Effect of rectus sheath anaesthesia versus thoracic epidural analgesia on postoperative recovery quality after elective open abdominal surgery in a French regional hospital: the study protocol of a randomised controlled QoR-RECT-CATH trial

Thomas Maury 1,2, Arpiné Elnar 3, Sandra Marchionni, Romain Frisoni, Christophe Goetz, Antoine Bécret

ABSTRACT

Introduction Enhanced recovery after surgery (ERAS) protocols increase patient well-being while significantly reducing mortality, costs and length-of-stay after surgery. A key component is multimodal analgesia that prevents postoperative pain and facilitates early refeeding and mobilisation. Thoracic epidural analgesia (TEA) was long the gold standard for locoregional anaesthesia in anterior abdominal wall surgery. However, newer wall-block techniques such as rectus-sheath block (RSB) may be preferable because they are less invasive and may provide equivalent analgesia with fewer side effects. Since the evidence base remains limited, the Quality Of Recovery enhanced by REctus sheath CATHeter (QoR-RECT-CATH) randomised controlled trial (RCT) was designed to assess whether RSB elicits better postoperative rehabilitation than TEA after laparotomy.

Methods and analysis This open-label parallel-arm 1:1-allocated RCT will determine whether RSB is superior to TEA in 110 patients undergoing scheduled midline laparotomy in terms of postoperative rehabilitation quality. The setting is a regional French hospital that provides opioid-free anaesthesia for all laparotomies within an ERAS programme. Recruited patients will be ≥18 years, scheduled to undergo laparotomy, have American Society of Anesthesiologists (ASA) score 1–4 and lack contraindications to ropivacaine/TEA. TEA-allocated patients will receive an epidural catheter before surgery while RSB-allocated patients will receive rectus sheath catheters after surgery. All other pre/peri/postoperative procedures will be identical, including multimodal postoperative analgesia provided according to our standard of care. Primary objective is a change in total Quality-Of-Recovery-15 French-language (QoR-15F) score on postoperative day (POD) 2 relative to baseline. QoR-15F is a patient-reported outcome measure that is commonly used to measure ERAS outcomes. The 15 secondary objectives include postoperative pain scores, opioid consumption, functional recovery measures and adverse events.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Quality Of Recovery enhanced by REctus sheath CATHeter (QoR-RECT-CATH) is a randomised controlled trial designed to determine whether wall blocks elicit better postoperative rehabilitation than thoracic epidural analgesia.
⇒ Patient rehabilitation will be determined with Quality-of-Recovery-15 French-language, a validated patient-reported outcome measurement.
⇒ Postoperative rescue opioid consumption will be directly correlated with pain levels as we provide opioid-free anaesthesia.
⇒ Patients and physicians are not blinded to locoregional technique, which may cause implicit bias.
⇒ Single-centre study at a regional hospital.

INTRODUCTION

Enhanced recovery after surgery (ERAS) protocols are multimodal evidence-based perioperative care pathways that promote early recovery after surgery and have been shown to increase patient well-being and reduce mortality, costs and length of hospital stay. They were initially developed for colorectal surgery but are now considered suitable for most major surgical specialties. The key elements are preoperative counselling,
optimised nutrition, early mobilisation and standardised anaesthetic and analgesic regimens.\(^2\) With regards to the latter, locoregional anaesthesia is advised to reduce intra- and postoperative morphine requirements.\(^4\) This reflects the fact that high perioperative opioid doses increase postoperative complications,\(^5\) including fatigue, prolonged bed rest, delayed bowel function resumption and depressed immune responses.\(^7\)–\(^10\) One way to reduce perioperative opioid doses is to use opioid-free anaesthesia (OFA).\(^11\)–\(^12\) Indeed, many hospitals, including ours,\(^19\) now routinely employ OFA for all abdominal carcinoma operations.\(^19\)

Until relatively recently, thoracic epidural analgesia (TEA) was considered to be the gold-standard locoregional analgesia for surgery on the abdominal anterior wall because it has strong analgesic effects on the affected dermatomes. Moreover, compared with general anaesthesia alone, TEA used on its own or concomitantly with general anaesthesia reduces postoperative mortality and multiple cardiovascular, respiratory and gastrointestinal morbidity outcomes.\(^7\)–\(^15\)

