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Endoscopic Ultrasonographic Drainage of Pancreatic Fluid Collections

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Abstract

Fluid collections of the pancreatic area are a non-negligible complication of the pancreatitis and of the pancreatic traumas. Some of these will have clinical repercussion and will need treatment. In the last 25 years, minimally invasive treatments have slowly become the treatment of choice. Especially endoscopic ultrasonographic drainage has proven to be an effective and safe technique in these conditions. We describe the technique and comment on some critical aspects that need to be considered. The procedure may be performed in several steps or in one step, and we must choose case by case which option seems the best. We describe mainly the one-step technique because in our experience it is easier and quicker. In this chapter we wanted to set up a detailed guide that shows step by step how the technique is performed, with the hope that it may be useful for the interventional echoendoscopist.
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Non-neoplastic pancreatic fluid collections may be classified as acute fluid collections, necrosis, acute pseudocysts, chronic pseudocysts or abscesses [1]. Pancreatic pseudocysts are localized collections, usually liquid, surrounded by a non-epithelial wall (granulation or connective tissue), caused by disruption or obstruction of a pancreatic duct. Other pseudocysts are related to the maturation of an acute collection, or to the liquefaction of a necrotic area, detritus and secretions, which is then encapsulated [1, 2]. A minimum of 4 weeks must pass for their wall to be considered mature. These lesions can develop as a result of acute or chronic pancreatitis, pancreatic trauma or pancreatic duct obstruction [1].

Although fluid collections are common during acute pancreatitis, they are usually too small or they disappear spontaneously, with the result that less than 10% of all cases will be clinically relevant. When pseudocysts are large they may cause symptoms such as dyspepsia, pain and abdominal fullness. Severe complications such as infection, bleeding and rupture may also occur, but in some cases, pseudocysts may be asymptomatic. In general, pseudocysts of ≤6 cm may be closely followed in time. In the past it was widely believed that pseudocysts had to be treated when they were >6 cm and persisted >6 weeks. However, spontaneous resolution may occur in a non-negligible number of patients. Today, the trend is to closely observe the pseudocysts and to treat them only when they grow, cause symptoms, or when complications occur [1–3]. Formerly, surgery was considered the gold standard but it also involved significant morbidity and mortality rates [1, 3, 4]. Thus, in the last 25 years, endoscopic and radiological drainage have slowly become the treatment of choice, and surgery is currently reserved for recurrent pseudocysts or pseudocysts associated with other (pancreatic) abnormalities that require surgical therapy [3].

Pancreatic abscesses may be classified according to their origin: postpancreatitic, postsurgical or posttraumatic. Postpancreatitic abscesses result from infection of a necrotic area, a fluid collection or a pseudocyst. This occurs spontaneously in about 10% of the cases due to bacterial translocation, usually 20–40 days after the acute episode. However, the most common cause of infection is iatrogenic due to inappropriate handling of the lesion [2]. Postsurgical and posttraumatic abscesses are often contaminated by intestinal or by external microorganisms. The treatment should always include an appropriate antibiotic therapy. However, this is insufficient and the patient might die if drainage is not performed. The approach to the abscesses is similar to pseudocysts, and currently minimally invasive treatments are also preferred [1, 3–5].

Minimally invasive treatments include percutaneous drainage under radiological guidance (transabdominal US or CT scan) or endoscopic drainage. Both drainage modalities have advantages and disadvantages. Therefore, patients with pancreatic pseudocysts or abscesses must be treated by a multidisciplinary team consisting of surgeons, radiologists, and gastroenterologists because there are specific indications for each type of procedure, and these indications are also dependent on local expertise [3, 6]. In our opinion, whenever possible, the best approach to performing drainage is the natural way – toward the intestinal lumen.

Procedural Aspects

To perform this kind of drainage, endoscopic ultrasonography (EUS) has some advantages over other techniques. Along with other authors, we believe that it should be the technique of choice [1, 3–5, 7–15]. It can characterize the lesion, thus helping to differentiate a pseudocyst, that should be drained, from other cystic lesions [3, 7]. The differential diagnosis is broad and includes benign cysts (<5%), cystic neoplasms of the pancreas (5–10%) and real non-neoplastic collections (80–90%) [2, 16]. A diagnosis of pseudocyst should be considered when previous acute or chronic pancreatitis, or etiological explanation exist. Pseudocysts are usually lesions with anechoic fluid, sometimes with an echoic level due to sedimented detritus, rarely with septa, that have a regular and echoic wall (without focal thickenings, internal projections or calcium), and with high amylase content [2, 16].

Abscesses are often morphologically similar to pseudocysts. However, their content is usually more echoic, relatively dense but fluid, with multiple hyperechoic spots in relation to detritus and microbubbles. Occasionally, if abscesses result from the infection of a necrotic area they may be more anfractuous and complex.

EUS also allows the nearest point of lesion to the wall of the digestive tract to be located. It is particularly useful in evaluating this aspect in non-protruding collections [1, 3, 14]. Furthermore, EUS imaging avoids confusion with other extrinsic potential impacts on the gastric or duodenal wall, such as the gallbladder or the caudate lobe of the liver [3]. At the same time, it measures the distance between the cavity of the cyst and the intestinal lumen. Thus, the classical approach is that the risk of leakage into the peritoneum decreases if this distance is ≤1 cm. However, this also depends on other factors such as location, degree of maturation, or presence of inflammatory adhesions between surfaces [1–4, 7]. Another consideration is the existence of true vessels or submucosal varicose veins that are not infrequently associated with this condition, and which can be interposed between the intestinal lumen and the pseudocyst. The use of color Doppler and power Doppler can help identify these structures and allow maneuvers to avoid them during puncture [1, 3, 7, 12, 14, 17]. One of the most important issues is the ability of EUS to guide the movements of the instruments in real time outside the intestinal wall.

