Endoscopic ultrasound in chronic pancreatitis: Where are we now?

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Abstract
Endoscopic ultrasonography (EUS) is well suited for assessment of the pancreas due to its high resolution and the proximity of the transducer to the pancreas, avoiding air in the gut. Evaluation of chronic pancreatitis (CP) was an early target for EUS, initially just for diagnosis but later for therapeutic purposes. The diagnosis of CP is still accomplished using the standard scoring based on nine criteria, all considered to be of equal value. For diagnosis of any CP, at least three or four criteria must be fulfilled, but for diagnosis of severe CP at least six criteria are necessary. The Rosemont classification, more restrictive, aims to standardize the criteria and assigns different values to different features, but requires further validation. EUS-fine needle aspiration (EUS-FNA) is less advisable for diagnosis of diffuse CP due to its potential side effects. Elastography and contrast-enhanced EUS are orientation in differentiating a focal pancreatic mass in a parenchyma with features of CP, but they cannot replace EUS-FNA. The usefulness of EUS-guided celiac block for painful CP is still being debated with regard to the best technique and the indications. EUS-guided drainage of pseudocysts is preferred in non-bulging pseudocysts or in the presence of portal hypertension. EUS-guided drainage of the main pancreatic duct should be reserved for cases in which endoscopic retrograde cholangiopancreatography has failed owing to difficult cannulation of the papilla or difficult endotherapy. It should be performed only by highly skilled endoscopists, due to the high rate of complications.

Key words: Endoscopic ultrasonography; Pancreatic neoplasms; Chronic pancreatitis; Contrast agents; Nerve block; Pancreatic pseudocyst; Drainage; Elastography; Main pancreatic duct

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INTRODUCTION
Chronic pancreatitis (CP) is an irreversible and progressive inflammatory process featuring pathological modifications of fibrosis, inflammatory infiltration, and destruction of exocrine and endocrine tissue, resulting in characteristic morphological changes in the parenchyma and pancreatic ducts. These modifications vary in intensity and distribution (diffuse or patchy). This has several consequences: (1) Biopsy specimens are difficult to obtain and not always
relevant, because they do not fully display the signs of CP; moreover, duct biopsy is usually avoided due to the risk of acute pancreatitis; (2) Most imaging methods reflect only partially the CP modifications, especially those typical for late stages of the disease; some methods, such as endoscopic retrograde cholangiopancreatography (ERCP) and magnetic retrograde cholangiopancreatography (MRCP) detect only the ductal features of CP; and (3) The findings of pancreatic function tests are not modified until a late stage in the natural history of the disease. Endoscopic ultrasonography (EUS) accomplishes the quality of being an imaging method able to detect both early and late changes in the parenchyma and pancreatic ducts.

The pancreas is well assessed by EUS due to the method’s high resolution and the proximity of the transducer to the pancreas with the possibility of avoiding air in the gut. In patients with CP, EUS was performed initially for diagnosis, then for differential diagnosis, and later for therapeutic purposes (Figure 1).

**POSITIVE DIAGNOSIS**

Despite its advantage of assessing the pancreas at very close range, EUS, being operator dependent, is still imperfect in establishing the diagnosis of chronic pancreatitis. The various pathological aspects of the disease are shown as different EUS features, and the same importance for diagnosis has been attributed to all of them. There have been several attempts to define the disease on ductal and parenchymal criteria, initially embracing 11 criteria, then focusing on nine factors corresponding to histopathological changes: five parenchymal criteria (hyperechoic foci, hyperechoic strands, parenchymal lobularity, cysts, calcifications) and four ductal criteria (pancreatic duct dilatation, pancreatic duct irregularity, hyperechoic pancreatic duct walls, visible pancreatic side branches) (Figure 2). Very rarely are all these manifestations present simultaneously. Some of these features have been found also in elderly people, males (OR = 1.8, 95% CI: 1.3-2.55), persons with a history of alcohol consumption abuse (OR = 5.1, 95% CI: 3.1-8.5), smokers (OR = 1.7, 95% CI: 1.2-2.4), and those with history of acute pancreatitis. Some features, like gland atrophy or lobularity aspect, can impede the complete assessment of all features (e.g. visualization of side branches of pancreatic ducts).

The interobserver agreement in one study using these criteria was moderate (κ = 0.45), with good agreement only for duct dilatation and lobularity; the main drawback of the study was the limited experience of some examiners with pancreatic EUS. The most important criterion for the diagnosis was considered by all experts to be pancreatic stones, followed by visible side branches and lobularity, and the least significant was main pancreatic duct (MPD) dilatation. In an EUS study in which both digital linear and radial echo endoscopes were employed, the interobserver variability also moderate (κ = 0.50 and 0.61 respectively); the best concordance between the two methods was found for detection of cysts, calcifications, and visible side branches.

Because histological evaluation of the pancreas is usually difficult, different gold standards have been used to establish the optimum number of EUS criteria for diagnosis of CP. The secretin direct pancreatic test has 85% sensitivity and 85% specificity for CP diagnosis, and the false-negative results are due to preserved pancreatic exocrine function. Using one or two criteria for mild pancreatitis, three to five for moderate pancreatitis, and more than five for severe forms, the agreement with the secretin test as gold standard was 100% for normal parenchyma and severe disease, 50% for moderate forms, and 13% for mild disease. On comparison of both EUS radial and linear assessment with the endoscopic secretin test during the same procedure, the best EUS accuracy was obtained for a cut-off point of more than four criteria (accuracy of 84% and 74%, respectively). The same group obtained lower sensitivity and specificity for diagnosis using four EUS criteria when cholecystokinin was used instead of secretin to test pancreatic function. Comparison of assessment by non-blinded EUS (three to five criteria for diagnosis) and endoscopic retrograde cholangiopancreatography (ERCP; Cambridge classification) showed quite similar sensitivity (72% vs 68%) and specificity (76% vs 79%) for either mild or severe chronic pancreatitis, with the secretin endoscopic direct pancreatic test as the reference. However, the odds ratio for exocrine insufficiency was higher for EUS assessment than for ERCP. To obtain the best specificity and

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**Figure 1** Flowchart of the endoscopic ultrasonography utility in chronic pancreatitis. EUS: Endoscopic ultrasonography; CP: Chronic pancreatitis; CE-EUS: Contrast enhanced endoscopic ultrasonography; MPD: Main pancreatic duct.

**Figure 2** Chronic pancreatitis. Parenchymal and ductal pancreatic stones as hyperechoic structures with shadowing and stenosis of the main pancreatic duct.
the best negative predictive value for diagnosis, six criteria were needed, however, the sensitivity was only 26%[8,14]. Secretin-stimulated EUS detected the features of CP better than EUS without secretin (12/13 patients) and the sensitized EUS seemed to be able to predict a favorable outcome or success of endoscopic treatment[13] (Table 1).