However, TEA is invasive, high-cost and labour-intensive and associated with a high rate of failed epidural catheter placement.\(^16\) In addition, the vasomotor and motor paralysis induced by neuraxial anaesthesia lower blood pressure and mobility, which can cause prolonged paralytic ileus\(^16\)–\(^17\) and hamper achievement of two key ERAS objectives, namely, early oral refeeding and mobilisation. Furthermore, the advantages of TEA are increasingly being diluted by the evolution of less invasive surgical techniques and the growing efficiency of ERAS protocols.\(^16\) Finally, new locoregional analgesic techniques have emerged, including thoracic paravertebral block, surgical wound infiltration catheters and anterior abdominal wall anaesthetic blockade.\(^18\)

Of these techniques, a particularly well-investigated one is the transverse abdominis plane (TAP) block. It is a one-sided or two-sided injection of a local anaesthetic agent that targets the abdominal nervous branches from T6 to L1.\(^19\)–\(^21\) Multiple meta-analyses, including seven conducted in the last 2 years, show that compared with placebo/conventional pain controls (4–36 randomised controlled trials (RCTs)), TAP block consistently associates with significantly less pain, morphine consumption and postoperative nausea/vomiting (PONV) in general or more specific abdominal surgical fields (eg, bariatric surgery).\(^22\)–\(^25\) The results are more equivocal when TAP block is compared with TEA in general abdominal or colorectal surgery (6–18 RCTs), with some finding no clinically significant difference in pain scores\(^26\)–\(^28\) but others reporting that TAP associates with better pain relief, morphine consumption, hypotension, length of stay (LOS) and PONV.\(^26\)–\(^29\)

However, it should be noted that three of the four TAP versus TEA meta-analyses combined different TAP protocols, including unilateral/ bilateral and single-shot/continuous approaches: unilateral TAP may be insufficient to cover the surgical site while single-shot TAP may not be directly comparable to TEA, which is a continuous infusion.\(^27\) The single meta-analysis comparing bilateral continuous TAP to TEA (nine RCTs) observed no difference in pain control but less hypotension and PONV with TAP.\(^26\) Thus, TAP appears to have some advantages over TEA, although they may be limited.

Another anterior abdominal-wall anaesthetic block is the posterior rectus sheath block (RSB), which targets the anterior nervous branches of the same dermatomes as TAP (T6 to L1) to anaesthetise the medial abdominal quadrants.\(^30\) It is much less well studied than TAP: when limiting the studies to those in the last decade due to changes in clinical practices, the literature reveals seven RCTs\(^31\)–\(^37\) and four retrospective cohort studies\(^38\)–\(^41\) (table 1). Only two of these RCTs included more than 100 patients: Tueki et al\(^37\) and the TERC study (Krige et al)\(^36\) with, respectively, 50 and 65 patients in each arm. Three of the RCTs compared RSB to general anaesthetic alone, saline use in identically placed catheters or rescue analgesia: in all, RSB associated with significantly better pain relief and opioid consumption.\(^31\)–\(^35\) The remaining four RCTs and all four retrospective studies compared RSB to TEA.\(^34\)–\(^41\) Apart from two RCTs that showed higher postoperative opioid consumption in RSB,\(^34\)–\(^37\) and one who highlighted less pain on POD 1 but higher pain scores and more morphine consumption on POD 3 in TEA,\(^36\) these studies did not observe major differences in postoperative opioid consumption, pain scores, patient satisfaction, LOS or side effects.\(^35\)–\(^41\) Two detected higher ileus rates\(^34\)–\(^38\) and three highlighted higher sedation scores\(^34\)–\(^36\) in RSB while two found that RSB associated with less hypotension and shorter time to mobilisation\(^34\)–\(^40\) (table 1). Krige et al highlighted that RSB might be more cost-effective.\(^36\) Thus, RSB may have a similar analgesic effect to TEA while having fewer side effects. This was also the conclusion of a recent meta-analysis of the RSB RCTs, but this systematic review did not include the most recent Tueki et al’s RCT and TERSC study, both having the largest sample sizes among published studies.\(^42\)

Up to date, there is a need for RSB versus TEA prospective studies with greater sample sizes, standardised RSB procedures, including a variety of surgical procedures and studying all key rehabilitation components (eg, only two of the studies included in the meta-analysis examined PONV,\(^36\)–\(^37\) table 1). Moreover, only one of the RCTs\(^36\) on RSB have examined patient-reported outcomes, which may reflect the impact of analgesia techniques on patient functional abilities, comfort, and well-being better than single measures such as pain relief.

