First Experience With Rectus Sheath Block for Postoperative Analgesia After Pancreas Transplant: A Retrospective Observational Study

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ABSTRACT

Background. Standard of care for postoperative analgesia after pancreas transplant has been thoracic epidural analgesia (TEA). A high incidence of venous graft thrombosis necessitated a change to a more aggressive anticoagulation protocol. To minimize the risk of epidural hemorrhages, we changed from TEA to rectus sheath block (RSB) in 2017.

Methods. From June 2016 to December 2017, a total of 29 consecutive pancreas transplant recipients were included. Sixteen were treated with TEA and 13 were treated with RSB. In the TEA group, the catheter was inserted before induction of general anesthesia, and an epidural infusion was started intraoperatively. An ultrasound-guided RSB was performed bilaterally, and a bolus of local anesthetic was administered before an 18G catheter was inserted. The patients received intermittent local anesthetic boluses every 4 hours in addition to an intravenous patient-controlled analgesia with oxycodone. Both groups received oral acetaminophen and additional rescue opioids.

Results. The administered amount of intravenous morphine equivalents (MEQ) was not significantly different between the RSB and TEA groups. The median MEQ consumption per day during the stay at the surgical ward was 23 mg MEQ/d (interquartile range [IQR], 14−33 mg MEQ/d) in the TEA group compared with 19 mg MEQ/d (IQR, 14−32 mg MEQ/d) in the RSB group ($P = .4$). The duration of the pain catheters was significantly longer in the RSB group. We had no complications related to insertion, use, or removal of the RSB or the TEA catheters, and overall patient satisfaction and comfort was good.

Conclusion. Compared with TEA, RSB was equally effective and safe for postoperative analgesia in heavily anticoagulated pancreas transplant patients.

THE NORWEGIAN pancreas transplantation program was initiated more than 3 decades ago [1]. The majority have been simultaneous pancreas–kidney transplants, but the number of pancreas alone transplants and pancreas transplants after kidney transplant has increased during the last decade. The surgical approach for all types of pancreas transplant (PTX) is a midline laparotomy.

Studies have shown a reduced mortality and morbidity using neuraxial blocks together with general anesthesia compared with systemic opioids in adults undergoing surgery [2,3], and thoracic epidural analgesia (TEA) is considered by many to be the criterion standard for postoperative pain relief after open abdominal surgery. Therefore, TEA has been the cornerstone for postoperative analgesia after laparatomies in our department. We have not experienced any TEA-related severe neurologic complications after PTX.

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To improve endoscopic access for scheduled pancreas graft biopsies and therapeutic interventions [4,5], we changed the exocrine drainage from duodenojejunostomy to duodenoduodenostomy in 2012. However, with this new procedure, we registered a higher incidence of venous pancreas graft thrombosis, which led us to introduce a more aggressive anticoagulation protocol [4,5]. Accordingly, because of the risk of eliciting epidural hematomas in such heavily anticoagulated patients, we considered it unsafe to continue with TEA.

Rectus sheath block (RSB) was first described by Schleich to provide muscle relaxation and analgesia of the anterior abdominal wall [6]. With the introduction of real-time ultrasound (US)- guided techniques, there has been increasing interest and use of truncal blocks in the field of abdominal surgery [7,8]. The rectus muscle and overlying skin is innervated from the anterior rami of spinal nerves T7 to L1, and the nerves and nerve plexus do not need to be identified [9]. Local anesthetic (LA) is injected in the compartment between the posterior layer of the rectus sheath and the rectus muscle reaching the intended nerves [10,11].

The objective of this report was to compare the safety and efficacy of RSB with TEA shortly after having changed from TEA to RSB in pancreas transplant patients.

METHODS

This was a single-center retrospective observational study evaluating all pancreas transplant patients between June 2016 and December 2017 (pancreas transplant alone, simultaneous pancreas–kidney transplant, and pancreas transplant after kidney transplant).

Rectus sheath block was introduced in April 2017 because of the potential increased risk of epidural hemorrhages with the new anticoagulation regime. All RSBs were included after this date, and all except 2 of the TEAs were included before this date. Two TEAs were inserted instead of an RSB after this change because the responsible anesthesiologist on call was not comfortable with the new technique. One patient with a history of chronic pain was excluded from the analysis because of difficulties managing the patient's postoperative pain, and 1 patient who did not receive a TEA because of time shortage and critically long cold ischemia time was excluded.