Using ERCP as gold standard, more than two criteria or three criteria, respectively, were found to be optimal for diagnosis[21,23]. The EUS sensitivity for diagnosis varied between 68% and 100% and the specificity was 78%-97% when ERCP was considered the gold standard (Table 1). The overall agreement with ERCP was $k = 0.51$, but the concordance for mild forms on EUS was only 83%. The factors most predictive for abnormal ERCP were ductal stones and parenchymal calcifications[8]. Among patients with a normal pancreaticogram, 84.2% were found to have parenchymal changes of CP (accentuation of lobular pattern, focal areas of reduced echogenicity, hyperechoic foci) or increased ductal wall echogenicity. During follow-up (median 18 mo), 68% of patients with initially normal findings on ERCP progressed to an abnormal pancreaticogram, supporting the importance of EUS description for early CP. However, this evolution was not confirmed in a second study of alcoholic chronic cirrhosis and CP[14-17].

Pathologic diagnosis, the ideal gold standard, is rarely obtained from surgical specimens, EUS fine needle aspiration (EUS-FNA) or Tru-Cut core biopsies. The correspondence of EUS criteria to pathologic changes is shown in Table 2[21,22]. One recent paper showed that in postmortem pancreatic specimens the presence of more than three EUS standard criteria of CP correlated with the histologic diagnosis, but these features were also present in elderly persons dying of diseases other than CP[23] and in 59% of asymptomatic alcohol abusers[8].

Comparing the EUS standard criteria with the histologic findings from specimens obtained during surgery, fulfillment of five or more criteria was associated with sensitivity of 60% and specificity of 83%, compared with 87% and 64% respectively when three criteria were

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### Table 1  Diagnostic value of endoscopic ultrasonography in chronic pancreatitis

| Author | No. of pts | No. of EUS criteria | Threshold for CP diagnosis | Comparison | Sn | Sp | PPV | NPV | Acc |
|--------|------------|---------------------|---------------------------|------------|----|----|-----|-----|-----|
| Wiersema et al[8] | 69 | 11 | > 3 = dg | EUS vs ERCP | 100 | 79 |  |
| | | | | EUS vs ERCP + secretin test | 70 | 33 |  |
| | | | | EUS vs ERCP + history | 90 | 66 |  |
| | | | | EUS vs secretin test | 84 | 78 |  |
| | | | | EUS vs ERCP | 86.1 | 95.4 |  |
| | | | | EUS vs ERCP + secretin test | 84.2 | 97.6 |  |
| Catalano et al[9] | 80 | 11 | 1-2 mild | EUS vs ERCP | > 85 | < 85 |  |
| | | | 3-5 moderate |  |  |  |
| | | | > 5 severe |  |  |  |
| Sahai et al[9] | 126 | 9 | > 2 for any CP | EUS vs ERCP | > 85 | < 85 |  |
| | | | < 3 = fibrosis |  |  |  |
| | | | > 6 = severe |  |  |  |
| Conwell et al[14] | 56 | 9 | 4.5 = equivocal | EUS vs ePFT | 36 | 94 | 41 |  |
| | | | > 6 = definite | 26 | 100 | 39 |  |
| Stevens et al[15] | 83 | 9 | 3.5 = dg | EUS vs ERCP | 68 | 79 | 83 | 62 |  |
| | | | 6-9 = severe |  |  |  |
| Stevens et al[16] | 100 | 9 | > 4 | Radial EUS vs ePFT | 68 | 95 | 84 |  |
| | | | Linear EUS vs ePFT | 44 | 95 | 74 |  |
| Stevens et al[17] | 50 | 9 | > 4 | EUS vs secretin ePFT | 71 | 92 |  |
| | | | EUS vs CCK ePFT | 63 | 85 |  |
| Zimmermann et al[18] | 21 | 9 | > 4 | EUS vs histology (surgery) | 78 | 73 |  |
| Varadarajulu et al[19] | 21 | 9 | > 4 | EUS vs histology$^a$ (surgery) | 90 | 85.7 | 88.1 |  |
| Chong et al[20] | 71 | 9 | > 3 = dg | EUS vs histology$^a$ (surgery) | 83.3 | 80 |  |
| Bhutani et al[21] | 11 | 9 | > 4 = severe fibrosis | EUS vs histology (autopsy) |  |  |  |

$^a$Non-calcific chronic pancreatitis. ePFT: Endoscopic pancreatic function test; EUS: Endoscopic ultrasonography; ERCP: Endoscopic retrograde cholangiopancreatography; Sn: Sensitivity; Sp: Specificity; Acc: Accuracy; CCK: Cholecystokinin; PPV: Positive predictive value; NPV: Negative predictive value.

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### Table 2  Correspondence between standard endoscopic ultrasonography criteria and pathologic features in chronic pancreatitis (adapted from Sahai AV 2002[21])

| Standard EUS criteria | Pathologic features |
|-----------------------|---------------------|
| Parenchymal criteria  |                     |
| Hyperechoic foci      | Small calcifications |
| Hyperechoic strands   | Fibrosis             |
| Lobularity            | Edema or fibrosis    |
| Cysts                 | Pseudocysts          |
| Calcifications        | Calcifications       |
| Ductal criteria       |                     |
| MPD dilatation        | MPD dilatation       |
| MPD irregularity       | MPD irregular        |
| Hyperechoic MPD walls | Ductal fibrosis or edema |
| Visible side branches | Dilated secondary branches |

EUS: Endoscopic ultrasonography; MPD: Main pancreatic duct.
Anechoic, rounded/elliptical structures with or without septations
Hyperechoic foci with shadowing
Head, body and tail only
Minor
Major B
Minor
Lobularity with honeycombing
Minor
Hyperechoic lines
Cysts
1 major feature A +
Lobularity with honeycombing
Minor
Irregularity of MPD contour
MPD dilation
Echogenic structures within the MPD with acoustic shadowing
Uneven or irregular outline and ectatic course
Body and tail only
Body and tail only
Body and tail only
Body and tail only
Body and tail only

MPD: Main pancreatic duct.

Table 3 Rosemont consensus definitions

| Rank | Features                      | Definition                                                                 | Location       |
|------|-------------------------------|---------------------------------------------------------------------------|----------------|
| 1    | Major A 1                     | Hyperechoic foci with shadowing                                          | Body and tail only |
| 2    | Major B 2                     | Lobularity with honeycombing                                             | Body and tail only |
|      | Minor 3                        | Lobularity with honeycombing                                             | Body and tail only |
| 3    | Minor 4                        | Hyperechoic foci without shadowing                                       | Body and tail only |
| 4    | Minor 5                        | Cysts                                                                     | Head, body and tail only |
| 5    | Minor 6                        | Stranding                                                                 | Body and tail only |

Table 4 Rosemont diagnostic stratification

| Stratum          | Criteria                                                                 |
|------------------|---------------------------------------------------------------------------|
| Consistent with CP | 1 major feature A + ≥ 3 minor features                                |
|                  | 1 major feature A + major feature B                                      |
|                  | 2 major feature                                                           |
| Suggestive of CP  | 1 major feature A + < 3 minor features                                   |
|                  | 1 major feature B + ≥ 3 minor features                                   |
|                  | ≥ 5 minor features (any)                                                 |
| Indeterminate for CP | 3 or 4 minor features major feature B alone or with < 3 minor features |
| Normal           | ≤ 2 minor features                                                       |

1Excludes cysts, dilated main pancreatic duct, hyperechoic non-shadowing foci, dilated side branch. CP: Chronic pancreatitis.