To address these issues, we designed QoR-RECT-CATH, which is an open-label 1:1-allocated parallel-arm RCT that will determine whether RSB is superior to TEA in patients undergoing scheduled midline laparotomy in terms of postoperative rehabilitation quality. The setting is a regional tertiary-care hospital in north-eastern France. The primary outcome measure is the total Quality of Recovery-15 (QoR-15)\(^13\) score on POD 2. QoR-15 is a psychometric patient-reported outcome measure that is validated in several languages, fulfils COnsensus-based
<table>
<thead>
<tr>
<th>Paper, year</th>
<th>Type study</th>
<th>Number of patients</th>
<th>Type of surgery</th>
<th>Type RSB</th>
<th>Comparator</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>RSB vs TEA</td>
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<tr>
<td>Godden et al,</td>
<td>Retrospective,</td>
<td>109 patients (24</td>
<td>Open colorectal cancer surgery</td>
<td>Bilateral US-guided RSB catheters before</td>
<td>TEA</td>
<td>NS for pain and morphine consumption Less hypotension on POD1 in RSB group</td>
</tr>
<tr>
<td>2013</td>
<td>109 patients</td>
<td>85 TEA)</td>
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<td>surgery</td>
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<td>Finch et al,</td>
<td>Retrospective,</td>
<td>45 patients (29</td>
<td>Laparotomy in gynaecological oncology</td>
<td>Bilateral US-guided RSB catheters (14 before</td>
<td>TEA</td>
<td>NS for pain and morphine consumption</td>
</tr>
<tr>
<td>2013</td>
<td>45 patients</td>
<td>16 TEA)</td>
<td></td>
<td>surgery, 7 after surgery)</td>
<td></td>
<td></td>
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<tr>
<td>Tudor et al,</td>
<td>Retrospective,</td>
<td>95 patients (73</td>
<td>Elective open or laparoscopic converted-</td>
<td>Bilateral RSB catheters placed by surgeon</td>
<td>TEA</td>
<td>NS for pain, morphine consumption and LOS. Less time to mobilisation in</td>
</tr>
<tr>
<td>2015</td>
<td>95 patients</td>
<td>22 TEA)</td>
<td>to-open colorectal resection</td>
<td>after surgery</td>
<td></td>
<td>RSB group</td>
</tr>
<tr>
<td>Yassin et al,</td>
<td>RCT, 60 patients</td>
<td>(29 RSB, 31 TEA)</td>
<td>Elective laparotomy</td>
<td>Bilateral US-guided RSB catheters after</td>
<td>TEA</td>
<td>NS for pain more morphine consumption and sedation in RSB group</td>
</tr>
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<td>2017</td>
<td>RCT, 60 patients</td>
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<td>Hausken et al,</td>
<td>Retrospective,</td>
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<td>TEA</td>
<td>NS on pain and morphine consumption, time to mobilisation, and patient</td>
</tr>
<tr>
<td>2019</td>
<td>29 patients</td>
<td>16 TEA)</td>
<td></td>
<td>surgery</td>
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<td>comfort.</td>
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<tr>
<td>Gupta et al,</td>
<td>RCT, 60 patients</td>
<td>(30 RSB, 30 TEA)</td>
<td>Midline incision laparotomy</td>
<td>Bilateral US-guided RSB catheters after</td>
<td>TEA</td>
<td>NS for pain, morphine consumption, LOS and complications.</td>
</tr>
<tr>
<td>2020</td>
<td>RCT, 60 patients</td>
<td>(30 RSB, 30 TEA)</td>
<td></td>
<td>surgery</td>
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<td></td>
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<tr>
<td>Tueki et al,</td>
<td>RCT, 100 patients</td>
<td>(50 RSB, 50 TEA)</td>
<td>Major elective abdominal cancer surgery</td>
<td>Bilateral US-guided rectus sheath block</td>
<td>TEA</td>
<td>Similar pain scores at rest and coughing. Less fentanyl consumption in</td>
</tr>
<tr>
<td>2018</td>
<td>RCT, 100 patients</td>
<td>(50 RSB, 50 TEA)</td>
<td>with midline incision (cystectomy,</td>
<td>before surgery, surgically placed catheters</td>
<td></td>
<td>TEA group</td>
</tr>
<tr>
<td>Krige et al,</td>
<td>RCT, 132 patients</td>
<td>(66 RSB, 66 TEA, 1</td>
<td>Major elective abdominal surgery with</td>
<td>in rectus sheath plane before closure</td>
<td></td>
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<tr>
<td>2022</td>
<td>RCT, 132 patients</td>
<td>excluded from</td>
<td>midline incision (cystectomy, colectomy,</td>
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<td></td>
<td></td>
<td>analysis in TEA</td>
<td>colectomy, hysterectomy, anterior pelvic</td>
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<td></td>
<td></td>
<td>group)</td>
<td>resection)</td>
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<td>RSB vs GA alone</td>
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<tr>
<td>Bashandy and</td>
<td>RCT, 56 patients</td>
<td>(29 RSB, 27 GA</td>
<td>Midline incision for abdominal cancer</td>
<td>Bilateral US-guided catheters before</td>
<td>GA alone</td>
<td>Less pain and morphine consumption on POD0 and POD1 in RSB group.</td>
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<tr>
<td>Elkholy, 2014</td>
<td>RCT, 56 patients</td>
<td>alone)</td>
<td></td>
<td>surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bakshi et al,</td>
<td>RCT, 71 patients</td>
<td>(36 RSB, 35 saline</td>
<td>Elective midline laparotomy for</td>
<td>Bilateral surgically placed and US-guided</td>
<td>Saline</td>
<td>Less pain and morphine consumption on POD1 and POD2 in RSB group.</td>
</tr>
<tr>
<td>2016</td>
<td>RCT, 71 patients</td>
<td>catheter)</td>
<td>gynaecological oncology</td>
<td>catheters after surgery</td>
<td>control</td>
<td></td>
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Continued
Standards for the selection of Health Measurement Instruments (COSMIN) criteria and is well accepted in the ERAS field. Indeed, some societies recommend QoR-15 implementation in routine care to assess adherence to ERAS protocols and their effects. The French version (QoR-15 F) was recently validated (online supplemental file 1).