All patients gave oral and written consent to save their clinical data for use in research and quality assessment studies, and, in accordance with the national guidelines, there was consequently no need for ethics approval for quality analyses.

General Anesthesia Protocol

All patients received a standardized anesthesia protocol according to the institution's guidelines: induction with 100 to 200 μg fentanyl, 3 to 5 mg/kg thiopental, and 0.15 mg/kg cisatracurium. General anesthesia was maintained with a mix of oxygen or air and inhalational anesthetics (sevoflurane or desflurane) and repeated doses of fentanyl. Intraoperative monitoring included electrocardiography, pulse oximetry, capnography, urine output, esophageal temperature, and invasive arterial and central venous pressure. Ringer's lactate was used perioperatively together with blood products as needed and insulin or glucose for glycemic control and treatment of hyperkalemia. Vasoactive agents were administrated at the anesthesiologists' discretion to keep the mean arterial pressure >60 mm Hg.

Thoracic Epidural Analgesia and RSB Catheters. Thoracic epidural analgesia catheters were inserted before induction of general anesthesia at the midthoracic level (Th 7–10) using the loss of resistance technique. An 18G catheter (Portex, Closed End 3 Eyes, Smiths Medical, Minneapolis, Minn, United States) was inserted 4 to 6 cm into the epidural space, and a test dose of 4 mL lidocaine 10 mg/mL was injected.

With the patient still under general anesthesia, the RSB catheters were inserted bilaterally after the surgical procedure including skin closure but before breaking down the sterile field. Guided by a US transducer (linear 4–12 MHz, LOGIQ, GE Healthcare, Chicago, Ill, United States), an 18-gauge 100-mm US-visible needle (Contiplex Tuohy Ultra 360, B. Braun Medical, Melsungen, Germany) was inserted in-plane lateral to medial direction between the rectus muscle and the posterior rectus sheath. Then 20 mL ropivacaine 2 mg/mL was injected, and the correct distribution of the injectate was confirmed by US visualization. Finally, and also US-guided, a catheter (Contiplex Ultra catheter with tapered tip and lateral eyes, B. Braun Medical) was inserted about 5 cm into the rectus sheath and secured to the skin through a short subcutaneous tunnel to prevent dislodgement. The discontinuation and removal of the indwelling pain relief catheters was performed by the attending surgeons at the ward in close collaboration with the acute pain team. Patient comfort and satisfaction were assessed from the nurses' reports and analgetic consumption from the medical records.

Postoperative Care

Analgesia. All patients were extubated in the operating room and transferred directly to a high-dependency unit at the surgical ward. The TEA group received 1 g acetaminophen every 6 hours and a continuous epidural infusion with a mix of bupivacaine (1 mg/mL), fentanyl (2 μg/mL), and epinephrine (2 μg/mL) 5 to 10 mL/h (maximum, 15 mL/h), with a patient-controlled bolus of 5-mL dosage every 30 minutes allowed. The postoperative analgesic protocol in the RSB group also included 1 g acetaminophen every 6 hours, a patient-controlled analgesia (PCA) system with oxycodone boluses of 1 mg (8-minute lockout, maximum of 7 dosages/h), and no baseline infusion. A bolus dosage of 20 mL ropivacaine 2 mg/mL was injected in the RSB catheter every 4 hours on both sides. In both groups, rescue medication was provided with 1 to 2 mg intravenous ketobemidone or oxycodone. When oral intake was possible, oxycodone 5 mg was administrated orally, and slow-release oxycodone 10 mg every 12 hours was started to facilitate discontinuation of RSB and TEA. All opioids given, including oxycodone administered by the patients with PCA, oxycodone or ketobemidone administered by the nurses, oral oxycodone, and fentanyl in the epidural mixture for the TEA group, were converted to intravenous morphine equivalents (MEQs) [12], with a ratio of 3:1 from oral to intravenous formulation. Nonsteroidal anti-inflammatory drugs were not used because of their nephrotoxicity and anticoagulation effect on thrombocytes. Total amount of MEQs needed were compared between the groups day by day for the first 5 postoperative days.

