

Original Research Article

A PROSPECTIVE STUDY TO ASSESS THE EFFECT OF PERIPHERAL NERVE BLOCK TECHNIQUE VERSUS INTRAVENOUS ANALGESIA FOR POSTOPERATIVE PAIN MANAGEMENT FOR LAPAROTOMY INCISIONS

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ABSTRACT

Background: Effective postoperative analgesia after laparotomy is essential for patient comfort and recovery. This study compared peripheral nerve block catheter techniques with intravenous analgesia for postoperative pain management following laparotomy incisions.

Materials and Methods: A prospective randomized controlled study included 80 adult patients undergoing major abdominal surgery through midline or subcostal incisions. Patients were allocated equally to a catheter group receiving rectus sheath or medial open transversus abdominis plane catheter analgesia with 0.25% bupivacaine and an I.V. group receiving tramadol. Postoperative pain, rescue analgesic requirement, nausea and vomiting, paralytic ileus, and tachycardia were assessed.

Results: Baseline demographic and clinical characteristics were comparable between groups. Rescue analgesia was required significantly less frequently in the catheter group than in the I.V. group (35.0% vs. 72.5%; $p=0.0008$). For midline incisions, the requirement was 38.7% versus 77.1%, respectively ($p=0.0015$). Overall PONV was comparable (25.0% vs. 32.5%; $p=0.458$). Overall paralytic ileus was also similar (72.5% vs. 75.0%; $p=0.784$); however, ileus persisting beyond 24 hours after midline incision was significantly lower with catheter analgesia (12.9% vs. 60.0%; $p=0.0001$). Tachycardia did not differ significantly (30.0% vs. 47.5%; $p=0.203$).

Conclusion: Peripheral nerve block catheter analgesia reduced rescue analgesic requirements and prolonged postoperative ileus compared with intravenous analgesia, supporting its use for postoperative pain management after laparotomy.

Keywords: Laparotomy; postoperative pain; peripheral nerve block; rectus sheath catheter; transversus abdominis plane block; intravenous analgesia.

INTRODUCTION

Postoperative pain remains an important clinical concern after major abdominal surgery, with inadequate analgesia potentially impairing functional recovery and contributing to adverse postoperative outcomes. Contemporary perioperative pain management therefore emphasizes multimodal strategies that combine systemic and regional analgesic techniques while limiting unnecessary opioid exposure.^[1,2]

Laparotomy is associated with substantial abdominal wall pain because of disruption of the musculo-fascial layers and sensory nerves supplying the incision. Regional analgesic techniques targeting the abdominal wall have consequently gained increasing attention as alternatives or adjuncts to systemic analgesia. Among these, transversus abdominis plane (TAP) and rectus sheath blocks provide analgesia by delivering local anaesthetic within defined fascial planes and can be incorporated into multimodal postoperative analgesic protocols.^[2,3]

Evidence suggests that fascial plane techniques can reduce postoperative opioid requirements following abdominal surgery. A network meta-analysis of 67 randomized trials involving 4410 patients undergoing midline laparotomy found that continuous TAP and continuous rectus sheath blocks were among the most effective non-neuraxial techniques for reducing postoperative opioid consumption and resting pain scores.^[3] More recent evidence also supports the analgesic and opioid-sparing effects of TAP block across abdominal surgical procedures.^[4]

The rectus sheath block has demonstrated reductions in early postoperative pain and 24-hour intravenous morphine-equivalent consumption in a systematic review of randomized controlled trials, although the magnitude of benefit may vary according to surgical procedure and block technique.^[5,6] This variability, together with the need for sustained analgesia after large abdominal incisions, supports further evaluation of catheter-based regional techniques.

The present study was therefore undertaken to compare peripheral nerve block catheter analgesia, using rectus sheath and medial open transversus abdominis plane catheter techniques, with intravenous tramadol analgesia for postoperative pain management following laparotomy incisions. The study also evaluated rescue analgesic requirements and selected postoperative adverse outcomes, including nausea and vomiting, paralytic ileus, and tachycardia.

