IJMA

International Journal of Medical Arts

VOLUME 6, ISSUE 6, JUNE 2024

P- ISSN: 2636-4174
E- ISSN: 2682-3780

Available online at Journal Website
https://ijma.journals.ekb.eg/
Main Subject [Anesthesia]

Original Article

External Oblique Intercostal Plane Block Versus Rectus Sheath Plane Block in Supra-umbilical Surgical Incisions; Randomized Controlled Double-Blinded Clinical Trial

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Article information

Received: 24-04-2024

Accepted: 31-05-2024

DOI: 10.21608/IJMA.2024.285088.1960.

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Citation: Gad M, Kandel AM, Abd-Ellatief AF, Eldadamony ZEM. External Oblique Intercostal Plane Block Versus Rectus Sheath Plane Block in Supra-umbilical Surgical Incisions; Randomized Controlled Double-Blinded Clinical Trial. IJMA 2024 June; 6 [6]: 4536-4543. doi: 10.21608/IJMA.2024.285088.1960.

ABSTRACT

Background: Surgical repair for supraumbilical hernias is a common surgical procedure that is often associated with significant post-operative pain. Some regional blocks have been described to alleviate pain after such procedures, including the "rectus sheath block"[RSB] and "external oblique intercostal plane block" [EOIPB].

Aim of the work: To compare the analgesic effects of RSB and EOIPB in patients undergoing procedures through upper midline laparotomies.

Patients and Methods: This prospective randomized trial included 75 patients who were assigned into three groups: RSB group where the local anesthetic mixture [5 ml lidocaine 2%, 10 ml bupivacaine 0.25%, and 5 ml normal saline] was injected into the plane deep to the posterolateral muscle aspect, EOIPB group the same anesthetic mixture was delivered deep to the EOM and superficial to the ribs and intercostal musculature, and control group with no block

Results: Preoperative parameters and operative time comparable in three groups of study. VAS during rest in both blocks were significantly lower compared to control group at all time points. The two block groups had comparable pain scores at the initial two readings. VAS during cough [or movement] showed similar findings. The patients requiring rescue opioid analgesia was lower in two block groups. The duration to the first rescue analgesia was in favor of the two block groups. The 24-hour morphine consumption had the lowest value in the EOIPB group, followed by the RSB group, the control group had the highest consumption.

Conclusion: EOIPB is associated with better postoperative analgesia compared to the RSB. It is recommended that the former block be performed in such cases to enhance postoperative outcomes.

Keywords: Supraumbilical Hernias; Pain; Regional Blocks; External Oblique; Intercostal; Rectus Sheath.

INTRODUCTION

Patients undergoing open surgical repair of "anterior abdominal wall hernias" or "complex abdominal wall reconstruction" often report moderate to severe postoperative pain [1]. If inadequately managed, the patient may develop lower lung atelectasis, hemodynamic abnormalities, delayed immobilization, poor satisfaction, and insufficient cooperation during postoperative physiotherapy [2]. The previously mentioned drawbacks of inadequate pain management are associated with increased patient morbidity. Hence, it is crucial to manage postoperative pain after such incisions to avoid these dreadful consequences [3, 4].

Epidural analgesia was the best traditional approach in such cases as it provides analgesia for both visceral and parietal elements of pain. Nonetheless, besides its invasiveness, it has other serious drawbacks, including hypotension, motor block, shivering, pruritus, nausea, and vomiting [4, 5]. Therefore, multiple regional block techniques have been introduced into the perioperative practice to improve postoperative analgesia with a safer profile compared to epidural analgesia [6].

The parietal component of pain is the major source of patient distress after hernial repair procedures [7]. The central portion of the anterior abdominal wall received its nerve supply from the ventral T7 – T12 spinal nerve roots [8]. Therefore, some regional blocks could be beneficial in incisions located in that region, including the "rectus sheath block" [RSB] [9] and "external oblique intercostal plane block" [EOIPB] [10].