Because the different pathological characteristics of CP vary in importance, the nine-criteria scheme assigning each criterion the same importance is insufficiently reliable and its diagnostic accuracy doubtful. The Rosemont classification, elaborated by international consensus, uses parenchymal and ductal criteria divided into major and minor features (Table 3). On this basis the findings are classified as “consistent with CP”, “suggestive of CP”, “indeterminate for CP”, or “normal” (Table 4). This system, quite complicated and more restrictive in diagnosing CP, proved to agree with the diagnostic classification of the nine-criteria scheme in 74% of cases, increasing to 84% when “suggestive of CP” was included. Using this system, the findings were similar for radial and linear EUS, with good results for parenchymal criteria (cysts 100%, hyperechoic foci 98%, lobularity/dilated ducts 94%) and modest results for dilated side branch, irregular pancreatic duct and hyperechoic wall of MPD in 40%. In a recent multicenter study, 14 experts evaluated 50 recorded videos using the standard nine EUS criteria (diagnostic: > 4 criteria) and the Rosemont criteria (diagnostic: suggestive of CP or consistent
Elastography evaluates tissue strain resulting from compression and that strain is smaller in harder tissue than in softer tissue. Different tissue elasticity patterns are marked supplementary on the grey-color scale with different colors (blue for hard tissue and red for soft tissue). EUS elastography in CP shows a honeycomb aspect with predominantly hard strands, corresponding to fulfillment of four standard diagnostic criteria. The sensitivity, specificity, and accuracy were found to be 66%, 57%, and 60%, respectively, and the method was considered useful in cases of equivocal EUS (three criteria or fewer). Further studies overcame the limitations of qualitative image analysis by means of digital image quantification, which helps to differentiate benign (normal pancreas and chronic pseudotumoral pancreatitis) from malignant lesions (pancreatic cancer and neuroendocrine tumors) with higher sensitivity, specificity, and accuracy (91.4%, 87.9%, and 89.7%, respectively). Using a scoring system based on different color patterns in the images, the differentiation between benign and malignant pancreatic masses had sensitivity of 92.3% and specificity of 80%.

### Differential Diagnosis

If focal hypoechoic lesion are found in the pancreatic parenchyma, the differential diagnosis includes primary or secondary pancreatic tumor, focal CP, and autoimmune pancreatitis. Several methods have been developed for this purpose.

#### Elastography

Elastography evaluates tissue strain resulting from compression and that strain is smaller in harder tissue than in softer tissue. Different tissue elasticity patterns are marked supplementary on the grey-color scale with different colors (blue for hard tissue and red for soft tissue). EUS elastography in CP shows a honeycomb aspect with predominantly hard strands, corresponding to fulfillment of four standard diagnostic criteria. The sensitivity, specificity, and accuracy were found to be 66%, 57%, and 60%, respectively, and the method was considered useful in cases of equivocal EUS (three criteria or fewer). Further studies overcame the limitations of qualitative image analysis by means of digital image quantification, which helps to differentiate benign (normal pancreas and chronic pseudotumoral pancreatitis) from malignant lesions (pancreatic cancer and neuroendocrine tumors) with higher sensitivity, specificity, and accuracy (91.4%, 87.9%, and 89.7%, respectively). Using a scoring system based on different color patterns in the images, the differentiation between benign and malignant pancreatic masses had sensitivity of 92.3% and specificity of 80%.

### Contrast-Enhanced EUS

Ultrasound contrast agents increase the signal from the blood and improves the detectability of small vessels flow during ultrasound examinations. Before and after injection of Sonovue® (Bracco), the focal pancreatitis shows no detectable vascularization or the vessels appear regular over a distance of at least 20 mm, with detection of both arterial and venous vessels in the contrast-enhanced phase (Figure 3). Based on the perfusion characteristics of microvessels, contrast-enhanced US facilitates differential diagnosis between inflammatory lesions and ductal adenocarcinoma. The specificity of the discrimination between benign and malignant focal pancreatic lesions was found to be 93.3% using power Doppler contrast-enhanced EUS (CE-EUS) compared with 83.3% for conventional EUS. The hypovascular aspect of lesions under power Doppler CE-EUS seemed highly sensitive and specific (91.1% and 93.3%, respectively) for adenocarcinoma. During power Doppler CE-EUS examinations the ultrasound frequency returned to the transducer is the same with that transmitted, but the method is associated with artifacts resulting from turbulent flow (blooming and overpainting). The use of contrast agents is preferred using harmonic frequencies which result from non-linear and non-symmetrical oscillation of the microbubbles. This yields an image with complete “subtraction” of the tissue-derived signal, optimized by using a low mechanical index, which allows continuous real-time assessment of the microvascularization during contrast medium uptake.
Harmonic CE-EUS shows an iso vascular homogeneous pattern of CP\cite{59} or, in severe forms, a hypovascular pattern, due to extensive fibrosis\cite{60} (Figure 4A). Our results confirmed that severe CP may be hypovascular on harmonic CE-EUS, and quantitative assessment of images can improve differentiation between adenocarcinomas and chronic pancreatitis (accuracy of 86\%) (unpublished data), but, similar to elastography, cannot replace the use of EUS-FNA.

**EUS-FNA of focal lesions**

The EUS sensitivity for detection of suspected pancreatic mass in a parenchyma with CP modifications was 100\%, but the positive predictive value of pancreatic malignancy in these situations was only 60\%, because some malignant masses present internal or peripheral calcifications, similar to focal CP\cite{59}. The sensitivity of EUS-FNA for malignancy in parenchymal masses with features of CP is only 54\%-74\%, compared with 89\% when the surrounding parenchyma is normal\cite{51,52,53}. However, in the event of high suspicion of malignancy with negative EUS-FNA, repeated FNA yields a positive diagnosis in 84\% of cases, whereas half of the failures of first biopsies are attributed to the presence of CP\cite{59}. Kras mutation and allele deletions of the microsatellite or of the tumor suppressors can be reliably detected in EUS-FNA samples from pancreatic masses, improving the diagnostic accuracy\cite{57,58}. The search for codon-12 Kras mutation revealed no cases in patients with pseudotumor CP, in contrast to the adenocarcinoma group, although 6\%-12\% of patients with diffuse CP and PanIN lesions had presented Kras mutations in a previous meta-analysis\cite{53,54}.

**EUS THERAPY**

**EUS-guided celiac block**

One of the therapeutic uses of EUS in CP is celiac plexus blockade, i.e. temporary inhibition of the celiac plexus using a combination of local anesthesia and steroids, with the aim of reducing pain and improving the quality of life\cite{61}. This guidance is preferred to CT-guided blockade because the details of the region are better appreciated and the side effects are fewer and less severe\cite{62}. Frequently the celiac ganglia can be seen as a unique or concatenate hypoechoic structure, less well delineated, with some whitish strands inside\cite{63}.

Some issues regarding EUS-guided celiac block remain to be resolved. The indication is pain in CP, but some studies included pain accompanying moderate pancreatitis\cite{59} or patients with pain that had not responded to other forms of treatment\cite{59}. Another unclarified issue is the technique of injection (central or bilateral) and the quantity of steroid needed. The majority of studies used the bilateral injection technique, considered equal in safety to central injection, but the results of the two techniques concerning the alleviation of pain were close and contradictory\cite{64,65}, showing the need for a placebo-controlled trial\cite{66}. Direct injection of triamcinolone within the celiac ganglia (13 patients) compared with alcohol injection (5 patients) yielded disappointing results in respect of pain alleviation for steroid use (38\% vs 80\%)\cite{67}. A comparative study of results between the celiac region injection and celiac ganglia injection for EUS-guided celiac block is still lacking.