MATERIALS AND METHODS

Study Design and Setting: A prospective randomized controlled study was conducted in the Departments of General Surgery at GMERS Medical College, Dharpur-Patan, and PDU Medical College, Rajkot. The study population comprised patients admitted to the Department of General Surgery at GMERS Medical College, Dharpur-Patan, who were scheduled to undergo elective or emergency general surgical procedures. Patients undergoing class I (clean) and class II (clean-contaminated) major abdominal surgeries performed through unilateral or bilateral subcostal or midline incisions were considered for enrolment.

Prior approval for conducting the study was obtained from the Scientific and Ethical Review Committee of the Department of General Surgery, GMERS Medical College, Dharpur-Patan, 2021. All operative procedures were performed by consultant surgeons from the Department of General Surgery.

Study Population: A total of 80 patients were enrolled during the study period. Participants were allocated equally into two study groups, with 40 patients in each group. The catheter group consisted of 31 patients managed with a rectus sheath (RS) catheter and 9 patients managed with a medial open transversus abdominis plane (MOTAP) catheter. The intravenous (IV) group comprised 40 patients who

received intravenous tramadol for postoperative analgesia.

Eligibility Criteria: Patients aged >18 years undergoing major abdominal class I or class II elective or emergency surgery through a unilateral or bilateral subcostal or midline incision were eligible for inclusion.

Patients were excluded if they were unable to provide informed consent or comply with postoperative pain assessment, could not be extubated following surgery, had concomitant epidural anaesthesia, suffered from a chronic pain disorder, had a pre-existing abdominal wall infection, or underwent laparoscopic surgery.

Randomization and Group Allocation: Eligible patients were allocated to one of two treatment groups using a closed-envelope randomization technique:

- Group 1 – Catheter group: postoperative regional analgesia using either a rectus sheath catheter or a MOTAP catheter.
- Group 2 – Intravenous analgesia group: postoperative intravenous tramadol analgesia.

An equal number of patients were included in each treatment group.

Preoperative Assessment: Baseline demographic and clinical information was recorded using a structured proforma. A detailed history and clinical examination were performed for each participant, followed by routine preoperative investigations.

Materials Used for Regional Analgesia: The materials required for catheter placement included a standard three-orifice epidural catheter (16 FG), a 16-FG Tuohy needle measuring 100–150 mm, a 10-mL syringe, a long artery forceps, a stab knife, normal saline, and 0.25% bupivacaine.

Rectus Sheath Catheter: Following completion of the surgical procedure and before closure of the fascial layer, the peritoneum was incised approximately 5 cm lateral to the fascial margin, just above the arcuate line, to gain access posterior to the rectus abdominis muscle. A potential plane was developed between the posterior rectus sheath and the rectus muscle by advancing a long artery forceps towards the costal margin. Normal saline was then instilled to delineate the plane.

The peritoneal cavity was re-entered approximately 5 cm lateral to the midline near the costal margin. The distal portion of a 16-FG, multi-orifice epidural catheter was grasped with the forceps and drawn through the newly created tunnel. The distal end of the tunnel was subsequently closed using polyglactin or polypropylene sutures. The proximal end of the catheter was then brought retrogradely through a Tuohy needle introduced through the skin and rectus muscle into the peritoneal cavity, with the needle positioned close to the proximal end of the sub-rectal tunnel. The catheter was secured to the skin using Steri-Strips.

Medial Open Transversus Abdominis Plane (MOTAP) Catheter: For placement of the MOTAP catheter, a Tuohy needle was introduced 1–2 cm in a

medial-to-lateral direction into the anatomical plane between the internal oblique and transversus abdominis muscles before closure of the fascial layers. Following removal of the stylet, 10 mL of normal saline was injected to establish and delineate the plane. A 16-FG multi-orifice epidural catheter was then advanced through the Tuohy needle into the transversus abdominis plane in the direction of the iliac crest until resistance was encountered. The Tuohy needle was withdrawn without displacing the catheter. It was subsequently reintroduced through the skin superior to the incision and advanced to exit through the rectus muscle internally. The proximal end of the catheter was passed retrogradely and secured to the skin.