Until a few years ago, only echoendoscopes with a small-caliber working channel were available. With this equipment, only stents with a maximum size of 7 Fr could be inserted or the endoscope had to be exchanged with a large-channel side-viewing endoscope (ERCP-type) leaving the guidewire in place [3]. With the development of large-channel echoendoscopes, 10-Fr stents can be inserted [3]. Due to the laboriousness of the classical procedure (in several steps), a one-step system has been designed [3–5, 8]. This system enables an easier and faster placement of the stent. In our opinion, this device shortens the procedure time by more than 80% and in some selected cases allows the procedure to be performed exclusively under endoscopic ultrasound control.

The availability of a previous CT scan or MRI enables a broader view of the situation to be seen [1, 3]. It allows the relationship of the collection with the intestinal wall to be characterized prior to the procedure. In some cases a CT scan can warn about the presence of abnormal vessels or a splenic artery pseudoaneurysm, but its resolution is insufficient to show varices in the gut wall [3]. Furthermore, this may be interesting to determine the attitude to take and the possible drainage method to adopt. Besides, CT scan or MRI provide a reference for subsequent follow-up. In our opinion, these imaging modalities complement the EUS image. Thus the availability of a previous CT scan or MRI is not mandatory but is advisable.

Patient Preparation

In outpatients it is advisable to keep individuals under observation in hospital for some days after the procedure. Patients with pseudocysts or pancreatic abscesses usually suffer difficulties of gastric emptying, especially if they are not on an absolute diet. Therefore, in patients who are eating, we recommend a soft midday meal without vegetables, and then an exclusively clear liquid diet. If there is a functional or organic gastric or intestinal subocclusion, it may be advisable to add prokinetic drugs and, in some cases, to leave a nasogastric aspiration tube in place. The goal is to keep the gastric and duodenal lumen clean during the procedure.

Special care must be taken with patients taking non-steroidal anti-inflammatory or anti-coagulant drugs or platelet aggregation inhibitors. If drainage is necessary, it is compulsory to improve coagulation status prior to the procedure. The procedures are relatively long and must be performed under conscious sedation or under anesthesia. A mixture of midazolam and meperidine or propofol and/or remifentanil may be used depending on the patient's characteristics and local expertise. It is advisable to have pulsioximetry, electrocardiographic recording, capnography and, if necessary, the possibility of patient intubation.

Prophylactic or therapeutic antibiotic treatment should be delivered. Inpatients will already be under antibiotic treatment but this may not be the case for outpatients without infection. For patients without antibiotics, we regularly use a prophylactic intravenous broad-spectrum quinolone during the procedure in the same protocol as other punctures of cystic lesions [18]. The patient is then admitted and continues with intravenous antibiotic therapy for several days. When an abscess is drained it is better to take a culture, if possible, and to treat the infection with specific antibiotics [1, 4].

The procedure is usually performed in two possible postures. If the use of x-ray is not expected, it can be done in left lateral decubitus. When x-ray is used, it is better to perform the procedure in a supine position to obtain a good radiological projection. As patients are usually sedated or anesthetized, it is desirable to seek the maximum stability in their posture.

Accessories

The usual endoscope to perform an EUS-guided drainage of a pseudocyst or abscess is a linear ultrasonic gastrovideoscope with large diameter working channel (3.7 or 3.8 mm), forceps elevator and Doppler (usually called therapeutic echoendoscope). In some rare cases other endoscopes such as a large-channel side-viewing endoscope or different kinds of gastroscopes can be useful. There is also a novel prototype forward-viewing US endoscope (XGiF-UCT160; Olympus Medical Systems Europe, Hamburg, Germany) [14]. This prototype is a modification of a commercially available therapeutic echoendoscope (GF-UCT140; Olympus). Its main modifications are forward-viewing optics and US, plus a large working channel in alignment with the endoscope shaft. These modifications enable the endoscopist to create a cystogastrostomy/duodenostomy guided by EUS by means of a frontal incision without angle. But this device is very specific and very expensive, and it probably can be used in only a few cases. In addition, it is not commercially available. In this chapter we will refer to the conventional therapeutic linear echoendoscopes.

Although using the one-step system most drainages can be performed without radiological control, it is highly desirable to have x-ray equipment at hand. When the procedure is going to be performed using the method in several steps, it must be done with radiological control. When cutting current is going to be used, it is necessary to have an electrosurgical unit. This unit must be able to use cutting and electrocoagulation current in a blended fashion.

There are many approaches and many useful gadgets to make a perfect drainage. We will describe in detail our favorite system (one-step) and more briefly the other gadgets that are also commonly used in pancreatobiliar endoscopy.