Our hypothesis is that the RSB group will significantly greater improvement in QoR-15F scores on POD 2 relative to baseline than the TEA group. The 15 secondary study objectives include postoperative pain scores, opioid consumption, measures of functional recovery, and adverse events.

METHODS AND ANALYSIS
Study design and setting
QoR-RECT-CATH is a prospective, open-labelled, randomised clinical trial registered on ClinicalTrials.gov. The study was approved by the national French ethics committee (Sud-Ouest et Outre-Mer I Ethical Committee) and is taking place in a single French regional hospital (Hôpital de Mercy, Centre Hospitalier Régional Metz-Thionville) in Ars-Laquenexy, France. The inclusion schedule provides a total inclusion period of 24 months and patient inclusion began in November 2021. This manuscript was written according to Standard Protocol Items: Recommendations for Interventional Trials guidelines.

Participant eligibility and consent
Patients scheduling abdominal surgery are prescreened by both surgeons and anaesthetists, during the anaesthesiology consultation, which usually takes place 30 to 3 days before surgery. Potentially eligible patients are then assessed for eligibility by the investigating anaesthesiologist (when available) at the preanaesthetic visit (inclusion visit) on the day before surgery (figure 1). The anaesthesiologist checks the eligibility criteria, provides oral and written information on the study context and objectives and then seeks written informed consent from the patients (table 2, model consent form available as online supplemental file 2).

The inclusion criteria are patients ≥18 years of age, ASA class I–IV, who are scheduled to undergo open elective surgery involving median laparotomy (over or under the umbilicus or under the xiphoid-pubic line) and gave free and informed written consent, are able to read and understand the French language and are affiliated to the social security system. Patients are excluded if they are deprived of their liberty by a judicial or administrative decision, are undergoing psychiatric care under articles L.3212–1 and L.3213–1 of the French Public Health Code, are included in another study, have any contraindication to local anaesthetics (allergy, porphyria, haemolytic anaemia, uncontrolled epilepsy or severe cardiac conduction disorders) or TEA (coagulation disorders, progressive neurological disease or severe spinal disorder), will bear a median retromuscular abdominal prosthesis after surgery, have a decompensated chronic illness, or are pregnant.

