Introduction

Acute pancreatitis (AP) is an inflammatory condition that includes local and systemic manifestations, showing a mild behavior in most patients. Infected pancreatic necrosis is the most aggressive scenario with a high mortality rate. According to the PANTER trial, the “step-up approach” has shown a lower rate of new-onset organ failure compared with open necrosectomy. Whenever possible, major surgical interventions in infected pancreatitis should be delayed as long as possible, ideally until the fourth week since the onset of symptoms. The selection and timing of the procedure are key points, taking into account the clinical condition of the patient, the location, the availability of equipment, and the experience of the surgical team. The technical description of the laparoscopic retroperitoneal necrosectomy is presented focused on the path to the retroperitoneum, anatomical aspects, and tips and tricks. Furthermore, the step-up approach flowchart, indications, contraindications, patient's workup, post-operative management, advantages, complications, and technique video are included. Although laparoscopic necrosectomy requires mastery of retroperitoneal anatomy and good laparoscopic skills, it is an exceptional tool for the surgeon within the arsenal for this difficult and serious condition. The authors have adopted the laparoscopic retroperitoneal necrosectomy as part of the step-up approach and have found it very replicable and ergonomic.

Keywords: Infected pancreatic necrosis; retroperitoneal necrosectomy; laparoscopic technique

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This manuscript aims to describe a minimally invasive therapeutic option for patients with necrotizing pancreatitis as well as some tips, tricks, and risks. Indications and contraindications are listed below (Table 1).

**Patient’s workup**

Most infected necrotizing pancreatitis progress within the second and fourth week, posterior to the initial inflammatory phase (1). The presence of gas within peripancreatic collections is highly sensitive and specific for infection. The contrast-enhanced computed tomography (CECT) allows the identification, localization, and quantification of the necrotic collections (Figure 1).

All candidates for laparoscopic retroperitoneal necrosectomy should be receiving supportive care, broad-spectrum antibiotic, and an unsuccessful percutaneous drainage background (1,4,8). To decrease the complications and mortality rates, the necrosectomy should be at least delayed until the fourth week since the onset of symptoms (8). The equipment preference card is shown below (Table 2).

**Pre-operative preparation**

Most (peri)pancreatic collections spread to the lesser sac and/or paracolic gutter. (Figure 1).
and both paracolic gutters (9,10). Our approach description is based on the left-side approach. Although the right-side approach is very similar, the particularities are later described.

The patient is placed in a right lateral decubitus, the patient body tilted to 40–60° angle, and the left arm flexed with 90° abduction. All pressure sites must be cradled on bean bags. The surgical team is organized as in Figure 2. The percutaneous drain should be cut 2–3 cm over the skin level and the abdomen is prepared in case of emergency laparotomy. A two-percent chlorhexidine and isopropyl alcohol solution is used.

**Surgical technique**

**Retroperitoneal access and trocar position**

A 1.5 cm skin incision is made where the percutaneous drain is located. After being cannulated with a 0.035 guidewire, the drain is removed.

The incision is dilated with the finger until the 10-mm trocar (without the obturator) slides without resistance. Under laparoscopic view, the retroperitoneal insufflation is set up to 10 mmHg. A second 10-mm trocar (surgeon’s right hand) is placed under the 12
1
2
th costal border over the posterior axillary line. The 5-mm trocar (surgeon’s left hand) is inserted keeping an ergonomic triangulation with the other trocars. Ideally over the anterior axillary line, as shown in Figure 3. Employing the laparoscope and insufflation, the view and identification of structures are enhanced.

**Debridement**

A fenestrated atraumatic grasper and the irrigation/suction handpiece are simultaneously employed. Debridement of the necrotic tissue should be started from lateral to medial, avoiding the resection of the strongly fixed tissue. The target necrotic tissue has a peculiar dark gray tone. The irrigation of hydrogen peroxide solution highlights the devitalized tissue, contributes to the blunt dissection, and provides hemostasis. Moreover, saline solution is irrigated for clearing the liquid debris. In case of bleeding, packing is usually successful; otherwise, the ultrasonic scalpel (bipolar device is another option) allows hemostatic control with a low risk of injury.