The question of cost-effectiveness remains unresolved. Some studies followed up the patients for only 1-4 wk\cite{68,69}. The only study with an extended follow-up period showed duration of pain relief of up to 673 d. This raises the question of whether the natural course of the disease may have been responsible, because there were no data indicative of the level of severity of CP: duration of disease from onset of pain, presence of diabetes, or calcifications\cite{64}.

In many studies, the alleviation of pain varied from 55\% to 70\% with a short duration of follow-up\cite{68,69,70}. Persistence of pain alleviation for as long as 24 wk was seen in no patients\cite{69} or in only 10\% of patients\cite{70}. Two meta-analyses showed efficacy in managing chronic abdominal pain in 51.46%\cite{71} and 59.45%\cite{72} of patients respectively. The rate of major complications seemed very low (0.6\%), being represented by retroperitoneal abscess\cite{73}.

**EUS-guided drainage of pseudocysts**

Therapeutic intervention in patients with chronic pancreatic pseudocysts is indicated when at least one complica-
tion is present (compression of large vessels, obstruction of duodenum, stomach, or common bile duct, infection, hemorrhage into pancreatic pseudocyst, pancreatocutaneous-pleural fistula) or when symptoms occur (safety, pain, nausea or vomiting, upper gastrointestinal bleeding) [73-74]. Since 1996, several series of EUS-guided drainage have been reported, especially for collections without bulging onto the gut wall or with parietal vessels due to portal hypertension [75-77]. The main limitation is location of the fluid collection further than 1 to 1.5 cm from the gut wall [97-98] (Figure 4).

This method is preferred for surgical drainage, which is associated with a high rate of mortality and morbidity [93]. However, a non-randomized case-control study showed the same rates of treatment success, complications, and reinterventions for surgical and EUS-guided drainage, but with lower costs and shorter hospital stay for the EUS-guided procedure [93].

Conventional endoscopic drainage and EUS-guided drainage were compared in four papers. In a prospective non-randomized study, the two approaches seemed equally safe and effective [82], but this was not confirmed in a second non-randomized study, where EUS represented a salvage method in the case of failure of conventional endoscopic drainage owing to non-bulging pseudocysts or location in the tail of the organ, but was a more time-consuming procedure [86]. The conclusion of this second study was that EUS should be reserved for pseudocysts located in the tail of the pancreas, because these are unlikely to cause luminal compression or are technically difficult to access. Also, EUS assessment would identify a tumor in 5% of pseudocysts [84]. A third randomized clinical trial showed a significantly better success rate for EUS than for conventional endoscopic-guided drainage (100% vs 33%), despite the small number of patients, even after statistical adjustment for luminal compression [86]. A fourth randomized study confirmed also a significant advantage for EUS over conventional endoscopic drainage (94% vs 72%); both were considered first-line methods for treatment of bulging pseudocysts, but the authors recommended that EUS-guided drainage should be preferred for non-bulging pseudocysts [91].

Several aspects of EUS-guided drainage remain to be elucidated. First among these is the issue of the means used to create the communication between gut and pseudocyst. There are two major techniques for obtaining this communication: (1) balloon dilatation of a previous puncture site, with a 93%-100% success rate [83,84,87-89]; and (2) coagulation of the communication site by means of a cys	ostomy (success rate of 95% when two procedures per patient were performed [80] and 71%-82% with one procedure per patient [91-93]), a Giovannini needle (success rate of 94% [94]), but only 84% after the first attempt [86], or a needle-knife, with the same success rate as balloon dilatation but a higher perforation rate [86,90,91,92]. Larger comparative studies will be necessary to assess the best device with the highest success rate and the lowest complication rate. The prototype “transluminal balloon accessotome”, which combines a needle-knife and a dilating balloon, will probably allow easier drainage in one single step, reducing the exchange of accessories and simplifying the procedure [97]. Moreover, the use of the prototype three-layer puncture kit, which allows the simultaneous insertion of two guidewires at the initial puncture in one step, or the use of a larger working channel in the echo-endoscope, would allow safer and faster drainage [98]. Furthermore, the use of a forward-viewing echoendoscope seems promising for drainage of pseudocysts, even those inaccessible with a conventional therapeutic side-viewing EUS endoscope [99]. A further issue to be resolved is that of the morphological or biological factors that predict therapeutic success. Knowledge of such factors would facilitate selection of patients suitable for direct surgery. Moreover, to avoid pseudocyst relapse, described in 4%-17% of cases after 6-9 mo follow-up [94,95,100], communication with a secondary pancreatic duct, should be assessed very carefully.

**EUS-guided drainage of main pancreatic duct**

EUS-guided drainage of the MPD is a second-line procedure indicated when ERCP is unsuccessful owing to inability to cannulate the MPD (severe inflammation, previous surgery, postsurgical stricture) or difficult endotherapy (tight stenosis, large stone, MPD rupture, pancreas division). In practice, there are only few cases in which ERCP cannot be successfully performed by an experienced endoscopist, and recent studies suggests the superiority of surgery in managing pain. Thus, only a very small number of patients, namely those in whom ERCP fails and surgery cannot be performed safely, are good candidates for this procedure [100]. Using the transpapillary approach or the transpapillary rendezvous approach, EUS-guided drainage of the MPD remains technically challenging because of difficulty in orienting the endoscope along the axis of the duct, difficult dilatation of the transmural tract due to pancreatic fibrosis, or the acute angle of the needle in relation to the MPD. Despite success rates of 68%-71%, the complication rates were important in all four series published (5%-43%); the complications included perforations, bleeding, pancreatitis, fever, and postprocedural pain [102-105]. EUS-guided drainage of the MPD should continue to be confined to tertiary care centers and very experienced endoscopists.

**CONCLUSION**

The diagnosis of CP is still accomplished using the standard scoring based on nine criteria each considered as having the same value. For diagnosis of any CP, at least three or four of these criteria must be present, but for diagnosis of severe CP more than six criteria must be fulfilled. The more restrictive Rosemont classification aims to standardize the criteria and assigns different values to different features, but requires further validation. EUS-FNA is less advisable for diagnosis of diffuse CP due to the possible side effects. Elastography and contrast-enhanced EUS are orientation in differentiating focal pancreatic mass, but they cannot replace EUS-FNA. The utility of EUS-guided celiac block for painful CP is still a matter of debate with...
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to regard best to technique and the indications. EUS-guided drainage of pseudocysts is preferred especially in nonbulging pseudocysts or presence of portal hypertension. EUS-guided drainage of the MPD should be reserved for cases of unsuccessful ERCP caused by difficult cannulation of the papilla or difficult endotherapy. It should be performed only by highly skilled endoscopists, due to the high risk of complications.