The one-step system NWOA (Giovannini Needle Wire Oasis®, Cook Ireland Ltd, Limerick, Ireland) is available in two sizes: 8.5 and 10 Fr [4, 6, 8]. Each size is designed to place stents of 8.5 or 10 Fr respectively. The 8.5-stent is a modified Cotton-Leung® (Amsterdam) biliary stent and the 10-stent is a modified Soehendra® Tannenbaum® biliary stent. This system is only adapted to straight stents. The system consists of four basic elements telescopically positioned. The external element is a plastic positioner-pusher catheter of 8.5 or 10 Fr, according to the stent size. It has within it a plastic dilator-introducer catheter, which overhangs about 90 mm beyond the positioner-pusher catheter tip. The innermost element, within the introducer catheter, is a long guidewire with a movable core (to regulate the stiffness) and a metallic tip that allows the use of electrosurgical current in the same way as a needle knife. The stent is placed on the tip of the pusher catheter and over the introducer catheter. Stents of 5 cm length are those normally used and when they are placed on the system, they must be put with the tapered tip forward. Both sizes of stents have their advantages and disadvantages: 8.5-Fr stents are placed much more easily but they are also, in theory, more easily blocked. In later sections we will address their functioning in more detail.

To perform the procedure in several steps the required devices to puncture the collection are a normal 19-gauge endoscopic ultrasound needle and a 0.035-inch hydrophilic guidewire.

Other authors prefer a 10-Fr cystotome that is designed to electrosurgically cannulate the transgastric or transduodenal wall into a visibly bulging pancreatic fluid collection, as performed in the classical approach (without endoscopic ultrasonographic guide). A cystotome is a device manufactured by Cook consisting of a 10-Fr catheter, with another 5-Fr catheter inside it, and within this second catheter a 0.038-inch needle-knife wire [1, 19]. Smaller caliber (6- and 8.5-Fr) cystotomes (Cysto-Gastro set), manufactured by Endo-flex® GmbH (Voerde, Düsseldorf), have recently appeared on the market.

If the cystotome is not going to be used to enlarge the hole, a graduated dilation catheter or a balloon dilator has to be used [3, 4, 17]. The stents may be straight or with pigtail ends. Within the procedure in several steps, double pigtail stents are usually preferred. In order to place the stent, a normal stent introducer set is usually utilized. Some authors in selected cases have placed covered self-expanding metallic stents with different calibers with the idea of removing them later [20].

In some pseudocysts with a dense content and in abscesses it can be useful to place a nasocystic pigtail end catheter to make continuous washings [1, 3, 9, 13]. We prefer a small-caliber catheter (e.g. 5 Fr) because it is less likely for an accidental looping and strangulation to occur and, moreover, it is less troublesome for the patient. The outer end of the catheter must be connected to a gravity drip or, preferably, to a mechanical infusion volumetric pump with a normal saline solution. The mechanical pump helps avoid disruption of flow caused by obstruction of the stents due to debris or the high density of the fluid.

Technique

We start the procedure with a linear therapeutic echoendoscope because most patients have previously been studied with a CT scan, MRI and/or radial EUS. Based on these images, we often design a previous mental plan to assess the best approach: transgastric, transduodenal, or both. With the tip of the echoendoscope inside the stomach or duodenum, we explore the wall between the gut lumen and the collection, measuring its thickness and the presence of blood vessels. It is highly recommendable to perform a scan of the wall with color or power Doppler [1, 3–9, 11–13, 15, 17, 21]. We must always choose the window where the wall is thinner and without vessels between surfaces. Chronic collections with an inflammatory or infectious component would have low risk of leakage, whereas pseudocysts with little inflammation would have a higher risk. There might be other factors related to the procedure such as the use of graduate dilators or electrosurgical current. It should be borne in mind that the graduated dilation catheter exerts an axial force that could detach the surfaces. However, the diathermic effect may help to keep the surfaces together due to the melting of tissue and the inflammatory reaction [22]. Some critical aspects to consider are listed in table 1.

One-Step Technique. When we are going to use the one-step device, we usually prefer the 8.5-Fr stents because they penetrate through the stomach wall more easily [6, 8]. The stent must be preloaded on the tip of the positioner-pusher catheter and over the dilator-introducer catheter. We must be careful and place the tapered tip of the stent in a forward position to facilitate penetration. The metallic tip of the internal guidewire must protrude 1 mm beyond the tip of the dilator-introducer catheter to obtain the needle-knife effect. When this guidewire is correctly positioned, we must fix it by tightening the screw of the contact pin adapter. We must consider that in some cases, depending on the morphology of the collection, there might not be much

Table 1. Critical aspects in endoscopic ultrasonographic drainage of pancreatic fluid collections

Successful drainage
Correct diagnosis
True pancreatic fluid collection vs. cystic neoplasm
Determination optimal drainage site
Avoiding interposed vessels (Doppler)
Minor distance between collection and gut lumen
Preventing peritoneal perforation or other organ penetration
Selection of the suitable technique case by case
Ultrasonic characterization of collection content and endoscopical appearance of the liquid
Anechoic content and/or crystalline liquid: one stent
No pure anechoic fluid and/or cloudy, dark liquid or debris: multiple stents
Lumps of necrosis, microbubbles and/or purulent liquid: multiples stents + nasocystic irrigation
Assessing definitive withdrawal of stents

space between the walls. The accidental contact of the needle-knife tip with the contralateral wall of the collection might, thus, increase the risk of perforation and internal bleeding. One trick to avoid this is to place the tapered tip of the stent immediately behind the tip of the needle knife, to put the tip of positioner-pusher catheter next to the end of the stent (fig. 1), and to strongly fix the system with a surgical artery clamp placed near the catheter handle (fig. 2).