RSB was initially described in 1899, and its analgesic efficacy has been reported in patients undergoing midline abdominal procedures like periumbilical procedures and laparotomies [9]. That block was traditionally described to provide analgesia for T9 – T11 dermatomes that could reach T6 when the anesthetic mixture is injected at higher levels, making it a suitable analgesic regimen for any midline laparotomy, whatever its level [11].

EOIPB is a recently described facial plane block that provides analgesia by blocking both lateral and anterior intercostal nerve branches [12]. It provides a block of the T7 – T11 dermatomes in the anterolateral abdominal plane [10]. Its efficacy has been proven in multiple abdominal procedures [12, 13]. It has some advantages over other fascial blocks, like the "erector spinae block," as it can be performed in the supine position and does not need changes in patient posture during the surgical procedure [10].

The international and Egyptian literature does not contain studies comparing the previous two block techniques in patients undergoing procedures through upper midline laparotomies. That was a good motive for us to conduct the present study, which aims to compare the analgesic effects of RSB and EOIPB in such patients.

PATIENTS AND METHODS

Our prospective randomized trial was conducted at Al-Azhar University Hospital, New Damietta [Anaesthesiology and Pain Management Department in collaboration with the General Surgery Department]. This study included adult patients diagnosed with an uncomplicated primary supraumbilical hernia and scheduled for elective hernioplasty. Patients meeting the previous criteria were clinically, radiologically, and biochemically assessed prior to admission. Their physical status was classified according to the "American Society of Anaesthesiologists" [ASA] classification [14]. We excluded patients whose ASA class was III or higher. We also excluded patients with infraumbilical hernia, complicated hernial defects [strangulated, incarcerated, or obstructed cases], recurrent hernias, or who had a history of allergy to the local anesthetic agents used in the study.

Seventy-five patients were found eligible for our study. Their agreement to participate in our research was documented in a written consent explaining the surgical procedure, block technique, and possible complications of each. Using "computer-generated randomization," the study patients were divided into three groups according to the block procedure planned to be performed, the EOIPB and RSB groups, in addition to the control group that received no block.

The patients were admitted to the surgical ward the night before surgery, where thrombo-prophylaxis was done for risky patients. On the day of surgery, all patients received IV paracetamol [1 gm] and IM tenoxicam [20 mg] two hours prior to the operation as a part of our pre-emptive analgesia protocol. In the surgical theatre, basic hemodynamic parameters were assessed for all cases, and the procedures were performed under general anesthesia that was induced, maintained, and reversed, as previously published in multiple researches published by the authors of this article [15, 16]. The vital signs and oxygen saturation were closely monitored in all patients throughout the

surgical procedure. All hernial defects were repaired through a transverse supraumbilical incision, and no bowel or omental resections were done in any patient. After the closure of the hernial defect, an onlay polyproline mesh was placed over the defect in all cases.

After the closure of the skin incision and prior to the reversal of the general anesthesia, the block procedures were performed according to the group allocation. We used a high-frequency transducer of a portable ultrasound device that is available in the operative theatre to perform both blocks [Siemens, Los Angeles, California, USA]. The procedures were performed under aseptic conditions.

In the RSB group, the transducer was placed in a horizontal position in the midline parallel to the surgical incision [usually within T7 – T11 dermatomes]. The linea alba was identified. Then, the probe was moved laterally to identify the rectus abdominis muscle with the underlying posterior sheath. A sonovisible needle was inserted under vision until it reached the plane deep to the posterolateral muscle aspect [just superficial to the posterior sheath]. Duplex guidance [available in the same device] was also used to avoid puncture injury to the epigastric vessels inside the rectus sheath. A local anesthetic mixture [5 ml lidocaine 2%, 10 ml bupivacaine 0.25%, and 5 ml normal saline] was injected into that plane, and we noticed hydro dissection of the plane with subsequent elevation of the rectus muscle away from the posterior sheath. The procedure was repeated on the other side.

