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Comparison Of Rectus Sheath Catheter Versus Epidural Catheter For Post-Operative Pain Management In Midline Laparotomy Incisions

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Abstract
Introduction: *Rectus sheath catheters (RSCs) are increasingly being used to provide postoperative analgesia following midline laparotomy incision. They can be potentially better as they avoid the recognised complications associated with Epidural Analgesia (EA). This study compares these two methods of analgesia. Outcomes include average pain scores, time to mobilisation and length of stay.*
Methods: *This was a 14-month single centre observational study including all patients undergoing midline laparotomy incision for both benign and malignant disease. Patients received either EA or RSCs. Data were collected prospectively and analysed using chi square test or t-test.*
Result: *A total of 36 patients were identified and detailed indications for surgery, operation and complications were recorded. The Mean NRS pain score in RSC group gradually reduced over the period of time from 5.61 to 2.5 while the mean NRS pain score in TEA group reduced from 5.77 to 2.11.The mean time to for postoperative ambulation was 7 ± 1.18 hours and 8.28 ± 1.87 hours in RSC group and EA group respectively. Total 2 (11.1%) patients in RSC group and 4 (22.2%) patients in EA group required rescue analgesia after 12 h of laparotomy. Total 2 (11.1%) patients in RSC group and 5 (27.8%) patients in EA group experienced tachycardia following midline incision. There was no statistical difference in postoperative pain scores or length of stay among both the groups.*
Conclusion: *RSCs provide equivalent analgesia to EA and avoid the recognised potential complications of EA. They are associated with a shorter time to mobilisation.*
Keywords: *Analgesia, Epidural, Rectus sheath catheter, Laparotomy*

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I. Introduction

The World Health Organization and International Association for the Study of Pain have recognized pain relief as a human right. (1) Laparotomies which constitute a large proportion of general surgical operations necessitate a midline incisions and are commonly accompanied by postoperative pain which is derived mainly from abdominal wall incision in which significant wound pain persists for at least 72 h in contrast to minimal invasive surgeries where the pain is visceral and subsides within 24 h. (2, 3)

Recent surveys from USA and Europe indicate failure in establishment of significant improvement in Postoperative Pain with inadequate management. (4) Modern Surgery and Anesthetic practices are focused to facilitate rapid post-operative recovery of patients using better anesthesia, minimal invasive surgical techniques and analgesia. Enhanced recovery protocols (ERP) consisting of series of multimodality interventions which aims to expedite recovery after major surgery by reducing complications, morbidity and accelerating functional recovery, with a focus on early mobilization and early oral nutrition. (5) One of the key elements in all ERP is the provision of adequate post-operative analgesia by attenuating the stress response and providing adequate pain relief to allow mobilization, optimize respiratory function and sleep, and minimize factors that delay the return of normal gastrointestinal function. (6) Postoperative analgesia also reduces the incidence of chest infection and deep venous thrombosis. (7) Various analgesic techniques include pre-emptive analgesia, opioid analgesia, intravenous patient-controlled analgesia (IVPCA), epidural and spinal analgesia, non-opioid analgesia, local infiltration and peripheral nerve blocks through single injection techniques or USG guided/surgically placed catheters are employed for postoperative analgesia following laparotomy. (8) Opioid based analgesia are associated with adverse effects including sedation, hypotension, respiratory depression, motor block, nausea, vomiting, delirium,