The kit has a flap positioner sleeve to lay the flap flat during the stent introduction inside the working channel of the echoendoscope. However, when 8.5-Fr stents are used, it is not necessary to utilize this gadget because the flap in the folded back position fits well through the large working channel. The contact pin adapter must be connected with the cable of the electrosurgical unit, and the patient must have the corresponding electrosurgical electrode connected, preferably on the abdominal skin but not in the x-ray field. We usually use 250 W of blended (cutting and electrocoagulation) flow current with the intention that the needle-knife incision does not slip on the intestinal surface, while the fulguration is creating a correct size hole.

When the tip of the one-step device appears in the ultrasound image, we must seek the best incision angle, as perpendicular as possible to the wall between the intestinal lumen and the collection. Therefore, we must play with the up/down angulation control and the elevator forceps control. If the incision angle is not the correct one, we could cause a false way. When the tip of the device rests on the intestinal surface in the right direction, we can step on the cutting pedal of the electrosurgical unit and push slowly but decisively the one-step system. The needle knife, the dilator-introducer catheter and the tip of the stent will penetrate into the collection. During all this time it is very important not to separate the tip of the echoendoscope from the wall because, otherwise we would lose the ultrasound image and, above all, the axial force. We can usually watch the collection content boiling on the tip of the introducer catheter and, immediately behind this tip, a change in size of the catheter that corresponds to the tip of the stent (fig. 3, 4). Moreover, in some cases it is possible to watch the stent flap inside the collection. The stent is well positioned when the internal tip and flap are inside the collection cavity.

Only at this moment can we very carefully and slowly separate the tip of the echoendoscope from the intestinal surface without losing the direction. Once this is done, we can see in the optical image the stent go through the wall and its end with the external flap out of the wall and out of the echoendoscope channel. With the positioner-pusher catheter we can control the depth of penetration (fig. 5). Then, we can release the clamp that is fixing the positioner-pusher catheter to the dilator-introducer catheter and then carefully pull out the latter until the stent is released. We can immediately see the output of collection content through the stent hole (fig. 6, 7). If we do not see the output of liquid, we should see it while aspirating with the endoscope. If despite all this the liquid does not come out, either the stent is not well placed or there is a dense or solid content.

If the liquid is clear as water (pure pancreatic secretion) and the pseudocyst has an anechoic content, one stent may be enough (fig. 6). If the liquid is dark, cloudy, hematic, or with small particles of debris, we must place more than one stent (two or more) [3]. To place another stent we must seek a new window, and perform the procedure in the same way. If the one-step device has not been deteriorated, we can use it with a new preloaded stent. If it has been deteriorated, it is necessary to use a completely new kit. In most cases with more or less fluid liquid, to place between 2 and 4 stents is usually sufficient. In these cases we should keep the patient under observation a few days and then perform the follow-up as an outpatient. In some cases, to obtain a little quantity of content of the lesion it may be desirable to take a culture and antibiogram.

When there is dense content, solid debris or pus (fig. 7), it is necessary to place a nasocystic pigtail end catheter to make continuous washings [3]. As argued above, we usually use a 5-Fr catheter. This size of nasocystic catheter has the advantage that it fits perfectly through the stents of 8.5 Fr (fig. 8). To place it we use the internal guidewire of the one-step kit or a new hydrophilic guidewire of 0.035 inch and 480 cm of length. It is necessary to place this guidewire deeply inside the collection through one of the stents. Then, we can cautiously insert the nasocystic drainage over the guidewire through the stent until its pigtail tip is placed within the collection (fig. 8, 9). Once this is done, we can withdraw the internal guidewire of the catheter and, very slowly and carefully, the echoendoscope. We must simultaneously push the nasocystic catheter at the same speed. Throughout all this step of the procedure we use only endoscopic image control.

When we have removed the echoendoscope and all the length of the catheter is out of the endoscope, we cut off the catheter surplus. Next, we must place the external end that comes out of the mouth of the patient through one of the nostrils. In order to do this, it is necessary to use the short pre-curved catheter that is available in the nasocystic catheter kit. When we have the catheter placed through the nose, it is essential to fix the nasocystic catheter in the nasal flap with adhesive plaster to prevent accidental pulling. Finally, we must connect the Luer lock adapter on the external end of the nasocystic catheter.

Using a slim gastroscope, we may check the correct position and function of the stents and the washing catheter. If the system works, when saline solution is injected under pressure through the nasocystic catheter, the collection content must exit through the unoccupied stents (fig. 9, 10). In some cases, when the patient has an abscess, we wash the collection initially with 100 ml of povidone-iodine 5%. Afterwards, we connect the nasocystic catheter to a drip with a mechanical infusion volumetric pump for washing with saline solution. We frequently use a washing flow of 20–80 ml/h, depending on the patient's clinical conditions. It is important to carefully control the balance of liquids in the patient to avoid hydric overload. The patient should be admitted and under continuous washings for at least 1 week. Then we recommend performing a new CT scan or MRI to check progression. If the clinical parameters of infection and the collection size have decreased, we must assess the removal of the washing catheter. When the lesion or clinical parameters have not changed significantly, we must carry on with the washings and reconsider the antibiotic treatment. When the lesion is bigger, we must check