In the EOIPB group, the same probe was placed vertically over the patient's chest at the level of the 6th or 7th ribs in the area between the midclavicular and anterior axillary lines. The external oblique muscle [EOM] with the underlying ribs and intercostal muscles were identified. If there was a debate regarding the EOM identification, the probe was moved caudally to the subcostal level to identify the three anterior abdominal wall muscles, then moved cranially again after confirming the correct muscle. The same anesthetic mixture was delivered deep to the EOM and superficial to the ribs and intercostal musculature. The procedure was repeated on the other side.

Postoperatively, the "visual analogue scale" [VAS] was used to assess postoperative pain [17], and it was assessed at a three-hour interval during the early 12 hours after the procedure, then at 18 and 24 hours. It was recorded during rest and cough [or movement]. Postoperative analgesia was achieved by IV ibuprofen infusion [800 mg/ 8 hours] and IV acetaminophen [1 gm/ 8 hours]. IV morphine [2 - 3 mg increment] was administered for break-through pain [18], and that dose was repeated every five minutes until desirable [VAS $\leq$ 3] or undesirable events [respiratory depression] occurred. The duration till the first morphine dose was recorded and the total 24-hour morphine consumption was also recorded for every patient.

All patients were discharged home after 24 hours, and the incidence of adverse events, like nausea, vomiting and block-related complications, was recorded. Both patients and data collectors were unaware of group allocation, making our study double-blinded in nature.

Study outcomes: We considered the 24-hour IV morphine consumption as our Primary outcome. Secondary outcomes included pain score changes during rest and movement, the duration elapsed till the first rescue analgesic, and the incidence of adverse events.

Sample size estimation: We estimated the required sample size using the SPSS Sample Power version 3.0.1. Kartalov and his colleagues published a study evaluating the efficacy of RSB in patients undergoing umbilical hernia repair. These authors found that 24-hour postoperative morphine consumption was 3.73 ± 1.41 mg in the RSB group and 8.76 ± 2.41 mg in the control group [19]. The difference between the two groups was taken to calculate the sample size, which was estimated to be 25 patients in each group to achieve an 80% study power and a 95% significance level.

Statistical analysis: The SPSS software was used to analyse our data. In order to compare the three study groups, we used either of the following three tests: the ANOVA to compare means, the Chi-square test to compare frequencies, or the Kruskal–Wallis test to compare medians. Moreover, post hoc was performed to reveal the statistical differences between any two groups [p1 for the EOIPB and RSB groups, P2 for EOIPB and controls, and P3 for RSB and controls]. Any obtained p-value was considered statistically significant if its value was less than 0.05.

RESULTS

As illustrated in Table 1, the demographic patient criteria and ASA physical status did not express notable statistical differences between

the three groups. Additionally, the duration of the operation had a median value of 65 minutes in the two block groups, compared to 70 minutes in controls [p = 0.795].

During rest, both blocks induced lower pain scores compared to controls at all time points [p < 0.05]. Although the two block groups had comparable pain scores at the initial two readings, subsequent ones showed the superiority of the EOIPB [p < 0.05], and that superiority persisted till the end of the first postoperative day [Table 2]. Assessment of pain scores during cough [or movement] showed similar findings [Table 3].

Although all patients in the study were commenced on postoperative IV paracetamol and ibuprofen, all patients in the control group required rescue opioid analgesia. Contrarily, only 36% of patients in the EOIPB group expressed the same request, which was significantly lower than the RSB group [64%] [p = 0.001].

In patients who requested opioid analgesia, the duration to the first rescue analgesia was in favor of the two block groups. However, the EOIPB group had a longer duration compared to the other block despite the absence of statistical significance [p = 0.376]. Subsequently, the 24-hour morphine consumption had the lowest value in the EOIPB group, followed by the RSB group, whereas the control group had the highest consumption [Table 4].