REFERENCES

1 Wiersema MJ, Wiersema LM. Endosonography of the pancreas: normal variation versus changes of early chronic pancreatitis. Gastrointest Endosc Clin N Am 1995; 5: 487-496
2 Catalano MF, Lahoti S, Geenen JE, Hogan WJ. Prospective evaluation of endoscopic ultrasonography, endoscopic retrograde pancreatography, and secretin test in the diagnosis of chronic pancreatitis. Gastrointest Endosc 1998; 48: 11-17
3 The International Working Group for Minimum Standard Terminology for Gastrointestinal Endosonography. Reproduction of minimal standard terminology in gastrointestinal endosonography. Dig Endosc 1998; 10: 158-188
4 Wiersema MJ, Hawes RH, Lehman GA, Kochman ML, Sherman S, Kopecky KK. Prospective evaluation of endoscopic ultrasonography and endoscopic retrograde cholangiopancreatography in patients with chronic abdominal pain of suspected pancreatic origin. Endoscopy 1993; 25: 555-564
5 Bhutan MS. Endoscopic ultrasonography: changes of chronic pancreatitis in asymptomatic and symptomatic alcoholic patients. J Ultrasound Med 1999; 18: 455-462
6 Yousof JJ, Sahai AV. A prospective, quantitative assessment of the effect of ethanol and other variables on the endosonographic appearance of the pancreas. Clin Gastroenterol Hepatol 2004; 2: 405-409
7 Rajan E, Clain JE, Levy MJ, Nordon ID, Wang KK, Wiersema MJ, Vaquez-Queiroz E, Nelson BJ, Jondal ML, Kendall RK, Harmsen WS, Zinsmeister AR. Age-related changes in the pancreas identified by EUS: a prospective evaluation. Gastrointest Endosc 2005; 61: 401-406
8 Sahai AV, Zimmerman M, Aabakken L, Tarnasky PR, Cunnigham JT, van Velse A, Hawes RH, Hoffman BJ. Prospective assessment of the ability of endoscopic ultrasound to diagnose, exclude, or establish the severity of chronic pancreatitis found by endoscopic retrograde cholangiopancreatography. Gastrointest Endosc 1998; 48: 18-25
9 Wallace MB, Hawes RH, Durkalski V, Chak A, Mallory S, Catalano MF, Wiersema MJ, Bhutani MS, Ciaccia D, Kochman ML, Gress FG, Van Velse A, Hoffman BJ. The reliability of EUS for the diagnosis of chronic pancreatitis: interobserver agreement among experienced endosonographers. Gastrointest Endosc 2001; 53: 294-299
10 Stevens T, Zuccaro G Jr, Dumot JA, Vargo JJ, Parsi MA, Lopez R, Kirchner HL, Purich E, Conwell DL. Prospective comparison of radial and linear endoscopic ultrasound for diagnosis of chronic pancreatitis. Endoscopy 2009; 41: 836-841
11 Heij HA, Obertop H, van Blankenstein M, ten Kate FW, Westbrook DL. Relationship between functional and histological changes in chronic pancreatitis. Dig Dis Sci 1986; 31: 1009-1013
12 Stevens T, Dumot JA, Zuccaro G Jr, Vargo JJ, Parsi MA, Lopez R, Kirchner HL, Purich E, Conwell DL. Evaluation of duct-cell and acinar-cell function and endosonographic abnormalities in patients with suspected chronic pancreatitis. Clin Gastroenterol Hepatol 2009; 7: 114-119
13 Stevens T, Conwell DL, Zuccaro G Jr, Vargo JJ, Dumot JA, Lopez R. Comparison of endoscopic ultrasound and endoscopic retrograde pancreatography for the prediction of pancreatic exocrine insufficiency. Dig Dis Sci 2008; 53: 1146-1151
14 Conwell DL, Zuccaro G, Purich E, Fein S, Vargo JJ, Dumot JA, VanLente F, Lopez R, Trofill P. Comparison of endoscopic ultrasound chronic pancreatitis criteria to the endoscopic secretin-stimulated pancreatic function test. Dig Dis Sci 2007; 52: 1206-1210
15 Catalano MF, Lahoti S, Alcocer E, Geenen JE, Hogan WJ. Dynamic imaging of the pancreas using real-time endoscopic ultrasonography with secretin stimulation. Gastrointest Endosc 1998; 48: 580-587
16 Kahl S, Glasbrenner B, Leodolter A, Press M, Schulz HJ, Malfertheiner P. EUS in the diagnosis of early chronic pancreatitis: a prospective follow-up study. Gastrointest Endosc 2002; 55: 507-511
17 Hastier P, Buckley MJ, Francois E, Peten EP, Dumas R, Caroli-Bosc FX, Delmont JP. A prospective study of pancreatic disease in patients with alcoholic cirrhosis: comparative diagnostic value of ERCP and EUS and long-term significance of isolated parenchymal abnormalities. Gastrointest Endosc 1999; 49: 705-709
18 Miyakawa H, Suga T, Okamura K. Usefulness of endoscopic ultrasonography for the diagnosis of chronic pancreatitis. J Gastroenterol 2007; 42 Suppl 17: 85-89
19 Sahai AV, Mishra G, Penman ID, Williams D, Wallace MB, Hadzijahic N, Pearson A, Vanvelse A, Hoffman BJ, Hawes RH. EUS to detect evidence of pancreatic disease in patients with persistent or nonspecific dyspepsia. Gastrointest Endosc 2000; 52: 153-159
20 Gardner TB, Janec EM, Gordon SR. Relationship between patient symptoms and endoscopic findings in chronic pancreatitis. Pancreatology 2009; 9: 398-403
21 Sahai AV. EUS and chronic pancreatitis. Gastrointest Endosc 2006; 57: S76-S81
22 Bhutani MS, Arantes VN, Verma D, Moezzi J, Suryaprasad S, Kapadia AS, Gopalaswamy N. Histopathologic correlation of endoscopic ultrasound findings of chronic pancreatitis in human autopsies. Pancreas 2009; 38: 820-824
23 Zimmermann MJ, Mishra G, Lewin DN, Hawes RH, Coyle W, Adams DA, Hoffman B. Comparison of EUS findings with histopathology in chronic pancreatitis. Gastrointest Endosc 1997; 45: AB185
24 Varadarajulu S, Eltoum I, Tamhane A, Eloubeidi MA. Histopathologic correlates of nonalcoholic chronic pancreatitis by EUS: a prospective tissue characterization study. Gastrointest Endosc 2007; 66: 501-509
25 Chong AK, Hawes RH, Hoffman BJ, Adams DB, Lewin DN, Romaguero J. Diagnostic performance of EUS for chronic pancreatitis: a comparison with histopathology. Gastrointest Endosc 2007; 65: 808-814
26 Pungpapong S, Wallace MB, Woodward TA, Noh KW, Raimondo M. Accuracy of endoscopic ultrasonography and magnetic resonance cholangiopancreatography for the diagnosis of chronic pancreatitis: a prospective comparison study. J Clin Gastroenterol 2007; 41: 88-93
27 Wallace MB. Chronic pancreatitis. Gastrointest Endosc 2009; 69: S17-S120
28 Kubota K, Kato S, Akiyama T, Fujita K, Yoneda M, Takanashi H, Ogawa M, Inamori M, Abe Y, Kikikoshi H, Kobayashi N, Suito S, Hisatomy K, Matsuhashi N, Nakajima A. A proposal for differentiation between early- and advanced-stage autoimmune pancreatitis by endoscopic ultrasonography. Dig Endosc 2009; 21: 162-169
29 Hoki N, Mizuno N, Sawaki A, Tajika M, Takayama R, Shimizu Y, Bhatia V, Yamao K. Diagnosis of autoimmune pancreatitis using endoscopic ultrasonography. J Gastroenterol 2009; 44: 154-159
30 Deshpande V, Mino-Kenudson M, Brugge WR, Pitman MB, Fernandez-del Castillo C, Warshaw AL, Lauwers GY. Endoscopic ultrasound guided fine needle aspiration biopsy
of autoimmune pancreatitis: diagnostic criteria and pitfalls. Am J Surg Pathol 2005; 29: 1464-1471