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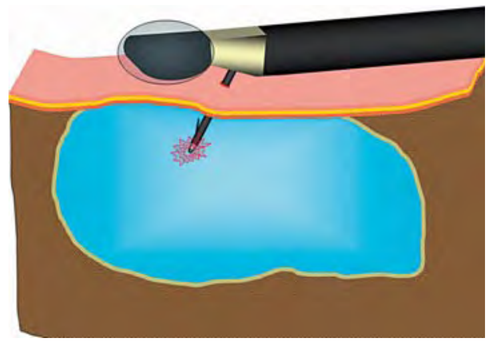
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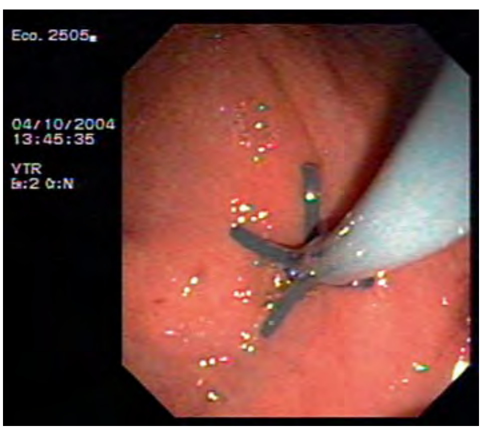

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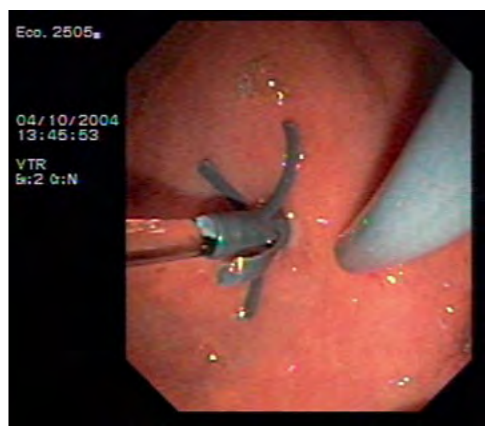

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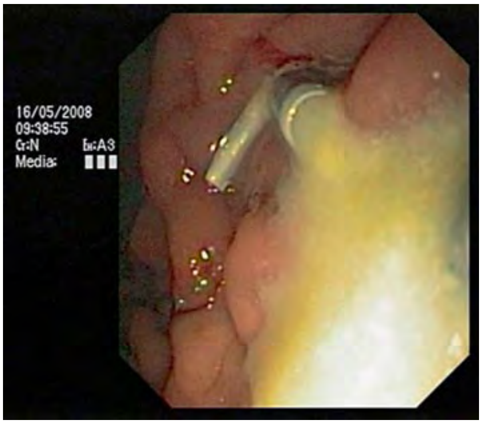
Fig. 1. Appropriate position of the stent, the dilator-introducer catheter and the needle-knife tip in the device. **Fig. 2.** Detail of the system with the stent and the surgical clamp positioned correctly.
Fig. 3. Ultrasonographic image showing the one-step device placing one stent. Note the content of the collection boiling. **Fig. 4.** Figure of one-step device making the hole and placing one stent at the same time.
Fig. 5. Endoscopic image showing the stent placement. We can control the deep of penetration of the stent with the positioner-pusher catheter. **Fig. 6.** Release of the prosthesis. Note the output of crystalline liquid.

the stents' permeability. This may be done by forcefully injecting 50–100 ml of saline solution through the nasocystic catheter and verifying the stents' permeability with a slim gastroscope. It is possible to perform this checking using x-ray control and radiographic liquid contrast, and if the stents are blocked we need a new endoscopic procedure to clean the system. In the event that we find ascitis, this is probably due to a leakage between the wall of the cyst and the

7 

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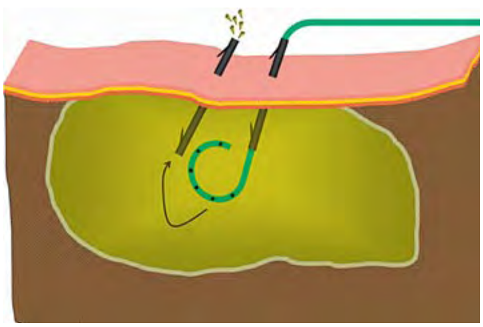
9 

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Fig. 7. Output of purulent material trough one stent recently placed. **Fig. 8.** Final assembly of a washing system with two stents and a nasocystic catheter. **Fig. 9.** Figure of the final assembly of a washing system to treat abscesses. **Fig. 10.** The same system as in figure 8, draining purulent content during the saline solution injection.

stomach. In this eventuality we must reduce the flow of the saline solution as little as possible and closely monitor the patient.

The nasocystic catheter should be withdrawn under endoscopic control to avoid removing the stent occupied by the catheter. In order to achieve this, we must fix the stent by holding it with a grasping forceps by the external flap, and then withdraw the entire catheter with the help of the visual control of the stent. Finally, we must check the permeability of all the stents by aspiration with the endoscope. These patients must stay admitted for 1–2 days more and then, if there are no complications, they must be discharged under oral antibiotic treatment. Some tricks are listed in table 2.