and ileus which delays the recovery process. (9) Multimodal analgesics are gaining importance in field of anaesthesia as they focus on limiting the excessive use of systemic opioid analgesia, targeting different receptors along the pain pathway with the goal of improving analgesia and reducing individual class-related side effects. (10) MMA is based on targeting various pain receptors along the pain pathway using more than one pharmacological class of analgesic medication with the goal of improving analgesia while reducing individual class-related side effects. (10) Epidural analgesia (EA), paravertebral blocks, and systemic analgesics are different analgesic methods used to effectively manage Postoperative pain in Thoracotomy. EA is often regarded as to be the gold standard as EA provides better analgesia than conventional analgesia models in post thoracotomy pain thereby reduces postoperative morbidity and mortality providing optimal analgesia without respiratory insufficiency. (11) However EA itself is also associated with significant clinical complications such as hypotension, urinary retention and even pulmonary complications from respiratory muscle weakness which can subvert its great potential. Acute angulation of thoracic spines also adds to the difficulties in terms of identifying the epidural space at mid thoracic level (T5–T6) for posterolateral thoracotomies which is substantially responsible for higher failure rates. EA may also lead to certain rare complications like nerve injury, epidural haematoma and epidural abscess (12) an equipotential regional anaesthetic technique used in thoracotomy for effective management of post-operative pain is rectus sheath catheter. It employs lockage of ventral rami of the seventh to twelfth intercostal nerves supply to rectus abdominis muscle and overlying skin. (13) There still has been limited literature evidences that support the safety and efficacy of RSC technique. Hence the aim of this study was to evaluate the effectiveness of RSCs on postoperative pain relief, time to mobilisation, amount of drug required with its associated complications and length of stay compared with EA.

II. PATIENTS AND METHODS

The prospective randomized study was conducted on 36 patients posted for class 1(clean) and class 2 (clean contaminated) upper midline laparotomy surgeries between August, 2019 to November, 2020 in the clinical setting, Dept. of General Surgery, Medical College Baroda and Sir Sayajirao General Hospital Vadodara.

Ethical consent: An approval of the study was obtained from Scientific and Ethical Review Committee of Medical College and Sir Sayajirao General Hospital (**IECHR-PGR/52-19**). Every patient signed an informed written consent for acceptance of participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Exclusion criteria: Extensive surgery beyond midline incision (e.g. abdomino-perineal resection), refusal of the patients, coagulopathies, local infection at sites of catheters insertion, systemic sepsis, severe cardiac or respiratory disease, severe renal or hepatic impairment, allergy to drugs used in the study and known substance abuse.

All patients were pre-medicated with midazolam 0.07 to 0.08 mg/kg IM once, up to 1 hour before surgery. Thirty minutes before surgery IV ranitidine hydrochloride (Zantac) 50 mg (2 mL) in 0.9% sodium chloride diluted to 20 mL were given slowly over a duration of 5 min.

All the patients were randomly distributed in two groups each with 18 members by a closed envelope technique, Group 1 –Rectus Sheath Catheter (RSC) group and Group 2 – Epidural (EA) group.

Rectus Sheath Block

Two sets of standard three orifice epidural catheters, which have multiple perforations at the end of the tubing (Perifix 402 filter set, 16 FG epidural needle, B. Braun Melsungen AG. 34209 Melsungen, Germany) were needed for each patient in this group. Post surgery the catheter was placed under vision.

Touhy needle 16FG was inserted 2-4 cm lateral to the midline at an angle of 45 degrees to the skin, through the anterior abdominal wall until reaching the potential space between the posterior layer of the rectus sheath and rectus abdominus muscle. To gain entry in the rectus sheath posterior to the muscle an incision in the peritoneum just above the arcuate line approximately 5 cm lateral to the fascial edge was made. Long forceps were inserted between the posterior sheath and rectus muscle to create a plane towards the coastal margin normal saline was infiltrated to delineate the plane avoiding injury tosuperior epigastric vessels. The tip of the forceps was used to pierce the posterior sheath by 5 cm from midline as near the costal margin as possible to re-enter the peritoneal cavity. The tip of the epidural catheter (16 F Gauze) with multiple opening was held by the forceps and pulled inside the tunnel and the distal end of tunnel was closed with polyglactin 910/polypropylene sutures. While the other end (proximal) of the catheter is passed retrogradely through a Touhy needle inserted through the skin and rectus muscle to enter the peritoneal cavity as close to the proximal end of the sub-rectal tunnel as possible. The catheter was fixed to skin with steri-strips and 10 mL of 0.25% of Bupivacaine was injected in each catheter every 6 hours interval.

Epidural anesthesia

In this group EA was performed by the insertion of transthoracic epidural catheter before induction of general anesthesia under complete aseptic conditions with the patient in the sitting position and neck and upper back flexed.