The MOTAP catheter was defined as a surgically positioned catheter placed between the transversus abdominis and internal oblique muscles in the subcostal region, parallel to the incision and extending obliquely towards the anterior superior iliac spine. A rectus sheath catheter was defined as a surgically placed catheter positioned between the rectus abdominis muscle and posterior rectus sheath, running parallel to a midline incision.

Postoperative Analgesic Protocol: Patients assigned to the catheter group received 0.25% bupivacaine through the indwelling catheter. A dose of 20 mL was administered as a bolus every 8 hours, with the dose adjusted according to body weight when required, up to a maximum of 2 mg/kg. The initial dose was administered immediately after extubation and treatment was continued for up to 48 hours or until two consecutive visual analogue scale (VAS) pain scores were <4, whichever occurred earlier.

Before administration of the first dose, aspiration was performed to exclude blood return. In the absence of blood aspiration, 5 mL of 0.25% bupivacaine was administered slowly over 2–3 minutes, followed by a 5-minute observation period. Patients were monitored for manifestations suggestive of local anaesthetic toxicity, including diplopia, tinnitus, perioral numbness, metallic taste, limb twitching, and confusion. If none of these symptoms occurred, the remaining calculated dose was administered slowly. Patients allocated to the intravenous analgesia group received tramadol at a dose of 2 mg/kg every 12 hours.

In the event of inadequate analgesia or regional block failure, additional rescue analgesia was provided using an intravenous non-steroidal anti-inflammatory drug, specifically intramuscular diclofenac sodium as documented in the study protocol.

The catheter was generally removed after 48 hours (postoperative day 3) or earlier if two consecutive VAS scores were <4.

Postoperative Assessment and Outcome Measures: Patients were prospectively monitored for postoperative pain and analgesia-related outcomes. Pain intensity was assessed using the visual analogue scale. VAS scores were recorded every 2 hours during the first 8 postoperative hours and subsequently every 8 hours for the next 48 hours. The

requirement for rescue analgesia was also documented.

The secondary postoperative parameters monitored included paralytic ileus, nausea and vomiting, tachycardia, hypotension, and respiratory depression. Patients in the catheter group were additionally assessed for catheter-related complications, including catheter-site infection, catheter-site haematoma, accidental catheter dislodgement, catheter blockage, and retention of the catheter during removal.

For the purposes of the study, paralytic ileus was defined as absence of bowel sounds during the first 8 postoperative hours. Tachycardia was defined as a postoperative pulse rate >100 beats/min. Block failure was considered when persistent pain was present despite administration of the prescribed catheter-based analgesic.

Sample Size: The study was time-bound, and 80 eligible patients were enrolled. Forty patients were included in the catheter group, comprising 31 patients with rectus sheath catheters and 9 patients with MOTAP catheters, while 40 patients were included in the intravenous analgesia group.

Statistical Analysis: The collected data were summarized using tabular and diagrammatic presentations. Associations between categorical variables in the catheter and intravenous analgesia groups were assessed using the chi-square test. A p-value <0.05 was considered statistically significant. Statistical analysis was performed using MedCalc software (MedCalc Software, Windows version; 1993–2013).

RESULTS

A total of 80 patients were included, with 40 patients in each group. Baseline demographic and clinical characteristics were comparable between the catheter and I.V. groups. The mean age was 42.15 and 41.17 years, respectively. Most patients were male, and class II surgeries and midline incisions predominated in both groups. None of the baseline differences between the groups was statistically significant [Table 1].

The requirement for rescue analgesia was significantly lower in the catheter group than in the I.V. group (35.0% vs. 72.5%; $\chi^2=11.314$, $p=0.0008$). Among patients with midline incisions, rescue analgesia was required in 38.7% and 77.1% of patients, respectively ($\chi^2=10.045$, $p=0.0015$). No significant difference was observed among patients with subcostal incisions [Table 2].