Several Steps Technique. To perform the procedure in several steps, x-ray equipment is required. When we have selected a window without vessels, we puncture the collection with a 19-gauge endoscopic ultrasound needle as in a normal diagnostic puncture. At this moment, it may be interesting to aspirate a quantity of content of the collection to decompress it and, if necessary, to perform a culture. Prior decompression of the collection may be useful in order to be able to inject radiographic contrast medium and thus reduce the risk of leakage. Next,

Table 2. Tricks (one-step technique)

- Stents of 8.5 Fr
- Place the tapered tip of the stent immediately behind the tip of the needle knife, and the positioner-pusher catheter next the end of the stent
- Fix the system strongly with a surgical artery clamp placed near the catheter handle
- Use 250 W of cutting and coagulation current blended
- Push the system slowly but decisively through the wall into the collection
- Perform the penetration time under ultrasonographic image control
- Release the stent under endoscopic image control
- If place a nasocystic catheter is needed, place a 5-Fr catheter through the last stent placed using the internal guidewire of the one-step kit
- Perform the initial washings under endoscopic image with 100 ml of povidone-iodine 5%
- Connect the nasocystic catheter with a mechanical infusion volumetric pump for washing with saline solution (20–80 ml/h)
- Nasocystic catheter should be withdrawn under endoscopic control to avoid removing the stent occupied by the catheter. Fix the stent by holding it with a grasping forceps by the external flap, and then withdraw the entire catheter with the help of the visual control of the stent

if necessary, we can inject contrast and obtain some radiological images. Then, we wash the needle lumen by injecting saline solution to lubricate its interior to facilitate the advancement of the 0.035-gauge hydrophilic guidewire. Now, we push the guidewire through the needle lumen deeply into the collection lumen. By using x-ray control we must confirm that the guidewire is coiled in the cavity to provide suitable anchorage.

Once this is done, we can use a 10-Fr cystotome to enlarge the initial hole. We prefer this device instead of using different kinds of dilators, because it is not necessary to separate the ultrasound probe from the gut wall while the hole is being enlarged. If we do not have a cystotome, a graduated dilation catheter or a balloon dilator may be used. But with this kind of device we probably lose the ultrasound probe contact and the axial force. Once we have the hole dilated and the guidewire in the cavity, we can separate the endoscope slowly and place a stent using a 10-Fr normal introducer catheter. In these cases we usually use a 10-Fr double pigtail end stent (fig. 11). If the placement of a new stent or of a nasocystic catheter is necessary, we must start again from the beginning, resulting in a more laborious technique. To avoid this, we can take advantage of the possibility that two guidewires can be simultaneously inserted into the 10-Fr cystotome or graduated dilator in a parallel position [23, 24]. Nevertheless, this procedure takes longer than the one-step method, and in our experience it is less safe, as we may lose access at any time, especially if the patient moves, because the time between the initial puncture and placement of the stents is too long.

To date, we have performed 29 procedures in 24 patients. In the first two procedures we only had available a non-therapeutic linear echoendoscope. As a result, we had to perform the procedures in two times and using the several steps technique, with a large-channel side-viewing endoscope in the second time. Once a linear therapeutic echoendoscope became available, we performed the procedures in one time. However, some of the first procedures were performed by the several steps technique using a 10-Fr cystotome and 10-Fr double pigtail end stents, because this is a well-contrasted technique commonly used in the literature. But, at the beginning, we used to employ the one-step system in a different fashion from the one previously described, and with x-ray guidance. As we gained experience, we gradually modified the procedure and usually performed it without x-ray guidance.

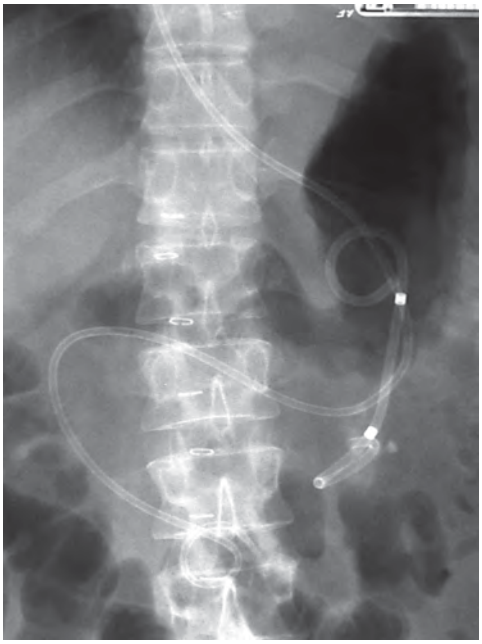

Fig. 11. Radiological image showing a double pigtail end stent and a nasocystic pigtail end catheter placed by the several steps technique.

Limitations and Complications

Limitations. There are several limitations to this technique. The presence of inaspiratable gastric content is a limitation that we have already described. This situation should be avoided because it increases the risk of bronchoaspiration and the risk of contamination of the collection content while this is being handled. The drainage, where the patient's stomach is not completely empty, should be performed only when there is a life-threatening risk (e.g. sepsis due to an abscess). Nevertheless, the airway must be protected by orotracheal intubation and the patient covered with broad-spectrum intravenous antibiotics.