Anticoagulation. The patients received a body weight–dependent dose of 1500 to 3000 IU unfractionated heparin intravenously before vessel clamping. Intraoperatively, and on postoperative day (POD) 1 they also received 500 mL dextran 40

Table 1. Comparison of Patient Characteristics, Preoperative Laboratory Values, Data Regarding the Surgery, and Ward Times Between the TEA and RSB Groups

	RSB (n = 13)	TEA (n = 16)	P Value
Patients			
Male, %	61.5	56.3	>.99
Age, y	41 (37.5–44.5)	39 (31–48)	.68
BMI	23.8 (22.8–26.3)	25.0 (23.8–28.2)	.30
Preoperative Laboratory			
Hemoglobin, g/dL	13.2 (11.6–13.8)	11.9 (10.2–14.6)	.39
Platelets, $\times 10^9$/L	290 (243–325)	248 (223–261)	.86
INR, N-ratio	1.0 (0.9–1.0)	1.0 (0.9–1.0)	.52
APTT, s	34 (31–36)	34 (30.5–41.5)	.49
Creatinine, μmol/L	335 (72–466)	107 (75.5–573)	.95
eGFR, mL/min/1.73^2	66 (8.5–94)	16.5 (10.2–112)	.57
Glucose, mmol/L	13.3 (9.3–20.6)	12.3 (5.2–18.4)	.31
Surgery			
Type of surgery			
SPK/PTA/PAK, No. (%)	6/6/1 (46.2/46.2/7.7)	9/7/0 (56.3/43.8/0)	>.99
Surgery time, hh:mm	03:46 (03:06–05:33)	03:56 (03:23–05:23)	.91
Intraoperatively administered fluid, mL	4290 (4076–5188)	4199 (3700–5332)	.66
Surgical ward time, d	11 (9–12)	11 (9–15)	.73

Data are presented as median (interquartile range) unless otherwise indicated.
Abbreviations: APTT, activated partial thromboplastin time; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); eGFR, estimated glomerular filtration rate; INR, international normalized ratio; PAK, pancreas transplant after kidney transplant; PTA, pancreas alone transplant; RSB, rectus sheath block; SPK, simultaneous pancreas-kidney transplant; TEA, thoracic epidural analgesia.

(Rheomacrodex) 100 mg/mL. Low−molecular weight heparin 5000 IU was routinely given subcutaneously once daily starting 6 hours postoperatively and was increased in the case of a thromboembolic event. Acetylsalicylic acid 75 mg was given orally once daily from POD 3.

Immunosuppression. All patients received a standardized immunosuppression regimen, including tacrolimus, mycophenolate mofetil, corticosteroids, and induction with antithymocyte globulin (Thymoglobuline, Genzyme, Oxford, United Kingdom).

Statistical Analyses

To compare the patients in the groups that received a TEA or an RSB, the *t* test was used for normally distributed continuous variables, and the Mann-Whitney test was used for continuous variables that did not show normal distribution. Histograms were used in addition to the Kolmogorov-Smirnov test of normality to determine normal distribution.

Because of the small sample size, the Fisher exact test was used to compare categorical variables between the groups. A *P* value < .05 was regarded as statistically significant; SPSS Statistics version 25 (IBM, Armonk, NY, United States) was used for statistical analyses.

RESULTS
Patient and Surgery Data

From June 2016 until December 2017, a total of 29 patients were included in the study (TEA, n = 16 vs RSB, n = 13). Patient characteristics, preoperative laboratory values, duration of the surgical procedure, time to discharge from the surgical ward, and amount of fluid administered intraoperatively did not differ between the TEA and RSB groups (Table 1).

Surgical Complications

Surgical complications were reported in 8 patients in the TEA group and in 4 patients in the RSB group (*P* = .45). In the TEA group, 3 patients had thrombectomies because of venous thrombi in the pancreas grafts, 1 required reoperation with evacuation of a hematoma, 1 required drainage to evacuate old blood, 1 had duodenal bleeding that was treated endoscopically, and 1 had ureteric stent insertion because of hydronephrosis. In the RSB group, there were 3 patients with venous thrombi in the pancreas graft treated with increased anticoagulation, 1 required reoperation to resolve leakage from the enteroanastomosis, 2 required ureteric stent insertions because of hydronephrosis, and 1 patient had graft pancreatitis.

Pain Treatment

In the TEA group, 5 of 16 patients (31%) reported suboptimal pain relief of the epidural. One patient received a new TEA on POD 1, and in 1 patient the TEA had a unilateral effect; both patients were offered a supplemental PCA. Three patients reported partial motor block. In 1 patient, the TEA was prematurely discontinued because of planned augmentation of the anticoagulation. In the RSB group, 1 patient reported unilateral effect, and his pain catheters were removed on POD 2.