**Drains placement and wound closure**

A 24–28 Fr silicon drain is inserted under direct vision through a 10-mm trocar and handed with the grasper to be placed in a distal location into the necrotic cavity. An
accessory 10 Fr drain could be introduced under direct view through the 5-mm trocar. It can be used for irrigation. The incision of the optical trocar is closed in one layer stitching the lumbodorsal and transversalis fascia using a figure-of-8 suture of a 2-0 slowly absorbable monofilament material. The skin is closed, and the drains fixed to the skin. The dissected tissue and collection sample should be sent for pathology and microbiology examination.

**Post-operative management**

In cases where a single intervention appears to be enough, we recommend intermittent irrigation through the 10–19 Fr drain with 200–500 mL 0.9% saline three times a day. In those cases with increased residual necrotic tissue, we prefer continuous irrigation with a total of 5–8 liters per day. Our personal indication is to remove the 10–19 Fr drain when the output fluid becomes clear. The 19–28 Fr drain should be removed when the output fluid is less than 30 mL/24 h and a fluid sampling with normal amylase levels. A CT scan is conducted between 1–2 weeks after the procedure. Residual collections should be reassessed and managed according to the step-up approach, based on location, size, and patient conditions (11).

**Ethical statement**

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s), and with the Helsinki Declaration (as revised in 2013). Informed consent was obtained from all patients.

**Tips and tricks**

**Route planning**

In cases with multiple percutaneous drainages, choose the drain with the most direct access to the largest collection cavity as guide for the first trocar.

**CO₂ insufflation**

The retroperitoneal insufflation must be at a maximum pressure of 10 mmHg in order to avoid bacterial translocation.

**Dissection**

Dissection must be focused on loose necrotic tissue, preserving the vitalized and vascularized pancreatic tissue.

Body and tail pancreas necrosis: the left-side dissection is limited by the posterior gastric wall anteriorly, the inferior pole of the spleen, and the anterior renal fascia posteriorly, having the transverse colon with its mesocolon as the inferior limit (Figure 4). Take care of the splenic artery and its branches crossing this plane to the splenic hilum.

Head and neck pancreas necrosis: the right-side dissection is limited by the parietal peritoneum and the duodenum anteriorly, and the anterior renal fascia as the posterior limit. The access to the head of the pancreas requires careful dissection of the retroperitoneum, creating a retroduodenal window. Due to the technical difficulty, these cases are usually more suitable for the endoscopic approach.

Paracolic gutter collections: the inferior left/right side dissection is limited anteriorly by the parietocolic ligament, the ascending/descending colon, and the mesocolon. As posterior limit the anterior renal fascia (Figure 5). Running through this path, the collection spreads to the pelvic cavity.

Perirenal abscess: it could be present a secondary perirenal abscess by the dissemination/translocation of the collection to the perirenal space. The anterior renal fascia must be incised for the aspiration of the collection and, if deemed necessary, drain placement (Figure 6).
Bleeding

Most of the dissection’s bleeding corresponds to capillary ruptures. The first measures are irrigation with hydrogen peroxide solution, transitory packing, and the use of energy devices. Only if these actions do not seem to be enough, an absorbable hemostatic sponge may be placed. Caution should be taken not to place the hemostatic sponge too close to the drains, to avoid clogging (see the Video 1).

The principal advantages and complications of this approach are listed below (Tables 3, 4).

### Conclusions

Currently, there are multiple options into the step-up approach for infected pancreatic necrosis, hence the accurate selection of the patient candidate for laparoscopic retroperitoneal necrosectomy is of most importance. Although this technique requires mastery of retroperitoneal anatomy and good laparoscopic skills, it is an exceptional tool for the surgeon within the arsenal for this difficult and serious condition. An additional advantage is the feasibility at any time without requiring radiologic or endoscopic intervention. Employing this laparoscopic technique, the view and identification of the anatomical structures are enhanced, as compared to other video-assisted one port approaches. The authors have adopted the laparoscopic retroperitoneal necrosectomy as part of the step-up approach and have found it very replicable and ergonomic.
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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s), and with the Helsinki Declaration (as revised in 2013). Informed consent was obtained from all patients.

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