Another limitation is the possibility of having a wide distance between the collection and the intestinal lumen. Classically, a distance >1 cm was considered risky [1, 3]. With the advent of EUS, this question is under review. In some articles it is considered that a distance >2 cm is risky but not an absolute contraindication, since there are other factors that also play a role to prevent perforation and leakage [1].

Endoscopic drainage is feasible only for pancreatic fluid collections located around the stomach and the duodenum. If these collections involve more distal locations, such as the paracolic regions, then these collections are not accessible through endoscopy and other adjunctive measures, such as percutaneous or surgical drainage need to be considered [15]. Postsurgical anatomic changes and impassable strictures may prevent the completion of the procedure [25]. Similarly, the presence of very large and thick varices in the ultrasound window may jeopardize the procedure. Although this eventuality is not infrequent, it is usually possible to find a low risk window [26]. This technique, as described here, is useful only in cases of collections with more or less fluid content and should not be used to treat completely solid necrosis. This topic is discussed in another chapter.

Complications. The complications of this procedure may be classified as early and late complications [3]. The most common early complications are perforation into peritoneum and leakage, bleeding, loss of a stent into the collection during its placement, and accidental puncture of other organs [3, 4, 7–9]. Perforation and leakage can usually be avoided if the procedure is correctly indicated and performed under endoscopic ultrasound guidance in real time thus allowing the selection of the best window for puncture. Factors to be considered are distance, location, degree of maturation, or presence of inflammatory adhesions between surfaces. The degree of maturation and the inflammatory adhesions between surfaces, along with the use of an electrosurgical device, are probably the most important factors to prevent perforations and/or leakages. When endoscopic ultrasonographic guidance is used the accidental puncture of other organs is a very uncommon complication [27].

There are two types of immediate bleedings: bleeding due to a laceration of wall vessels at the entry site, and the bleeding of vessels of the deep wall of the collection [3]. With echoendoscopy guidance and the use of Doppler it is possible to avoid the first type of bleedings [1, 3–9, 11–13, 15, 17, 21]. However, in these cases, the clinical implications are different depending on whether the bleeding occurs into the intestinal lumen or into the collection. If the patient bleeds on the gastric face toward the lumen, we might be able to treat it with endoscopic hemostatic techniques. If the bleeding is toward the collection, the endoscopic or echoendoscopic treatment may be more difficult, and if bleeding is uncontrollable, abundant or has hemodynamic repercussion a radiological embolization or a surgical approach might be necessary [1, 28].

In this context, we treated a patient that had a secondary vessel of the splenic artery between the gastric wall and pseudocyst wall. Prior to drainage we embolized this vessel prophylactically by using a modified cyanoacrylate (Glubran 2®) mixed with Ethiodol (Lipiodol®), guided by endoscopic ultrasound. We then placed two stents with a minimized risk. There were no complications due to this procedure and the patient progressed adequately.

The immediate bleeding of the deep wall of the collection may be the consequence of the laceration of a normal vessel caused by the accidental contact with the tip of the one-step device. A trick that we usually use to reduce this risk has been described in the previous section. Another classical origin of this complication is the rupture of a pseudoaneurysm due to the sudden decompression of the pseudocyst [1]. These eventualities will not be entirely prevented by the use of endoscopic ultrasound guidance [3]. In these cases radiological embolization or surgical treatment may be necessary. There is one report of the prophylactic embolization of a pseudoaneurysm of the splenic artery prior to the procedure which yielded good results [1].

The accidental loss of a stent into the collection during its placement is a possible complication especially when we use short straight stents. In some cases it is feasible to enlarge the hole with a 10- or 15-mm balloon dilator and to rescue the stent with a slim gastroscope. Another less aggressive trick is to create a system that fixes the stent to the catheters of the device and permits the controlled release of the stent.

Late complications may be delayed bleeding due to laceration of a deep vessel of the pseudocyst due to a decubitus of the stent, infection, progressive formation of ascites with or without associated pneumoperitoneum, and recurrence [1, 4, 9, 12]. The first complication is unusual and unpredictable. Laceration of a vessel might be facilitated by the size reduction and collapse of the cavity which causes that the internal tip of the stent, free in its interior before this eventuality, rests now on the contralateral wall to the puncture point. In this sense, some authors suggest a treatment with hydrogen pump inhibitors with the intent of reducing the potential erosion of intracystic vessels due to gastric acid [12]. However, in our opinion, the acid could play a beneficial role in reducing the number of microorganisms in the gastric lumen and contributing to the sclerosis of the wall of the collection.

Table 3. Limitations and complications

Limitations	
	Non-aspirable gastric content
	Distance between the collection and the intestinal lumen
	Collections located around the stomach and duodenum only
	Postsurgical anatomic changes and impassable strictures
	Presence of completely solid necrosis
Complications	
Early complications	
	Perforation to peritoneum and leakage
	Bleeding
	Laceration of wall vessels at the entry site
	Laceration of vessels of the deep wall of the collection
	Rupture of a pseudoaneurysm due to sudden decompression
	Accidental loss of a stent into the collection during their placement
Late complications	
	Delayed bleeding by laceration of a deep vessel of the collection due to a decubitus of the stent
	Postprocedural infection: blockage or dislodgement of the stents
	Progressive formation of ascitis with or without pneumoperitoneum: undetected or late leakage
	Recurrence: early or non-indicated withdrawal of the stent

Postprocedural infection may occur related to the blockage or dislodgement of the stents. Dysfunction of the stents in the first days after placement will induce the infection of the collection [1, 4, 8, 9, 12]. Notwithstanding, the later blockage of the stents will not cause an infection because the formation of a mature fistula around the stent tract (loose seton effect) will allow the continuous output of fluid content alongside the stents [1, 3]. The development of an infection of the collection may be prevented with an adequate number of stents and, if necessary, with the placement of a nasocystic catheter, as indicated previously (table 1) [1, 3, 9, 12]. When the infection has already occurred it must be treated as an abscess. Ascites and pneumoperitoneum are due to the existence of a leakage and its prevention has already been discussed.