Mizuno N, Bhatia V, Hosoda W, Sawaki A, Hoki N, Haru K, Takagi T, Ko SB, Yatabe Y, Goto H, Yamao K. Histological diagnosis of autoimmune pancreatitis using EUS-guided trucut biopsy: a comparison study with EUS-FNA. J Gastroenterol 2009; 44: 742-750

Iríssawa A, Katakura K, Ohira H, Sato A, Bhutani MS, Hernandez LV, Koizumi M. Usefulness of endoscopic ultrason sound to diagnose the severity of chronic pancreatitis. J Gastroenterol 2007; 42 Suppl 17: 90-94

Catalano MF, Sahai A, Levy M, Romagnuolo J, Wiersema M, Brugge W, Freeman M, Yamao K, Canto M, Hernandez LV. EUS-based criteria for the diagnosis of chronic pancreatitis: the Rosemont classification. Gastrointest Endosc 2009; 69: 1251-1261

Hernandez LV, Sahai A, Brugge WR, Wiersema MJ, Catalano MF. Standardized weighted criteria for EUS features of chronic pancreatitis: the Rosemont classification. Gastrointest Endosc 2006; 67: A296-A297

Catalano MF, Hernandez LV, Kaul V, Guda NM, Pezanoski JP, Guda NM, Ramasamy D, Samavedy R, Geenen JE. EUS diagnosis of chronic pancreatitis: comparison of the current criteria vs the new “Rosemont criteria” developed by an international consensus conference. Gastrointest Endosc 2008; 67: AB215

Catalano MF, Kaul V, Hernandez LV, Pezanoski JP, Guda NM, Ramasamy D, Samavedy R, Geenen JE. Diagnosis of chronic pancreatitis (CP) by endoscopic ultrasonography (EUS) - radial vs. linear endosonography (EUS). Gastrointest Endosc 2008; 67: AB208

Stevens T, Lopez R, Adler DG, Al-Haddad MA, Conway J, Dewitt JM, Formskorg CE, Kahaleh M, Lee LS, Levy MJ, Mishra G, Piraka CR, Papachristou GI, Shah RJ, Topazian MD, Venclovas CE, Wilkens RL, Wolfe JH, Yamao K, Yamao K, Venclovas CE, Wilkens RL, Wolfe JH, Yamao K, Yamao K, Venclovas CE, Wilkens RL, Wolfe JH, Yamao K. Multicenter comparison of the interobserver agreement of standard EUS scoring and Rosemont classification scoring for diagnosis of chronic pancreatitis. Gastrointest Endosc 2011; 74: 519-526

Hollerbach S, Klammann A, Topalidis T, Schmiegel WH. Endoscopic ultrasonography (EUS) and fine-needle aspiration (FNA) cytology for diagnosis of chronic pancreatitis. Endoscopy 2001; 33: 824-831

DeWitt J, McGreevy K, LeBlanc J, McHenry L, Cummings O, Sherman S. EUS-guided Trucut biopsy of suspected non-focal chronic pancreatitis. Gastrointest Endosc 2005; 62: 76-84

Levy MJ, Reddy RP, Wiersema MJ, Smyrk TC, Clain JE, Harewood GC, Pearson RK, Rajan E, Topazian MD, Yassa M, Te, Chari ST, Petersen BT. EUS-guided trucut biopsy in establishing autoimmune pancreatitis as the cause of obstructive jaundice. Gastrointest Endosc 2005; 61: 467-472

Janssen J, Schöldner E, Greiner L. EUS elastography of the pancreas: feasibility and pattern description of the normal pancreas, chronic pancreatitis, and focal pancreatic lesions. Gastrointest Endosc 2007; 65: 971-978

Micames CG, Gress FG. EUS elastography: a step ahead? Gastrointest Endosc 2007; 65: 979-981

Sáftoiu A, Vilmann P, Gorunescu F, Gheonea DI, Gorunescu M, Ciurea T, Popescu GL, Iordache A, Hassan H, Iordache S. Neural network analysis of dynamic sequences of EUS elastography used for the differential diagnosis of chronic pancreatitis and pancreatic cancer. Gastrointest Endosc 2008; 68: 1086-1094

Giovannini M, Thomas B, Erwan B, Christian P, Fabrice C, Benjamin E, Geneviève M, Paolo A, Pierre D, Robert Y, Walter S, Hanz S, Carl S, Christoph D, Pierre E, Jean-Luc VL, Jacques D, Peter V, Andrian S. Endoscopic ultrasound elastography for evaluation of lymph nodes and pancreatic masses: a multicenter study. World J Gastroenterol 2009; 15: 1587-1593

Hirche TO, Ignee A, Barreiros AP, Schreiber-Dietrich D, Jungblut S, Ott M, Hirche H, Dietrich CF. Indications and limitations of endoscopic ultrasound elastography for evaluation of focal pancreatic lesions. Endoscopy 2008; 40: 910-917

Dietrich CF, Hirche TO, Ott M, Ignee A. Real-time tissue elastography in the diagnosis of autoimmune pancreatitis. Endoscopy 2009; 41: 718-720

Hocke M, Schulze E, Gottschalk P, Topalidis T, Dietrich CF. Contrast-enhanced endoscopic ultrasound in discrimination between focal pancreatitis and pancreatic cancer. World J Gastroenterol 2006; 12: 246-250

Dietrich CF, Ignee A, Braden B, Barreiros AP, Ott M, Hocke M. Improved differentiation of pancreatic tumors using contrast-enhanced endoscopic ultrasound. Clin Gastroenterol Hepatol 2008; 6: 590-597.e1

Kitano M, Sakamoto H, Matsu T, Iyo Y, Maekawa K, von Schrenk T, Kudo M. A novel perfusion imaging technique of the pancreas: contrast-enhanced harmonic EUS (with video). Gastrointest Endosc 2008; 67: 141-150

Seicean A, Badea R, Stan-Iuga R, Gulei I, Pop T, Pasco U. The added value of real-time harmonics contrast-enhanced endoscopic ultrasonography for the characterisation of pancreatic diseases in routine practice. J Gastrointestin Liver Dis 2010; 19: 99-104

Fritscher-Ravens A, Brand L, Knöffel WT, Bobrowisc C, Topalidis T, Thonke F, de Werth A, Soehendra N. Comparison of endoscopic ultrasound-guided fine needle aspiration for focal pancreatic lesions in patients with normal parenchyma and chronic pancreatitis. Am J Gastroenterol 2002; 97: 2768-2775