Time to mobilization out of bed and walking for a short distance (around the bed) was similar in both groups.

Overall, patient satisfaction and comfort was good with both TEA and RSB, and we had no complications related to the insertion, use, or removal of the catheters. Compared with the patients treated with a TEA, the administered

Day-to-day consumption of morphine equivalents (MEQ)
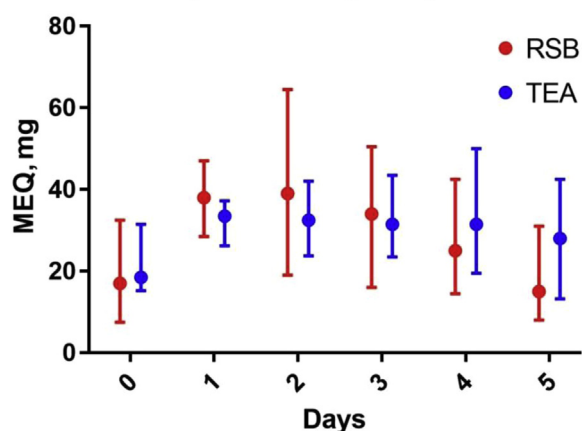
Fig 1. Median and interquartile ranges of morphine equivalents (MEQs) day by day from the day of surgery (day 0) and the first 5 postoperative days for the thoracic epidural (TEA) and the rectus sheath block (RSB) groups. No significant differences were seen between the groups on any day.

amount of MEQs during the stay at the surgical ward was statistically similar in the RSB group; the median in the RSB group was 233 mg (interquartile range [IQR], 177–431 mg) compared with 229 mg (IQR, 163–425 mg) in the TEA group ($P = .70$). The median MEQ consumption per day during the stay at the surgical ward was 23 mg MEQ/d (IQR, 14–33 mg MEQ/d) in the TEA group compared with 19 mg MEQ/d (IQR, 14–32 mg MEQ/d) in the RSB group ($P = .4$). The day-to-day distribution of MEQ from POD 0 to 5 showed a peak of opioid consumption at POD 2 and 3 and thereafter a reduction in both groups. There were no significant differences in MEQ doses administered between the RSB and TEA groups days 0 to 5. Graphically, a tendency toward a more rapid decrease in MEQ doses in the RSB group compared with the TEA group from the peak at POD 2 to 3 to POD 5 can be observed, although it is not statistically significant (POD 2–5, $P = .11$; POD 3–5, $P = .07$) (Fig 1). The duration of the indwelling pain catheters was significantly longer in the RSB group with a median of 9 days (IQR, 6.5–10 days) compared with 5 days (IQR, 5–7.8 days) in the TEA group ($P = .04$). The PCA devices in the RSB group were discontinued after a median of 6 days (range, 4–13) days.

DISCUSSION

The data suggest that RSB in combination with PCA is safe and may provide an equally effective postoperative analgesia as that of a TEA after PTX. This is in accordance with a retrospective study comparing RSB vs TEA in open abdominal procedures where they demonstrated no difference in postoperative pain scores or length of hospital stay. However, the time to mobilization was prolonged in patients

receiving TEA [13], whereas there was no difference in our study. In a currently ongoing randomized controlled trial, the investigators seek to explore if RSB is an alternative to TEA in open midline laparatomies regarding pain score and patient experience in the setting of enhanced recovery after surgery [14]. In our study, the patients in the RSB group received 80 mg ropivacaine every 4 hours; thus, a systemic LA effect may have contributed to the pain relief in this group. In a systematic review and meta-analysis, systemic administration of local anesthetics was superior to placebo for relieving neuropathic pain and comparable with other analgesics used on the same indication [15]. In addition, it appears that there is an advantage with bolus dosage rather than infusion in this type of block because the amount of volume will give an increased effect. In a recently published prospective randomized study from Finland on patients undergoing midline laparotomy [16], they compared 3 different methods of RSB (continuous infusion, repeated-dose, and single-dose), and pain assessment was in favor of repeated dosage during the first 24 hours. However, it remains unclear whether bolus or continuous infusion is preferable in other abdominal wall blocks, and a randomized crossover study in healthy volunteers for transverse abdominal plane block failed to support the hypothesis that changing of the LA techniques influenced the cutaneous effect 6 hours after administration [17]. In our study, we did not observe any signs of local anesthetic toxicity. In a recent review [7] addressing systemic LA concentration after abdominal wall blocks, they found that LA absorption could lead to detectable concentrations exceeding the commonly accepted threshold of LA toxicity; however, it appears that the safety profile regarding these techniques are good.