Interventions
Both RSB and TEA are routinely used in our centre and are provided in the study according to the randomisation schedule. The patient is admitted to hospital the day before these interventions and abdominal surgery (admission day). After surgery and intervention (POD 0), the patients stay in the postsurgery room until an Aldrete score of 9 or more is achieved. They are then moved to the nursing ward and discharged home by surgeons when

Table 1

<table>
<thead>
<tr>
<th>Paper, year</th>
<th>Type study</th>
<th>Number of patients</th>
<th>Type of surgery</th>
<th>Type RSB</th>
<th>Comparator</th>
<th>Findings</th>
</tr>
</thead>
</table>

A&P, anterior and posterior; GA, general anaesthesia; LOS, length of stay; NS, not significant; P, posterior; POD, postoperative day; RCT, randomised controlled trial; RS, rectus sheath; RSB, rectus sheath block; S, saline; TEA, thoracic epidural analgesia; US, ultrasound.
### Table 2: Calendar of patient registration, intervention and surgery, evaluations and discharge

<table>
<thead>
<tr>
<th>Timepoint</th>
<th>Trial events</th>
<th>Interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-surgery</strong></td>
<td></td>
<td></td>
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<tr>
<td>Eligibility screen</td>
<td>x</td>
<td></td>
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<tr>
<td>Written information</td>
<td>x</td>
<td></td>
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<tr>
<td>Patient information</td>
<td>x</td>
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<tr>
<td><strong>Surgery</strong></td>
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<tr>
<td>Allocation</td>
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<tr>
<td>TEA catheter (s) Placement or RSB</td>
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<tr>
<td>RSB catheter use</td>
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<tr>
<td>TEA catheter use</td>
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<tr>
<td><strong>Post-surgery</strong></td>
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<tr>
<td>Pain</td>
<td>x</td>
<td></td>
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<tr>
<td>Total morphine consumption</td>
<td>x</td>
<td></td>
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<tr>
<td>Hypoesthesia</td>
<td>x</td>
<td></td>
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<tr>
<td>QoR-15F</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>x</td>
<td></td>
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<tr>
<td>Blood test</td>
<td>x</td>
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<tr>
<td>Blood pressure</td>
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<tr>
<td>ASA score</td>
<td>x</td>
<td></td>
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<tr>
<td>Age, size, weight, BMI</td>
<td>x</td>
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<tr>
<td><strong>Discharge</strong></td>
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<tr>
<td>Eligibility screen</td>
<td>x</td>
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<tr>
<td>Written information</td>
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<tr>
<td>Patient information</td>
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<tr>
<td><strong>Post-discharge</strong></td>
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<tr>
<td>Pain</td>
<td>x</td>
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<tr>
<td>Pain</td>
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<tr>
<td>Total morphine consumption</td>
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<td></td>
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<tr>
<td>Hypoesthesia</td>
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<tr>
<td>QoR-15F</td>
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<tr>
<td>Hypertension</td>
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<tr>
<td>Blood test</td>
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<td>Blood pressure</td>
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<td>ASA score</td>
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<tr>
<td>Age, size, weight, BMI</td>
<td>x</td>
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ASA, American Society of Anesthesiologists; BMI, body mass index; POD, postoperative day; QoR-15F, French version of Quality of Recovery-15 questionnaire; RSB, rectus sheath block; TEA, thoracic epidural analgesia.
such as when the patient still feels pain. Conducted whenever catheter malfunction is suspected, tested with a −4°C freezing pack on the abdominal skin. 72 hours (table 2).

RSB involves bilateral ultrasound-guided insertion of a catheter into the posterior rectus abdominis muscle sheath. In our hospital, preoperative placement of RSC has been reported to haunt surgeons’ work, with catheters being accidentally cut, displaced or trapped in surgical sutures. We did not opt for surgically placed RSC at the end because surgeons in our centre are not familiar with RSC placement under ultrasound guidance, and literature has shown that surgical plane catheters’ efficiency is more consistent when catheter position is confirmed with the aid of echography, even when catheters are positioned by surgeons under direct vision. Therefore, catheters are placed after surgery by the anaesthesiologist, while the patient is still under general anaesthesia. The rectus sheath is expanded by the first injection of 20 mL of ropivacaine (2 mg/mL) per side, after which two elastomeric pumps will continuously deliver 5 mL/h per side of the same ropivacaine solution for 72 hours (table 2).