Barthet M, Portal I, Boujaoude J, Bernard JP, Sahel J. Endoscopic ultrasonographic diagnosis of pancreatic cancer complicating chronic pancreatitis. Endoscopy 1996; 28: 487-491

Ardehgh JC, Lopes CV, Campos AD, Pereira de Lima LF, Venc Q, Módena JL. Endoscopic ultrasound and fine needle aspiration in chronic pancreatitis: differential diagnosis between pseudotumoral masses and pancreatic cancer. JOP 2007; 8: 413-421

Varadarajulu S, Tamhane S, Eloubeidi MA. Yield of EUS-guided FNA of pancreatic masses in the presence or the absence of chronic pancreatitis. Gastrointest Endosc 2005; 62: 728-736; quiz 751, 753

Krishna NB, Mehra M, Reddy AV, Agrawal A. EUS/EUS-FNA for suspected pancreatic cancer: influence of chronic pancreatitis and clinical presentation with or without obstructive jaundice on performance characteristics. Gastrointest Endosc 2009; 70: 70-79

Eloubeidi MA, Varadarajulu S, Desai S, Wilcox CM. Value of repeat endoscopic ultrasound-guided fine needle aspiration for suspected pancreatic cancer. J Gastroenterol Hepatol 2008; 23: 567-570

Khalid A, Nodit L, Zaidh M, Bauer K, Brody D, Finkelstein SD, McGrath KM. Endoscopic ultrasound fine needle aspiration DNA analysis to differentiate malignant and benign pancreatic masses. Am J Gastroenterol 2006; 101: 2493-2500

Salek C, Bozevska L, Zavoral M, Nosek V, Kasperlova L, Ryska M, Strnad R, Traboulsi E, Minarik M. Evaluation of clinical relevance of examining K-ras, p16 and p53 mutations along with allelic losses at 9p and 18q in EUS-guided fine needle aspiration samples of patients with chronic pancreatitis and pancreatic cancer. World J Gastroenterol 2007; 13: 3714-3720

Bournet B, Souque A, Sesnese P, Assenat E, Barthet M, Tesarv P, Auby A, Toole D, Hammel P, Levy P, Russ-niewsky P, Bouisson M, Escourrou J, Cordelier P, Buscall L. Endoscopic ultrasound-guided fine-needle aspiration biopsy coupled with KRAS mutation assay to distinguish pancreatic cancer from pseudotumoral chronic pancreatitis. Endoscopy 2009; 41: 552-557

Löhr M, Kloppeg G, Maisonneuve P, Lowenfelds AL, Lütjens J. Frequency of K-ras mutations in pancreatic intraductal neoplasias associated with pancreatic ductal adenocarcinoma.
and chronic pancreatitis: a meta-analysis. Neoplasia 2005; 7: 17-23
61 Michaels AJ, Draganov PV. Endoscopic ultrasonography guided celiac plexus neuromylysis and celiac plexus block in the management of pain due to pancreatic cancer and chronic pancreatitis. World J Gastroenterol 2007; 13: 3575-3580
62 Gress F, Schmitt C, Sherman S, Ikenberry S, Lehman G. A prospective randomized comparison of endoscopic ultrasound- and computed tomography-guided celiac plexus block for managing chronic pancreatitis. Am J Gastroenterol 1999; 94: 900-905
63 Levy M, Rajan E, Keeny G, Fletcher JG, Topazian M. Neurorl ganglia visualized by endoscopic ultrasound. Am J Gastroenterol 2006; 101: 1787-1791
64 LeBlanc JK, DeWitt J, Johnson C, Okumw W, McGreevy G, Symms M, McHenry L, Sherman S, Imperiale T. A prospective randomized trial of 1 versus 2 injections during EUS-guided celiac plexus block for chronic pancreatitis. Gastrointest Endosc 2009; 69: 835-842
65 Santosh D, Lakhatia S, Gupta R, Reddy DN, Rao GV, Tandan M, Ramachandani M, Guda NM. Clinical trial: a randomized trial comparing fluoroscopy guided percutaneous technique vs. endoscopic ultrasound guided technique of coeliac plexus block for treatment of pain in chronic pancreatitis. Aliment Pharmacol Ther 2009; 29: 979-984
66 Sahai AV, Lemelin V, Lam E, Paquin SC. Central vs. bilateral endoscopic ultrasound-guided celiac plexus block or neurolysis: a comparative study of short-term effectiveness. Am J Gastroenterol 2009; 104: 326-329
67 Sahai AV, Wyse J. EUS-guided celiac plexus block for chronic pancreatitis: a placebo-controlled trial should be the first priority. Gastrointest Endosc 2010; 71: 430-431; author reply 431
68 Levy MJ, Topazian MD, Wiersema MJ, Clain JE, Rajan E, Wong K, de la Mora JG, Gleeson FC, Pearson RK, Pelaez MC, Petersen BT, Vege SS, Chari ST. Initial evaluation of the efficacy and safety of endoscopic ultrasound-guided direct Ganglia neurolysis and block. Am J Gastroenterol 2008; 103: 98-103
69 Gress F, Schmitt C, Sherman S, Ciaccia D, Ikenberry S, Lehman G. Endoscopic ultrasound-guided celiac plexus block for managing abdominal pain associated with chronic pancreatitis: a prospective single center experience. Am J Gastroenterol 2001; 96: 409-416
70 Kaufman M, Singh G, Das S, Concha-Parra R, Erber J, Michaels C, Gress F. Efficacy of endoscopic ultrasound-guided celiac plexus block and celiac plexus neurolysis for managing abdominal pain associated with chronic pancreatitis and pancreatic cancer. J Clin Gastroenterol 2010; 44: 127-134
71 Puli SR, Reddy JB, Bechtold ML, Antillon MR, Brugge WR. EUS-guided celiac plexus neurolysis for pain due to chronic pancreatitis or pancreatic cancer pain: a meta-analysis and systematic review. Dig Dis Sci 2009; 54: 2330-2337
72 O'Toole TM, Schmulewitz N. Complication rates of EUS-guided celiac plexus blockade and neurolysis: results of a large case series. Endoscopy 2009; 41: 593-597
73 Raj M, Chen RY. Interventional applications of endoscopic ultrasond. J Gastroenterol Hepatol 2006; 21: 348-357
74 Aghdassi A, Mayerle J, Kraft M, Sielenkämper AW, Heidecke CD, Lerch MM. Diagnosis and treatment of pancreatic pseudocysts in chronic pancreatitis. Pancreas 2008; 36: 105-112
75 Bhattacheraya D, Amorini BJ. Minimally invasive approaches to the management of pancreatic pseudocysts: review of the literature. Surg Laparosc Endosc Percutan Tech 2003; 13: 141-148
76 Vosoghi M, Sial S, Barrett B, Feng J, Lee T, Stabile BE, Eyselien VE. EUS-guided pancreatic pseudocyst drainage: review and experience at Harbor-UCLA Medical Center. MedGenMed 2002; 4: 2
77 Barthet M, Bugallo M, Moreira LS, Bastid C, Sastre B, Sahel J, Management of cysts and pseudocysts complicating chronic pancreatitis. A retrospective study of 143 patients. Gastroenterol Clin Biol 1993; 17: 270-276
78 Smits ME, Rauws EA, Tytgat GN, Huibregtse K. The efficacy of endoscopic treatment of pancreatic pseudocysts. Gastrointest Endosc 1995; 42: 202-207
79 Binmoeller KF, Feiert H, Walter A, Soehendra N. Transpapillary and transmural drainage of pancreatic pseudocysts. Gastrointest Endosc 1995; 42: 219-224
80 Giovannini M, Bernardini D, Seitz JF. Cystogastrostomy entirely performed under endosonography guidance for pancreatic pseudocyst: results in six patients. Gastrointest Endosc 1998; 48: 200-203
81 Seewald S, Ang TL, Kida M, Teng KY, Soehendra N. EUS 2008 Working Group document: evaluation of EUS-guided drainage of pancreatic-fluid collections (with videos). Gastrointest Endosc 2009; 69: S13-S21
82 Varadarajulu S, Lopes TL, Wilcox CM, Drellichman ER, Kilgore ML, Christen JD. EUS versus surgical cyst-gastrostomy for management of pancreatic pseudocysts. Gastrointest Endosc 2008; 68: 649-655
83 Kaehler M, Shami VM, Conaway MR, Tokar J, Rockoff T, De La Rue SA, De Lange E, Bassignani M, Gay S, Adams RB, Yeaton P. Endoscopic ultrasound drainage of pancreatic pseudocyst: a prospective comparison with conventional endoscopic drainage. Endoscopy 2006; 38: 335-359
84 Varadarajulu S, Wilcox CM, Thamhane A, Eloubeidi MA, Blackley J, Canon CL. Role of EUS in drainage of peripancreatic fluid collections not amenable for endoscopic transmural drainage. Gastrointest Endosc 2007; 66: 1107-1119
85 Varadarajulu S, Christen JD, Thamhane A, Drellichman ER, Wilcox CM. Prospective randomized trial comparing EUS and EGD for transmural drainage of pancreatic pseudocysts (with videos). Gastrointest Endosc 2008; 68: 1102-1111
86 Park DH, Lee SS, Moon SH, Choi SY, Jung SW, Seo DW, Lee SK, Kim MH. Endoscopic ultrasound-guided versus conventional transmural drainage for pancreatic pseudocysts: a prospective randomized trial. Endoscopy 2009; 41: 842-848
87 Kaehler M, Shami VM, Conaway MR, Tokar J, Rockoff T, De La Rue SA, De Lange E, Bassignani M, Gay S, Adams RB, Yeaton P. Endoscopic ultrasound drainage of pancreatic pseudocyst: a prospective comparison with conventional endoscopic drainage. Endoscopy 2006; 38: 335-359
88 Barteth M, Lamblin G, Gasmi M, Vittin V, Desjeux A, Grimaud JC. Clinical usefulness of a treatment algorithm for pancreatic pseudocysts. Gastrointest Endosc 2008; 67: 245-252
89 Will U, Wegener C, Graf KJ, Wanzar I, Manger T, Meyer F. Differential treatment and early outcome in the interventional endoscopic management of pancreatic pseudocysts in 27 patients. World J Gastroenterol 2006; 12: 4175-4178
90 Hooley LC, Debroux S, Delhaye M, Arvanitakis M, Le Moine O, Deviere J. Endoscopic drainage of pancreatic-fluid collections in 116 patients: a comparison of etiologies, drainage techniques, and outcomes. Gastrointest Endosc 2006; 63: 635-643
91 Ahlawat SK, Charabaty-Pishvaian A, Jackson PG, Haddad NG. Single-step EUS-guided pancreatic pseudocyst drainage using a large channel linear array echoendoscope and cystostome: results in 11 patients. JOP 2006; 7: 616-624
92 McKay C, Denley S, Carter R. One-step, EUS-guided drainage of pancreatic pseudocysts. Experience in 52 patients. Gastrointest Endosc 2008; 67: A1226
93 Krüger M, Schneider AS, Manns MP, Meier PN. Endoscopic management of pancreatic pseudocysts or abscesses after an EUS-guided 1-step procedure for initial access. Gastrointest Endosc 2006; 63: 409-416
94 Lopes CV, Pesenti C, Bories E, Caillol F, Giovannini M. Endoscopic-ultrasound-guided endoscopic transmural drainage of pancreatic pseudocysts and abscesses. Stand J Gastroenterol 2007; 42: 524-529
Azar RR, Oh YS, Janalagadda SS, Edmundowicz SA. Wire-guided pancreatic pseudocyst drainage by using a modified needle knife and therapeutic echoendoscope. *Gastrointest Endosc* 2006; 63: 688-692

