontinued before tracheal extubation. To manage postoperative pain, the authors used four types of analgesics; namely, tramadol 12 mg by patient controlled intravenous analgesia (iv-PCA), flurbiprofen 50 mg intravenously, rokisoprophen 60 mg orally, and dicrofenac 50 mg suppositories (Table 1). Patient-controlled analgesia (PCA) was performed by intravenous administration of 300 mg of tramadol and 44 ml of saline in a total of 50 ml using the bolus settings for 12 mg tramadol with a ten-minute lockout interval time without basal infusion.

Table 1. — *Postoperative pain relief medication.*

		Group A	Group B	Group C
Theater	Tramadol 2 mg/kg	11	9	8
Theater	Acetaminophen 400 mg	6	5	10
Theater	Flurubiprophen 50 mg	2	0	2
Ward	PCIA*	3	2	0
Ward	Flurubiprophen 50 mg	7	6	9
Ward	Rokisoprophen 60 mg	7	3	10
Ward	Diclofenac 50 mg	2	0	0

*PCIA: patient controlled intravenous analgesia.

Assessment

The sites of administration of TAP and RS blocks were visually checked for the presence of hematoceles or infection. The total amounts of remifentanil and propofol administered to each patient were recorded. The presence or absence of nausea and vomiting after extubation and during the first 24 hours post-surgery were recorded for each patient.

Analgesic effects were evaluated by the presence or absence of umbilical pain on the completion of general anesthesia and pain intensity using a numerical rating scale (NRS) at zero, six, 12, 24, and 48 hours post-surgery. NRS was used to assess pain intensity in patients who were able to self-report. All patients were assessed on an 11-point scale numbered from 0 to 10 (high scores indicating intolerable pain).

Statistical analysis

All data are expressed as medians and ranges. Statistical analyses were conducted by a Chi-square test and one-way analysis of variance. A level of $p < 0.05$ was considered to be significant.

Table 2. — *Demographics of 3 groups.*

	Group A	Group B	Group C
Number	12	12	12
Age (yrs)	35±7	35±8	35±12
Body weight (cm)	55±5	52±3	52±6
Body height (kg)	162±5	158±3	159±6
Anesthesia (min)*	159±24	130±31	123±10
Operation (min)*	107±26	78±31	74±15
Pneumoperitoneum (min)*	86±25	57±32	50±14
Remifentanil (mg)	1.6±0.4	1.3±0.2	1.1±0.5

*Group A was significantly higher than Group B and C ($p < 0.05$).

Results

All patients successfully underwent transumbilical SILS without open conversion. No complications due to the block procedures were encountered. There were no significant differences in age, body height and weight, or in the doses of anesthetic among the three groups (Table 2). The duration of anesthesia and surgery in Group A was significantly longer than that in Groups B and C ($p < 0.05$).

No patients in the three groups showed nausea and vomiting after extubation and during the first 24 hours post-surgery. Umbilical pain on the completion of general anesthesia was significantly less frequent in Group B (1/12) than Group A (7/12) ($p = 0.03$) (Figure 2).

Postoperative NRS in Group B was significantly lower than that of Group A at zero ($p = 0.02$) and six ($p = 0.03$) hours post-surgery and Group C at zero ($p = 0.001$), six ($p = 0.02$), and 12 ($p = 0.004$) hours post-surgery (Figure 3). There were no significant differences in the NRS scores at 24 and 48 hours post-surgery.

Discussion

This retrospective study revealed that a combination of RS and TAP blocks more greatly reduced abdominal pain in the early postoperative period as compared with either RS or TAP blocks alone in patients having undergone SILS for ovarian tumors.

Smith *et al.* reported that postoperative analgesia evaluated with visual analogue pain scores was significantly lower in patients supplemented with bilateral RS blocks as compared to those without these blocks after diagnostic laparoscopy [12]. This regional anesthetic technique has become increasingly popular and is used to provide analgesia for umbilical and epigastric hernia repair, laparoscopic surgery, and other small midline incisions. El-Dawlatly *et al.* reported that US-guided TAP blocks substantially reduced the perioperative opioid consumption in patients undergoing laparoscopic cholecystectomy under standard general anesthesia [13]. To the present authors' knowledge, the adequate method of trunk blocks for SILS remains known because reports regarding this issue have been scarce until now [9].

The anterior abdominal wall, including the skin, muscle, and parietal peritoneum, are innervated by the anterior rami

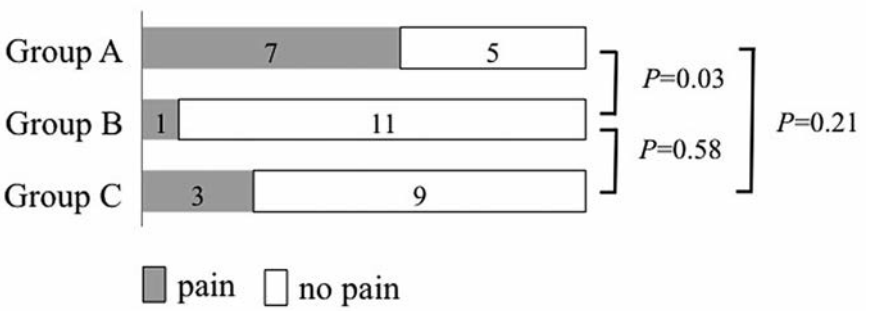

Figure 2. — Umbilical pain at the completion of general anesthesia in Groups A, B, and C.