TEA involves preoperative placement of an epidural catheter, preferably at T8 (the ideal puncture level for analgesia in median xiphopubic laparotomy). Local anaesthetic (3–5 mL of 20 mg/mL lidocaine) is applied to the skin and the epidural space is determined by a midline puncture using the loss of resistance technique. The anaesthesiologist then inserts 4 cm of the catheter into the epidural space and secures it. Continuous epidural infusion of ropivacaine (2 mg/mL) at 0.1 mL/hour/kg of theoretical ideal weight is then started. The optimal infusion rate is subsequently adjusted based on the clinical haemodynamic variations of the patient. After surgery, patients receive a patient-controlled epidural analgesia (PCEA) pump that provides a continuous infusion and, if needed, 5 mL boluses up to every 20 min, for 72 hours (table 2). The sufficiency of TEA analgesia is tested with a −4°C freezing pack on the abdominal skin in the post surgery room. This test is repeated daily and conducted whenever catheter malfunction is suspected, such as when the patient still feels pain.

Concomitant care

The only management-related difference between the RSB and TEA groups is the allocated locoregional analgesic. Thus, preoperative care is the same for both groups, and all patients will undergo OFA with dexmedetomidine, ketamine, dexamethasone, lidocaine (unless the patient is receiving TEA) and ketoprofen (if not contraindicated) according to the established protocols of Mercy Hospital (table 3). In RSB patients, intravenous lidocaine administration is discontinued before RSB placement and use.

It is possible that the RSB and especially TEA catheter cannot be placed or is not placed correctly during the intervention due to technical problems. In the case of primary TEA catheter placement failure, intravenous lidocaine (which is contraindicated in our centre in patients receiving epidural analgesia) will be started when the anaesthesia is induced before surgery.

Postoperative pain management is multimodal: it includes the RSB/TEA and the following drugs (if not contraindicated), which are initially administered intravenously and then replaced with oral equivalent drugs as soon as the patient can eat: acetaminophen (1 g four times/day), nefopam (20 mg six times/day or 120 mg/day infusion; the dose may be reduced to 80 mg/day, if the patient is ≥75 years old), ketoprofen (50 mg three times/day intravenously followed by two oral intakes/day of long-acting 100 mg ketoprofen) and ondansetron (4 mg three times/day) in the case of PONV.

If pain persists with visual analogue pain scale (VAS) ≥4 despite the analgesic protocol above (and, in the case of TEA patients, optimal use of the PCEA), the RSB/TEA analgesia is deemed insufficient, possibly because of incorrect catheter placement or accidental catheter displacement. In this case, the anaesthesiologist in charge prescribes intravenous morphine titration by 2 mg, starting at 2 mg and going up to 10 mg, after which an intravenous morphine patient-controlled analgesia pump (base settings: up to 1 mg every 7 min, no continuous infusion) is given. Other regional or local analgesic techniques, such as wound infiltration, are prohibited.

### Table 3 Protocol for opioid-free anaesthesia induction in abdominal surgery at Mercy Hospital

<table>
<thead>
<tr>
<th>Drug</th>
<th>Anaesthetic induction dose</th>
<th>Surgery estimated to last less than 90 min</th>
<th>Surgery estimated to last more than 90 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dexametomidine</td>
<td>0.5 to 1 µg/kg after the IV line is set</td>
<td>10 µg bolus if pupil response to nociceptive stimulation</td>
<td>Continuous infusion of 0.5 to 1 µg/kg/h, stopped 1 hour before the end of surgery</td>
</tr>
<tr>
<td>Ketamine</td>
<td>0.5 mg/kg</td>
<td>Maximum reinnjection of 0.25 mg/kg/h</td>
<td>Continuous infusion of 0.25 mg/kg/h</td>
</tr>
<tr>
<td>Lidocaine</td>
<td>1.5–2 mg/kg</td>
<td>Maximum reinnjection of 2 mg/kg/h, unless patient is receiving TEA</td>
<td>Continuous infusion of 2 mg/kg/h, unless patient is receiving TEA</td>
</tr>
<tr>
<td>Dexamethasone</td>
<td>8–12 mg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ketoprophén</td>
<td>100 mg if not contraindicated</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TEA, thoracic epidural analgesia.
A registered nurse removes all catheters 72 hours after surgery completion (table 2).