Obviously, an optimally functioning TEA provides sufficient and excellent pain relief. However, epidural failure rate is reported as high as 30% [18], thus leaving many patients with inadequate pain treatment. In addition, a spinal epidural hematoma is a rare but potentially catastrophic complication after neuraxial blockade, as it may cause permanent neurologic sequela including paraplegia [19]. A spinal epidural hematoma may occur in any patient, but occurs more often in anticoagulated patients even after removal of the epidural catheter [20]. A practical challenge arises when the patient has an ongoing anticoagulation and the epidural catheter needs to be removed. Some patients may also need additional heparin infusion during radiologic procedures such as thrombectomies. In a large nationwide analysis in the United States including more than 1.3 million epidural procedures in nonobstetric patients, a spinal hematoma was revealed in 18.5 of 100,000 catheterizations. Predictors of hematomas included vascular surgery, teaching status of the hospital, and comorbidity. Patients with spinal hematomas had significantly higher in-hospital mortality [21]. Possible serious complications associated with RSB are bleeding in the abdominal wall and needle bowel perforation. In our series, we did not have any of these complications. Bowel perforation has been reported; however, real-time US imaging and the use of atraumatic Tuohy

needles would reduce this potentially harmful complication. In addition, an incomplete RSB may be caused by anatomic variation because the anterior cutaneous branch of the nerves do not penetrate the posterior wall of the rectus sheath in up to 30% of the population [22].

One primary indication for RSB is to provide post-operative abdominal wall analgesia when TEA is contra-indicated, for example, serious bleeding abnormalities or anticoagulation (low−molecular weight heparin together with more than 1 platelet inhibitor). Moreover, RSB does not provide complete analgesia, including the deep visceral pain component after major abdominal surgery, and needs to be combined with multimodal analgesia, such as PCA, steroids, and nonsteroid anti-inflammatory drugs.

This report is limited by its retrospective character and that relatively few patients from only 1 center are reported. Because the change in the anticoagulation protocol neces-sitated a change in the postoperative pain management, a randomization between TEA and RSB was not possible. In addition, US-guided abdominal blocks are still relatively new in our unit. Furthermore, we do not have complete pain score data. However, the nurse reports were complete, and overall good patient satisfaction was reported in the vast majority of the patients. In order to calculate MEQ from the amount of opioids given, we converted all opioids including the epidural fentanyl into MEQ [12]. Fentanyl is absorbed systemically from the epidural space, but since our epidural mixture contains epinephrine in addition to bupivacaine and fentanyl, this would probably minimize the systemic absorption of fentanyl, and a smaller total amount of MEQ in the TEA group might then be more likely [23]. However, we did not find any difference in overall MEQs between the groups. The day-to-day consumption of MEQ for both groups reported a peak at POD 2 to 3 corresponding with the time of early maximal ambulation. The explanation for the delayed decrease in opioid consumption seen in the TEA group during the first 5 PODs is probably that weaning from indwelling pain catheters was faster in the TEA group (median, 5 days; IQR, 5−7.8 days) than the RSB group (median, 9 days; IQR, 6.5−10 days) (P= .04) and that during the weaning time there will be an increased use of opioids to facilitate the discontinuation. Concomitant use of sustained-release oxycodone to facilitate the discontinuation was used in both groups and may also have contributed to an increased cumulative amount of opioids in the RSB group beyond the first 5 PODs because of the longer duration of the indwelling catheters.

Our experience with TEA after PTX is that it is feasible to remove the catheters around POD 4 to 6 when the patients report adequate pain relief with oral medication alone. Rectus sheath block represents a new method of pain management in our transplant unit, and this may have contributed to the delayed weaning of the RSB catheters compared with TEA, which has been a more common practice after major surgical procedures. Increased experi-ence with this new pain management in the future may lead to a more rapid weaning of RSB catheters comparable with

TEA. Furthermore, increased anticoagulation is not a contraindication to let the RSB catheters stay in place for a prolonged time period because a possible bleeding in the rectus muscle after removal is far less harmful than an epidural hematoma [24].

In conclusion, the reported data suggest that RSB in combination with PCA is a safe and feasible postoperative analgesic technique comparable with TEA after PTX.

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