At the level of appropriate thoracic inter-vertebral space, Tuohy needle of 18 G was inserted in midline, between the spinous processes. A sudden loss of sensation with a slight clicking sensation felt by operator was used as an indicator for the adequacy of entry of tip of needle in Epidural space through Ligamentum Flavum breach. A catheter was threaded through the needle up to 4-6 cm into epidural space and the needle was withdrawn followed by fixation of catheter with adhesive tape or dressing and 10 ml of 0.125% Bupivacaine was injected at an interval of every 6 hours into the epidural catheter, given before skin closure.

Bupivacaine was given for initial 48 hours irrespective of pain score in both the groups and after 48 hours it was continued till two consecutive NRS score noted below 3.

In cases of block failure (poor pain control) evidenced by NRS at rest >5 or dynamic >6, patient received additional rescue doses of intravenous NSAIDS in form of intravenous Diclofenac. Post-operative pain assessment was done at every 2 hours for initial 12 hrs and at every 6 hours thereafter till the catheter remains in situ. Static and Dynamic pain on NRS in both the groups was measured and patients from both groups were compared for final analysis. The catheters were removed after 48 hours when two consecutive NRS pain scores were less than 3 for dynamic pain.

Outcome measures: All the patients were observed for post-operative Numeric Rating Scale for pain, requirement of rescue analgesia, tachycardia, hypotension, catheter related complication e.g., catheter site infection, catheter site hematoma, accidental pull out of catheter, catheter blockage and retained catheter at the time of removal.

Statistical analysis: Analysis was carried out using Chi-square test or t test to determine association between various variables of RSC group and EA group.

III. Results:

Table 1 gives demographic details about the patient. In RSC group 09 patients were below 40 years of age and 09 patients were above 40 years of age while in the EA group 10 patients were below 40 years of age while 08 patients were above 40 years of age. Mean age in RSC group was 42.61 years & in EA group was 39.67 years. In RSC group 08 patients were male and 10 patients were female while in the EA group 07 patients were male and 11 patients were female. P value is not significant in both the cases which shows equal distribution of patients in both the groups.

Table 1: Demographic details of the patients

Sr No:	Parameter	RSC Group (%)	EA group (%)	P value
1	**Age**	09 (50)	10 (55.6)	0.73
	<40 years	09 (50)	08 (44.4)	
	>40 years			
2	**Gender**			
	Male	08 (44.4)	07 (38.9)	0.73
	Female	10 (55.6)	11 (61.1)	

In RSC group 2 patients were of clean surgery while all other (16) patients were of clean contaminated surgery. In EA group all the patients were of clean contaminated surgery.

Table 2 shows the distribution of patients depending upon the type of surgery performed in both the groups.

In RSC group gastric surgeries were performed in 4 patients while in EA group 04 patients has undergone gastric surgeries, intestinal resection anastomosis was performed in 5 patients in RSC group and 04 patients in EA group. Biliary surgeries were performed in 02 patients for both the groups. Feeding jejunostomy was performed in 03 patients for RSC group while 06 patients for EA group. P value is not significant, suggesting equal distribution of patients in both the groups regarding type of surgeries.

Table 2: Distribution of patients depending upon the type of surgery performed in both groups

Sr No.	Type of Surgery	RSC group (%)	EA group (%)	P value
1	Gastric surgeries	04 (22.22)	04 (22.22)	0.77
2	Intestinal Resection-Anastomosis	05 (27.78)	04 (22.22)	
3	Biliary surgeries	02 (11.11)	02 (11.11)	
4	Feeding Jejunostomy	03 (16.67)	06 (33.33)	
5	Other surgeries (Splenic/Pancreatic surgeries, etc.)	04 (22.22)	02 (11.11)	

Mean NRS pain score at rest in RSC group gradually reduced over the period of time from 5.61 to 2.5 without any sudden reduction. Mean NRS pain score at rest in EA group also gradually reduced over the period of time from 5.77 to 2.11 without any sudden reduction. However, Mean NRS score between the two groups at different post- operative time was statistically insignificant.

Mean Dynamic NRS pain score in RSC group, as seen at rest, gradually reduced over the period of time from 6.55 to 2.44 without any sudden reduction. Similarly, Mean Dynamic NRS pain score in EA group also gradually reduced over the period of time from 6.55 to 2.33 without any sudden reduction. However, Mean NRS score between the two groups at different post- operative time was statistically insignificant.