Early resumption of feeding and early mobilisation is facilitated according to our local ERAS protocol.32

Antithrombotic prophylaxis is achieved with enoxaparin (4000 IU/day) if renal malfunction is absent. However, if the estimated glomerular filtration rate is ≤ 30 mL/min/1.73 m², subcutaneous unfractionated heparin is administered. Removal of the TEA requires an antithrombotic treatment window.

Outcome measures

Table 2 shows the variables that are recorded and when they are collected. Age, height, weight, body mass index and blood pressure are measured during the inclusion visit. Blood tests are conducted the same day. QoR-15F is administered on admission day and daily on POD 1–3. The primary outcome is change in the mean total QoR-15F score on POD2 relative to admission day score. This questionnaire contains 15 questions that evaluate five dimensions of postoperative recovery, namely, pain, physical discomfort, autonomy, feelings and psychological support.43 45 Each question is scored from 0 (worst recovery) to 10 (best recovery). Total scores range from 0 to 150. The minimal variation of clinical significance of this score is eight points. The French version of this form, the QoR-15F, has recently been validated (online supplemental file 1).19

The secondary endpoints are: (1) total QoR-15F scores on POD 1, POD 2 and POD 3, (2) total morphine consumption by POD 2, (3) mean pain scores at rest on POD 1 and POD 2 (calculated from patients’ nursing charts and measured by using VAS), (4) time to mobilisation (defined as number of hours until the patient can stand up with the help of nurses), (5) time (days) to first flatus and time to first bowel movement, (6) maximal walking distance (m) on POD 1, POD 2 and POD 3 (estimated by nurses based on floor distance markings in surgery wards), (7) overall LOS (days), and whether the following events occur during the 72-hour postoperative period, (8) arterial hypotension, (9) PONV (nausea, vomiting or retching), (10) urinary catheter needed due to urine retention, (11) failed RSB or TEA catheter placement resulting in premature stop of local anaesthetic administration, (12) other RSB/TEA-related events that result in premature stop of local anaesthetic administration (eg, systemic anaesthetic toxicity, catheter blockage or knotting, catheter-related infection or infusion pump failure)31 or (13) RSB/TEA-linked adverse events (severe and non-severe), (14) patient satisfaction is also determined on discharge and 30 days after discharge with a VAS ranging from 0 (not satisfied at all) to 10 (very satisfied), (15) whether the patient requires revision surgery within 30 days of discharge will also be determined retrospectively from the medical records.

Sample size

RSB and TEA patients are randomised at a 1:1 ratio. Unilateral testing for RSB superiority over TEA in terms of the primary objective (change in total QoR-15F score on POD2 relative to baseline) will require 55 patients per group (110 patients in total). This calculation was based on the following: (1) an RCT on laparoscopic colorectal cancer surgery showed that general anaesthesia combined with epidural block led to mean total QoR-15 scores of 116 (SD=4) and 123 (SD=7) on POD 3 and POD 7, respectively.32  (2) Our ongoing Réhabilitation Améliorée Après Chirurgie pour HYSterectomie programmée (RAACHYS) study investigating the impact of an ERAS programme on patients undergoing hysterectomy shows that on POD 1, the SD of the mean total QoR-15F score is 20. Therefore, for the sample size calculation, we hypothesised that the SD would be 15. (3) An 8-point difference in QoR-15 scores is clinically relevant.53 Thus, if the estimated mean total QoR-15F score of the TEA groups is 120, an 8-point improvement represents a 7% difference. Using this together with a risk α set to 5% and power 1–β set to 80%, 55 patients/group are needed to show that RSB is superior to TEA in terms of total QoR-15F score evolution. We expect no losses to follow-up between the randomisation, on the day before surgery, and POD2.