PONV occurred in 25.0% of patients in the catheter group and 32.5% in the I.V. group, with no statistically significant difference ($p=0.458$). Similar non-significant differences were observed following both midline and subcostal incisions [Table 3].

Overall, postoperative paralytic ileus occurred in 72.5% of patients in the catheter group and 75.0% in the I.V. group ($p=0.784$). However, among patients with midline incisions, ileus persisting beyond 24 hours was significantly less frequent in the catheter

group than in the I.V. group (12.9% vs. 60.0%; $\chi^2=15.496$, $p=0.0001$) [Table 4].

Postoperative tachycardia was observed in 30.0% of patients in the catheter group compared with 47.5% in the I.V. group; however, the difference was not statistically significant ($\chi^2=1.621$, $p=0.203$) [Table 5].

The key statistically significant outcomes are summarized in Table 6, with catheter-based analgesia showing lower requirements for rescue analgesia and a lower incidence of prolonged ileus following midline incision.

Table 1: Baseline demographic and clinical characteristics

Characteristic	Catheter group (n=40)	I.V group (n=40)	χ^2	p-value
Age <40 years	19 (47.5%)	23 (57.5%)	0.802	0.370
Age >40 years	21 (52.5%)	17 (42.5%)		
Mean age (years)	42.15	41.17	—	—
Male	31 (77.5%)	28 (70.0%)	0.581	0.445
Female	9 (22.5%)	12 (30.0%)		
Class I surgery	6 (15.0%)	8 (20.0%)	0.346	0.556
Class II surgery	34 (85.0%)	32 (80.0%)		
Midline incision	31 (77.5%)	35 (87.5%)	1.385	0.239
Subcostal incision	9 (22.5%)	5 (12.5%)		

Table 2: Requirement of rescue analgesia

Subgroup	Catheter group	I.V group	χ^2	p-value
Overall	14/40 (35.0%)	29/40 (72.5%)	11.314	0.0008
Midline incision	12/31 (38.7%)	27/35 (77.1%)	10.045	0.0015
Subcostal incision	2/9 (22.2%)	2/6 (33.3%)	0.000	1.000
12–24 h post-op	1/40 (2.5%)	3/40 (7.5%)	—	—

Table 3: Postoperative nausea and vomiting (PONV)

Subgroup	Catheter group	I.V group	χ^2	p-value
Overall	10/40 (25.0%)	13/40 (32.5%)	0.549	0.458
Midline incision	7/31 (22.6%)	10/34 (29.4%)	0.604	0.436
Subcostal incision	3/9 (33.4%)	3/6 (50.0%)	0.012	0.914

Table 4: Postoperative paralytic ileus

Subgroup	Catheter group	I.V group	χ^2	p-value
Overall	29/40 (72.5%)	30/40 (75.0%)	0.075	0.784
Midline, >8 h	26/31 (83.9%)	28/35 (80.0%)	0.000	1.000
Midline, >24 h	4/31 (12.9%)	21/35 (60.0%)	15.496	0.0001
Subcostal, >8 h	3/9 (33.3%)	2/5 (40.0%)	—	—
Subcostal, >24 h	1/9 (11.1%)	1/5 (20.0%)	—	—

Table 5: Postoperative tachycardia

Outcome	Catheter group (n=40)	I.V group (n=40)	χ^2	p-value
Tachycardia present	12 (30.0%)	19 (47.5%)	1.621	0.203
Tachycardia absent	28 (70.0%)	21 (52.5%)		

Table 6: Summary of key significant findings

Outcome	Catheter group	I.V group	p-value	Direction
Rescue analgesia — overall	35.0%	72.5%	0.0008	Catheter favored
Rescue analgesia — midline	38.7%	77.1%	0.0015	Catheter favored
Paralytic ileus — midline, >24h	12.9%	60.0%	0.0001	Catheter favored