Table 3: Distribution of Patients according to Rating Scale (Pain Score)

Sr No.	Periodicity of measurement of NRS	RSC group Mean VAS pain score	EA group Mean VAS pain score	P Value
Mean Numerical Rating Scale				
1	At 06 h	5.61	5.77	0.99
2	At 12 h	5.66	5.61	
3	At 18 h	4.5	5.05	
4	At 24 h	3.72	3.83	
5	At 30 h	3.22	3.22	
6	At 36 h	2.94	2.88	
7	At 42 h	2.55	2.44	
8	At 48 h	2.5	2.11	
Mean Dynamic Numerical Rating Scale				
1	At 06 h	6.55	6.55	0.99
2	At 12 h	6.22	6.5	
3	At 18 h	5.44	5.72	
4	At 24 h	4.83	4.55	
5	At 30 h	3.77	4.05	
6	At 36 h	3.33	3.55	
7	At 42 h	3	3.05	
8	At 48 h	2.44	2.33	

Mean frequency of doses required via catheters for post-operative analgesia and rescue analgesia required in RSC group were 10.22 ± 1.47 and 1.72 ± 0.89 respectively while in EA group was 9.78 ± 0.8 and 2.0 ± 0.68. However, this difference was not statistically significant as p value is 0.13 which is not significant.

Table 4 gives details about the rescue analgesia required before and after 12 hours after surgery. In RSC group 17 patients required rescue analgesia within 12 hours of surgery while in EA group all the patients required rescue analgesia within 12 hours. After completion of 12 hours 02 patients required rescue analgesia in RSC group while in EA group 04 patients required rescue analgesia Even though, in present study, requirement of rescue analgesia was observed more in EA group than RSC group (4 as compared to 2), it could not achieve statistical significance.

Table 4: Distribution of Patients according to rescue analgesia required before and after 12 hours

Sr No.	Parameter	RSC Group (%)	EA Group (%)	P Value
1	Resue Analgesia required within 12 hours	17 (94.4)	18 (100)	0.99 (NS)
2	Resue Analgesia required after 12 hours	02 (11.1)	04 (22.2)	0.37 (NS)

According to table 5, Mean time required for patients to ambulate in RSC group was 7 ± 1.18 hours while in EA group 8.28 ± 1.87. This difference between the two groups regarding time to ambulate was statistically significant and time to ambulate post operatively was significantly less RSC group.

Table 5: Effect on ability to ambulate post operatively

Sr No.	Parameter	RSC Group (%)	EA Group (%)	P value
1	Mean time (hours) taken to ambulate	7 ± 1.18	8.28 ± 1.87	**0.009 (Significant)**
2	Maximum time (hours) taken to ambulate in a single case	9	14	
3	Minimum time (hours) taken to ambulate in a single case	5	6	

In RSC group 02 (11.1%) patients had only tachycardia as complication. Similarly, in EA group also, 02 (11.1%) of patients had isolated tachycardia as a complication whereas other 02 patients (11.1%) in EA group, had tachycardia along with hypotension as complication. 01 (5.5%) of patients in EA group had hypotension as an isolated complication.

Table 6: Distribution of Patients according to Complications observed in both the groups

Sr No.	Parameter	RSC Group (%)	EA Group (%)	P value
1	Complications Present	02 (11.1)	05 (27.8)	0.2
2	Complications Absent	16 (88.9)	13 (72.2)	
Type of Complications				
1	Tachycardia	02 (11.1)	02 (11.1)	NA
2	Hypotension	00	01 (5.5)	
3	Tachycardia with Hypotension	00	02 (11.1)	

Mean post-operative stay in days for RSC group was 8.5 days, whereas for EA group, it was 10.5 days. The difference, however, is statistically not significant. Maximum post-operative stay for a single case in RSC group was 14 days as compared to 18 days in EA group. Minimum stay for single case was 3 days and 5 days post-operatively for RSC and EA respectively.