Antillon MR, Shah RJ, Stiegmann G, Chen YK. Single-step EUS-guided transmural drainage of simple and complicated pancreatic pseudocysts. *Gastrointest Endosc* 2006; 63: 797-803

Reddy DN, Gupta R, Lakhtakia S, Jalal PK, Rao GV. Use of a novel transluminal balloon accessotome in transmural drainage of pancreatic pseudocyst (with video). *Gastrointest Endosc* 2008; 68: 362-365

Seewald S, Thonke F, Ang TL, Omar S, Seitz U, Groth S, Zhong Y, Yekebas E, Izbicki J, Soehendra N. One-step, simultaneous double-wire technique facilitates pancreatic pseudocyst and abscess drainage (with videos). *Gastrointest Endosc* 2006; 64: 805-808

Voermans RP, Eisendrath P, Bruno MJ, Le Moine O, Devière J, Fockens P. Initial evaluation of a novel prototype forward-viewing US endoscope in transmural drainage of pancreatic pseudocysts (with videos). *Gastrointest Endosc* 2007; 66: 1013-1017

Varadarajulu S, Tamhane A, Blakely J. Graded dilation technique for EUS-guided drainage of peripancreatic fluid collections: an assessment of outcomes and complications and technical proficiency (with video). *Gastrointest Endosc* 2008; 68: 656-666

Ginès A, Varadarajulu S, Napoleon B. EUS 2008 Working Group document: evaluation of EUS-guided pancreatic-duct drainage (with video). *Gastrointest Endosc* 2009; 69: S43-S48

Tessier G, Bories E, Arvanitakis M, Hittelet A, Pesenti C, Le Moine O, Giovannini M, Devière J. EUS-guided pancreaticogastrostomy and pancreatobulbostomy for the treatment of pain in patients with pancreatic ductal dilatation inaccessible for transpapillary endoscopic therapy. *Gastrointest Endosc* 2007; 66: 253-261

Kahaleh M, Hernandez AJ, Tokar J, Adams RB, Shami VM, Yeaton P. EUS-guided pancreaticogastrostomy: analysis of its efficacy to drain inaccessible pancreatic ducts. *Gastrointest Endosc* 2007; 66: 224-230

Will U, Fueldner F, Thieme AK, Goldmann B, Gerlach R, Wanzar I, Meyer F. Transgastric pancreatography and EUS-guided drainage of the pancreatic duct. *J Hepatobiliary Pancreat Surg* 2007; 14: 377-382

Mallery S, Matlock J, Freeman ML. EUS-guided rendezvous drainage of obstructed biliary and pancreatic ducts: Report of 6 cases. *Gastrointest Endosc* 2004; 59: 100-107

Seicean A. Endoscopic ultrasound in chronic pancreatitis