Allocation

The 1:1 randomisation list has been established by our hospital statistician. The allocation of each enrolled participant is concealed in sequentially numbered opaque-sealed envelopes that are stored in the anaesthesiology department. The investigator draws the next-numbered envelope and then explains the allocated technique again to the participant. The investigator will also use this information to prepare the operating room and its schedule for the allocated protocol.

Blinding

Placement of a placebo epidural catheter seemed unethical because of the potential for severe neurological complications. Even though those complications are rare, their rates are higher with thoracic epidurals and older patients than those commonly admitted for obstetrical settings.35–37 Therefore, we chose to keep the patients unblinded regarding the allocated locoregional analgesia.

Follow-up and data collection

The data will be collected prospectively from case report forms, completed by the patients and paramedical staff and from computerised medical records. The patients will be called by telephone 30 days after surgery to determine patient satisfaction and adverse events. The data will then be transcribed in a pseudonymised manner into a database. The data include the primary and secondary endpoints and demographic/clinical variables. The data collection process will be monitored by trained research staff.

Statistical analyses

The RSB and TEA groups will be compared in terms of demographic/clinical and primary/secondary outcome variables by Wilcoxon’s or Fisher’s exact tests. Linear
regression analysis will be used to determine whether
the two groups differ in terms of change in QoR-15
scores between admission day and POD 2 or continuous
secondary-outcome variables after integrating potential
confounders such as use of patient-controlled opioid
analgesia. Logistic regression analyses will be conducted
for categorical variables. Alpha risk will be set to 5%. All
analyses will be conducted on the intention-to-treat popu-
lation (ie, according to allocation) regardless of whether
they received locoregional anaesthesia for 72 hours. This
reflects the fact that failed of catheter placement or
premature stop of local anaesthetics administration (eg,
for secondary catheter displacement) is inherently linked
to the failure rates of each technique.

Safety reporting
Both RSB and TEA are routinely used in our unit and
all QoR-RECT CATH patients will be cared for according
to our standard hospital protocols. Since the only new
element is the randomisation of locoregional anaes-
thetia techniques, the safety elements will be analysed
by the trial committee. The trial committee is composed
of the investigators who conceived the project, our study
methodologist and our sponsor representative. They will
approve the scientific protocol and coordinate the trans-
mision of information to other professionals. They will
remain available to answer any difficulties during the
research. Only unexpected serious adverse events or any
adverse drug-related effect will be reported to the rele-
vant regional pharmacovigilance centre. Moreover, any
adverse effects that relate to a medical device will be trans-
mitted to the medical device authorities.

Auditing
Auditing can occur at any moment during the research,
including during protocol development, data manage-
ment and publication of the study results. Audits will
be conducted by independent professionals who are
mandated by the study sponsor. Investigators will comply
with sponsor and relevant authority requirement during
auditing and research inspection.

Patient and public involvement
Patients and the public were not involved in the concep-
tion of this clinical trial. Results will be disseminated
via peer-reviewed journals and presentations at relevant
conferences, published in the peer-reviewed literature
and presented at relevant conferences and communi-
cated via professional networks. Individual participant
data underlying the results would not be publicly avail-
able, according to French law and the methodology of
the French Data Protection Authority (Commission
Nationale de l’Informatique et des Libertés (CNIL)).

Ethics and dissemination
This trial involves human beings, type 2 according to the
Jardé law study. It is being conducted in accordance with
the French public-health code and the Declaration of
Helsinki. The protocol was approved by the French ethics
committee (Sud-Ouest et Outre-Mer I French Ethical
Committee, n°ID RCB: 2021-A00270-41 – CPP 1-21-027
ID 11692) on 19 April 2021. In accordance with the
law, all patients are individually provided with oral and
written information before inclusion and written consent
is sought systematically by the investigator at the time of
inclusion. The data processing complies with the baseline
methodology (Méthodologie de référence (MR 001)) of
the CNIL to which the Centre Hospitalier Régional Metz-
Thionville has signed its compliance commitment (11
May 2009; No. 1363172). The results of this study will be
made public through peer-reviewed publication, thesis
manuscripts and, if possible, conference publications.

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regulatory file to the French ethics committee and registering the study on clinical
trials.gov. AE reviewed the manuscript and submitted it for publication. All authors
critically revised and modified the protocol and the article; approved the final
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