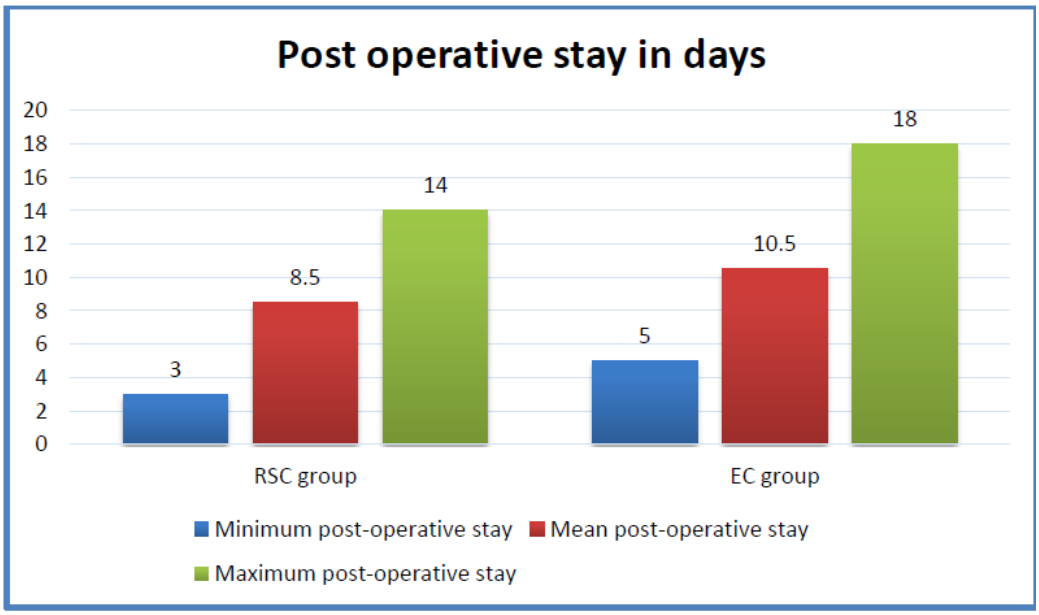

Figure `1: Mean post-operative stay represented in days

IV. Discussion

The effective relief of pain is of the utmost importance to anyone treating patients undergoing surgery. Moderate to severe acute pain left untreated regardless of the site results in high health care cost through, delayed hospital discharge, less patient satisfaction, delayed postoperative mobilization and enhancement of chronic postoperative pain. (14) Unpleasant sensory input and interactions between neurohormonal substances and complex physiologic mechanisms results in postoperative pain. Administration of parenteral opioids has always been challenging due to exacerbation of population's susceptibility to sleep apnea and respiratory depression. (15) Use of multimodal analgesic approach avoiding sedatives and giving preference to regional blocks has always been a general consensus for pain management. (16) Epidural analgesia has been established as a cornerstone in the perioperative care for management of post-operative pain management is confined to the dermatomal distribution of skin incision which is an advantage over other analgesic techniques hence it helps in avoiding opioid associated adverse effects including respiratory depression, heamodynamic instability, ineffective cough and secretion clearance (17). EA also minimizes post-operative pain and helps in early patient mobilization and reduced incidence of deep vein thrombosis. (18) In comparison to local anesthetics wherein dermatomal sensory spread varies according to the site of injection, high-thoracic epidurals have minimal cranial but marked caudal spread. (19) For rapid onset of sensory block and profound muscle relaxation high concentration of bupivacaine is most preferred to minimize the need for intraoperative neuromuscular blocking agents. (20) Insertion of needle in epidural space with imprecise placement of catheter in mid-thoracic epidural space accompanied persistent perioperative hypotension are common complications in patient undergoing upper abdominal surgery. (21) EA is also associated with increased risk of veterbral canal hematomas after epidural block. (22) Increased incidence of infection is also observed due to Staphylococcus aureus *after EA leading to* Epidural abscess and radicular compression. (23) It is imperative to find an alternative means of providing effective post-operative analgesia has led to the development of continuous peripheral nerve block with catheter. This is a new regional anesthetic technique that allows sensory blockade of the anterolateral abdominal wall which can be achieved by surgically/ultrasound guided placement of catheter in retro-rectus (RS catheter) for midline laparotomies. (24) Thoracotomy requires a very painful incision, involving multiple muscle layers, rib resection, and continuous motion as the patient breathes. The rectus sheath block (RSB) being first described in 1899 was initially used for the relaxation of abdominal wall muscle relaxation during laparotomy before the introduction of neuromuscular block. RSB aims to block the terminal branches of the T9–11 intercostal nerves which run between IOM (internal oblique muscle) and TAM (transverse abdominis muscle) to penetrate the posterior wall of RAM and end in an anterior cutaneous branch supplying the skin of the umbilical area wherein a catheter is place for continuous infusion of local anesthetics. (25, 26) RSB with general anesthesia not only helps in reducing used of opioid anesthetics during surgery but also supress excessive stimulation by skin incisions. (27) It is evidently reported that administration of RSB to patients undergoing major gynecological surgery were successfully controlled by significant reduction in postoperative pain. (28)