No patients developed block-related adverse events in the two block groups [0% incidence rate for hematoma and infection]. Nausea and vomiting were encountered in 8%, 16%, and 28% in the three groups, respectively. Nonetheless, that difference was insignificant in the statistical analysis [Table 5].

Table [1]: Basic demographic data and operative time in the study groups

		EOIPB group [n = 25]	RSB group [n = 25]	Control group [n = 25]	P value
Age [years]		46.12 ± 8.81	44.56 ± 8.80	45.92 ± 8.84	0.794
Sex, n [%]	**Males**	20 [80%]	17 [68%]	19 [76%]	0.611
	Females	5 [20%]	8 [32%]	6 [24%]	
ASA class, n [%]	**I**	11 [44%]	9 [36%]	10 [40%]	0.846
	II	14 [56%]	16 [64%]	15 [60%]	
Duration of surgery [min.]		65 [45 – 85]	65 [45 – 90]	70 [50 – 85]	0.795

Table [2]: VAS changes during rest

	EOIPB group [n = 25]	RSB group [n = 25]	Control group [n = 25]	P value
0 hour	2 [1 – 3]	2 [1 – 3]	4 [3 – 6]	< 0.001*
				P1 = 0.996
				P2 < 0.001*
				P3 < 0.001*
Three hours	2 [1 – 3]	2 [1 – 4]	4 [3 – 6]	< 0.001*
				P1 = 0.990
				P2 < 0.001*
				P3 < 0.001*
Six hours	2 [1 – 3]	3 [1 – 4]	4 [3 – 6]	< 0.001*
				P1 = 0.035*
				P2 < 0.001*
				P3 < 0.001*
Nine hours	2 [1 – 4]	3 [2 – 5]	4 [3 – 7]	< 0.001*
				P1 = 0.023*
				P2 < 0.001*
				P3 < 0.001*
12 hours	2 [2 - 4]	3 [2 – 5]	5 [4 – 7]	< 0.001*
				P1 = 0.012*
				P2 < 0.001*
				P3 < 0.001*
18 hours	3 [2 – 4]	4 [3 – 5]	5 [4 – 7]	< 0.001*
				P1 = 0.002*
				P2 < 0.001*
				P3 < 0.001*
24 hours	3 [2 – 4]	4 [3 – 5]	6 [4 – 7]	< 0.001*
				P1 = 0.004*
				P2 < 0.001*
				P3 < 0.001*

Table [3]: VAS changes during cough or movement

	EOIPB group [n = 25]	RSB group [n = 25]	Control group [n = 25]	P value
0 hour	3 [2 – 4]	3 [2 – 5]	5 [4 – 7]	< 0.001*
				P1 = 0.999
				P2 < 0.001*
				P3 < 0.001*
Three hours	3 [2 – 4]	3 [2 – 5]	5 [4 – 7]	< 0.001*
				P1 = 0.994
				P2 < 0.001*
				P3 < 0.001*
Six hours	3 [2 – 5]	4 [2 – 5]	5 [4 – 7]	< 0.001*
				P1 = 0.033*
				P2 < 0.001*
				P3 < 0.001*
Nine hours	4 [2 – 5]	4 [3 – 6]	5 [4 – 8]	< 0.001*
				P1 = 0.038*
				P2 < 0.001*
				P3 < 0.001*
12 hours	4 [3 – 5]	4 [3 – 6]	6 [5 – 8]	< 0.001*
				P1 = 0.018*
				P2 < 0.001*
				P3 < 0.001*
18 hours	4 [3 – 5]	5 [4 – 6]	6 [5 – 8]	< 0.001*
				P1 = 0.003*
				P2 < 0.001*
				P3 < 0.001*
24 hours	4 [3 – 6]	5 [4 – 6]	7 [5 – 8]	< 0.001*
				P1 = 0.011*
				P2 < 0.001*
				P3 < 0.001*