When there is obstruction of the main pancreatic duct in a distal segment, or the tone of the papillary sphincter hinders the decompression of this duct, transmural drainage of the lesion might be insufficient. Theoretically, the collection may relapse in a high percentage of cases when the stent is removed. In these situations, it seems logical to place a transpapillary stent to decompress the proximal pancreatic duct. Nevertheless, authors with extensive experience are favorable to use only the transmural way. This might help to maintain a continuous flow through the stents preventing their blockage and permitting the maturation of a persistent fistula around the stent tract [1].

It is unclear when the stents must be withdrawn. Some authors propose removing the stents 3 months after their placement but, possibly, this is related to a higher recurrence rate [4]. At the beginning of our series, we usually withdrew the stents and we had one recurrence of the collection. As a result, we decided not to remove the stents at least for a long period of time. Since then, we have had no further recurrences. When performing the follow-up, some patients had spontaneously expelled some or all of the stents, and the cavity had been definitively reabsorbed and sclerosed. Because of this, in our view, the stents should not be withdrawn. In our series no patient has had problems related to permanence, late dislodgement, or intestinal migration of

Table 4. Results of some of the latest series published in the literature and our experience

Reference (first author)	Pts n	More than one collection	Total procedures	Patients who needed more than one procedure	Several steps	One step	Complications not manageable with conservative approach	Deaths related to procedure	Immediate success of the procedure	Definitive resolution
Hookey 2006	51	24 (47%)	–	–	51 (100%)	0 (0%)	6 (11%)	0 (0%)	49 (96%)	45 (88%)
Kruger 2006	35	0 (0%)	–	9 (27%)	19 (36%)	33 (63%)	0 (0%)	0 (0%)	33 (94%)	29 (88%)
Ahlawat 2006	11	1 (1%)	12	1 (1%)	12 (100%)	0 (0%)	2 (2%)	0 (0%)	12 (100%)	9 (82%)
Lopes 2007	51	1 (2%)	62	8 (15%)	34 (55%)	28 (45%)	3 (5%)	0 (0%)	60 (96%)	48 (94%)
Varadarajulu 2008	60	6 (10%)	62	9 (15%)	62 (100%)	0 (0%)	1 (2%)	0 (0%)	57 (95%)	53 (93%)
Our experience 2009	24	1 (4%)	29	4 (17%)	5 (17%)	24 (83%)	2 (7%)	0 (0%)	28 (96%)	21 (88%)
Total	232	33 (14%)	–	–	183 (68%)	85 (32%)	14 (5%)	0 (0%)	238 (96%)	205 (88%)

stents during years of follow-up. The most important limitations and complications are outlined in table 3.

Outcomes

Results of some of the latest series published in the literature and our experience are shown in table 4 [1, 4, 8, 9, 19]. In this table we have included series with fluid collections (pseudocysts, and abscesses or necrosis more or less fluid) but no completely solid necroses. The table contains a total of 232 patients who underwent one or more drainage procedures guided by EUS. 33 patients (14%) had more than one collection. Some of these patients needed more than one drainage procedure but some publications do not specify the total number of procedures or the procedures per patient. In this table the real one-step technique has been used only in three series, in a total of 85 patients (32%). We have not found series comparing the several steps technique vs. the one-step technique specifically. 14 patients had non-resoluble complications with conservative approach. An important number of these were patients with severe pathologies. No patient died due to drainage guided by EUS. In one series that includes treatments performed with and without EUS guidance [1], 1 patient died. However, we have not included the group without EUS guidance in the table.

When assessing outcomes, it is important to distinguish between immediate success of the procedure and definitive resolution. The former refers to successfully achieving access and drainage of the fluid collection, whereas the latter pertains to complete and permanent resolution of this fluid collection [15]. This is important because, although the procedure may have been technically successful, there are other factors, some of which we have already mentioned, which can derail the final result. One of these factors is the early withdrawal of the stents solely because imaging techniques have shown the collection to have disappeared.

Conclusion

Endoscopic ultrasonographic drainage is an effective and safe technique for treatment of pancreatic fluid collections. It should be performed only by physicians expert in EUS and ERCP. There are some critical aspects of the technique that are necessary to consider: the adequate diagnosis of the collection, to determine the most appropriate puncture point (without vessels, minimum distance, avoiding other organ penetration…), and the choice of the best technique. The technique may be performed in several steps or in one step, and we must choose case by case which option we are most comfortable with. Another important issue is timing of the placement of one or more stents and a nasocystic catheter. The last important question is when we should withdraw the stents and if this is really necessary. We favor the one-step technique because in our experience it is easier and quicker. In our view, new accessories should be developed, preferably in the one-step modality, so that the procedure becomes even safer, easier and quicker.

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