It is also observed that inserting a catheter into the rectus sheath for continuous infusion immediately before the operation not only results in complete recovery from anesthesia but is also be more helpful in controlling postoperative pain for a longer period of time. Early observational studies of RSC analgesia for open urological and colorectal surgery suggest that RSC technique is safe and effective. (29) The mean NRS pain scores were found to be similar between EA and RSC groups during rest and mobilization while on comparing the time to ambulation it was observed that RSC is associated with significantly shorter time compared to patients who received EA analgesia suggesting early mobilization, due to which, early recovery possible in RSC group. A consistent observation was made randomised controlled trial compared US-guided RSC analgesia with EA for midline laparotomy. (30)

On Comparisons of rescue analgesic drug injections used by the patients at postoperative at different time points among both the groups were interesting and it was observed that the number of rescue analgesic drug use was statistically insignificant. During the postoperative period, there was no significant difference in requirement of rescue analgesic between the two groups at 12 h after surgery. This means that the patients in both group felt relatively mild pain until 2 h after the operation, but the visceral pain increased gradually over time as the effect of analgesia gradually disappeared after 3 h indicating equal effectiveness of Rectus sheath analgesia with analgesia via Epidural catheter. (31)

Common catheter related complications includes blocking, dislodging or leaking which are most commonly observed in studies where catheters were inserted under ultrasonographic guidance. A contrast observation in our study was no catheter related complication were observed due to insertion of catheter under direct vision. (32)

In present study rectus sheath block also prevents the hemodynamic responses of surgical incision, so patients having ischemic heart disease or stenotic valvular lesion like mitral or aortic stenosis, where tachycardia is undesirable, will also benefit from pre incisional bilateral ultrasound guided rectus sheath block which was consistent with other similar study. (33) Rectus sheath block offers the major advantage of mobility. Time to mobilisation was significantly shorter in the group receiving RSCs. Furthermore, this group of patients avoided the complications associated with epidural anaesthesia. We hypothesise an explanation for this longer time to full mobility is that those patients who receive EA may feel confined to their bed, both by the motor and sensory effects produced by the epidural itself, and the physical attachment to the infusion pump. For this reason, in many cases, mobilisation can only be achieved when the requirement for analgesia can be met by oral analgesia, allowing discontinuation of the epidural infusion. (34) Rectus sheath block is not associated with the physiological sympathectomy that accompanies central neuraxial blockade avoiding haemodynamic fluctuations which are commonly seen with such a blockade and hence can be considered as a viable option in the presence of relative coagulopathy. (34)

V. Conclusion

Both EA and RSA provided satisfactory control of postoperative pain with practically insignificant postoperative complications. But Ultrasonography-guided rectus sheath blocks offer significant advantages, such as providing noninvasive imaging of the anatomy, facilitating real-time needle guidance, and allowing observation of the local anaesthetic spread within the correct tissue plane, better heamodynamic stability with good and early mobility. For improved quality of post-operative analgesia in hemodynamically unstable patients, with goal of Enhanced Recovery after Surgery, use of RS catheters can be recommended in class I and II abdominal surgeries. Rectus sheath block is likely to be useful in selected patients requiring simple periumbilical surgery, primarily those in whom the risks accompanying general anaesthesia or central neuraxial blockade. However few limitations of the study were drain placement and its relation to NRS was not assessed in present study and unequal concentrations of bupivacaine was used in both the groups due to institutional protocols.

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