Table [4]: Postoperative analgesic request and 24-hour morphine consumption

	EOIPB group [n = 25]	RSB group [n = 25]	Control group [n = 25]	P value
Cases required analgesic	9 [36%]	16 [64%]	25 [100%]	< 0.001*
				P1 = 0.001*
				P2 < 0.001*
				P3 < 0.001*
First analgesic request [hour]	18 [9 – 24]	12 [3 – 24]	0 [0 – 12]	< 0.001*
				P1 = 0.376
				P2 < 0.001*
				P3 < 0.001*
24-hour morphine consumption [mg]	3 [3 – 6]	6 [3 – 12]	12 [6 – 12]	< 0.001*
				P1= 0.002*
				P2 < 0.001*
				P3 = 0.003*

Table [5]: Incidence of adverse events

	EOIPB group [n = 25]	RSB group [n = 25]	Control group [n = 25]	P value
Nausea and vomiting	2 [8 %]	4 [16 %]	7 [28 %]	0.171
Hematoma	0 [0%]	0 [0%]	--	--
Puncture site infection	0 [0%]	0 [0%]	--	--

DISCUSSION

In the present trial that compared EOIPB with RSB in patients diagnosed with supraumbilical hernias and scheduled for open hernioplasty, pre-operative parameters and operative time expressed no notable statistical differences among the three groups. VAS during rest in both blocks were significantly lower compared to control group at all time points. The two block groups had comparable pain scores at the initial two readings, subsequent ones showed the superiority of the EOIPB, and that superiority persisted till the end of the first postoperative day. VAS during cough [or movement] showed similar findings. The patients requiring rescue opioid analgesia was lower in two block groups. The duration to the first rescue analgesia was in favor of the two block groups. The 24-hour morphine consumption had the lowest value in the EOIPB group, followed by the RSB group, the control group had the highest consumption.

We should highlight that we strongly believe in the concept of "pre-emptive analgesia" as we administered preoperative acetaminophen and tenoxicam for all of the included cases two hours before the study, as the prevention of both central and peripheral sensitization should have its beneficial positive impact on postoperative analgesic outcomes, as stated by previous reports [20-22].

However, we installed both blocks after the surgical procedure, and we have a reasonable explanation for that action. In patients with supra-umbilical hernial defects, omentum or bowel loops could be herniating through the defect in the linea alba or rectus sheath. That may pose a potential risk for its injury or rupture during installation of the RSB, especially since we are anaesthesiologists, after all, not experienced radiologists. Although we are experienced in ultrasound-guided regional blocks [15, 16, 23], that experience is mainly in patients with normal ultrasonographic anatomy. That is why we preferred patient safety and installed the block procedures after the restoration of the normal anatomy. Although the EOIPB is far away from that disturbed anatomical region, we installed it after the operation in order not to jeopardize our results, and one should consider that concept an advantage of the EOIPB over the RSB in patients with midline anatomical defects.

We should also highlight that we commenced all patients on regular IV paracetamol and ibuprofen during their admission, even in the two block groups. That is because we believe in the concept of "multimodal analgesia," which is proven to have an opioid-sparing effect [24, 25]. That was evident in the two block groups, as not all patients requested rescue opioid analgesia, as encountered in the control group.

Starting with the RSB, one could see that it yielded a better analgesic profile compared to the control group, and that was evident in post-operative pain scores, opioid requirements, and first-rescue analgesia. **Kumar *et al.*** [26] also found that RSB is effective in maintaining post-operative analgesia in Pediatric patients undergoing supraumbilical pylomyotomy. The time to the first rescue analgesic ranged between 2.9 and 7.9 hours [median = 4.7 hours], and the required paracetamol doses ranged between one and three during the first 24 hours after the operation.