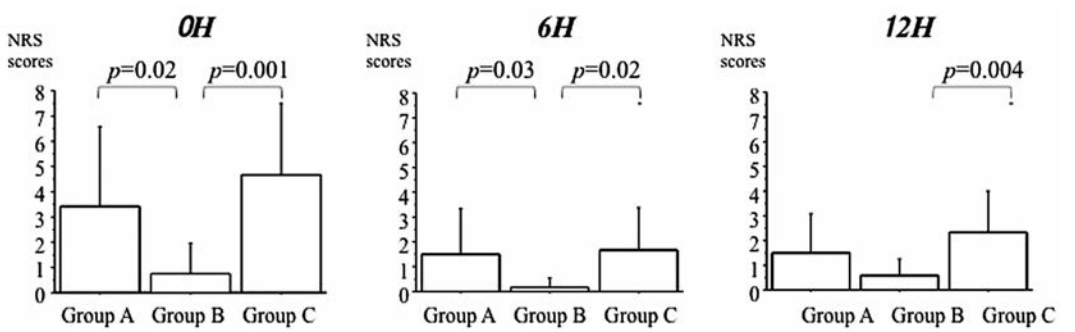

Figure 3. — Numerical rating scale (NRS) scores at zero, six, and 12 hours post-surgery in Groups A, B, and C.

of T6–L1, which include the intercostal, subcostal, ilioinguinal, and iliohypogastric nerves. The thoracolumbar nerves course through the lateral abdominal wall within TAP. The sensory nerves send out a lateral cutaneous branch near the midaxillary line, and continue within TAP to supply sensation to the abdominal wall as far as the midline. There is extensive branching and communication of the segmental nerves within TAP [14]. The US-guided TAP block results in sensory blockade below the umbilicus (T10–L1) according to the data reported by Shibata *et al.* [15] and Tran *et al.* [16]. An injection of local anesthetic within TAP can therefore potentially provide unilateral analgesia to the skin, muscle, and parietal peritoneum of the anterior abdominal wall mostly in the area between T10 and L1 [14].

RS block has been used to provide surgical anesthesia as well as postoperative analgesia for surgical procedures involving a vertical midline laparotomy incision and laparoscopic procedures [17, 18]. Bilateral RS blocks have recently been used for the repair of umbilical hernias in pediatric patients [10, 11]. Because the RS plexus forms a longitudinal band of nerve fibers running cranio-caudally with the deep inferior epigastric artery, the RS block covers several segmental levels [19]. In between the rectus abdominis muscle and the three lateral muscles, including EAOM, IOAM, and TAM, is the linea semilunaris. The RS block targets only the midline, not beyond the linea semilunaris, whereas the TAP block targets the nerves of the anterolateral abdominal wall within the neurovascular plane. When an injection is applied in the posterior aspect of RS, the local anesthetic spreads out and blocks nerves from T6–T11 as they enter RS [14].

Prior to this present study, the authors speculated that the RS block would be preferable for analgesia after SILS. This is because the surgical incision of performing SILS is limited only to the umbilicus. The umbilicus is always innervated by a branch of T10. Therefore, either RS or TAP blocks alone should theoretically cover the umbilical area. The fact that the combination of US-guided RS and TAP blocks reduced early postoperative pain compared with either RS and TAP blocks alone in patients undergoing gynecological transumbilical SILS may suggest that the pain was not limited to the umbilicus and had spread over a wider area. The present authors surmise that patients feel two kinds of pain post-SILS. One is pain continuously caused by the large laparoscopic port scar and the other is pain from the expansion of the peritoneum during surgery. The latter, pneumoperitoneum, might be responsible for early postoperative anterior abdominal pain. The combination of RS and TAP blocks is considered to cover a greater cranial area as compared with the TAP block alone, as well as the area beyond the linea semilunaris, where the RS block is known to have minimal effect. It is speculated that the combination block is successful because the RS block efficiently reduces pain cephalad to the umbilicus and the TAP block reduces pain related to pneumoperitoneum by covering the area of the entire anterolateral abdomen.

El-Dawlatly *et al.* reported that US guidance enabled the exact placement of local anesthetic for TAP blocks [13]. TAP blocks were previously conducted using a landmark-based technique within the ilio-lumbar triangle of Petit as described by McDonnell *et al.* [4]. The use of US-guided blocks may decrease the risk of complications, although no study has directly compared landmark-based approaches with US-guided techniques. The key to success with regional anesthesia is to place the correct dose of local anesthetic in the right anatomic location. Using real-time US imaging, the tip of the needle and the spread of local anesthetic can be observed within the potential space [20, 21]. The present authors have routinely performed abdominal wall blocks with US guidance. If the correct spread is not observed, the needle is carefully redirected until adequate placement is achieved. They did not encounter any complications due to RS and/or TAP block procedures in this case series.

This study had some limitations. First, the authors did not include the evaluation of the sensory block in the skin in this retrospective study. Second, they collected the data used in this study from existing medical records. The pain scores and quantities of the three types of analgesics used to manage postoperative pain were documented by different nurses and therefore might have been transcribed inconsistently. Third, Group A had significantly longer durations of anesthesia, surgery, and pneumoperitoneum than Groups B and C. However, this study did include a good baseline comparability of age, body height and weight, and disease similarity among the three groups.

Previous reports have shown that trunk blocks rely on the spread of injectates through an appropriate plane and thus, the volume of local anesthetic used is critical to their success. In particular, adequate volume is more important than a high concentration. The choice of local anesthetic also varies amongst the publications. The most common seems to be ropivicaine or bupivacaine in varying degrees of strength and volume [17]. Future studies will be needed to evaluate variations in the type, strength, and volume of local anesthetics.

Conclusion

The combination of US-guided RS and TAP blocks is useful to reduce early postoperative abdominal pain compared with either RS or TAP blocks alone in patients undergoing transumbilical SILS for ovarian tumors.

A portion of this data was presented in an abstract/poster form at the annual meeting of the American Society of Anesthesiologists (ASA) 2012 in Washington, DC, USA.

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