DISCUSSION

The present prospective randomized study demonstrated that catheter-based peripheral nerve block provided a significant analgesic advantage over intravenous tramadol following laparotomy. The most important finding was the substantially lower requirement for rescue analgesia in the catheter group (35.0% vs. 72.5%; $p=0.0008$), with a similar benefit among patients undergoing midline incision (38.7% vs. 77.1%; $p=0.0015$). This finding is consistent with recent evidence showing that regional fascial-plane techniques reduce postoperative analgesic and opioid requirements after abdominal surgery.^[7]

The benefit observed in the present study is also supported specifically by evidence concerning rectus sheath block. Studies have reported significantly lower early postoperative pain scores and reduced 24-hour intravenous morphine-equivalent consumption with rectus sheath block compared with standard analgesic care.^[5,8] The use of an indwelling catheter in the present study may have contributed to sustained abdominal wall analgesia because repeated bupivacaine administration allowed analgesic coverage to continue beyond the duration expected from a single injection. Recent clinical experience has similarly described rectus sheath catheters as an opioid-sparing technique used after laparotomy, with

repeated administration of bupivacaine to the surgical compartment.^[9]

An important secondary finding was the significantly lower incidence of paralytic ileus persisting beyond 24 hours among patients with midline incisions in the catheter group (12.9% vs. 60.0%; $p=0.0001$). Although overall ileus rates did not differ significantly between groups, the reduction in prolonged ileus is clinically relevant because postoperative ileus remains a frequent complication after abdominal surgery and can delay recovery. The observed finding may partly reflect reduced reliance on systemic analgesia, although the present study was not designed to establish a causal relationship between the analgesic technique and bowel recovery. The overall incidence of PONV was lower with catheter analgesia than with intravenous analgesia (25.0% vs. 32.5%), but the difference was not statistically significant. This finding should be interpreted cautiously because PONV is influenced by multiple perioperative factors, including anaesthetic exposure, patient characteristics and analgesic requirements. Recent evidence indicates that regional analgesic techniques can reduce opioid exposure, but reductions in opioid-related adverse effects are not necessarily uniform across different abdominal procedures and regional techniques.^[6,7,10] Postoperative tachycardia was also numerically less frequent in the catheter group (30.0% vs. 47.5%), although the difference was not statistically significant. Pain-related sympathetic activation could potentially contribute to postoperative tachycardia; however, the present data do not permit a direct attribution of this outcome to analgesic efficacy. The absence of significant differences in these secondary outcomes emphasizes that the principal demonstrated advantage of catheter analgesia in this study was its opioid/rescue-analgesic-sparing effect.

The results are particularly relevant for midline laparotomy, where rectus sheath analgesia directly targets the anterior abdominal wall. A 2024 randomized controlled trial evaluating rectus sheath block in patients undergoing transabdominal midline surgery reported improved postoperative recovery, supporting the clinical utility of this technique in comparable surgical settings.^[11] Similarly, a recent randomized trial comparing erector spinae plane and rectus sheath blocks in midline abdominal surgery confirms the continuing role of fascial-plane techniques in postoperative analgesia.^[12,13]

The present study has some limitations. The sample size was relatively small, and only a limited number of patients underwent subcostal incisions, restricting meaningful subgroup comparisons. In addition, the catheter group included two different techniques—rectus sheath and MOTAP catheters—so the independent efficacy of each technique could not be established. Nevertheless, the randomized design and comparable baseline characteristics strengthen the observed comparison between regional catheter-based and intravenous analgesia.

CONCLUSION

Peripheral nerve block using indwelling catheter techniques provided more effective postoperative analgesia following laparotomy incisions than intravenous analgesia, as demonstrated by the significantly lower requirement for rescue analgesia and reduced incidence of prolonged postoperative paralytic ileus. Although no significant differences were observed in postoperative nausea and vomiting or tachycardia, the overall findings support catheter-based regional analgesia as an effective approach for postoperative pain management in patients undergoing laparotomy.

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