Additionally, **Kartalov *et al.*** [19] investigated the same block in adult patients undergoing umbilical hernia repair, and they found that postoperative pain scores were significantly lower in the RSB group compared to controls throughout the early postoperative 24 hours. Moreover, the 24-hour morphine requirement decreased significantly in the RSB group [3.73 vs. 8.76 mg in controls – p = 0.0007]. The opioid-sparing effect of the RSB was also confirmed in a previous meta-analysis that included ten trials evaluating the efficacy of that block in pediatrics undergoing umbilical procedures [27].

When it comes to the EOIPB, our results showed that it yielded better analgesia compared to the control group [less pain, less opioid intake, and a more prolonged period to the first rescue analgesia]. Other previous studies confirmed the same perspective in other abdominal procedures.

Korkusuz *et al.* [28] studied the analgesic efficacy of bilateral EOIPB in laparoscopic cholecystectomy patients. Patients who received the block had lower pain scores during rest and motion during the initial 24 hours after the operation compared to controls. In addition, there was a significant reduction in 24-hour tramadol consumption in the block group, resulting in a better recovery profile.

Petiz *et al.* [29] reported the analgesic efficacy of EOIPB in five individuals undergoing nephrectomy for kidney donation. The authors reported that the five individuals had a median pain score of three by the end of the surgical procedure and that pain was mainly attributed to the visceral

rather than the parietal element. The authors reported that the EOIPB could be used as an alternative to the epidural block in such cases. **White and Ji** [10], in their case series, confirmed the analgesic efficacy of the same block in obese patients undergoing upper abdominal surgeries [one patient had distal pancreatectomy, while the other had laparoscopic cholecystectomy].

Our findings revealed that EOIPB had some analgesic superiority over the RSB. That could be explained by the fact that the former provides analgesia to the anterior and lateral abdominal walls, as stated by **Elsharkawy *et al.*** [12]. The previous authors explained the action of that block by staining both anterior and lateral intercostal nerve branches [T7 – T10] in their cadaveric research.

That is a reasonable explanation for our finding, as all patients were operated on through a transverse rather than a longitudinal incision. Some incisions or the underlying dissection planes may have extended beyond the lateral border of the rectus sheath, which necessitated the block of the lateral branches along with the anterior branches, which are covered only by the RSB.

The same concept was also confirmed by **Yörükoğlu *et al.*** [30], who found that the "transversus abdominis plane block" is superior to the RSB in ladies undergoing cesarean delivery [through a transverse Pfannenstiel incision]. The authors even reported that the RSB provided inadequate analgesia for such procedures. That is why some authors recommended the RSB for midline laparotomy incisions rather than other abdominal incisions [9, 31].

We noted that the control group had a higher incidence of nausea and vomiting compared to the block groups. That could be explained by two facts: either as a reflex to more pain severity or secondary to increased opioid consumption [32]. However, the incidence of that complication in the three groups lies within the reported range in the literature which is estimated to occur in up to 50% after general anesthesia and surgery [33].

We did not encounter any block-related adverse events in our study. The absence of infectious complications could be explained by the aseptic precautions taken during block installation, while absent hematomas could be explained by the use of duplex signals to avoid vascular puncture.

Our trial handled a unique pain management topic. Nonetheless, it has some limitations. We enrolled a relatively small patient sample, which was gathered from a single educational institution. Moreover, we should have followed the patients for some period to evaluate if the blocks had any impact on the incidence of post-hernioplasty chronic pain. The upcoming studies should address the previous limitations.

Conclusion: Although RSB and EOIPB expressed significantly a better analgesic profile in patients undergoing supraumbilical hernia repair compared to controls, the latter block had significant advantages over the former, as it yielded better pain scores, less opioid request, and more prolonged duration to the first rescue analgesia.

Conflicts of interest: Nil.

Funding sources: This research was self-funded and did not receive any specific grants.

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IJMA

International Journal of Medical Arts

VOLUME 6, ISSUE 6, JUNE 2024

P- ISSN: 2636-4174
E- ISSN: 2682-3780