Abdominal incisional hernias are iatrogenic complications of surgical abdominal wall repair, with an incidence ranging between 3.8 and 11.5% [1]. Among them, large incisional hernias with loss of domain of the abdominal wall remain a surgical challenge. This is because it is difficult to replace the content of the herniated sac into the peritoneal cavity [2], which conveys the risk of abdominal compartment syndrome by increasing intra-abdominal pressure with subsequent respiratory, vascular, and visceral complications [3]. To prevent those complications preoperative progressive pneumoperitoneum (PPP) was proposed by Goni-Moreno [4]. PPP increases the volume of the abdominal cavity and facilitates further reintegration of viscera [4]. PPP is currently performed using a catheter surgically placed under small laparotomy. This technique conveys non-negligible morbidity and mortality [3,5,6]. To overcome those risks, a radiological adaptation of the Goni-Moreno PPP technique has been developed in our institution.
The purpose of this technical note was to describe the modified Goni-Moreno PPP.

Procedure

This technique consists of placing a percutaneous multipurpose drainage catheter in the intraperitoneal space, under local anesthesia with ultrasound and fluoroscopy guidance. The procedure first begins with a careful analysis of the preoperative computed tomography (CT) examination initially requested by the surgeons to evaluate the volume and the content of the hernia sac, to measure the diameter of the abdominal wall dehiscence and to assess trophicity of the abdominal muscles. CT is used to better determine the most appropriate puncture site for catheter entry, which has to be placed far from both the wall dehiscence and gastrointestinal structures (Fig. 1). Then ultrasound screening allows identifying the abdominal wall, the hyperechoic line of parietal peritoneum and the underlying fat tissue, which is the greater omentum in most cases. Passing through the parietal peritoneum under ultrasound guidance, the puncture of the underlying fat tissue is performed under local anesthesia (Lidocaine hydrochloride 1%, Hospira, Lake Forest, IL, USA) using a 16-G sheathed needle (Fig. 1). The intraperitoneal position of the catheter is assessed using fluoroscopy by injecting iodinated contrast material, which is expected to mold the peritoneal cavity. Then a hydrophilic, 0.035-inch

![Image of the procedure](image)

**Figure 1.** A radiological Goni-Moreno procedure in a 66-year-old woman: a: photograph shows the patient with midline large incisional hernia in supine position before the procedure; b: coronal unenhanced CT image shows the most appropriate puncture site (arrow) in the right flank in front of the greater omentum (star); c: axial high frequency with a linear probe ultrasound image at the level of the CT targeted site shows the needle track (arrowheads) through the subcutaneous fat and the parietal peritoneum (arrows) up to the greater omentum (stars); d–f: fluoroscopic images respectively show the peritoneal opacification (arrowheads) through the catheter (dashed arrow), peritoneal catheterism with Seldinger technique using a hydrophilic guide wire (short arrow), and the placement of the multipurpose drainage catheter (long arrow); g: photograph shows drainage catheter fixed to the skin and the filter (arrow) to begin insufflation of filtered air; h and i: axial unenhanced CT images show the pneumoperitoneum (arrowheads) and the final position of the drainage catheter (arrow) in the peritoneal cavity, just behind the mesentery.
guidewire (Radifocus®, M Standard type, Terumo, Tokyo, Japan) is introduced into the peritoneal cavity (Fig. 1). The abdominal wall track is subsequently dilated by dilators of 6- and 8-Fr. Finally, a 8.5-Fr, 25-cm long multipurpose drainage catheter (Ultrasound®, Cook Medical, Bloomington, IN, USA) is inserted using the Seldinger technique under fluoroscopy guidance. Then, the catheter is fixed to the skin by a single notch and a catheter stabilization device (Statlock®, Bard Medical Division, Covington, LA, USA). Immediately after, the first insufflation of approximately 500 ml of filtered air is performed through the dedicated 0.2 μm filter (Perifix® Filter, B. Braun, Melsungen, Germany).

Right or left flank catheter placement may be not feasible in some circumstances. The peritoneal line may indeed be not visible on ultrasound in obese patients with thick abdominal wall. Peritoneal adhesions due to previous surgeries may also prevent the adequate placement of the catheter. In those cases, a peritoneal perihepatic approach may be an alternative [7]. An 18-G sheathed needle is placed under ultrasound guidance to the front of the right or left hepatic lobe, penetrating few millimeters the liver parenchyma. After removal of the inner stylet of sheath needle, the patient is asked to fully expire and the tip of the sheath is expected to move into the peritoneal cavity by passive retraction from the upwardly displaced hepatic parenchyma during the full expiration.

Finally, low dose unenhanced abdominopelvic CT is performed immediately after the procedure to assess the intra-peritoneal catheter placement and pneumoperitoneum diffusion (Fig. 1). The filtered-air insufflation is progressive with 500 to 1500 mL per day under medical surveillance. Depending on the patient tolerance, the total volume of air ranges from 5 to 15 liters, obtained in 2 to 3 weeks. The use of an abdominal belt helps decrease the volume of air in the hernia sac.

**Discussion**

Originally, PPP was created by insufflating filtered air into the abdominal cavity by daily abdominal puncture. This technique required several punctures into the abdomen. To limit the number of punctures, access via surgical subcutaneous implantable port was proposed. The catheter placement was performed under general anesthesia most of the time by a small laparotomy with left or right Mc Burney’s incision, and the intra peritoneal catheter was then directed to the pelvis and connected to a port in the subcutaneous fat or subcutaneously tunnelled to an exit site [3, 5, 8]. Although this surgical route was less invasive, it was associated with a risk of viscera perforation during adhesiolysis, catheter malposition, and migration or secondary port infection due to iterative punctures [3, 5, 6].

To avoid those risks, we developed under local anesthesia the image-guided PPP technique as described above. In a recent study from our institution, this PPP procedure has been showed less invasive and safer with no complications reported compared to the surgical method [6]. The larger caliber of the catheter surgically placed compared to the multipurpose drains used in our technique, as well as the surgical procedure, may increase the subcutaneous emphysema and the risk of infection. The absence of bowel wound could be explained by performing peritoneal puncture under ultrasound guidance far from gastrointestinal structures, and peritoneal cavity opacification under fluoroscopy before drain placement. In case of failure, peritoneal peritoneal puncture can be used [7]. Although this technique is effective, it should be a second line method in our experience, due to the risk of hepatic puncture and its potential complications [7].

Indications of PPP are mostly midline and lateral incisional hernias with loss of domain and a transverse diameter more than 10 cm and/or a hernia sac volume >15% compared to abdominal cavity [2, 3, 9, 10]. Eligible patients underwent pulmonary functional testing and respiratory physiotherapy before surgery. Some patients with comorbidity, who were not eligible to elective hernia repair in the past, can now undergo the procedure thanks to the use of our mini invasive radiological procedure for PPP. Therefore, from our experience, this technique should be preferred to the Goni-Moreno technique.

**Disclosure of interest**

The authors declare that they have no competing interest.

**References**